Nova Documentation

Release 32.1.0.dev222

OpenStack Foundation

Feb 06, 2026

CONTENTS

CHAPTER

ONE

WHAT IS NOVA?

Nova is the OpenStack project that provides a way to provision compute instances (aka virtual servers). Nova supports creating virtual machines, baremetal servers (through the use of ironic), and has limited support for system containers. Nova runs as a set of daemons on top of existing Linux servers to provide that service.

It requires the following additional OpenStack services for basic function:

- Keystone: This provides identity and authentication for all OpenStack services.
- Glance: This provides the compute image repository. All compute instances launch from glance images.
- Neutron: This is responsible for provisioning the virtual or physical networks that compute instances connect to on boot.
- Placement: This is responsible for tracking inventory of resources available in a cloud and assisting in choosing which provider of those resources will be used when creating a virtual machine.

It can also integrate with other services to include: persistent block storage, encrypted disks, and baremetal compute instances.

CHAPTER

TWO

FOR END USERS

As an end user of nova, youll use nova to create and manage servers with either tools or the API directly.

2.1 User Documentation

The OpenStack Compute service allows you to control an Infrastructure-as-a-Service (IaaS) cloud computing platform. It gives you control over instances and networks, and allows you to manage access to the cloud through users and projects.

Compute does not include virtualization software. Instead, it defines drivers that interact with underlying virtualization mechanisms that run on your host operating system, and exposes functionality over a web-based API.

2.1.1 End user guide

2.1.1.1 Availability zones

Availability Zones are an end-user visible logical abstraction for partitioning a cloud without knowing the physical infrastructure. Availability zones can be used to partition a cloud on arbitrary factors, such as location (country, datacenter, rack), network layout and/or power source. Because of the flexibility, the names and purposes of availability zones can vary massively between clouds.

In addition, other services, such as the networking service and the block storage service, also provide an availability zone feature. However, the implementation of these features differs vastly between these different services. Consult the documentation for these other services for more information on their implementation of this feature.

Tip

Server Groups provide another mechanism for configuring the colocation of instances during scheduling. For more information, refer to *Server Groups*.

Usage

Availability zones can only be created and configured by an admin but they can be used by an end-user when creating an instance. For example:

```
$ openstack server create --availability-zone ZONE ... SERVER
```

It is also possible to specify a destination host and/or node using this command; however, this is an admin-only operation by default. For more information, see *Using availability zones to select hosts*.

2.1.1.2 Security Groups

Security groups are sets of IP filter rules that are applied to all servers, which define networking access to the server. Group rules are project-specific; project members can edit the default rules for their group and add new rule sets.

All projects have a `default` security group which is applied to any port that has no other security group defined. Unless you change the default, this security group denies all incoming traffic and allows only outgoing traffic from your instance.

Its important to note early on that security groups and their quota are resources of the networking service, Neutron. They are modelled as an attribute of ports rather than servers. With this said, Nova provides utility APIs that allow users to add and remove security groups from all ports attached to a server. In addition, it is possible to specify security groups to configure for newly created ports when creating a new server, and to retrieve the combined set of security groups for all ports attached to a server.

Note

Nova previously provided its own security group APIs. These were proxy APIs for Neutron APIs and have been deprecated since microversion 2.36.

Usage

Security group-related operations can be broken down into three categories: operations on security groups and security group rules themselves, operations on ports, and operations on servers.

Security group and security group rule operations

By default, security groups can be created by any project member. For example:

```
$ openstack security group create --description <description> ... <name>
```

Tip

When adding a new security group, you should pick a descriptive but brief name. This name shows up in brief descriptions of the servers that use it where the longer description field often does not. For example, seeing that a server is using security group `http` is much easier to understand than `bobs_group` or `secgrp1`.

Security groups are really only containers for rules. Security group rules define the actual IP filter rules that will be applied. Security groups deny everything by default, so rules indicate what is allowed. Typically, a security group rule will be configured with the following attributes: an IP protocol (one of ICMP, TCP, or UDP), a destination port or port range, and a remote IP range (in CIDR format). You create security group rules by specifying these attributes and the security group to which the rules should be added. For example:

```
$ openstack security group rule create \
    --protocol <protocol> --dst-port <port-range> \
    --remote-ip <ip-address> \
    <group>
```

Note

The <port-range> argument takes the form of port or from-port:to-port. This specifies the range of local ports that connections are allowed to access, **not** the source and destination ports of the connection.

Alternatively, rather than specifying a remote IP range, you can specify a remote security group. A remote group will allow requests with the specified protocol(s) and port(s) from any server with said port. If you create a security group rule with remote group foo and apply the security group to server bar, bar will be able to receive matching traffic from any other server with security group foo. Security group rules with remote security groups are created in much the same way as security group rules with remote IPs. For example:

```
$ openstack security group rule create \
    --protocol <protocol> --dst-port <port-range> \
    --remote-group <remote-group> \
    <group>
```

Once created, both security groups and security group rules can be listed. For example:

```
$ openstack security group list
$ openstack security group rule list <group>
```

Likewise, you can inspect an individual security group or security group rule. For example:

```
$ openstack security group show <group>
$ openstack security group rule show <group> <rule>
```

Finally, you can delete security groups. This will delete both the security group and associated security group rules. For example:

```
$ openstack security group delete <group>
```

Alternatively, you can delete individual rules from an existing group. For example:

```
$ openstack security group rule delete <rule>
```

Port operations

Security groups are an attribute of ports. By default, Neutron will assign the default security group to all newly created ports. It is possible to disable this behavior. For example:

```
$ openstack port create --no-security-group ... <name>
```

It is possible to specify different security groups when creating a new port. For example:

```
$ openstack port create --security-group <group> ... <name>
```

Note

If you specify a security group when creating the port, the `default` security group **will not** be added to the port. If you wish to add the `default` security group, you will need to specify this also.

Additional security groups can also be added or removed from existing ports. For example:

```
$ openstack port set --security-group <group> ... <port>
$ openstack port unset --security-group <group> ... <port>
```

It is also possible to remove all security groups from a port. For example:

```
$ openstack port set --no-security-group <port>
```

Server operations

It is possible to manipulate and configure security groups on an server-wide basis. When you create a new server, networks can be either automatically allocated (a feature known as Get me a network) or manually configured. In both cases, attaching a network to a server results in the creation of a port. It is possible to specify one or more security groups to assign to these ports. For example:

```
$ openstack server create --security-group <group> ... <name>
```

Important

These security groups will only apply to automatically created ports. They will not apply to any pre-created ports attached to the server at boot. If no security group is specified, the `default` security group for the current project will be used. It is not possible to specify that no security group should be applied to automatically created ports. If you wish to remove the `default` security group from a servers ports, you will need to use pre-created ports or remove the security group after the server has been created.

Once a server has been created, it is possible to add or remove a security group from all ports attached to the server. For example:

```
$ openstack server add security group <server> <group>
$ openstack server remove security group <server> <group>
```

Note

Unless customised, the `default` security group allows egress traffic from the server. If you remove this group and do not allow egress traffic via another security group, your server will no longer be able to communicate with the *metadata service*.

It is also possible to view the security groups associated with a server. For example:

```
$ openstack server show -f value -c security_groups
```

Important

As security groups are an attribute of ports rather than servers, this value is the combined set of security groups assigned to all ports. Different ports may have different sets of security groups. You can inspect the port with `openstack port show` to see the exact security groups assigned to an individual port.

Example

Lets look through a worked example of creating security groups for a deployment of 3 web server hosts and 2 database hosts. First, well configure the security group that will allow HTTP traffic to the web server hosts.

```
$ openstack security group create \
    --description "Allows Web traffic anywhere on the Internet." \
    web
+-----------------+-----------------------------------------------------------
↪-----------------------------------------------------------+
| Field           | Value                                                     ␣
↪                                                          |
+-----------------+-----------------------------------------------------------
↪-----------------------------------------------------------+
| created_at      | 2016-11-03T13:50:53Z                                      ␣
↪                                                          |
| description     | Allows Web traffic anywhere on the Internet.              ␣
↪                                                          |
| headers         |                                                           ␣
↪                                                          |
| id              | c0b92b20-4575-432a-b4a9-eaf2ad53f696                      ␣
↪                                                          |
| name            | web                                                       ␣
↪                                                          |
| project_id      | 5669caad86a04256994cdf755df4d3c1                          ␣
↪                                                          |
| project_id      | 5669caad86a04256994cdf755df4d3c1                          ␣
↪                                                          |
| revision_number | 1                                                         ␣
↪                                                          |
| rules           | created_at='2016-11-03T13:50:53Z', direction='egress',␣
↪ethertype='IPv4', id='4d8cec94-e0ee-4c20-9f56-8fb67c21e4df',      |
|                 | project_id='5669caad86a04256994cdf755df4d3c1', revision_
↪number='1', updated_at='2016-11-03T13:50:53Z'                     |
|                 | created_at='2016-11-03T13:50:53Z', direction='egress',␣
↪ethertype='IPv6', id='31be2ad1-be14-4aef-9492-ecebede2cf12',      |
|                 | project_id='5669caad86a04256994cdf755df4d3c1', revision_
↪number='1', updated_at='2016-11-03T13:50:53Z'                     |
| updated_at      | 2016-11-03T13:50:53Z                                      ␣
↪                                                          |
+-----------------+-----------------------------------------------------------
↪-----------------------------------------------------------+
```

Once created, we can add a new group rule to allow ingress HTTP traffic on port 80:

```
$ openstack security group rule create \
    --protocol tcp --dst-port 80:80 --remote-ip 0.0.0.0/0 \
    web
+-------------------+--------------------------------------+
| Field             | Value                                |
+-------------------+--------------------------------------+
| created_at        | 2016-11-06T14:02:00Z                 |
| description       |                                      |
| direction         | ingress                              |
| ethertype         | IPv4                                 |
| headers           |                                      |
| id                | 2ba06233-d5c8-43eb-93a9-8eaa94bc9eb5 |
| port_range_max    | 80                                   |
| port_range_min    | 80                                   |
| project_id        | 5669caad86a04256994cdf755df4d3c1     |
| project_id        | 5669caad86a04256994cdf755df4d3c1     |
| protocol          | tcp                                  |
| remote_group_id   | None                                 |
| remote_ip_prefix  | 0.0.0.0/0                            |
| revision_number   | 1                                    |
| security_group_id | c0b92b20-4575-432a-b4a9-eaf2ad53f696 |
| updated_at        | 2016-11-06T14:02:00Z                 |
+-------------------+--------------------------------------+
```

You can create complex rule sets by creating additional rules. In this instance we want to pass both HTTP and HTTPS traffic so well add an additional rule:

```
$ openstack security group rule create \
    --protocol tcp --dst-port 443:443 --remote-ip 0.0.0.0/0 \
    web
+-------------------+--------------------------------------+
| Field             | Value                                |
+-------------------+--------------------------------------+
| created_at        | 2016-11-06T14:09:20Z                 |
| description       |                                      |
| direction         | ingress                              |
| ethertype         | IPv4                                 |
| headers           |                                      |
| id                | 821c3ef6-9b21-426b-be5b-c8a94c2a839c |
| port_range_max    | 443                                  |
| port_range_min    | 443                                  |
| project_id        | 5669caad86a04256994cdf755df4d3c1     |
| project_id        | 5669caad86a04256994cdf755df4d3c1     |
| protocol          | tcp                                  |
| remote_group_id   | None                                 |
| remote_ip_prefix  | 0.0.0.0/0                            |
| revision_number   | 1                                    |
| security_group_id | c0b92b20-4575-432a-b4a9-eaf2ad53f696 |
| updated_at        | 2016-11-06T14:09:20Z                 |
+-------------------+--------------------------------------+
```

Note

Despite only outputting the newly added rule, this operation is additive (both rules are created and enforced).

Thats one security group wrapped up. Next, the database hosts. These are running MySQL and we would like to both restrict traffic to the relevant port (`3306` in this case) **and** to restrict ingress traffic to requests from the web server hosts. While we could specify a CIDR for the IP addresses of the web servers, a preferred solution is to configure a source group. This will allow us to dynamically add and remove web server hosts with the `web` security group applied without needing to modify the security group for the database hosts. Lets create the security group and the necessary rule:

```
$ openstack security group create database
$ openstack security group rule create \
    --protocol tcp --dst-port 3306 --remote-group web \
    database
```

The `database` rule will now allows access to MySQLs default port from any server that uses the `web` group.

Now that weve created the security group and rules, lets list them to verify everything:

```
$ openstack security group list
+--------------------------------------+----------+-------------+
| Id                                   | Name     | Description |
+--------------------------------------+----------+-------------+
| 73580272-d8fa-4927-bd55-c85e43bc4877 | default  | default     |
| c0b92b20-4575-432a-b4a9-eaf2ad53f696 | web      | web server  |
| 40e1e336-e207-494f-a3ec-a3c222336b22 | database | database    |
+--------------------------------------+----------+-------------+
```

We can also inspect the rules for the security group. Lets look at the `web` security group:

```
$ openstack security group rule list web
+--------------------------------------+-------------+-----------+------------
↪-----+-----------------------+
| ID                                   | IP Protocol | IP Range  | Port Range␣
↪     | Remote Security Group |
+--------------------------------------+-------------+-----------+------------
↪-----+-----------------------+
| 2ba06233-d5c8-43eb-93a9-8eaa94bc9eb5 | tcp         | 0.0.0.0/0 | 80:80      ␣
↪     | None                  |
| 821c3ef6-9b21-426b-be5b-c8a94c2a839c | tcp         | 0.0.0.0/0 | 443:443    ␣
↪     | None                  |
+--------------------------------------+-------------+-----------+------------
↪-----+-----------------------+
```

Assuming everything looks correct, you can now use these security groups when creating your new servers.

2.1.1.3 Launch instances

Instances are virtual machines that run inside the cloud.

Before you can launch an instance, gather the following parameters:

- The **instance source** can be an image, snapshot, or block storage volume that contains an image or snapshot.
- A **name** for your instance.
- The **flavor** for your instance, which defines the compute, memory, and storage capacity of nova computing instances. A flavor is an available hardware configuration for a server. It defines the size of a virtual server that can be launched.
- Any **user data** files. A *user data* file is a special key in the metadata service that holds a file that cloud-aware applications in the guest instance can access. For example, one application that uses user data is the cloud-init system, which is an open-source package from Ubuntu that is available on various Linux distributions and that handles early initialization of a cloud instance.
- Access and security credentials, which include one or both of the following credentials:
  - A **key pair** for your instance, which are SSH credentials that are injected into images when they are launched. For the key pair to be successfully injected, the image must contain the `cloud-init` package. Create at least one key pair for each project. If you already have generated a key pair with an external tool, you can import it into OpenStack. You can use the key pair for multiple instances that belong to that project.
  - A **security group** that defines which incoming network traffic is forwarded to instances. Security groups hold a set of firewall policies, known as *security group rules*.
- If needed, you can assign a **floating (public) IP address** to a running instance to make it accessible from outside the cloud. See *Manage IP addresses*.
- You can also attach a block storage device, or **volume**, for persistent storage.

Note

Instances that use the default security group cannot, by default, be accessed from any IP address outside of the cloud. If you want those IP addresses to access the instances, you must modify the rules for the default security group.

After you gather the parameters that you need to launch an instance, you can launch it from an *image* or a *volume*. You can launch an instance directly from one of the available OpenStack images or from an image that you have copied to a persistent volume. The OpenStack Image service provides a pool of images that are accessible to members of different projects.

Gather parameters to launch an instance

Before you begin, source the OpenStack RC file.

1. Create a flavor.

   Creating a flavor is typically only available to administrators of a cloud because this has implications for scheduling efficiently in the cloud.

```
$  openstack flavor create --ram 512 --disk 1 --vcpus 1 m1.tiny
```

2. List the available flavors.

```
$ openstack flavor list
```

Note the ID of the flavor that you want to use for your instance:

```
+-----+-----------+-------+------+-----------+-------+-----------+
| ID  | Name      |   RAM | Disk | Ephemeral | VCPUs | Is_Public |
+-----+-----------+-------+------+-----------+-------+-----------+
| 1   | m1.tiny   |   512 |    1 |         0 |     1 | True      |
| 2   | m1.small  |  2048 |   20 |         0 |     1 | True      |
| 3   | m1.medium |  4096 |   40 |         0 |     2 | True      |
| 4   | m1.large  |  8192 |   80 |         0 |     4 | True      |
| 5   | m1.xlarge | 16384 |  160 |         0 |     8 | True      |
+-----+-----------+-------+------+-----------+-------+-----------+
```

3. List the available images.

```
$ openstack image list
```

Note the ID of the image from which you want to boot your instance:

```
+--------------------------------------+---------------------------------
↪+--------+
| ID                                   | Name                            ␣
↪| Status |
+--------------------------------------+---------------------------------
↪+--------+
| 397e713c-b95b-4186-ad46-6126863ea0a9 | cirros-0.3.5-x86_64-uec         ␣
↪| active |
| df430cc2-3406-4061-b635-a51c16e488ac | cirros-0.3.5-x86_64-uec-kernel ␣
↪| active |
| 3cf852bd-2332-48f4-9ae4-7d926d50945e | cirros-0.3.5-x86_64-uec-ramdisk␣
↪| active |
+--------------------------------------+---------------------------------
↪+--------+
```

You can also filter the image list by using **grep** to find a specific image, as follows:

```
$ openstack image list | grep 'kernel'

| df430cc2-3406-4061-b635-a51c16e488ac | cirros-0.3.5-x86_64-uec-kernel ␣
↪| active |
```

4. List the available security groups.

```
$ openstack security group list
```

Note

If you are an admin user, this command will list groups for all tenants.

Note the ID of the security group that you want to use for your instance:

```
+--------------------------------------+---------+------------------------
↪+----------------------------------+
| ID                                   | Name    | Description           ␣
↪| Project                          |
+--------------------------------------+---------+------------------------
↪+----------------------------------+
| b0d78827-0981-45ef-8561-93aee39bbd9f | default | Default security group␣
↪| 5669caad86a04256994cdf755df4d3c1 |
| ec02e79e-83e1-48a5-86ad-14ab9a8c375f | default | Default security group␣
↪| 1eaaf6ede7a24e78859591444abf314a |
+--------------------------------------+---------+------------------------
↪+----------------------------------+
```

If you have not created any security groups, you can assign the instance to only the default security group.

You can view rules for a specified security group:

```
$ openstack security group rule list default
```

5. List the available key pairs, and note the key pair name that you use for SSH access.

```
$ openstack keypair list
```

Launch an instance

You can launch an instance from various sources.

Launch an instance from an image

Follow the steps below to launch an instance from an image.

1. After you gather required parameters, run the following command to launch an instance. Specify the server name, flavor ID, and image ID.

```
$ openstack server create --flavor FLAVOR_ID --image IMAGE_ID --key-name␣
↪KEY_NAME \
  --user-data USER_DATA_FILE --security-group SEC_GROUP_NAME --property␣
↪KEY=VALUE \
  INSTANCE_NAME
```

Optionally, you can provide a key name for access control and a security group for security. You can also include metadata key and value pairs. For example, you can add a description for your server by providing the `--property description="My Server"` parameter.

You can pass *user data* in a local file at instance launch by using the `--user-data USER-DATA-FILE` parameter.

Important

If you boot an instance with an INSTANCE_NAME greater than 63 characters, Compute truncates it automatically when turning it into a host name to ensure the correct work of dnsmasq. The corresponding warning is written into the `neutron-dnsmasq.log` file.

The following command launches the `MyCirrosServer` instance with the `m1.small` flavor (ID of 1), `cirros-0.3.2-x86_64-uec` image (ID of `397e713c-b95b-4186-ad46-6126863ea0a9`), `default` security group, `KeyPair01` key, and a user data file called `cloudinit.file`:

```
$ openstack server create --flavor 1 --image 397e713c-b95b-4186-ad46-
↪6126863ea0a9 \
  --security-group default --key-name KeyPair01 --user-data cloudinit.
↪file \
  myCirrosServer
```

Depending on the parameters that you provide, the command returns a list of server properties.

```
+--------------------------------------+------------------------------------
↪-------------+
| Field                                | Value                              ␣
↪             |
+--------------------------------------+------------------------------------
↪-------------+
| OS-DCF:diskConfig                    | MANUAL                             ␣
↪             |
| OS-EXT-AZ:availability_zone          |                                    ␣
↪             |
| OS-EXT-SRV-ATTR:host                 | None                               ␣
↪             |
| OS-EXT-SRV-ATTR:hypervisor_hostname  | None                               ␣
↪             |
| OS-EXT-SRV-ATTR:instance_name        |                                    ␣
↪             |
| OS-EXT-STS:power_state               | NOSTATE                            ␣
↪             |
| OS-EXT-STS:task_state                | scheduling                         ␣
↪             |
| OS-EXT-STS:vm_state                  | building                           ␣
↪             |
| OS-SRV-USG:launched_at               | None                               ␣
↪             |
| OS-SRV-USG:terminated_at             | None                               ␣
↪             |
| accessIPv4                           |                                    ␣
↪             |
| accessIPv6                           |                                    ␣
↪             |
| addresses                            |                                    ␣
↪             |
```

(continues on next page)

(continued from previous page)

```
| adminPass                            | E4Ksozt4Efi8                                 ␣
↪              |
| config_drive                         |                                              ␣
↪              |
| created                              | 2016-11-30T14:48:05Z                         ␣
↪              |
| flavor                               | m1.tiny                                      ␣
↪              |
| hostId                               |                                              ␣
↪              |
| id                                   | 89015cc9-bdf1-458a-8518-
↪fdca2b4a5785          |
| image                                | cirros (397e713c-b95b-4186-ad46-
↪6126863ea0a9) |
| key_name                             | KeyPair01                                    ␣
↪              |
| name                                 | myCirrosServer                               ␣
↪              |
| os-extended-volumes:volumes_attached | []                                           ␣
↪              |
| progress                             | 0                                            ␣
↪              |
| project_id                           | 5669caad86a04256994cdf755df4d3c1␣
↪              |
| properties                           |                                              ␣
↪              |
| security_groups                      | [{u'name': u'default'}]                      ␣
↪              |
| status                               | BUILD                                        ␣
↪              |
| updated                              | 2016-11-30T14:48:05Z                         ␣
↪              |
| user_id                              | c36cec73b0e44876a4478b1e6cd749bb␣
↪              |
| metadata                             | {u'KEY': u'VALUE'}                           ␣
↪              |
+--------------------------------------+----------------------------------
↪-------------+
```

A status of `BUILD` indicates that the instance has started, but is not yet online.

A status of `ACTIVE` indicates that the instance is active.

2. Copy the server ID value from the `id` field in the output. Use the ID to get server details or to delete your server.
3. Copy the administrative password value from the `adminPass` field. Use the password to log in to your server.
4. Check if the instance is online.

```
$ openstack server list
```

The list shows the ID, name, status, and private (and if assigned, public) IP addresses for all instances in the project to which you belong:

```
+--------------+----------------------+--------+------------+-------------
↪+------------------+------------+
| ID           | Name                 | Status | Task State | Power State␣
↪| Networks         | Image Name |
+--------------+----------------------+--------+------------+-------------
↪+------------------+------------+
| 84c6e57d...  | myCirrosServer       | ACTIVE | None       | Running     ␣
↪| private=10.0.0.3 | cirros     |
| 8a99547e...  | myInstanceFromVolume | ACTIVE | None       | Running     ␣
↪| private=10.0.0.4 | centos     |
+--------------+----------------------+--------+------------+-------------
↪+------------------+------------+
```

If the status for the instance is ACTIVE, the instance is online.

5. To view the available options for the **`openstack server list`** command, run the following command:

```
$ openstack help server list
```

> **Note**
>
> If you did not provide a key pair, security groups, or rules, you can access the instance only from inside the cloud through VNC. Even pinging the instance is not possible.

Launch an instance from a volume

You can boot instances from a volume instead of an image.

To complete these tasks, use these parameters on the **`openstack server create`** command:

Task	openstack server create parameter(s)	Information
Boot an instance from an image and attach a non-bootable volume.	`--block-device`	*Boot instance from image and attach non-bootable volume*
Create a volume from an image and boot an instance from that volume.	`--boot-from-volume` and `--image`; `--block-device`	*Boot instance from volume*
Boot from an existing source image, volume, or snapshot.	`--volume` or `--snapshot`; `--block-device`	*Boot instance from volume*
Attach a swap disk to an instance.	`--swap`	*Attach swap or ephemeral disk to an instance*
Attach an ephemeral disk to an instance.	`--ephemeral`	*Attach swap or ephemeral disk to an instance*

Note

To attach a volume to a running instance, refer to the Cinder documentation.

Note

The maximum limit on the number of disk devices allowed to attach to a single server is configurable with the option *`compute.max_disk_devices_to_attach`*.

Boot instance from image and attach non-bootable volume

You can create a non-bootable volume and attach that volume to an instance that you boot from an image.

To create a non-bootable volume, do not create it from an image. The volume must be entirely empty with no partition table and no file system.

1. Create a non-bootable volume.

```
$ openstack volume create --size 8 test-volume
+---------------------+--------------------------------------+
| Field               | Value                                |
+---------------------+--------------------------------------+
| attachments         | []                                   |
| availability_zone   | nova                                 |
| bootable            | false                                |
| consistencygroup_id | None                                 |
| created_at          | 2021-06-01T15:01:31.000000           |
| description         | None                                 |
| encrypted           | False                                |
| id                  | 006efd7a-48a8-4c75-bafb-6b483199d284 |
| migration_status    | None                                 |
```

(continues on next page)

(continued from previous page)

```
| multiattach          | False                                |
| name                 | test-volume                          |
| properties           |                                      |
| replication_status   | None                                 |
| size                 | 8                                    |
| snapshot_id          | None                                 |
| source_volid         | None                                 |
| status               | creating                             |
| type                 | lvmdriver-1                          |
| updated_at           | None                                 |
| user_id              | 0a4d2edb9042412ba4f719a547d42f79     |
+----------------------+--------------------------------------+
```

2. List volumes and confirm that it is in the `available` state.

```
$ openstack volume list
+--------------------------------------+-------------+-----------+------+-
↪------------+
| ID                                   | Name        | Status    | Size |␣
↪Attached to |
+--------------------------------------+-------------+-----------+------+-
↪------------+
| 006efd7a-48a8-4c75-bafb-6b483199d284 | test-volume | available |    8 |␣
↪            |
+--------------------------------------+-------------+-----------+------+-
↪------------+
```

3. Create an instance, specifying the volume as a block device to attach.

```
$ openstack server create \
    --flavor $FLAVOR --image $IMAGE --network $NETWORK \
    --block-device uuid=006efd7a-48a8-4c75-bafb-6b483199d284,source_
↪type=volume,destination_type=volume \
    --wait test-server
+-------------------------------------+--------------------------------------
↪-----------------------------+
| Field                               | Value                                ␣
↪                            |
+-------------------------------------+--------------------------------------
↪-----------------------------+
| OS-DCF:diskConfig                   | MANUAL                               ␣
↪                            |
| OS-EXT-AZ:availability_zone         | nova                                 ␣
↪                            |
| OS-EXT-SRV-ATTR:host                | devstack-ubuntu2004                  ␣
↪                            |
| OS-EXT-SRV-ATTR:hypervisor_hostname | devstack-ubuntu2004                  ␣
↪                            |
| OS-EXT-SRV-ATTR:instance_name       | instance-00000008                    ␣
↪                            |
```

(continues on next page)

(continued from previous page)

```
| OS-EXT-STS:power_state               | Running                                ␣
↪                                    |
| OS-EXT-STS:task_state                | None                                   ␣
↪                                    |
| OS-EXT-STS:vm_state                  | active                                 ␣
↪                                    |
| OS-SRV-USG:launched_at               | 2021-06-01T15:13:48.000000             ␣
↪                                    |
| OS-SRV-USG:terminated_at             | None                                   ␣
↪                                    |
| accessIPv4                           |                                        ␣
↪                                    |
| accessIPv6                           |                                        ␣
↪                                    |
| addresses                            | private=10.0.0.55,␣
↪fde3:4790:906b:0:f816:3eff:fed5:ebd9         |
| adminPass                            | CZ76LZ9pNXzt                           ␣
↪                                    |
| config_drive                         |                                        ␣
↪                                    |
| created                              | 2021-06-01T15:13:37Z                   ␣
↪                                    |
| flavor                               | m1.tiny (1)                            ␣
↪                                    |
| hostId                               |␣
↪425d65fe75c1e53cecbd32d3e6863142355507b6edebbeaa56ff341c7         |
| id                                   | 446d1b00-b729-49b3-9dab-
↪40a3fbe190cf                           |
| image                                | cirros-0.5.1-x86_64-disk␣
↪(44d317a3-6183-4063-868b-aa0728576f5f) |
| key_name                             | None                                   ␣
↪                                    |
| name                                 | test-server                            ␣
↪                                    |
| progress                             | 0                                      ␣
↪                                    |
| project_id                           | ae93f388f934458c8e6583f8ab0dba2d       ␣
↪                                    |
| properties                           |                                        ␣
↪                                    |
| security_groups                      | name='default'                         ␣
↪                                    |
| status                               | ACTIVE                                 ␣
↪                                    |
| updated                              | 2021-06-01T15:13:49Z                   ␣
↪                                    |
| user_id                              | 0a4d2edb9042412ba4f719a547d42f79       ␣
↪                                    |
| volumes_attached                     | id='006efd7a-48a8-4c75-bafb-
```

(continues on next page)

(continued from previous page)

```
↪6b483199d284'                          |
+--------------------------------------+--------------------------------------
↪-----------------------------+
```

4. List volumes once again to ensure the status has changed to `in-use` and the volume is correctly reporting the attachment.

```
$ openstack volume list
+--------------------------------------+-------------+--------+------+----
↪-----------------------------------+
| ID                                   | Name        | Status | Size |␣
↪Attached to                         |
+--------------------------------------+-------------+--------+------+----
↪-----------------------------------+
| 006efd7a-48a8-4c75-bafb-6b483199d284 | test-volume | in-use |    1 |␣
↪Attached to test-server on /dev/vdb  |
+--------------------------------------+-------------+--------+------+----
↪-----------------------------------+
```

Boot instance from volume

You can create a bootable volume from an existing image, volume, or snapshot. This procedure shows you how to create a volume from an image and use the volume to boot an instance.

1. List available images, noting the ID of the image that you wish to use.

```
$ openstack image list
+--------------------------------------+--------------------------+-------
↪-+
| ID                                   | Name                     |␣
↪Status |
+--------------------------------------+--------------------------+-------
↪-+
| 44d317a3-6183-4063-868b-aa0728576f5f | cirros-0.5.1-x86_64-disk |␣
↪active |
+--------------------------------------+--------------------------+-------
↪-+
```

2. Create an instance, using the chosen image and requesting boot from volume behavior.

```
$ openstack server create \
    --flavor $FLAVOR --network $NETWORK \
    --image 44d317a3-6183-4063-868b-aa0728576f5f --boot-from-volume 10 \
    --wait test-server
+--------------------------------------+--------------------------------------
↪----------------------+
| Field                                | Value                                ␣
↪                      |
+--------------------------------------+--------------------------------------
↪----------------------+
```

(continues on next page)

(continued from previous page)

```
| OS-DCF:diskConfig                   | MANUAL                                 ␣
↪                          |
| OS-EXT-AZ:availability_zone         | nova                                   ␣
↪                          |
| OS-EXT-SRV-ATTR:host                | devstack-ubuntu2004                    ␣
↪                          |
| OS-EXT-SRV-ATTR:hypervisor_hostname | devstack-ubuntu2004                    ␣
↪                          |
| OS-EXT-SRV-ATTR:instance_name       | instance-0000000c                      ␣
↪                          |
| OS-EXT-STS:power_state              | Running                                ␣
↪                          |
| OS-EXT-STS:task_state               | None                                   ␣
↪                          |
| OS-EXT-STS:vm_state                 | active                                 ␣
↪                          |
| OS-SRV-USG:launched_at              | 2021-06-01T16:02:06.000000             ␣
↪                          |
| OS-SRV-USG:terminated_at            | None                                   ␣
↪                          |
| accessIPv4                          |                                        ␣
↪                          |
| accessIPv6                          |                                        ␣
↪                          |
| addresses                           | private=10.0.0.3,␣
↪fde3:4790:906b:0:f816:3eff:fe40:bdd    |
| adminPass                           | rqT3RUYYa5H5                           ␣
↪                          |
| config_drive                        |                                        ␣
↪                          |
| created                             | 2021-06-01T16:01:55Z                   ␣
↪                          |
| flavor                              | m1.tiny (1)                            ␣
↪                          |
| hostId                              |␣
↪425d65fe75c1e53cecbd32d3e686314235507b6edebbeaa56ff341c7 |
| id                                  | 69b09fa0-6f24-4924-8311-
↪c9bcdeb90dcb                       |
| image                               | N/A (booted from volume)               ␣
↪                          |
| key_name                            | None                                   ␣
↪                          |
| name                                | test-server                            ␣
↪                          |
| progress                            | 0                                      ␣
↪                          |
| project_id                          | ae93f388f934458c8e6583f8ab0dba2d       ␣
↪                          |
| properties                          |                                        ␣
```

(continues on next page)

(continued from previous page)

```
↪                          |
| security_groups                     | name='default'                 ␣
↪                          |
| status                              | ACTIVE                         ␣
↪                          |
| updated                             | 2021-06-01T16:02:07Z           ␣
↪                          |
| user_id                             | 0a4d2edb9042412ba4f719a547d42f79 ␣
↪                          |
| volumes_attached                    | id='673cbfcb-351c-42cb-9659-
↪bca5b2a0361c'                  |
+-------------------------------------+--------------------------------
↪----------------------+
```

Note

Volumes created in this manner will not be deleted when the server is deleted and will need to be manually deleted afterwards. If you wish to change this behavior, you will need to pre-create the volume manually as discussed below.

3. List volumes to ensure a new volume has been created and that its status is `in-use` and the volume is correctly reporting the attachment.

```
$ openstack volume list
+--------------------------------------+------+--------+------+-----------
↪---------------------------+
| ID                                   | Name | Status | Size | Attached␣
↪to                           |
+--------------------------------------+------+--------+------+-----------
↪---------------------------+
| 673cbfcb-351c-42cb-9659-bca5b2a0361c |      | in-use |    1 | Attached␣
↪to test-server on /dev/vda  |
+--------------------------------------+------+--------+------+-----------
↪---------------------------+

$ openstack server volume list test-server
+--------------------------------------+----------+-----------------------
↪---------------+----------------------------------------+
| ID                                   | Device   | Server ID             ␣
↪               | Volume ID                              |
+--------------------------------------+----------+-----------------------
↪---------------+----------------------------------------+
| 673cbfcb-351c-42cb-9659-bca5b2a0361c | /dev/vda | 9c7f68d4-4d84-4c1e-
↪83af-b8c6a56ad005 | 673cbfcb-351c-42cb-9659-bca5b2a0361c |
+--------------------------------------+----------+-----------------------
↪---------------+----------------------------------------+
```

Rather than relying on nova to create the volume from the image, it is also possible to pre-create the volume before creating the instance. This can be useful when you want more control over the created

volume, such as enabling encryption.

1. List available images, noting the ID of the image that you wish to use.

```
$ openstack image list
+--------------------------------------+--------------------------+-------
↪-+
| ID                                   | Name                     |␣
↪Status |
+--------------------------------------+--------------------------+-------
↪-+
| 44d317a3-6183-4063-868b-aa0728576f5f | cirros-0.5.1-x86_64-disk |␣
↪active |
+--------------------------------------+--------------------------+-------
↪-+
```

2. Create a bootable volume from the chosen image.

   Cinder makes a volume bootable when `--image` parameter is passed.

```
$ openstack volume create \
    --image 44d317a3-6183-4063-868b-aa0728576f5f --size 10 \
    test-volume
+---------------------+--------------------------------------+
| Field               | Value                                |
+---------------------+--------------------------------------+
| attachments         | []                                   |
| availability_zone   | nova                                 |
| bootable            | false                                |
| consistencygroup_id | None                                 |
| created_at          | 2021-06-01T15:40:56.000000           |
| description         | None                                 |
| encrypted           | False                                |
| id                  | 9c7f68d4-4d84-4c1e-83af-b8c6a56ad005 |
| migration_status    | None                                 |
| multiattach         | False                                |
| name                | test-volume                          |
| properties          |                                      |
| replication_status  | None                                 |
| size                | 10                                   |
| snapshot_id         | None                                 |
| source_volid        | None                                 |
| status              | creating                             |
| type                | lvmdriver-1                          |
| updated_at          | None                                 |
| user_id             | 0a4d2edb9042412ba4f719a547d42f79     |
+---------------------+--------------------------------------+
```

Note

If you want to create a volume to a specific storage backend, you need to use an image which

has the `cinder_img_volume_type` property. For more information, refer to the cinder docs.

Note

A bootable encrypted volume can also be created by adding the `--type ENCRYPTED_VOLUME_TYPE` parameter to the volume create command. For example:

```
$ openstack volume create \
    --type ENCRYPTED_VOLUME_TYPE --image IMAGE --size SIZE \
    test-volume
```

This requires an encrypted volume type which must be created ahead of time by an admin. Refer to the horizon documentation. for more information.

3. Create an instance, specifying the volume as the boot device.

```
$ openstack server create \
    --flavor $FLAVOR --network $NETWORK \
    --volume 9c7f68d4-4d84-4c1e-83af-b8c6a56ad005\
    --wait test-server
+-------------------------------------+----------------------------------
↪----------------------+
| Field                               | Value                            ␣
↪                      |
+-------------------------------------+----------------------------------
↪----------------------+
| OS-DCF:diskConfig                   | MANUAL                           ␣
↪                      |
| OS-EXT-AZ:availability_zone         | nova                             ␣
↪                      |
| OS-EXT-SRV-ATTR:host                | devstack-ubuntu2004              ␣
↪                      |
| OS-EXT-SRV-ATTR:hypervisor_hostname | devstack-ubuntu2004              ␣
↪                      |
| OS-EXT-SRV-ATTR:instance_name       | instance-0000000a                ␣
↪                      |
| OS-EXT-STS:power_state              | Running                          ␣
↪                      |
| OS-EXT-STS:task_state               | None                             ␣
↪                      |
| OS-EXT-STS:vm_state                 | active                           ␣
↪                      |
| OS-SRV-USG:launched_at              | 2021-06-01T15:43:21.000000       ␣
↪                      |
| OS-SRV-USG:terminated_at            | None                             ␣
↪                      |
| accessIPv4                          |                                  ␣
↪                      |
| accessIPv6                          |                                  ␣
```

(continues on next page)

(continued from previous page)

```
↪                                    |
| addresses                          | private=10.0.0.47,␣
↪fde3:4790:906b:0:f816:3eff:fe89:b004  |
| adminPass                          | ueX74zzHWqL4                    ␣
↪                                    |
| config_drive                       |                                 ␣
↪                                    |
| created                            | 2021-06-01T15:43:13Z            ␣
↪                                    |
| flavor                             | m1.tiny (1)                     ␣
↪                                    |
| hostId                             |␣
↪425d65fe75c1e53cecbd32d3e686314235507b6edebbeaa56ff341c7 |
| id                                 | 367b7d42-627c-4d10-a2a0-
↪f759501499a6                        |
| image                              | N/A (booted from volume)        ␣
↪                                    |
| key_name                           | None                            ␣
↪                                    |
| name                               | test-server                     ␣
↪                                    |
| progress                           | 0                               ␣
↪                                    |
| project_id                         | ae93f388f934458c8e6583f8ab0dba2d ␣
↪                                    |
| properties                         |                                 ␣
↪                                    |
| security_groups                    | name='default'                  ␣
↪                                    |
| status                             | ACTIVE                          ␣
↪                                    |
| updated                            | 2021-06-01T15:43:22Z            ␣
↪                                    |
| user_id                            | 0a4d2edb9042412ba4f719a547d42f79 ␣
↪                                    |
| volumes_attached                   | id='9c7f68d4-4d84-4c1e-83af-
↪b8c6a56ad005'                       |
+------------------------------------+---------------------------------
↪----------------------+
```

Note

The example here uses the `--volume` option for simplicity. The `--block-device` option could also be used for more granular control over the parameters. See the openstack server create documentation for details.

4. List volumes once again to ensure the status has changed to `in-use` and the volume is correctly reporting the attachment.

```
$ openstack volume list
+--------------------------------------+-------------+--------+------+----
↪---------------------------------+
| ID                                   | Name        | Status | Size |␣
↪Attached to                         |
+--------------------------------------+-------------+--------+------+----
↪---------------------------------+
| 9c7f68d4-4d84-4c1e-83af-b8c6a56ad005 | test-volume | in-use |   10 |␣
↪Attached to test-server on /dev/vda  |
+--------------------------------------+-------------+--------+------+----
↪---------------------------------+

$ openstack server volume list test-server
+--------------------------------------+----------+--------------------------
↪---------------+-----------------------------------------+
| ID                                   | Device   | Server ID
↪               | Volume ID                               |
+--------------------------------------+----------+--------------------------
↪---------------+-----------------------------------------+
| 9c7f68d4-4d84-4c1e-83af-b8c6a56ad005 | /dev/vda | c2368c38-6a7d-4fe8-
↪bc4e-483e90e7608b | 9c7f68d4-4d84-4c1e-83af-b8c6a56ad005 |
+--------------------------------------+----------+--------------------------
↪---------------+-----------------------------------------+
```

Attach swap or ephemeral disk to an instance

Use the `--swap` option of the `openstack server` command to attach a swap disk on boot or the `--ephemeral` option to attach an ephemeral disk on boot. The latter can be specified multiple times. When you terminate the instance, both disks are deleted.

Boot an instance with a 512 MB swap disk and 2 GB ephemeral disk.

```
$ openstack server create \
    --flavor FLAVOR --image IMAGE --network NETWORK \
    --ephemeral size=2 --swap 512
    --wait test-server
```

Note

The flavor defines the maximum swap and ephemeral disk size. You cannot exceed these maximum values.

Launch an instance using ISO image

Boot an instance from an ISO image

OpenStack supports booting instances using ISO images. But before you make such instances functional, use the **`openstack server create`** command with the following parameters to boot an instance:

```
$ openstack server create --image ubuntu-14.04.2-server-amd64.iso \
  --nic net-id = NETWORK_UUID \
  --flavor 2 INSTANCE_NAME
+--------------------------------------+--------------------------------------
↪------+
| Field                                | Value                                ␣
↪      |
+--------------------------------------+--------------------------------------
↪------+
| OS-DCF:diskConfig                    | MANUAL                               ␣
↪      |
| OS-EXT-AZ:availability_zone          | nova                                 ␣
↪      |
| OS-EXT-SRV-ATTR:host                 | -                                    ␣
↪      |
| OS-EXT-SRV-ATTR:hypervisor_hostname  | -                                    ␣
↪      |
| OS-EXT-SRV-ATTR:instance_name        | instance-00000004                    ␣
↪      |
| OS-EXT-STS:power_state               | 0                                    ␣
↪      |
| OS-EXT-STS:task_state                | scheduling                           ␣
↪      |
| OS-EXT-STS:vm_state                  | building                             ␣
↪      |
| OS-SRV-USG:launched_at               | -                                    ␣
↪      |
| OS-SRV-USG:terminated_at             | -                                    ␣
↪      |
| accessIPv4                           |                                      ␣
↪      |
| accessIPv6                           |                                      ␣
↪      |
| adminPass                            | ZaiYeC8iucgU                         ␣
↪      |
| config_drive                         |                                      ␣
↪      |
| created                              | 2015-06-01T16:34:50Z                 ␣
↪      |
| flavor                               | m1.small (2)                         ␣
↪      |
| hostId                               |                                      ␣
↪      |
| id                                   | 1e1797f3-1662-49ff-ae8c-a77e82ee1571␣
↪      |
| image                                | ubuntu-14.04.2-server-amd64.iso      ␣
↪      |
| key_name                             | -                                    ␣
↪      |
| metadata                             | {}                                   ␣
```

(continues on next page)

(continued from previous page)

```
↪      |
| name                                | INSTANCE_NAME                        ␣
↪      |
| os-extended-volumes:volumes_attached | []                                   ␣
↪      |
| progress                            | 0                                    ␣
↪      |
| security_groups                     | default                              ␣
↪      |
| status                              | BUILD                                ␣
↪      |
| tenant_id                           | ccef9e62b1e645df98728fb2b3076f27     ␣
↪      |
| updated                             | 2014-05-09T16:34:51Z                 ␣
↪      |
| user_id                             | fef060ae7bfd4024b3edb97dff59017a     ␣
↪      |
+-------------------------------------+--------------------------------------
↪------+
```

In this command, `ubuntu-14.04.2-server-amd64.iso` is the ISO image, and `INSTANCE_NAME` is the name of the new instance. `NETWORK_UUID` is a valid network id in your system.

Create a bootable volume for the instance to reside on after shutdown.

1. Create the volume:

```
$ openstack volume create \
  --size <SIZE_IN_GB> \
  --bootable VOLUME_NAME
```

2. Attach the instance to the volume:

```
$ openstack server add volume
  INSTANCE_NAME \
  VOLUME_NAME \
  --device /dev/vda
```

Note

You need the Block Storage service to preserve the instance after shutdown. The `--block-device` argument, used with the legacy **`nova boot`**, will not work with the OpenStack **`openstack server create`** command. Instead, the **`openstack volume create`** and **`openstack server add volume`** commands create persistent storage.

After the instance is successfully launched, connect to the instance using a remote console and follow the instructions to install the system as using ISO images on regular computers. When the installation is finished and system is rebooted, the instance asks you again to install the operating system, which means your instance is not usable. If you have problems with image creation, please check the Virtual Machine Image Guide for reference.

Make the instances booted from ISO image functional

Now complete the following steps to make your instances created using ISO image actually functional.

1. Delete the instance using the following command.

```
$ openstack server delete INSTANCE_NAME
```

2. After you delete the instance, the system you have just installed using your ISO image remains, because the parameter `shutdown=preserve` was set, so run the following command.

```
$ openstack volume list
+--------------------------+--------------------------+-----------+------+-
↪------------+
| ID                       | Name                     | Status    | Size |␣
↪Attached to |
+--------------------------+--------------------------+-----------+------+-
↪------------+
| 8edd7c97-1276-47a5-9563- |dc01d873-d0f1-40b6-bfcc- | available |   10 |␣
↪             |
| 1025f4264e4f             | 26a8d955a1d9-blank-vol   |           |      |␣
↪             |
+--------------------------+--------------------------+-----------+------+-
↪------------+
```

   You get a list with all the volumes in your system. In this list, you can find the volume that is attached to your ISO created instance, with the false bootable property.

3. Upload the volume to glance.

```
$ openstack image create --volume SOURCE_VOLUME IMAGE_NAME
$ openstack image list
+--------------------+------------+--------+
| ID                 | Name       | Status |
+--------------------+------------+--------+
| 74303284-f802-... | IMAGE_NAME | active |
+--------------------+------------+--------+
```

   The `SOURCE_VOLUME` is the UUID or a name of the volume that is attached to your ISO created instance, and the `IMAGE_NAME` is the name that you give to your new image.

4. After the image is successfully uploaded, you can use the new image to boot instances.

   The instances launched using this image contain the system that you have just installed using the ISO image.

Boot an instance using PXE

Follow the steps below to boot an existing instance using PXE.

Create an image with iPXE

iPXE is open source boot firmware. See the documentation for more details: https://ipxe.org/docs

Use the iPXE image as a rescue image

Boot the instance from the iPXE image using rescue.

Legacy instance rescue

The ordering of disks is not guaranteed to be consistent.

```
$ openstack server rescue --image IPXE_IMAGE INSTANCE_NAME
```

Stable device instance rescue

To preserve the ordering of disks when booting, use stable device rescue.

1. Ensure that the `hw_rescue_device` (`cdrom` | `disk` | `floppy`) and/or the `hw_rescue_bus` (`scsi` | `virtio` | `ide` | `usb`) image properties are set on the image. For example:

   ```
   $ openstack image set --property hw_rescue_device=disk IPXE_IMAGE
   ```

   or:

   ```
   $ openstack image set --property hw_rescue_bus=virtio IPXE_IMAGE
   ```

   or:

   ```
   $ openstack image set --property hw_rescue_device=disk \
   --property hw_rescue_bus=virtio IPXE_IMAGE
   ```

2. Run the rescue using the API microversion 2.87 or later:

   ```
   $ openstack --os-compute-api-version 2.87 server rescue \
   --image IPXE_IMAGE INSTANCE_NAME
   ```

2.1.1.4 Server Groups

Server groups provide a mechanism for indicating the locality of servers relative to other servers. They allow you to indicate whether servers should run on the same host (affinity) or different hosts (anti-affinity). Affinity is advantageous if you wish to minimise network latency, while anti-affinity can improve fault-tolerance and load distribution.

Note

Server groups are useful for separating or grouping workloads but should not generally be relied on to provide HA. Instead, consider using availability zones. Unlike server groups, availability zones can only be configured by admins but they are often used to model failure domains, particularly in larger deployments. For more information, refer to *Availability zones*.

Server groups can be configured with a policy and rules. There are currently four policies supported:

`affinity`
: Restricts instances belonging to the server group to the same host.

`anti-affinity`
: Restricts instances belonging to the server group to separate hosts.

`soft-affinity`
: Attempts to restrict instances belonging to the server group to the same host. Where it is not possible to schedule all instances on one host, they will be scheduled together on as few hosts as possible.

> **Note**
>
> Requires API microversion 2.15 or later.

`soft-anti-affinity`
: Attempts to restrict instances belonging to the server group to separate hosts. Where it is not possible to schedule all instances to separate hosts, they will be scheduled on as many separate hosts as possible.

> **Note**
>
> Requires API microversion 2.15 or later.

There is currently one rule supported:

`max_server_per_host`
: Indicates the max number of instances that can be scheduled to any given host when using the `anti-affinity` policy. This rule is not compatible with other policies.

> **Note**
>
> Requires API microversion 2.64 or later.

Usage

Server groups can be configured and used by end-users. For example:

```
$ openstack --os-compute-api-version 2.64 server group create \
    --policy POLICY --rule RULE NAME
```

Once a server group has been created, you can use it when creating a server. This is achieved using the `--hint` option. For example:

```
$ openstack server create \
    --hint group=SERVER_GROUP_UUID ... NAME
```

Once created, a server group cannot be modified. In addition, a server cannot move between server groups. In both cases, this is because doing so would require potentially moving the server to satisfy the server group policy.

2.1.1.5 Metadata

Nova presents configuration information to instances it starts via a mechanism called metadata. These mechanisms are widely used via helpers such as cloud-init to specify things like the root password the instance should use.

This metadata is made available via either a *config drive* or the *metadata service* and can be somewhat customised by the user using the *user data* feature. This guide provides an overview of these features along with a summary of the types of metadata available.

Types of metadata

There are three separate groups of users who need to be able to specify metadata for an instance.

User provided data

The user who booted the instance can pass metadata to the instance in several ways. For authentication keypairs, the keypairs functionality of the nova API can be used to upload a key and then specify that key during the nova boot API request. For less structured data, a small opaque blob of data may be passed via the *user data* feature of the nova API. Examples of such unstructured data would be the puppet role that the instance should use, or the HTTP address of a server from which to fetch post-boot configuration information.

Nova provided data

Nova itself needs to pass information to the instance via its internal implementation of the metadata system. Such information includes the requested hostname for the instance and the availability zone the instance is in. This happens by default and requires no configuration by the user or deployer.

Nova provides both an *OpenStack metadata API* and an *EC2-compatible API*. Both the OpenStack metadata and EC2-compatible APIs are versioned by date. These are described later.

Deployer provided data

A deployer of OpenStack may need to pass data to an instance. It is also possible that this data is not known to the user starting the instance. An example might be a cryptographic token to be used to register the instance with Active Directory post boot the user starting the instance should not have access to Active Directory to create this token, but the nova deployment might have permissions to generate the token on the users behalf. This is possible using the *vendordata* feature, which must be configured by your cloud operator.

The metadata service

> **Note**
>
> This section provides end user information about the metadata service. For deployment information about the metadata service, refer to the *admin guide*.

The *metadata service* provides a way for instances to retrieve instance-specific data via a REST API. Instances access this service at `169.254.169.254` or at `fe80::a9fe:a9fe`. All types of metadata, be it user-, nova- or vendor-provided, can be accessed via this service.

Changed in version 22.0.0: Starting with the Victoria release the metadata service is accessible over IPv6 at the link-local address `fe80::a9fe:a9fe`.

Note

As with all IPv6 link-local addresses, the metadata IPv6 address is not complete without a zone identifier (in a Linux guest that is usually the interface name concatenated after a percent sign). Please also note that in URLs you should URL-encode the percent sign itself. For example, assuming that the primary network interface in the guest is `ens2` substitute `http://[fe80::a9fe:a9fe%25ens2]:80/...` for `http://169.254.169.254/...`.

Using the metadata service

To retrieve a list of supported versions for the *OpenStack metadata API*, make a GET request to `http://169.254.169.254/openstack`, which will return a list of directories:

```
$ curl http://169.254.169.254/openstack
2012-08-10
2013-04-04
2013-10-17
2015-10-15
2016-06-30
2016-10-06
2017-02-22
2018-08-27
latest
```

Refer to *OpenStack format metadata* for information on the contents and structure of these directories.

To list supported versions for the *EC2-compatible metadata API*, make a GET request to `http://169.254.169.254`, which will, once again, return a list of directories:

```
$ curl http://169.254.169.254
1.0
2007-01-19
2007-03-01
2007-08-29
2007-10-10
2007-12-15
2008-02-01
2008-09-01
2009-04-04
latest
```

Refer to *EC2-compatible metadata* for information on the contents and structure of these directories.

Config drives

Note

This section provides end user information about config drives. For deployment information about the config drive feature, refer to the *admin guide*.

Config drives are special drives that are attached to an instance when it boots. The instance can mount this drive and read files from it to get information that is normally available through the metadata service.

One use case for using the config drive is to pass a networking configuration when you do not use DHCP to assign IP addresses to instances. For example, you might pass the IP address configuration for the instance through the config drive, which the instance can mount and access before you configure the network settings for the instance.

Using the config drive

To enable the config drive for an instance, pass the `--config-drive true` parameter to the **`openstack server create`** command.

The following example enables the config drive and passes a user data file and two key/value metadata pairs, all of which are accessible from the config drive:

```
$ openstack server create --config-drive true --image my-image-name \
    --flavor 1 --key-name mykey --user-data ./my-user-data.txt \
    --property role=webservers --property essential=false MYINSTANCE
```

Note

The Compute service can be configured to always create a config drive. For more information, refer to *the admin guide*.

If your guest operating system supports accessing disk by label, you can mount the config drive as the `/dev/disk/by-label/configurationDriveVolumeLabel` device. In the following example, the config drive has the `config-2` volume label:

```
# mkdir -p /mnt/config
# mount /dev/disk/by-label/config-2 /mnt/config
```

If your guest operating system does not use `udev`, the `/dev/disk/by-label` directory is not present. You can use the **`blkid`** command to identify the block device that corresponds to the config drive. For example:

```
# blkid -t LABEL="config-2" -odevice
/dev/vdb
```

Once identified, you can mount the device:

```
# mkdir -p /mnt/config
# mount /dev/vdb /mnt/config
```

Once mounted, you can examine the contents of the config drive:

```
$ cd /mnt/config
$ find . -maxdepth 2
.
./ec2
./ec2/2009-04-04
./ec2/latest
./openstack
./openstack/2012-08-10
./openstack/2013-04-04
./openstack/2013-10-17
./openstack/2015-10-15
./openstack/2016-06-30
./openstack/2016-10-06
./openstack/2017-02-22
./openstack/latest
```

The files that appear on the config drive depend on the arguments that you pass to the **openstack server create** command. The format of this directory is the same as that provided by the *metadata service*, with the exception that the EC2-compatible metadata is now located in the `ec2` directory instead of the root (`/`) directory. Refer to the *OpenStack format metadata* and *EC2-compatible metadata* sections for information about the format of the files and subdirectories within these directories.

Setting in image

```
$ openstack image set IMG-UUID --property img_config_drive=mandatory
```

The img_config_drive image metadata property can be used to force enable the config drive. Setting img_config_drive specifies whether the image needs a config drive.

Nova metadata

As noted previously, nova provides its metadata in two formats: OpenStack format and EC2-compatible format.

OpenStack format metadata

Changed in version 12.0.0: Support for network metadata was added in the Liberty release.

Metadata from the OpenStack API is distributed in JSON format. There are two files provided for each version: `meta_data.json` and `network_data.json`. The `meta_data.json` file contains nova-specific information, while the `network_data.json` file contains information retrieved from neutron. For example:

```
$ curl http://169.254.169.254/openstack/2018-08-27/meta_data.json
```

```
{
   "random_seed": "yu5ZnkqF2CqnDZVAfZgarG...",
   "availability_zone": "nova",
   "keys": [
       {
```

(continues on next page)

(continued from previous page)


```
            "data": "ssh-rsa AAAAB3NzaC1y...== Generated by Nova\n",
            "type": "ssh",
            "name": "mykey"
        }
    ],
    "hostname": "test.novalocal",
    "launch_index": 0,
    "meta": {
       "priority": "low",
       "role": "webserver"
    },
    "devices": [
        {
            "type": "nic",
            "bus": "pci",
            "address": "0000:00:02.0",
            "mac": "00:11:22:33:44:55",
            "tags": ["trusted"]
        },
        {
            "type": "disk",
            "bus": "ide",
            "address": "0:0",
            "serial": "disk-vol-2352423",
            "path": "/dev/sda",
            "tags": ["baz"]
        }
    ],
    "project_id": "f7ac731cc11f40efbc03a9f9e1d1d21f",
    "public_keys": {
        "mykey": "ssh-rsa AAAAB3NzaC1y...== Generated by Nova\n"
    },
    "name": "test"
}
```


```
$ curl http://169.254.169.254/openstack/2018-08-27/network_data.json
```


```
{
    "links": [
        {
            "ethernet_mac_address": "fa:16:3e:9c:bf:3d",
            "id": "tapcd9f6d46-4a",
            "mtu": null,
            "type": "bridge",
            "vif_id": "cd9f6d46-4a3a-43ab-a466-994af9db96fc"
        }
    ],
    "networks": [
        {
```


(continues on next page)

(continued from previous page)

```
            "id": "network0",
            "link": "tapcd9f6d46-4a",
            "network_id": "99e88329-f20d-4741-9593-25bf07847b16",
            "type": "ipv4_dhcp"
        }
    ],
    "services": [
        {
            "address": "8.8.8.8",
            "type": "dns"
        }
    ]
}
```

:Download network_data.json JSON schema.

EC2-compatible metadata

The EC2-compatible API is compatible with version 2009-04-04 of the Amazon EC2 metadata service This means that virtual machine images designed for EC2 will work properly with OpenStack.

The EC2 API exposes a separate URL for each metadata element. Retrieve a listing of these elements by making a GET query to `http://169.254.169.254/2009-04-04/meta-data/`. For example:

```
$ curl http://169.254.169.254/2009-04-04/meta-data/
ami-id
ami-launch-index
ami-manifest-path
block-device-mapping/
hostname
instance-action
instance-id
instance-type
kernel-id
local-hostname
local-ipv4
placement/
public-hostname
public-ipv4
public-keys/
ramdisk-id
reservation-id
security-groups
```

```
$ curl http://169.254.169.254/2009-04-04/meta-data/block-device-mapping/
ami
```

```
$ curl http://169.254.169.254/2009-04-04/meta-data/placement/
availability-zone
```

```
$ curl http://169.254.169.254/2009-04-04/meta-data/public-keys/
0=mykey
```

Instances can retrieve the public SSH key (identified by keypair name when a user requests a new instance) by making a GET request to `http://169.254.169.254/2009-04-04/meta-data/public-keys/0/openssh-key`:

```
$ curl http://169.254.169.254/2009-04-04/meta-data/public-keys/0/openssh-key
ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAAAgQDYVEprvtYJXVOBN0XNKVVRNCRX6BlnNbI+US\
LGais1sUWPwtSg7z9K9vhbYAPUZcq8c/s5S9dg5vTHbsiyPCIDOKyeHba4MUJq8Oh5b2i71/3B\
ISpyxTBH/uZDHdslW2a+SrPDCeuMMoss9NFhBdKtDkdG9zyi0ibmCP6yMdEX8Q== Generated\
by Nova
```

User data

User data is a blob of data that the user can specify when they launch an instance. The instance can access this data through the metadata service or config drive. Commonly used to pass a shell script that the instance runs on boot.

For example, one application that uses user data is the cloud-init system, which is an open-source package from Ubuntu that is available on various Linux distributions and which handles early initialization of a cloud instance.

You can place user data in a local file and pass it through the `--user-data <user-data-file>` parameter at instance creation.

```
$ openstack server create --image ubuntu-cloudimage --flavor 1 \
    --user-data mydata.file VM_INSTANCE
```

Note

The provided user data should not be base64-encoded, as it will be automatically encoded in order to pass valid input to the REST API, which has a limit of 65535 bytes after encoding.

Once booted, you can access this data from the instance using either the metadata service or the config drive. To access it via the metadata service, make a GET request to either `http://169.254.169.254/openstack/{version}/user_data` (OpenStack API) or `http://169.254.169.254/{version}/user-data` (EC2-compatible API). For example:

```
$ curl http://169.254.169.254/openstack/2018-08-27/user_data
```

```
#!/bin/bash
echo 'Extra user data here'
```

Vendordata

Note

This section provides end user information about the vendordata feature. For deployment information about this feature, refer to the *admin guide*.

Changed in version 14.0.0: Support for dynamic vendor data was added in the Newton release.

Where configured, instances can retrieve vendor-specific data from the metadata service or config drive. To access it via the metadata service, make a GET request to either `http://169.254.169.254/openstack/{version}/vendor_data.json` or `http://169.254.169.254/openstack/{version}/vendor_data2.json`, depending on the deployment. For example:

```
$ curl http://169.254.169.254/openstack/2018-08-27/vendor_data2.json
```

```
{
    "testing": {
        "value1": 1,
        "value2": 2,
        "value3": "three"
    }
}
```

Note

The presence and contents of this file will vary from deployment to deployment.

General guidelines

- Do not rely on the presence of the EC2 metadata in the metadata API or config drive, because this content might be removed in a future release. For example, do not rely on files in the `ec2` directory.
- When you create images that access metadata service or config drive data and multiple directories are under the `openstack` directory, always select the highest API version by date that your consumer supports. For example, if your guest image supports the `2012-03-05`, `2012-08-05`, and `2013-04-13` versions, try `2013-04-13` first and fall back to a previous version if `2013-04-13` is not present.

2.1.1.6 Manage IP addresses

Each instance has a private, fixed IP address and can also have a public, or floating IP address. Private IP addresses are used for communication between instances, and public addresses are used for communication with networks outside the cloud, including the Internet.

When you launch an instance, it is automatically assigned a private IP address that stays the same until you explicitly terminate the instance. Rebooting an instance has no effect on the private IP address.

A pool of floating IP addresses, configured by the cloud administrator, is available in OpenStack Compute. The project quota defines the maximum number of floating IP addresses that you can allocate to the project. After you allocate a floating IP address to a project, you can:

- Associate the floating IP address with an instance of the project.
- Disassociate a floating IP address from an instance in the project.
- Delete a floating IP from the project which automatically deletes that IPs associations.

Use the **openstack** commands to manage floating IP addresses.

List floating IP address information

To list all pools that provide floating IP addresses, run:

```
$ openstack floating ip pool list
+--------+
| name   |
+--------+
| public |
| test   |
+--------+
```

Note

If this list is empty, the cloud administrator must configure a pool of floating IP addresses.

To list all floating IP addresses that are allocated to the current project, run:

```
$ openstack floating ip list
+--------------------------------------+---------------------+---------------
↪--+------+
| ID                                   | Floating IP Address | Fixed IP␣
↪Address | Port |
+--------------------------------------+---------------------+---------------
↪--+------+
| 760963b2-779c-4a49-a50d-f073c1ca5b9e | 172.24.4.228        | None          ␣
↪   | None |
| 89532684-13e1-4af3-bd79-f434c9920cc3 | 172.24.4.235        | None          ␣
↪   | None |
| ea3ebc6d-a146-47cd-aaa8-35f06e1e8c3d | 172.24.4.229        | None          ␣
↪   | None |
+--------------------------------------+---------------------+---------------
↪--+------+
```

For each floating IP address that is allocated to the current project, the command outputs the floating IP address, the ID for the instance to which the floating IP address is assigned, the associated fixed IP address, and the pool from which the floating IP address was allocated.

Associate floating IP addresses

You can assign a floating IP address to a project and to an instance.

1. Run the following command to allocate a floating IP address to the current project. By default, the floating IP address is allocated from the public pool. The command outputs the allocated IP address:

```
$ openstack floating ip create public
+---------------------+--------------------------------------+
| Field               | Value                                |
```

(continues on next page)

(continued from previous page)

```
+---------------------+--------------------------------------+
| created_at          | 2016-11-30T15:02:05Z                 |
| description         |                                      |
| fixed_ip_address    | None                                 |
| floating_ip_address | 172.24.4.236                         |
| floating_network_id | 0bf90de6-fc0f-4dba-b80d-96670dfb331a |
| headers             |                                      |
| id                  | c70ad74b-2f64-4e60-965e-f24fc12b3194 |
| port_id             | None                                 |
| project_id          | 5669caad86a04256994cdf755df4d3c1     |
| project_id          | 5669caad86a04256994cdf755df4d3c1     |
| revision_number     | 1                                    |
| router_id           | None                                 |
| status              | DOWN                                 |
| updated_at          | 2016-11-30T15:02:05Z                 |
+---------------------+--------------------------------------+
```

2. List all project instances with which a floating IP address could be associated.

```
$ openstack server list
+---------------------+------+---------+------------+-------------+-------
↪----------+------------+
| ID                  | Name | Status  | Task State | Power State |␣
↪Networks         | Image Name |
+---------------------+------+---------+------------+-------------+-------
↪----------+------------+
| d5c854f9-d3e5-4f... | VM1  | ACTIVE  | -          | Running     |␣
↪private=10.0.0.3 | cirros     |
| 42290b01-0968-43... | VM2  | SHUTOFF | -          | Shutdown    |␣
↪private=10.0.0.4 | centos     |
+---------------------+------+---------+------------+-------------+-------
↪----------+------------+
```

Note the server ID to use.

3. List ports associated with the selected server.

```
$ openstack port list --device-id SERVER_ID
+--------------------------------------+------+-------------------+-------
↪-----------------------------------------------------------+--------+
| ID                                   | Name | MAC Address       | Fixed␣
↪IP Addresses                                             | Status |
+--------------------------------------+------+-------------------+-------
↪-----------------------------------------------------------+--------+
| 40e9dea9-f457-458f-bc46-6f4ebea3c268 |      | fa:16:3e:00:57:3e | ip_
↪address='10.0.0.4', subnet_id='23ee9de7-362e-             | ACTIVE |
|                                      |      |                   | 49e2-
↪a3b0-0de1c14930cb'                                        |        |
|                                      |      |                   | ip_
↪address='fd22:4c4c:81c2:0:f816:3eff:fe00:573e', subnet_id |        |
```

(continues on next page)

(continued from previous page)

```
|                                      |      |                  | =
↪'a2b3acbe-fbeb-40d3-b21f-121268c21b55'                          |        |
+--------------------------------------+------+------------------+-------
↪-----------------------------------------------------+--------+
```

Note the port ID to use.

4. Associate an IP address with an instance in the project, as follows:

```
$ openstack floating ip set --port PORT_ID FLOATING_IP_ADDRESS
```

For example:

```
$ openstack floating ip set --port 40e9dea9-f457-458f-bc46-6f4ebea3c268␣
↪172.24.4.225
```

The instance is now associated with two IP addresses:

```
$ openstack server list
+------------------+------+--------+------------+-------------+-----------
↪--------------------+------------+
| ID               | Name | Status | Task State | Power State | Networks ␣
↪                   | Image Name |
+------------------+------+--------+------------+-------------+-----------
↪--------------------+------------+
| d5c854f9-d3e5... | VM1  | ACTIVE | -          | Running     |␣
↪private=10.0.0.3, 172.24.4.225| cirros     |
| 42290b01-0968... | VM2  | SHUTOFF| -          | Shutdown    |␣
↪private=10.0.0.4               | centos     |
+------------------+------+--------+------------+-------------+-----------
↪--------------------+------------+
```

After you associate the IP address and configure security group rules for the instance, the instance is publicly available at the floating IP address.

Disassociate floating IP addresses

To disassociate a floating IP address from an instance:

```
$ openstack floating ip unset --port FLOATING_IP_ADDRESS
```

To remove the floating IP address from a project:

```
$ openstack floating ip delete FLOATING_IP_ADDRESS
```

The IP address is returned to the pool of IP addresses that is available for all projects. If the IP address is still associated with a running instance, it is automatically disassociated from that instance.

2.1.1.7 Image Signature Certificate Validation

Nova can determine if the certificate used to generate and verify the signature of a signed image (see Glance Image Signature Verification documentation) is trusted by the user. This feature is called certificate validation and can be applied to the creation or rebuild of an instance.

Certificate validation is meant to be performed jointly with image signature verification but each feature has its own Nova configuration option, to be specified in the `[glance]` section of the `nova.conf` configuration file. To enable certificate validation, set *`glance.enable_certificate_validation`* to True. To enable signature validation, set *`glance.verify_glance_signatures`* to True. Conversely, to disable either of these features, set their option to False or do not include the option in the Nova configurations at all.

Certificate validation operates in concert with signature validation in Cursive. It takes in a list of trusted certificate IDs and verifies that the certificate used to sign the image being booted is cryptographically linked to at least one of the provided trusted certificates. This provides the user with confidence in the identity and integrity of the image being booted.

Certificate validation will only be performed if image signature validation is enabled. However, the presence of trusted certificate IDs overrides the `enable_certificate_validation` and `verify_glance_signatures` settings. In other words, if a list of trusted certificate IDs is provided to the instance create or rebuild commands, signature verification and certificate validation will be performed, regardless of their settings in the Nova configurations. See *Using Signature Verification* for details.

Note

Certificate validation configuration options must be specified in the Nova configuration file that controls the `nova-osapi_compute` and `nova-compute` services, as opposed to other Nova services (conductor, scheduler, etc.).

Requirements

Key manager that is a backend to the Castellan Interface. Possible key managers are:

- Barbican
- Vault

Limitations

- As of the 18.0.0 Rocky release, only the libvirt compute driver supports trusted image certification validation. The feature is not, however, driver specific so other drivers should be able to support this feature over time. See the feature support matrix for information on which drivers support the feature at any given release.
- As of the 18.0.0 Rocky release, image signature and trusted image certification validation is not supported with the Libvirt compute driver when using the `rbd` image backend (`[libvirt]/images_type=rbd`) and `RAW` formatted images. This is due to the images being cloned directly in the `RBD` backend avoiding calls to download and verify on the compute.
- As of the 18.0.0 Rocky release, trusted image certification validation is not supported with volume-backed (*boot from volume*) instances. The block storage service support may be available in a future release:

https://blueprints.launchpad.net/cinder/+spec/certificate-validate

- Trusted image certification support can be controlled via policy configuration if it needs to be disabled. See the `os_compute_api:servers:create:trusted_certs` and `os_compute_api:servers:rebuild:trusted_certs` policy rules.

Configuration

Nova will use the key manager defined by the Castellan key manager interface, which is the Barbican key manager by default. To use a different key manager, update the `backend` value in the `[key_manager]` group of the nova configuration file. For example:

```
[key_manager]
backend = barbican
```

Note

If these lines do not exist, then simply add them to the end of the file.

Using Signature Verification

An image will need a few properties for signature verification to be enabled:

`img_signature`
Signature of your image. Signature restrictions are:

- 255 character limit

`img_signature_hash_method`
Method used to hash your signature. Possible hash methods are:

- SHA-224
- SHA-256
- SHA-384
- SHA-512

`img_signature_key_type`
Key type used for your image. Possible key types are:

- RSA-PSS
- DSA
- ECC-CURVES
  - SECT571K1
  - SECT409K1
  - SECT571R1
  - SECT409R1
  - SECP521R1
  - SECP384R1

img_signature_certificate_uuid
UUID of the certificate that you uploaded to the key manager. Possible certificate types are:

- X_509

Using Certificate Validation

Certificate validation is triggered by one of two ways:

1. The Nova configuration options `verify_glance_signatures` and `enable_certificate_validation` are both set to True:

```
[glance]
verify_glance_signatures = True
enable_certificate_validation = True
```

2. A list of trusted certificate IDs is provided by one of three ways:

> **Note**
>
> The command line support is pending changes https://review.opendev.org/#/c/500396/ and https://review.opendev.org/#/c/501926/ to python-novaclient and python-openstackclient, respectively.

Environment Variable
Use the environment variable `OS_TRUSTED_IMAGE_CERTIFICATE_IDS` to define a comma-delimited list of trusted certificate IDs. For example:

```
$ export OS_TRUSTED_IMAGE_CERTIFICATE_IDS=79a6ad17-3298-4e55-8b3a-
↪1672dd93c40f,b20f5600-3c9d-4af5-8f37-3110df3533a0
```

Command-Line Flag
If booting or rebuilding an instance using the **nova** commands, use the `--trusted-image-certificate-id` flag to define a single trusted certificate ID. The flag may be used multiple times to specify multiple trusted certificate IDs. For example:

```
$ nova boot myInstanceName \
    --flavor 1 \
    --image myImageId \
    --trusted-image-certificate-id 79a6ad17-3298-4e55-8b3a-
↪1672dd93c40f \
    --trusted-image-certificate-id b20f5600-3c9d-4af5-8f37-
↪3110df3533a0
```

If booting or rebuilding an instance using the **openstack server** commands, use the `--trusted-image-certificate-id` flag to define a single trusted certificate ID. The flag may be used multiple times to specify multiple trusted certificate IDs. For example:

```
$ openstack --os-compute-api-version=2.63 server create␣
↪myInstanceName \
    --flavor 1 \
    --image myImageId \
```

(continues on next page)

(continued from previous page)

```
    --nic net-id=fd25c0b2-b36b-45a8-82e4-ab52516289e5 \
    --trusted-image-certificate-id 79a6ad17-3298-4e55-8b3a-
↪1672dd93c40f \
    --trusted-image-certificate-id b20f5600-3c9d-4af5-8f37-
↪3110df3533a0
```

Nova Configuration Option

Use the Nova configuration option *glance.default_trusted_certificate_ids* to define a comma-delimited list of trusted certificate IDs. This configuration value is only used if `verify_glance_signatures` and `enable_certificate_validation` options are set to True, and the trusted certificate IDs are not specified anywhere else. For example:

```
[glance]
default_trusted_certificate_ids=79a6ad17-3298-4e55-8b3a-1672dd93c40f,
↪b20f5600-3c9d-4af5-8f37-3110df3533a0
```

Example Usage

For these instructions, we will construct a 4-certificate chain to illustrate that it is possible to have a single trusted root certificate. We will upload all four certificates to Barbican. Then, we will sign an image and upload it to Glance, which will illustrate image signature verification. Finally, we will boot the signed image from Glance to show that certificate validation is enforced.

Enable certificate validation

Enable image signature verification and certificate validation by setting both of their Nova configuration options to True:

```
[glance]
verify_glance_signatures = True
enable_certificate_validation = True
```

Create a certificate chain

As mentioned above, we will construct a 4-certificate chain to illustrate that it is possible to have a single trusted root certificate. Before we begin to build our certificate chain, we must first create files for OpenSSL to use for indexing and serial number tracking:

```
$ touch index.txt
$ echo '01' > serial.txt
```

Create a certificate configuration file

For these instructions, we will create a single configuration file called `ca.conf`, which contains various sections that we can specify for use on the command-line during certificate requests and generation.

Note that this certificate will be able to sign other certificates because it is a certificate authority. Also note the root CAs unique common name (root). The intermediate certificates common names will be specified on the command-line when generating the corresponding certificate requests.

`ca.conf`:

```
[ req ]
prompt             = no
distinguished_name = dn-param
x509_extensions    = ca_cert_extensions

[ ca ]
default_ca = ca_default

[ dn-param ]
C  = US
CN = Root CA

[ ca_cert_extensions ]
keyUsage         = keyCertSign, digitalSignature
basicConstraints = CA:TRUE, pathlen:2

[ ca_default ]
new_certs_dir = .              # Location for new certs after signing
database      = ./index.txt    # Database index file
serial        = ./serial.txt   # The current serial number

default_days  = 1000
default_md    = sha256

policy        = signing_policy
email_in_dn   = no

[ intermediate_cert_extensions ]
keyUsage         = keyCertSign, digitalSignature
basicConstraints = CA:TRUE, pathlen:1

[client_cert_extensions]
keyUsage         = keyCertSign, digitalSignature
basicConstraints = CA:FALSE

[ signing_policy ]
countryName            = optional
stateOrProvinceName    = optional
localityName           = optional
organizationName       = optional
organizationalUnitName = optional
commonName             = supplied
emailAddress           = optional
```

Generate the certificate authority (CA) and corresponding private key

For these instructions, we will save the certificate as `cert_ca.pem` and the private key as `key_ca.pem`. This certificate will be a self-signed root certificate authority (CA) that can sign other CAs and non-CA certificates.

```
$ openssl req \
    -x509 \
    -nodes \
    -newkey rsa:1024 \
    -config ca.conf \
    -keyout key_ca.pem \
    -out cert_ca.pem

Generating a 1024 bit RSA private key
..............................++++++
...++++++
writing new private key to 'key_ca.pem'
-----
```

Create the first intermediate certificate

Create a certificate request for the first intermediate certificate. For these instructions, we will save the certificate request as `cert_intermediate_a.csr` and the private key as `key_intermediate_a.pem`.

```
$ openssl req \
    -nodes \
    -newkey rsa:2048 \
    -subj '/CN=First Intermediate Certificate' \
    -keyout key_intermediate_a.pem \
    -out cert_intermediate_a.csr

Generating a 2048 bit RSA private key
..................................................................................
↪..............................+++
.....+++
writing new private key to 'key_intermediate_a.pem'
-----
```

Generate the first intermediate certificate by signing its certificate request with the CA. For these instructions we will save the certificate as `cert_intermediate_a.pem`.

```
$ openssl ca \
    -config ca.conf \
    -extensions intermediate_cert_extensions \
    -cert cert_ca.pem \
    -keyfile key_ca.pem \
    -out cert_intermediate_a.pem \
    -infiles cert_intermediate_a.csr

Using configuration from ca.conf
Check that the request matches the signature
Signature ok
The Subject's Distinguished Name is as follows
commonName            :ASN.1 12:'First Intermediate Certificate'
Certificate is to be certified until Nov 15 16:24:21 2020 GMT (1000 days)
```

(continues on next page)

(continued from previous page)

```
Sign the certificate? [y/n]:y


1 out of 1 certificate requests certified, commit? [y/n]y
Write out database with 1 new entries
Data Base Updated
```

Create the second intermediate certificate

Create a certificate request for the second intermediate certificate. For these instructions, we will save the certificate request as `cert_intermediate_b.csr` and the private key as `key_intermediate_b.pem`.

```
$ openssl req \
    -nodes \
    -newkey rsa:2048 \
    -subj '/CN=Second Intermediate Certificate' \
    -keyout key_intermediate_b.pem \
    -out cert_intermediate_b.csr

Generating a 2048 bit RSA private key
..........+++
.............................................+++
writing new private key to 'key_intermediate_b.pem'
-----
```

Generate the second intermediate certificate by signing its certificate request with the first intermediate certificate. For these instructions we will save the certificate as `cert_intermediate_b.pem`.

```
$ openssl ca \
    -config ca.conf \
    -extensions intermediate_cert_extensions \
    -cert cert_intermediate_a.pem \
    -keyfile key_intermediate_a.pem \
    -out cert_intermediate_b.pem \
    -infiles cert_intermediate_b.csr

Using configuration from ca.conf
Check that the request matches the signature
Signature ok
The Subject's Distinguished Name is as follows
commonName            :ASN.1 12:'Second Intermediate Certificate'
Certificate is to be certified until Nov 15 16:25:42 2020 GMT (1000 days)
Sign the certificate? [y/n]:y


1 out of 1 certificate requests certified, commit? [y/n]y
Write out database with 1 new entries
Data Base Updated
```

Create the client certificate

Create a certificate request for the client certificate. For these instructions, we will save the certificate request as `cert_client.csr` and the private key as `key_client.pem`.

```
$ openssl req \
    -nodes \
    -newkey rsa:2048 \
    -subj '/CN=Client Certificate' \
    -keyout key_client.pem \
    -out cert_client.csr

Generating a 2048 bit RSA private key
.....................................................................................
↪.....................................................+++
.....................................................................................
↪.................+++
writing new private key to 'key_client.pem'
-----
```

Generate the client certificate by signing its certificate request with the second intermediate certificate. For these instructions we will save the certificate as `cert_client.pem`.

```
$ openssl ca \
    -config ca.conf \
    -extensions client_cert_extensions \
    -cert cert_intermediate_b.pem \
    -keyfile key_intermediate_b.pem \
    -out cert_client.pem \
    -infiles cert_client.csr

Using configuration from ca.conf
Check that the request matches the signature
Signature ok
The Subject's Distinguished Name is as follows
commonName            :ASN.1 12:'Client Certificate'
Certificate is to be certified until Nov 15 16:26:46 2020 GMT (1000 days)
Sign the certificate? [y/n]:y


1 out of 1 certificate requests certified, commit? [y/n]y
Write out database with 1 new entries
Data Base Updated
```

Upload the generated certificates to the key manager

In order interact with the key manager, the user needs to have a `creator` role.

To list all users with a `creator` role, run the following command as an admin:

```
$ openstack role assignment list --role creator --names
```

(continues on next page)

(continued from previous page)

```
+--------+------------------------------+-------+------------------+--------
↪+-----------+
| Role    | User                         | Group | Project          | Domain␣
↪| Inherited |
+--------+------------------------------+-------+------------------+--------
↪+-----------+
| creator | project_a_creator_2@Default |       | project_a@Default |       ␣
↪| False     |
| creator | project_b_creator@Default   |       | project_b@Default |       ␣
↪| False     |
| creator | project_a_creator@Default   |       | project_a@Default |       ␣
↪| False     |
+--------+------------------------------+-------+------------------+--------
↪+-----------+
```

To give the `demo` user a `creator` role in the `demo` project, run the following command as an admin:

```
$ openstack role add --user demo --project demo creator
```

Note

This command provides no output. If the command fails, the user will see a 4xx Client error indicating that Secret creation attempt not allowed and to please review your user/project privileges.

Note

The following openstack secret commands require that the python-barbicanclient package is installed.

```
$ openstack secret store \
    --name CA \
    --algorithm RSA \
    --expiration 2018-06-29 \
    --secret-type certificate \
    --payload-content-type "application/octet-stream" \
    --payload-content-encoding base64 \
    --payload "$(base64 cert_ca.pem)"

$ openstack secret store \
    --name IntermediateA \
    --algorithm RSA \
    --expiration 2018-06-29 \
    --secret-type certificate \
    --payload-content-type "application/octet-stream" \
    --payload-content-encoding base64 \
    --payload "$(base64 cert_intermediate_a.pem)"

$ openstack secret store \
```

(continues on next page)

(continued from previous page)

```
    --name IntermediateB \
    --algorithm RSA \
    --expiration 2018-06-29 \
    --secret-type certificate \
    --payload-content-type "application/octet-stream" \
    --payload-content-encoding base64 \
    --payload "$(base64 cert_intermediate_b.pem)"

$ openstack secret store \
    --name Client \
    --algorithm RSA \
    --expiration 2018-06-29 \
    --secret-type certificate \
    --payload-content-type "application/octet-stream" \
    --payload-content-encoding base64 \
    --payload "$(base64 cert_client.pem)"
```

The responses should look something like this:

```
+---------------+------------------------------------------------------------------
↪-----------------+
| Field         | Value                                                            ␣
↪                 |
+---------------+------------------------------------------------------------------
↪-----------------+
| Secret href   | http://127.0.0.1/key-manager/v1/secrets/8fbcce5d-d646-4295-
↪ba8a-269fc9451eeb |
| Name          | CA                                                               ␣
↪                 |
| Created       | None                                                             ␣
↪                 |
| Status        | None                                                             ␣
↪                 |
| Content types | {u'default': u'application/octet-stream'}                        ␣
↪                 |
| Algorithm     | RSA                                                              ␣
↪                 |
| Bit length    | 256                                                              ␣
↪                 |
| Secret type   | certificate                                                      ␣
↪                 |
| Mode          | cbc                                                              ␣
↪                 |
| Expiration    | 2018-06-29T00:00:00+00:00                                        ␣
↪                 |
+---------------+------------------------------------------------------------------
↪-----------------+
```

Save off the certificate UUIDs (found in the secret href):

```
$ cert_ca_uuid=8fbcce5d-d646-4295-ba8a-269fc9451eeb
$ cert_intermediate_a_uuid=0b5d2c72-12cc-4ba6-a8d7-3ff5cc1d8cb8
$ cert_intermediate_b_uuid=674736e3-f25c-405c-8362-bbf991e0ce0a
$ cert_client_uuid=125e6199-2de4-46e3-b091-8e2401ef0d63
```

Create a signed image

For these instructions, we will download a small CirrOS image:

```
$ wget -nc -O cirros.tar.gz http://download.cirros-cloud.net/0.3.5/cirros-0.3.
↪5-source.tar.gz

--2018-02-19 11:37:52--  http://download.cirros-cloud.net/0.3.5/cirros-0.3.5-
↪source.tar.gz
Resolving download.cirros-cloud.net (download.cirros-cloud.net)... 64.90.42.85
Connecting to download.cirros-cloud.net (download.cirros-cloud.net)|64.90.42.
↪85|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 434333 (424K) [application/x-tar]
Saving to: cirros.tar.gz

cirros.tar.gz       100%[===================>] 424.15K  --.-KB/s    in 0.1s

2018-02-19 11:37:54 (3.79 MB/s) - cirros.tar.gz saved [434333/434333]
```

Sign the image with the generated client private key:

```
$ openssl dgst \
    -sha256 \
    -sign key_client.pem \
    -sigopt rsa_padding_mode:pss \
    -out cirros.self_signed.signature \
    cirros.tar.gz
```

Note

This command provides no output.

Save off the base64 encoded signature:

```
$ base64_signature=$(base64 -w 0 cirros.self_signed.signature)
```

Upload the signed image to Glance:

```
$ openstack image create \
    --public \
    --container-format bare \
    --disk-format qcow2 \
    --property img_signature="$base64_signature" \
```

(continues on next page)

(continued from previous page)

```
    --property img_signature_certificate_uuid="$cert_client_uuid" \
    --property img_signature_hash_method='SHA-256' \
    --property img_signature_key_type='RSA-PSS' \
    --file cirros.tar.gz \
    cirros_client_signedImage

+------------------+------------------------------------------------------------
↪--------------+
| Field            | Value                                                      ␣
↪              |
+------------------+------------------------------------------------------------
↪--------------+
| checksum         | d41d8cd98f00b204e9800998ecf8427e                           ␣
↪              |
| container_format | bare                                                       ␣
↪              |
| created_at       | 2019-02-06T06:29:56Z                                       ␣
↪              |
| disk_format      | qcow2                                                      ␣
↪              |
| file             | /v2/images/17f48a6c-e592-446e-9c91-00fbc436d47e/file       ␣
↪              |
| id               | 17f48a6c-e592-446e-9c91-00fbc436d47e                       ␣
↪              |
| min_disk         | 0                                                          ␣
↪              |
| min_ram          | 0                                                          ␣
↪              |
| name             | cirros_client_signedImage                                  ␣
↪              |
| owner            | 45e13e63606f40d6b23275c3cd91aec2                           ␣
↪              |
| properties       | img_signature='swA/
↪hZi3WaNh35VMGlnfGnBWuXMlUbdO8h306uG7W3nwOyZP6dGRJ3  |
|                  | Xoi/
↪07Bo2dMUB9saFowqVhdlW5EywQAK6vgDsi9O5aItHM4u7zUPw+2e8eeaIoHlGhTks  |
|                  |␣
↪kmW9isLy0mYA9nAfs3coChOIPXW4V8VgVXEfb6VYGHWm0nShiAP1e0do9WwitsE/TVKoS  |
|                  | QnWjhggIYij5hmUZ628KAygPnXklxVhqPpY/
↪dFzL+tTzNRD0nWAtsc5wrl6/8HcNzZsaP  |
|                  |␣
↪oexAysXJtcFzDrf6UQu66D3UvFBVucRYL8S3W56It3Xqu0+InLGaXJJpNagVQBb476zB2  |
|                  | ZzZ5RJ/4Zyxw==',                                           ␣
↪              |
|                  | img_signature_certificate_uuid='125e6199-2de4-46e3-b091-
↪8e2401ef0d63', |
|                  | img_signature_hash_method='SHA-256',                       ␣
↪              |
|                  | img_signature_key_type='RSA-PSS',                          ␣
```

(continues on next page)

(continued from previous page)

```
↪               |
|                 | os_hash_algo='sha512',                                  ␣
↪               |
|                 | os_hash_value=
↪'cf83e1357eefb8bdf1542850d66d8007d620e4050b5715dc83f4a92 |
|                 |␣
↪1d36ce9ce47d0d13c5d85f2b0ff8318d2877eec2f63b931bd47417a81a538327af927d |
|                 | a3e',                                                   ␣
↪               |
|                 | os_hidden='False'                                       ␣
↪               |
| protected       | False                                                   ␣
↪               |
| schema          | /v2/schemas/image                                       ␣
↪               |
| size            | 0                                                       ␣
↪               |
| status          | active                                                  ␣
↪               |
| tags            |                                                         ␣
↪               |
| updated_at      | 2019-02-06T06:29:56Z                                    ␣
↪               |
| virtual_size    | None                                                    ␣
↪               |
| visibility      | public                                                  ␣
↪               |
+-----------------+---------------------------------------------------------
↪--------------+
```

Note

Creating the image can fail if validation does not succeed. This will cause the image to be deleted and the Glance log to report that Signature verification failed for the given image ID.

Boot the signed image

Boot the signed image without specifying trusted certificate IDs:

```
$ nova boot myInstance \
    --flavor m1.tiny \
    --image cirros_client_signedImage
```

Note

The instance should fail to boot because certificate validation fails when the feature is enabled but no trusted image certificates are provided. The Nova log output should indicate that Image signature certificate validation failed because Certificate chain building failed.

Boot the signed image with trusted certificate IDs:

```
$ nova boot myInstance \
    --flavor m1.tiny \
    --image cirros_client_signedImage \
    --trusted-image-certificate-id $cert_ca_uuid,$cert_intermediate_a_uuid \
    --trusted-image-certificate-id $cert_intermediate_b_uuid
```

Note

The instance should successfully boot and certificate validation should succeed. The Nova log output should indicate that Image signature certificate validation succeeded.

Other Links

- https://etherpad.openstack.org/p/mitaka-glance-image-signing-instructions
- https://etherpad.openstack.org/p/queens-nova-certificate-validation
- https://wiki.openstack.org/wiki/OpsGuide/User-Facing_Operations
- http://specs.openstack.org/openstack/nova-specs/specs/rocky/approved/nova-validate-certificates.html

2.1.1.8 Resize an instance

You can change the size of an instance by changing its flavor. This rebuilds the instance and therefore results in a restart.

To list the VMs you want to resize, run:

```
$ openstack server list
```

Once you have the name or UUID of the server you wish to resize, resize it using the **`openstack server resize`** command:

```
$ openstack server resize --flavor FLAVOR SERVER
```

Note

By default, the **`openstack server resize`** command gives the guest operating system a chance to perform a controlled shutdown before the instance is powered off and the instance is resized. This behavior can be configured by the administrator but it can also be overridden on a per image basis using the `os_shutdown_timeout` image metadata setting. This allows different types of operating systems to specify how much time they need to shut down cleanly. See Useful image properties for details.

Resizing can take some time. During this time, the instance status will be `RESIZE`:

```
$ openstack server list
+----------------------+----------------+--------+----------------------------
```

(continues on next page)

(continued from previous page)

```
↪-------------+
| ID                   | Name           | Status | Networks                ␣
↪              |
+----------------------+----------------+--------+--------------------------
↪-------------+
| 67bc9a9a-5928-47c... | myCirrosServer | RESIZE | admin_internal_net=192.168.
↪111.139      |
+----------------------+----------------+--------+--------------------------
↪-------------+
```

When the resize completes, the instance status will be `VERIFY_RESIZE`. You can now confirm the resize to change the status to `ACTIVE`:

```
$ openstack server resize confirm SERVER
```

Note

The resized server may be automatically confirmed based on the administrators configuration of the deployment.

If the resize does not work as expected, you can revert the resize. This will revert the instance to the old flavor and change the status to `ACTIVE`:

```
$ openstack server resize revert SERVER
```

2.1.1.9 Reboot an instance

You can soft or hard reboot a running instance. A soft reboot attempts a graceful shut down and restart of the instance. A hard reboot power cycles the instance.

To reboot a server, use the **`openstack server reboot`** command:

```
$ openstack server reboot SERVER
```

By default, when you reboot an instance it is a soft reboot. To perform a hard reboot, pass the `--hard` parameter as follows:

```
$ openstack server reboot --hard SERVER
```

It is also possible to reboot a running instance into rescue mode. For example, this operation may be required if a filesystem of an instance becomes corrupted with prolonged use. See *Rescue an instance* for more details.

2.1.1.10 Rescue an instance

Instance rescue provides a mechanism for access, even if an image renders the instance inaccessible. Two rescue modes are currently provided.

Instance rescue

By default the instance is booted from the provided rescue image or a fresh copy of the original instance image if a rescue image is not provided. The root disk and optional regenerated config drive are also attached to the instance for data recovery.

Note

Rescuing a volume-backed instance is not supported with this mode.

Stable device instance rescue

As of 21.0.0 (Ussuri) an additional stable device rescue mode is available. This mode now supports the rescue of volume-backed instances.

This mode keeps all devices both local and remote attached in their original order to the instance during the rescue while booting from the provided rescue image. This mode is enabled and controlled by the presence of `hw_rescue_device` or `hw_rescue_bus` image properties on the provided rescue image.

As their names suggest these properties control the rescue device type (`cdrom`, `disk` or `floppy`) and bus type (`scsi`, `virtio`, `ide`, or `usb`) used when attaching the rescue image to the instance.

Support for each combination of the `hw_rescue_device` and `hw_rescue_bus` image properties is dependent on the underlying hypervisor and platform being used. For example the `IDE` bus is not available on POWER KVM based compute hosts.

Note

This mode is only supported when using the Libvirt virt driver.

This mode is not supported when using the LXC hypervisor as enabled by the *`libvirt.virt_type`* configurable on the computes.

Usage

Note

Pause, suspend, and stop operations are not allowed when an instance is running in rescue mode, as triggering these actions causes the loss of the original instance state and makes it impossible to unrescue the instance.

To perform an instance rescue, use the **`openstack server rescue`** command:

```
$ openstack server rescue SERVER
```

Note

On running the **`openstack server rescue`** command, an instance performs a soft shutdown first. This means that the guest operating system has a chance to perform a controlled shutdown before the instance is powered off. The shutdown behavior is configured by the *`shutdown_timeout`* parameter

that can be set in the `nova.conf` file. Its value stands for the overall period (in seconds) a guest operating system is allowed to complete the shutdown.

The timeout value can be overridden on a per image basis by means of `os_shutdown_timeout` that is an image metadata setting allowing different types of operating systems to specify how much time they need to shut down cleanly.

To rescue an instance that boots from a volume you need to use the *2.87 microversion or later*.

```
$ openstack --os-compute-api-version 2.87 server rescue SERVER
```

If you want to rescue an instance with a specific image, rather than the default one, use the `--image` parameter:

```
$ openstack server rescue --image IMAGE_ID SERVER
```

To restart the instance from the normal boot disk, run the following command:

```
$ openstack server unrescue SERVER
```

2.1.1.11 Block Device Mapping in Nova

Nova has a concept of block devices that can be exposed to cloud instances. There are several types of block devices an instance can have (we will go into more details about this later in this document), and which ones are available depends on a particular deployment and the usage limitations set for tenants and users. Block device mapping is a way to organize and keep data about all of the block devices an instance has.

When we talk about block device mapping, we usually refer to one of two things

1. API/CLI structure and syntax for specifying block devices for an instance boot request
2. The data structure internal to Nova that is used for recording and keeping, which is ultimately persisted in the block_device_mapping table. However, Nova internally has several slightly different formats for representing the same data. All of them are documented in the code and or presented by a distinct set of classes, but not knowing that they exist might trip up people reading the code. So in addition to BlockDeviceMapping[1] objects that mirror the database schema, we have:

   2.1 The API format - this is the set of raw key-value pairs received from the API client, and is almost immediately transformed into the object; however, some validations are done using this format. We will refer to this format as the API BDMs from now on.

   2.2 The virt driver format - this is the format defined by the classes in `nova.virt.block_device`. This format is used and expected by the code in the various virt drivers. These classes, in addition to exposing a different format (mimicking the Python dict interface), also provide a place to bundle some functionality common to certain types of block devices (for example attaching volumes which has to interact with both Cinder and the virt driver code). We will refer to this format as Driver BDMs from now on.

   For more details on this please refer to the *Driver BDM Data Structures* reference document.

[1] In addition to the BlockDeviceMapping Nova object, we also have the BlockDeviceDict class in `nova.block_device` module. This class handles transforming and validating the API BDM format.

Note

The maximum limit on the number of disk devices allowed to attach to a single server is configurable with the option *compute.max_disk_devices_to_attach*.

API BDM data format and its history

In the early days of Nova, block device mapping general structure closely mirrored that of the EC2 API. During the Havana release of Nova, block device handling code, and in turn the block device mapping structure, had work done on improving the generality and usefulness. These improvements included exposing additional details and features in the API. In order to facilitate this, a new extension was added to the v2 API called `BlockDeviceMappingV2Boot`[2], that added an additional `block_device_mapping_v2` field to the instance boot API request.

Block device mapping v1 (aka legacy)

This was the original format that supported only cinder volumes (similar to how EC2 block devices support only EBS volumes). Every entry was keyed by device name (we will discuss why this was problematic in its own section later on this page), and would accept only:

- UUID of the Cinder volume or snapshot
- Type field - used only to distinguish between volumes and Cinder volume snapshots
- Optional size field
- Optional `delete_on_termination` flag

While all of Nova internal code only uses and stores the new data structure, we still need to handle API requests that use the legacy format. This is handled by the Nova API service on every request. As we will see later, since block device mapping information can also be stored in the image metadata in Glance, this is another place where we need to handle the v1 format. The code to handle legacy conversions is part of the `nova.block_device` module.

Intermezzo - problem with device names

Using device names as the primary per-instance identifier, and exposing them in the API, is problematic for Nova mostly because several hypervisors Nova supports with its drivers cant guarantee that the device names the guest OS assigns are the ones the user requested from Nova. Exposing such a detail in the public API of Nova is obviously not ideal, but it needed to stay for backwards compatibility. It is also required for some (slightly obscure) features around overloading a block device in a Glance image when booting an instance[3].

The plan for fixing this was to allow users to not specify the device name of a block device, and Nova will determine it (with the help of the virt driver), so that it can still be discovered through the API and used when necessary, like for the features mentioned above (and preferably only then).

Another use for specifying the device name was to allow the boot from volume functionality, by specifying a device name that matches the root device name for the instance (usually `/dev/vda`).

Currently (mid Liberty) users are discouraged from specifying device names for all calls requiring or allowing block device mapping, except when trying to override the image block device mapping on

[2] This work predates API microversions and thus the only way to add it was by means of an API extension.

[3] This is a feature that the EC2 API offers as well and has been in Nova for a long time, although it has been broken in several releases. More info can be found on this bug

instance boot, and it will likely remain like that in the future. Libvirt device driver will outright override any device names passed with its own values.

Block device mapping v2

New format was introduced in an attempt to solve issues with the original block device mapping format discussed above, and also to allow for more flexibility and addition of features that were not possible with the simple format we had.

New block device mapping is a list of dictionaries containing the following fields (in addition to the ones that were already there):

- source_type - this can have one of the following values:
  - `image`
  - `volume`
  - `snapshot`
  - `blank`
- destination_type - this can have one of the following values:
  - `local`
  - `volume`
- guest_format - Tells Nova how/if to format the device prior to attaching, should be only used with blank local images. Denotes a swap disk if the value is `swap`.
- device_name - See the previous section for a more in depth explanation of this - currently best left empty (not specified that is), unless the user wants to override the existing device specified in the image metadata. In case of Libvirt, even when passed in with the purpose of overriding the existing image metadata, final set of device names for the instance may still get changed by the driver.
- disk_bus and device_type - low level details that some hypervisors (currently only libvirt) may support. Some example disk_bus values can be: `ide`, `usb`, `virtio`, `scsi`, while device_type may be `disk`, `cdrom`, `floppy`, `lun`. This is not an exhaustive list as it depends on the virtualization driver, and may change as more support is added. Leaving these empty is the most common thing to do.
- boot_index - Defines the order in which a hypervisor will try devices when attempting to boot the guest from storage. Each device which is capable of being used as boot device should be given a unique boot index, starting from 0 in ascending order. Some hypervisors may not support booting from multiple devices, so will only consider the device with boot index of 0. Some hypervisors will support booting from multiple devices, but only if they are of different types - eg a disk and CD-ROM. Setting a negative value or None indicates that the device should not be used for booting. The simplest usage is to set it to 0 for the boot device and leave it as None for any other devices.
- volume_type - Added in microversion 2.67 to the servers create API to support specifying volume type when booting instances. When we snapshot a volume-backed server, the block_device_mapping_v2 image metadata will include the volume_type from the BDM record so if the user then creates another server from that snapshot, the volume that nova creates from that snapshot will use the same volume_type. If a user wishes to change that volume type in the image metadata, they can do so via the image API.

Valid source / destination combinations

Combination of the `source_type` and `destination_type` will define the kind of block device the entry is referring to. The following combinations are supported:

- `image` -> `local` - this is only currently reserved for the entry referring to the Glance image that the instance is being booted with (it should also be marked as a boot device). It is also worth noting that an API request that specifies this, also has to provide the same Glance uuid as the `image_ref` parameter to the boot request (this is done for backwards compatibility and may be changed in the future). This functionality might be extended to specify additional Glance images to be attached to an instance after boot (similar to kernel/ramdisk images) but this functionality is not supported by any of the current drivers.
- `volume` -> `volume` - this is just a Cinder volume to be attached to the instance. It can be marked as a boot device.
- `snapshot` -> `volume` - this works exactly as passing `type=snap` does. It would create a volume from a Cinder volume snapshot and attach that volume to the instance. Can be marked bootable.
- `image` -> `volume` - As one would imagine, this would download a Glance image to a cinder volume and attach it to an instance. Can also be marked as bootable. This is really only a shortcut for creating a volume out of an image before booting an instance with the newly created volume.
- `blank` -> `volume` - Creates a blank Cinder volume and attaches it. This will also require the volume size to be set.
- `blank` -> `local` - Depending on the guest_format field (see below), this will either mean an ephemeral blank disk on hypervisor local storage, or a swap disk (instances can have only one of those).

Nova will not allow mixing of BDMv1 and BDMv2 in a single request, and will do basic validation to make sure that the requested block device mapping is valid before accepting a boot request.

FAQs

1. Is it possible to configure nova to automatically use cinder to back all root disks with volumes?

   No, there is nothing automatic within nova that converts a non-*boot-from-volume* request to convert the image to a root volume. Several ideas have been discussed over time which are captured in the spec for volume-backed flavors. However, if you wish to force users to always create volume-backed servers, you can configure the API service by setting *`max_local_block_devices`* to 0. This will result in any non-boot-from-volume server create request to fail with a 400 response.

2.1.1.12 REST API Version History

This documents the changes made to the REST API with every microversion change. The description for each version should be a verbose one which has enough information to be suitable for use in user documentation.

2.1

This is the initial version of the v2.1 API which supports microversions. The V2.1 API is from the REST API users point of view exactly the same as v2.0 except with strong input validation.

A user can specify a header in the API request:

```
X-OpenStack-Nova-API-Version: <version>
```

where <version> is any valid api version for this API.

If no version is specified then the API will behave as if a version request of v2.1 was requested.

2.2

Added Keypair type.

A user can request the creation of a certain type of keypair (`ssh` or `x509`) in the `os-keypairs` plugin

If no keypair type is specified, then the default `ssh` type of keypair is created.

Fixes status code for `os-keypairs` create method from 200 to 201

Fixes status code for `os-keypairs` delete method from 202 to 204

2.3 (Maximum in Kilo)

Exposed additional attributes in `os-extended-server-attributes`: `reservation_id`, `launch_index`, `ramdisk_id`, `kernel_id`, `hostname`, `root_device_name`, `userdata`.

Exposed `delete_on_termination` for `volumes_attached` in `os-extended-volumes`.

This change is required for the extraction of EC2 API into a standalone service. It exposes necessary properties absent in public nova APIs yet. Add info for Standalone EC2 API to cut access to Nova DB.

2.4

Show the `reserved` status on a `FixedIP` object in the `os-fixed-ips` API extension. The extension allows one to `reserve` and `unreserve` a fixed IP but the show method does not report the current status.

2.5

Before version 2.5, the command `nova list --ip6 xxx` returns all servers for non-admins, as the filter option is silently discarded. There is no reason to treat ip6 different from ip, though, so we just add this option to the allowed list.

2.6

A new API for getting remote console is added:

```
POST /servers/<uuid>/remote-consoles
{
  "remote_console": {
    "protocol": ["vnc"|"rdp"|"serial"|"spice"],
    "type": ["novnc"|"xpvnc"|"rdp-html5"|"spice-html5"|"serial"]
  }
}
```

Example response:

```
{
  "remote_console": {
    "protocol": "vnc",
    "type": "novnc",
    "url": "http://example.com:6080/vnc_auto.html?path=%3Ftoken%3DXYZ"
  }
}
```

The old APIs `os-getVNCConsole`, `os-getSPICEConsole`, `os-getSerialConsole` and `os-getRDPConsole` are removed.

2.7

Check the `is_public` attribute of a flavor before adding tenant access to it. Reject the request with `HTTPConflict` error.

2.8

Add `mks` protocol and `webmks` type for remote consoles.

2.9

Add a new `locked` attribute to the detailed view, update, and rebuild action. `locked` will be `true` if anyone is currently holding a lock on the server, `false` otherwise.

2.10

Added `user_id` parameter to `os-keypairs` plugin, as well as a new property in the request body, for the create operation.

Administrators will be able to list, get details and delete keypairs owned by users other than themselves and to create new keypairs on behalf of their users.

2.11

Exposed attribute `forced_down` for `os-services`. Added ability to change the `forced_down` attribute by calling an update.

2.12 (Maximum in Liberty)

Exposes VIF `net_id` attribute in `os-virtual-interfaces`. User will be able to get Virtual Interfaces `net_id` in Virtual Interfaces list and can determine in which network a Virtual Interface is plugged into.

2.13

Add information `project_id` and `user_id` to `os-server-groups` API response data.

2.14

Remove `onSharedStorage` parameter from servers evacuate action. Nova will automatically detect if the instance is on shared storage.

`adminPass` is removed from the response body. The user can get the password with the servers `os-server-password` action.

2.15

From this version of the API users can choose soft-affinity and soft-anti-affinity rules too for server-groups.

2.16

Exposes new `host_status` attribute for servers/detail and servers/{server_id}. Ability to get nova-compute status when querying servers. By default, this is only exposed to cloud administrators.

2.17

Add a new API for triggering crash dump in an instance. Different operation systems in instance may need different configurations to trigger crash dump.

2.18

Establishes a set of routes that makes project_id an optional construct in v2.1.

2.19

Allow the user to set and get the server description. The user will be able to set the description when creating, rebuilding, or updating a server, and get the description as part of the server details.

2.20

From this version of the API user can call detach and attach volumes for instances which are in `shelved` and `shelved_offloaded` state.

2.21

The `os-instance-actions` API now returns information from deleted instances.

2.22

A new resource, `servers:migrations`, is added. A new API to force live migration to complete added:

```
POST /servers/<uuid>/migrations/<id>/action
{
  "force_complete": null
}
```

2.23

From this version of the API users can get the migration summary list by index API or the information of a specific migration by get API. Add `migration_type` for old `/os-migrations` API, also add `ref` link to the `/servers/{uuid}/migrations/{id}` for it when the migration is an in-progress live-migration.

2.24

A new API call to cancel a running live migration:

```
DELETE /servers/<uuid>/migrations/<id>
```

2.25 (Maximum in Mitaka)

Modify input parameter for `os-migrateLive`. The `block_migration` field now supports an `auto` value and the `disk_over_commit` flag is removed.

2.26

Added support of server tags.

A user can create, update, delete or check existence of simple string tags for servers by the `os-server-tags` plugin.

Tags have the following schema restrictions:

- Tag is a Unicode bytestring no longer than 60 characters.
- Tag is a non-empty string.
- / is not allowed to be in a tag name
- Comma is not allowed to be in a tag name in order to simplify requests that specify lists of tags
- All other characters are allowed to be in a tag name
- Each server can have up to 50 tags.

The resource point for these operations is `/servers/<server_id>/tags`.

A user can add a single tag to the server by making a `PUT` request to `/servers/<server_id>/tags/<tag>`.

where `<tag>` is any valid tag name.

A user can replace **all** current server tags to the new set of tags by making a `PUT` request to the `/servers/<server_id>/tags`. The new set of tags must be specified in request body. This set must be in list `tags`.

A user can remove specified tag from the server by making a `DELETE` request to `/servers/<server_id>/tags/<tag>`.

where `<tag>` is tag name which user wants to remove.

A user can remove **all** tags from the server by making a `DELETE` request to the `/servers/<server_id>/tags`.

A user can get a set of server tags with information about server by making a `GET` request to `/servers/<server_id>`.

Request returns dictionary with information about specified server, including list `tags`:

```
{
    'id': {server_id},
    ...
    'tags': ['foo', 'bar', 'baz']
}
```

A user can get **only** a set of server tags by making a `GET` request to `/servers/<server_id>/tags`.

Response

```
{
   'tags': ['foo', 'bar', 'baz']
}
```

A user can check if a tag exists or not on a server by making a `GET` request to `/servers/{server_id}/tags/{tag}`.

Request returns `204 No Content` if tag exist on a server or `404 Not Found` if tag doesnt exist on a server.

A user can filter servers in `GET /servers` request by new filters:

- `tags`
- `tags-any`
- `not-tags`
- `not-tags-any`

These filters can be combined. Also user can use more than one string tags for each filter. In this case string tags for each filter must be separated by comma. For example:

```
GET /servers?tags=red&tags-any=green,orange
```

2.27

Added support for the new form of microversion headers described in the Microversion Specification. Both the original form of header and the new form is supported.

2.28

Nova API `hypervisor.cpu_info` change from string to JSON object.

From this version of the API the hypervisors `cpu_info` field will be returned as JSON object (not string) by sending GET request to the `/v2.1/os-hypervisors/{hypervisor_id}`.

2.29

Updates the POST request body for the `evacuate` action to include the optional `force` boolean field defaulted to False. Also changes the evacuate action behaviour when providing a `host` string field by calling the nova scheduler to verify the provided host unless the `force` attribute is set.

2.30

Updates the POST request body for the `live-migrate` action to include the optional `force` boolean field defaulted to False. Also changes the live-migrate action behaviour when providing a `host` string field by calling the nova scheduler to verify the provided host unless the `force` attribute is set.

2.31

Fix `os-console-auth-tokens` to return connection info for all types of tokens, not just RDP.

2.32

Adds an optional, arbitrary tag item to the networks item in the server boot request body. In addition, every item in the block_device_mapping_v2 array can also have an optional, arbitrary tag item. These tags are used to identify virtual device metadata, as exposed in the metadata API and on the config drive. For example, a network interface on the virtual PCI bus tagged with nic1 will appear in the metadata along with its bus (PCI), bus address (ex: 0000:00:02.0), MAC address, and tag (nic1).

Note

A bug has caused the tag attribute to no longer be accepted for networks starting with version 2.37 and for block_device_mapping_v2 starting with version 2.33. In other words, networks could only be tagged between versions 2.32 and 2.36 inclusively and block devices only in version 2.32. As of version 2.42 the tag attribute has been restored and both networks and block devices can be tagged again.

2.33

Support pagination for hypervisor by accepting limit and marker from the GET API request:

```
GET /v2.1/{tenant_id}/os-hypervisors?marker={hypervisor_id}&limit={limit}
```

In the context of device tagging at server create time, 2.33 also removes the tag attribute from block_device_mapping_v2. This is a bug that is fixed in 2.42, in which the tag attribute is reintroduced.

2.34

Checks in `os-migrateLive` before live-migration actually starts are now made in background. `os-migrateLive` is not throwing *400 Bad Request* if pre-live-migration checks fail.

2.35

Added pagination support for keypairs.

Optional parameters limit and marker were added to GET /os-keypairs request, the default sort_key was changed to name field as ASC order, the generic request format is:

```
GET /os-keypairs?limit={limit}&marker={kp_name}
```

2.36

All the APIs which proxy to another service were deprecated in this version, also the fping API. Those APIs will return 404 with Microversion 2.36. The network related quotas and limits are removed from API also. The deprecated API endpoints as below:

```
'/images'
'/os-networks'
'/os-tenant-networks'
'/os-fixed-ips'
'/os-floating-ips'
'/os-floating-ips-bulk'
'/os-floating-ip-pools'
'/os-floating-ip-dns'
'/os-security-groups'
'/os-security-group-rules'
'/os-security-group-default-rules'
'/os-volumes'
'/os-snapshots'
'/os-baremetal-nodes'
'/os-fping'
```

Note

A regression was introduced in this microversion which broke the `force` parameter in the `PUT /os-quota-sets` API. The fix will have to be applied to restore this functionality.

Changed in version 18.0.0: The `os-fping` API was completely removed in the 18.0.0 (Rocky) release. On deployments newer than this, the API will return HTTP 410 (Gone) regardless of the requested microversion.

Changed in version 21.0.0: The `os-security-group-default-rules` API was completely removed in the 21.0.0 (Ussuri) release. On deployments newer than this, the APIs will return HTTP 410 (Gone) regardless of the requested microversion.

Changed in version 21.0.0: The `os-networks` API was partially removed in the 21.0.0 (Ussuri) release. On deployments newer than this, some endpoints of the API will return HTTP 410 (Gone) regardless of the requested microversion.

Changed in version 21.0.0: The `os-tenant-networks` API was partially removed in the 21.0.0 (Ussuri) release. On deployments newer than this, some endpoints of the API will return HTTP 410 (Gone) regardless of the requested microversion.

2.37

Added support for automatic allocation of networking, also known as Get Me a Network. With this microversion, when requesting the creation of a new server (or servers) the `networks` entry in the `server` portion of the request body is required. The `networks` object in the request can either be a list or an enum with values:

1. *none* which means no networking will be allocated for the created server(s).
2. *auto* which means either a network that is already available to the project will be used, or if one

does not exist, will be automatically created for the project. Automatic network allocation for a project only happens once for a project. Subsequent requests using *auto* for the same project will reuse the network that was previously allocated.

Also, the `uuid` field in the `networks` object in the server create request is now strictly enforced to be in UUID format.

In the context of device tagging at server create time, 2.37 also removes the tag attribute from networks. This is a bug that is fixed in 2.42, in which the tag attribute is reintroduced.

2.38 (Maximum in Newton)

Before version 2.38, the command `nova list --status invalid_status` was returning empty list for non admin user and 500 InternalServerError for admin user. As there are sufficient statuses defined already, any invalid status should not be accepted. From this version of the API admin as well as non admin user will get 400 HTTPBadRequest if invalid status is passed to nova list command.

2.39

Deprecates image-metadata proxy API that is just a proxy for Glance API to operate the image metadata. Also removes the extra quota enforcement with Nova *metadata* quota (quota checks for createImage and createBackup actions in Nova were removed). After this version Glance configuration option *image_property_quota* should be used to control the quota of image metadatas. Also, removes the *maxImageMeta* field from *os-limits* API response.

2.40

Optional query parameters `limit` and `marker` were added to the `os-simple-tenant-usage` endpoints for pagination. If a limit isnt provided, the configurable `max_limit` will be used which currently defaults to 1000.

```
GET /os-simple-tenant-usage?limit={limit}&marker={instance_uuid}
GET /os-simple-tenant-usage/{tenant_id}?limit={limit}&marker={instance_uuid}
```

A tenants usage statistics may span multiple pages when the number of instances exceeds limit, and API consumers will need to stitch together the aggregate results if they still want totals for all instances in a specific time window, grouped by tenant.

Older versions of the `os-simple-tenant-usage` endpoints will not accept these new paging query parameters, but they will start to silently limit by `max_limit` to encourage the adoption of this new microversion, and circumvent the existing possibility of DoS-like usage requests when there are thousands of instances.

2.41

The uuid attribute of an aggregate is now returned from calls to the */os-aggregates* endpoint. This attribute is auto-generated upon creation of an aggregate. The *os-aggregates* API resource endpoint remains an administrator-only API.

2.42 (Maximum in Ocata)

In the context of device tagging at server create time, a bug has caused the tag attribute to no longer be accepted for networks starting with version 2.37 and for block_device_mapping_v2 starting with version 2.33. Microversion 2.42 restores the tag parameter to both networks and block_device_mapping_v2, allowing networks and block devices to be tagged again.

2.43

The `os-hosts` API is deprecated as of the 2.43 microversion. Requests made with microversion >= 2.43 will result in a 404 error. To list and show host details, use the `os-hypervisors` API. To enable or disable a service, use the `os-services` API. There is no replacement for the *shutdown*, *startup*, *reboot*, or *maintenance_mode* actions as those are system-level operations which should be outside of the control of the compute service.

2.44

The following APIs which are considered as proxies of Neutron networking API, are deprecated and will result in a 404 error response in new Microversion:

```
POST /servers/{server_uuid}/action
{
    "addFixedIp": {...}
}

POST /servers/{server_uuid}/action
{
    "removeFixedIp": {...}
}

POST /servers/{server_uuid}/action
{
    "addFloatingIp": {...}
}

POST /servers/{server_uuid}/action
{
    "removeFloatingIp": {...}
}
```

Those server actions can be replaced by calling the Neutron API directly.

The nova-network specific API to query the servers interfaces is deprecated:

```
GET /servers/{server_uuid}/os-virtual-interfaces
```

To query attached neutron interfaces for a specific server, the API *GET /servers/{server_uuid}/os-interface* can be used.

2.45

The `createImage` and `createBackup` server action APIs no longer return a `Location` header in the response for the snapshot image, they now return a json dict in the response body with an `image_id` key and uuid value.

2.46

The request_id created for every inbound request is now returned in `X-OpenStack-Request-ID` in addition to `X-Compute-Request-ID` to be consistent with the rest of OpenStack. This is a signaling only microversion, as these header settings happen well before microversion processing.

2.47

Replace the `flavor` name/ref with the actual flavor details from the embedded flavor object when displaying server details. Requests made with microversion >= 2.47 will no longer return the flavor ID/link but instead will return a subset of the flavor details. If the user is prevented by policy from indexing extra-specs, then the `extra_specs` field will not be included in the flavor information.

2.48

Before version 2.48, VM diagnostics response was just a blob of data returned by each hypervisor. From this version VM diagnostics response is standardized. It has a set of fields which each hypervisor will try to fill. If a hypervisor driver is unable to provide a specific field then this field will be reported as None.

2.49

Continuing from device role tagging at server create time introduced in version 2.32 and later fixed in 2.42, microversion 2.49 allows the attachment of network interfaces and volumes with an optional `tag` parameter. This tag is used to identify the virtual devices in the guest and is exposed in the metadata API. Because the config drive cannot be updated while the guest is running, it will only contain metadata of devices that were tagged at boot time. Any changes made to devices while the instance is running - be it detaching a tagged device or performing a tagged device attachment - will not be reflected in the config drive.

Tagged volume attachment is not supported for shelved-offloaded instances.

2.50

The `server_groups` and `server_group_members` keys are exposed in GET & PUT `os-quota-class-sets` APIs Response body. Networks related quotas have been filtered out from os-quota-class. Below quotas are filtered out and not available in `os-quota-class-sets` APIs from this microversion onwards.

- fixed_ips
- floating_ips
- networks,
- security_group_rules
- security_groups

2.51

There are two changes for the 2.51 microversion:

- Add `volume-extended` event name to the `os-server-external-events` API. This will be used by the Block Storage service when extending the size of an attached volume. This signals the Compute service to perform any necessary actions on the compute host or hypervisor to adjust for the new volume block device size.
- Expose the `events` field in the response body for the `GET /servers/{server_id}/os-instance-actions/{request_id}` API. This is useful for API users to monitor when a volume extend operation completes for the given server instance. By default only users with the administrator role will be able to see event `traceback` details.

2.52

Adds support for applying tags when creating a server. The tag schema is the same as in the *2.26* microversion.

2.53 (Maximum in Pike)

os-services

Services are now identified by uuid instead of database id to ensure uniqueness across cells. This microversion brings the following changes:

- `GET /os-services` returns a uuid in the `id` field of the response
- `DELETE /os-services/{service_uuid}` requires a service uuid in the path
- The following APIs have been superseded by `PUT /os-services/{service_uuid}/`:
  - `PUT /os-services/disable`
  - `PUT /os-services/disable-log-reason`
  - `PUT /os-services/enable`
  - `PUT /os-services/force-down`

  `PUT /os-services/{service_uuid}` takes the following fields in the body:
  - `status` - can be either enabled or disabled to enable or disable the given service
  - `disabled_reason` - specify with status=disabled to log a reason for why the service is disabled
  - `forced_down` - boolean indicating if the service was forced down by an external service
- `PUT /os-services/{service_uuid}` will now return a full service resource representation like in a `GET` response

os-hypervisors

Hypervisors are now identified by uuid instead of database id to ensure uniqueness across cells. This microversion brings the following changes:

- `GET /os-hypervisors/{hypervisor_hostname_pattern}/search` is deprecated and replaced with the `hypervisor_hostname_pattern` query parameter on the `GET /os-hypervisors` and `GET /os-hypervisors/detail` APIs. Paging with `hypervisor_hostname_pattern` is not supported.

- `GET /os-hypervisors/{hypervisor_hostname_pattern}/servers` is deprecated and replaced with the `with_servers` query parameter on the `GET /os-hypervisors` and `GET /os-hypervisors/detail` APIs.
- `GET /os-hypervisors/{hypervisor_id}` supports the `with_servers` query parameter to include hosted server details in the response.
- `GET /os-hypervisors/{hypervisor_id}` and `GET /os-hypervisors/{hypervisor_id}/uptime` APIs now take a uuid value for the `{hypervisor_id}` path parameter.
- The `GET /os-hypervisors` and `GET /os-hypervisors/detail` APIs will now use a uuid marker for paging across cells.
- The following APIs will now return a uuid value for the hypervisor id and optionally service id fields in the response:
  - `GET /os-hypervisors`
  - `GET /os-hypervisors/detail`
  - `GET /os-hypervisors/{hypervisor_id}`
  - `GET /os-hypervisors/{hypervisor_id}/uptime`

2.54

Allow the user to set the server key pair while rebuilding.

2.55

Adds a `description` field to the flavor resource in the following APIs:

- `GET /flavors`
- `GET /flavors/detail`
- `GET /flavors/{flavor_id}`
- `POST /flavors`
- `PUT /flavors/{flavor_id}`

The embedded flavor description will not be included in server representations.

2.56

Updates the POST request body for the `migrate` action to include the optional `host` string field defaulted to `null`. If `host` is set the migrate action verifies the provided host with the nova scheduler and uses it as the destination for the migration.

2.57

The 2.57 microversion makes the following changes:

- The `personality` parameter is removed from the server create and rebuild APIs.
- The `user_data` parameter is added to the server rebuild API.

- The `maxPersonality` and `maxPersonalitySize` limits are excluded from the `GET /limits` API response.
- The `injected_files`, `injected_file_content_bytes` and `injected_file_path_bytes` quotas are removed from the `os-quota-sets` and `os-quota-class-sets` APIs.

2.58

Add pagination support and `changes-since` filter for os-instance-actions API. Users can now use `limit` and `marker` to perform paginated query when listing instance actions. Users can also use `changes-since` filter to filter the results based on the last time the instance action was updated.

2.59

Added pagination support for migrations, there are four changes:

- Add pagination support and `changes-since` filter for os-migrations API. Users can now use `limit` and `marker` to perform paginate query when listing migrations.
- Users can also use `changes-since` filter to filter the results based on the last time the migration record was updated.
- `GET /os-migrations`, `GET /servers/{server_id}/migrations/{migration_id}` and `GET /servers/{server_id}/migrations` will now return a uuid value in addition to the migrations id in the response.
- The query parameter schema of the `GET /os-migrations` API no longer allows additional properties.

2.60 (Maximum in Queens)

From this version of the API users can attach a `multiattach` capable volume to multiple instances. The API request for creating the additional attachments is the same. The chosen virt driver and the volume back end has to support the functionality as well.

2.61

Exposes flavor extra_specs in the flavor representation. Now users can see the flavor extra-specs in flavor APIs response and do not need to call `GET /flavors/{flavor_id}/os-extra_specs` API. If the user is prevented by policy from indexing extra-specs, then the `extra_specs` field will not be included in the flavor information. Flavor extra_specs will be included in Response body of the following APIs:

- `GET /flavors/detail`
- `GET /flavors/{flavor_id}`
- `POST /flavors`
- `PUT /flavors/{flavor_id}`

2.62

Adds `host` (hostname) and `hostId` (an obfuscated hashed host id string) fields to the instance action `GET /servers/{server_id}/os-instance-actions/{req_id}` API. The display of the newly added `host` field will be controlled via policy rule `os_compute_api:os-instance-actions:events`,

which is the same policy used for the `events.traceback` field. If the user is prevented by policy, only `hostId` will be displayed.

2.63

Adds support for the `trusted_image_certificates` parameter, which is used to define a list of trusted certificate IDs that can be used during image signature verification and certificate validation. The list is restricted to a maximum of 50 IDs. Note that `trusted_image_certificates` is not supported with volume-backed servers.

The `trusted_image_certificates` request parameter can be passed to the server create and rebuild APIs:

- `POST /servers`
- `POST /servers/{server_id}/action (rebuild)`

The `trusted_image_certificates` parameter will be in the response body of the following APIs:

- `GET /servers/detail`
- `GET /servers/{server_id}`
- `PUT /servers/{server_id}`
- `POST /servers/{server_id}/action (rebuild)`

2.64

Enable users to define the policy rules on server group policy to meet more advanced policy requirement. This microversion brings the following changes in server group APIs:

- Add `policy` and `rules` fields in the request of POST `/os-server-groups`. The `policy` represents the name of policy. The `rules` field, which is a dict, can be applied to the policy, which currently only support `max_server_per_host` for `anti-affinity` policy.
- The `policy` and `rules` fields will be returned in response body of POST, GET `/os-server-groups` API and GET `/os-server-groups/{server_group_id}` API.
- The `policies` and `metadata` fields have been removed from the response body of POST, GET `/os-server-groups` API and GET `/os-server-groups/{server_group_id}` API.

2.65 (Maximum in Rocky)

Add support for abort live migrations in `queued` and `preparing` status for API `DELETE /servers/{server_id}/migrations/{migration_id}`.

2.66

The `changes-before` filter can be included as a request parameter of the following APIs to filter by changes before or equal to the resource `updated_at` time:

- `GET /servers`
- `GET /servers/detail`
- `GET /servers/{server_id}/os-instance-actions`
- `GET /os-migrations`

2.67

Adds the `volume_type` parameter to `block_device_mapping_v2`, which can be used to specify cinder `volume_type` when creating a server.

2.68

Remove support for forced live migration and evacuate server actions.

2.69

Add support for returning minimal constructs for `GET /servers`, `GET /servers/detail`, `GET /servers/{server_id}` and `GET /os-services` when there is a transient unavailability condition in the deployment like an infrastructure failure. Starting from this microversion, the responses from the down part of the infrastructure for the above four requests will have missing key values to make it more resilient. The response body will only have a minimal set of information obtained from the available information in the API database for the down cells. See handling down cells for more information.

2.70

Exposes virtual device tags for volume attachments and virtual interfaces (ports). A `tag` parameter is added to the response body for the following APIs:

Volumes

- GET /servers/{server_id}/os-volume_attachments (list)
- GET /servers/{server_id}/os-volume_attachments/{volume_id} (show)
- POST /servers/{server_id}/os-volume_attachments (attach)

Ports

- GET /servers/{server_id}/os-interface (list)
- GET /servers/{server_id}/os-interface/{port_id} (show)
- POST /servers/{server_id}/os-interface (attach)

2.71

The `server_groups` parameter will be in the response body of the following APIs to list the server groups to which the server belongs:

- `GET /servers/{server_id}`
- `PUT /servers/{server_id}`
- `POST /servers/{server_id}/action (rebuild)`

2.72 (Maximum in Stein)

API microversion 2.72 adds support for creating servers with neutron ports that has resource request, e.g. neutron ports with QoS minimum bandwidth rule. Deleting servers with such ports have already been handled properly as well as detaching these type of ports.

API limitations:

- Creating servers with Neutron networks having QoS minimum bandwidth rule is not supported.
- Attaching Neutron ports and networks having QoS minimum bandwidth rule is not supported.
- Moving (resizing, migrating, live-migrating, evacuating, unshelving after shelve offload) servers with ports having resource request is not yet supported.

2.73

API microversion 2.73 adds support for specifying a reason when locking the server and exposes this information via `GET /servers/detail`, `GET /servers/{server_id}`, `PUT servers/{server_id}` and `POST /servers/{server_id}/action` where the action is rebuild. It also supports `locked` as a filter/sort parameter for `GET /servers/detail` and `GET /servers`.

2.74

API microversion 2.74 adds support for specifying optional `host` and/or `hypervisor_hostname` parameters in the request body of `POST /servers`. These request a specific destination host/node to boot the requested server. These parameters are mutually exclusive with the special `availability_zone` format of `zone:host:node`. Unlike `zone:host:node`, the `host` and/or `hypervisor_hostname` parameters still allow scheduler filters to be run. If the requested host/node is unavailable or otherwise unsuitable, earlier failure will be raised. There will be also a new policy named `compute:servers:create:requested_destination`. By default, it can be specified by administrators only.

2.75

Multiple API cleanups are done in API microversion 2.75:

- 400 error response for an unknown parameter in the querystring or request body.
- Make the server representation consistent among GET, PUT and rebuild server API responses. `PUT /servers/{server_id}` and `POST /servers/{server_id}/action {rebuild}` API responses are modified to add all the missing fields which are returned by `GET /servers/{server_id}`.
- Change the default return value of the `swap` field from the empty string to 0 (integer) in flavor APIs.
- Always return the `servers` field in the response of the `GET /os-hypervisors`, `GET /os-hypervisors/detail` and `GET /os-hypervisors/{hypervisor_id}` APIs even when there are no servers on a hypervisor.

2.76

Adds `power-update` event name to `os-server-external-events` API. The changes to the power state of an instance caused by this event can be viewed through `GET /servers/{server_id}/os-instance-actions` and `GET /servers/{server_id}/os-instance-actions/{request_id}`.

2.77

API microversion 2.77 adds support for specifying availability zone when unshelving a shelved offloaded server.

2.78

Add server sub-resource `topology` to show server NUMA information.

- `GET /servers/{server_id}/topology`

The default behavior is configurable using two new policies:

- `compute:server:topology:index`
- `compute:server:topology:host:index`

2.79 (Maximum in Train)

API microversion 2.79 adds support for specifying the `delete_on_termination` field in the request body when attaching a volume to a server, to support configuring whether to delete the data volume when the server is destroyed. Also, `delete_on_termination` is added to the GET responses when showing attached volumes, and the `delete_on_termination` field is contained in the POST API response body when attaching a volume.

The affected APIs are as follows:

- `POST /servers/{server_id}/os-volume_attachments`
- `GET /servers/{server_id}/os-volume_attachments`
- `GET /servers/{server_id}/os-volume_attachments/{volume_id}`

2.80

Microversion 2.80 changes the list migrations APIs and the os-migrations API.

Expose the `user_id` and `project_id` fields in the following APIs:

- `GET /os-migrations`
- `GET /servers/{server_id}/migrations`
- `GET /servers/{server_id}/migrations/{migration_id}`

The `GET /os-migrations` API will also have optional `user_id` and `project_id` query parameters for filtering migrations by user and/or project, for example:

- `GET /os-migrations?user_id=ef9d34b4-45d0-4530-871b-3fb535988394`
- `GET /os-migrations?project_id=011ee9f4-8f16-4c38-8633-a254d420fd54`
- `GET /os-migrations?user_id=ef9d34b4-45d0-4530-871b-3fb535988394&project_id=011ee9f4-8f1`

2.81

Adds support for image cache management by aggregate by adding `POST /os-aggregates/{aggregate_id}/images`.

2.82

Adds `accelerator-request-bound` event to `os-server-external-events` API. This event is sent by Cyborg to indicate completion of the binding event for one accelerator request (ARQ) associated with an instance.

2.83

Allow the following filter parameters for `GET /servers/detail` and `GET /servers` for non-admin :

- `availability_zone`
- `config_drive`
- `key_name`
- `created_at`
- `launched_at`
- `terminated_at`
- `power_state`
- `task_state`
- `vm_state`
- `progress`
- `user_id`

2.84

The `GET /servers/{server_id}/os-instance-actions/{request_id}` API returns a `details` parameter for each failed event with a fault message, similar to the server `fault.message` parameter in `GET /servers/{server_id}` for a server with status `ERROR`.

2.85

Adds the ability to specify `delete_on_termination` in the `PUT /servers/{server_id}/os-volume_attachments/{volume_id}` API, which allows changing the behavior of volume deletion on instance deletion.

2.86

Add support for validation of known extra specs. This is enabled by default for the following APIs:

- `POST /flavors/{flavor_id}/os-extra_specs`
- `PUT /flavors/{flavor_id}/os-extra_specs/{id}`

Validation is only used for recognized extra spec namespaces, currently: `accel`, `aggregate_instance_extra_specs`, `capabilities`, `hw`, `hw_rng`, `hw_video`, `os`, `pci_passthrough`, `powervm`, `quota`, `resources`, `trait`, and `vmware`.

2.87 (Maximum in Ussuri and Victoria)

Adds support for rescuing boot from volume instances when the compute host reports the `COMPUTE_RESCUE_BFV` capability trait.

2.88 (Maximum in Wallaby)

The following fields are no longer included in responses for the `GET /os-hypervisors/detail` and `GET /os-hypervisors/{hypervisor_id}` APIs:

- `current_workload`
- `cpu_info`
- `vcpus`
- `vcpus_used`
- `free_disk_gb`
- `local_gb`
- `local_gb_used`
- `disk_available_least`
- `free_ram_mb`
- `memory_mb`
- `memory_mb_used`
- `running_vms`

These fields were removed as the information they provided were frequently misleading or outright wrong, and many can be better queried from placement.

In addition, the `GET /os-hypervisors/statistics` API, which provided a summary view with just the fields listed above, has been removed entirely and will now raise a HTTP 404 with microversion 2.88 or greater.

Finally, the `GET /os-hypervisors/{hypervisor}/uptime` API, which provided a similar response to the `GET /os-hypervisors/detail` and `GET /os-hypervisors/{hypervisor_id}` APIs but with an additional `uptime` field, has been removed in favour of including this field in the primary `GET /os-hypervisors/detail` and `GET /os-hypervisors/{hypervisor_id}` APIs.

2.89

`attachment_id` and `bdm_uuid` are now included in the responses for `GET /servers/{server_id}/os-volume_attachments` and `GET /servers/{server_id}/os-volume_attachments/{volume_id}`. Additionally the `id` field is dropped from the response as it duplicates the `volumeId` field.

2.90 (Maximum in Xena and Yoga)

The `POST /servers` (create server), `PUT /servers/{id}` (update server) and `POST /servers/{server_id}/action (rebuild)` (rebuild server) APIs now accept a `hostname` parameter, allowing users to configure a hostname when creating the instance. When specified, this will replace the auto-generated hostname based on the display name.

In addition, the `OS-EXT-SRV-ATTR:hostname` field for all server responses is now visible to all users. Previously this was an admin-only field.

2.91

Add support to unshelve instance to a specific host.

Add support to pin a server to an availability zone or unpin a server from any availability zone.

2.92

The `POST /os-keypairs` API now forbids to generate a keypair and allows new safe characters, specifically @ and . (dot character).

2.93 (Maximum in Zed)

Add support for volume backed server rebuild. The end user will provide the image with the rebuild command and it will rebuild the volume with the new image similar to the result of rebuilding an ephemeral disk.

2.94

The `hostname` parameter to the `POST /servers` (create server), `PUT /servers/{id}` (update server) and `POST /servers/{server_id}/action (rebuild)` (rebuild server) APIs is now allowed to be a Fully Qualified Domain Name (FQDN).

2.95 (Maximum in 2023.1 Antelope and 2023.2 Bobcat)

Any evacuated instances will be now stopped at destination. This requires minimum nova release 27.0.0, OpenStack release 2023.1 Antelope. Operators can still use previous microversion for older behavior.

2.96 (Maximum in 2024.1 Caracal and 2024.2 Dalmatian)

The `server show`, `server list --long`, `server update`, and `server rebuild` responses now include the pinned availability zone as well.

2.97

This microversion introduces the new Manila Share Attachment feature, streamlining the process of attaching and mounting Manila file shares to instances. It includes a new set of APIs to easily add, remove, list, and display shares. For detailed insights and usage instructions, please refer to the manage-shares documentation.

2.98

Add support for including image properties as new `properties` subkey under the struct at the existing `image` key in the response for `GET /servers/{server_id}` (server show), `GET /servers/detail` (list server long), `PUT /servers/{server_id}` (server update), and in the rebuild case of `POST /server/{server_id}/action` (server rebuild) API response.

2.99

Add the `spice-direct` console type to the spice console protocol. Also add a `tls_port` field to the return value from `GET /os-console-auth-tokens/{console_token}` and no longer allow random query string parameters.

2.100 (Maximum in 2025.1 Epoxy and 2025.2 Flamingo)

The `GET /servers/{server_id}`, `GET /servers/detail` `PUT /servers/{server_id}` and `POST /server/{server_id}/action` (rebuild) responses now include the scheduler hints provided during server creation.

2.2 Tools for using Nova

- Horizon: The official web UI for the OpenStack Project.
- OpenStack Client: The official CLI for OpenStack Projects. You should use this as your CLI for most things, it includes not just nova commands but also commands for most of the projects in OpenStack.
- Nova Client: For some very advanced features (or administrative commands) of nova you may need to use nova client. It is still supported, but the `openstack` cli is recommended.

2.3 Writing to the API

All end user (and some administrative) features of nova are exposed via a REST API, which can be used to build more complicated logic or automation with nova. This can be consumed directly, or via various SDKs. The following resources will help you get started with consuming the API directly.

- Compute API Guide: The concept guide for the API. This helps lay out the concepts behind the API to make consuming the API reference easier.
- Compute API Reference: The complete reference for the compute API, including all methods and request / response parameters and their meaning.
- *Compute API Microversion History*: The compute API evolves over time through Microversions. This provides the history of all those changes. Consider it a whats new in the compute API.
- *Block Device Mapping*: One of the trickier parts to understand is the Block Device Mapping parameters used to connect specific block devices to computes. This deserves its own deep dive.
- *Metadata*: Provide information to the guest instance when it is created.

Nova can be configured to emit notifications over RPC.

- *Versioned Notifications*: This provides information on the notifications emitted by nova.

Other end-user guides can be found under *User Documentation*.

CHAPTER

THREE

FOR OPERATORS

3.1 Architecture Overview

- *Nova architecture*: An overview of how all the parts in nova fit together.

3.1.1 Nova System Architecture

Nova comprises multiple server processes, each performing different functions. The user-facing interface is a REST API, while internally Nova components communicate via an RPC message passing mechanism.

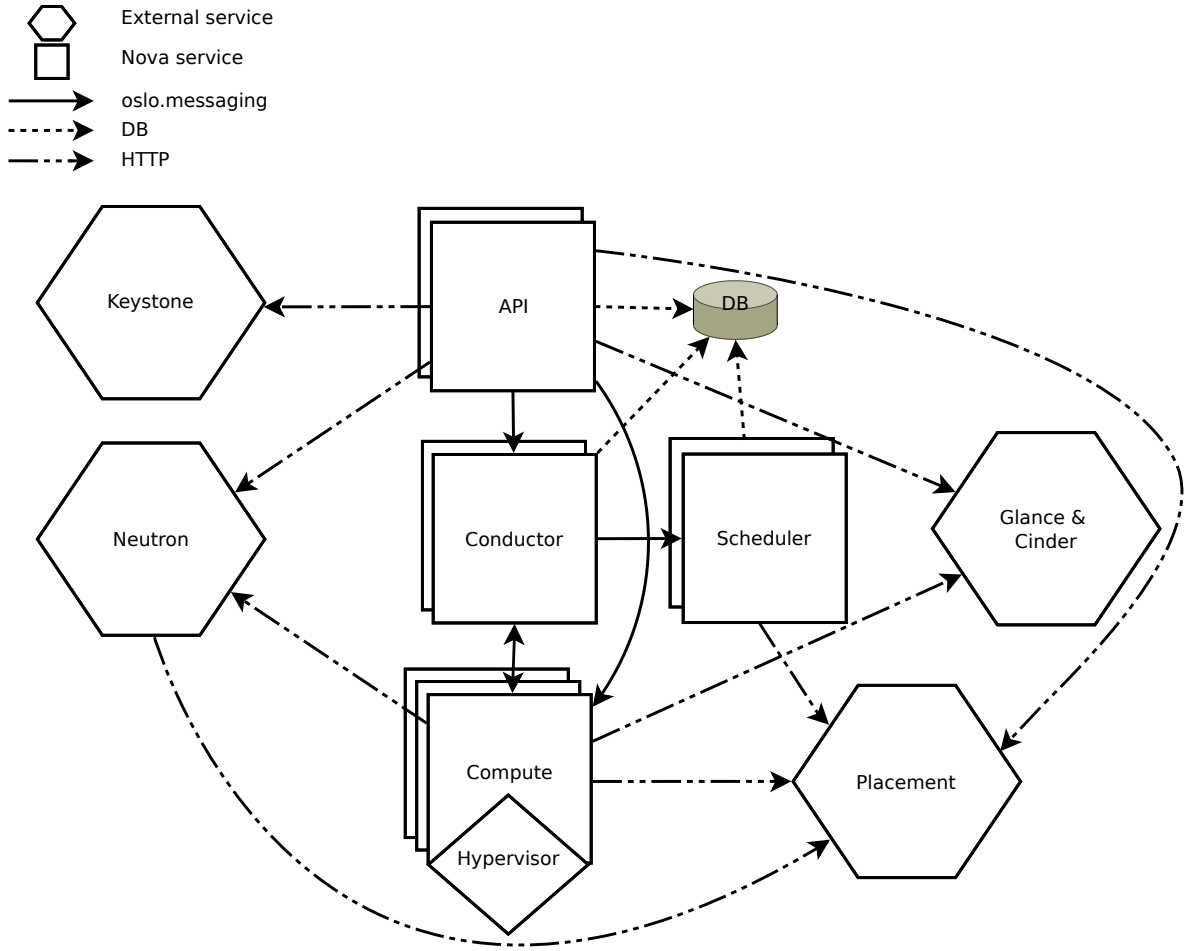
The API servers process REST requests, which typically involve database reads/writes, optionally sending RPC messages to other Nova services, and generating responses to the REST calls. RPC messaging is done via the **oslo.messaging** library, an abstraction on top of message queues. Nova uses a messaging-based, shared nothing architecture and most of the major nova components can be run on multiple servers, and have a manager that is listening for RPC messages. The one major exception is the compute service, where a single process runs on the hypervisor it is managing (except when using the VMware or Ironic drivers). The manager also, optionally, has periodic tasks. For more details on our RPC system, refer to *AMQP and Nova*.

Nova uses traditional SQL databases to store information. These are (logically) shared between multiple components. To aid upgrade, the database is accessed through an object layer that ensures an upgraded control plane can still communicate with a compute nodes running the previous release. To make this possible, services running on the compute node proxy database requests over RPC to a central manager called the conductor.

To horizontally expand Nova deployments, we have a deployment sharding concept called *cells*. All deployments contain at least one cell. For more information, refer to *Cells (v2)*.

3.1.1.1 Components

Below you will find a helpful explanation of the key components of a typical Nova deployment.



- **DB**: SQL database for data storage.
- **API**: Component that receives HTTP requests, converts commands and communicates with other components via the **oslo.messaging** queue or HTTP.
- **Scheduler**: Decides which host gets each instance.
- **Compute**: Manages communication with hypervisor and virtual machines.
- **Conductor**: Handles requests that need coordination (build/resize), acts as a database proxy, or handles object conversions.
- **:placement-doc:‘Placement <>‘**: Tracks resource provider inventories and usages.

While all services are designed to be horizontally scalable, you should have significantly more computes than anything else.

3.1.1.2 Hypervisors

Nova controls hypervisors through an API server. Selecting the best hypervisor to use can be difficult, and you must take budget, resource constraints, supported features, and required technical specifications into account. However, the majority of OpenStack development is done on systems using KVM-based hypervisors. For a detailed list of features and support across different hypervisors, see *Feature Support Matrix*.

You can also orchestrate clouds using multiple hypervisors in different availability zones. Nova supports the following hypervisors:

- Baremetal
- Kernel-based Virtual Machine (KVM)
- Linux Containers (LXC)
- Quick Emulator (QEMU)
- Virtuozzo
- VMware vSphere
- zVM

For more information about hypervisors, see *Hypervisors* section in the Nova Configuration Reference.

3.1.1.3 Projects, users, and roles

To begin using Nova, you must create a user with the Identity service.

The Nova system is designed to be used by different consumers in the form of projects on a shared system, and role-based access assignments. Roles control the actions that a user is allowed to perform.

Projects are isolated resource containers that form the principal organizational structure within the Nova service. They typically consist of networks, volumes, instances, images, keys, and users. A user can specify the project by appending `project_id` to their access key.

For projects, you can use quota controls to limit the number of processor cores and the amount of RAM that can be allocated. Other projects also allow quotas on their own resources. For example, neutron allows you to manage the amount of networks that can be created within a project.

Roles control the actions a user is allowed to perform. By default, most actions do not require a particular role, but you can configure them by editing the `policy.yaml` file for user roles. For example, a rule can be defined so that a user must have the `admin` role in order to be able to allocate a public IP address.

A project limits users access to particular images. Each user is assigned a user name and password. Keypairs granting access to an instance are enabled for each user, but quotas are set, so that each project can control resource consumption across available hardware resources.

Note

Earlier versions of OpenStack used the term `tenant` instead of `project`. Because of this legacy terminology, some command-line tools use `--tenant_id` where you would normally expect to enter a project ID.

3.1.1.4 Block storage

OpenStack provides two classes of block storage: storage that is provisioned by Nova itself, and storage that is managed by the block storage service, Cinder.

Nova-provisioned block storage

Nova provides the ability to create a root disk and an optional ephemeral volume. The root disk will always be present unless the instance is a *Boot From Volume* instance.

The root disk is associated with an instance, and exists only for the life of this very instance. Generally, it is used to store an instances root file system, persists across the guest operating system reboots, and is

removed on an instance deletion. The amount of the root ephemeral volume is defined by the flavor of an instance.

In addition to the root volume, flavors can provide an additional ephemeral block device. It is represented as a raw block device with no partition table or file system. A cloud-aware operating system can discover, format, and mount such a storage device. Nova defines the default file system for different operating systems as ext4 for Linux distributions, VFAT for non-Linux and non-Windows operating systems, and NTFS for Windows. However, it is possible to configure other filesystem types.

Note

For example, the `cloud-init` package included into an Ubuntus stock cloud image, by default, formats this space as an ext4 file system and mounts it on `/mnt`. This is a cloud-init feature, and is not an OpenStack mechanism. OpenStack only provisions the raw storage.

Cinder-provisioned block storage

The OpenStack Block Storage service, Cinder, provides persistent volumes that are represented by a persistent virtualized block device independent of any particular instance.

Persistent volumes can be accessed by a single instance or attached to multiple instances. This type of configuration requires a traditional network file system to allow multiple instances accessing the persistent volume. It also requires a traditional network file system like NFS, CIFS, or a cluster file system such as Ceph. These systems can be built within an OpenStack cluster, or provisioned outside of it, but OpenStack software does not provide these features.

You can configure a persistent volume as bootable and use it to provide a persistent virtual instance similar to the traditional non-cloud-based virtualization system. It is still possible for the resulting instance to keep ephemeral storage, depending on the flavor selected. In this case, the root file system can be on the persistent volume, and its state is maintained, even if the instance is shut down. For more information about this type of configuration, see Introduction to the Block Storage service.

3.1.1.5 Building blocks

In OpenStack the base operating system is usually copied from an image stored in the OpenStack Image service, glance. This is the most common case and results in an ephemeral instance that starts from a known template state and loses all accumulated states on virtual machine deletion. It is also possible to put an operating system on a persistent volume in the OpenStack Block Storage service. This gives a more traditional persistent system that accumulates states which are preserved on the OpenStack Block Storage volume across the deletion and re-creation of the virtual machine. To get a list of available images on your system, run:

```
$ openstack image list
+--------------------------------------+-----------------------------+--------
↪+
| ID                                   | Name                        | Status␣
↪|
+--------------------------------------+-----------------------------+--------
↪+
| aee1d242-730f-431f-88c1-87630c0f07ba | Ubuntu 14.04 cloudimg amd64 | active␣
↪|
| 0b27baa1-0ca6-49a7-b3f4-48388e440245 | Ubuntu 14.10 cloudimg amd64 | active␣
```

(continues on next page)

(continued from previous page)

```
↪|
| df8d56fc-9cea-4dfd-a8d3-28764de3cb08 | jenkins                      | active␣
↪|
+--------------------------------------+------------------------------+--------
↪+
```

The displayed image attributes are:

ID
: Automatically generated UUID of the image

Name
: Free form, human-readable name for image

Status
: The status of the image. Images marked `ACTIVE` are available for use.

Server
: For images that are created as snapshots of running instances, this is the UUID of the instance the snapshot derives from. For uploaded images, this field is blank.

Virtual hardware templates are called `flavors`. By default, these are configurable by admin users, however, that behavior can be changed by redefining the access controls `policy.yaml` on the `nova-api` server. For more information, refer to *Nova Policies*.

For a list of flavors that are available on your system:

```
$ openstack flavor list
+-----+-----------+-------+------+-----------+-------+-----------+
| ID  | Name      |   RAM | Disk | Ephemeral | VCPUs | Is_Public |
+-----+-----------+-------+------+-----------+-------+-----------+
| 1   | m1.tiny   |   512 |    1 |         0 |     1 | True      |
| 2   | m1.small  |  2048 |   20 |         0 |     1 | True      |
| 3   | m1.medium |  4096 |   40 |         0 |     2 | True      |
| 4   | m1.large  |  8192 |   80 |         0 |     4 | True      |
| 5   | m1.xlarge | 16384 |  160 |         0 |     8 | True      |
+-----+-----------+-------+------+-----------+-------+-----------+
```

3.1.1.6 Nova service architecture

These basic categories describe the service architecture and information about the cloud controller.

API server

At the heart of the cloud framework is an API server, which makes command and control of the hypervisor, storage, and networking programmatically available to users.

The API endpoints are basic HTTP web services which handle authentication, authorization, and basic command and control functions using various API interfaces under the Amazon, Rackspace, and related models. This enables API compatibility with multiple existing tool sets created for interaction with offerings from other vendors. This broad compatibility prevents vendor lock-in.

Message queue

A messaging queue brokers the interaction between compute nodes (processing), the networking controllers (software which controls network infrastructure), API endpoints, the scheduler (determines which physical hardware to allocate to a virtual resource), and similar components. Communication to and from the cloud controller is handled by HTTP requests through multiple API endpoints.

A typical message passing event begins with the API server receiving a request from a user. The API server authenticates the user and ensures that they are permitted to issue the subject command. The availability of objects implicated in the request is evaluated and, if available, the request is routed to the queuing engine for the relevant workers. Workers continually listen to the queue based on their role, and occasionally their type host name. When an applicable work request arrives on the queue, the worker takes assignment of the task and begins executing it. Upon completion, a response is dispatched to the queue which is received by the API server and relayed to the originating user. Database entries are queried, added, or removed as necessary during the process.

Compute worker

Compute workers manage computing instances on host machines. The API dispatches commands to compute workers to complete these tasks:

- Run instances
- Delete instances (Terminate instances)
- Reboot instances
- Attach volumes
- Detach volumes
- Get console output

Network Controller

The Network Controller manages the networking resources on host machines. The API server dispatches commands through the message queue, which are subsequently processed by Network Controllers. Specific operations include:

- Allocating fixed IP addresses
- Configuring VLANs for projects
- Configuring networks for compute nodes

3.2 Installation

The detailed install guide for nova. A functioning nova will also require having installed keystone, glance, neutron, and placement. Ensure that you follow their install guides first.

3.2.1 Compute service

3.2.1.1 Overview

The OpenStack project is an open source cloud computing platform that supports all types of cloud environments. The project aims for simple implementation, massive scalability, and a rich set of features. Cloud computing experts from around the world contribute to the project.

OpenStack provides an Infrastructure-as-a-Service (IaaS) solution through a variety of complementary services. Each service offers an Application Programming Interface (API) that facilitates this integration.

This guide covers step-by-step deployment of the major OpenStack services using a functional example architecture suitable for new users of OpenStack with sufficient Linux experience. This guide is not intended to be used for production system installations, but to create a minimum proof-of-concept for the purpose of learning about OpenStack.

After becoming familiar with basic installation, configuration, operation, and troubleshooting of these OpenStack services, you should consider the following steps toward deployment using a production architecture:

- Determine and implement the necessary core and optional services to meet performance and redundancy requirements.
- Increase security using methods such as firewalls, encryption, and service policies.
- Implement a deployment tool such as Ansible, Chef, Puppet, or Salt to automate deployment and management of the production environment.

Example architecture

The example architecture requires at least two nodes (hosts) to launch a basic virtual machine (VM) or instance. Optional services such as Block Storage and Object Storage require additional nodes.

Important

The example architecture used in this guide is a minimum configuration, and is not intended for production system installations. It is designed to provide a minimum proof-of-concept for the purpose of learning about OpenStack. For information on creating architectures for specific use cases, or how to determine which architecture is required, see the Architecture Design Guide.

Warning

Once a cloud has been deployed, changing the host name of *any* node in the deployment is not supported. In some cases, it may be possible to remove a node from the deployment, and add it again under a different host name. Renaming a node in situ will result in problems that will require multiple manual fixes.

This example architecture differs from a minimal production architecture as follows:

- Networking agents reside on the controller node instead of one or more dedicated network nodes.
- Overlay (tunnel) traffic for self-service networks traverses the management network instead of a dedicated network.

For more information on production architectures, see the Architecture Design Guide, OpenStack Operations Guide, and OpenStack Networking Guide.

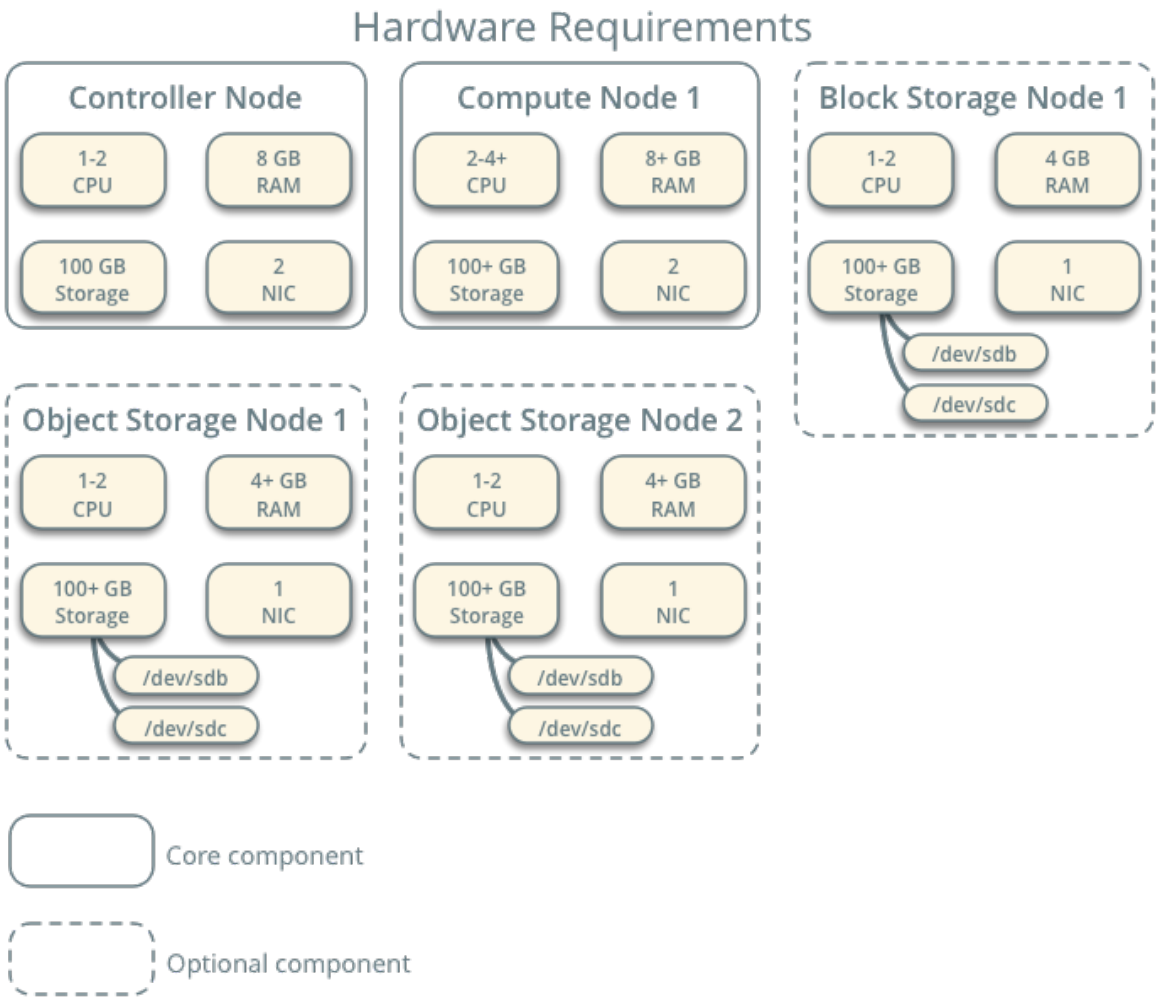


Fig. 1: **Hardware requirements**

Controller

The controller node runs the Identity service, Image service, management portions of Compute, management portion of Networking, various Networking agents, and the Dashboard. It also includes supporting services such as an SQL database, message queue, and Network Time Protocol (NTP).

Optionally, the controller node runs portions of the Block Storage, Object Storage, Orchestration, and Telemetry services.

The controller node requires a minimum of two network interfaces.

Compute

The compute node runs the hypervisor portion of Compute that operates instances. By default, Compute uses the kernel-based VM (KVM) hypervisor. The compute node also runs a Networking service agent that connects instances to virtual networks and provides firewalling services to instances via security groups.

You can deploy more than one compute node. Each node requires a minimum of two network interfaces.

Block Storage

The optional Block Storage node contains the disks that the Block Storage and Shared File System services provision for instances.

For simplicity, service traffic between compute nodes and this node uses the management network. Production environments should implement a separate storage network to increase performance and security.

You can deploy more than one block storage node. Each node requires a minimum of one network interface.

Object Storage

The optional Object Storage node contain the disks that the Object Storage service uses for storing accounts, containers, and objects.

For simplicity, service traffic between compute nodes and this node uses the management network. Production environments should implement a separate storage network to increase performance and security.

This service requires two nodes. Each node requires a minimum of one network interface. You can deploy more than two object storage nodes.

Networking

Choose one of the following virtual networking options.

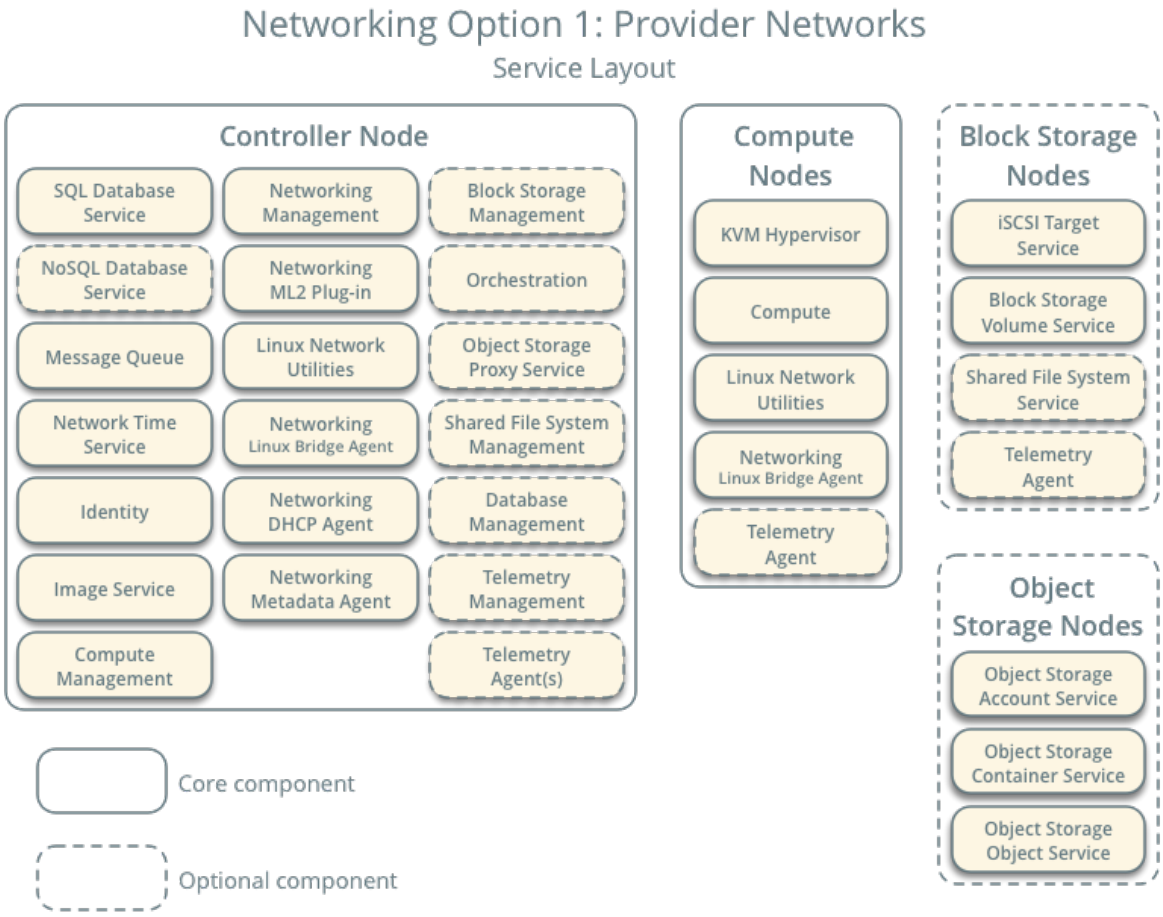
Networking Option 1: Provider networks

The provider networks option deploys the OpenStack Networking service in the simplest way possible with primarily layer-2 (bridging/switching) services and VLAN segmentation of networks. Essentially, it bridges virtual networks to physical networks and relies on physical network infrastructure for layer-3 (routing) services. Additionally, a DHCP<Dynamic Host Configuration Protocol (DHCP) service provides IP address information to instances.

The OpenStack user requires more information about the underlying network infrastructure to create a virtual network to exactly match the infrastructure.

Warning

This option lacks support for self-service (private) networks, layer-3 (routing) services, and advanced services such as Load-Balancer-as-a-Service (LBaaS) and FireWall-as-a-Service (FWaaS). Consider the self-service networks option below if you desire these features.



Networking Option 2: Self-service networks

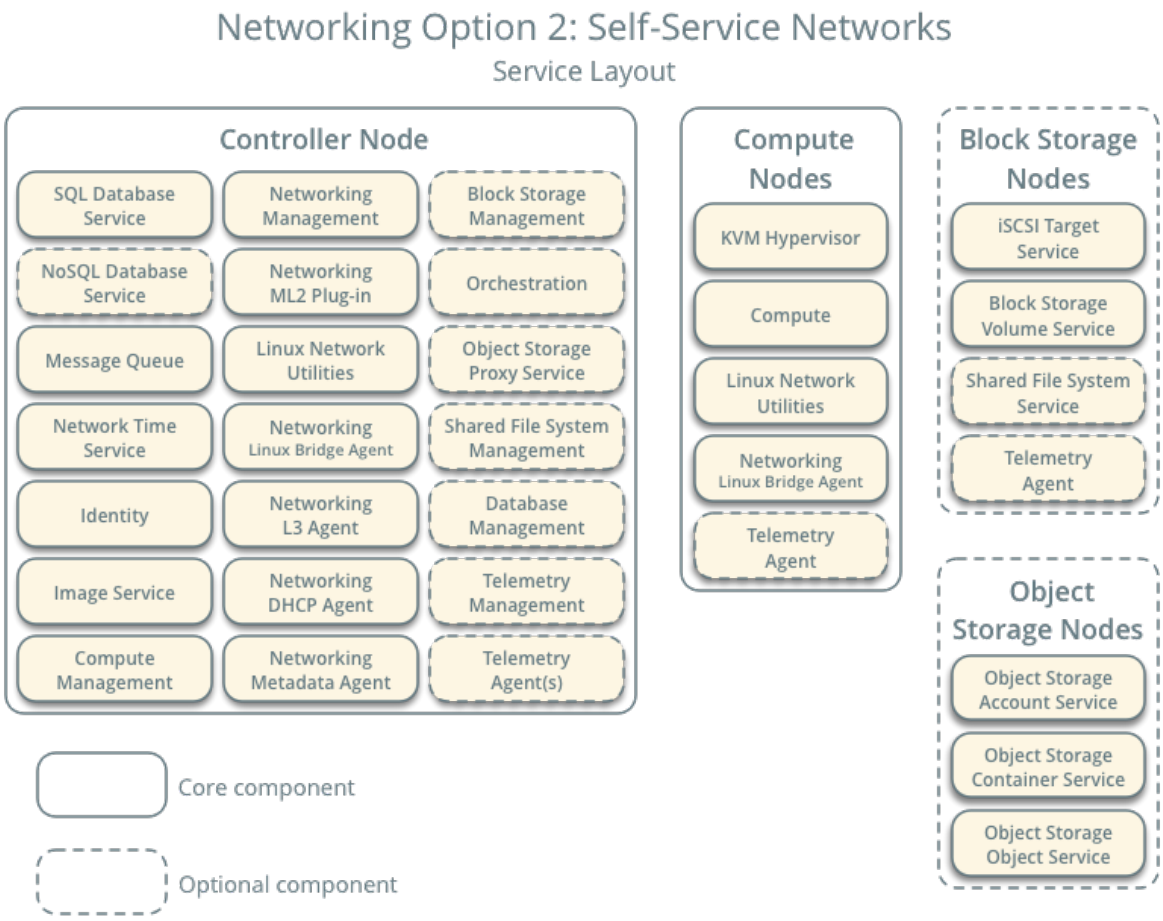
The self-service networks option augments the provider networks option with layer-3 (routing) services that enable self-service networks using overlay segmentation methods such as Virtual Extensible LAN (VXLAN). Essentially, it routes virtual networks to physical networks using Network Address Translation (NAT). Additionally, this option provides the foundation for advanced services such as LBaaS and FWaaS.

The OpenStack user can create virtual networks without the knowledge of underlying infrastructure on the data network. This can also include VLAN networks if the layer-2 plug-in is configured accordingly.

3.2.1.2 Compute service overview

Todo

Update a lot of the links in here.


Networking Option 2: Self-Service Networks
Service Layout
Controller Node
SQL Database Service
Networking Management
Block Storage Management
NoSQL Database Service
Networking ML2 Plug-in
Orchestration
Message Queue
Linux Network Utilities
Object Storage Proxy Service
Network Time Service
Networking Linux Bridge Agent
Shared File System Management
Identity
Networking L3 Agent
Database Management
Image Service
Networking DHCP Agent
Telemetry Management
Compute Management
Networking Metadata Agent
Telemetry Agent(s)
Compute Nodes
KVM Hypervisor
Compute
Linux Network Utilities
Networking Linux Bridge Agent
Telemetry Agent
Block Storage Nodes
iSCSI Target Service
Block Storage Volume Service
Shared File System Service
Telemetry Agent
Object Storage Nodes
Object Storage Account Service
Object Storage Container Service
Object Storage Object Service
Core component
Optional component

Use OpenStack Compute to host and manage cloud computing systems. OpenStack Compute is a major part of an Infrastructure-as-a-Service (IaaS) system. The main modules are implemented in Python.

OpenStack Compute interacts with OpenStack Identity for authentication, OpenStack Placement for resource inventory tracking and selection, OpenStack Image service for disk and server images, and OpenStack Dashboard for the user and administrative interface. Image access is limited by projects, and by users; quotas are limited per project (the number of instances, for example). OpenStack Compute can scale horizontally on standard hardware, and download images to launch instances.

OpenStack Compute consists of two *WSGI* APIs and a number of services:

Compute API
: Accepts and responds to end user compute API calls. The service supports the OpenStack Compute API. It enforces some policies and initiates most orchestration activities, such as running an instance.

Metadata API
: Accepts metadata requests from instances. For more information, refer to *Metadata service*.

`nova-compute` service
: A worker daemon that creates and terminates virtual machine instances through hypervisor APIs. The default hypervisor is libvirt with KVM or QEMU, but other hypervisors are supported.

  Processing is fairly complex. Basically, the daemon accepts actions from the queue and performs a series of system commands such as launching a KVM instance and updating its state in the database.

`nova-scheduler` service
: Takes a virtual machine instance request from the queue and determines on which compute server host it runs.

`nova-conductor` module
: Mediates interactions between the `nova-compute` service and the database. It eliminates direct accesses to the cloud database made by the `nova-compute` service. The `nova-conductor` module scales horizontally. However, do not deploy it on nodes where the `nova-compute` service runs. For more information, see the `conductor` section in the *Configuration Options*.

`nova-novncproxy` daemon
: Provides a proxy for accessing running instances through a VNC connection. Supports browser-based novnc clients.

`nova-spicehtml5proxy` daemon
: Provides a proxy for accessing running instances through a SPICE connection. Supports browser-based HTML5 client.

The queue
: A central hub for passing messages between daemons. Usually implemented with RabbitMQ but other options are available.

SQL database
: Stores most build-time and run-time states for a cloud infrastructure, including:

  - Available instance types
  - Instances in use
  - Available networks
  - Projects

Theoretically, OpenStack Compute can support any database that SQLAlchemy supports. Common databases are SQLite3 for test and development work, MySQL, MariaDB, and PostgreSQL.

3.2.1.3 Install and configure controller node

This section describes how to install and configure the Compute service on the controller node for Ubuntu, Red Hat Enterprise Linux and CentOS Stream.

Install and configure controller node for Ubuntu

This section describes how to install and configure the Compute service, code-named nova, on the controller node.

Prerequisites

Before you install and configure the Compute service, you must create databases, service credentials, and API endpoints.

1. To create the databases, complete these steps:

   - Use the database access client to connect to the database server as the `root` user:

     ```
     # mysql
     ```

   - Create the `nova_api`, `nova`, and `nova_cell0` databases:

     ```
     MariaDB [(none)]> CREATE DATABASE nova_api;
     MariaDB [(none)]> CREATE DATABASE nova;
     MariaDB [(none)]> CREATE DATABASE nova_cell0;
     ```

   - Grant proper access to the databases:

     ```
     MariaDB [(none)]> GRANT ALL PRIVILEGES ON nova_api.* TO 'nova'@
     ↪'localhost' \
       IDENTIFIED BY 'NOVA_DBPASS';
     MariaDB [(none)]> GRANT ALL PRIVILEGES ON nova_api.* TO 'nova'@'%' \
       IDENTIFIED BY 'NOVA_DBPASS';

     MariaDB [(none)]> GRANT ALL PRIVILEGES ON nova.* TO 'nova'@'localhost
     ↪' \
       IDENTIFIED BY 'NOVA_DBPASS';
     MariaDB [(none)]> GRANT ALL PRIVILEGES ON nova.* TO 'nova'@'%' \
       IDENTIFIED BY 'NOVA_DBPASS';

     MariaDB [(none)]> GRANT ALL PRIVILEGES ON nova_cell0.* TO 'nova'@
     ↪'localhost' \
       IDENTIFIED BY 'NOVA_DBPASS';
     MariaDB [(none)]> GRANT ALL PRIVILEGES ON nova_cell0.* TO 'nova'@'%'␣
     ↪\
       IDENTIFIED BY 'NOVA_DBPASS';
     ```

     Replace `NOVA_DBPASS` with a suitable password.

   - Exit the database access client.

2. Source the admin credentials to gain access to admin-only CLI commands:

```
$ . admin-openrc
```

3. Create the Compute service credentials:

   - Create the nova user:

```
$ openstack user create --domain default --password-prompt nova

User Password:
Repeat User Password:
+---------------------+----------------------------------+
| Field               | Value                            |
+---------------------+----------------------------------+
| domain_id           | default                          |
| enabled             | True                             |
| id                  | 8a7dbf5279404537b1c7b86c033620fe |
| name                | nova                             |
| options             | {}                               |
| password_expires_at | None                             |
+---------------------+----------------------------------+
```

   - Add the admin role to the nova user:

```
$ openstack role add --project service --user nova admin
```

> **Note**
>
> This command provides no output.

   - Create the nova service entity:

```
$ openstack service create --name nova \
  --description "OpenStack Compute" compute

+-------------+----------------------------------+
| Field       | Value                            |
+-------------+----------------------------------+
| description | OpenStack Compute                |
| enabled     | True                             |
| id          | 060d59eac51b4594815603d75a00aba2 |
| name        | nova                             |
| type        | compute                          |
+-------------+----------------------------------+
```

4. Create the Compute API service endpoints:

```
$ openstack endpoint create --region RegionOne \
  compute public http://controller:8774/v2.1
```

(continues on next page)

(continued from previous page)

```
+--------------+------------------------------------------+
| Field        | Value                                    |
+--------------+------------------------------------------+
| enabled      | True                                     |
| id           | 3c1caa473bfe4390a11e7177894bcc7b         |
| interface    | public                                   |
| region       | RegionOne                                |
| region_id    | RegionOne                                |
| service_id   | 060d59eac51b4594815603d75a00aba2         |
| service_name | nova                                     |
| service_type | compute                                  |
| url          | http://controller:8774/v2.1              |
+--------------+------------------------------------------+

$ openstack endpoint create --region RegionOne \
  compute internal http://controller:8774/v2.1

+--------------+------------------------------------------+
| Field        | Value                                    |
+--------------+------------------------------------------+
| enabled      | True                                     |
| id           | e3c918de680746a586eac1f2d9bc10ab         |
| interface    | internal                                 |
| region       | RegionOne                                |
| region_id    | RegionOne                                |
| service_id   | 060d59eac51b4594815603d75a00aba2         |
| service_name | nova                                     |
| service_type | compute                                  |
| url          | http://controller:8774/v2.1              |
+--------------+------------------------------------------+

$ openstack endpoint create --region RegionOne \
  compute admin http://controller:8774/v2.1

+--------------+------------------------------------------+
| Field        | Value                                    |
+--------------+------------------------------------------+
| enabled      | True                                     |
| id           | 38f7af91666a47cfb97b4dc790b94424         |
| interface    | admin                                    |
| region       | RegionOne                                |
| region_id    | RegionOne                                |
| service_id   | 060d59eac51b4594815603d75a00aba2         |
| service_name | nova                                     |
| service_type | compute                                  |
| url          | http://controller:8774/v2.1              |
+--------------+------------------------------------------+
```

5. Install Placement service and configure user and endpoints:

   - Refer to the Placement service install guide for more information.

Install and configure components

Note

Default configuration files vary by distribution. You might need to add these sections and options rather than modifying existing sections and options. Also, an ellipsis (`...`) in the configuration snippets indicates potential default configuration options that you should retain.

1. Install the packages:

```
# apt install nova-api nova-conductor nova-novncproxy nova-scheduler
```

2. Edit the `/etc/nova/nova.conf` file and complete the following actions:

   - In the `[api_database]` and `[database]` sections, configure database access:

```
[api_database]
# ...
connection = mysql+pymysql://nova:NOVA_DBPASS@controller/nova_api

[database]
# ...
connection = mysql+pymysql://nova:NOVA_DBPASS@controller/nova
```

     Replace `NOVA_DBPASS` with the password you chose for the Compute databases.

   - In the `[DEFAULT]` section, configure `RabbitMQ` message queue access (RabbitMQ should be already installed and configured):

```
[DEFAULT]
# ...
transport_url = rabbit://openstack:RABBIT_PASS@controller:5672/
```

     Replace `RABBIT_PASS` with the password you chose for the `openstack` account in `RabbitMQ`.

   - In the `[keystone_authtoken]` section, configure Identity service access:

```
[keystone_authtoken]
# ...
www_authenticate_uri = http://controller:5000/
auth_url = http://controller:5000/
memcached_servers = controller:11211
auth_type = password
project_domain_name = Default
user_domain_name = Default
project_name = service
username = nova
password = NOVA_PASS
```

     Replace `NOVA_PASS` with the password you chose for the `nova` user in the Identity service.

> **Note**
>
> Comment out or remove any other options in the `[keystone_authtoken]` section.

- In the `[service_user]` section, configure *service user tokens*:

```
[service_user]
send_service_user_token = true
auth_url = https://controller/identity
auth_type = password
project_domain_name = Default
project_name = service
user_domain_name = Default
username = nova
password = NOVA_PASS
```

  Replace `NOVA_PASS` with the password you chose for the `nova` user in the Identity service.

- In the `[DEFAULT]` section, configure the `my_ip` option to use the management interface IP address of the controller node:

```
[DEFAULT]
# ...
my_ip = 10.0.0.11
```

- Configure the `[neutron]` section of **/etc/nova/nova.conf**. Refer to the Networking service install guide for more information.

- In the `[vnc]` section, configure the VNC proxy to use the management interface IP address of the controller node:

```
[vnc]
enabled = true
# ...
server_listen = $my_ip
server_proxyclient_address = $my_ip
```

- In the `[glance]` section, configure the location of the Image service API:

```
[glance]
# ...
api_servers = http://controller:9292
```

- In the `[oslo_concurrency]` section, configure the lock path:

```
[oslo_concurrency]
# ...
lock_path = /var/lib/nova/tmp
```

- Due to a packaging bug, remove the `log_dir` option from the `[DEFAULT]` section.

- In the `[placement]` section, configure access to the Placement service:

```
[placement]
# ...
region_name = RegionOne
project_domain_name = Default
project_name = service
auth_type = password
user_domain_name = Default
auth_url = http://controller:5000/v3
username = placement
password = PLACEMENT_PASS
```

Replace `PLACEMENT_PASS` with the password you choose for the `placement` service user created when installing Placement. Comment out or remove any other options in the `[placement]` section.

3. Populate the `nova-api` database:

```
# su -s /bin/sh -c "nova-manage api_db sync" nova
```

Note

Ignore any deprecation messages in this output.

4. Register the `cell0` database:

```
# su -s /bin/sh -c "nova-manage cell_v2 map_cell0" nova
```

5. Create the `cell1` cell:

```
# su -s /bin/sh -c "nova-manage cell_v2 create_cell --name=cell1 --verbose
↪" nova
```

6. Populate the nova database:

```
# su -s /bin/sh -c "nova-manage db sync" nova
```

7. Verify nova cell0 and cell1 are registered correctly:

```
# su -s /bin/sh -c "nova-manage cell_v2 list_cells" nova
+-------+--------------------------------------+------------------------
↪--------------------------+-------------------------------------------
↪-----------------+----------+
|  Name |                 UUID                 |                       ␣
↪Transport URL                    |                   Database␣
↪Connection                       | Disabled |
+-------+--------------------------------------+------------------------
↪--------------------------+-------------------------------------------
↪-----------------+----------+
| cell0 | 00000000-0000-0000-0000-000000000000 |                       ␣
↪none:/                           | mysql+pymysql://nova:****@controller/
```

(continues on next page)

(continued from previous page)

```
↪nova_cell0?charset=utf8 |  False   |
| cell1 | f690f4fd-2bc5-4f15-8145-db561a7b9d3d | rabbit://
↪openstack:****@controller:5672/nova_cell1 | mysql+pymysql://
↪nova:****@controller/nova_cell1?charset=utf8 |  False   |
+-------+--------------------------------------+------------------------
↪-------------------------+-----------------------------------------------
↪-----------------+----------+
```

Finalize installation

- Restart the Compute services:

```
# service nova-api restart
# service nova-scheduler restart
# service nova-conductor restart
# service nova-novncproxy restart
```

Install and configure controller node for Red Hat Enterprise Linux and CentOS

This section describes how to install and configure the Compute service, code-named nova, on the controller node.

Prerequisites

Before you install and configure the Compute service, you must create databases, service credentials, and API endpoints.

1. To create the databases, complete these steps:
   - Use the database access client to connect to the database server as the `root` user:

     ```
     $ mysql -u root -p
     ```

   - Create the `nova_api`, `nova`, and `nova_cell0` databases:

     ```
     MariaDB [(none)]> CREATE DATABASE nova_api;
     MariaDB [(none)]> CREATE DATABASE nova;
     MariaDB [(none)]> CREATE DATABASE nova_cell0;
     ```

   - Grant proper access to the databases:

     ```
     MariaDB [(none)]> GRANT ALL PRIVILEGES ON nova_api.* TO 'nova'@
     ↪'localhost' \
       IDENTIFIED BY 'NOVA_DBPASS';
     MariaDB [(none)]> GRANT ALL PRIVILEGES ON nova_api.* TO 'nova'@'%' \
       IDENTIFIED BY 'NOVA_DBPASS';

     MariaDB [(none)]> GRANT ALL PRIVILEGES ON nova.* TO 'nova'@'localhost
     ↪' \
       IDENTIFIED BY 'NOVA_DBPASS';
     MariaDB [(none)]> GRANT ALL PRIVILEGES ON nova.* TO 'nova'@'%' \
     ```

(continues on next page)

(continued from previous page)

```
  IDENTIFIED BY 'NOVA_DBPASS';

MariaDB [(none)]> GRANT ALL PRIVILEGES ON nova_cell0.* TO 'nova'@
↪'localhost' \
  IDENTIFIED BY 'NOVA_DBPASS';
MariaDB [(none)]> GRANT ALL PRIVILEGES ON nova_cell0.* TO 'nova'@'%'␣
↪\
  IDENTIFIED BY 'NOVA_DBPASS';
```

Replace `NOVA_DBPASS` with a suitable password.

- Exit the database access client.

2. Source the `admin` credentials to gain access to admin-only CLI commands:

```
$ . admin-openrc
```

3. Create the Compute service credentials:

- Create the `nova` user:

```
$ openstack user create --domain default --password-prompt nova

User Password:
Repeat User Password:
+---------------------+----------------------------------+
| Field               | Value                            |
+---------------------+----------------------------------+
| domain_id           | default                          |
| enabled             | True                             |
| id                  | 8a7dbf5279404537b1c7b86c033620fe |
| name                | nova                             |
| options             | {}                               |
| password_expires_at | None                             |
+---------------------+----------------------------------+
```

- Add the `admin` role to the `nova` user:

```
$ openstack role add --project service --user nova admin
```

Note

This command provides no output.

- Create the `nova` service entity:

```
$ openstack service create --name nova \
  --description "OpenStack Compute" compute

+-------------+----------------------------------+
| Field       | Value                            |
```

(continues on next page)

(continued from previous page)

```
+-------------+----------------------------------+
| description | OpenStack Compute                |
| enabled     | True                             |
| id          | 060d59eac51b4594815603d75a00aba2 |
| name        | nova                             |
| type        | compute                          |
+-------------+----------------------------------+
```

4. Create the Compute API service endpoints:

```
$ openstack endpoint create --region RegionOne \
  compute public http://controller:8774/v2.1

+--------------+-----------------------------------------+
| Field        | Value                                   |
+--------------+-----------------------------------------+
| enabled      | True                                    |
| id           | 3c1caa473bfe4390a11e7177894bcc7b        |
| interface    | public                                  |
| region       | RegionOne                               |
| region_id    | RegionOne                               |
| service_id   | 060d59eac51b4594815603d75a00aba2        |
| service_name | nova                                    |
| service_type | compute                                 |
| url          | http://controller:8774/v2.1             |
+--------------+-----------------------------------------+

$ openstack endpoint create --region RegionOne \
  compute internal http://controller:8774/v2.1

+--------------+-----------------------------------------+
| Field        | Value                                   |
+--------------+-----------------------------------------+
| enabled      | True                                    |
| id           | e3c918de680746a586eac1f2d9bc10ab        |
| interface    | internal                                |
| region       | RegionOne                               |
| region_id    | RegionOne                               |
| service_id   | 060d59eac51b4594815603d75a00aba2        |
| service_name | nova                                    |
| service_type | compute                                 |
| url          | http://controller:8774/v2.1             |
+--------------+-----------------------------------------+

$ openstack endpoint create --region RegionOne \
  compute admin http://controller:8774/v2.1

+--------------+-----------------------------------------+
| Field        | Value                                   |
+--------------+-----------------------------------------+
```

(continues on next page)

(continued from previous page)

```
| enabled      | True                                     |
| id           | 38f7af91666a47cfb97b4dc790b94424         |
| interface    | admin                                    |
| region       | RegionOne                                |
| region_id    | RegionOne                                |
| service_id   | 060d59eac51b4594815603d75a00aba2         |
| service_name | nova                                     |
| service_type | compute                                  |
| url          | http://controller:8774/v2.1              |
+--------------+------------------------------------------+
```

5. Install Placement service and configure user and endpoints:

   - Refer to the Placement service install guide for more information.

Install and configure components

Note

Default configuration files vary by distribution. You might need to add these sections and options rather than modifying existing sections and options. Also, an ellipsis (`...`) in the configuration snippets indicates potential default configuration options that you should retain.

1. Install the packages:

```
# dnf install openstack-nova-api openstack-nova-conductor \
  openstack-nova-novncproxy openstack-nova-scheduler
```

2. Edit the `/etc/nova/nova.conf` file and complete the following actions:

   - In the `[api_database]` and `[database]` sections, configure database access:

```
[api_database]
# ...
connection = mysql+pymysql://nova:NOVA_DBPASS@controller/nova_api

[database]
# ...
connection = mysql+pymysql://nova:NOVA_DBPASS@controller/nova
```

     Replace `NOVA_DBPASS` with the password you chose for the Compute databases.

   - In the `[DEFAULT]` section, configure `RabbitMQ` message queue access (RabbitMQ should be already installed and configured):

```
[DEFAULT]
# ...
transport_url = rabbit://openstack:RABBIT_PASS@controller:5672/
```

     Replace `RABBIT_PASS` with the password you chose for the `openstack` account in `RabbitMQ`.

- In the `[keystone_authtoken]` section, configure Identity service access:

```
[keystone_authtoken]
# ...
www_authenticate_uri = http://controller:5000/
auth_url = http://controller:5000/
memcached_servers = controller:11211
auth_type = password
project_domain_name = Default
user_domain_name = Default
project_name = service
username = nova
password = NOVA_PASS
```

Replace `NOVA_PASS` with the password you chose for the `nova` user in the Identity service.

Note

Comment out or remove any other options in the `[keystone_authtoken]` section.

- In the `[service_user]` section, configure *service user tokens*:

```
[service_user]
send_service_user_token = true
auth_url = https://controller/identity
auth_type = password
project_domain_name = Default
project_name = service
user_domain_name = Default
username = nova
password = NOVA_PASS
```

Replace `NOVA_PASS` with the password you chose for the `nova` user in the Identity service.

- In the `[DEFAULT]` section, configure the `my_ip` option to use the management interface IP address of the controller node:

```
[DEFAULT]
# ...
my_ip = 10.0.0.11
```

- Configure the `[neutron]` section of **/etc/nova/nova.conf**. Refer to the Networking service install guide for more details.
- In the `[vnc]` section, configure the VNC proxy to use the management interface IP address of the controller node:

```
[vnc]
enabled = true
# ...
server_listen = $my_ip
server_proxyclient_address = $my_ip
```

- In the [glance] section, configure the location of the Image service API:

```
[glance]
# ...
api_servers = http://controller:9292
```

- In the [oslo_concurrency] section, configure the lock path:

```
[oslo_concurrency]
# ...
lock_path = /var/lib/nova/tmp
```

- In the [placement] section, configure access to the Placement service:

```
[placement]
# ...
region_name = RegionOne
project_domain_name = Default
project_name = service
auth_type = password
user_domain_name = Default
auth_url = http://controller:5000/v3
username = placement
password = PLACEMENT_PASS
```

Replace PLACEMENT_PASS with the password you choose for the placement service user created when installing Placement. Comment out or remove any other options in the [placement] section.

3. Populate the nova-api database:

```
# su -s /bin/sh -c "nova-manage api_db sync" nova
```

Note

Ignore any deprecation messages in this output.

4. Register the cell0 database:

```
# su -s /bin/sh -c "nova-manage cell_v2 map_cell0" nova
```

5. Create the cell1 cell:

```
# su -s /bin/sh -c "nova-manage cell_v2 create_cell --name=cell1 --verbose
↪" nova
```

6. Populate the nova database:

```
# su -s /bin/sh -c "nova-manage db sync" nova
```

7. Verify nova cell0 and cell1 are registered correctly:

```
# su -s /bin/sh -c "nova-manage cell_v2 list_cells" nova
+-------+--------------------------------------+--------------------------
↪-------------------------+-------------------------------------------
↪-----------------+----------+
|  Name |                 UUID                 |                 
↪Transport URL                       |                      Database␣
↪Connection                          | Disabled |
+-------+--------------------------------------+--------------------------
↪-------------------------+-------------------------------------------
↪-----------------+----------+
| cell0 | 00000000-0000-0000-0000-000000000000 |                       ␣
↪none:/                              | mysql+pymysql://nova:****@controller/
↪nova_cell0?charset=utf8 |  False   |
| cell1 | f690f4fd-2bc5-4f15-8145-db561a7b9d3d | rabbit://
↪openstack:****@controller:5672/nova_cell1 | mysql+pymysql://
↪nova:****@controller/nova_cell1?charset=utf8 |  False   |
+-------+--------------------------------------+--------------------------
↪-------------------------+-------------------------------------------
↪-----------------+----------+
```

Finalize installation

- Start the Compute services and configure them to start when the system boots:

```
# systemctl enable \
    openstack-nova-api.service \
    openstack-nova-scheduler.service \
    openstack-nova-conductor.service \
    openstack-nova-novncproxy.service
# systemctl start \
    openstack-nova-api.service \
    openstack-nova-scheduler.service \
    openstack-nova-conductor.service \
    openstack-nova-novncproxy.service
```

3.2.1.4 Install and configure a compute node

This section describes how to install and configure the Compute service on a compute node for Ubuntu, Red Hat Enterprise Linux and CentOS Stream.

The service supports several hypervisors to deploy instances or virtual machines (VMs). For simplicity, this configuration uses the Quick EMUlator (QEMU) hypervisor with the kernel-based VM (KVM) extension on compute nodes that support hardware acceleration for virtual machines. On legacy hardware, this configuration uses the generic QEMU hypervisor. You can follow these instructions with minor modifications to horizontally scale your environment with additional compute nodes.

Note

This section assumes that you are following the instructions in this guide step-by-step to configure the first compute node. If you want to configure additional compute nodes, prepare them in a similar

fashion to the first compute node in the *example architectures* section. Each additional compute node requires a unique IP address.

Install and configure a compute node for Ubuntu

This section describes how to install and configure the Compute service on a compute node. The service supports several hypervisors to deploy instances or virtual machines (VMs). For simplicity, this configuration uses the Quick EMUlator (QEMU) hypervisor with the kernel-based VM (KVM) extension on compute nodes that support hardware acceleration for virtual machines. On legacy hardware, this configuration uses the generic QEMU hypervisor. You can follow these instructions with minor modifications to horizontally scale your environment with additional compute nodes.

Note

This section assumes that you are following the instructions in this guide step-by-step to configure the first compute node. If you want to configure additional compute nodes, prepare them in a similar fashion to the first compute node in the *example architectures* section. Each additional compute node requires a unique IP address.

Install and configure components

Note

Default configuration files vary by distribution. You might need to add these sections and options rather than modifying existing sections and options. Also, an ellipsis (`...`) in the configuration snippets indicates potential default configuration options that you should retain.

1. Install the packages:

```
# apt install nova-compute
```

2. Edit the `/etc/nova/nova.conf` file and complete the following actions:

   - In the `[DEFAULT]` section, configure `RabbitMQ` message queue access:

```
[DEFAULT]
# ...
transport_url = rabbit://openstack:RABBIT_PASS@controller
```

     Replace `RABBIT_PASS` with the password you chose for the `openstack` account in `RabbitMQ`.

   - In the `[service_user]` section, configure *service user tokens*:

```
[service_user]
send_service_user_token = true
auth_url = https://controller/identity
auth_type = password
project_domain_name = Default
```

(continues on next page)

(continued from previous page)

```
project_name = service
user_domain_name = Default
username = nova
password = NOVA_PASS
```

Replace `NOVA_PASS` with the password you chose for the `nova` user in the Identity service.

- In the `[DEFAULT]` section, configure the `my_ip` option:

```
[DEFAULT]
# ...
my_ip = MANAGEMENT_INTERFACE_IP_ADDRESS
```

Replace `MANAGEMENT_INTERFACE_IP_ADDRESS` with the IP address of the management network interface on your compute node, typically 10.0.0.31 for the first node in the *example architecture*.

- Configure the `[neutron]` section of **/etc/nova/nova.conf**. Refer to the Networking service install guide for more details.
- In the `[vnc]` section, enable and configure remote console access:

```
[vnc]
# ...
enabled = true
server_listen = 0.0.0.0
server_proxyclient_address = $my_ip
novncproxy_base_url = http://controller:6080/vnc_auto.html
```

The server component listens on all IP addresses and the proxy component only listens on the management interface IP address of the compute node. The base URL indicates the location where you can use a web browser to access remote consoles of instances on this compute node.

Note

If the web browser to access remote consoles resides on a host that cannot resolve the `controller` hostname, you must replace `controller` with the management interface IP address of the controller node.

- In the `[glance]` section, configure the location of the Image service API:

```
[glance]
# ...
api_servers = http://controller:9292
```

- In the `[oslo_concurrency]` section, configure the lock path:

```
[oslo_concurrency]
# ...
lock_path = /var/lib/nova/tmp
```

- In the `[placement]` section, configure the Placement API:

```
[placement]
# ...
region_name = RegionOne
project_domain_name = Default
project_name = service
auth_type = password
user_domain_name = Default
auth_url = http://controller:5000/v3
username = placement
password = PLACEMENT_PASS
```

Replace `PLACEMENT_PASS` with the password you choose for the `placement` user in the Identity service. Comment out any other options in the `[placement]` section.

Finalize installation

1. Determine whether your compute node supports hardware acceleration for virtual machines:

```
$ egrep -c '(vmx|svm)' /proc/cpuinfo
```

If this command returns a value of `one or greater`, your compute node supports hardware acceleration which typically requires no additional configuration.

If this command returns a value of `zero`, your compute node does not support hardware acceleration and you must configure `libvirt` to use QEMU instead of KVM.

- Edit the `[libvirt]` section in the `/etc/nova/nova-compute.conf` file as follows:

```
[libvirt]
# ...
virt_type = qemu
```

2. Restart the Compute service:

```
# service nova-compute restart
```

Note

If the `nova-compute` service fails to start, check `/var/log/nova/nova-compute.log`. The error message `AMQP server on controller:5672 is unreachable` likely indicates that the firewall on the controller node is preventing access to port 5672. Configure the firewall to open port 5672 on the controller node and restart `nova-compute` service on the compute node.

Add the compute node to the cell database

Important

Run the following commands on the **controller** node.

1. Source the admin credentials to enable admin-only CLI commands, then confirm there are compute hosts in the database:

```
$ . admin-openrc

$ openstack compute service list --service nova-compute
+----+-------+--------------+------+-------+---------+--------------------
↪--------+
| ID | Host  | Binary       | Zone | State | Status  | Updated At
↪        |
+----+-------+--------------+------+-------+---------+--------------------
↪--------+
| 1  | node1 | nova-compute | nova | up    | enabled | 2017-04-
↪14T15:30:44.000000 |
+----+-------+--------------+------+-------+---------+--------------------
↪--------+
```

2. Discover compute hosts:

```
# su -s /bin/sh -c "nova-manage cell_v2 discover_hosts --verbose" nova

Found 2 cell mappings.
Skipping cell0 since it does not contain hosts.
Getting compute nodes from cell 'cell1': ad5a5985-a719-4567-98d8-
↪8d148aaae4bc
Found 1 computes in cell: ad5a5985-a719-4567-98d8-8d148aaae4bc
Checking host mapping for compute host 'compute': fe58ddc1-1d65-4f87-9456-
↪bc040dc106b3
Creating host mapping for compute host 'compute': fe58ddc1-1d65-4f87-9456-
↪bc040dc106b3
```

Note

When you add new compute nodes, you must run `nova-manage cell_v2 discover_hosts` on the controller node to register those new compute nodes. Alternatively, you can set an appropriate interval in `/etc/nova/nova.conf`:

```
[scheduler]
discover_hosts_in_cells_interval = 300
```

Install and configure a compute node for Red Hat Enterprise Linux and CentOS

This section describes how to install and configure the Compute service on a compute node. The service supports several hypervisors to deploy instances or virtual machines (VMs). For simplicity, this configuration uses the Quick EMUlator (QEMU) hypervisor with the kernel-based VM (KVM) extension on compute nodes that support hardware acceleration for virtual machines. On legacy hardware, this configuration uses the generic QEMU hypervisor. You can follow these instructions with minor modifications to horizontally scale your environment with additional compute nodes.

Note

This section assumes that you are following the instructions in this guide step-by-step to configure the first compute node. If you want to configure additional compute nodes, prepare them in a similar fashion to the first compute node in the *example architectures* section. Each additional compute node requires a unique IP address.

Install and configure components

Note

Default configuration files vary by distribution. You might need to add these sections and options rather than modifying existing sections and options. Also, an ellipsis (`...`) in the configuration snippets indicates potential default configuration options that you should retain.

1. Install the packages:

```
# dnf install openstack-nova-compute
```

2. Edit the `/etc/nova/nova.conf` file and complete the following actions:

   - In the `[DEFAULT]` section, configure `RabbitMQ` message queue access:

```
[DEFAULT]
# ...
transport_url = rabbit://openstack:RABBIT_PASS@controller
```

     Replace `RABBIT_PASS` with the password you chose for the `openstack` account in `RabbitMQ`.

   - In the `[service_user]` section, configure *service user tokens*:

```
[service_user]
send_service_user_token = true
auth_url = https://controller/identity
auth_type = password
project_domain_name = Default
project_name = service
user_domain_name = Default
username = nova
password = NOVA_PASS
```

     Replace `NOVA_PASS` with the password you chose for the `nova` user in the Identity service.

   - In the `[DEFAULT]` section, configure the `my_ip` option:

```
[DEFAULT]
# ...
my_ip = MANAGEMENT_INTERFACE_IP_ADDRESS
```

     Replace `MANAGEMENT_INTERFACE_IP_ADDRESS` with the IP address of the management network interface on your compute node, typically 10.0.0.31 for the first node in the *example*

architecture.

- Configure the `[neutron]` section of **/etc/nova/nova.conf**. Refer to the Networking service install guide for more details.
- In the `[vnc]` section, enable and configure remote console access:

```
[vnc]
# ...
enabled = true
server_listen = 0.0.0.0
server_proxyclient_address = $my_ip
novncproxy_base_url = http://controller:6080/vnc_auto.html
```

The server component listens on all IP addresses and the proxy component only listens on the management interface IP address of the compute node. The base URL indicates the location where you can use a web browser to access remote consoles of instances on this compute node.

Note

If the web browser to access remote consoles resides on a host that cannot resolve the `controller` hostname, you must replace `controller` with the management interface IP address of the controller node.

- In the `[glance]` section, configure the location of the Image service API:

```
[glance]
# ...
api_servers = http://controller:9292
```

- In the `[oslo_concurrency]` section, configure the lock path:

```
[oslo_concurrency]
# ...
lock_path = /var/lib/nova/tmp
```

- In the `[placement]` section, configure the Placement API:

```
[placement]
# ...
region_name = RegionOne
project_domain_name = Default
project_name = service
auth_type = password
user_domain_name = Default
auth_url = http://controller:5000/v3
username = placement
password = PLACEMENT_PASS
```

Replace `PLACEMENT_PASS` with the password you choose for the `placement` user in the Identity service. Comment out any other options in the `[placement]` section.

Finalize installation

1. Determine whether your compute node supports hardware acceleration for virtual machines:

```
$ egrep -c '(vmx|svm)' /proc/cpuinfo
```

   If this command returns a value of `one or greater`, your compute node supports hardware acceleration which typically requires no additional configuration.

   If this command returns a value of `zero`, your compute node does not support hardware acceleration and you must configure `libvirt` to use QEMU instead of KVM.

   - Edit the `[libvirt]` section in the `/etc/nova/nova.conf` file as follows:

```
[libvirt]
# ...
virt_type = qemu
```

2. Start the Compute service including its dependencies and configure them to start automatically when the system boots:

```
# systemctl enable libvirtd.service openstack-nova-compute.service
# systemctl start libvirtd.service openstack-nova-compute.service
```

Note

If the `nova-compute` service fails to start, check `/var/log/nova/nova-compute.log`. The error message `AMQP server on controller:5672 is unreachable` likely indicates that the firewall on the controller node is preventing access to port 5672. Configure the firewall to open port 5672 on the controller node and restart `nova-compute` service on the compute node.

Add the compute node to the cell database

Important

Run the following commands on the **controller** node.

1. Source the admin credentials to enable admin-only CLI commands, then confirm there are compute hosts in the database:

```
$ . admin-openrc

$ openstack compute service list --service nova-compute
+----+-------+--------------+------+-------+---------+----------------------
↪--------+
| ID | Host  | Binary       | Zone | State | Status  | Updated At
↪        |
+----+-------+--------------+------+-------+---------+----------------------
↪--------+
| 1  | node1 | nova-compute | nova | up    | enabled | 2017-04-
```

(continues on next page)

(continued from previous page)

```
↪14T15:30:44.000000 |
+----+-------+-------------+------+-------+---------+-------------------
↪--------+
```

2. Discover compute hosts:

```
# su -s /bin/sh -c "nova-manage cell_v2 discover_hosts --verbose" nova

Found 2 cell mappings.
Skipping cell0 since it does not contain hosts.
Getting compute nodes from cell 'cell1': ad5a5985-a719-4567-98d8-
↪8d148aaae4bc
Found 1 computes in cell: ad5a5985-a719-4567-98d8-8d148aaae4bc
Checking host mapping for compute host 'compute': fe58ddc1-1d65-4f87-9456-
↪bc040dc106b3
Creating host mapping for compute host 'compute': fe58ddc1-1d65-4f87-9456-
↪bc040dc106b3
```

Note

When you add new compute nodes, you must run `nova-manage cell_v2 discover_hosts` on the controller node to register those new compute nodes. Alternatively, you can set an appropriate interval in `/etc/nova/nova.conf`:

```
[scheduler]
discover_hosts_in_cells_interval = 300
```

3.2.1.5 Verify operation

Verify operation of the Compute service.

Note

Perform these commands on the controller node.

1. Source the `admin` credentials to gain access to admin-only CLI commands:

```
$ . admin-openrc
```

2. List service components to verify successful launch and registration of each process:

```
$ openstack compute service list

+----+--------------------+------------+----------+---------+-------+-----
↪----------------------+
| Id | Binary             | Host       | Zone     | Status  | State |␣
↪Updated At                 |
+----+--------------------+------------+----------+---------+-------+-----
↪----------------------+
```

(continues on next page)

(continued from previous page)

```
|  1 | nova-scheduler     | controller | internal | enabled | up    |␣
↪2016-02-09T23:11:15.000000 |
|  2 | nova-conductor     | controller | internal | enabled | up    |␣
↪2016-02-09T23:11:16.000000 |
|  3 | nova-compute       | compute1   | nova     | enabled | up    |␣
↪2016-02-09T23:11:20.000000 |
+----+--------------------+------------+----------+---------+-------+-----
↪----------------------+
```

Note

This output should indicate two service components enabled on the controller node and one service component enabled on the compute node.

3. List API endpoints in the Identity service to verify connectivity with the Identity service:

Note

Below endpoints list may differ depending on the installation of OpenStack components.

```
$ openstack catalog list

+-----------+-----------+-----------------------------------------+
| Name      | Type      | Endpoints                               |
+-----------+-----------+-----------------------------------------+
| keystone  | identity  | RegionOne                               |
|           |           |   public: http://controller:5000/v3/    |
|           |           | RegionOne                               |
|           |           |   internal: http://controller:5000/v3/  |
|           |           | RegionOne                               |
|           |           |   admin: http://controller:5000/v3/     |
|           |           |                                         |
| glance    | image     | RegionOne                               |
|           |           |   admin: http://controller:9292         |
|           |           | RegionOne                               |
|           |           |   public: http://controller:9292        |
|           |           | RegionOne                               |
|           |           |   internal: http://controller:9292      |
|           |           |                                         |
| nova      | compute   | RegionOne                               |
|           |           |   admin: http://controller:8774/v2.1    |
|           |           | RegionOne                               |
|           |           |   internal: http://controller:8774/v2.1 |
|           |           | RegionOne                               |
|           |           |   public: http://controller:8774/v2.1   |
|           |           |                                         |
| placement | placement | RegionOne                               |
```

(continues on next page)

(continued from previous page)

```
|           |           |   public: http://controller:8778        |
|           |           | RegionOne                               |
|           |           |   admin: http://controller:8778         |
|           |           | RegionOne                               |
|           |           |   internal: http://controller:8778      |
|           |           |                                         |
+-----------+-----------+-----------------------------------------+
```

Note

Ignore any warnings in this output.

4. List images in the Image service to verify connectivity with the Image service:

```
$ openstack image list

+--------------------------------------+-------------+-------------+
| ID                                   | Name        | Status      |
+--------------------------------------+-------------+-------------+
| 9a76d9f9-9620-4f2e-8c69-6c5691fae163 | cirros      | active      |
+--------------------------------------+-------------+-------------+
```

5. Check the cells and placement API are working successfully and that other necessary prerequisites are in place:

```
# nova-status upgrade check

+---------------------------------------------------------------------+
| Upgrade Check Results                                               |
+---------------------------------------------------------------------+
| Check: Cells v2                                                     |
| Result: Success                                                     |
| Details: None                                                       |
+---------------------------------------------------------------------+
| Check: Placement API                                                |
| Result: Success                                                     |
| Details: None                                                       |
+---------------------------------------------------------------------+
| Check: Cinder API                                                   |
| Result: Success                                                     |
| Details: None                                                       |
+---------------------------------------------------------------------+
| Check: Policy File JSON to YAML Migration                           |
| Result: Success                                                     |
| Details: None                                                       |
+---------------------------------------------------------------------+
| Check: Older than N-1 computes                                      |
| Result: Success                                                     |
| Details: None                                                       |
```

(continues on next page)

(continued from previous page)

```
+-----------------------------------------------------------------------+
```

3.3 Deployment Considerations

There is information you might want to consider before doing your deployment, especially if it is going to be a larger deployment. For smaller deployments the defaults from the *install guide* will be sufficient.

- **Compute Driver Features Supported**: While the majority of nova deployments use libvirt/kvm, you can use nova with other compute drivers. Nova attempts to provide a unified feature set across these, however, not all features are implemented on all backends, and not all features are equally well tested.
  - *Feature Support by Use Case*: A view of what features each driver supports based on whats important to some large use cases (General Purpose Cloud, NFV Cloud, HPC Cloud).
  - *Feature Support full list*: A detailed dive through features in each compute driver backend.
- *Cells v2 configuration*: For large deployments, cells v2 cells allow sharding of your compute environment. Upfront planning is key to a successful cells v2 layout.
- *Running nova-api on wsgi*: Considerations for deploying under WSGI.

3.3.1 Feature Classification

This document presents a matrix that describes which features are ready to be used and which features are works in progress. It includes links to relevant documentation and functional tests.

Warning

Please note: this is a work in progress!

3.3.1.1 Aims

Users want reliable, long-term solutions for their use cases. The feature classification matrix identifies which features are complete and ready to use, and which should be used with caution.

The matrix also benefits developers by providing a list of features that require further work to be considered complete.

Below is a matrix for a selection of important verticals:

- *General Purpose Cloud Features*
- *NFV Cloud Features*
- *HPC Cloud Features*

For more details on the concepts in each matrix, please see *Notes on Concepts*.

3.3.1.2 General Purpose Cloud Features

This is a summary of the key features dev/test clouds, and other similar general purpose clouds need, and it describes their current state.

Below there are sections on NFV and HPC specific features. These look at specific features and scenarios that are important to those more specific sets of use cases. Summary

Feature	*Maturity*	Ironi CI	libvirt+kvm (x86 & ppc64)	libvirt+kvm (s390x)	libvirt+virtu CT	libvirt+virtu VM	VMwa CI	IBM zVM CI
Create Server and Delete Server	complete	*?*	✓	*?*	✓	✓	✓	✓
Snapshot Server	complete	*?*	✓	*?*	✓	✓	*?*	✓
Server power ops	complete	*?*	✓	*?*	✓	✓	✓	✓
Rebuild Server	complete	*?*	✓	*?*	✓	✓	✓	×
Resize Server	complete	*?*	✓	*?*	✓	✓	✓	×
Volume Operations	complete	×	✓	*?*	✓	✓	✓	×
Custom disk configurations on boot	complete	×	✓	*?*	×	✓	✓	×
Custom neutron configurations on boot	complete	×	✓	*?*	*?*	*?*	✓	✓
Pause a Server	complete	×	✓	*?*	×	✓	✓	✓
Suspend a Server	complete	×	✓	*?*	✓	✓	✓	×
Server console output	complete	×	✓	*?*	*?*	*?*	✓	✓
Server Rescue	complete	×	✓	*?*	✓	✓	✓	×
Server Config Drive	complete	✓	✓	*?*	×	✓	✓	✓
Server Change Password	experimental	×	✓	*?*	×	×	×	×
Server Shelve and Unshelve	complete	×	✓	*?*	×	✓	×	×

Details

- **Create Server and Delete Server** This includes creating a server, and deleting a server. Specifically this is about booting a server from a glance image using the default disk and network configuration.

  info:

  - **Maturity:** `complete`

  - **API Docs:** https://docs.openstack.org/api-ref/compute/#servers-servers
  - **Admin Docs:** https://docs.openstack.org/nova/latest/user/launch-instances.html
  - **Tempest tests:** 9a438d88-10c6-4bcd-8b5b-5b6e25e1346f, 585e934c-448e-43c4-acbf-d06a9b899997

  drivers:

  - **libvirt+kvm (x86 & ppc64):** `complete`
  - **libvirt+kvm (s390x):** `unknown`
  - **libvirt+virtuozzo CT:** `partial`
  - **libvirt+virtuozzo VM:** `partial`
  - **VMware CI:** `complete`
  - **Ironic CI:** `unknown`
  - **IBM zVM CI:** `complete`

- **Snapshot Server** This is creating a glance image from the currently running server.

  info:

  - **Maturity:** `complete`
  - **API Docs:** https://docs.openstack.org/api-ref/compute/?expanded=#servers-run-an-action-servers-action
  - **Admin Docs:** https://docs.openstack.org/glance/latest/admin/troubleshooting.html
  - **Tempest tests:** aaacd1d0-55a2-4ce8-818a-b5439df8adc9

  drivers:

  - **libvirt+kvm (x86 & ppc64):** `complete`
  - **libvirt+kvm (s390x):** `unknown`
  - **libvirt+virtuozzo CT:** `partial`
  - **libvirt+virtuozzo VM:** `partial`
  - **VMware CI:** `unknown`
  - **Ironic CI:** `unknown`
  - **IBM zVM CI:** `complete`

- **Server power ops** This includes reboot, shutdown and start.

  info:

  - **Maturity:** `complete`
  - **API Docs:** https://docs.openstack.org/api-ref/compute/?expanded=#servers-run-an-action-servers-action
  - **Admin Docs:**
  - **Tempest tests:** 2cb1baf6-ac8d-4429-bf0d-ba8a0ba53e32, af8eafd4-38a7-4a4b-bdbc-75145a580560

  drivers:

  - **libvirt+kvm (x86 & ppc64):** `complete`
  - **libvirt+kvm (s390x):** `unknown`
  - **libvirt+virtuozzo CT:** `partial`
  - **libvirt+virtuozzo VM:** `partial`
  - **VMware CI:** `complete`
  - **Ironic CI:** `unknown`
  - **IBM zVM CI:** `complete`

- **Rebuild Server** You can rebuild a server, optionally specifying the glance image to use.

  info:

  - **Maturity:** `complete`
  - **API Docs:** https://docs.openstack.org/api-ref/compute/?expanded=#servers-run-an-action-servers-action
  - **Admin Docs:**
  - **Tempest tests:** aaa6cdf3-55a7-461a-add9-1c8596b9a07c

  drivers:

  - **libvirt+kvm (x86 & ppc64):** `complete`
  - **libvirt+kvm (s390x):** `unknown`
  - **libvirt+virtuozzo CT:** `partial`
  - **libvirt+virtuozzo VM:** `partial`
  - **VMware CI:** `complete`
  - **Ironic CI:** `unknown`
  - **IBM zVM CI:** `missing`

- **Resize Server** You resize a server to a new flavor, then confirm or revert that operation.

  info:

  - **Maturity:** `complete`
  - **API Docs:** https://docs.openstack.org/api-ref/compute/?expanded=#servers-run-an-action-servers-action
  - **Admin Docs:**
  - **Tempest tests:** 1499262a-9328-4eda-9068-db1ac57498d2

  drivers:

  - **libvirt+kvm (x86 & ppc64):** `complete`
  - **libvirt+kvm (s390x):** `unknown`
  - **libvirt+virtuozzo CT:** `complete`
  - **libvirt+virtuozzo VM:** `partial`
  - **VMware CI:** `complete`

  - **Ironic CI:** unknown
  - **IBM zVM CI:** missing

- **Volume Operations** This is about attaching volumes, detaching volumes.

  info:

  - **Maturity:** complete
  - **API Docs:** https://docs.openstack.org/api-ref/compute/#servers-with-volume-attachments-servers-os-volume-attachments
  - **Admin Docs:** https://docs.openstack.org/cinder/latest/admin/blockstorage-manage-volumes.html
  - **Tempest tests:** fff42874-7db5-4487-a8e1-ddda5fb5288d

  drivers:

  - **libvirt+kvm (x86 & ppc64):** complete
  - **libvirt+kvm (s390x):** unknown
  - **libvirt+virtuozzo CT:** complete
  - **libvirt+virtuozzo VM:** complete
  - **VMware CI:** complete
  - **Ironic CI:** missing
  - **IBM zVM CI:** missing

- **Custom disk configurations on boot** This is about supporting all the features of BDMv2. This includes booting from a volume, in various ways, and specifying a custom set of ephemeral disks. Note some drivers only supports part of what the API allows.

  info:

  - **Maturity:** complete
  - **API Docs:** https://docs.openstack.org/api-ref/compute/?expanded=create-image-createimage-action-detail#create-server
  - **Admin Docs:** https://docs.openstack.org/nova/latest/user/block-device-mapping.html
  - **Tempest tests:** 557cd2c2-4eb8-4dce-98be-f86765ff311b, 36c34c67-7b54-4b59-b188-02a2f458a63b

  drivers:

  - **libvirt+kvm (x86 & ppc64):** complete
  - **libvirt+kvm (s390x):** unknown
  - **libvirt+virtuozzo CT:** missing
  - **libvirt+virtuozzo VM:** complete
  - **VMware CI:** partial
  - **Ironic CI:** missing
  - **IBM zVM CI:** missing

- **Custom neutron configurations on boot** This is about supporting booting from one or more neutron ports, or all the related short cuts such as booting a specified network. This does not include SR-IOV or similar, just simple neutron ports.

  info:

  - **Maturity:** `complete`
  - **API Docs:** https://docs.openstack.org/api-ref/compute/?&expanded=create-server-detail
  - **Admin Docs:**
  - **Tempest tests:** 2f3a0127-95c7-4977-92d2-bc5aec602fb4

  drivers:

  - **libvirt+kvm (x86 & ppc64):** `complete`
  - **libvirt+kvm (s390x):** `unknown`
  - **libvirt+virtuozzo CT:** `unknown`
  - **libvirt+virtuozzo VM:** `unknown`
  - **VMware CI:** `partial`
  - **Ironic CI:** `missing`
  - **IBM zVM CI:** `partial`

- **Pause a Server** This is pause and unpause a server, where the state is held in memory.

  info:

  - **Maturity:** `complete`
  - **API Docs:** https://docs.openstack.org/api-ref/compute/?#pause-server-pause-action
  - **Admin Docs:**
  - **Tempest tests:** bd61a9fd-062f-4670-972b-2d6c3e3b9e73

  drivers:

  - **libvirt+kvm (x86 & ppc64):** `complete`
  - **libvirt+kvm (s390x):** `unknown`
  - **libvirt+virtuozzo CT:** `missing`
  - **libvirt+virtuozzo VM:** `partial`
  - **VMware CI:** `partial`
  - **Ironic CI:** `missing`
  - **IBM zVM CI:** `complete`

- **Suspend a Server** This suspend and resume a server, where the state is held on disk.

  info:

  - **Maturity:** `complete`
  - **API Docs:** https://docs.openstack.org/api-ref/compute/?expanded=suspend-server-suspend-action-detail

  - **Admin Docs:**
  - **Tempest tests:** 0d8ee21e-b749-462d-83da-b85b41c86c7f

  drivers:

  - **libvirt+kvm (x86 & ppc64):** `complete`
  - **libvirt+kvm (s390x):** `unknown`
  - **libvirt+virtuozzo CT:** `partial`
  - **libvirt+virtuozzo VM:** `partial`
  - **VMware CI:** `complete`
  - **Ironic CI:** `missing`
  - **IBM zVM CI:** `missing`

- **Server console output** This gets the current server console output.

  info:

  - **Maturity:** `complete`
  - **API Docs:** https://docs.openstack.org/api-ref/compute/#show-console-output-os-getconsoleoutput-action
  - **Admin Docs:**
  - **Tempest tests:** 4b8867e6-fffa-4d54-b1d1-6fdda57be2f3

  drivers:

  - **libvirt+kvm (x86 & ppc64):** `complete`
  - **libvirt+kvm (s390x):** `unknown`
  - **libvirt+virtuozzo CT:** `unknown`
  - **libvirt+virtuozzo VM:** `unknown`
  - **VMware CI:** `partial`
  - **Ironic CI:** `missing`
  - **IBM zVM CI:** `complete`

- **Server Rescue** This boots a server with a new root disk from the specified glance image to allow a user to fix a boot partition configuration, or similar.

  info:

  - **Maturity:** `complete`
  - **API Docs:** https://docs.openstack.org/api-ref/compute/#rescue-server-rescue-action
  - **Admin Docs:**
  - **Tempest tests:** fd032140-714c-42e4-a8fd-adcd8df06be6, 70cdb8a1-89f8-437d-9448-8844fd82bf46

  drivers:

  - **libvirt+kvm (x86 & ppc64):** `complete`

  - **libvirt+kvm (s390x):** unknown
  - **libvirt+virtuozzo CT:** partial
  - **libvirt+virtuozzo VM:** complete
  - **VMware CI:** complete
  - **Ironic CI:** missing
  - **IBM zVM CI:** missing

- **Server Config Drive** This ensures the user data provided by the user when booting a server is available in one of the expected config drive locations.

  info:

  - **Maturity:** complete
  - **API Docs:** https://docs.openstack.org/api-ref/compute/#create-server
  - **Admin Docs:** https://docs.openstack.org/nova/latest/admin/config-drive.html
  - **Tempest tests:** 7fff3fb3-91d8-4fd0-bd7d-0204f1f180ba

  drivers:

  - **libvirt+kvm (x86 & ppc64):** complete
  - **libvirt+kvm (s390x):** unknown
  - **libvirt+virtuozzo CT:** missing
  - **libvirt+virtuozzo VM:** partial
  - **VMware CI:** complete
  - **Ironic CI:** partial
  - **IBM zVM CI:** complete

- **Server Change Password** The ability to reset the password of a user within the server.

  info:

  - **Maturity:** experimental
  - **API Docs:** https://docs.openstack.org/api-ref/compute/#change-administrative-password-changepassword-action
  - **Admin Docs:**
  - **Tempest tests:** 6158df09-4b82-4ab3-af6d-29cf36af858d

  drivers:

  - **libvirt+kvm (x86 & ppc64):** partial
  - **libvirt+kvm (s390x):** unknown
  - **libvirt+virtuozzo CT:** missing
  - **libvirt+virtuozzo VM:** missing
  - **VMware CI:** missing
  - **Ironic CI:** missing

  - **IBM zVM CI:** `missing`

- **Server Shelve and Unshelve** The ability to keep a server logically alive, but not using any cloud resources. For local disk based instances, this involves taking a snapshot, called offloading.

  info:

  - **Maturity:** `complete`
  - **API Docs:** https://docs.openstack.org/api-ref/compute/#shelve-server-shelve-action
  - **Admin Docs:**
  - **Tempest tests:** 1164e700-0af0-4a4c-8792-35909a88743c,c1b6318c-b9da-490b-9c67-9339b627271f

  drivers:

  - **libvirt+kvm (x86 & ppc64):** `complete`
  - **libvirt+kvm (s390x):** `unknown`
  - **libvirt+virtuozzo CT:** `missing`
  - **libvirt+virtuozzo VM:** `complete`
  - **VMware CI:** `missing`
  - **Ironic CI:** `missing`
  - **IBM zVM CI:** `missing`

3.3.1.3 NFV Cloud Features

Network Function Virtualization (NFV) is about virtualizing network node functions into building blocks that may connect, or chain together to create a particular service. It is common for this workloads needing bare metal like performance, i.e. low latency and close to line speed performance.

Important

In deployments older than Train, or in mixed Stein/Train deployments with a rolling upgrade in progress, unless *`specifically enabled`*, live migration is not possible for instances with a NUMA topology when using the libvirt driver. A NUMA topology may be specified explicitly or can be added implicitly due to the use of CPU pinning or huge pages. Refer to bug #1289064 for more information. As of Train, live migration of instances with a NUMA topology when using the libvirt driver is fully supported.

Summary

Feature	*Maturity*	libvirt+kvm (x86 & ppc64)	libvirt+kvm (s390x)
NUMA Placement	experimental	✓	*?*
CPU Pinning Policy	experimental	✓	*?*
CPU Pinning Thread Policy	experimental	✓	*?*

Details

- **NUMA Placement** Configure placement of instance vCPUs and memory across host NUMA nodes

  info:

  - **Maturity:** `experimental`
  - **API Docs:** https://docs.openstack.org/api-ref/compute/#create-server
  - **Admin Docs:** https://docs.openstack.org/nova/latest/admin/cpu-topologies.html#customizing-instance-cpu-pinning-policies
  - **Tempest tests:** 9a438d88-10c6-4bcd-8b5b-5b6e25e1346f, 585e934c-448e-43c4-acbf-d06a9b899997

  drivers:

  - **libvirt+kvm (x86 & ppc64):** `partial`
  - **libvirt+kvm (s390x):** `unknown`

- **CPU Pinning Policy** Enable/disable binding of instance vCPUs to host CPUs

  info:

  - **Maturity:** `experimental`
  - **API Docs:** https://docs.openstack.org/api-ref/compute/#create-server
  - **Admin Docs:** https://docs.openstack.org/nova/latest/admin/cpu-topologies.html#customizing-instance-cpu-pinning-policies
  - **Tempest tests:**

  drivers:

  - **libvirt+kvm (x86 & ppc64):** `partial`
  - **libvirt+kvm (s390x):** `unknown`

- **CPU Pinning Thread Policy** Configure usage of host hardware threads when pinning is used

  info:

  - **Maturity:** `experimental`
  - **API Docs:** https://docs.openstack.org/api-ref/compute/#create-server
  - **Admin Docs:** https://docs.openstack.org/nova/latest/admin/cpu-topologies.html#customizing-instance-cpu-pinning-policies
  - **Tempest tests:**

  drivers:

  - **libvirt+kvm (x86 & ppc64):** `partial`
  - **libvirt+kvm (s390x):** `unknown`

3.3.1.4 HPC Cloud Features

High Performance Compute (HPC) cloud have some specific needs that are covered in this set of features.
Summary

Feature	*Maturity*	Ironi	libvirt+kvm (x86 & ppc64)	libvirt+kvm (s390x)	libvirt+virtuoz CT	libvirt+virtuoz VM	VMware CI
GPU Passthroug	experimental	*?*	✓ *l*	*?*	✓	✓	×
Virtual GPUs	experimental	×	✓ *queens*	*?*	*?*	*?*	×

Details

- **GPU Passthrough** The PCI passthrough feature in OpenStack allows full access and direct control of a physical PCI device in guests. This mechanism is generic for any devices that can be attached to a PCI bus. Correct driver installation is the only requirement for the guest to properly use the devices.

  info:

  - **Maturity:** `experimental`
  - **API Docs:** https://docs.openstack.org/api-ref/compute/#create-server
  - **Admin Docs:** https://docs.openstack.org/nova/latest/admin/pci-passthrough.html
  - **Tempest tests:** 9a438d88-10c6-4bcd-8b5b-5b6e25e1346f, 585e934c-448e-43c4-acbf-d06a9b899997

  drivers:

  - **libvirt+kvm (x86 & ppc64):** `complete` (updated in L release)
  - **libvirt+kvm (s390x):** `unknown`
  - **libvirt+virtuozzo CT:** `partial`
  - **libvirt+virtuozzo VM:** `partial`
  - **VMware CI:** `missing`
  - **Ironic:** `unknown`

- **Virtual GPUs** Attach a virtual GPU to an instance at server creation time

  info:

  - **Maturity:** `experimental`
  - **API Docs:** https://docs.openstack.org/api-ref/compute/#create-server
  - **Admin Docs:** https://docs.openstack.org/nova/latest/admin/virtual-gpu.html
  - **Tempest tests:**

  drivers:

- **libvirt+kvm (x86 & ppc64):** `partial` (updated in QUEENS release)
- **libvirt+kvm (s390x):** `unknown`
- **libvirt+virtuozzo CT:** `unknown`
- **libvirt+virtuozzo VM:** `unknown`
- **VMware CI:** `missing`
- **Ironic:** `missing`

3.3.1.5 Notes on Concepts

This document uses the following terminology.

Users

These are the users we talk about in this document:

application deployer
: creates and deletes servers, directly or indirectly using an API

application developer
: creates images and apps that run on the cloud

cloud operator
: administers the cloud

self service administrator
: runs and uses the cloud

Note

This is not an exhaustive list of personas, but rather an indicative set of users.

Feature Group

To reduce the size of the matrix, we organize the features into groups. Each group maps to a set of user stories that can be validated by a set of scenarios and tests. Typically, this means a set of tempest tests.

This list focuses on API concepts like attach and detach volumes, rather than deployment specific concepts like attach an iSCSI volume to a KVM based VM.

Deployment

A deployment maps to a specific test environment. We provide a full description of the environment, so it is possible to reproduce the reported test results for each of the Feature Groups.

This description includes all aspects of the deployment, for example the hypervisor, number of nova-compute services, storage, network driver, and types of images being tested.

Feature Group Maturity

The Feature Group Maturity rating is specific to the API concepts, rather than specific to a particular deployment. That detail is covered in the deployment rating for each feature group.

> **Note**
>
> Although having some similarities, this list is not directly related to the Interop effort.

Feature Group ratings:

Incomplete
Incomplete features are those that do not have enough functionality to satisfy real world use cases.

Experimental
Experimental features should be used with extreme caution. They are likely to have little or no upstream testing, and are therefore likely to contain bugs.

Complete
For a feature to be considered complete, it must have:

- complete API docs (concept and REST call definition)
- complete Administrator docs
- tempest tests that define if the feature works correctly
- sufficient functionality and reliability to be useful in real world scenarios
- a reasonable expectation that the feature will be supported long-term

Complete and Required
There are various reasons why a complete feature may be required, but generally it is when all drivers support that feature. New drivers need to prove they support all required features before they are allowed in upstream Nova.

Required features are those that any new technology must support before being allowed into tree. The larger the list, the more features are available on all Nova based clouds.

Deprecated
Deprecated features are those that are scheduled to be removed in a future major release of Nova. If a feature is marked as complete, it should never be deprecated.

If a feature is incomplete or experimental for several releases, it runs the risk of being deprecated and later removed from the code base.

Deployment Rating for a Feature Group

The deployment rating refers to the state of the tests for each Feature Group on a particular deployment.

Deployment ratings:

Unknown
No data is available.

Not Implemented
No tests exist.

Implemented
Self declared that the tempest tests pass.

Regularly Tested
Tested by third party CI.

Checked
Tested as part of the check or gate queue.

The eventual goal is to automate this list from a third party CI reporting system, but currently we document manual inspections in an ini file. Ideally, we will review the list at every milestone.

3.3.2 Feature Support Matrix

When considering which capabilities should be marked as mandatory the following general guiding principles were applied

- **Inclusivity** - people have shown ability to make effective use of a wide range of virtualization technologies with broadly varying feature sets. Aiming to keep the requirements as inclusive as possible, avoids second-guessing what a user may wish to use the cloud compute service for.
- **Bootstrapping** - a practical use case test is to consider that starting point for the compute deploy is an empty data center with new machines and network connectivity. The look at what are the minimum features required of a compute service, in order to get user instances running and processing work over the network.
- **Competition** - an early leader in the cloud compute service space was Amazon EC2. A sanity check for whether a feature should be mandatory is to consider whether it was available in the first public release of EC2. This had quite a narrow feature set, but none the less found very high usage in many use cases. So it serves to illustrate that many features need not be considered mandatory in order to get useful work done.
- **Reality** - there are many virt drivers currently shipped with Nova, each with their own supported feature set. Any feature which is missing in at least one virt driver that is already in-tree, must by inference be considered optional until all in-tree drivers support it. This does not rule out the possibility of a currently optional feature becoming mandatory at a later date, based on other principles above.

Summary

Feature	*Status*	**Ironic**	**Libvirt KVM (aarch64)**
Attach block volume to instance	optional	×	✓
Attach tagged block device to instance	optional	×	✓
Detach block volume from instance	optional	×	✓
Extend block volume attached to instance	optional	×	✓
Attach virtual network interface to instance	optional	✓	✓
Attach tagged virtual network interface to instance	optional	×	*?*
Detach virtual network interface from instance	optional	✓	✓
Set the host in a maintenance mode	optional	×	×
Evacuate instances from a host	optional	*?*	✓
Rebuild instance	optional	✓	✓
Rebuild volume backed instance	optional	×	✓
Guest instance status	mandatory	✓	✓
Guest host uptime	optional	×	✓

Feature	*Status*	**Ironic**	**Libvirt KVM (aarch64)**
Guest host ip	optional	×	✓
Live migrate instance across hosts	optional	×	×
Force live migration to complete	optional	×	×
Abort an in-progress or queued live migration	optional	×	×
Launch instance	mandatory	✓	✓
Stop instance CPUs (pause)	optional	×	✓
Reboot instance	optional	✓	✓
Rescue instance	optional	✓	*?*
Resize instance	optional	×	✓
Restore instance	optional	×	✓
Set instance admin password	optional	×	*?*
Save snapshot of instance disk	optional	×	✓
Suspend instance	optional	×	✓
Swap block volumes	optional	×	*?*
Shutdown instance	mandatory	✓	✓
Trigger crash dump	optional	✓	*?*
Resume instance CPUs (unpause)	optional	×	✓
uefi boot	optional	✓	✓
Device tags	optional	×	✓
quiesce	optional	×	*?*
unquiesce	optional	×	*?*
Attach block volume to multiple instances	optional	×	*?*
Attach encrypted block volume to server	optional	×	*?*
Validate image with trusted certificates	optional	×	✓
File backed memory	optional	×	*?*
Report CPU traits	optional	×	*?*
SR-IOV ports with resource request	optional	×	×
Boot instance with secure encrypted memory	optional	×	×
Cache base images for faster instance boot	optional	×	✓
Boot instance with an emulated trusted platform module (TPM)	optional	×	×
Boot instance with stateless firmware	optional	×	×

Details

- **Attach block volume to instance Status: optional.**

  CLI commands:

  - `nova volume-attach <server> <volume>`

  Notes: The attach volume operation provides a means to hotplug additional block storage to a running instance. This allows storage capabilities to be expanded without interruption of service. In a cloud model it would be more typical to just spin up a new instance with large storage, so the ability to hotplug extra storage is for those cases where the instance is considered to be more of a pet than cattle. Therefore this operation is not considered to be mandatory to support.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `complete`

  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `complete`
  - **zVM:** `missing`

- **Attach tagged block device to instance Status: optional.**

  CLI commands:

  - `nova volume-attach <server> <volume> [--tag <tag>]`

  Notes: Attach a block device with a tag to an existing server instance. See Device tags for more information.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `complete`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `missing`
  - **zVM:** `missing`

- **Detach block volume from instance Status: optional.**

  CLI commands:

  - `nova volume-detach <server> <volume>`

  Notes: See notes for attach volume operation.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `complete`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`

  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `complete`
  - **zVM:** `missing`

- **Extend block volume attached to instance Status: optional.**

  CLI commands:

  - `cinder extend <volume> <new_size>`

  Notes: The extend volume operation provides a means to extend the size of an attached volume. This allows volume size to be expanded without interruption of service. In a cloud model it would be more typical to just spin up a new instance with large storage, so the ability to extend the size of an attached volume is for those cases where the instance is considered to be more of a pet than cattle. Therefore this operation is not considered to be mandatory to support.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `complete`
  - **Libvirt KVM (ppc64):** `unknown`
  - **Libvirt KVM (s390x):** `unknown`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `unknown`
  - **VMware vCenter:** `missing`
  - **zVM:** `missing`

- **Attach virtual network interface to instance Status: optional.**

  CLI commands:

  - `nova interface-attach <server>`

  Notes: The attach interface operation provides a means to hotplug additional interfaces to a running instance. Hotplug support varies between guest OSes and some guests require a reboot for new interfaces to be detected. This operation allows interface capabilities to be expanded without interruption of service. In a cloud model it would be more typical to just spin up a new instance with more interfaces.

  Driver Support:

  - **Ironic:** `complete`

  - **Libvirt KVM (aarch64):** complete
  - **Libvirt KVM (ppc64):** complete
  - **Libvirt KVM (s390x):** complete
  - **Libvirt KVM (x86):** complete
  - **Libvirt LXC:** missing
  - **Libvirt QEMU (x86):** complete
  - **Libvirt Virtuozzo CT:** complete
  - **Libvirt Virtuozzo VM:** complete
  - **VMware vCenter:** complete
  - **zVM:** missing

- **Attach tagged virtual network interface to instance Status: optional.**

  CLI commands:

  - nova interface-attach <server> [--tag <tag>]

  Notes: Attach a virtual network interface with a tag to an existing server instance. See Device tags for more information.

  Driver Support:

  - **Ironic:** missing
  - **Libvirt KVM (aarch64):** unknown
  - **Libvirt KVM (ppc64):** complete
  - **Libvirt KVM (s390x):** complete
  - **Libvirt KVM (x86):** complete
  - **Libvirt LXC:** missing
  - **Libvirt QEMU (x86):** complete
  - **Libvirt Virtuozzo CT:** missing
  - **Libvirt Virtuozzo VM:** complete
  - **VMware vCenter:** missing
  - **zVM:** missing

- **Detach virtual network interface from instance Status: optional.**

  CLI commands:

  - nova interface-detach <server> <port_id>

  Notes: See notes for attach-interface operation.

  Driver Support:

  - **Ironic:** complete
  - **Libvirt KVM (aarch64):** complete
  - **Libvirt KVM (ppc64):** complete

  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `complete`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `complete`
  - **zVM:** `missing`

- **Set the host in a maintenance mode Status: optional.**

  CLI commands:

  - `nova host-update <host>`

  Notes: This operation allows a host to be placed into maintenance mode, automatically triggering migration of any running instances to an alternative host and preventing new instances from being launched. This is not considered to be a mandatory operation to support. The driver methods to implement are host_maintenance_mode and set_host_enabled.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `missing`
  - **Libvirt KVM (ppc64):** `missing`
  - **Libvirt KVM (s390x):** `missing`
  - **Libvirt KVM (x86):** `missing`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `missing`
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `missing`
  - **VMware vCenter:** `missing`
  - **zVM:** `missing`

- **Evacuate instances from a host Status: optional.**

  CLI commands:

  - `nova evacuate <server>`
  - `nova host-evacuate <host>`

  Notes: A possible failure scenario in a cloud environment is the outage of one of the compute nodes. In such a case the instances of the down host can be evacuated to another host. It is assumed that the old host is unlikely ever to be powered back on, otherwise the evacuation attempt will be rejected. When the instances get moved to the new host, their volumes get re-attached and the locally stored data is dropped. That happens in the same way as a rebuild. This is not considered to be a mandatory operation to support.

Driver Support:

- **Ironic:** unknown
- **Libvirt KVM (aarch64):** complete
- **Libvirt KVM (ppc64):** unknown
- **Libvirt KVM (s390x):** complete
- **Libvirt KVM (x86):** complete
- **Libvirt LXC:** unknown
- **Libvirt QEMU (x86):** unknown
- **Libvirt Virtuozzo CT:** missing
- **Libvirt Virtuozzo VM:** missing
- **VMware vCenter:** unknown
- **zVM:** unknown

- **Rebuild instance Status: optional.**

  CLI commands:

  - `nova rebuild <server> <image>`

  Notes: A possible use case is additional attributes need to be set to the instance, nova will purge all existing data from the system and remakes the VM with given information such as metadata and personalities. Though this is not considered to be a mandatory operation to support.

  Driver Support:

  - **Ironic:** complete
  - **Libvirt KVM (aarch64):** complete
  - **Libvirt KVM (ppc64):** complete
  - **Libvirt KVM (s390x):** complete
  - **Libvirt KVM (x86):** complete
  - **Libvirt LXC:** complete
  - **Libvirt QEMU (x86):** complete
  - **Libvirt Virtuozzo CT:** complete
  - **Libvirt Virtuozzo VM:** complete
  - **VMware vCenter:** complete
  - **zVM:** unknown

- **Rebuild volume backed instance Status: optional.**

  CLI commands:

  - `openstack server rebuild --reimage-boot-volume --image <image> <server>`

Notes: This will wipe out all existing data in the root volume of a volume backed instance. This is available from microversion 2.93 and onwards.

Driver Support:

- **Ironic:** `missing`
- **Libvirt KVM (aarch64):** `complete`
- **Libvirt KVM (ppc64):** `complete`
- **Libvirt KVM (s390x):** `complete`
- **Libvirt KVM (x86):** `complete`
- **Libvirt LXC:** `unknown`
- **Libvirt QEMU (x86):** `complete`
- **Libvirt Virtuozzo CT:** `missing`
- **Libvirt Virtuozzo VM:** `missing`
- **VMware vCenter:** `missing`
- **zVM:** `missing`

- **Guest instance status Status: mandatory.**

  Notes: Provides realtime information about the power state of the guest instance. Since the power state is used by the compute manager for tracking changes in guests, this operation is considered mandatory to support.

  Driver Support:

  - **Ironic:** `complete`
  - **Libvirt KVM (aarch64):** `complete`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `complete`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `complete`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `complete`
  - **zVM:** `complete`

- **Guest host uptime Status: optional.**

  Notes: Returns the result of host uptime since power on, its used to report hypervisor status.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `complete`

  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `complete`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `complete`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `missing`
  - **zVM:** `complete`

- **Guest host ip Status: optional.**

  Notes: Returns the ip of this host, its used when doing resize and migration.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `complete`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `complete`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `complete`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `complete`
  - **zVM:** `complete`

- **Live migrate instance across hosts Status: optional.**

  CLI commands:

  - `nova live-migration <server>`
  - `nova host-evacuate-live <host>`

  Notes: Live migration provides a way to move an instance off one compute host, to another compute host. Administrators may use this to evacuate instances from a host that needs to undergo maintenance tasks, though of course this may not help if the host is already suffering a failure. In general instances are considered cattle rather than pets, so it is expected that an instance is liable to be killed if host maintenance is required. It is technically challenging for some hypervisors to provide support for the live migration operation, particularly those built on the container based virtualization. Therefore this operation is not considered mandatory to support.

  Driver Support:

  - **Ironic:** `missing`

  - **Libvirt KVM (aarch64):** `missing`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `complete`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `complete`
  - **zVM:** `missing`

- **Force live migration to complete Status: optional.**

  CLI commands:

  - `nova live-migration-force-complete <server> <migration>`

  Notes: Live migration provides a way to move a running instance to another compute host. But it can sometimes fail to complete if an instance has a high rate of memory or disk page access. This operation provides the user with an option to assist the progress of the live migration. The mechanism used to complete the live migration depends on the underlying virtualization subsystem capabilities. If libvirt/qemu is used and the post-copy feature is available and enabled then the force complete operation will cause a switch to post-copy mode. Otherwise the instance will be suspended until the migration is completed or aborted.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `missing`
  - **Libvirt KVM (ppc64):** `complete` **Notes:** Requires libvirt>=1.3.3, qemu>=2.5.0
  - **Libvirt KVM (s390x):** `complete` **Notes:** Requires libvirt>=1.3.3, qemu>=2.5.0
  - **Libvirt KVM (x86):** `complete` **Notes:** Requires libvirt>=1.3.3, qemu>=2.5.0
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete` **Notes:** Requires libvirt>=1.3.3, qemu>=2.5.0
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `missing`
  - **VMware vCenter:** `missing`
  - **zVM:** `missing`

- **Abort an in-progress or queued live migration Status: optional.**

  CLI commands:

  - `nova live-migration-abort <server> <migration>`

Notes: Live migration provides a way to move a running instance to another compute host. But it can sometimes need a large amount of time to complete if an instance has a high rate of memory or disk page access or is stuck in queued status if there are too many in-progress live migration jobs in the queue. This operation provides the user with an option to abort in-progress live migrations. When the live migration job is still in queued or preparing status, it can be aborted regardless of the type of underneath hypervisor, but once the job status changes to running, only some of the hypervisors support this feature.

Driver Support:

- **Ironic:** `missing`
- **Libvirt KVM (aarch64):** `missing`
- **Libvirt KVM (ppc64):** `complete`
- **Libvirt KVM (s390x):** `complete`
- **Libvirt KVM (x86):** `complete`
- **Libvirt LXC:** `missing`
- **Libvirt QEMU (x86):** `complete`
- **Libvirt Virtuozzo CT:** `unknown`
- **Libvirt Virtuozzo VM:** `unknown`
- **VMware vCenter:** `missing`
- **zVM:** `missing`

- **Launch instance Status: mandatory.**

  Notes: Importing pre-existing running virtual machines on a host is considered out of scope of the cloud paradigm. Therefore this operation is mandatory to support in drivers.

  Driver Support:

  - **Ironic:** `complete`
  - **Libvirt KVM (aarch64):** `complete`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `complete`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `complete`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `complete`
  - **zVM:** `complete`

- **Stop instance CPUs (pause) Status: optional.**

  CLI commands:

  - `nova pause <server>`

Notes: Stopping an instances CPUs can be thought of as roughly equivalent to suspend-to-RAM. The instance is still present in memory, but execution has stopped. The problem, however, is that there is no mechanism to inform the guest OS that this takes place, so upon unpausing, its clocks will no longer report correct time. For this reason hypervisor vendors generally discourage use of this feature and some do not even implement it. Therefore this operation is considered optional to support in drivers.

Driver Support:

- **Ironic:** `missing`
- **Libvirt KVM (aarch64):** `complete`
- **Libvirt KVM (ppc64):** `complete`
- **Libvirt KVM (s390x):** `complete`
- **Libvirt KVM (x86):** `complete`
- **Libvirt LXC:** `complete`
- **Libvirt QEMU (x86):** `complete`
- **Libvirt Virtuozzo CT:** `missing`
- **Libvirt Virtuozzo VM:** `complete`
- **VMware vCenter:** `missing`
- **zVM:** `complete`

- **Reboot instance Status: optional.**

  CLI commands:

  - `nova reboot <server>`

  Notes: It is reasonable for a guest OS administrator to trigger a graceful reboot from inside the instance. A host initiated graceful reboot requires guest co-operation and a non-graceful reboot can be achieved by a combination of stop+start. Therefore this operation is considered optional.

  Driver Support:

  - **Ironic:** `complete`
  - **Libvirt KVM (aarch64):** `complete`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `complete`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `complete`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `complete`
  - **zVM:** `complete`

- **Rescue instance Status: optional.**

  CLI commands:

  - `nova rescue <server>`

  Notes: The rescue operation starts an instance in a special configuration whereby it is booted from an special root disk image. The goal is to allow an administrator to recover the state of a broken virtual machine. In general the cloud model considers instances to be cattle, so if an instance breaks the general expectation is that it be thrown away and a new instance created. Therefore this operation is considered optional to support in drivers.

  Driver Support:

  - **Ironic:** `complete`
  - **Libvirt KVM (aarch64):** `unknown`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `complete`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `complete`
  - **zVM:** `missing`

- **Resize instance Status: optional.**

  CLI commands:

  - `nova resize <server> <flavor>`

  Notes: The resize operation allows the user to change a running instance to match the size of a different flavor from the one it was initially launched with. There are many different flavor attributes that potentially need to be updated. In general it is technically challenging for a hypervisor to support the alteration of all relevant config settings for a running instance. Therefore this operation is considered optional to support in drivers.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `complete`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `complete`

  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `complete`
  - **zVM:** `missing`

- **Restore instance Status: optional.**

  CLI commands:

  - `nova resume <server>`

  Notes: See notes for the suspend operation

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `complete`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `complete`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `complete`
  - **zVM:** `missing`

- **Set instance admin password Status: optional.**

  CLI commands:

  - `nova set-password <server>`

  Notes: Provides a mechanism to (re)set the password of the administrator account inside the instance operating system. This requires that the hypervisor has a way to communicate with the running guest operating system. Given the wide range of operating systems in existence it is unreasonable to expect this to be practical in the general case. The configdrive and metadata service both provide a mechanism for setting the administrator password at initial boot time. In the case where this operation were not available, the administrator would simply have to login to the guest and change the password in the normal manner, so this is just a convenient optimization. Therefore this operation is not considered mandatory for drivers to support.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `unknown`
  - **Libvirt KVM (ppc64):** `missing`
  - **Libvirt KVM (s390x):** `missing`
  - **Libvirt KVM (x86):** `complete` **Notes:** Requires libvirt>=1.2.16 and hw_qemu_guest_agent.

  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete` **Notes:** Requires libvirt>=1.2.16 and hw_qemu_guest_agent.
  - **Libvirt Virtuozzo CT:** `complete` **Notes:** Requires libvirt>=2.0.0
  - **Libvirt Virtuozzo VM:** `complete` **Notes:** Requires libvirt>=2.0.0
  - **VMware vCenter:** `missing`
  - **zVM:** `missing`

- **Save snapshot of instance disk Status: optional.**

  CLI commands:

  - `nova image-create <server> <name>`

  Notes: The snapshot operation allows the current state of the instance root disk to be saved and uploaded back into the glance image repository. The instance can later be booted again using this saved image. This is in effect making the ephemeral instance root disk into a semi-persistent storage, in so much as it is preserved even though the guest is no longer running. In general though, the expectation is that the root disks are ephemeral so the ability to take a snapshot cannot be assumed. Therefore this operation is not considered mandatory to support.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `complete`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `complete`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `complete`
  - **zVM:** `complete`

- **Suspend instance Status: optional.**

  CLI commands:

  - `nova suspend <server>`

  Notes: Suspending an instance can be thought of as roughly equivalent to suspend-to-disk. The instance no longer consumes any RAM or CPUs, with its live running state having been preserved in a file on disk. It can later be restored, at which point it should continue execution where it left off. As with stopping instance CPUs, it suffers from the fact that the guest OS will typically be left with a clock that is no longer telling correct time. For container based virtualization solutions, this operation is particularly technically challenging to implement and is an area of active research. This operation tends to make more sense when thinking of instances as pets, rather than cattle, since

with cattle it would be simpler to just terminate the instance instead of suspending. Therefore this operation is considered optional to support.

Driver Support:

- **Ironic:** `missing`
- **Libvirt KVM (aarch64):** `complete`
- **Libvirt KVM (ppc64):** `complete`
- **Libvirt KVM (s390x):** `complete`
- **Libvirt KVM (x86):** `complete`
- **Libvirt LXC:** `missing`
- **Libvirt QEMU (x86):** `complete`
- **Libvirt Virtuozzo CT:** `complete`
- **Libvirt Virtuozzo VM:** `complete`
- **VMware vCenter:** `complete`
- **zVM:** `missing`

- **Swap block volumes Status: optional.**

  CLI commands:

  - `nova volume-update <server> <attachment> <volume>`

  Notes: The swap volume operation is a mechanism for changing a running instance so that its attached volume(s) are backed by different storage in the host. An alternative to this would be to simply terminate the existing instance and spawn a new instance with the new storage. In other words this operation is primarily targeted towards the pet use case rather than cattle, however, it is required for volume migration to work in the volume service. This is considered optional to support.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `unknown`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `missing`
  - **zVM:** `missing`

- **Shutdown instance Status: mandatory.**

  CLI commands:

  - `nova delete <server>`

  Notes: The ability to terminate a virtual machine is required in order for a cloud user to stop utilizing resources and thus avoid indefinitely ongoing billing. Therefore this operation is mandatory to support in drivers.

  Driver Support:

  - **Ironic:** `complete`
  - **Libvirt KVM (aarch64):** `complete`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `complete` **Notes:** Fails in latest Ubuntu Trusty kernel from security repository (3.13.0-76-generic), but works in upstream 3.13.x kernels as well as default Ubuntu Trusty latest kernel (3.13.0-58-generic).
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `complete`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `complete`
  - **zVM:** `complete`

- **Trigger crash dump Status: optional.**

  CLI commands:

  - `nova trigger-crash-dump <server>`

  Notes: The trigger crash dump operation is a mechanism for triggering a crash dump in an instance. The feature is typically implemented by injecting an NMI (Non-maskable Interrupt) into the instance. It provides a means to dump the production memory image as a dump file which is useful for users. Therefore this operation is considered optional to support.

  Driver Support:

  - **Ironic:** `complete`
  - **Libvirt KVM (aarch64):** `unknown`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `missing`

  - **VMware vCenter:** missing
  - **zVM:** missing

- **Resume instance CPUs (unpause) Status: optional.**

  CLI commands:

  - nova unpause <server>

  Notes: See notes for the Stop instance CPUs operation

  Driver Support:

  - **Ironic:** missing
  - **Libvirt KVM (aarch64):** complete
  - **Libvirt KVM (ppc64):** complete
  - **Libvirt KVM (s390x):** complete
  - **Libvirt KVM (x86):** complete
  - **Libvirt LXC:** complete
  - **Libvirt QEMU (x86):** complete
  - **Libvirt Virtuozzo CT:** complete
  - **Libvirt Virtuozzo VM:** complete
  - **VMware vCenter:** missing
  - **zVM:** complete

- **uefi boot Status: optional.**

  Notes: This allows users to boot a guest with uefi firmware.

  Driver Support:

  - **Ironic:** partial **Notes:** depends on hardware support
  - **Libvirt KVM (aarch64):** complete
  - **Libvirt KVM (ppc64):** missing
  - **Libvirt KVM (s390x):** missing
  - **Libvirt KVM (x86):** complete
  - **Libvirt LXC:** missing
  - **Libvirt QEMU (x86):** complete
  - **Libvirt Virtuozzo CT:** missing
  - **Libvirt Virtuozzo VM:** missing
  - **VMware vCenter:** complete
  - **zVM:** missing

- **Device tags Status: optional.**

  CLI commands:

  - `nova boot`

  Notes: This allows users to set tags on virtual devices when creating a server instance. Device tags are used to identify virtual device metadata, as exposed in the metadata API and on the config drive. For example, a network interface tagged with nic1 will appear in the metadata along with its bus (ex: PCI), bus address (ex: 0000:00:02.0), MAC address, and tag (nic1). If multiple networks are defined, the order in which they appear in the guest operating system will not necessarily reflect the order in which they are given in the server boot request. Guests should therefore not depend on device order to deduce any information about their network devices. Instead, device role tags should be used. Device tags can be applied to virtual network interfaces and block devices.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `complete`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** unknown
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** unknown
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `missing`
  - **zVM:** `missing`

- **quiesce Status: optional.**

  Notes: Quiesce the specified instance to prepare for snapshots. For libvirt, guest filesystems will be frozen through qemu agent.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** unknown
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `missing`
  - **VMware vCenter:** `missing`
  - **zVM:** `missing`

- **unquiesce Status: optional.**

  Notes: See notes for the quiesce operation

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** unknown
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `missing`
  - **VMware vCenter:** `missing`
  - **zVM:** `missing`

- **Attach block volume to multiple instances Status: optional.**

  CLI commands:

  - `nova volume-attach <server> <volume>`

  Notes: The multiattach volume operation is an extension to the attach volume operation. It allows to attach a single volume to multiple instances. This operation is not considered to be mandatory to support. Note that for the libvirt driver, this is only supported if qemu<2.10 or libvirt>=3.10.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** unknown
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `missing`
  - **zVM:** `missing`

- **Attach encrypted block volume to server Status: optional.**

  CLI commands:

  - `nova volume-attach <server> <volume>`

Notes: This is the same as the attach volume operation except with an encrypted block device. Encrypted volumes are controlled via admin-configured volume types in the block storage service. Since attach volume is optional this feature is also optional for compute drivers to support.

Driver Support:

- **Ironic:** `missing`
- **Libvirt KVM (aarch64):** unknown
- **Libvirt KVM (ppc64):** unknown
- **Libvirt KVM (s390x):** unknown
- **Libvirt KVM (x86):** `complete` **Notes:** For native QEMU decryption of the encrypted volume (and rbd support), QEMU>=2.6.0 and libvirt>=2.2.0 are required and only the luks type provider is supported. Otherwise both luks and cryptsetup types are supported but not natively, i.e. not all volume types are supported.
- **Libvirt LXC:** `missing`
- **Libvirt QEMU (x86):** `complete` **Notes:** The same restrictions apply as KVM x86.
- **Libvirt Virtuozzo CT:** `missing`
- **Libvirt Virtuozzo VM:** unknown
- **VMware vCenter:** `missing`
- **zVM:** `missing`

- **Validate image with trusted certificates Status: optional.**

  CLI commands:

  - `nova boot --trusted-image-certificate-id ...`

  Notes: Since trusted image certification validation is configurable by the cloud deployer it is considered optional. However, it is a virt-agnostic feature so there is no good reason that all virt drivers cannot support the feature since it is mostly just plumbing user requests through the virt driver when downloading images.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `complete`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `complete`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `complete`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `missing`
  - **zVM:** `missing`

- **File backed memory Status: optional.**

  Notes: The file backed memory feature in Openstack allows a Nova node to serve guest memory from a file backing store. This mechanism uses the libvirt file memory source, causing guest instance memory to be allocated as files within the libvirt memory backing directory. This is only supported if qemu>2.6 and libvirt>4.0.0

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** unknown
  - **Libvirt KVM (ppc64):** unknown
  - **Libvirt KVM (s390x):** unknown
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `missing`
  - **VMware vCenter:** `missing`
  - **zVM:** `missing`

- **Report CPU traits Status: optional.**

  Notes: The report CPU traits feature in OpenStack allows a Nova node to report its CPU traits according to CPU mode configuration. This gives users the ability to boot instances based on desired CPU traits.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** unknown
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `missing`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `missing`
  - **VMware vCenter:** `missing`
  - **zVM:** `missing`

- **SR-IOV ports with resource request Status: optional.**

  CLI commands:

  - `nova boot --nic port-id <neutron port with resource request> ...`

Notes: To support neutron SR-IOV ports (vnic_type=direct or vnic_type=macvtap) with resource request the virt driver needs to include the parent_ifname key in each subdict which represents a VF under the pci_passthrough_devices key in the dict returned from the ComputeDriver.get_available_resource() call.

Driver Support:

- **Ironic:** `missing`
- **Libvirt KVM (aarch64):** `missing`
- **Libvirt KVM (ppc64):** `missing`
- **Libvirt KVM (s390x):** `missing`
- **Libvirt KVM (x86):** `complete`
- **Libvirt LXC:** `missing`
- **Libvirt QEMU (x86):** `complete`
- **Libvirt Virtuozzo CT:** `missing`
- **Libvirt Virtuozzo VM:** `missing`
- **VMware vCenter:** `missing`
- **zVM:** `missing`

- **Boot instance with secure encrypted memory Status: optional.**

  CLI commands:

  - `openstack server create <usual server create parameters>`

  Notes: The feature allows VMs to be booted with their memory hardware-encrypted with a key specific to the VM, to help protect the data residing in the VM against access from anyone other than the user of the VM. The Configuration and Security Guides specify usage of this feature.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `missing`
  - **Libvirt KVM (ppc64):** `missing`
  - **Libvirt KVM (s390x):** `missing`
  - **Libvirt KVM (x86):** `partial` **Notes:** This feature is currently only available with hosts which support the SEV (Secure Encrypted Virtualization) technology from AMD.
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `missing`
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `missing`
  - **VMware vCenter:** `missing`
  - **zVM:** `missing`

- **Cache base images for faster instance boot Status: optional.**

  CLI commands:

  - `openstack server create <usual server create parameters>`

  Notes: Drivers supporting this feature cache base images on the compute host so that subsequent boots need not incur the expense of downloading them. Partial support entails caching an image after the first boot that uses it. Complete support allows priming the cache so that the first boot also benefits. Image caching support is tunable via config options in the [image_cache] group.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `complete`
  - **Libvirt KVM (ppc64):** `complete`
  - **Libvirt KVM (s390x):** `complete`
  - **Libvirt KVM (x86):** `complete`
  - **Libvirt LXC:** `unknown`
  - **Libvirt QEMU (x86):** `complete`
  - **Libvirt Virtuozzo CT:** `complete`
  - **Libvirt Virtuozzo VM:** `complete`
  - **VMware vCenter:** `partial`
  - **zVM:** `missing`

- **Boot instance with an emulated trusted platform module (TPM) Status: optional.**

  CLI commands:

  - `openstack server create <usual server create parameters>`

  Notes: Allows VMs to be booted with an emulated trusted platform module (TPM) device. Only lifecycle operations performed by the VM owner are supported, as the users credentials are required to unlock the virtual device files on the host.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `missing`
  - **Libvirt KVM (ppc64):** `missing`
  - **Libvirt KVM (s390x):** `missing`
  - **Libvirt KVM (x86):** `partial` **Notes:** Move operations are not yet supported.
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `partial` **Notes:** Move operations are not yet supported.
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `missing`
  - **VMware vCenter:** `missing`

  - **zVM:** `missing`

- **Boot instance with stateless firmware Status: optional.**

  CLI commands:

  - `openstack server create <usual server create parameters>`

  Notes: The feature allows VMs to be booted with read-only firmware image without NVRAM file. This feature is especially useful for confidential computing use case because it allows more complete measurement of elements involved in the boot chain and disables the potential attack serface from hypervisors.

  Driver Support:

  - **Ironic:** `missing`
  - **Libvirt KVM (aarch64):** `missing`
  - **Libvirt KVM (ppc64):** `missing`
  - **Libvirt KVM (s390x):** `missing`
  - **Libvirt KVM (x86):** `partial` **Notes:** This feature is supported only with UEFI firmware
  - **Libvirt LXC:** `missing`
  - **Libvirt QEMU (x86):** `missing`
  - **Libvirt Virtuozzo CT:** `missing`
  - **Libvirt Virtuozzo VM:** `missing`
  - **VMware vCenter:** `missing`
  - **zVM:** `missing`

Notes:

- **This document is a continuous work in progress**

3.3.3 Cells (v2)

Added in version 16.0.0: (Pike)

This document describes the layout of a deployment with cells v2, including deployment considerations for security and scale and recommended practices and tips for running and maintaining cells v2 for admins and operators. It is focused on code present in Pike and later, and while it is geared towards people who want to have multiple cells for whatever reason, the nature of the cells v2 support in Nova means that it applies in some way to all deployments.

Before reading any further, there is a nice overview presentation that Andrew Laski gave at the Austin (Newton) summit which may be worth watching.

Note

Cells v2 is different to the cells feature found in earlier versions of nova, also known as Cells v1. Cells v1 was deprecated in 16.0.0 (Pike) and removed entirely in Train (20.0.0).

3.3.3.1 Overview

The purpose of the cells functionality in nova is to allow larger deployments to shard their many compute nodes into cells. All nova deployments are by definition cells deployments, even if most will only ever have a single cell. This means a multi-cell deployment will not be radically different from a standard nova deployment.

Consider such a deployment. It will consists of the following components:

- The Compute API which provides the external REST API to users.
- The **nova-scheduler** and `placement` services which are responsible for tracking resources and deciding which compute node instances should be on.
- An API database that is used primarily by the Compute API and **nova-scheduler** (called *API-level services* below) to track location information about instances, as well as a temporary location for instances being built but not yet scheduled.
- The **nova-conductor** service which offloads long-running tasks for the API-level services and insulates compute nodes from direct database access
- The **nova-compute** service which manages the virt driver and hypervisor host.
- A cell database which is used by API, conductor and compute services, and which houses the majority of the information about instances.
- A cell0 database which is just like the cell database, but contains only instances that failed to be scheduled. This database mimics a regular cell, but has no compute nodes and is used only as a place to put instances that fail to land on a real compute node (and thus a real cell).
- A message queue which allows the services to communicate with each other via RPC.

In smaller deployments, there will typically be a single message queue that all services share and a single database server which hosts the API database, a single cell database, as well as the required cell0 database. Because we only have one real cell, we consider this a single-cell deployment.

In larger deployments, we can opt to shard the deployment using multiple cells. In this configuration there will still only be one global API database but there will be a cell database (where the bulk of the instance information lives) for each cell, each containing a portion of the instances for the entire deployment within, as well as per-cell message queues and per-cell **nova-conductor** instances. There will also be an additional **nova-conductor** instance, known as a *super conductor*, to handle API-level operations.

In these larger deployments, each of the nova services will use a cell-specific configuration file, all of which will at a minimum specify a message queue endpoint (i.e. *transport_url*). Most of the services will also contain database connection configuration information (i.e. *database.connection*), while API-level services that need access to the global routing and placement information will also be configured to reach the API database (i.e. *api_database.connection*).

Note

The pair of *transport_url* and *database.connection* configured for a service defines what cell a service lives in.

API-level services need to be able to contact other services in all of the cells. Since they only have one configured *transport_url* and *database.connection*, they look up the information for the other cells in the API database, with records called *cell mappings*.

Note

The API database must have cell mapping records that match the *transport_url* and *database.connection* configuration options of the lower-level services. See the `nova-manage` *Cells v2 Commands* commands for more information about how to create and examine these records.

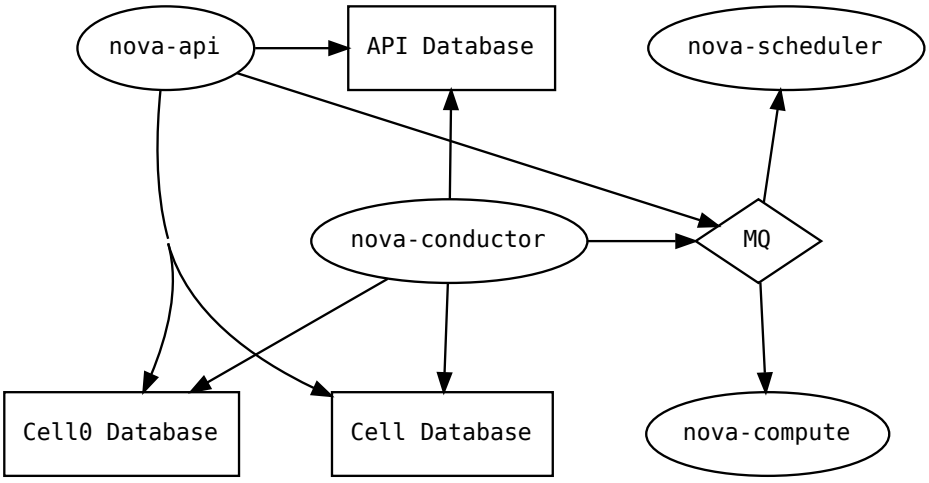
The following section goes into more detail about the difference between single-cell and multi-cell deployments.

3.3.3.2 Service layout

The services generally have a well-defined communication pattern that dictates their layout in a deployment. In a small/simple scenario, the rules do not have much of an impact as all the services can communicate with each other on a single message bus and in a single cell database. However, as the deployment grows, scaling and security concerns may drive separation and isolation of the services.

Single cell

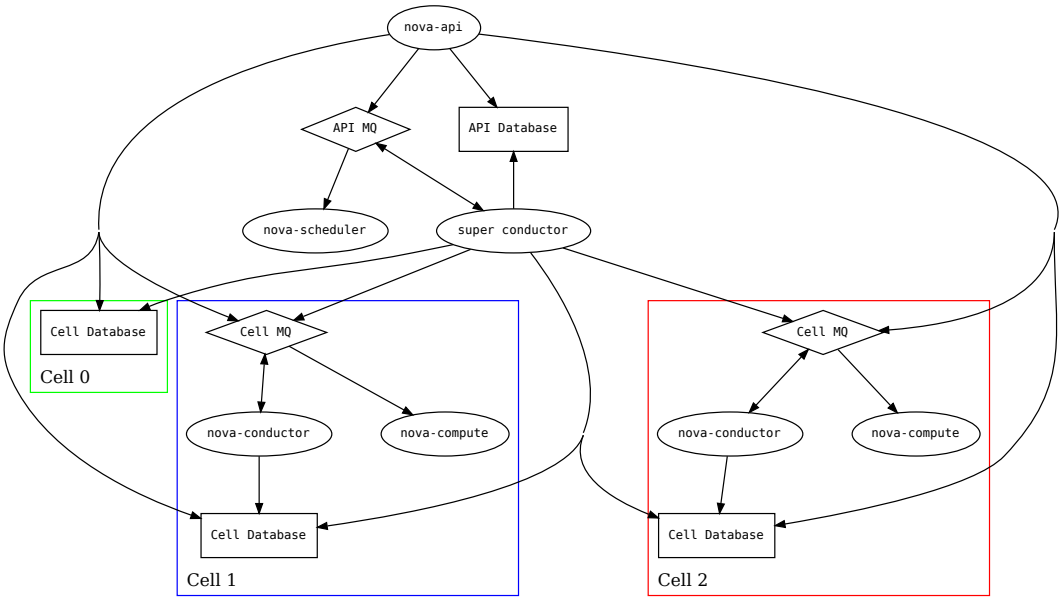
This is a diagram of the basic services that a simple (single-cell) deployment would have, as well as the relationships (i.e. communication paths) between them:



All of the services are configured to talk to each other over the same message bus, and there is only one cell database where live instance data resides. The cell0 database is present (and required) but as no compute nodes are connected to it, this is still a single cell deployment.

Multiple cells

In order to shard the services into multiple cells, a number of things must happen. First, the message bus must be split into pieces along the same lines as the cell database. Second, a dedicated conductor must be run for the API-level services, with access to the API database and a dedicated message queue. We call this *super conductor* to distinguish its place and purpose from the per-cell conductor nodes.



It is important to note that services in the lower cell boxes only have the ability to call back to the placement API but cannot access any other API-layer services via RPC, nor do they have access to the API database for global visibility of resources across the cloud. This is intentional and provides security and failure domain isolation benefits, but also has impacts on some things that would otherwise require this any-to-any communication style. Check *Operations requiring upcalls* below for the most up-to-date information about any caveats that may be present due to this limitation.

3.3.3.3 Database layout

As mentioned previously, there is a split between global data and data that is local to a cell. These databases schema are referred to as the *API* and *main* database schemas, respectively.

API database

The API database is the database used for API-level services, such as the Compute API and, in a multi-cell deployment, the superconductor. The models and migrations related to this database can be found in `nova.db.api`, and the database can be managed using the **`nova-manage api_db`** commands.

Main (cell-level) database

The main database is the database used for cell-level **`nova-conductor`** instances. The models and migrations related to this database can be found in `nova.db.main`, and the database can be managed using the **`nova-manage db`** commands.

3.3.3.4 Usage

As noted previously, all deployments are in effect now cells v2 deployments. As a result, setup of any nova deployment - even those that intend to only have one cell - will involve some level of cells configuration. These changes are configuration-related, both in the main nova configuration file as well as some extra records in the databases.

All nova deployments must now have the following databases available and configured:

1. The API database
2. One special cell database called cell0
3. One (or eventually more) cell databases

Thus, a small nova deployment will have an API database, a cell0, and what we will call here a cell1 database. High-level tracking information is kept in the API database. Instances that are never scheduled are relegated to the cell0 database, which is effectively a graveyard of instances that failed to start. All successful/running instances are stored in cell1.

Note

Since Nova services make use of both configuration file and some databases records, starting or restarting those services with an incomplete configuration could lead to an incorrect deployment. Only restart the services once you are done with the described steps below.

Note

The following examples show the full expanded command line usage of the setup commands. This is to make it easier to visualize which of the various URLs are used by each of the commands. However, you should be able to put all of that in the config file and **nova-manage** will use those values. If need be, you can create separate config files and pass them as `nova-manage --config-file foo.conf` to control the behavior without specifying things on the command lines.

Configuring a new deployment

If you are installing Nova for the first time and have no compute hosts in the database yet then it will be necessary to configure cell0 and at least one additional real cell. To begin, ensure your API database schema has been populated using the **nova-manage api_db sync** command. Ensure the connection information for this database is stored in the `nova.conf` file using the *api_database.connection* config option:

```
[api_database]
connection = mysql+pymysql://root:secretmysql@dbserver/nova_api?charset=utf8
```

Since there may be multiple cell databases (and in fact everyone will have cell0 and cell1 at a minimum), connection info for these is stored in the API database. Thus, the API database must exist and must provide information on how to connect to it before continuing to the steps below, so that **nova-manage** can find your other databases.

Next, we will create the necessary records for the cell0 database. To do that we will first use **nova-manage cell_v2 map_cell0** to create and map cell0. For example:

```
$ nova-manage cell_v2 map_cell0 \
    --database_connection mysql+pymysql://root:secretmysql@dbserver/nova_
↪cell0?charset=utf8
```

Note

If you dont specify `--database_connection` then the commands will use the *database.connection* value from your config file and mangle the database name to have a `_cell0` suffix

Warning

If your databases are on separate hosts then you should specify `--database_connection` or make certain that the `nova.conf` being used has the *database.connection* value pointing to the same user/password/host that will work for the cell0 database. If the cell0 mapping was created incorrectly, it can be deleted using the **nova-manage cell_v2 delete_cell** command before running **nova-manage cell_v2 map_cell0** again with the proper database connection value.

We will then use **nova-manage db sync** to apply the database schema to this new database. For example:

```
$ nova-manage db sync \
    --database_connection mysql+pymysql://root:secretmysql@dbserver/nova_
↪cell0?charset=utf8
```

Since no hosts are ever in cell0, nothing further is required for its setup. Note that all deployments only ever have one cell0, as it is special, so once you have done this step you never need to do it again, even if you add more regular cells.

Now, we must create another cell which will be our first regular cell, which has actual compute hosts in it, and to which instances can actually be scheduled. First, we create the cell record using **nova-manage cell_v2 create_cell**. For example:

```
$ nova-manage cell_v2 create_cell \
    --name cell1 \
    --database_connection  mysql+pymysql://root:secretmysql@127.0.0.1/nova?
↪charset=utf8 \
    --transport-url rabbit://stackrabbit:secretrabbit@mqserver:5672/
```

Note

If you dont specify the database and transport urls then **nova-manage** will use the *transport_url* and *database.connection* values from the config file.

Note

It is a good idea to specify a name for the new cell you create so you can easily look up cell UUIDs with the **nova-manage cell_v2 list_cells** command later if needed.

Note

The **nova-manage cell_v2 create_cell** command will print the UUID of the newly-created cell if `--verbose` is passed, which is useful if you need to run commands like **nova-manage cell_v2 discover_hosts** targeted at a specific cell.

At this point, the API database can now find the cell database, and further commands will attempt to look inside. If this is a completely fresh database (such as if youre adding a cell, or if this is a new deployment), then you will need to run **nova-manage db sync** on it to initialize the schema.

Now we have a cell, but no hosts are in it which means the scheduler will never actually place instances there. The next step is to scan the database for compute node records and add them into the cell we just created. For this step, you must have had a compute node started such that it registers itself as a running service. You can identify this using the **openstack compute service list** command:

```
$ openstack compute service list --service nova-compute
```

Once that has happened, you can scan and add it to the cell using the **nova-manage cell_v2 discover_hosts** command:

```
$ nova-manage cell_v2 discover_hosts
```

This command will connect to any databases for which you have created cells (as above), look for hosts that have registered themselves there, and map those hosts in the API database so that they are visible to the scheduler as available targets for instances. Any time you add more compute hosts to a cell, you need to re-run this command to map them from the top-level so they can be utilized. You can also configure a periodic task to have Nova discover new hosts automatically by setting the *scheduler.discover_hosts_in_cells_interval* to a time interval in seconds. The periodic task is run by the **nova-scheduler** service, so you must be sure to configure it on all of your **nova-scheduler** hosts.

Note

In the future, whenever you add new compute hosts, you will need to run the **nova-manage cell_v2 discover_hosts** command after starting them to map them to the cell if you did not configure automatic host discovery using *scheduler.discover_hosts_in_cells_interval*.

Adding a new cell to an existing deployment

You can add additional cells to your deployment using the same steps used above to create your first cell. We can create a new cell record using **nova-manage cell_v2 create_cell**. For example:

```
$ nova-manage cell_v2 create_cell \
    --name cell2 \
    --database_connection  mysql+pymysql://root:secretmysql@127.0.0.1/nova?
↪charset=utf8 \
    --transport-url rabbit://stackrabbit:secretrabbit@mqserver:5672/
```

Note

If you dont specify the database and transport urls then **nova-manage** will use the *transport_url* and *database.connection* values from the config file.

Note

It is a good idea to specify a name for the new cell you create so you can easily look up cell UUIDs with the **nova-manage cell_v2 list_cells** command later if needed.

Note

The **nova-manage cell_v2 create_cell** command will print the UUID of the newly-created cell if `--verbose` is passed, which is useful if you need to run commands like **nova-manage cell_v2 discover_hosts** targeted at a specific cell.

You can repeat this step for each cell you wish to add to your deployment. Your existing cell database will be reused - this simply informs the top-level API database about your existing cell databases.

Once youve created your new cell, use **nova-manage cell_v2 discover_hosts** to map compute hosts to cells. This is only necessary if you havent enabled automatic discovery using the *scheduler.discover_hosts_in_cells_interval* option. For example:

```
$ nova-manage cell_v2 discover_hosts
```

Note

This command will search for compute hosts in each cell database and map them to the corresponding cell. This can be slow, particularly for larger deployments. You may wish to specify the `--cell_uuid` option, which will limit the search to a specific cell. You can use the **nova-manage cell_v2 list_cells** command to look up cell UUIDs if you are going to specify `--cell_uuid`.

Finally, run the **nova-manage cell_v2 map_instances** command to map existing instances to the new cell(s). For example:

```
$ nova-manage cell_v2 map_instances
```

Note

This command will search for instances in each cell database and map them to the correct cell. This can be slow, particularly for larger deployments. You may wish to specify the `--cell_uuid` option, which will limit the search to a specific cell. You can use the **nova-manage cell_v2 list_cells** command to look up cell UUIDs if you are going to specify `--cell_uuid`.

Note

The `--max-count` option can be specified if you would like to limit the number of instances to map

in a single run. If `--max-count` is not specified, all instances will be mapped. Repeated runs of the command will start from where the last run finished so it is not necessary to increase `--max-count` to finish. An exit code of 0 indicates that all instances have been mapped. An exit code of 1 indicates that there are remaining instances that need to be mapped.

Template URLs in Cell Mappings

Starting in the 18.0.0 (Rocky) release, the URLs provided in the cell mappings for `--database_connection` and `--transport-url` can contain variables which are evaluated each time they are loaded from the database, and the values of which are taken from the corresponding base options in the hosts configuration file. The base URL is parsed and the following elements may be substituted into the cell mapping URL (using `rabbit://bob:s3kret@myhost:123/nova?sync=true#extra`):

Table 2: Cell Mapping URL Variables

Variable	Meaning	Part of example URL
`scheme`	The part before the `://`	`rabbit`
`username`	The username part of the credentials	`bob`
`password`	The password part of the credentials	`s3kret`
`hostname`	The hostname or address	`myhost`
`port`	The port number (must be specified)	`123`
`path`	The path part of the URL (without leading slash)	`nova`
`query`	The full query string arguments (without leading question mark)	`sync=true`
`fragment`	Everything after the first hash mark	`extra`

Variables are provided in curly brackets, like `{username}`. A simple template of `rabbit://{username}:{password}@otherhost/{path}` will generate a full URL of `rabbit://bob:s3kret@otherhost/nova` when used with the above example.

Note

The *`database.connection`* and *`transport_url`* values are not reloaded from the configuration file during a SIGHUP, which means that a full service restart will be required to notice changes in a cell mapping record if variables are changed.

Note

The *`transport_url`* option can contain an extended syntax for the netloc part of the URL (i.e. `userA:passwordA@hostA:portA,userB:passwordB@hostB:portB`). In this case, substitutions of the form `username1`, `username2`, etc will be honored and can be used in the template URL.

The templating of these URLs may be helpful in order to provide each service host with its own credentials for, say, the database. Without templating, all hosts will use the same URL (and thus credentials) for accessing services like the database and message queue. By using a URL with a template that results in the credentials being taken from the host-local configuration file, each host will use different values for those connections.

Assuming you have two service hosts that are normally configured with the cell0 database as their primary connection, their (abbreviated) configurations would look like this:

```
[database]
connection = mysql+pymysql://service1:foo@myapidbhost/nova_cell0
```

and:

```
[database]
connection = mysql+pymysql://service2:bar@myapidbhost/nova_cell0
```

Without cell mapping template URLs, they would still use the same credentials (as stored in the mapping) to connect to the cell databases. However, consider template URLs like the following:

```
mysql+pymysql://{username}:{password}@mycell1dbhost/nova
```

and:

```
mysql+pymysql://{username}:{password}@mycell2dbhost/nova
```

Using the first service and cell1 mapping, the calculated URL that will actually be used for connecting to that database will be:

```
mysql+pymysql://service1:foo@mycell1dbhost/nova
```

3.3.3.5 Design

Prior to the introduction of cells v2, when a request hit the Nova API for a particular instance, the instance information was fetched from the database. The information contained the hostname of the compute node on which the instance was currently located. If the request needed to take action on the instance (which it generally would), the hostname was used to calculate the name of a queue and a message was written there which would eventually find its way to the proper compute node.

The meat of the cells v2 feature was to split this hostname lookup into two parts that yielded three pieces of information instead of one. Basically, instead of merely looking up the *name* of the compute node on which an instance was located, we also started obtaining database and queue connection information. Thus, when asked to take action on instance $foo, we now:

1. Lookup the three-tuple of (database, queue, hostname) for that instance
2. Connect to that database and fetch the instance record
3. Connect to the queue and send the message to the proper hostname queue

The above differs from the previous organization in two ways. First, we now need to do two database lookups before we know where the instance lives. Second, we need to demand-connect to the appropriate database and queue. Both of these changes had performance implications, but it was possible to mitigate them through the use of things like a memcache of instance mapping information and pooling of connections to database and queue systems. The number of cells will always be much smaller than the number of instances.

There were also availability implications with the new feature since something like a instance list which might query multiple cells could end up with a partial result if there is a database failure in a cell. These issues can be mitigated, as discussed in *Handling cell failures*. A database failure within a cell would cause larger issues than a partial list result so the expectation is that it would be addressed quickly and cells v2 will handle it by indicating in the response that the data may not be complete.

3.3.3.6 Comparison with cells v1

Prior to the introduction of cells v2, nova had a very similar feature, also called cells or referred to as cells v1 for disambiguation. Cells v2 was an effort to address many of the perceived shortcomings of the cell v1 feature. Benefits of the cells v2 feature over the previous cells v1 feature include:

- Native sharding of the database and queue as a first-class-feature in nova. All of the code paths will go through the lookup procedure and thus we wont have the same feature parity issues as we do with current cells.
- No high-level replication of all the cell databases at the top. The API will need a database of its own for things like the instance index, but it will not need to replicate all the data at the top level.
- It draws a clear line between global and local data elements. Things like flavors and keypairs are clearly global concepts that need only live at the top level. Providing this separation allows compute nodes to become even more stateless and insulated from things like deleted/changed global data.
- Existing non-cells users will suddenly gain the ability to spawn a new cell from their existing deployment without changing their architecture. Simply adding information about the new database and queue systems to the new index will allow them to consume those resources.
- Existing cells users will need to fill out the cells mapping index, shutdown their existing cells synchronization service, and ultimately clean up their top level database. However, since the high-level organization is not substantially different, they will not have to re-architect their systems to move to cells v2.
- Adding new sets of hosts as a new cell allows them to be plugged into a deployment and tested before allowing builds to be scheduled to them.

3.3.3.7 Caveats

Note

Many of these caveats have been addressed since the introduction of cells v2 in the 16.0.0 (Pike) release. These are called out below.

Cross-cell move operations

Support for cross-cell cold migration and resize was introduced in the 21.0.0 (Ussuri) release. This is documented in *Cross-cell resize*. Prior to this release, it was not possible to cold migrate or resize an instance from a host in one cell to a host in another cell.

It is not currently possible to live migrate, evacuate or unshelve an instance from a host in one cell to a host in another cell.

Quota-related quirks

Quotas are now calculated live at the point at which an operation would consume more resource, instead of being kept statically in the database. This means that a multi-cell environment may incorrectly calculate the usage of a tenant if one of the cells is unreachable, as those resources cannot be counted. In this case, the tenant may be able to consume more resource from one of the available cells, putting them far over quota when the unreachable cell returns.

Note

Starting in the Train (20.0.0) release, it is possible to configure counting of quota usage from the placement service and API database to make quota usage calculations resilient to down or poor-performing cells in a multi-cell environment. See the quotas documentation for more details.

Starting in the 2023.2 Bobcat (28.0.0) release, it is possible to configure unified limits quotas, which stores quota limits as Keystone unified limits and counts quota usage from the placement service and API database. See the *unified limits documentation* for more details.

Performance of listing instances

Prior to the 17.0.0 (Queens) release, the instance list operation may not sort and paginate results properly when crossing multiple cell boundaries. Further, the performance of a sorted list operation across multiple cells was considerably slower than with a single cell. This was resolved as part of the efficient-multi-cell-instance-list-and-sort spec.

Notifications

With a multi-cell environment with multiple message queues, it is likely that operators will want to configure a separate connection to a unified queue for notifications. This can be done in the configuration file of all nodes. Refer to the oslo.messaging configuration documentation for more details.

Nova Metadata API service

Starting from the 19.0.0 (Stein) release, the *nova metadata API service* can be run either globally or per cell using the `api.local_metadata_per_cell` configuration option.

Global

If you have networks that span cells, you might need to run Nova metadata API globally by setting `api.local_metadata_per_cell` to `false`. When running globally, it should be configured as an API-level service with access to the `api_database.connection` information.

Local per cell

Running Nova metadata API per cell can have better performance and data isolation in a multi-cell deployment. If your networks are segmented along cell boundaries, then you can run Nova metadata API service per cell by setting `api.local_metadata_per_cell` to `true`. If you choose to run it per cell, you should also configure each neutron-metadata-agent service to point to the hostname/IP address of the corresponding Compute Metadata API.

Console proxies

Starting from the 18.0.0 (Rocky) release, console proxies must be run per cell because console token authorizations are stored in cell databases. This means that each console proxy server must have access to the `database.connection` information for the cell database containing the instances for which it is proxying console access. This functionality was added as part of the convert-consoles-to-objects spec.

Operations requiring upcalls

If you deploy multiple cells with a superconductor as described above, computes and cell-based conductors will not have the ability to speak to the scheduler as they are not connected to the same MQ. This is by design for isolation, but currently the processes are not in place to implement some features without such connectivity. Thus, anything that requires a so-called upcall will not function. This impacts the following:

1. Instance reschedules during boot and resize (part 1)

   Note

   This has been resolved in the Queens release.

2. Instance affinity reporting from the compute nodes to scheduler
3. The late anti-affinity check during server create and evacuate
4. Querying host aggregates from the cell

   Note

   This has been resolved in the Rocky release.

5. Attaching a volume and `[cinder] cross_az_attach = False`
6. Instance reschedules during boot and resize (part 2)

   Note

   This has been resolved in the Ussuri release.

The first is simple: if you boot an instance, it gets scheduled to a compute node, fails, it would normally be re-scheduled to another node. That requires scheduler intervention and thus it will not work in Pike with a multi-cell layout. If you do not rely on reschedules for covering up transient compute-node failures, then this will not affect you. To ensure you do not make futile attempts at rescheduling, you should set *`scheduler.max_attempts`* to `1` in `nova.conf`.

The second two are related. The summary is that some of the facilities that Nova has for ensuring that affinity/anti-affinity is preserved between instances does not function in Pike with a multi-cell layout. If you dont use affinity operations, then this will not affect you. To make sure you dont make futile attempts at the affinity check, you should set *`workarounds.disable_group_policy_check_upcall`* to `True` and *`filter_scheduler.track_instance_changes`* to `False` in `nova.conf`.

The fourth was previously only a problem when performing live migrations using the since-removed XenAPI driver and not specifying `--block-migrate`. The driver would attempt to figure out if block migration should be performed based on source and destination hosts being in the same aggregate. Since aggregates data had migrated to the API database, the cell conductor would not be able to access the aggregate information and would fail.

The fifth is a problem because when a volume is attached to an instance in the *nova-compute* service, and `[cinder]/cross_az_attach=False` in nova.conf, we attempt to look up the availability zone that the instance is in which includes getting any host aggregates that the `instance.host` is in. Since the

aggregates are in the API database and the cell conductor cannot access that information, so this will fail. In the future this check could be moved to the *nova-api* service such that the availability zone between the instance and the volume is checked before we reach the cell, except in the case of *boot from volume* where the *nova-compute* service itself creates the volume and must tell Cinder in which availability zone to create the volume. Long-term, volume creation during boot from volume should be moved to the top-level superconductor which would eliminate this AZ up-call check problem.

The sixth is detailed in bug 1781286 and is similar to the first issue. The issue is that servers created without a specific availability zone will have their AZ calculated during a reschedule based on the alternate host selected. Determining the AZ for the alternate host requires an up call to the API DB.

3.3.3.8 Handling cell failures

For an explanation on how `nova-api` handles cell failures please see the Handling Down Cells section of the Compute API guide. Below, you can find some recommended practices and considerations for effectively tolerating cell failure situations.

Configuration considerations

Since a cell being reachable or not is determined through timeouts, it is suggested to provide suitable values for the following settings based on your requirements.

1. *`database.max_retries`* is 10 by default meaning every time a cell becomes unreachable, it would retry 10 times before nova can declare the cell as a down cell.
2. *`database.retry_interval`* is 10 seconds and *`oslo_messaging_rabbit.rabbit_retry_interval`* is 1 second by default meaning every time a cell becomes unreachable it would retry every 10 seconds or 1 second depending on if its a database or a message queue problem.
3. Nova also has a timeout value called `CELL_TIMEOUT` which is hardcoded to 60 seconds and that is the total time the nova-api would wait before returning partial results for the down cells.

The values of the above settings will affect the time required for nova to decide if a cell is unreachable and then take the necessary actions like returning partial results.

The operator can also control the results of certain actions like listing servers and services depending on the value of the *`api.list_records_by_skipping_down_cells`* config option. If this is true, the results from the unreachable cells will be skipped and if it is false, the request will just fail with an API error in situations where partial constructs cannot be computed.

Disabling down cells

While the temporary outage in the infrastructure is being fixed, the affected cells can be disabled so that they are removed from being scheduling candidates. To enable or disable a cell, use **`nova-manage cell_v2 update_cell --cell_uuid <cell_uuid> --disable`**. See the *Cells v2 Commands* man page for details on command usage.

Known issues

1. **Services and Performance:** In case a cell is down during the startup of nova services, there is the chance that the services hang because of not being able to connect to all the cell databases that might be required for certain calculations and initializations. An example scenario of this situation is if *`upgrade_levels.compute`* is set to `auto` then the `nova-api` service hangs on startup if there is at least one unreachable cell. This is because it needs to connect to all the cells to gather

information on each of the compute services version to determine the compute version cap to use. The current workaround is to pin the *upgrade_levels.compute* to a particular version like rocky and get the service up under such situations. See bug 1815697 for more details. Also note that in general during situations where cells are not reachable certain slowness may be experienced in operations requiring hitting all the cells because of the aforementioned configurable timeout/retry values.

2. **Counting Quotas:** Another known issue is in the current approach of counting quotas where we query each cell database to get the used resources and aggregate them which makes it sensitive to temporary cell outages. While the cell is unavailable, we cannot count resource usage residing in that cell database and things would behave as though more quota is available than should be. That is, if a tenant has used all of their quota and part of it is in cell A and cell A goes offline temporarily, that tenant will suddenly be able to allocate more resources than their limit (assuming cell A returns, the tenant will have more resources allocated than their allowed quota).

Note

Starting in the Train (20.0.0) release, it is possible to configure counting of quota usage from the placement service and API database to make quota usage calculations resilient to down or poor-performing cells in a multi-cell environment. See the quotas documentation for more details.

3.3.3.9 FAQs

- How do I find out which hosts are bound to which cell?

  There are a couple of ways to do this.

  1. Run **`nova-manage cell_v2 discover_hosts --verbose`**.

     This does not produce a report but if you are trying to determine if a host is in a cell you can run this and it will report any hosts that are not yet mapped to a cell and map them. This command is idempotent.

  2. Run **`nova-manage cell_v2 list_hosts`**.

     This will list hosts in all cells. If you want to list hosts in a specific cell, you can use the `--cell_uuid` option.

- I updated the `database_connection` and/or `transport_url` in a cell using the `nova-manage cell_v2 update_cell` command but the API is still trying to use the old settings.

  The cell mappings are cached in the compute API service worker so you will need to restart the worker process to rebuild the cache. Note that there is another global cache tied to request contexts, which is used in the nova-conductor and nova-scheduler services, so you might need to do the same if you are having the same issue in those services. As of the 16.0.0 (Pike) release there is no timer on the cache or hook to refresh the cache using a SIGHUP to the service.

- I have upgraded from Newton to Ocata and I can list instances but I get a HTTP 404 (NotFound) error when I try to get details on a specific instance.

  Instances need to be mapped to cells so the API knows which cell an instance lives in. When upgrading, the **`nova-manage cell_v2 simple_cell_setup`** command will automatically map the instances to the single cell which is backed by the existing nova database. If you have already upgraded and did not use the **`nova-manage cell_v2 simple_cell_setup`** command, you can run the **`nova-manage cell_v2 map_instances`** command with the `--cell_uuid` option to

map all instances in the given cell. See the *Cells v2 Commands* man page for details on command usage.

- Can I create a cell but have it disabled from scheduling?

  Yes. It is possible to create a pre-disabled cell such that it does not become a candidate for scheduling new VMs. This can be done by running the **nova-manage cell_v2 create_cell** command with the `--disabled` option.

- How can I disable a cell so that the new server create requests do not go to it while I perform maintenance?

  Existing cells can be disabled by running **nova-manage cell_v2 update_cell** with the `--disable` option and can be re-enabled once the maintenance period is over by running this command with the `--enable` option.

- I disabled (or enabled) a cell using the **nova-manage cell_v2 update_cell** or I created a new (pre-disabled) cell(mapping) using the **nova-manage cell_v2 create_cell** command but the scheduler is still using the old settings.

  The cell mappings are cached in the scheduler worker so you will either need to restart the scheduler process to refresh the cache, or send a SIGHUP signal to the scheduler by which it will automatically refresh the cells cache and the changes will take effect.

- Why was the cells REST API not implemented for cells v2? Why are there no CRUD operations for cells in the API?

  One of the deployment challenges that cells v1 had was the requirement for the API and control services to be up before a new cell could be deployed. This was not a problem for large-scale public clouds that never shut down, but is not a reasonable requirement for smaller clouds that do offline upgrades and/or clouds which could be taken completely offline by something like a power outage. Initial devstack and gate testing for cells v1 was delayed by the need to engineer a solution for bringing the services partially online in order to deploy the rest, and this continues to be a gap for other deployment tools. Consider also the FFU case where the control plane needs to be down for a multi-release upgrade window where changes to cell records have to be made. This would be quite a bit harder if the way those changes are made is via the API, which must remain down during the process.

  Further, there is a long-term goal to move cell configuration (i.e. cell_mappings and the associated URLs and credentials) into config and get away from the need to store and provision those things in the database. Obviously a CRUD interface in the API would prevent us from making that move.

- Why are cells not exposed as a grouping mechanism in the API for listing services, instances, and other resources?

  Early in the design of cells v2 we set a goal to not let the cell concept leak out of the API, even for operators. Aggregates are the way nova supports grouping of hosts for a variety of reasons, and aggregates can cut across cells, and/or be aligned with them if desired. If we were to support cells as another grouping mechanism, we would likely end up having to implement many of the same features for them as aggregates, such as scheduler features, metadata, and other searching/filtering operations. Since aggregates are how Nova supports grouping, we expect operators to use aggregates any time they need to refer to a cell as a group of hosts from the API, and leave actual cells as a purely architectural detail.

  The need to filter instances by cell in the API can and should be solved by adding a generic by-aggregate filter, which would allow listing instances on hosts contained within any aggregate, including one that matches the cell boundaries if so desired.

- Why are the API responses for `GET /servers`, `GET /servers/detail`, `GET /servers/{server_id}` and `GET /os-services` missing some information for certain cells at certain times? Why do I see the status as UNKNOWN for the servers in those cells at those times when I run `openstack server list` or `openstack server show`?

  Starting from microversion 2.69 the API responses of `GET /servers`, `GET /servers/detail`, `GET /servers/{server_id}` and `GET /os-services` may contain missing keys during down cell situations. See the Handling Down Cells section of the Compute API guide for more information on the partial constructs.

  For administrative considerations, see *Handling cell failures*.

3.3.3.10 References

A large number of cells v2-related presentations have been given at various OpenStack and OpenInfra Summits over the years. These provide an excellent reference on the history and development of the feature along with details from real-world users of the feature.

- Newton Summit Video - Nova Cells V2: Whats Going On?
- Pike Summit Video - Scaling Nova: How CellsV2 Affects Your Deployment
- Queens Summit Video - Add Cellsv2 to your existing Nova deployment
- Rocky Summit Video - Moving from CellsV1 to CellsV2 at CERN
- Stein Summit Video - Scaling Nova with CellsV2: The Nova Developer and the CERN Operator perspective
- Train Summit Video - Whats new in Nova Cellsv2?

3.3.4 Using WSGI with Nova

Changed in version 33.0.0: Removed support for the eventlet server scripts, `nova-api`, `nova-api-metadata` and `nova-api-os-compute`. Only WSGI-based deployments are supported going forward and it is no longer possible to run the compute API and metadata APIs in the same process, as it was with the eventlet scripts.

Changed in version 33.0.0: Removed the `nova-api-wsgi` and `nova-metadata-wsgi` WSGI scripts previously provided by Nova. Deployment tooling should instead reference the Python module paths for these services, `nova.wsgi.osapi_compute` and `nova.wsgi.metadata`, if their chosen WSGI server supports this (gunicorn, uWSGI) or implement a `.wsgi` script themselves if not (mod_wsgi).

Nova provides two APIs: a compute API (a.k.a. the REST API) and a *metadata API*. Both of these APIs are implemented as generic Python HTTP servers that implement WSGI and are expected to be deployed using a server with WSGI support.

To facilitate this, Nova provides a WSGI module for each API that provide the `application` object that most WSGI servers require. These can be found at `nova.wsgi.osapi_compute` and `nova.wsgi.metadata` for the compute API and the metadata API, respectively. The `application` objects are automatically configured with configuration from `nova.conf` and `api-paste.ini` by default, and the the config files and config directory can be overridden via the `OS_NOVA_CONFIG_FILES` and `OS_NOVA_CONFIG_DIR` environment variables.

Note

File paths listed in `OS_NOVA_CONFIG_FILES` are relative to `OS_NOVA_CONFIG_DIR` and delimited by `;`.

DevStack deploys the compute and metadata APIs behind Apache using uwsgi via mod_proxy_uwsgi. Inspecting the configuration created there can provide some guidance on one option for managing the WSGI scripts. It is important to remember, however, that one of the major features of using WSGI is that there are many different ways to host a WSGI application. Different servers make different choices about performance and configurability. It is up to you, as a deployer, to choose an appropriate server for your deployment.

3.4 Maintenance

Once you are running nova, the following information is extremely useful.

- *Admin Guide*: A collection of guides for administrating nova.
- *Flavors*: What flavors are and why they are used.
- *Upgrades*: How nova is designed to be upgraded for minimal service impact, and the order you should do them in.
- *Quotas*: Managing project quotas in nova.
- *Aggregates*: Aggregates are a useful way of grouping hosts together for scheduling purposes.
- *Scheduling*: How the scheduler is configured, and how that will impact where compute instances land in your environment. If you are seeing unexpected distribution of compute instances in your hosts, youll want to dive into this configuration.
- *Exposing custom metadata to compute instances*: How and when you might want to extend the basic metadata exposed to compute instances (either via metadata server or config drive) for your specific purposes.

3.4.1 Admin Documentation

The OpenStack Compute service allows you to control an Infrastructure-as-a-Service (IaaS) cloud computing platform. It gives you control over instances and networks, and allows you to manage access to the cloud through users and projects.

Compute does not include virtualization software. Instead, it defines drivers that interact with underlying virtualization mechanisms that run on your host operating system, and exposes functionality over a web-based API.

3.4.1.1 Overview

To effectively administer compute, you must understand how the different installed nodes interact with each other. Compute can be installed in many different ways using multiple servers, but generally multiple compute nodes control the virtual servers and a cloud controller node contains the remaining Compute services.

The Compute cloud works using a series of daemon processes named `nova-*` that exist persistently on the host machine. These binaries can all run on the same machine or be spread out on multiple boxes in a large deployment. The responsibilities of services and drivers are:

Services

Compute API
: A WSGI application that serves the Nova OpenStack Compute API.

Metadata API
: A WSGI application that serves the Nova Metadata API.

nova-compute
: Manages virtual machines. Loads a Service object, and exposes the public methods on ComputeManager through a Remote Procedure Call (RPC).

nova-conductor
: Provides database-access support for compute nodes (thereby reducing security risks).

nova-scheduler
: Dispatches requests for new virtual machines to the correct node.

nova-novncproxy
: Provides a VNC proxy for browsers, allowing VNC consoles to access virtual machines.

nova-spicehtml5proxy
: Provides a SPICE proxy for browsers, allowing SPICE consoles to access virtual machines.

nova-serialproxy
: Provides a serial console proxy, allowing users to access a virtual machines serial console.

The architecture is covered in much greater detail in *Nova System Architecture*.

Note

Some services have drivers that change how the service implements its core functionality. For example, the `nova-compute` service supports drivers that let you choose which hypervisor type it can use.

3.4.1.2 Deployment Considerations

There is information you might want to consider before doing your deployment, especially if it is going to be a larger deployment. For smaller deployments the defaults from the *install guide* will be sufficient.

- **Compute Driver Features Supported**: While the majority of nova deployments use libvirt/kvm, you can use nova with other compute drivers. Nova attempts to provide a unified feature set across these, however, not all features are implemented on all backends, and not all features are equally well tested.
  - *Feature Support by Use Case*: A view of what features each driver supports based on whats important to some large use cases (General Purpose Cloud, NFV Cloud, HPC Cloud).
  - *Feature Support full list*: A detailed dive through features in each compute driver backend.
- *Cells v2 configuration*: For large deployments, cells v2 cells allow sharding of your compute environment. Upfront planning is key to a successful cells v2 layout.
- *Availability Zones*: Availability Zones are an end-user visible logical abstraction for partitioning a cloud without knowing the physical infrastructure.
- Placement service: Overview of the placement service, including how it fits in with the rest of nova.

- *Running nova-api on wsgi*: Considerations for deploying the APIs.
- *Nova service concurrency*: Considerations on how to use and tune Nova services in threading mode.

Host aggregates

Host aggregates are a mechanism for partitioning hosts in an OpenStack cloud, or a region of an OpenStack cloud, based on arbitrary characteristics. Examples where an administrator may want to do this include where a group of hosts have additional hardware or performance characteristics.

Host aggregates started out as a way to use Xen hypervisor resource pools, but have been generalized to provide a mechanism to allow administrators to assign key-value pairs to groups of machines. Each node can have multiple aggregates, each aggregate can have multiple key-value pairs, and the same key-value pair can be assigned to multiple aggregates. This information can be used in the scheduler to enable advanced scheduling, to set up Xen hypervisor resource pools or to define logical groups for migration.

Host aggregates are not explicitly exposed to users. Instead administrators map flavors to host aggregates. Administrators do this by setting metadata on a host aggregate, and matching flavor extra specifications. The scheduler then endeavors to match user requests for instances of the given flavor to a host aggregate with the same key-value pair in its metadata. Compute nodes can be in more than one host aggregate. Weight multipliers can be controlled on a per-aggregate basis by setting the desired `xxx_weight_multiplier` aggregate metadata.

Administrators are able to optionally expose a host aggregate as an *Availability Zone*. Availability zones are different from host aggregates in that they are explicitly exposed to the user, and hosts can only be in a single availability zone. Administrators can configure a default availability zone where instances will be scheduled when the user fails to specify one. For more information on how to do this, refer to *Availability Zones*.

Note

It is not allowed to move instances between Availability Zones. If adding a host to an aggregate or removing a host from an aggregate would cause an instance to move between Availability Zones, including moving from or moving to the default AZ, then the operation will be rejected. The administrator should drain the instances from the host first then the host can be moved.

Configure scheduler to support host aggregates

One common use case for host aggregates is when you want to support scheduling instances to a subset of compute hosts because they have a specific capability. For example, you may want to allow users to request compute hosts that have SSD drives if they need access to faster disk I/O, or access to compute hosts that have GPU cards to take advantage of GPU-accelerated code.

To configure the scheduler to support host aggregates, the *`filter_scheduler.enabled_filters`* configuration option must contain the `AggregateInstanceExtraSpecsFilter` in addition to the other filters used by the scheduler. Add the following line to `nova.conf` on the host that runs the `nova-scheduler` service to enable host aggregates filtering, as well as the other filters that are typically enabled:

```
[filter_scheduler]
enabled_filters=...,AggregateInstanceExtraSpecsFilter
```

Example: Specify compute hosts with SSDs

This example configures the Compute service to enable users to request nodes that have solid-state drives (SSDs). You create a `fast-io` host aggregate in the `nova` availability zone and you add the `ssd=true` key-value pair to the aggregate. Then, you add the `node1`, and `node2` compute nodes to it.

```
$ openstack aggregate create --zone nova fast-io
+-------------------+---------------------------+
| Field             | Value                     |
+-------------------+---------------------------+
| availability_zone | nova                      |
| created_at        | 2016-12-22T07:31:13.013466 |
| deleted           | False                     |
| deleted_at        | None                      |
| id                | 1                         |
| name              | fast-io                   |
| updated_at        | None                      |
+-------------------+---------------------------+

$ openstack aggregate set --property ssd=true 1
+-------------------+---------------------------+
| Field             | Value                     |
+-------------------+---------------------------+
| availability_zone | nova                      |
| created_at        | 2016-12-22T07:31:13.000000 |
| deleted           | False                     |
| deleted_at        | None                      |
| hosts             | []                        |
| id                | 1                         |
| name              | fast-io                   |
| properties        | ssd='true'                |
| updated_at        | None                      |
+-------------------+---------------------------+

$ openstack aggregate add host 1 node1
+-------------------+-------------------------------------------------------+
| Field             | Value                                                 |
+-------------------+-------------------------------------------------------+
| availability_zone | nova                                                  |
| created_at        | 2016-12-22T07:31:13.000000                            |
| deleted           | False                                                 |
| deleted_at        | None                                                  |
| hosts             | [u'node1']                                            |
| id                | 1                                                     |
| metadata          | {u'ssd': u'true', u'availability_zone': u'nova'}      |
| name              | fast-io                                               |
| updated_at        | None                                                  |
+-------------------+-------------------------------------------------------+

$ openstack aggregate add host 1 node2
+-------------------+-------------------------------------------------------+
```

(continues on next page)

(continued from previous page)

```
| Field             | Value                                                 |
+-------------------+-------------------------------------------------------+
| availability_zone | nova                                                  |
| created_at        | 2016-12-22T07:31:13.000000                            |
| deleted           | False                                                 |
| deleted_at        | None                                                  |
| hosts             | [u'node1', u'node2']                                  |
| id                | 1                                                     |
| metadata          | {u'ssd': u'true', u'availability_zone': u'nova'}      |
| name              | fast-io                                               |
| updated_at        | None                                                  |
+-------------------+-------------------------------------------------------+
```

Use the **`openstack flavor create`** command to create the `ssd.large` flavor called with an ID of 6, 8 GB of RAM, 80 GB root disk, and 4 vCPUs.

```
$ openstack flavor create --id 6 --ram 8192 --disk 80 --vcpus 4 ssd.large
+----------------------------+-----------+
| Field                      | Value     |
+----------------------------+-----------+
| OS-FLV-DISABLED:disabled   | False     |
| OS-FLV-EXT-DATA:ephemeral  | 0         |
| disk                       | 80        |
| id                         | 6         |
| name                       | ssd.large |
| os-flavor-access:is_public | True      |
| ram                        | 8192      |
| rxtx_factor                | 1.0       |
| swap                       |           |
| vcpus                      | 4         |
+----------------------------+-----------+
```

Once the flavor is created, specify one or more key-value pairs that match the key-value pairs on the host aggregates with scope `aggregate_instance_extra_specs`. In this case, that is the `aggregate_instance_extra_specs:ssd=true` key-value pair. Setting a key-value pair on a flavor is done using the **`openstack flavor set`** command.

```
$ openstack flavor set \
    --property aggregate_instance_extra_specs:ssd=true ssd.large
```

Once it is set, you should see the `extra_specs` property of the `ssd.large` flavor populated with a key of `ssd` and a corresponding value of `true`.

```
$ openstack flavor show ssd.large
+----------------------------+-------------------------------------------+
| Field                      | Value                                     |
+----------------------------+-------------------------------------------+
| OS-FLV-DISABLED:disabled   | False                                     |
| OS-FLV-EXT-DATA:ephemeral  | 0                                         |
| disk                       | 80                                        |
```

(continues on next page)

(continued from previous page)

```
| id                         | 6                                          |
| name                       | ssd.large                                  |
| os-flavor-access:is_public | True                                       |
| properties                 | aggregate_instance_extra_specs:ssd='true'  |
| ram                        | 8192                                       |
| rxtx_factor                | 1.0                                        |
| swap                       |                                            |
| vcpus                      | 4                                          |
+----------------------------+--------------------------------------------+
```

Now, when a user requests an instance with the `ssd.large` flavor, the scheduler only considers hosts with the `ssd=true` key-value pair. In this example, these are `node1` and `node2`.

Aggregates in Placement

Aggregates also exist in placement and are not the same thing as host aggregates in nova. These aggregates are defined (purely) as groupings of related resource providers. Since compute nodes in nova are represented in placement as resource providers, they can be added to a placement aggregate as well. For example, get the UUID of the compute node using **`openstack hypervisor list`** and add it to an aggregate in placement using **`openstack resource provider aggregate set`**.

```
$ openstack --os-compute-api-version 2.53 hypervisor list
+--------------------------------------+---------------------+-----------------
↪-+-----------------+-------+
| ID                                   | Hypervisor Hostname | Hypervisor␣
↪Type | Host IP         | State |
+--------------------------------------+---------------------+-----------------
↪-+-----------------+-------+
| 815a5634-86fb-4e1e-8824-8a631fee3e06 | node1               | QEMU            ␣
↪ | 192.168.1.123   | up    |
+--------------------------------------+---------------------+-----------------
↪-+-----------------+-------+

$ openstack --os-placement-api-version 1.2 resource provider aggregate set \
    --aggregate df4c74f3-d2c4-4991-b461-f1a678e1d161 \
    815a5634-86fb-4e1e-8824-8a631fee3e06
```

Some scheduling filter operations can be performed by placement for increased speed and efficiency.

Note

The nova-api service attempts (as of nova 18.0.0) to automatically mirror the association of a compute host with an aggregate when an administrator adds or removes a host to/from a nova host aggregate. This should alleviate the need to manually create those association records in the placement API using the `openstack resource provider aggregate set` CLI invocation.

Tenant Isolation with Placement

In order to use placement to isolate tenants, there must be placement aggregates that match the membership and UUID of nova host aggregates that you want to use for isolation. The same key pattern in aggregate metadata used by the *AggregateMultiTenancyIsolation* filter controls this function, and is enabled by setting `scheduler.limit_tenants_to_placement_aggregate` to `True`.

```
$ openstack --os-compute-api-version=2.53 aggregate create myagg
+-------------------+--------------------------------------+
| Field             | Value                                |
+-------------------+--------------------------------------+
| availability_zone | None                                 |
| created_at        | 2018-03-29T16:22:23.175884           |
| deleted           | False                                |
| deleted_at        | None                                 |
| id                | 4                                    |
| name              | myagg                                |
| updated_at        | None                                 |
| uuid              | 019e2189-31b3-49e1-aff2-b220ebd91c24 |
+-------------------+--------------------------------------+

$ openstack --os-compute-api-version=2.53 aggregate add host myagg node1
+-------------------+--------------------------------------+
| Field             | Value                                |
+-------------------+--------------------------------------+
| availability_zone | None                                 |
| created_at        | 2018-03-29T16:22:23.175884           |
| deleted           | False                                |
| deleted_at        | None                                 |
| hosts             | [u'node1']                           |
| id                | 4                                    |
| name              | myagg                                |
| updated_at        | None                                 |
| uuid              | 019e2189-31b3-49e1-aff2-b220ebd91c24 |
+-------------------+--------------------------------------+

$ openstack project list -f value | grep 'demo'
9691591f913949818a514f95286a6b90 demo

$ openstack aggregate set \
    --property filter_tenant_id=9691591f913949818a514f95286a6b90 myagg

$ openstack --os-placement-api-version=1.2 resource provider aggregate set \
    --aggregate 019e2189-31b3-49e1-aff2-b220ebd91c24 \
    815a5634-86fb-4e1e-8824-8a631fee3e06
```

Note that the `filter_tenant_id` metadata key can be optionally suffixed with any string for multiple tenants, such as `filter_tenant_id3=$tenantid`.

Usage

Much of the configuration of host aggregates is driven from the API or command-line clients. For example, to create a new aggregate and add hosts to it using the **openstack** client, run:

```
$ openstack aggregate create my-aggregate
$ openstack aggregate add host my-aggregate my-host
```

To list all aggregates and show information about a specific aggregate, run:

```
$ openstack aggregate list
$ openstack aggregate show my-aggregate
```

To set and unset a property on the aggregate, run:

```
$ openstack aggregate set --property pinned=true my-aggregrate
$ openstack aggregate unset --property pinned my-aggregate
```

To rename the aggregate, run:

```
$ openstack aggregate set --name my-awesome-aggregate my-aggregate
```

To remove a host from an aggregate and delete the aggregate, run:

```
$ openstack aggregate remove host my-aggregate my-host
$ openstack aggregate delete my-aggregate
```

For more information, refer to the OpenStack Client documentation.

Configuration

In addition to CRUD operations enabled by the API and clients, the following configuration options can be used to configure how host aggregates and the related availability zones feature operate under the hood:

- *default_schedule_zone*
- *scheduler.limit_tenants_to_placement_aggregate*
- *cinder.cross_az_attach*

Finally, as discussed previously, there are a number of host aggregate-specific scheduler filters. These are:

- *AggregateImagePropertiesIsolation*
- *AggregateInstanceExtraSpecsFilter*
- *AggregateIoOpsFilter*
- *AggregateMultiTenancyIsolation*
- *AggregateNumInstancesFilter*
- *AggregateTypeAffinityFilter*

The following configuration options are applicable to the scheduler configuration:

- *cpu_allocation_ratio*

- *ram_allocation_ratio*
- *filter_scheduler.max_instances_per_host*
- *filter_scheduler.aggregate_image_properties_isolation_separator*
- *filter_scheduler.aggregate_image_properties_isolation_namespace*

Image Caching

Aggregates can be used as a way to target multiple compute nodes for the purpose of requesting that images be pre-cached for performance reasons.

Note

Some of the virt drivers provide image caching support, which improves performance of second-and-later boots of the same image by keeping the base image in an on-disk cache. This avoids the need to re-download the image from Glance, which reduces network utilization and time-to-boot latency. Image pre-caching is the act of priming that cache with images ahead of time to improve performance of the first boot.

Assuming an aggregate called `my-aggregate` where two images should be pre-cached, running the following command will initiate the request:

```
$ nova aggregate-cache-images my-aggregate image1 image2
```

Note that image pre-caching happens asynchronously in a best-effort manner. The images and aggregate provided are checked by the server when the command is run, but the compute nodes are not checked to see if they support image caching until the process runs. Progress and results are logged by each compute, and the process sends `aggregate.cache_images.start`, `aggregate.cache_images.progress`, and `aggregate.cache_images.end` notifications, which may be useful for monitoring the operation externally.

References

- Curse your bones, Availability Zones! (Openstack Summit Vancouver 2018)

Compute service node firewall requirements

Console connections for virtual machines, whether direct or through a proxy, are received on ports `5900` to `5999`. The firewall on each Compute service node must allow network traffic on these ports.

This procedure modifies the iptables firewall to allow incoming connections to the Compute services.

Configuring the service-node firewall

1. Log in to the server that hosts the Compute service, as root.
2. Edit the `/etc/sysconfig/iptables` file, to add an INPUT rule that allows TCP traffic on ports from `5900` to `5999`. Make sure the new rule appears before any INPUT rules that REJECT traffic:

   ```
   -A INPUT -p tcp -m multiport --dports 5900:5999 -j ACCEPT
   ```

3. Save the changes to the `/etc/sysconfig/iptables` file, and restart the `iptables` service to pick up the changes:

```
$ service iptables restart
```

4. Repeat this process for each Compute service node.

Availability Zones

Note

This section provides deployment and admin-user usage information about the availability zone feature. For end-user information about availability zones, refer to the *user guide*.

Availability Zones are an end-user visible logical abstraction for partitioning a cloud without knowing the physical infrastructure. They can be used to partition a cloud on arbitrary factors, such as location (country, datacenter, rack), network layout and/or power source.

Note

Availability Zones should not be assumed to map to fault domains and provide no intrinsic HA benefit by themselves.

Availability zones are not modeled in the database; rather, they are defined by attaching specific metadata information to an *aggregate* The addition of this specific metadata to an aggregate makes the aggregate visible from an end-user perspective and consequently allows users to schedule instances to a specific set of hosts, the ones belonging to the aggregate. There are a few additional differences to note when comparing availability zones and host aggregates:

- A host can be part of multiple aggregates but it can only be in one availability zone.
- By default a host is part of a default availability zone even if it doesnt belong to an aggregate. The name of this default availability zone can be configured using `default_availability_zone` config option.

Warning

The use of the default availability zone name in requests can be very error-prone. Since the user can see the list of availability zones, they have no way to know whether the default availability zone name (currently `nova`) is provided because a host belongs to an aggregate whose AZ metadata key is set to `nova`, or because there is at least one host not belonging to any aggregate. Consequently, it is highly recommended for users to never ever ask for booting an instance by specifying an explicit AZ named `nova` and for operators to never set the AZ metadata for an aggregate to `nova`. This can result is some problems due to the fact that the instance AZ information is explicitly attached to `nova` which could break further move operations when either the host is moved to another aggregate or when the user would like to migrate the instance.

Note

Availability zone names must NOT contain `:` since it is used by admin users to specify hosts where instances are launched in server creation. See *Using availability zones to select hosts* for

more information.

Note

It is not allowed to move instances between Availability Zones. If adding a host to an aggregate or removing a host from an aggregate would cause an instance to move between Availability Zones, including moving from or moving to the default AZ, then the operation will be rejected. The administrator should drain the instances from the host first then the host can be moved.

In addition, other services, such as the networking service and the block storage service, also provide an availability zone feature. However, the implementation of these features differs vastly between these different services. Consult the documentation for these other services for more information on their implementation of this feature.

Availability Zones with Placement

In order to use placement to honor availability zone requests, there must be placement aggregates that match the membership and UUID of nova host aggregates that you assign as availability zones. An aggregate metadata key is used to controls this function. As of 28.0.0 (Bobcat), this is the only way to schedule instances to availability-zones.

```
$ openstack --os-compute-api-version=2.53 aggregate create myaz
+-------------------+--------------------------------------+
| Field             | Value                                |
+-------------------+--------------------------------------+
| availability_zone | None                                 |
| created_at        | 2018-03-29T16:22:23.175884           |
| deleted           | False                                |
| deleted_at        | None                                 |
| id                | 4                                    |
| name              | myaz                                 |
| updated_at        | None                                 |
| uuid              | 019e2189-31b3-49e1-aff2-b220ebd91c24 |
+-------------------+--------------------------------------+

$ openstack --os-compute-api-version=2.53 aggregate add host myaz node1
+-------------------+--------------------------------------+
| Field             | Value                                |
+-------------------+--------------------------------------+
| availability_zone | None                                 |
| created_at        | 2018-03-29T16:22:23.175884           |
| deleted           | False                                |
| deleted_at        | None                                 |
| hosts             | [u'node1']                           |
| id                | 4                                    |
| name              | myagg                                |
| updated_at        | None                                 |
| uuid              | 019e2189-31b3-49e1-aff2-b220ebd91c24 |
+-------------------+--------------------------------------+
```

(continues on next page)

(continued from previous page)

```
$ openstack aggregate set --property availability_zone=az002 myaz
```

Implications for moving servers

There are several ways to move a server to another host: evacuate, resize, cold migrate, live migrate, and unshelve. Move operations typically go through the scheduler to pick the target host.

Prior to API microversion 2.68, using older openstackclient (pre-5.5.0) and novaclient, it was possible to specify a target host and the request forces the server to that host by bypassing the scheduler. Only evacuate and live migrate can forcefully bypass the scheduler and move a server to specified host and even then it is highly recommended to *not* force and bypass a scheduler.

- live migrate with force host (works with older openstackclients(pre-5.5.0):

```
$ openstack server migrate --live <host> <server>
```

- live migrate without forcing:

```
$ openstack server migrate --live-migration --host <host> <server>
```

While support for server evacuate command to openstackclient was added in 5.5.3 and there it never exposed ability to force an evacuation, but it was previously possible with novaclient.

- evacuate with force host:

```
$ nova evacuate --force <server> <host>
```

- evacuate without forcing using novaclient:

```
$ nova evacuate
```

- evacuate without forcing using openstackclient:

```
$ openstack server evacuate --host <host> <server>
```

With respect to availability zones, a server is restricted to a zone if:

1. The server was created in a specific zone with the `POST /servers` request containing the `availability_zone` parameter.
2. If the server create request did not contain the `availability_zone` parameter but the API service is configured for *`default_schedule_zone`* then by default the server will be scheduled to that zone.
3. The shelved offloaded server was unshelved by specifying the `availability_zone` with the `POST /servers/{server_id}/action` request using microversion 2.77 or greater.
4. *`cinder.cross_az_attach`* is False, *`default_schedule_zone`* is None, the server is created without an explicit zone but with pre-existing volume block device mappings. In that case the server will be created in the same zone as the volume(s) if the volume zone is not the same as *`default_availability_zone`*. See *Resource affinity* for details.

If the server was not created in a specific zone then it is free to be moved to other zones.

Resource affinity

The *cinder.cross_az_attach* configuration option can be used to restrict servers and the volumes attached to servers to the same availability zone.

A typical use case for setting `cross_az_attach=False` is to enforce compute and block storage affinity, for example in a High Performance Compute cluster.

By default `cross_az_attach` is True meaning that the volumes attached to a server can be in a different availability zone than the server. If set to False, then when creating a server with pre-existing volumes or attaching a volume to a server, the server and volume zone must match otherwise the request will fail. In addition, if the nova-compute service creates the volumes to attach to the server during server create, it will request that those volumes are created in the same availability zone as the server, which must exist in the block storage (cinder) service.

As noted in the *Implications for moving servers* section, forcefully moving a server to another zone could also break affinity with attached volumes.

Note

`cross_az_attach=False` is not widely used nor tested extensively and thus suffers from some known issues:

- Bug 1694844. This is fixed in the 21.0.0 (Ussuri) release by using the volume zone for the server being created if the server is created without an explicit zone, *default_schedule_zone* is None, and the volume zone does not match the value of *default_availability_zone*.
- Bug 1781421

Using availability zones to select hosts

We can combine availability zones with a specific host and/or node to select where an instance is launched. For example:

```
$ openstack server create --availability-zone ZONE:HOST:NODE ... SERVER
```

Note

It is possible to use `ZONE`, `ZONE:HOST`, and `ZONE::NODE`.

Note

This is an admin-only operation by default, though you can modify this behavior using the `os_compute_api:servers:create:forced_host` rule in `policy.yaml`.

However, as discussed previously, when launching instances in this manner the scheduler filters are not run. For this reason, this behavior is considered legacy behavior and, starting with the 2.74 microversion, it is now possible to specify a host or node explicitly. For example:

```
$ openstack --os-compute-api-version 2.74 server create \
    --host HOST --hypervisor-hostname HYPERVISOR ... SERVER
```

Note

This is an admin-only operation by default, though you can modify this behavior using the `compute:servers:create:requested_destination` rule in `policy.yaml`.

This avoids the need to explicitly select an availability zone and ensures the scheduler filters are not bypassed.

Usage

Creating an availability zone (AZ) is done by associating metadata with a *host aggregate*. For this reason, the **`openstack`** client provides the ability to create a host aggregate and associate it with an AZ in one command. For example, to create a new aggregate, associating it with an AZ in the process, and add host to it using the **`openstack`** client, run:

```
$ openstack aggregate create --zone my-availability-zone my-aggregate
$ openstack aggregate add host my-aggregate my-host
```

Note

While it is possible to add a host to multiple host aggregates, it is not possible to add them to multiple availability zones. Attempting to add a host to multiple host aggregates associated with differing availability zones will result in a failure.

Alternatively, you can set this metadata manually for an existing host aggregate. For example:

```
$ openstack aggregate set \
    --property availability_zone=my-availability-zone my-aggregate
```

To list all host aggregates and show information about a specific aggregate, in order to determine which AZ the host aggregate(s) belong to, run:

```
$ openstack aggregate list --long
$ openstack aggregate show my-aggregate
```

Finally, to disassociate a host aggregate from an availability zone, run:

```
$ openstack aggregate unset --property availability_zone my-aggregate
```

Configuration

Refer to *Host aggregates* for information on configuring both host aggregates and availability zones.

Configuration

To configure your Compute installation, you must define configuration options in these files:

- `nova.conf` contains most of the Compute configuration options and resides in the `/etc/nova` directory.
- `api-paste.ini` defines Compute limits and resides in the `/etc/nova` directory.

- Configuration files for related services, such as the Image and Identity services.

A list of config options based on different topics can be found below:

Service User Tokens

Warning

Configuration of service user tokens is **required** for every Nova service for security reasons. See https://bugs.launchpad.net/nova/+bug/2004555 for details.

Configure Nova to send service user tokens alongside regular user tokens when making REST API calls to other services. The identity service (Keystone) will authenticate a request using the service user token if the regular user token has expired.

This is important when long-running operations such as live migration or snapshot take long enough to exceed the expiry of the user token. Without the service token, if a long-running operation exceeds the expiry of the user token, post operations such as cleanup after a live migration could fail when Nova calls other service APIs like block-storage (Cinder) or networking (Neutron).

The service token is also used by services to validate whether the API caller is a service. Some service APIs are restricted to service users only.

To set up service tokens, create a `nova` service user and `service` role in the identity service (Keystone) and assign the `service` role to the `nova` service user.

Then, configure the *service_user* section of the Nova configuration file, for example:

```
[service_user]
send_service_user_token = true
auth_url = $AUTH_URL
auth_type = password
project_domain_name = $PROJECT_DOMAIN_NAME
project_name = service
user_domain_name = $USER_DOMAIN_NAME
username = nova
password = $SERVICE_USER_PASSWORD
...
```

And configure the other identity options as necessary for the service user, much like you would configure nova to work with the image service (Glance) or networking service (Neutron).

Note

Please note that the role assigned to the *service_user* needs to be in the configured *keystone_authtoken.service_token_roles* of other services such as block-storage (Cinder), image (Glance), and networking (Neutron).

Compute API configuration

The Compute API, is the component of OpenStack Compute that receives and responds to user requests, whether they be direct API calls, or via the CLI tools or dashboard.

Configure Compute API password handling

The OpenStack Compute API enables users to specify an administrative password when they create, rebuild, rescue or evacuate a server instance. If the user does not specify a password, a random password is generated and returned in the API response.

In practice, how the admin password is handled depends on the hypervisor in use and might require additional configuration of the instance. For example, you might have to install an agent to handle the password setting. If the hypervisor and instance configuration do not support setting a password at server create time, the password that is returned by the create API call is misleading because it was ignored.

To prevent this confusion, set the `enable_instance_password` configuration to `False` to disable the return of the admin password for installations that do not support setting instance passwords.

Resize

Resize (or Server resize) is the ability to change the flavor of a server, thus allowing it to upscale or downscale according to user needs. For this feature to work properly, you might need to configure some underlying virt layers.

This document describes how to configure hosts for standard resize. For information on *cross-cell resize*, refer to *Cross-cell resize*.

Virt drivers

Todo

This section needs to be updated for other virt drivers, shared storage considerations, etc.

KVM

Resize on KVM is implemented currently by transferring the images between compute nodes over ssh. For KVM you need hostnames to resolve properly and passwordless ssh access between your compute hosts. Direct access from one compute host to another is needed to copy the VM file across.

Cloud end users can find out how to resize a server by reading *Resize an instance*.

Automatic confirm

There is a periodic task configured by configuration option *resize_confirm_window* (in seconds). If this value is not 0, the `nova-compute` service will check whether servers are in a resized state longer than the value of *resize_confirm_window* and if so will automatically confirm the resize of the servers.

Cross-cell resize

Note

This document describes how to configure nova for cross-cell resize. For information on *same-cell resize*, refer to *Resize*. For information on the cells v2 feature, refer to *Cells (v2)*.

Historically resizing and cold migrating a server has been explicitly restricted to within the same cell in which the server already exists. The cross-cell resize feature allows configuring nova to allow resizing and cold migrating servers across cells.

The full design details are in the Ussuri spec and there is a video from a summit talk with a high-level overview.

Use case

There are many reasons to use multiple cells in a nova deployment beyond just scaling the database and message queue. Cells can also be used to shard a deployment by hardware generation and feature functionality. When sharding by hardware generation, it would be natural to setup a host aggregate for each cell and map flavors to the aggregate. Then when it comes time to decommission old hardware the deployer could provide new flavors and request that users resize to the new flavors, before some deadline, which under the covers will migrate their servers to the new cell with newer hardware. Administrators could also just cold migrate the servers during a maintenance window to the new cell.

Requirements

To enable cross-cell resize functionality the following conditions must be met.

Minimum compute versions

All compute services must be upgraded to 21.0.0 (Ussuri) or later and not be pinned to older RPC API versions in `upgrade_levels.compute`.

Policy configuration

The policy rule `compute:servers:resize:cross_cell` controls who can perform a cross-cell resize or cold migrate operation. By default the policy disables the functionality for *all* users. A microversion is not required to opt into the behavior, just passing the policy check. As such, it is recommended to start by allowing only certain users to be able to perform a cross-cell resize or cold migration, for example by setting the rule to `rule:admin_api` or some other rule for test teams but not normal users until you are comfortable supporting the feature.

Compute driver

There are no special compute driver implementations required to support the feature, it is built on existing driver interfaces used during resize and shelve/unshelve. However, only the libvirt compute driver has integration testing in the `nova-multi-cell` CI job.

Networking

The networking API must expose the `Port Bindings Extended` API extension which was added in the 13.0.0 (Rocky) release for Neutron.

Notifications

The types of events and their payloads remain unchanged. The major difference from same-cell resize is the *publisher_id* may be different in some cases since some events are sent from the conductor service rather than a compute service. For example, with same-cell resize the `instance.resize_revert.start` notification is sent from the source compute host in the finish_revert_resize method but with cross-cell resize that same notification is sent from the conductor service.

Obviously the actual message queue sending the notifications would be different for the source and target cells assuming they use separate transports.

Instance actions

The overall instance actions named `resize`, `confirmResize` and `revertResize` are the same as same-cell resize. However, the *events* which make up those actions will be different for cross-cell resize since the event names are generated based on the compute service methods involved in the operation and there are different methods involved in a cross-cell resize. This is important for triage when a cross-cell resize operation fails.

Scheduling

The *CrossCellWeigher* is enabled by default. When a scheduling request allows selecting compute nodes from another cell the weigher will by default *prefer* hosts within the source cell over hosts from another cell. However, this behavior is configurable using the *`filter_scheduler.cross_cell_move_weight_multiplier`* configuration option if, for example, you want to drain old cells when resizing or cold migrating.

Code flow

The end user experience is meant to not change, i.e. status transitions. A successfully cross-cell resized server will go to `VERIFY_RESIZE` status and from there the user can either confirm or revert the resized server using the normal confirmResize and revertResize server action APIs.

Under the covers there are some differences from a traditional same-cell resize:

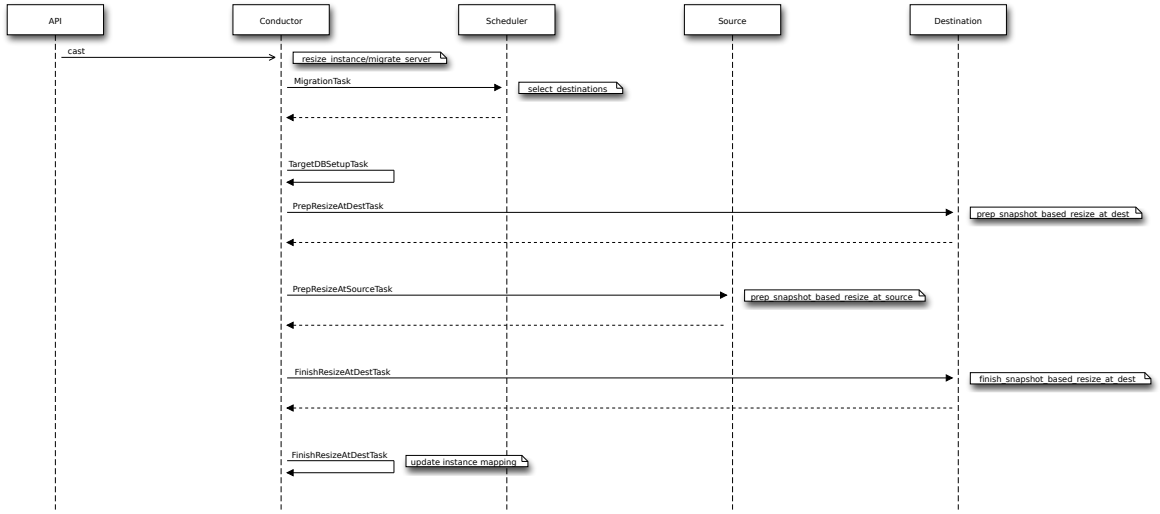
- There is no inter-compute interaction. Everything is synchronously orchestrated from the (super)conductor service. This uses the *`long_rpc_timeout`* configuration option.
- The orchestration tasks in the (super)conductor service are in charge of creating a copy of the instance and its related records in the target cell database at the beginning of the operation, deleting them in case of rollback or when the resize is confirmed/reverted, and updating the `instance_mappings` table record in the API database.
- Non-volume-backed servers will have their root disk uploaded to the image service as a temporary snapshot image just like during the shelveOffload operation. When finishing the resize on the destination host in the target cell that snapshot image will be used to spawn the guest and then the snapshot image will be deleted.

Sequence diagram

The following diagrams are current as of the 21.0.0 (Ussuri) release.

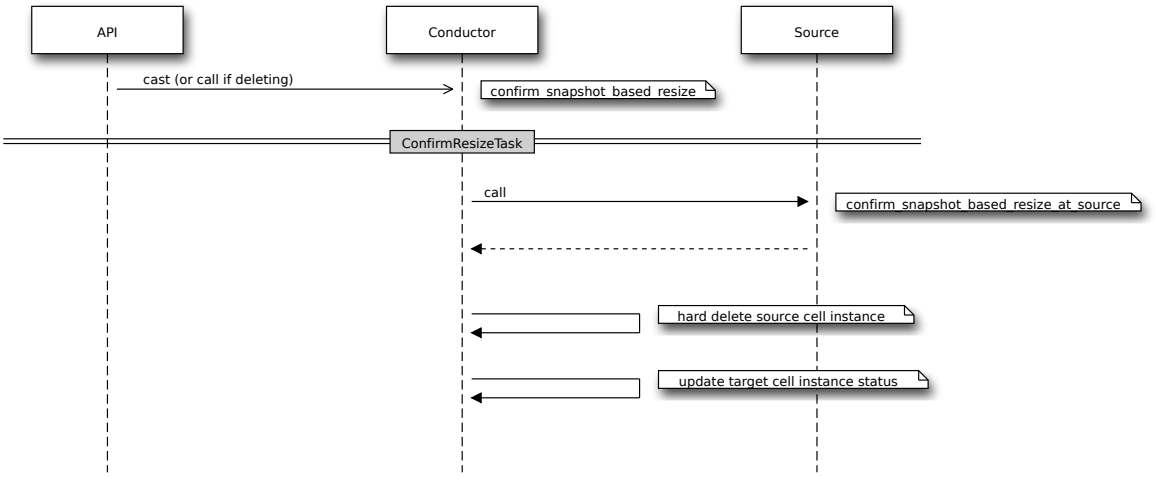
Resize

This is the sequence of calls to get the server to `VERIFY_RESIZE` status.



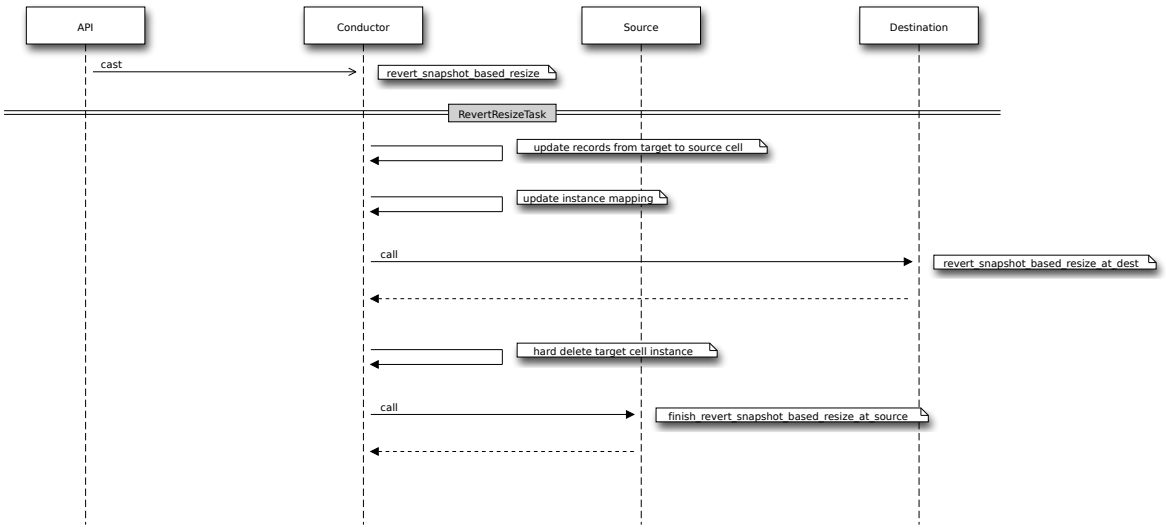
Confirm resize

This is the sequence of calls when confirming or deleting a server in `VERIFY_RESIZE` status.



Revert resize

This is the sequence of calls when reverting a server in `VERIFY_RESIZE` status.



Limitations

These are known to not yet be supported in the code:

- Instances with ports attached that have *bandwidth-aware* resource provider allocations. Nova falls back to same-cell resize if the server has such ports.
- Rescheduling to alternative hosts within the same target cell in case the primary selected host fails the `prep_snapshot_based_resize_at_dest` call.

These may not work since they have not been validated by integration testing:

- Instances with PCI devices attached.
- Instances with a NUMA topology.

Other limitations:

- The config drive associated with the server, if there is one, will be re-generated on the destination host in the target cell. Therefore if the server was created with personality files they will be lost. However, this is no worse than evacuating a server that had a config drive when the source and destination compute host are not on shared storage or when shelve offloading and unshelving a server with a config drive. If necessary, the resized server can be rebuilt to regain the personality files.
- The `_poll_unconfirmed_resizes` periodic task, which can be *`configured`* to automatically confirm pending resizes on the target host, *might* not support cross-cell resizes because doing so would require an *up-call* to the API to confirm the resize and cleanup the source cell database.

Troubleshooting

Timeouts

Configure a *service user* in case the user token times out, e.g. during the snapshot and download of a large server image.

If RPC calls are timing out with a `MessagingTimeout` error in the logs, check the *`long_rpc_timeout`* option to see if it is high enough though the default value (30 minutes) should be sufficient.

Recovering from failure

The orchestration tasks in conductor that drive the operation are built with rollbacks so each part of the operation can be rolled back in order if a subsequent task fails.

The thing to keep in mind is the `instance_mappings` record in the API DB is the authority on where the instance lives and that is where the API will go to show the instance in a `GET /servers/{server_id}` call or any action performed on the server, including deleting it.

So if the resize fails and there is a copy of the instance and its related records in the target cell, the tasks should automatically delete them but if not you can hard-delete the records from whichever cell is *not* the one in the `instance_mappings` table.

If the instance is in `ERROR` status, check the logs in both the source and destination compute service to see if there is anything that needs to be manually recovered, for example volume attachments or port bindings, and also check the (super)conductor service logs. Assuming volume attachments and port bindings are OK (current and pointing at the correct host), then try hard rebooting the server to get it back to `ACTIVE` status. If that fails, you may need to rebuild the server on the source host. Note that the guests disks on the source host are not deleted until the resize is confirmed so if there is an issue prior to confirm or confirm itself fails, the guest disks should still be available for rebuilding the instance if necessary.

Configuring Fibre Channel Support

Fibre Channel support in OpenStack Compute is remote block storage attached to compute nodes for VMs.

Todo

This below statement needs to be verified for current release

Fibre Channel supported only the KVM hypervisor.

Compute and Block Storage support Fibre Channel automatic zoning on Brocade and Cisco switches. On other hardware Fibre Channel arrays must be pre-zoned or directly attached to the KVM hosts.

KVM host requirements

You must install these packages on the KVM host:

`sysfsutils`
: Nova uses the `systool` application in this package.

`sg3-utils` or `sg3_utils`
: Nova uses the `sg_scan` and `sginfo` applications.

Installing the `multipath-tools` or `device-mapper-multipath` package is optional.

Configuring iSCSI interface and offload support

Compute supports open-iscsi iSCSI interfaces for offload cards. Offload hardware must be present and configured on every compute node where offload is desired. Once an open-iscsi interface is configured, the iface name (`iface.iscsi_ifacename`) should be passed to libvirt via the `iscsi_iface` parameter for use. All iSCSI sessions will be bound to this iSCSI interface.

Currently supported transports (`iface.transport_name`) are `be2iscsi`, `bnx2i`, `cxgb3i`, `cxgb4i`, `qla4xxx`, `ocs`, `tcp`. Configuration changes are required on the compute node only.

iSER is supported using the separate iSER LibvirtISERVolumeDriver and will be rejected if used via the `iscsi_iface` parameter.

iSCSI iface configuration

- Note the distinction between the transport name (`iface.transport_name`) and iface name (`iface.iscsi_ifacename`). The actual iface name must be specified via the iscsi_iface parameter to libvirt for offload to work.
- The default name for an iSCSI iface (open-iscsi parameter `iface.iscsi_ifacename`) is in the format transport_name.hwaddress when generated by `iscsiadm`.
- `iscsiadm` can be used to view and generate current iface configuration. Every network interface that supports an open-iscsi transport can have one or more iscsi ifaces associated with it. If no ifaces have been configured for a network interface supported by an open-iscsi transport, this command will create a default iface configuration for that network interface. For example :

```
# iscsiadm -m iface
default tcp,<empty>,<empty>,<empty>,<empty>
iser iser,<empty>,<empty>,<empty>,<empty>
bnx2i.00:05:b5:d2:a0:c2 bnx2i,00:05:b5:d2:a0:c2,5.10.10.20,<empty>,<empty>
```

  The output is in the format:

```
iface_name transport_name,hwaddress,ipaddress,net_ifacename,initiatorname
```

- Individual iface configuration can be viewed via

```
# iscsiadm -m iface -I IFACE_NAME
# BEGIN RECORD 2.0-873
iface.iscsi_ifacename = cxgb4i.00:07:43:28:b2:58
iface.net_ifacename = <empty>
iface.ipaddress = 102.50.50.80
iface.hwaddress = 00:07:43:28:b2:58
iface.transport_name = cxgb4i
iface.initiatorname = <empty>
# END RECORD
```

  Configuration can be updated as desired via

```
# iscsiadm -m iface-I IFACE_NAME--op update -n iface.SETTING -v VALUE
```

- All iface configurations need a minimum of `iface.iface_name`, `iface.transport_name` and `iface.hwaddress` to be correctly configured to work. Some transports may require `iface.ipaddress` and `iface.net_ifacename` as well to bind correctly.

  Detailed configuration instructions can be found at: https://github.com/open-iscsi/open-iscsi/blob/master/README

Hypervisors

KVM

KVM is configured as the default hypervisor for Compute.

Note

This document contains several sections about hypervisor selection. If you are reading this document linearly, you do not want to load the KVM module before you install `nova-compute`. The `nova-compute` service depends on qemu-kvm, which installs `/lib/udev/rules.d/45-qemu-kvm.rules`, which sets the correct permissions on the `/dev/kvm` device node.

The KVM hypervisor supports the following virtual machine image formats:

- Raw
- QEMU Copy-on-write (QCOW2)
- QED Qemu Enhanced Disk
- VMware virtual machine disk format (vmdk)

This section describes how to enable KVM on your system. For more information, see the following distribution-specific documentation:

- Fedora: Virtualization Getting Started Guide
- Ubuntu: KVM/Installation
- Debian: KVM Guide
- Red Hat Enterprise Linux (RHEL): Getting started with virtualization
- openSUSE: Setting Up a KVM VM Host Server
- SLES: Virtualization with KVM.

Configuration

To enable KVM explicitly, add the following configuration options to the `/etc/nova/nova.conf` file:

```
[DEFAULT]
compute_driver = libvirt.LibvirtDriver

[libvirt]
virt_type = kvm
```

Enable KVM

The following sections outline how to enable KVM based hardware virtualization on different architectures and platforms. To perform these steps, you must be logged in as the `root` user.

For x86-based systems

1. To determine whether the `svm` or `vmx` CPU extensions are present, run this command:

   ```
   # grep -E 'svm|vmx' /proc/cpuinfo
   ```

   This command generates output if the CPU is capable of hardware-virtualization. Even if output is shown, you might still need to enable virtualization in the system BIOS for full support.

   If no output appears, consult your system documentation to ensure that your CPU and motherboard support hardware virtualization. Verify that any relevant hardware virtualization options are enabled in the system BIOS.

   The BIOS for each manufacturer is different. If you must enable virtualization in the BIOS, look for an option containing the words `virtualization`, `VT`, `VMX`, or `SVM`.

2. To list the loaded kernel modules and verify that the `kvm` modules are loaded, run this command:

   ```
   # lsmod | grep kvm
   ```

   If the output includes `kvm_intel` or `kvm_amd`, the `kvm` hardware virtualization modules are loaded and your kernel meets the module requirements for OpenStack Compute.

   If the output does not show that the `kvm` module is loaded, run this command to load it:

   ```
   # modprobe -a kvm
   ```

   Run the command for your CPU. For Intel, run this command:

   ```
   # modprobe -a kvm-intel
   ```

   For AMD, run this command:

   ```
   # modprobe -a kvm-amd
   ```

   Because a KVM installation can change user group membership, you might need to log in again for changes to take effect.

   If the kernel modules do not load automatically, use the procedures listed in these subsections.

If the checks indicate that required hardware virtualization support or kernel modules are disabled or unavailable, you must either enable this support on the system or find a system with this support.

Note

Some systems require that you enable VT support in the system BIOS. If you believe your processor supports hardware acceleration but the previous command did not produce output, reboot your machine, enter the system BIOS, and enable the VT option.

If KVM acceleration is not supported, configure Compute to use a different hypervisor, such as *QEMU*.

These procedures help you load the kernel modules for Intel-based and AMD-based processors if they do not load automatically during KVM installation.

Intel-based processors

If your compute host is Intel-based, run these commands as root to load the kernel modules:

```
# modprobe kvm
# modprobe kvm-intel
```

Add these lines to the `/etc/modules` file so that these modules load on reboot:

```
kvm
kvm-intel
```

AMD-based processors

If your compute host is AMD-based, run these commands as root to load the kernel modules:

```
# modprobe kvm
# modprobe kvm-amd
```

Add these lines to `/etc/modules` file so that these modules load on reboot:

```
kvm
kvm-amd
```

For POWER-based systems

KVM as a hypervisor is supported on POWER systems PowerNV platform.

1. To determine if your POWER platform supports KVM based virtualization run the following command:

   ```
   # cat /proc/cpuinfo | grep PowerNV
   ```

   If the previous command generates the following output, then CPU supports KVM based virtualization.

   ```
   platform: PowerNV
   ```

   If no output is displayed, then your POWER platform does not support KVM based hardware virtualization.

2. To list the loaded kernel modules and verify that the `kvm` modules are loaded, run the following command:

   ```
   # lsmod | grep kvm
   ```

   If the output includes `kvm_hv`, the `kvm` hardware virtualization modules are loaded and your kernel meets the module requirements for OpenStack Compute.

   If the output does not show that the `kvm` module is loaded, run the following command to load it:

   ```
   # modprobe -a kvm
   ```

   For PowerNV platform, run the following command:

```
# modprobe -a kvm-hv
```

Because a KVM installation can change user group membership, you might need to log in again for changes to take effect.

For AArch64-based systems

Todo

Populate this section.

Configure Compute backing storage

Backing Storage is the storage used to provide the expanded operating system image, and any ephemeral storage. Inside the virtual machine, this is normally presented as two virtual hard disks (for example, `/dev/vda` and `/dev/vdb` respectively). However, inside OpenStack, this can be derived from one of these methods: `lvm`, `qcow`, `rbd` or `flat`, chosen using the *`libvirt.images_type`* option in `nova.conf` on the compute node.

Note

The option `raw` is acceptable but deprecated in favor of `flat`. The Flat back end uses either raw or QCOW2 storage. It never uses a backing store, so when using QCOW2 it copies an image rather than creating an overlay. By default, it creates raw files but will use QCOW2 when creating a disk from a QCOW2 if *`force_raw_images`* is not set in configuration.

QCOW is the default backing store. It uses a copy-on-write philosophy to delay allocation of storage until it is actually needed. This means that the space required for the backing of an image can be significantly less on the real disk than what seems available in the virtual machine operating system.

Flat creates files without any sort of file formatting, effectively creating files with the plain binary one would normally see on a real disk. This can increase performance, but means that the entire size of the virtual disk is reserved on the physical disk.

Local LVM volumes can also be used. Set the *`libvirt.images_volume_group`* configuration option to the name of the LVM group you have created.

Direct download of images from Ceph

When the Glance image service is set up with the Ceph backend and Nova is using a local ephemeral store (`[libvirt]/images_type!=rbd`), it is possible to configure Nova to download images directly into the local compute image cache.

With the following configuration, images are downloaded using the RBD export command instead of using the Glance HTTP API. In some situations, especially for very large images, this could be substantially faster and can improve the boot times of instances.

On the Glance API node in `glance-api.conf`:

```
[DEFAULT]
show_image_direct_url=true
```

On the Nova compute node in nova.conf:

```
[glance]
enable_rbd_download=true
rbd_user=glance
rbd_pool=images
rbd_ceph_conf=/etc/ceph/ceph.conf
rbd_connect_timeout=5
```

Nested guest support

You may choose to enable support for nested guests that is, allow your Nova instances to themselves run hardware-accelerated virtual machines with KVM. Doing so requires a module parameter on your KVM kernel module, and corresponding `nova.conf` settings.

Host configuration

To enable nested KVM guests, your compute node must load the `kvm_intel` or `kvm_amd` module with `nested=1`. You can enable the `nested` parameter permanently, by creating a file named `/etc/modprobe.d/kvm.conf` and populating it with the following content:

```
options kvm_intel nested=1
options kvm_amd nested=1
```

A reboot may be required for the change to become effective.

Nova configuration

To support nested guests, you must set your *`libvirt.cpu_mode`* configuration to one of the following options:

Host passthrough (`host-passthrough`)
: In this mode, nested virtualization is automatically enabled once the KVM kernel module is loaded with nesting support.

  ```
  [libvirt]
  cpu_mode = host-passthrough
  ```

  However, do consider the other implications that *host passthrough* mode has on compute functionality.

Host model (`host-model`)
: In this mode, nested virtualization is automatically enabled once the KVM kernel module is loaded with nesting support, **if** the matching CPU model exposes the `vmx` feature flag to guests by default (you can verify this with `virsh capabilities` on your compute node). If your CPU model does not pass in the `vmx` flag, you can force it with *`libvirt.cpu_model_extra_flags`*:

  ```
  [libvirt]
  cpu_mode = host-model
  cpu_model_extra_flags = vmx
  ```

  Again, consider the other implications that apply to the *host model* mode.

Custom (`custom`)

In custom mode, the same considerations apply as in host-model mode, but you may *additionally* want to ensure that libvirt passes not only the `vmx`, but also the `pcid` flag to its guests:

```
[libvirt]
cpu_mode = custom
cpu_models = IvyBridge
cpu_model_extra_flags = vmx,pcid
```

More information on CPU models can be found in *CPU models*.

Limitations

When enabling nested guests, you should be aware of (and inform your users about) certain limitations that are currently inherent to nested KVM virtualization. Most importantly, guests using nested virtualization will, *while nested guests are running*,

- fail to complete live migration;
- fail to resume from suspend.

See the KVM documentation for more information on these limitations.

KVM performance tweaks

The VHostNet kernel module improves network performance. To load the kernel module, run the following command as root:

```
# modprobe vhost_net
```

Troubleshooting

Trying to launch a new virtual machine instance fails with the `ERROR` state, and the following error appears in the `/var/log/nova/nova-compute.log` file:

```
libvirtError: internal error no supported architecture for os type 'hvm'
```

This message indicates that the KVM kernel modules were not loaded.

If you cannot start VMs after installation without rebooting, the permissions might not be set correctly. This can happen if you load the KVM module before you install `nova-compute`. To check whether the group is set to `kvm`, run:

```
# ls -l /dev/kvm
```

If it is not set to `kvm`, run:

```
# udevadm trigger
```

QEMU

From the perspective of the Compute service, the QEMU hypervisor is very similar to the KVM hypervisor. Both are controlled through libvirt, both support the same feature set, and all virtual machine images that are compatible with KVM are also compatible with QEMU. The main difference is that QEMU does

not support native virtualization. Consequently, QEMU has worse performance than KVM and is a poor choice for a production deployment.

The typical uses cases for QEMU are

- Running on older hardware that lacks virtualization support.
- Running the Compute service inside of a virtual machine for development or testing purposes, where the hypervisor does not support native virtualization for guests.

Configuration

To enable QEMU, configure *DEFAULT.compute_driver* = `libvirt.LibvirtDriver` and *libvirt.virt_type* = `qemu`. For example:

```
[DEFAULT]
compute_driver = libvirt.LibvirtDriver

[libvirt]
virt_type = qemu
```

For some operations you may also have to install the **`guestmount`** utility:

On Ubuntu:

```
# apt-get install guestmount
```

On Red Hat Enterprise Linux, Fedora, or CentOS:

```
# dnf install libguestfs-tools
```

On openSUSE:

```
# zypper install guestfs-tools
```

The QEMU hypervisor supports the following virtual machine image formats:

- Raw
- QEMU Copy-on-write (qcow2)
- VMware virtual machine disk format (vmdk)

LXC (Linux containers)

LXC (also known as Linux containers) is a virtualization technology that works at the operating system level. This is different from hardware virtualization, the approach used by other hypervisors such as KVM, Xen, and VMware. LXC (as currently implemented using libvirt in the Compute service) is not a secure virtualization technology for multi-tenant environments (specifically, containers may affect resource quotas for other containers hosted on the same machine). Additional containment technologies, such as AppArmor, may be used to provide better isolation between containers, although this is not the case by default. For all these reasons, the choice of this virtualization technology is not recommended in production.

If your compute hosts do not have hardware support for virtualization, LXC will likely provide better performance than QEMU. In addition, if your guests must access specialized hardware, such as GPUs, this might be easier to achieve with LXC than other hypervisors.

Note

Some OpenStack Compute features might be missing when running with LXC as the hypervisor. See the hypervisor support matrix for details.

Configuration

To enable LXC, configure *DEFAULT.compute_driver* = libvirt.LibvirtDriver and *libvirt.virt_type* = lxc. For example:

```
[DEFAULT]
compute_driver = libvirt.LibvirtDriver

[libvirt]
virt_type = lxc
```

On Ubuntu, enable LXC support in OpenStack by installing the nova-compute-lxc package.

VMware vSphere

Introduction

OpenStack Compute supports the VMware vSphere product family and enables access to advanced features such as vMotion, High Availability, and Dynamic Resource Scheduling (DRS).

This section describes how to configure VMware-based virtual machine images for launch. The VMware driver supports vCenter version 5.5.0 and later.

The VMware vCenter driver enables the nova-compute service to communicate with a VMware vCenter server that manages one or more ESX host clusters. The driver aggregates the ESX hosts in each cluster to present one large hypervisor entity for each cluster to the Compute scheduler. Because individual ESX hosts are not exposed to the scheduler, Compute schedules to the granularity of clusters and vCenter uses DRS to select the actual ESX host within the cluster. When a virtual machine makes its way into a vCenter cluster, it can use all vSphere features.

The following sections describe how to configure the VMware vCenter driver.

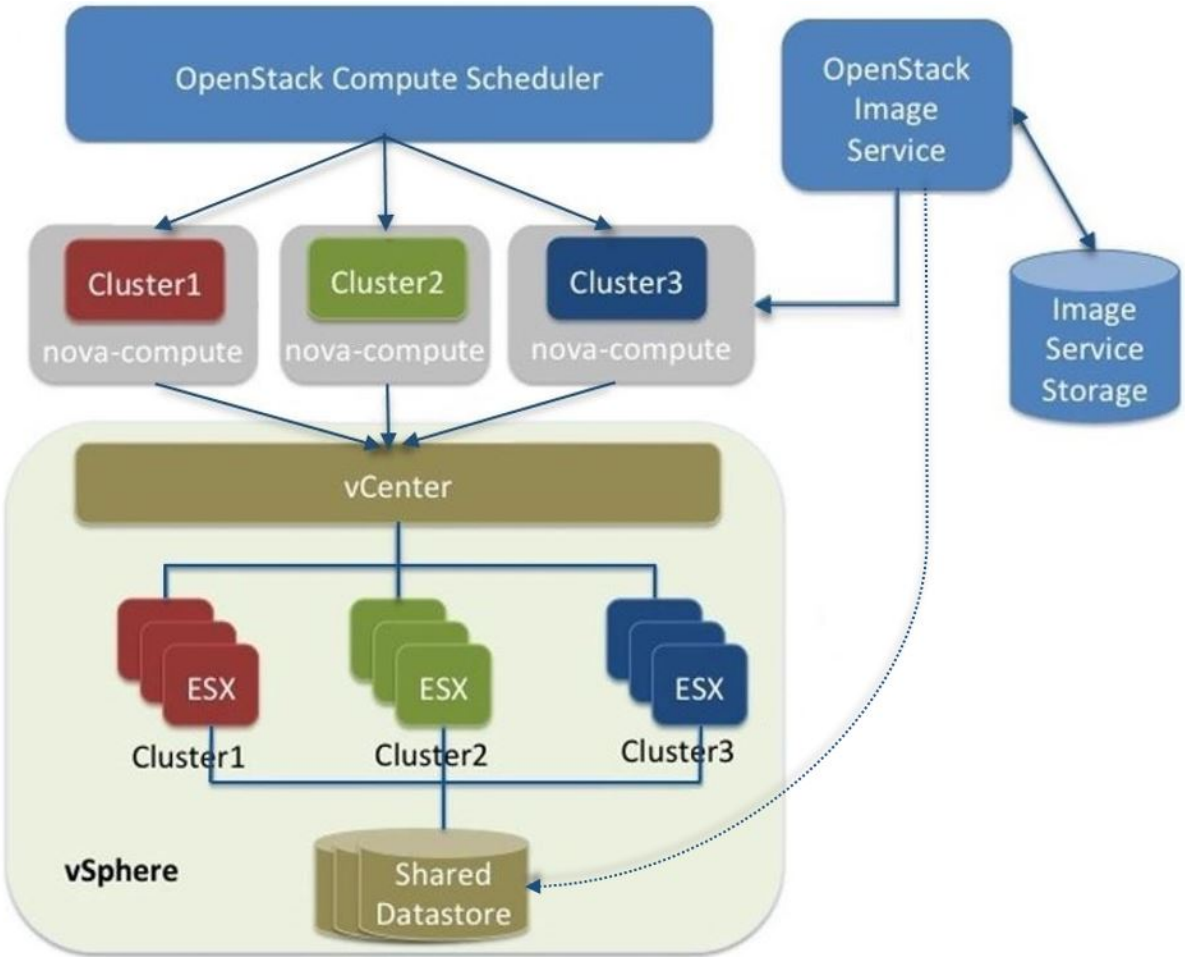
High-level architecture

The following diagram shows a high-level view of the VMware driver architecture:

VMware driver architecture

As the figure shows, the OpenStack Compute Scheduler sees three hypervisors that each correspond to a cluster in vCenter. nova-compute contains the VMware driver. You can run with multiple nova-compute services. It is recommended to run with one nova-compute service per ESX cluster thus ensuring that while Compute schedules at the granularity of the nova-compute service it is also in effect able to schedule at the cluster level. In turn the VMware driver inside nova-compute interacts with the vCenter APIs to select an appropriate ESX host within the cluster. Internally, vCenter uses DRS for placement.

The VMware vCenter driver also interacts with the Image service to copy VMDK images from the Image service back-end store. The dotted line in the figure represents VMDK images being copied from the


OpenStack Compute Scheduler
OpenStack Image Service
Cluster1
nova-compute
Cluster2
nova-compute
Cluster3
nova-compute
Image Service Storage
vCenter
ESX
Cluster1
ESX
Cluster2
ESX
Cluster3
vSphere
Shared Datastore

OpenStack Image service to the vSphere data store. VMDK images are cached in the data store so the copy operation is only required the first time that the VMDK image is used.

After OpenStack boots a VM into a vSphere cluster, the VM becomes visible in vCenter and can access vSphere advanced features. At the same time, the VM is visible in the OpenStack dashboard and you can manage it as you would any other OpenStack VM. You can perform advanced vSphere operations in vCenter while you configure OpenStack resources such as VMs through the OpenStack dashboard.

The figure does not show how networking fits into the architecture. For details, see *Networking with VMware vSphere*.

Configuration overview

To get started with the VMware vCenter driver, complete the following high-level steps:

1. Configure vCenter. See *Prerequisites and limitations*.
2. Configure the VMware vCenter driver in the `nova.conf` file. See *VMware vCenter driver*.
3. Load desired VMDK images into the Image service. See *Images with VMware vSphere*.
4. Configure the Networking service (neutron). See *Networking with VMware vSphere*.

Prerequisites and limitations

Use the following list to prepare a vSphere environment that runs with the VMware vCenter driver:

Copying VMDK files
: In vSphere 5.1, copying large image files (for example, 12 GB and greater) from the Image service can take a long time. To improve performance, VMware recommends that you upgrade to VMware vCenter Server 5.1 Update 1 or later. For more information, see the Release Notes.

DRS
: For any cluster that contains multiple ESX hosts, enable DRS and enable fully automated placement.

Shared storage
: Only shared storage is supported and data stores must be shared among all hosts in a cluster. It is recommended to remove data stores not intended for OpenStack from clusters being configured for OpenStack.

Clusters and data stores
: Do not use OpenStack clusters and data stores for other purposes. If you do, OpenStack displays incorrect usage information.

Networking
: The networking configuration depends on the desired networking model. See *Networking with VMware vSphere*.

Security groups
: If you use the VMware driver with OpenStack Networking and the NSX plug-in, security groups are supported.

> **Note**
>
> The NSX plug-in is the only plug-in that is validated for vSphere.

VNC

The port range 5900 - 6105 (inclusive) is automatically enabled for VNC connections on every ESX host in all clusters under OpenStack control.

> **Note**
>
> In addition to the default VNC port numbers (5900 to 6000) specified in the above document, the following ports are also used: 6101, 6102, and 6105.

You must modify the ESXi firewall configuration to allow the VNC ports. Additionally, for the firewall modifications to persist after a reboot, you must create a custom vSphere Installation Bundle (VIB) which is then installed onto the running ESXi host or added to a custom image profile used to install ESXi hosts. For details about how to create a VIB for persisting the firewall configuration modifications, see Knowledge Base.

> **Note**
>
> The VIB can be downloaded from openstack-vmwareapi-team/Tools.

To use multiple vCenter installations with OpenStack, each vCenter must be assigned to a separate availability zone. This is required as the OpenStack Block Storage VMDK driver does not currently work across multiple vCenter installations.

VMware vCenter service account

OpenStack integration requires a vCenter service account with the following minimum permissions. Apply the permissions to the `Datacenter` root object, and select the *Propagate to Child Objects* option.

Table 3: vCenter permissions tree

All Privileges			
	Datastore		
		Allocate space	
		Browse datastore	
		Low level file operation	
		Remove file	
	Extension		
		Register extension	
	Folder		
		Create folder	
	Host		
		Configuration	
			Maintenance
			Network configuration
			Storage partition configuration
	Network		
		Assign network	

continues on next page

Table 3 – continued from previous page

All Privileges			
	Resource		
		Assign virtual machine to resource pool	
		Migrate powered off virtual machine	
		Migrate powered on virtual machine	
	Virtual Machine		
		Configuration	
			Add existing disk
			Add new disk
			Add or remove device
			Advanced
			CPU count
			Change resource
			Disk change tracking
			Host USB device
			Memory
			Modify device settings
			Raw device
			Remove disk
			Rename
			Set annotation
			Swapfile placement
		Interaction	
			Configure CD media
			Power Off
			Power On
			Reset
			Suspend
		Inventory	
			Create from existing
			Create new
			Move
			Remove
			Unregister
		Provisioning	
			Clone virtual machine
			Customize
			Create template from virtual machine
		Snapshot management	
			Create snapshot
			Remove snapshot
	Profile-driven storage		
		Profile-driven storage view	

continues on next page

Table 3 – continued from previous page

All Privileges			
	Sessions		
			Validate session
			View and stop sessions
	vApp		
		Export	
		Import	

VMware vCenter driver

Use the VMware vCenter driver (VMwareVCDriver) to connect OpenStack Compute with vCenter. This recommended configuration enables access through vCenter to advanced vSphere features like vMotion, High Availability, and Dynamic Resource Scheduling (DRS).

VMwareVCDriver configuration options

Add the following VMware-specific configuration options to the `nova.conf` file:

```
[DEFAULT]
compute_driver = vmwareapi.VMwareVCDriver

[vmware]
host_ip = <vCenter hostname or IP address>
host_username = <vCenter username>
host_password = <vCenter password>
cluster_name = <vCenter cluster name>
datastore_regex = <optional datastore regex>
```

Note

- Clusters: The vCenter driver can support only a single cluster. Clusters and data stores used by the vCenter driver should not contain any VMs other than those created by the driver.
- Data stores: The `datastore_regex` setting specifies the data stores to use with Compute. For example, `datastore_regex="nas.*"` selects all the data stores that have a name starting with nas. If this line is omitted, Compute uses the first data store returned by the vSphere API. It is recommended not to use this field and instead remove data stores that are not intended for OpenStack.
- Reserved host memory: The `reserved_host_memory_mb` option value is 512 MB by default. However, VMware recommends that you set this option to 0 MB because the vCenter driver reports the effective memory available to the virtual machines.
- The vCenter driver generates instance name by instance ID. Instance name template is ignored.
- The minimum supported vCenter version is 5.5.0. Starting in the OpenStack Ocata release any version lower than 5.5.0 will be logged as a warning. In the OpenStack Pike release this will be enforced.

A `nova-compute` service can control one or more clusters containing multiple ESXi hosts, making

`nova-compute` a critical service from a high availability perspective. Because the host that runs `nova-compute` can fail while the vCenter and ESX still run, you must protect the `nova-compute` service against host failures.

Note

Many `nova.conf` options are relevant to libvirt but do not apply to this driver.

Images with VMware vSphere

The vCenter driver supports images in the VMDK format. Disks in this format can be obtained from VMware Fusion or from an ESX environment. It is also possible to convert other formats, such as qcow2, to the VMDK format using the `qemu-img` utility. After a VMDK disk is available, load it into the Image service. Then, you can use it with the VMware vCenter driver. The following sections provide additional details on the supported disks and the commands used for conversion and upload.

Supported image types

Upload images to the OpenStack Image service in VMDK format. The following VMDK disk types are supported:

- `VMFS Flat Disks` (includes thin, thick, zeroedthick, and eagerzeroedthick). Note that once a VMFS thin disk is exported from VMFS to a non-VMFS location, like the OpenStack Image service, it becomes a preallocated flat disk. This impacts the transfer time from the Image service to the data store when the full preallocated flat disk, rather than the thin disk, must be transferred.
- `Monolithic Sparse disks`. Sparse disks get imported from the Image service into ESXi as thin provisioned disks. Monolithic Sparse disks can be obtained from VMware Fusion or can be created by converting from other virtual disk formats using the `qemu-img` utility.
- `Stream-optimized disks`. Stream-optimized disks are compressed sparse disks. They can be obtained from VMware vCenter/ESXi when exporting vm to ovf/ova template.

The following table shows the `vmware_disktype` property that applies to each of the supported VMDK disk types:

Table 4: OpenStack Image service disk type settings

vmware_disktype property	VMDK disk type
sparse	Monolithic Sparse
thin	VMFS flat, thin provisioned
preallocated (default)	VMFS flat, thick/zeroedthick/eagerzeroedthick
streamOptimized	Compressed Sparse

The `vmware_disktype` property is set when an image is loaded into the Image service. For example, the following command creates a Monolithic Sparse image by setting `vmware_disktype` to `sparse`:

```
$ openstack image create \
  --disk-format vmdk \
  --container-format bare \
  --property vmware_disktype="sparse" \
```

(continues on next page)

(continued from previous page)

```
 --property vmware_ostype="ubuntu64Guest" \
 ubuntu-sparse < ubuntuLTS-sparse.vmdk
```

Note

Specifying `thin` does not provide any advantage over `preallocated` with the current version of the driver. Future versions might restore the thin properties of the disk after it is downloaded to a vSphere data store.

The following table shows the `vmware_ostype` property that applies to each of the supported guest OS:

Note

If a glance image has a `vmware_ostype` property which does not correspond to a valid VMware guestId, VM creation will fail, and a warning will be logged.

Table 5: OpenStack Image service OS type settings

vmware_ostype property	Retail Name
asianux3_64Guest	Asianux Server 3 (64 bit)
asianux3Guest	Asianux Server 3
asianux4_64Guest	Asianux Server 4 (64 bit)
asianux4Guest	Asianux Server 4
darwin64Guest	Darwin 64 bit
darwinGuest	Darwin
debian4_64Guest	Debian GNU/Linux 4 (64 bit)
debian4Guest	Debian GNU/Linux 4
debian5_64Guest	Debian GNU/Linux 5 (64 bit)
debian5Guest	Debian GNU/Linux 5
dosGuest	MS-DOS
freebsd64Guest	FreeBSD x64
freebsdGuest	FreeBSD
mandrivaGuest	Mandriva Linux
netware4Guest	Novell NetWare 4
netware5Guest	Novell NetWare 5.1
netware6Guest	Novell NetWare 6.x
nld9Guest	Novell Linux Desktop 9
oesGuest	Open Enterprise Server
openServer5Guest	SCO OpenServer 5
openServer6Guest	SCO OpenServer 6
opensuse64Guest	openSUSE (64 bit)
opensuseGuest	openSUSE
os2Guest	OS/2
other24xLinux64Guest	Linux 2.4x Kernel (64 bit) (experimental)
other24xLinuxGuest	Linux 2.4x Kernel
other26xLinux64Guest	Linux 2.6x Kernel (64 bit) (experimental)
other26xLinuxGuest	Linux 2.6x Kernel (experimental)

continues on next page

Table 5 – continued from previous page

vmware_ostype property	Retail Name
otherGuest	Other Operating System
otherGuest64	Other Operating System (64 bit) (experimental)
otherLinux64Guest	Linux (64 bit) (experimental)
otherLinuxGuest	Other Linux
redhatGuest	Red Hat Linux 2.1
rhel2Guest	Red Hat Enterprise Linux 2
rhel3_64Guest	Red Hat Enterprise Linux 3 (64 bit)
rhel3Guest	Red Hat Enterprise Linux 3
rhel4_64Guest	Red Hat Enterprise Linux 4 (64 bit)
rhel4Guest	Red Hat Enterprise Linux 4
rhel5_64Guest	Red Hat Enterprise Linux 5 (64 bit) (experimental)
rhel5Guest	Red Hat Enterprise Linux 5
rhel6_64Guest	Red Hat Enterprise Linux 6 (64 bit)
rhel6Guest	Red Hat Enterprise Linux 6
sjdsGuest	Sun Java Desktop System
sles10_64Guest	SUSE Linux Enterprise Server 10 (64 bit) (experimental)
sles10Guest	SUSE Linux Enterprise Server 10
sles11_64Guest	SUSE Linux Enterprise Server 11 (64 bit)
sles11Guest	SUSE Linux Enterprise Server 11
sles64Guest	SUSE Linux Enterprise Server 9 (64 bit)
slesGuest	SUSE Linux Enterprise Server 9
solaris10_64Guest	Solaris 10 (64 bit) (experimental)
solaris10Guest	Solaris 10 (32 bit) (experimental)
solaris6Guest	Solaris 6
solaris7Guest	Solaris 7
solaris8Guest	Solaris 8
solaris9Guest	Solaris 9
suse64Guest	SUSE Linux (64 bit)
suseGuest	SUSE Linux
turboLinux64Guest	Turbolinux (64 bit)
turboLinuxGuest	Turbolinux
ubuntu64Guest	Ubuntu Linux (64 bit)
ubuntuGuest	Ubuntu Linux
unixWare7Guest	SCO UnixWare 7
win2000AdvServGuest	Windows 2000 Advanced Server
win2000ProGuest	Windows 2000 Professional
win2000ServGuest	Windows 2000 Server
win31Guest	Windows 3.1
win95Guest	Windows 95
win98Guest	Windows 98
windows7_64Guest	Windows 7 (64 bit)
windows7Guest	Windows 7
windows7Server64Guest	Windows Server 2008 R2 (64 bit)
winLonghorn64Guest	Windows Longhorn (64 bit) (experimental)
winLonghornGuest	Windows Longhorn (experimental)
winMeGuest	Windows Millennium Edition
winNetBusinessGuest	Windows Small Business Server 2003
winNetDatacenter64Guest	Windows Server 2003, Datacenter Edition (64 bit) (experimental)

continues on next page

Table 5 – continued from previous page

vmware_ostype property	Retail Name
winNetDatacenterGuest	Windows Server 2003, Datacenter Edition
winNetEnterprise64Guest	Windows Server 2003, Enterprise Edition (64 bit)
winNetEnterpriseGuest	Windows Server 2003, Enterprise Edition
winNetStandard64Guest	Windows Server 2003, Standard Edition (64 bit)
winNetEnterpriseGuest	Windows Server 2003, Enterprise Edition
winNetStandard64Guest	Windows Server 2003, Standard Edition (64 bit)
winNetStandardGuest	Windows Server 2003, Standard Edition
winNetWebGuest	Windows Server 2003, Web Edition
winNTGuest	Windows NT 4
winVista64Guest	Windows Vista (64 bit)
winVistaGuest	Windows Vista
winXPHomeGuest	Windows XP Home Edition
winXPPro64Guest	Windows XP Professional Edition (64 bit)
winXPProGuest	Windows XP Professional

Convert and load images

Using the `qemu-img` utility, disk images in several formats (such as, qcow2) can be converted to the VMDK format.

For example, the following command can be used to convert a qcow2 Ubuntu Trusty cloud image:

```
$ qemu-img convert -f qcow2 ~/Downloads/trusty-server-cloudimg-amd64-disk1.
↪img \
  -O vmdk trusty-server-cloudimg-amd64-disk1.vmdk
```

VMDK disks converted through `qemu-img` are `always` monolithic sparse VMDK disks with an IDE adapter type. Using the previous example of the Ubuntu Trusty image after the `qemu-img` conversion, the command to upload the VMDK disk should be something like:

```
$ openstack image create \
  --container-format bare --disk-format vmdk \
  --property vmware_disktype="sparse" \
  --property vmware_adaptertype="ide" \
  trusty-cloud < trusty-server-cloudimg-amd64-disk1.vmdk
```

Note that the `vmware_disktype` is set to `sparse` and the `vmware_adaptertype` is set to `ide` in the previous command.

If the image did not come from the `qemu-img` utility, the `vmware_disktype` and `vmware_adaptertype` might be different. To determine the image adapter type from an image file, use the following command and look for the `ddb.adapterType=` line:

```
$ head -20 <vmdk file name>
```

Assuming a preallocated disk type and an iSCSI lsiLogic adapter type, the following command uploads the VMDK disk:

```
$ openstack image create \
  --disk-format vmdk \
```

(continues on next page)

(continued from previous page)

```
  --container-format bare \
  --property vmware_adaptertype="lsiLogic" \
  --property vmware_disktype="preallocated" \
  --property vmware_ostype="ubuntu64Guest" \
  ubuntu-thick-scsi < ubuntuLTS-flat.vmdk
```

Currently, OS boot VMDK disks with an IDE adapter type cannot be attached to a virtual SCSI controller and likewise disks with one of the SCSI adapter types (such as, busLogic, lsiLogic, lsiLogicsas, paraVirtual) cannot be attached to the IDE controller. Therefore, as the previous examples show, it is important to set the `vmware_adaptertype` property correctly. The default adapter type is lsiLogic, which is SCSI, so you can omit the `vmware_adaptertype` property if you are certain that the image adapter type is lsiLogic.

Tag VMware images

In a mixed hypervisor environment, OpenStack Compute uses the `hypervisor_type` tag to match images to the correct hypervisor type. For VMware images, set the hypervisor type to `vmware`. Other valid hypervisor types include: `ironic`, `lxc`, and `qemu`. Note that `qemu` is used for both QEMU and KVM hypervisor types.

```
$ openstack image create \
  --disk-format vmdk \
  --container-format bare \
  --property vmware_adaptertype="lsiLogic" \
  --property vmware_disktype="preallocated" \
  --property hypervisor_type="vmware" \
  --property vmware_ostype="ubuntu64Guest" \
  ubuntu-thick-scsi < ubuntuLTS-flat.vmdk
```

Optimize images

Monolithic Sparse disks are considerably faster to download but have the overhead of an additional conversion step. When imported into ESX, sparse disks get converted to VMFS flat thin provisioned disks. The download and conversion steps only affect the first launched instance that uses the sparse disk image. The converted disk image is cached, so subsequent instances that use this disk image can simply use the cached version.

To avoid the conversion step (at the cost of longer download times) consider converting sparse disks to thin provisioned or preallocated disks before loading them into the Image service.

Use one of the following tools to pre-convert sparse disks.

vSphere CLI tools

Sometimes called the remote CLI or rCLI.

Assuming that the sparse disk is made available on a data store accessible by an ESX host, the following command converts it to preallocated format:

```
vmkfstools --server=ip_of_some_ESX_host -i \
  /vmfs/volumes/datastore1/sparse.vmdk \
  /vmfs/volumes/datastore1/converted.vmdk
```

Note that the vifs tool from the same CLI package can be used to upload the disk to be converted. The vifs tool can also be used to download the converted disk if necessary.

vmkfstools directly on the ESX host
If the SSH service is enabled on an ESX host, the sparse disk can be uploaded to the ESX data store through scp and the vmkfstools local to the ESX host can use used to perform the conversion. After you log in to the host through ssh, run this command:

```
vmkfstools -i /vmfs/volumes/datastore1/sparse.vmdk /vmfs/volumes/
↪datastore1/converted.vmdk
```

vmware-vdiskmanager
`vmware-vdiskmanager` is a utility that comes bundled with VMware Fusion and VMware Workstation. The following example converts a sparse disk to preallocated format:

```
'/Applications/VMware Fusion.app/Contents/Library/vmware-vdiskmanager' -r␣
↪sparse.vmdk -t 4 converted.vmdk
```

In the previous cases, the converted vmdk is actually a pair of files:

- The descriptor file `converted.vmdk`.
- The actual virtual disk data file `converted-flat.vmdk`.

The file to be uploaded to the Image service is `converted-flat.vmdk`.

Image handling

The ESX hypervisor requires a copy of the VMDK file in order to boot up a virtual machine. As a result, the vCenter OpenStack Compute driver must download the VMDK via HTTP from the Image service to a data store that is visible to the hypervisor. To optimize this process, the first time a VMDK file is used, it gets cached in the data store. A cached image is stored in a folder named after the image ID. Subsequent virtual machines that need the VMDK use the cached version and dont have to copy the file again from the Image service.

Even with a cached VMDK, there is still a copy operation from the cache location to the hypervisor file directory in the shared data store. To avoid this copy, boot the image in linked_clone mode. To learn how to enable this mode, see *vmware.use_linked_clone*.

Note

You can also use the `img_linked_clone` property (or legacy property `vmware_linked_clone`) in the Image service to override the linked_clone mode on a per-image basis.

If spawning a virtual machine image from ISO with a VMDK disk, the image is created and attached to the virtual machine as a blank disk. In that case `img_linked_clone` property for the image is just ignored.

If multiple compute nodes are running on the same host, or have a shared file system, you can enable them to use the same cache folder on the back-end data store. To configure this action, set the `cache_prefix` option in the `nova.conf` file. Its value stands for the name prefix of the folder where cached images are stored.

Note

This can take effect only if compute nodes are running on the same host, or have a shared file system.

You can automatically purge unused images after a specified period of time. To configure this action, set these options in the *image_cache* section in the `nova.conf` file:

- *image_cache.remove_unused_base_images*
- *image_cache.remove_unused_original_minimum_age_seconds*

Networking with VMware vSphere

The VMware driver supports networking with the Networking Service (neutron). Depending on your installation, complete these configuration steps before you provision VMs:

1. Before provisioning VMs, create a port group with the same name as the `vmware.integration_bridge` value in `nova.conf` (default is `br-int`). All VM NICs are attached to this port group for management by the OpenStack Networking plug-in.

Volumes with VMware vSphere

The VMware driver supports attaching volumes from the Block Storage service. The VMware VMDK driver for OpenStack Block Storage is recommended and should be used for managing volumes based on vSphere data stores. For more information about the VMware VMDK driver, see Cinders manual on the VMDK Driver (TODO: this has not yet been imported and published). Also an iSCSI volume driver provides limited support and can be used only for attachments.

Troubleshooting

Operators can troubleshoot VMware specific failures by correlating OpenStack logs to vCenter logs. Every RPC call which is made by an OpenStack driver has an `opID` which can be traced in the vCenter logs. For example consider the following excerpt from a `nova-compute` log:

```
Aug 15 07:31:09 localhost nova-compute[16683]: DEBUG oslo_vmware.service [-]␣
↪Invoking Folder.CreateVM_Task with opID=oslo.vmware-debb6064-690e-45ac-b0ae-
↪1b94a9638d1f {{(pid=16683) request_handler /opt/stack/oslo.vmware/oslo_
↪vmware/service.py:355}}
```

In this case the `opID` is `oslo.vmware-debb6064-690e-45ac-b0ae-1b94a9638d1f` and we can grep the vCenter log (usually `/var/log/vmware/vpxd/vpxd.log`) for it to find if anything went wrong with the `CreateVM` operation.

Virtuozzo

Virtuozzo 7.0.0 (or newer), or its community edition OpenVZ, provides both types of virtualization: Kernel Virtual Machines and OS Containers. The type of instance to span is chosen depending on the `hw_vm_type` property of an image.

Note

Some OpenStack Compute features may be missing when running with Virtuozzo as the hypervisor. See *Feature Support Matrix* for details.

Configuration

To enable LXC, configure *DEFAULT.compute_driver* = `libvirt.LibvirtDriver` and *libvirt.virt_type* = `parallels`. For example:

```
[DEFAULT]
compute_driver = libvirt.LibvirtDriver
force_raw_images = False

[libvirt]
virt_type = parallels
images_type = ploop
connection_uri = parallels:///system
inject_partition = -2
```

To enable Virtuozzo Virtual Machines, set the following options in `/etc/nova/nova.conf` on all hosts running the `nova-compute` service.

```
[DEFAULT]
compute_driver = libvirt.LibvirtDriver

[libvirt]
virt_type = parallels
images_type = qcow2
connection_uri = parallels:///system
```

zVM

z/VM System Requirements

- The appropriate APARs installed, the current list of which can be found: z/VM OpenStack Cloud Information (http://www.vm.ibm.com/sysman/osmntlvl.html).

Note

IBM z Systems hardware requirements are based on both the applications and the load on the system.

Active Engine Guide

Active engine is used as an initial configuration and management tool during deployed machine startup. Currently the z/VM driver uses `zvmguestconfigure` and `cloud-init` as a two stage active engine.

Installation and Configuration of zvmguestconfigure

Cloudlib4zvm supports initiating changes to a Linux on z Systems virtual machine while Linux is shut down or the virtual machine is logged off. The changes to Linux are implemented using an activation engine (AE) that is run when Linux is booted the next time. The first active engine, `zvmguestconfigure`, must be installed in the Linux on z Systems virtual server so it can process change request files transmitted by the cloudlib4zvm service to the reader of the virtual machine as a class X file.

Note

An additional activation engine, cloud-init, should be installed to handle OpenStack related tailoring of the system. The cloud-init AE relies on tailoring performed by `zvmguestconfigure`.

Installation and Configuration of cloud-init

OpenStack uses cloud-init as its activation engine. Some Linux distributions include cloud-init either already installed or available to be installed. If your distribution does not include cloud-init, you can download the code from https://launchpad.net/cloud-init/+download. After installation, if you issue the following shell command and no errors occur, cloud-init is installed correctly:

```
cloud-init init --local
```

Installation and configuration of cloud-init differs among different Linux distributions, and cloud-init source code may change. This section provides general information, but you may have to tailor cloud-init to meet the needs of your Linux distribution. You can find a community-maintained list of dependencies at http://ibm.biz/cloudinitLoZ.

As of the Rocky release, the z/VM OpenStack support has been tested with cloud-init 0.7.4 and 0.7.5 for RHEL6.x and SLES11.x, 0.7.6 for RHEL7.x and SLES12.x, and 0.7.8 for Ubuntu 16.04.

During cloud-init installation, some dependency packages may be required. You can use zypper and python setuptools to easily resolve these dependencies. See https://pypi.python.org/pypi/setuptools for more information.

Image guide

This guideline will describe the requirements and steps to create and configure images for use with z/VM.

Image Requirements

- The following Linux distributions are supported for deploy:
  - RHEL 6.2, 6.3, 6.4, 6.5, 6.6, and 6.7
  - RHEL 7.0, 7.1 and 7.2
  - SLES 11.2, 11.3, and 11.4
  - SLES 12 and SLES 12.1
  - Ubuntu 16.04
- A supported root disk type for snapshot/spawn. The following are supported:
  - FBA

  - ECKD

- An image deployed on a compute node must match the disk type supported by that compute node, as configured by the `zvm_diskpool_type` property in the zvmsdk.conf configuration file in zvm cloud connector A compute node supports deployment on either an ECKD or FBA image, but not both at the same time. If you wish to switch image types, you need to change the `zvm_diskpool_type` and `zvm_diskpool` properties in the zvmsdk.conf file, accordingly. Then restart the nova-compute service to make the changes take effect.
- If you deploy an instance with an ephemeral disk, both the root disk and the ephemeral disk will be created with the disk type that was specified by `zvm_diskpool_type` property in the zvmsdk.conf file. That property can specify either ECKD or FBA.
- The network interfaces must be IPv4 interfaces.
- Image names should be restricted to the UTF-8 subset, which corresponds to the ASCII character set. In addition, special characters such as `/`, `\`, `$`, `%`, `@` should not be used. For the FBA disk type vm, capture and deploy is supported only for an FBA disk with a single partition. Capture and deploy is not supported for the FBA disk type vm on a CMS formatted FBA disk.
- The virtual server/Linux instance used as the source of the new image should meet the following criteria:

  1. The root filesystem must not be on a logical volume.
  2. The minidisk on which the root filesystem resides should be a minidisk of the same type as desired for a subsequent deploy (for example, an ECKD disk image should be captured for a subsequent deploy to an ECKD disk).
  3. The minidisks should not be a full-pack minidisk, since cylinder 0 on full-pack minidisks is reserved, and should be defined with virtual address 0100.
  4. The root disk should have a single partition.
  5. The image being captured should not have any network interface cards (NICs) defined below virtual address 1100.

In addition to the specified criteria, the following recommendations allow for efficient use of the image:

- The minidisk on which the root filesystem resides should be defined as a multiple of full gigabytes in size (for example, 1GB or 2GB). OpenStack specifies disk sizes in full gigabyte values, whereas z/VM handles disk sizes in other ways (cylinders for ECKD disks, blocks for FBA disks, and so on). See the appropriate online information if you need to convert cylinders or blocks to gigabytes; for example: http://www.mvsforums.com/helpboards/viewtopic.php?t=8316.
- During subsequent deploys of the image, the OpenStack code will ensure that a disk image is not copied to a disk smaller than the source disk, as this would result in loss of data. The disk specified in the flavor should therefore be equal to or slightly larger than the source virtual machines root disk.

Ironic

Introduction

The ironic hypervisor driver wraps the Bare Metal (ironic) API, enabling Nova to provision baremetal resources using the same user-facing API as for server management.

This is the only driver in nova where one compute service can map to many hosts, meaning a `nova-compute` service can manage multiple `ComputeNodes`. An ironic driver managed compute ser-

vice uses the ironic `node uuid` for the compute node `hypervisor_hostname` (nodename) and `uuid` fields. The relationship of `instance:compute node:ironic node` is 1:1:1.

Scheduling of bare metal nodes is based on custom resource classes, specified via the `resource_class` property on a node and a corresponding resource property on a flavor (see the flavor documentation). The RAM and CPU settings on a flavor are ignored, and the disk is only used to determine the root partition size when a partition image is used (see the image documentation).

Configuration

- Configure the Compute service to use the Bare Metal service.
- Create flavors for use with the Bare Metal service.
- Conductors Groups.

Scaling and performance issues

- It is typical for a single nova-compute process to support several hundred Ironic nodes. There are known issues when you attempt to support more than 1000 Ironic nodes associated with a single nova-compute process, even though Ironic is able to scale out a single conductor group to much larger sizes. There are many other factors that can affect what is the maximum practical size of a conductor group within your deployment.
- The `update_available_resource` periodic task reports all the resources managed by Ironic. Depending the number of nodes, it can take a lot of time. The nova-compute will not perform any other operations when this task is running. You can use conductor groups to help shard your deployment between multiple nova-compute processes by setting *`ironic.conductor_group`*.
- The nova-compute process using the Ironic driver can be moved between different physical servers using active/passive failover. But when doing this failover, you must ensure *`host`* is the same no matter where the nova-compute process is running. Similarly you must ensure there are at most one nova-compute processes running for each conductor group.
- Running multiple nova-compute processes that point at the same conductor group is now deprecated. Please never have more than one host in the peer list: *`ironic.peer_list`*

Known limitations / Missing features

- Migrate
- Resize
- Snapshot
- Pause
- Shelve
- Evacuate

OpenStack Compute supports many hypervisors, which might make it difficult for you to choose one. Most installations use only one hypervisor. However, you can use *ComputeFilter* and *ImageProperties-Filter* to schedule different hypervisors within the same installation. The following links help you choose a hypervisor. See *Feature Support Matrix* for a detailed list of features and support across the hypervisors.

The following hypervisors are supported:

- KVM - Kernel-based Virtual Machine. The virtual disk formats that it supports is inherited from QEMU since it uses a modified QEMU program to launch the virtual machine. The supported formats include raw images, the qcow2, and VMware formats.
- LXC - Linux Containers (through libvirt), used to run Linux-based virtual machines.
- QEMU - Quick EMUlator, generally only used for development purposes.
- VMware vSphere 5.1.0 and newer - Runs VMware-based Linux and Windows images through a connection with a vCenter server.
- Virtuozzo 7.0.0 and newer - OS Containers and Kernel-based Virtual Machines supported. The supported formats include ploop and qcow2 images.
- zVM - Server virtualization on z Systems and IBM LinuxONE, it can run Linux, z/OS and more.
- Ironic - OpenStack project which provisions bare metal (as opposed to virtual) machines.

Nova supports hypervisors via virt drivers. Nova has the following in tree virt drivers:

- *compute_driver* = `libvirt.LibvirtDriver`

  This driver runs on Linux and supports multiple hypervisor backends, which can be configured via the *libvirt.virt_type* config option.
- *compute_driver* = `ironic.IronicDriver`
- *compute_driver* = `vmwareapi.VMwareVCDriver`
- *compute_driver* = `zvm.ZVMDriver`
- *compute_driver* = `fake.FakeDriver`

  This driver does not spawn any virtual machines and therefore should only be used during testing.

Compute log files

The corresponding log file of each Compute service is stored in the `/var/log/nova/` directory of the host on which each service runs.

Table 6: Log files used by Compute services

Log file	Service name (CentOS/Fedora/openSUSE/Red Hat Enterprise Linux/SUSE Linux Enterprise)	Service name (Ubuntu/Debian)
`nova-api.log`	`openstack-nova-api`	`nova-api`
`nova-compute.log`	`openstack-nova-compute`	`nova-compute`
`nova-conductor.log`	`openstack-nova-conductor`	`nova-conductor`
`nova-manage.log`	`nova-manage`	`nova-manage`
`nova-scheduler.log`	`openstack-nova-scheduler`	`nova-scheduler`

Compute service sample configuration files

Files in this section can be found in `/etc/nova`.

api-paste.ini

The Compute service stores its API configuration settings in the `api-paste.ini` file.

```
############
# Metadata #
############
[composite:metadata]
use = egg:Paste#urlmap
/: meta

[pipeline:meta]
pipeline = cors http_proxy_to_wsgi metaapp

[app:metaapp]
paste.app_factory = nova.api.metadata.handler:MetadataRequestHandler.factory

##############
# OpenStack #
##############

[composite:osapi_compute]
use = call:nova.api.openstack.urlmap:urlmap_factory
/: oscomputeversions
/v2: oscomputeversion_legacy_v2
/v2.1: oscomputeversion_v2
# v21 is an exactly feature match for v2, except it has more stringent
# input validation on the wsgi surface (prevents fuzzing early on the
# API). It also provides new features via API microversions which are
# opt into for clients. Unaware clients will receive the same frozen
# v2 API feature set, but with some relaxed validation
/v2/+: openstack_compute_api_v21_legacy_v2_compatible
/v2.1/+: openstack_compute_api_v21

[composite:openstack_compute_api_v21]
use = call:nova.api.auth:pipeline_factory_v21
keystone = cors http_proxy_to_wsgi compute_req_id faultwrap request_log␣
↪sizelimit osprofiler authtoken keystonecontext osapi_compute_app_v21

[composite:openstack_compute_api_v21_legacy_v2_compatible]
use = call:nova.api.auth:pipeline_factory_v21
keystone = cors http_proxy_to_wsgi compute_req_id faultwrap request_log␣
↪sizelimit osprofiler authtoken keystonecontext legacy_v2_compatible osapi_
↪compute_app_v21

[filter:request_log]
paste.filter_factory = nova.api.openstack.requestlog:RequestLog.factory

[filter:compute_req_id]
paste.filter_factory = nova.api.compute_req_id:ComputeReqIdMiddleware.factory
```

(continues on next page)

(continued from previous page)

```
[filter:faultwrap]
paste.filter_factory = nova.api.openstack:FaultWrapper.factory

[filter:osprofiler]
paste.filter_factory = nova.profiler:WsgiMiddleware.factory

[filter:sizelimit]
paste.filter_factory = oslo_middleware:RequestBodySizeLimiter.factory

[filter:http_proxy_to_wsgi]
paste.filter_factory = oslo_middleware.http_proxy_to_wsgi:HTTPProxyToWSGI.
↪factory

[filter:legacy_v2_compatible]
paste.filter_factory = nova.api.openstack:LegacyV2CompatibleWrapper.factory

[app:osapi_compute_app_v21]
paste.app_factory = nova.api.openstack.compute:APIRouterV21.factory

[pipeline:oscomputeversions]
pipeline = cors faultwrap request_log http_proxy_to_wsgi oscomputeversionapp

[pipeline:oscomputeversion_v2]
pipeline = cors compute_req_id faultwrap request_log http_proxy_to_wsgi␣
↪oscomputeversionapp_v2

[pipeline:oscomputeversion_legacy_v2]
pipeline = cors compute_req_id faultwrap request_log http_proxy_to_wsgi␣
↪legacy_v2_compatible oscomputeversionapp_v2

[app:oscomputeversionapp]
paste.app_factory = nova.api.openstack.compute.versions:Versions.factory

[app:oscomputeversionapp_v2]
paste.app_factory = nova.api.openstack.compute.versions:VersionsV2.factory

##########
# Shared #
##########

[filter:cors]
paste.filter_factory = oslo_middleware.cors:filter_factory
oslo_config_project = nova

[filter:keystonecontext]
paste.filter_factory = nova.api.auth:NovaKeystoneContext.factory

[filter:authtoken]
paste.filter_factory = keystonemiddleware.auth_token:filter_factory
```

rootwrap.conf

The `rootwrap.conf` file defines configuration values used by the rootwrap script when the Compute service needs to escalate its privileges to those of the root user.

It is also possible to disable the root wrapper, and default to sudo only. Configure the `disable_rootwrap` option in the `[workaround]` section of the `nova.conf` configuration file.

```
# Configuration for nova-rootwrap
# This file should be owned by (and only-writeable by) the root user

[DEFAULT]
# List of directories to load filter definitions from (separated by ',').
# These directories MUST all be only writeable by root !
filters_path=/etc/nova/rootwrap.d,/usr/share/nova/rootwrap

# List of directories to search executables in, in case filters do not
# explicitly specify a full path (separated by ',')
# If not specified, defaults to system PATH environment variable.
# These directories MUST all be only writeable by root !
exec_dirs=/sbin,/usr/sbin,/bin,/usr/bin,/usr/local/sbin,/usr/local/bin

# Enable logging to syslog
# Default value is False
use_syslog=False

# Which syslog facility to use.
# Valid values include auth, authpriv, syslog, local0, local1...
# Default value is 'syslog'
syslog_log_facility=syslog

# Which messages to log.
# INFO means log all usage
# ERROR means only log unsuccessful attempts
syslog_log_level=ERROR

# Rootwrap daemon exits after this seconds of inactivity
daemon_timeout=600

# Rootwrap daemon limits itself to that many file descriptors (Linux only)
rlimit_nofile=1024
```

Nova service concurrency

For a long time nova services relied almost exclusively on the Eventlet library for processing multiple API requests, RPC requests and other tasks that needed concurrency. Since Eventlet is not expected to support the next major cPython version the OpenStack TC set a goal to replace Eventlet and therefore Nova has started transitioning its concurrency model to native threads. During this transition Nova maintains the Eventlet based concurrency mode while building up support for the native threading mode.

Note

The native threading mode is experimental. Do not use it in production without first testing it in pre-production. If you do so please let us now how it went on the mailing list openstack-discuss@lists.openstack.org.

Selecting concurrency mode for a service

Since nova 33.0.0 (2026.1 Gazpacho) the nova-scheduler, nova-api, and nova-metadata are using native threading by default. The rest of the services are using eventlet by default in this release. The concurrency mode can be configured per service via setting the environment variable `OS_NOVA_DISABLE_EVENTLET_PATCHING`. Setting that variable to `true` requests the native threading mode while setting it to `false` requests the eventlet mode. If the variable is not set the above default is applied.

Note

Since nova 32.0.0 (2025.2 Flamingo) the nova-scheduler, nova-metadata, and nova-api can be switched to native threading mode.

Since nova 33.0.0 (2026.1 Gazpacho) also the nova-conductor can be switched to native threading mode.

Since nova 33.0.0 (2026.1. Gazpacho) the nova-scheduler, nova-metadata, and nova-api using native threading mode by default but still can be switched back to eventlet if needed.

Tunables for the native threading mode

As native threads are more expensive resources than greenthreads Nova provides a set of configuration options to allow fine tuning the deployment based on load and resource constraints. The default values are selected to support a basic, small deployment without consuming substantially more memory resources, than the legacy Eventlet mode. Increasing the size of the below thread pools means that the given service will consume more memory but will also allow more tasks to be executed concurrently.

- *`cell_worker_thread_pool_size`*: Used to execute tasks across all the cells within the deployment.

  E.g. To generate the result of the `openstack server list` CLI command, the nova-api service will use one native thread for each cell to load the nova instances from the related cell database.

  So if the deployment has many cells then the size of this pool probably needs to be increased.

  This option is only relevant for nova-api, nova-metadata, nova-scheduler, and nova-conductor as these are the services doing cross cell operations.

- *`executor_thread_pool_size`*: Used to handle incoming RPC requests. Services with many more inbound requests will need larger pools. For example, a single conductor serves requests from many computes as well as the scheduler. A compute node only serves requests from the API for lifecycle operations and other computes during migrations.

  This option is only relevant for nova-scheduler, nova-conductor, and nova-compute as these are the services acting as RPC servers.

- *default_thread_pool_size*: Used by various concurrent tasks in the service that are not categorized into the above pools.

  This option is relevant to every nova service using `nova.utils.spawn()`.

- *sync_power_state_pool_size*: Used by the nova-compute service to sync the power state of each instance on the host between the hypervisor and the DB. Since nova 33.0.0 (2026.1 Gazpacho) the default value of this option is changed from 1000 to 5 to have a sane default in native threading mode. Increasing this value in native threading mode increases the nova-compute memory consumption on a host that has many instances.

- *max_concurrent_live_migrations*: Used by the nova-compute service to limit the number of outgoing concurrent live migrations from the host. It is implemented via a thread pool. So increasing the the number of concurrent live migrations will increase the nova-compute service memory consumption in native threading mode. It is almost always a bad idea to use change this config option from its default value, 1. If more performant live migration is needed then enable *libvirt.live_migration_parallel_connections* instead.

Seeing the usage of the pools

When new work is submitted to any of these pools in both concurrency modes Nova logs the statistics of the pool (work executed, threads available, work queued, etc). This can be useful when fine tuning of the pool size is needed. The parameter *thread_pool_statistic_period* defines how frequently such logging happens from a specific pool in seconds. A value of 60 seconds means that stats will be logged from a pool maximum once every 60 seconds. The value 0 means that logging happens every time work is submitted to the pool. The default value is -1 meaning that the stats logging is disabled.

Preventing hanging threads

Threads from a pool are not cancellable once they are executing a task, therefore it is important to ensure external dependencies cannot hold up a task execution indefinitely as that will lead to having fewer threads in the pool available for incoming work and therefore reduced overall capacity.

Novas RPC interface already uses proper timeout handling to avoid hanging threads. But adding timeout handling to the Novas database interface is database server and database client library dependent.

For mysql-server the max_execution_time configuration option can be used to limit the execution time of a database query on the server side. Similar options exist for other database servers.

For the pymysql database client a client side timeout can be implemented by adding the read_timeout connection parameter to the connection string.

We recommend using both in deployments where Nova services are running in native threading mode.

Upgrading to nova 33.0.0 (2026.1. Gazpacho) or newer

In nova 33.0.0 (2026.1. Gazpacho) the default concurrency mode of nova-scheduler, nova-api, and nova-metadata service are switched to native threading. We recommend to decouple the upgrade from the concurrency mode change to reduce the risk of issues. To do that either test and tune the native threading mode of these services already in 2025.2 (Flamingo) or ensure that your service configuration is explicitly using the eventlet mode before you upgrade and only change to threading mode after the upgrade was successful.

3.4.1.3 Basic configuration

Once you have an OpenStack deployment up and running, you will want to manage it. The below guides cover everything from creating initial flavor and image to log management and live migration of instances.

- *Quotas*: Managing project quotas in nova.
- *Scheduling*: How the scheduler is configured, and how that will impact where compute instances land in your environment. If you are seeing unexpected distribution of compute instances in your hosts, youll want to dive into this configuration.
- *Exposing custom metadata to compute instances*: How and when you might want to extend the basic metadata exposed to compute instances (either via metadata server or config drive) for your specific purposes.

Manage the cloud

Show usage statistics for hosts and instances

You can show basic statistics on resource usage for hosts and instances.

Note

For more sophisticated monitoring, see the Ceilometer project. You can also use tools, such as Ganglia or Graphite, to gather more detailed data.

Show host usage statistics

The following examples show the host usage statistics for a host called `devstack`.

- List the hosts and the nova-related services that run on them:

```
$ openstack host list
+-----------+-------------+----------+
| Host Name | Service     | Zone     |
+-----------+-------------+----------+
| devstack  | conductor   | internal |
| devstack  | compute     | nova     |
| devstack  | network     | internal |
| devstack  | scheduler   | internal |
+-----------+-------------+----------+
```

- Get a summary of resource usage of all of the instances running on the host:

```
$ openstack host show devstack
+----------+----------------------------------+-----+-----------+---------
↪+
| Host     | Project                          | CPU | MEMORY MB | DISK GB␣
↪|
+----------+----------------------------------+-----+-----------+---------
↪+
| devstack | (total)                          | 2   | 4003      | 157     ␣
↪|
```

(continues on next page)

(continued from previous page)

```
| devstack | (used_now)                          | 3   | 5120      | 40      ␣
↪|
| devstack | (used_max)                          | 3   | 4608      | 40      ␣
↪|
| devstack | b70d90d65e464582b6b2161cf3603ced | 1   | 512       | 0       ␣
↪|
| devstack | 66265572db174a7aa66eba661f58eb9e | 2   | 4096      | 40      ␣
↪|
+----------+----------------------------------+-----+-----------+---------
↪+
```

The `CPU` column shows the sum of the virtual CPUs for instances running on the host.

The `MEMORY MB` column shows the sum of the memory (in MB) allocated to the instances that run on the host.

The `DISK GB` column shows the sum of the root and ephemeral disk sizes (in GB) of the instances that run on the host.

The row that has the value `used_now` in the `PROJECT` column shows the sum of the resources allocated to the instances that run on the host, plus the resources allocated to the host itself.

The row that has the value `used_max` in the `PROJECT` column shows the sum of the resources allocated to the instances that run on the host.

Note

These values are computed by using information about the flavors of the instances that run on the hosts. This command does not query the CPU usage, memory usage, or hard disk usage of the physical host.

Show instance usage statistics

- Get CPU, memory, I/O, and network statistics for an instance.

  1. List instances:

```
$ openstack server list
+----------+----------------------+--------+------------------+------
↪--+----------+
| ID       | Name                 | Status | Networks         |␣
↪Image  | Flavor   |
+----------+----------------------+--------+------------------+------
↪--+----------+
| 84c6e... | myCirrosServer       | ACTIVE | private=10.0.0.3 |␣
↪cirros | m1.tiny  |
| 8a995... | myInstanceFromVolume | ACTIVE | private=10.0.0.4 |␣
↪ubuntu | m1.small |
+----------+----------------------+--------+------------------+------
↪--+----------+
```

  2. Get diagnostic statistics:

Note

As of microversion v2.48, diagnostics information for all virt drivers will have a standard format as below. Before microversion 2.48, each hypervisor had its own format. For more details on diagnostics response message see server diagnostics api documentation.

```
$ nova diagnostics myCirrosServer
+----------------+-------------------------------------------------------
↪---------------------+
| Property       | Value                                                 ␣
↪                    |
+----------------+-------------------------------------------------------
↪---------------------+
| config_drive   | False                                                 ␣
↪                    |
| cpu_details    | []                                                    ␣
↪                    |
| disk_details   | [{"read_requests": 887, "errors_count": -1, "read_
↪bytes": 20273152,    |
|                | "write_requests": 89, "write_bytes": 303104}]         ␣
↪                    |
| driver         | libvirt                                               ␣
↪                    |
| hypervisor     | qemu                                                  ␣
↪                    |
| hypervisor_os  | linux                                                 ␣
↪                    |
| memory_details | {"used": 0, "maximum": 0}                             ␣
↪                    |
| nic_details    | [{"rx_packets": 9, "rx_drop": 0, "tx_octets":␣
↪1464, "tx_errors": 0,    |
|                | "mac_address": "fa:16:3e:fa:db:d3", "rx_octets":␣
↪958, "rx_rate": null, |
|                | "rx_errors": 0, "tx_drop": 0, "tx_packets": 9,
↪"tx_rate": null}]       |
| num_cpus       | 0                                                     ␣
↪                    |
| num_disks      | 1                                                     ␣
↪                    |
| num_nics       | 1                                                     ␣
↪                    |
| state          | running                                               ␣
↪                    |
| uptime         | 5528                                                  ␣
↪                    |
+----------------+-------------------------------------------------------
↪---------------------+
```

`config_drive` indicates if the config drive is supported on the instance.

`cpu_details` contains a list of details per vCPU.

`disk_details` contains a list of details per disk.

`driver` indicates the current driver on which the VM is running.

`hypervisor` indicates the current hypervisor on which the VM is running.

`nic_details` contains a list of details per vNIC.

`uptime` is the amount of time in seconds that the VM has been running.

Diagnostics prior to v2.48:

```
$ nova diagnostics myCirrosServer
+----------------------------+--------+
| Property                   | Value  |
+----------------------------+--------+
| memory                     | 524288 |
| memory-actual              | 524288 |
| memory-rss                 | 6444   |
| tap1fec8fb8-7a_rx          | 22137  |
| tap1fec8fb8-7a_rx_drop     | 0      |
| tap1fec8fb8-7a_rx_errors   | 0      |
| tap1fec8fb8-7a_rx_packets  | 166    |
| tap1fec8fb8-7a_tx          | 18032  |
| tap1fec8fb8-7a_tx_drop     | 0      |
| tap1fec8fb8-7a_tx_errors   | 0      |
| tap1fec8fb8-7a_tx_packets  | 130    |
| vda_errors                 | -1     |
| vda_read                   | 2048   |
| vda_read_req               | 2      |
| vda_write                  | 182272 |
| vda_write_req              | 74     |
+----------------------------+--------+
```

- Get summary statistics for each project:

```
$ openstack usage list
Usage from 2013-06-25 to 2013-07-24:
+---------+---------+--------------+-----------+---------------+
| Project | Servers | RAM MB-Hours | CPU Hours | Disk GB-Hours |
+---------+---------+--------------+-----------+---------------+
| demo    | 1       | 344064.44    | 672.00    | 0.00          |
| stack   | 3       | 671626.76    | 327.94    | 6558.86       |
+---------+---------+--------------+-----------+---------------+
```

System administrators can use the **`openstack`** to manage their clouds.

The `openstack` client can be used by all users, though specific commands might be restricted by the Identity service.

Managing the cloud with the openstack client

1. The `python-openstackclient` package provides an `openstack` shell that enables Compute API interactions from the command line. Install the client, and provide your user name and password (which can be set as environment variables for convenience), for the ability to administer the cloud from the command line.

   For more information on `python-openstackclient`, refer to the documentation.

2. Confirm the installation was successful:

```
$ openstack help
usage: openstack [--version] [-v | -q] [--log-file LOG_FILE] [-h] [--
↪debug]
           [--os-cloud <cloud-config-name>]
           [--os-region-name <auth-region-name>]
           [--os-cacert <ca-bundle-file>] [--verify | --insecure]
           [--os-default-domain <auth-domain>]
           ...
```

   Running **`openstack help`** returns a list of `openstack` commands and parameters. To get help for a subcommand, run:

```
$ openstack help SUBCOMMAND
```

   For a complete list of `openstack` commands and parameters, refer to the OpenStack Command-Line Reference.

3. Set the required parameters as environment variables to make running commands easier. For example, you can add `--os-username` as an `openstack` option, or set it as an environment variable. To set the user name, password, and project as environment variables, use:

```
$ export OS_USERNAME=joecool
$ export OS_PASSWORD=coolword
$ export OS_TENANT_NAME=coolu
```

4. The Identity service gives you an authentication endpoint, which Compute recognizes as `OS_AUTH_URL`:

```
$ export OS_AUTH_URL=http://hostname:5000/v2.0
```

Manage Compute services

You can enable and disable Compute services. The following examples disable and enable the `nova-compute` service.

1. List the Compute services:

```
$ openstack compute service list
+----+----------------+------------+----------+---------+-------+---------
↪-------------------+
| ID | Binary         | Host       | Zone     | Status  | State | Updated␣
↪At                 |
+----+----------------+------------+----------+---------+-------+---------
↪-------------------+
```

(continues on next page)

(continued from previous page)

```
|  4 | nova-scheduler | controller | internal | enabled | up    | 2016-12-
↪20T00:44:48.000000 |
|  5 | nova-conductor | controller | internal | enabled | up    | 2016-12-
↪20T00:44:54.000000 |
|  8 | nova-compute   | compute    | nova     | enabled | up    | 2016-10-
↪21T02:35:03.000000 |
+----+----------------+------------+----------+---------+-------+---------
↪-------------------+
```

2. Disable a nova service:

```
$ openstack compute service set --disable --disable-reason "trial log"␣
↪compute nova-compute
+----------+--------------+----------+-------------------+
| Host     | Binary       | Status   | Disabled Reason   |
+----------+--------------+----------+-------------------+
| compute  | nova-compute | disabled | trial log         |
+----------+--------------+----------+-------------------+
```

3. Check the service list:

```
$ openstack compute service list
+----+----------------+------------+----------+---------+-------+---------
↪-------------------+
| ID | Binary         | Host       | Zone     | Status  | State | Updated␣
↪At                 |
+----+----------------+------------+----------+---------+-------+---------
↪-------------------+
|  5 | nova-scheduler | controller | internal | enabled | up    | 2016-12-
↪20T00:44:48.000000 |
|  6 | nova-conductor | controller | internal | enabled | up    | 2016-12-
↪20T00:44:54.000000 |
|  9 | nova-compute   | compute    | nova     | disabled| up    | 2016-10-
↪21T02:35:03.000000 |
+----+----------------+------------+----------+---------+-------+---------
↪-------------------+
```

4. Enable the service:

```
$ openstack compute service set --enable compute nova-compute
+----------+--------------+---------+
| Host     | Binary       | Status  |
+----------+--------------+---------+
| compute  | nova-compute | enabled |
+----------+--------------+---------+
```

Configure Compute service groups

The Compute service must know the status of each compute node to effectively manage and use them. This can include events like a user launching a new VM, the scheduler sending a request to a live node, or a query to the ServiceGroup API to determine if a node is live.

When a compute worker running the nova-compute daemon starts, it calls the join API to join the compute group. Any service (such as the scheduler) can query the groups membership and the status of its nodes. Internally, the ServiceGroup client driver automatically updates the compute worker status.

Database ServiceGroup driver

By default, Compute uses the database driver to track if a node is live. In a compute worker, this driver periodically sends a `db update` command to the database, saying Im OK with a timestamp. Compute uses a pre-defined timeout (`service_down_time`) to determine if a node is dead.

The driver has limitations, which can be problematic depending on your environment. If a lot of compute worker nodes need to be checked, the database can be put under heavy load, which can cause the timeout to trigger, and a live node could incorrectly be considered dead. By default, the timeout is 60 seconds. Reducing the timeout value can help in this situation, but you must also make the database update more frequently, which again increases the database workload.

The database contains data that is both transient (such as whether the node is alive) and persistent (such as entries for VM owners). With the ServiceGroup abstraction, Compute can treat each type separately.

Memcache ServiceGroup driver

The memcache ServiceGroup driver uses memcached, a distributed memory object caching system that is used to increase site performance. For more details, see memcached.org.

To use the memcache driver, you must install memcached. You might already have it installed, as the same driver is also used for the OpenStack Object Storage and OpenStack dashboard. To install memcached, see the *Environment -> Memcached* section in the Installation Tutorials and Guides depending on your distribution.

These values in the `/etc/nova/nova.conf` file are required on every node for the memcache driver:

```
# Driver for the ServiceGroup service
servicegroup_driver = "mc"

# Memcached servers. Use either a list of memcached servers to use for␣
↪caching (list value),
# or "<None>" for in-process caching (default).
memcached_servers = <None>

# Timeout; maximum time since last check-in for up service (integer value).
# Helps to define whether a node is dead
service_down_time = 60
```

Logging

Logging module

Logging behavior can be changed by creating a configuration file. To specify the configuration file, add this line to the `/etc/nova/nova.conf` file:

```
log_config_append=/etc/nova/logging.conf
```

To change the logging level, add `DEBUG`, `INFO`, `WARNING`, or `ERROR` as a parameter.

The logging configuration file is an INI-style configuration file, which must contain a section called `logger_nova`. This controls the behavior of the logging facility in the `nova-*` services. For example:

```
[logger_nova]
level = INFO
handlers = stderr
qualname = nova
```

This example sets the debugging level to `INFO` (which is less verbose than the default `DEBUG` setting).

For more about the logging configuration syntax, including the `handlers` and `qualname` variables, see the Python documentation on logging configuration files.

For an example of the `logging.conf` file with various defined handlers, see the Example Configuration File for nova.

Syslog

OpenStack Compute services can send logging information to syslog. This is useful if you want to use rsyslog to forward logs to a remote machine. Separately configure the Compute service (nova), the Identity service (keystone), the Image service (glance), and, if you are using it, the Block Storage service (cinder) to send log messages to syslog. Open these configuration files:

- `/etc/nova/nova.conf`
- `/etc/keystone/keystone.conf`
- `/etc/glance/glance-api.conf`
- `/etc/glance/glance-registry.conf`
- `/etc/cinder/cinder.conf`

In each configuration file, add these lines:

```
debug = False
use_syslog = True
syslog_log_facility = LOG_LOCAL0
```

In addition to enabling syslog, these settings also turn off debugging output from the log.

> **Note**
>
> Although this example uses the same local facility for each service (`LOG_LOCAL0`, which corresponds to syslog facility `LOCAL0`), we recommend that you configure a separate local facility for each service,

as this provides better isolation and more flexibility. For example, you can capture logging information at different severity levels for different services. syslog allows you to define up to eight local facilities, `LOCAL0, LOCAL1, ..., LOCAL7`. For more information, see the syslog documentation.

Rsyslog

rsyslog is useful for setting up a centralized log server across multiple machines. This section briefly describe the configuration to set up an rsyslog server. A full treatment of rsyslog is beyond the scope of this book. This section assumes rsyslog has already been installed on your hosts (it is installed by default on most Linux distributions).

This example provides a minimal configuration for `/etc/rsyslog.conf` on the log server host, which receives the log files

```
# provides TCP syslog reception
$ModLoad imtcp
$InputTCPServerRun 1024
```

Add a filter rule to `/etc/rsyslog.conf` which looks for a host name. This example uses COMPUTE_01 as the compute host name:

```
:hostname, isequal, "COMPUTE_01" /mnt/rsyslog/logs/compute-01.log
```

On each compute host, create a file named `/etc/rsyslog.d/60-nova.conf`, with the following content:

```
# prevent debug from dnsmasq with the daemon.none parameter
*.*;auth,authpriv.none,daemon.none,local0.none -/var/log/syslog
# Specify a log level of ERROR
local0.error    @@172.20.1.43:1024
```

Once you have created the file, restart the `rsyslog` service. Error-level log messages on the compute hosts should now be sent to the log server.

Serial console

The serial console provides a way to examine kernel output and other system messages during troubleshooting if the instance lacks network connectivity.

Read-only access from server serial console is possible using the `os-GetSerialOutput` server action. Most cloud images enable this feature by default. For more information, see *Common errors and fixes for Compute*.

OpenStack Juno and later supports read-write access using the serial console using the `os-GetSerialConsole` server action. This feature also requires a websocket client to access the serial console.

Configuring read-write serial console access

1. On a compute node, edit the `/etc/nova/nova.conf` file:

   In the `[serial_console]` section, enable the serial console:

```
[serial_console]
# ...
enabled = true
```

2. In the `[serial_console]` section, configure the serial console proxy similar to graphical console proxies:

```
[serial_console]
# ...
base_url = ws://controller:6083/
listen = 0.0.0.0
proxyclient_address = MANAGEMENT_INTERFACE_IP_ADDRESS
```

The `base_url` option specifies the base URL that clients receive from the API upon requesting a serial console. Typically, this refers to the host name of the controller node.

The `listen` option specifies the network interface nova-compute should listen on for virtual console connections. Typically, 0.0.0.0 will enable listening on all interfaces.

The `proxyclient_address` option specifies which network interface the proxy should connect to. Typically, this refers to the IP address of the management interface.

When you enable read-write serial console access, Compute will add serial console information to the Libvirt XML file for the instance. For example:

```
<console type='tcp'>
  <source mode='bind' host='127.0.0.1' service='10000'/>
  <protocol type='raw'/>
  <target type='serial' port='0'/>
  <alias name='serial0'/>
</console>
```

Accessing the serial console on an instance

1. Use the **`nova get-serial-console`** command to retrieve the websocket URL for the serial console on the instance:

```
$ nova get-serial-console INSTANCE_NAME
```

Or use the **`openstack console url show`** command.

```
$ openstack console url show --serial INSTANCE_NAME
```

Type	Url
serial	ws://127.0.0.1:6083/?token=18510769-71ad-4e5a-8348-4218b5613b3d

Alternatively, use the API directly:

```
$ curl -i 'http://<controller>:8774/v2.1/<tenant_uuid>/servers/<instance_
↪uuid>/action' \
  -X POST \
```

(continues on next page)

(continued from previous page)

```
  -H "Accept: application/json" \
  -H "Content-Type: application/json" \
  -H "X-Auth-Project-Id: <project_id>" \
  -H "X-Auth-Token: <auth_token>" \
  -d '{"os-getSerialConsole": {"type": "serial"}}'
```

2. Use Python websocket with the URL to generate `.send`, `.recv`, and `.fileno` methods for serial console access. For example:

```
import websocket
ws = websocket.create_connection(
    'ws://127.0.0.1:6083/?token=18510769-71ad-4e5a-8348-4218b5613b3d',
    subprotocols=['binary', 'base64'])
```

Alternatively, use a Python websocket client.

Note

When you enable the serial console, typical instance logging using the **`nova console-log`** command is disabled. Kernel output and other system messages will not be visible unless you are actively viewing the serial console.

Secure with rootwrap

Rootwrap allows unprivileged users to safely run Compute actions as the root user. Compute previously used **`sudo`** for this purpose, but this was difficult to maintain, and did not allow advanced filters. The **`rootwrap`** command replaces **`sudo`** for Compute.

To use rootwrap, prefix the Compute command with **`nova-rootwrap`**. For example:

```
$ sudo nova-rootwrap /etc/nova/rootwrap.conf command
```

A generic `sudoers` entry lets the Compute user run **`nova-rootwrap`** as root. The **`nova-rootwrap`** code looks for filter definition directories in its configuration file, and loads command filters from them. It then checks if the command requested by Compute matches one of those filters and, if so, executes the command (as root). If no filter matches, it denies the request.

Note

Be aware of issues with using NFS and root-owned files. The NFS share must be configured with the `no_root_squash` option enabled, in order for rootwrap to work correctly.

Rootwrap is fully controlled by the root user. The root user owns the sudoers entry which allows Compute to run a specific rootwrap executable as root, and only with a specific configuration file (which should also be owned by root). The **`nova-rootwrap`** command imports the Python modules it needs from a cleaned, system-default PYTHONPATH. The root-owned configuration file points to root-owned filter definition directories, which contain root-owned filters definition files. This chain ensures that the Compute user itself is not in control of the configuration or modules used by the **`nova-rootwrap`** executable.

Configure rootwrap

Configure rootwrap in the `rootwrap.conf` file. Because it is in the trusted security path, it must be owned and writable by only the root user. The `rootwrap_config=entry` parameter specifies the files location in the sudoers entry and in the `nova.conf` configuration file.

The `rootwrap.conf` file uses an INI file format with these sections and parameters:

Table 7: **rootwrap.conf configuration options**

Configuration option=Default value	(Type) Description
[DEFAULT] filters_path=/etc/nova/rootwrap.d,/usr/share/nova/rootw	(ListOpt) Comma-separated list of directories containing filter definition files. Defines where rootwrap filters are stored. Directories defined on this line should all exist, and be owned and writable only by the root user.

If the root wrapper is not performing correctly, you can add a workaround option into the `nova.conf` configuration file. This workaround re-configures the root wrapper configuration to fall back to running commands as `sudo`, and is a Kilo release feature.

Including this workaround in your configuration file safeguards your environment from issues that can impair root wrapper performance. Tool changes that have impacted Python Build Reasonableness (PBR) for example, are a known issue that affects root wrapper performance.

To set up this workaround, configure the `disable_rootwrap` option in the `[workaround]` section of the `nova.conf` configuration file.

The filters definition files contain lists of filters that rootwrap will use to allow or deny a specific command. They are generally suffixed by `.filters` . Since they are in the trusted security path, they need to be owned and writable only by the root user. Their location is specified in the `rootwrap.conf` file.

Filter definition files use an INI file format with a `[Filters]` section and several lines, each with a unique parameter name, which should be different for each filter you define:

Table 8: **Filters configuration options**

Configuration option=Default value	(Type) Description
[Filters] filter_name=kpartx: CommandFilter, /sbin/kpartx, root	(ListOpt) Comma-separated list containing the filter class to use, followed by the Filter arguments (which vary depending on the Filter class selected).

Configure the rootwrap daemon

Administrators can use rootwrap daemon support instead of running rootwrap with **sudo**. The rootwrap daemon reduces the overhead and performance loss that results from running `oslo.rootwrap` with **sudo**. Each call that needs rootwrap privileges requires a new instance of rootwrap. The daemon prevents overhead from the repeated calls. The daemon does not support long running processes, however.

To enable the rootwrap daemon, set `use_rootwrap_daemon` to `True` in the Compute service configuration file.

Configure SSH between compute nodes

Todo

Consider merging this into a larger migration document or to the installation guide

If you are resizing or migrating an instance between hypervisors, you might encounter an SSH (Permission denied) error. Ensure that each node is configured with SSH key authentication so that the Compute service can use SSH to move disks to other nodes.

Note

It is not necessary that all the compute nodes share the same key pair. However for the ease of the configuration, this document only utilizes a single key pair for communication between compute nodes.

To share a key pair between compute nodes, complete the following steps:

1. On the first node, obtain a key pair (public key and private key). Use the root key that is in the `/root/.ssh/id_rsa` and `/root/.ssh/id_rsa.pub` directories or generate a new key pair.
2. Run **`setenforce 0`** to put SELinux into permissive mode.
3. Enable login abilities for the nova user:

   ```
   # usermod -s /bin/bash nova
   ```

   Ensure you can switch to the nova account:

   ```
   # su - nova
   ```

4. As root, create the folder that is needed by SSH and place the private key that you obtained in step 1 into this folder, and add the pub key to the authorized_keys file:

   ```
   mkdir -p /var/lib/nova/.ssh
   cp <private key>  /var/lib/nova/.ssh/id_rsa
   echo 'StrictHostKeyChecking no' >> /var/lib/nova/.ssh/config
   chmod 600 /var/lib/nova/.ssh/id_rsa /var/lib/nova/.ssh/authorized_keys
   echo <pub key> >> /var/lib/nova/.ssh/authorized_keys
   ```

5. Copy the whole folder created in step 4 to the rest of the nodes:

   ```
   # scp -r /var/lib/nova/.ssh remote-host:/var/lib/nova/
   ```

6. Ensure that the nova user can now log in to each node without using a password:

   ```
   # su - nova
   $ ssh *computeNodeAddress*
   $ exit
   ```

7. As root on each node, restart both libvirt and the Compute services:

```
# systemctl restart libvirtd.service
# systemctl restart openstack-nova-compute.service
```

Configure live migrations

Migration enables an administrator to move a virtual machine instance from one compute host to another. A typical scenario is planned maintenance on the source host, but migration can also be useful to redistribute the load when many VM instances are running on a specific physical machine.

This document covers live migrations using the *Libvirt* and VMWare hypervisors

Note

Not all Compute service hypervisor drivers support live-migration, or support all live-migration features. Similarly not all compute service features are supported.

Consult *Feature Support Matrix* to determine which hypervisors support live-migration.

See the *Configuration Guide* for details on hypervisor configuration settings.

The migration types are:

- **Non-live migration**, also known as cold migration or simply migration.

  The instance is shut down, then moved to another hypervisor and restarted. The instance recognizes that it was rebooted, and the application running on the instance is disrupted.

  This section does not cover cold migration.

- **Live migration**

  The instance keeps running throughout the migration. This is useful when it is not possible or desirable to stop the application running on the instance.

  Live migrations can be classified further by the way they treat instance storage:

  - **Shared storage-based live migration**. The instance has ephemeral disks that are located on storage shared between the source and destination hosts.
  - **Block live migration**, or simply block migration. The instance has ephemeral disks that are not shared between the source and destination hosts. Block migration is incompatible with read-only devices such as CD-ROMs and Configuration Drive (config_drive).
  - **Volume-backed live migration**. Instances use volumes rather than ephemeral disks.

  Block live migration requires copying disks from the source to the destination host. It takes more time and puts more load on the network. Shared-storage and volume-backed live migration does not copy disks.

Note

In a multi-cell cloud, instances can be live migrated to a different host in the same cell, but not across cells. Refer to the *cells v2 documentation*. for more information.

The following sections describe how to configure your hosts for live migrations using the libvirt virt driver and KVM hypervisor.

Libvirt

General configuration

To enable any type of live migration, configure the compute hosts according to the instructions below:

1. Set the following parameters in `nova.conf` on all compute hosts:

   - `server_listen=0.0.0.0`

     You must not make the VNC server listen to the IP address of its compute host, since that addresses changes when the instance is migrated.

     Important

     Since this setting allows VNC clients from any IP address to connect to instance consoles, you must take additional measures like secure networks or firewalls to prevent potential attackers from gaining access to instances.

   - `instances_path` must have the same value for all compute hosts. In this guide, the value `/var/lib/nova/instances` is assumed.

2. Ensure that name resolution on all compute hosts is identical, so that they can connect each other through their hostnames.

   If you use `/etc/hosts` for name resolution and enable SELinux, ensure that `/etc/hosts` has the correct SELinux context:

   ```
   # restorecon /etc/hosts
   ```

3. Enable password-less SSH so that root on one compute host can log on to any other compute host without providing a password. The `libvirtd` daemon, which runs as root, uses the SSH protocol to copy the instance to the destination and cant know the passwords of all compute hosts.

   You may, for example, compile roots public SSH keys on all compute hosts into an `authorized_keys` file and deploy that file to the compute hosts.

4. Configure the firewalls to allow libvirt to communicate between compute hosts.

   By default, libvirt uses the TCP port range from 49152 to 49261 for copying memory and disk contents. Compute hosts must accept connections in this range.

   For information about ports used by libvirt, see the libvirt documentation.

   Important

   Be mindful of the security risks introduced by opening ports.

Securing live migration streams

If your compute nodes have at least libvirt 4.4.0 and QEMU 2.11.0, it is strongly recommended to secure all your live migration streams by taking advantage of the QEMU-native TLS feature. This requires a pre-existing PKI (Public Key Infrastructure) setup. For further details on how to set this all up, refer to the *Secure live migration with QEMU-native TLS* document.

Block migration, volume-based live migration

If your environment satisfies the requirements for QEMU-native TLS, then block migration requires some setup; refer to the above section, *Securing live migration streams*, for details. Otherwise, no additional configuration is required for block migration and volume-backed live migration.

Be aware that block migration adds load to the network and storage subsystems.

Shared storage

Compute hosts have many options for sharing storage, for example NFS, shared disk array LUNs, Ceph or GlusterFS.

The next steps show how a regular Linux system might be configured as an NFS v4 server for live migration. For detailed information and alternative ways to configure NFS on Linux, see instructions for Ubuntu and RHEL.

1. Ensure that UID and GID of the nova user are identical on the compute hosts and the NFS server.
2. Create a directory with enough disk space for all instances in the cloud, owned by user nova. In this guide, we assume `/var/lib/nova/instances`.
3. Set the execute/search bit on the `instances` directory:

   ```
   $ chmod o+x /var/lib/nova/instances
   ```

   This allows qemu to access the `instances` directory tree.
4. Export `/var/lib/nova/instances` to the compute hosts. For example, add the following line to `/etc/exports`:

   ```
   /var/lib/nova/instances *(rw,sync,fsid=0,no_root_squash)
   ```

   The asterisk permits access to any NFS client. The option `fsid=0` exports the instances directory as the NFS root.

After setting up the NFS server, mount the remote filesystem on all compute hosts.

1. Assuming the NFS servers hostname is `nfs-server`, add this line to `/etc/fstab` to mount the NFS root:

   ```
   nfs-server:/ /var/lib/nova/instances nfs4 defaults 0 0
   ```
2. Test NFS by mounting the instances directory and check access permissions for the nova user:

   ```
   $ sudo mount -a -v
   $ ls -ld /var/lib/nova/instances/
   drwxr-xr-x. 2 nova nova 6 Mar 14 21:30 /var/lib/nova/instances/
   ```

Advanced configuration for KVM and QEMU

Live migration copies the instances memory from the source to the destination compute host. After a memory page has been copied, the instance may write to it again, so that it has to be copied again. Instances that frequently write to different memory pages can overwhelm the memory copy process and prevent the live migration from completing.

This section covers configuration settings that can help live migration of memory-intensive instances succeed.

1. **Live migration completion timeout**

   The Compute service will either abort or force complete a migration when it has been running too long. This behavior is configurable using the *libvirt.live_migration_timeout_action* config option. The timeout is calculated based on the instance size, which is the instances memory size in GiB. In the case of block migration, the size of ephemeral storage in GiB is added.

   The timeout in seconds is the instance size multiplied by the configurable parameter *libvirt.live_migration_completion_timeout*, whose default is 800. For example, shared-storage live migration of an instance with 8GiB memory will time out after 6400 seconds.

2. **Instance downtime**

   Near the end of the memory copy, the instance is paused for a short time so that the remaining few pages can be copied without interference from instance memory writes. The Compute service initializes this time to a small value that depends on the instance size, typically around 50 milliseconds. When it notices that the memory copy does not make sufficient progress, it increases the time gradually.

   You can influence the instance downtime algorithm with the help of three configuration variables on the compute hosts:

   ```
   live_migration_downtime = 500
   live_migration_downtime_steps = 10
   live_migration_downtime_delay = 75
   ```

   `live_migration_downtime` sets the target maximum period of time Nova will try to keep the instance paused during the last part of the memory copy, in *milliseconds*. This value may be exceeded if there is any reduction on the transfer rate after the VM is paused. The default is 500.

   `live_migration_downtime_steps` sets the total number of adjustment steps until `live_migration_downtime` is reached. The default is 10 steps.

   `live_migration_downtime_delay` sets the time interval between two adjustment steps in *seconds*. The default is 75.

3. **Auto-convergence**

   One strategy for a successful live migration of a memory-intensive instance is slowing the instance down. This is called auto-convergence. Both libvirt and QEMU implement this feature by automatically throttling the instances CPU when memory copy delays are detected.

   Auto-convergence is disabled by default. You can enable it by setting `live_migration_permit_auto_converge=true`.

   Caution

Before enabling auto-convergence, make sure that the instances application tolerates a slow-down.

Be aware that auto-convergence does not guarantee live migration success.

4. **Post-copy**

   Live migration of a memory-intensive instance is certain to succeed when you enable post-copy. This feature, implemented by libvirt and QEMU, activates the virtual machine on the destination host before all of its memory has been copied. When the virtual machine accesses a page that is missing on the destination host, the resulting page fault is resolved by copying the page from the source host.

   Post-copy is disabled by default. You can enable it by setting `live_migration_permit_post_copy=true`.

   When you enable both auto-convergence and post-copy, auto-convergence remains disabled.

Caution

The page faults introduced by post-copy can slow the instance down.

When the network connection between source and destination host is interrupted, page faults cannot be resolved anymore and the instance is rebooted.

Important

You may need to enable `unprivileged_userfaultfd` on newer kernels in order for post-copy to work.

```
sysctl vm.unprivileged_userfaultfd=1
```

The full list of live migration configuration parameters is documented in the *Nova Configuration Options*

VMware

vSphere configuration

Enable vMotion on all ESX hosts which are managed by Nova by following the instructions in this KB article.

Live-migrate instances

Live-migrating an instance means moving its virtual machine to a different OpenStack Compute server while the instance continues running. Before starting a live-migration, review the chapter *Configure live migrations*. It covers the configuration settings required to enable live-migration, but also reasons for migrations and non-live-migration options.

The instructions below cover shared-storage and volume-backed migration. To block-migrate instances, add the command-line option `-block-migrate` to the **`nova live-migration`** command, and `--block-migration` to the **`openstack server migrate`** command.

Manual selection of the destination host

1. Obtain the ID of the instance you want to migrate:

```
$ openstack server list

+--------------------------------------+------+--------+-----------------
↪+------------+
| ID                                   | Name | Status | Networks       ␣
↪| Image Name |
+--------------------------------------+------+--------+-----------------
↪+------------+
| d1df1b5a-70c4-4fed-98b7-423362f2c47c | vm1  | ACTIVE | private=a.b.c.d␣
↪| ...        |
| d693db9e-a7cf-45ef-a7c9-b3ecb5f22645 | vm2  | ACTIVE | private=e.f.g.h␣
↪| ...        |
+--------------------------------------+------+--------+-----------------
↪+------------+
```

2. Determine on which host the instance is currently running. In this example, `vm1` is running on `HostB`:

```
$ openstack server show d1df1b5a-70c4-4fed-98b7-423362f2c47c

+----------------------+--------------------------------------+
| Field                | Value                                |
+----------------------+--------------------------------------+
| ...                  | ...                                  |
| OS-EXT-SRV-ATTR:host | HostB                                |
| ...                  | ...                                  |
| addresses            | a.b.c.d                              |
| flavor               | m1.tiny                              |
| id                   | d1df1b5a-70c4-4fed-98b7-423362f2c47c |
| name                 | vm1                                  |
| status               | ACTIVE                               |
| ...                  | ...                                  |
+----------------------+--------------------------------------+
```

3. Select the compute node the instance will be migrated to. In this example, we will migrate the instance to `HostC`, because `nova-compute` is running on it:

```
$ openstack compute service list

+----+------------------+-------+----------+---------+-------+------------
↪----------------+
| ID | Binary           | Host  | Zone     | Status  | State | Updated At␣
↪               |
+----+------------------+-------+----------+---------+-------+------------
↪----------------+
|  3 | nova-conductor   | HostA | internal | enabled | up    | 2017-02-
↪18T09:42:29.000000 |
```

(continues on next page)

(continued from previous page)

```
|  4 | nova-scheduler   | HostA | internal | enabled | up    | 2017-02-
↪18T09:42:26.000000 |
|  5 | nova-compute     | HostB | nova     | enabled | up    | 2017-02-
↪18T09:42:29.000000 |
|  6 | nova-compute     | HostC | nova     | enabled | up    | 2017-02-
↪18T09:42:29.000000 |
+----+------------------+-------+----------+---------+-------+------------
↪----------------+
```

4. Check that `HostC` has enough resources for migration:

```
$ openstack host show HostC

+-------+------------+-----+-----------+---------+
| Host  | Project    | CPU | Memory MB | Disk GB |
+-------+------------+-----+-----------+---------+
| HostC | (total)    |  16 |     32232 |     878 |
| HostC | (used_now) |  22 |     21284 |     422 |
| HostC | (used_max) |  22 |     21284 |     422 |
| HostC | p1         |  22 |     21284 |     422 |
| HostC | p2         |  22 |     21284 |     422 |
+-------+------------+-----+-----------+---------+
```

   - `cpu`: Number of CPUs
   - `memory_mb`: Total amount of memory, in MB
   - `disk_gb`: Total amount of space for NOVA-INST-DIR/instances, in GB

   In this table, the first row shows the total amount of resources available on the physical server. The second line shows the currently used resources. The third line shows the maximum used resources. The fourth line and below shows the resources available for each project.

5. Migrate the instance:

```
$ openstack server migrate d1df1b5a-70c4-4fed-98b7-423362f2c47c --live-
↪migration --host HostC
```

6. Confirm that the instance has been migrated successfully:

```
$ openstack server show d1df1b5a-70c4-4fed-98b7-423362f2c47c

+----------------------+--------------------------------------+
| Field                | Value                                |
+----------------------+--------------------------------------+
| ...                  | ...                                  |
| OS-EXT-SRV-ATTR:host | HostC                                |
| ...                  | ...                                  |
+----------------------+--------------------------------------+
```

   If the instance is still running on `HostB`, the migration failed. The `nova-scheduler` and `nova-conductor` log files on the controller and the `nova-compute` log file on the source compute host can help pin-point the problem.

Automatic selection of the destination host

To leave the selection of the destination host to the Compute service, use the nova command-line client.

1. Obtain the instance ID as shown in step 1 of the section *Manual selection of the destination host*.
2. Leave out the host selection steps 2, 3, and 4.
3. Migrate the instance:

```
$ nova live-migration d1df1b5a-70c4-4fed-98b7-423362f2c47c
```

Monitoring the migration

1. Confirm that the instance is migrating:

```
$ openstack server show d1df1b5a-70c4-4fed-98b7-423362f2c47c

+----------------------+--------------------------------------+
| Field                | Value                                |
+----------------------+--------------------------------------+
| ...                  | ...                                  |
| status               | MIGRATING                            |
| ...                  | ...                                  |
+----------------------+--------------------------------------+
```

2. Check progress

   Use the nova command-line client for novas migration monitoring feature. First, obtain the migration ID:

```
$ nova server-migration-list d1df1b5a-70c4-4fed-98b7-423362f2c47c
+----+-------------+-----------  (...)
| Id | Source Node | Dest Node | (...)
+----+-------------+-----------+ (...)
| 2  | -           | -         | (...)
+----+-------------+-----------+ (...)
```

   For readability, most output columns were removed. Only the first column, **Id**, is relevant. In this example, the migration ID is 2. Use this to get the migration status.

```
$ nova server-migration-show d1df1b5a-70c4-4fed-98b7-423362f2c47c 2
+------------------------+--------------------------------------+
| Property               | Value                                |
+------------------------+--------------------------------------+
| created_at             | 2017-03-08T02:53:06.000000           |
| dest_compute           | controller                           |
| dest_host              | -                                    |
| dest_node              | -                                    |
| disk_processed_bytes   | 0                                    |
| disk_remaining_bytes   | 0                                    |
| disk_total_bytes       | 0                                    |
| id                     | 2                                    |
```

(continues on next page)

(continued from previous page)

```
| memory_processed_bytes | 65502513                             |
| memory_remaining_bytes | 786427904                            |
| memory_total_bytes     | 1091379200                           |
| server_uuid            | d1df1b5a-70c4-4fed-98b7-423362f2c47c |
| source_compute         | compute2                             |
| source_node            | -                                    |
| status                 | running                              |
| updated_at             | 2017-03-08T02:53:47.000000           |
+------------------------+--------------------------------------+
```

The output shows that the migration is running. Progress is measured by the number of memory bytes that remain to be copied. If this number is not decreasing over time, the migration may be unable to complete, and it may be aborted by the Compute service.

Note

The command reports that no disk bytes are processed, even in the event of block migration.

What to do when the migration times out

During the migration process, the instance may write to a memory page after that page has been copied to the destination. When that happens, the same page has to be copied again. The instance may write to memory pages faster than they can be copied, so that the migration cannot complete. There are two optional actions, controlled by *libvirt.live_migration_timeout_action*, which can be taken against a VM after *libvirt.live_migration_completion_timeout* is reached:

1. `abort` (default): The live migration operation will be cancelled after the completion timeout is reached. This is similar to using API `DELETE /servers/{server_id}/migrations/{migration_id}`.
2. `force_complete`: The compute service will either pause the VM or trigger post-copy depending on if post copy is enabled and available (*libvirt.live_migration_permit_post_copy* is set to `True`). This is similar to using API `POST /servers/{server_id}/migrations/{migration_id}/action (force_complete)`.

You can also read the *libvirt.live_migration_timeout_action* configuration option help for more details.

The following remarks assume the KVM/Libvirt hypervisor.

How to know that the migration timed out

To determine that the migration timed out, inspect the `nova-compute` log file on the source host. The following log entry shows that the migration timed out:

```
# grep WARNING.*d1df1b5a-70c4-4fed-98b7-423362f2c47c /var/log/nova/nova-
↪compute.log
...
WARNING nova.virt.libvirt.migration [req-...] [instance: ...]
live migration not completed after 1800 sec
```

Addressing migration timeouts

To stop the migration from putting load on infrastructure resources like network and disks, you may opt to cancel it manually.

```
$ nova live-migration-abort INSTANCE_ID MIGRATION_ID
```

To make live-migration succeed, you have several options:

- **Manually force-complete the migration**

  ```
  $ nova live-migration-force-complete INSTANCE_ID MIGRATION_ID
  ```

  The instance is paused until memory copy completes.

  Caution

  Since the pause impacts time keeping on the instance and not all applications tolerate incorrect time settings, use this approach with caution.

- **Enable auto-convergence**

  Auto-convergence is a Libvirt feature. Libvirt detects that the migration is unlikely to complete and slows down its CPU until the memory copy process is faster than the instances memory writes.

  To enable auto-convergence, set `live_migration_permit_auto_converge=true` in `nova.conf` and restart `nova-compute`. Do this on all compute hosts.

  Caution

  One possible downside of auto-convergence is the slowing down of the instance.

- **Enable post-copy**

  This is a Libvirt feature. Libvirt detects that the migration does not progress and responds by activating the virtual machine on the destination host before all its memory has been copied. Access to missing memory pages result in page faults that are satisfied from the source host.

  To enable post-copy, set `live_migration_permit_post_copy=true` in `nova.conf` and restart `nova-compute`. Do this on all compute hosts.

  When post-copy is enabled, manual force-completion does not pause the instance but switches to the post-copy process.

  Caution

  Possible downsides:

  - When the network connection between source and destination is interrupted, page faults cannot be resolved anymore, and the virtual machine is rebooted.
  - Post-copy may lead to an increased page fault rate during migration, which can slow the instance down.

If live migrations routinely timeout or fail during cleanup operations due to the user token timing out, consider configuring nova to use *service user tokens*.

Secure live migration with QEMU-native TLS

Context

The encryption offered by novas *libvirt.live_migration_tunnelled* does not secure all the different migration streams of a nova instance, namely: guest RAM, device state, and disks (via NBD) when using non-shared storage. Further, the tunnelling via libvirtd has inherent limitations: (a) it cannot handle live migration of disks in a non-shared storage setup (a.k.a. block migration); and (b) has a huge performance overhead and latency, because it burns more CPU and memory bandwidth due to increased number of data copies on both source and destination hosts.

To solve this existing limitation, QEMU and libvirt have gained (refer *below* for version details) support for native TLS, i.e. TLS built into QEMU. This will secure all data transports, including disks that are not on shared storage, without incurring the limitations of the tunnelled via libvirtd transport.

To take advantage of the native TLS support in QEMU and libvirt, nova has introduced new configuration attribute *libvirt.live_migration_with_native_tls*.

Prerequisites

(1) Version requirement: This feature needs at least libvirt 4.4.0 and QEMU 2.11.

(2) A pre-configured TLS environmenti.e. CA, server, and client certificates, their file permissions, et almust be correctly configured (typically by an installer tool) on all relevant compute nodes. To simplify your PKI (Public Key Infrastructure) setup, use deployment tools that take care of handling all the certificate lifecycle management. For example, refer to the TLS everywhere guide from the TripleO project.

(3) Password-less SSH setup for all relevant compute nodes.

(4) On all relevant compute nodes, ensure the TLS-related config attributes in `/etc/libvirt/qemu.conf` are in place:

```
default_tls_x509_cert_dir = "/etc/pki/qemu"
default_tls_x509_verify = 1
```

If it is not already configured, modify `/etc/sysconfig/libvirtd` on both (ComputeNode1 & ComputeNode2) to listen for TCP/IP connections:

```
LIBVIRTD_ARGS="--listen"
```

Then, restart the libvirt daemon (also on both nodes):

```
$ systemctl restart libvirtd
```

Refer to the *Related information* section on a note about the other TLS-related configuration attributes in `/etc/libvirt/qemu.conf`.

Validating your TLS environment on compute nodes

Assuming you have two compute hosts (`ComputeNode1`, and `ComputeNode2`) run the **`virt-pki-validate`** tool (comes with the `libvirt-client` package on your Linux distribution) on both the nodes to ensure all the necessary PKI files are configured are configured:

```
[ComputeNode1]$ virt-pki-validate
Found /usr/bin/certtool
Found CA certificate /etc/pki/CA/cacert.pem for TLS Migration Test
Found client certificate /etc/pki/libvirt/clientcert.pem for ComputeNode1
Found client private key /etc/pki/libvirt/private/clientkey.pem
Found server certificate /etc/pki/libvirt/servercert.pem for ComputeNode1
Found server private key /etc/pki/libvirt/private/serverkey.pem
Make sure /etc/sysconfig/libvirtd is setup to listen to
TCP/IP connections and restart the libvirtd service

[ComputeNode2]$ virt-pki-validate
Found /usr/bin/certtool
Found CA certificate /etc/pki/CA/cacert.pem for TLS Migration Test
Found client certificate /etc/pki/libvirt/clientcert.pem for ComputeNode2
Found client private key /etc/pki/libvirt/private/clientkey.pem
Found server certificate /etc/pki/libvirt/servercert.pem for ComputeNode2
Found server private key /etc/pki/libvirt/private/serverkey.pem
Make sure /etc/sysconfig/libvirtd is setup to listen to
TCP/IP connections and restart the libvirtd service
```

Other TLS environment related checks on compute nodes

IMPORTANT: Ensure that the permissions of certificate files and keys in `/etc/pki/qemu/*` directory on both source *and* destination compute nodes to be the following `0640` with `root:qemu` as the group/user. For example, on a Fedora-based system:

```
$ ls -lasrtZ /etc/pki/qemu
total 32
0 drwxr-xr-x. 10 root root system_u:object_r:cert_t:s0      110 Dec 10 10:39 .
↪.
4 -rw-r-----.  1 root qemu unconfined_u:object_r:cert_t:s0 1464 Dec 10 11:08␣
↪ca-cert.pem
4 -rw-r-----.  1 root qemu unconfined_u:object_r:cert_t:s0 1558 Dec 10 11:08␣
↪server-cert.pem
4 -rw-r-----.  1 root qemu unconfined_u:object_r:cert_t:s0 1619 Dec 10 11:09␣
↪client-cert.pem
8 -rw-r-----.  1 root qemu unconfined_u:object_r:cert_t:s0 8180 Dec 10 11:09␣
↪client-key.pem
8 -rw-r-----.  1 root qemu unconfined_u:object_r:cert_t:s0 8177 Dec 11 05:35␣
↪server-key.pem
0 drwxr-xr-x.  2 root root unconfined_u:object_r:cert_t:s0  146 Dec 11 06:01 .
```

Performing the migration

(1) On all relevant compute nodes, enable the *libvirt.live_migration_with_native_tls* configuration attribute and set the *libvirt.live_migration_scheme* configuration attribute to tls:

```
[libvirt]
live_migration_with_native_tls = true
live_migration_scheme = tls
```

> **Note**
>
> Setting both *libvirt.live_migration_with_native_tls* and *libvirt.live_migration_tunnelled* at the same time is invalid (and disallowed).

> **Note**
>
> Not setting *libvirt.live_migration_scheme* to `tls` will result in libvirt using the unencrypted TCP connection without displaying any error or a warning in the logs.

And restart the `nova-compute` service:

```
$ systemctl restart openstack-nova-compute
```

(2) Now that all TLS-related configuration is in place, migrate guests (with or without shared storage) from `ComputeNode1` to `ComputeNode2`. Refer to the *Live-migrate instances* document on details about live migration.

Related information

- If you have the relevant libvirt and QEMU versions (mentioned in the *Prerequisites* section earlier), then using the *libvirt.live_migration_with_native_tls* is strongly recommended over the more limited *libvirt.live_migration_tunnelled* option, which is intended to be deprecated in future.
- There are in total *nine* TLS-related config options in `/etc/libvirt/qemu.conf`:

```
default_tls_x509_cert_dir
default_tls_x509_verify
nbd_tls
nbd_tls_x509_cert_dir
migrate_tls_x509_cert_dir

vnc_tls_x509_cert_dir
spice_tls_x509_cert_dir
vxhs_tls_x509_cert_dir
chardev_tls_x509_cert_dir
```

If you set both `default_tls_x509_cert_dir` and `default_tls_x509_verify` parameters for all certificates, there is no need to specify any of the other `*_tls*` config options.

The intention (of libvirt) is that you can just use the `default_tls_x509_*` config attributes so

that you dont need to set any other `*_tls*` parameters, _unless_ you need different certificates for some services. The rationale for that is that some services (e.g. migration / NBD) are only exposed to internal infrastructure; while some services (VNC, Spice) might be exposed publicly, so might need different certificates. For OpenStack this does not matter, though, we will stick with the defaults.

- If they are not already open, ensure you open up these TCP ports on your firewall: `16514` (where the authenticated and encrypted TCP/IP socket will be listening on) and `49152-49215` (for regular migration) on all relevant compute nodes. (Otherwise you get `error: internal error: unable to execute QEMU command 'drive-mirror': Failed to connect socket: No route to host`).

Manage volumes

Depending on the setup of your cloud provider, they may give you an endpoint to use to manage volumes. You can use the `openstack` CLI to manage volumes.

For the purposes of the compute service, attaching, detaching and *creating a server from a volume* are of primary interest.

Refer to the CLI documentation for more information.

Volume multi-attach

Nova added support for multiattach volumes in the 17.0.0 Queens release.

This document covers the nova-specific aspects of this feature. Refer to the block storage admin guide for more details about creating multiattach-capable volumes.

Boot from volume and attaching a volume to a server that is not SHELVED_OFFLOADED is supported. Ultimately the ability to perform these actions depends on the compute host and hypervisor driver that is being used.

There is also a recorded overview and demo for volume multi-attach.

Requirements

- The minimum required compute API microversion for attaching a multiattach-capable volume to more than one server is *2.60*.
- Cinder 12.0.0 (Queens) or newer is required.
- The `nova-compute` service must be running at least Queens release level code (17.0.0) and the hypervisor driver must support attaching block storage devices to more than one guest. Refer to *Feature Support Matrix* for details on which compute drivers support volume multiattach.
- When using the libvirt compute driver, the following native package versions determine multiattach support:
  - libvirt must be greater than or equal to 3.10, or
  - qemu must be less than 2.10
- Swapping an *in-use* multiattach volume is not supported (this is actually controlled via the block storage volume retype API).

Known issues

- Creating multiple servers in a single request with a multiattach-capable volume as the root disk is not yet supported: https://bugs.launchpad.net/nova/+bug/1747985
- Subsequent attachments to the same volume are all attached in *read/write* mode by default in the block storage service. A future change either in nova or cinder may address this so that subsequent attachments are made in *read-only* mode, or such that the mode can be specified by the user when attaching the volume to the server.

Testing

Continuous integration testing of the volume multiattach feature is done via the `tempest-full` and `tempest-slow` jobs, which, along with the tests themselves, are defined in the tempest repository.

Managing volume attachments

During the lifecycle of an instance admins may need to check various aspects of how a given volume is mapped both to an instance and the underlying compute hosting the instance. This could even include refreshing different elements of the attachment to ensure the latest configuration changes within the environment have been applied.

Note

If you encounter any dangling volume attachments in either the Nova or Cinder databases, a `hard reboot` of the affected instance can help resolve the issue. During the instance reboot process, Nova performs a synchronization mechanism that verifies the availability of volume attachments in the Cinder database. Any missing or dangling/stale attachments are detected and deleted from both Nova and Cinder during `hard reboot` process.

Checking an existing attachment

Existing volume attachments can be checked using the following OpenStack Client commands:

List all volume attachments for a given instance:

```
$ openstack server volume list 216f9481-4c9d-4530-b865-51cedfa4b8e7
+--------------------------------------+----------+--------------------------
↪-----------+--------------------------------------+
| ID                                   | Device   | Server ID                ␣
↪            | Volume ID                            |
+--------------------------------------+----------+--------------------------
↪-----------+--------------------------------------+
| 8b9b3491-f083-4485-8374-258372f3db35 | /dev/vdb | 216f9481-4c9d-4530-b865-
↪51cedfa4b8e7 | 8b9b3491-f083-4485-8374-258372f3db35 |
+--------------------------------------+----------+--------------------------
↪-----------+--------------------------------------+
```

List all volume attachments for a given instance with the Cinder volume attachment and Block Device Mapping UUIDs also listed with microversion >=2.89:

```
$ openstack --os-compute-api-version 2.89 server volume list 216f9481-4c9d-
↪4530-b865-51cedfa4b8e7
+----------+--------------------------------------+--------------------------
↪----------+------+-----------------------+------------------------------
↪------+--------------------------------------+
| Device   | Server ID                            | Volume ID                ␣
↪            | Tag  | Delete On Termination? | Attachment ID                ␣
↪      | BlockDeviceMapping UUID              |
+----------+--------------------------------------+--------------------------
↪----------+------+-----------------------+------------------------------
↪------+--------------------------------------+
| /dev/vdb | 216f9481-4c9d-4530-b865-51cedfa4b8e7 | 8b9b3491-f083-4485-8374-
↪258372f3db35 | None | False                 | d338fb38-cfd5-461f-8753-
↪145dcbdb6c78 | 4e957e6d-52f2-44da-8cf8-3f1ab755e26d |
+----------+--------------------------------------+--------------------------
↪----------+------+-----------------------+------------------------------
↪------+--------------------------------------+
```

List all Cinder volume attachments for a given volume from microversion >= 3.27:

```
$ openstack --os-volume-api-version 3.27 volume attachment list --volume-id␣
↪8b9b3491-f083-4485-8374-258372f3db35
+--------------------------------------+--------------------------------------
↪+--------------------------------------+----------+
| ID                                   | Volume ID                            ␣
↪| Server ID                            | Status   |
+--------------------------------------+--------------------------------------
↪+--------------------------------------+----------+
| d338fb38-cfd5-461f-8753-145dcbdb6c78 | 8b9b3491-f083-4485-8374-258372f3db35␣
↪| 216f9481-4c9d-4530-b865-51cedfa4b8e7 | attached |
+--------------------------------------+--------------------------------------
↪+--------------------------------------+----------+
```

Show the details of a Cinder volume attachment from microversion >= 3.27:

```
$ openstack --os-volume-api-version 3.27 volume attachment show d338fb38-cfd5-
↪461f-8753-145dcbdb6c78
+-------------+------------------------------------------------------------------
↪------------------------------------------------------------------------------
↪------------------------------------------------------------------------------
↪------------------------------------------------------------------------------
↪------------------------------------------------------------------------------
↪------------------------------------------------------------------------------
↪-------------+
| Field       | Value                                                            ␣
↪                                                                              ␣
↪                                                                              ␣
↪                                                                              ␣
↪                                                                              ␣
↪                                                                              ␣
```

(continues on next page)

(continued from previous page)

```
↪              |
+-------------+-------------------------------------------------------------
↪-------------------------------------------------------------------------------
↪-------------------------------------------------------------------------------
↪-------------------------------------------------------------------------------
↪-------------------------------------------------------------------------------
↪-------------------------------------------------------------------------------
↪-------------+
| ID          | d338fb38-cfd5-461f-8753-145dcbdb6c78                          ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪              |
| Volume ID   | 8b9b3491-f083-4485-8374-258372f3db35                          ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪              |
| Instance ID | 216f9481-4c9d-4530-b865-51cedfa4b8e7                          ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪              |
| Status      | attached                                                      ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪              |
| Attach Mode | rw                                                            ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪              |
| Attached At | 2021-09-14T13:03:38.000000                                    ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
↪                                                                             ␣
```

(continues on next page)

(continued from previous page)

```
↪                |
| Detached At    |                                                                ␣
↪                                                                               ␣
↪                                                                               ␣
↪                                                                               ␣
↪                                                                               ␣
↪                                                                               ␣
↪                |
| Properties     | access_mode='rw', attachment_id='d338fb38-cfd5-461f-8753-
↪145dcbdb6c78', auth_method='CHAP', auth_password='4XyNNFV2TLPhKXoP', auth_
↪username='jsBMQhWZJXupA4eWHLQG', cacheable='False', driver_volume_type=
↪'iscsi', encrypted='False', qos_specs=, target_discovered='False', target_
↪iqn='iqn.2010-10.org.openstack:volume-8b9b3491-f083-4485-8374-258372f3db35',
↪ target_lun='0', target_portal='192.168.122.99:3260', volume_id='8b9b3491-
↪f083-4485-8374-258372f3db35' |
+----------------+--------------------------------------------------------------
↪--------------------------------------------------------------------------------
↪--------------------------------------------------------------------------------
↪--------------------------------------------------------------------------------
↪--------------------------------------------------------------------------------
↪--------------------------------------------------------------------------------
↪-------------+
```

Refresh a volume attachment with nova-manage

Added in version 24.0.0: (Xena)

Admins may also refresh an existing volume attachment using the following **nova-manage** commands.

Note

Users can also refresh volume attachments by shelving and later unshelving their instances. The following is an alternative to that workflow and useful for admins when having to mass refresh attachments across an environment.

Note

Future work will look into introducing an os-refresh admin API that will include orchestrating the shutdown of an instance and refreshing volume attachments among other things.

To begin the admin can use the `volume_attachment show` subcommand to dump existing details of the attachment directly from the Nova database. This includes the stashed `connection_info` not shared by the API.

```
$ nova-manage volume_attachment show 216f9481-4c9d-4530-b865-51cedfa4b8e7␣
↪8b9b3491-f083-4485-8374-258372f3db35 --json | jq .attachment_id
"d338fb38-cfd5-461f-8753-145dcbdb6c78"
```

If the stored `connection_info` or `attachment_id` are incorrect then the admin may want to refresh

the attachment to the compute host entirely by recreating the Cinder volume attachment record(s) and pulling down fresh `connection_info`. To do this we first need to ensure the instance is stopped:

```
$ openstack server stop 216f9481-4c9d-4530-b865-51cedfa4b8e7
```

Once stopped the host connector of the compute hosting the instance has to be fetched using the `volume_attachment get_connector` subcommand:

```
root@compute $ nova-manage volume_attachment get_connector --json > connector.
↪json
```

Note

Future work will remove this requirement and incorporate the gathering of the host connector into the main refresh command. Unfortunately until then it must remain a separate manual step.

We can then provide this connector to the `volume_attachment refresh` subcommand. This command will connect to the compute, disconnect any host volume connections, delete the existing Cinder volume attachment, recreate the volume attachment and finally update Novas database.

```
$ nova-manage volume_attachment refresh 216f9481-4c9d-4530-b865-51cedfa4b8e7␣
↪8b9b3491-f083-4485-8374-258372f3db35 connector.json
```

The Cinder volume attachment and connection_info stored in the Nova database should now be updated:

```
$ nova-manage volume_attachment show 216f9481-4c9d-4530-b865-51cedfa4b8e7␣
↪8b9b3491-f083-4485-8374-258372f3db35 --json | jq .attachment_id
"9ce46f49-5cfc-4c6c-b2f0-0287540d3246"
```

The instance can then be restarted and the event list checked

```
$ openstack server start $instance
```

Manage shares

Overview

With the Manila share attachment feature, users can easily attach file shares provided by Manila to their instances, and mount them within the instance. This feature eliminates the need for users to manually connect to and mount shares provided by Manila within their instances.

Use Cases

The Manila share attachment feature can be used in the following scenarios:

- As an operator I want the Manila datapath to be separate to any tenant accessible networks.
- As a user I want to attach Manila shares directly to my instance and have a simple interface with which to mount them within the instance.

  As a user I want to detach a directly attached Manila share from my instance.
- As a user I want to track the Manila shares attached to my instance.

Prerequisites

To use the Manila share attachment feature, you must have an OpenStack environment with Manila and Nova installed and configured. Additionally, your environment must meet the following requirements:

- The compute host running your instance must have `QEMU` version 5.0 or higher and `libvirt` version 6.2 or higher. If these requirements are met, the `COMPUTE_STORAGE_VIRTIO_FS` trait should be enabled on your compute host.
- All compute nodes must be upgraded to a nova version that enables the use of virtiofs.
- Additionally this initial implementation will require that the associated instances use file backed memory or huge pages. This is a requirement of virtio-fs.
- Kernel drivers and user land tools to support mounting NFS and CEPHFS shares.
- A kernel version of >= 5.4 within the instance guest OS to support mounting virtiofs shares.

Configure instance shared memory

This can be achieved by either configuring the instance with `hw:mem_page_size` extra spec.

or, you can enable the `COMPUTE_MEM_BACKING_FILE` trait by configuring the file_backed_memory feature in `libvirt` for nova-compute. This will allow the use of file-backed memory.

`COMPUTE_MEM_BACKING_FILE` support requires that operators configure one or more hosts with file backed memory. Ensuring the instance will land on one of these hosts can be achieved by creating an AZ englobing these hosts. And then instruct users to deploy their instances in this AZ. Alternatively, operators can guide the scheduler to choose a suitable host by adding `trait:COMPUTE_MEM_BACKING_FILE=required` as an extra spec or image property.

Limitations

- You must have an instance in the SHUTOFF state to attach or detach a share.
- Due to current virtiofs implementation in Qemu / libvirt, the following Nova features are blocked for VMs with shares attached:
  - evacuate
  - live_migrate
  - rebuild
  - resize(migrate)
  - resume
  - shelve
  - volume snapshot

Known bugs

- Due to a bug, the configuration drive is not refreshed at the appropriate time, causing the shares to remain invisible on the configuration drive. You can use the metadata service instead.
- The share backup process removes share access and locks because it requires exclusive access for backup consistency. This operation disrupts the share attachment, making it inaccessible for the VM.

To use this feature correctly, follow these steps:

1. Stop the VM.
2. Detach the share from the VM (Nova removes the lock).
3. Perform the backup using the Manila API.
4. Reattach the share (Nova reapplies the lock).
5. Start the VM.

- Nova does not send the users token alongside Novas service token, Manila will only recognize Nova as the requester during access creation. Consequently, the audit trail log will lack information indicating that Nova is acting on behalf of a user request. This is a significant limitation of the current implementation.
- The share is not marked as an error if the VM fails to delete.

Managing shares

Attaching a Share

To attach a Manila share to an instance, use the `POST /servers/{server_id}/shares API`, and specify the `share_id` of the share you want to attach. The tag parameter is optional and can be used to provide a string used to mount the share within the instance. If you do not provide a tag, the share_id will be used instead.

After issuing the attach request, the shares attachment state is recorded in the database and should quickly transition to attaching and then to inactive. The user should verify that the status reaches inactive before proceeding with any new operations; this transition should occur unless an error arises.

```
$ openstack server add share 9736bced-44f6-48fc-b913-f34c3ed95067 3d3aafde-
↪b4cb-45ab-8ac6-31ff93f69536 --tag mytag
+-----------------+--------------------------------------------------------------
↪---------------------------+
| Field           | Value                                                        ␣
↪                           |
+-----------------+--------------------------------------------------------------
↪---------------------------+
| Export Location | 192.168.122.76:/opt/stack/data/manila/mnt/share-25a777f7-
↪a582-465c-a94c-7293707cc5cb |
| Share ID        | 3d3aafde-b4cb-45ab-8ac6-31ff93f69536                         ␣
↪                           |
| Status          | inactive                                                     ␣
↪                           |
| Tag             | mytag                                                        ␣
↪                           |
| UUID            | b70403ee-f598-4552-b9e9-173343deff79                         ␣
↪                           |
+-----------------+--------------------------------------------------------------
↪---------------------------+
```

Then, when you power on the instance, the required operations will be done to attach the share, and set it as active if there are no errors. If the attach operation fails, the VM start operation will also fail.

```
$ openstack server share show  9736bced-44f6-48fc-b913-f34c3ed95067 3d3aafde-
↪b4cb-45ab-8ac6-31ff93f69536
+-----------------+--------------------------------------------------------
↪----------------------------+
| Field           | Value                                                  ␣
↪                            |
+-----------------+--------------------------------------------------------
↪----------------------------+
| Export Location | 192.168.122.76:/opt/stack/data/manila/mnt/share-25a777f7-
↪a582-465c-a94c-7293707cc5cb |
| Share ID        | 3d3aafde-b4cb-45ab-8ac6-31ff93f69536                   ␣
↪                            |
| Status          | active                                                 ␣
↪                            |
| Tag             | mytag                                                  ␣
↪                            |
| UUID            | b70403ee-f598-4552-b9e9-173343deff79                   ␣
↪                            |
+-----------------+--------------------------------------------------------
↪----------------------------+
```

After connecting to the VM, you can retrieve the tags of the attached share by querying the OpenStack metadata service.

Note: Here, we can see 2 shares attached to the instance with a defined tag (mytag) and another one with the default tag.

Note2: Using this mechanism, shares can be easily mounted automatically when the machine starts up.

```
$ curl -s -H "Metadata-Flavor: OpenStack" http://169.254.169.254/openstack/
↪latest/meta_data.json | jq .devices
[
  {
    "type": "share",
    "share_id": "3d3aafde-b4cb-45ab-8ac6-31ff93f69536",
    "tag": "mytag",
    "bus": "none",
    "address": "none"
  },
  {
    "type": "share",
    "share_id": "894a530c-6fa0-4aa1-97c9-4489d205c5ed",
    "tag": "894a530c-6fa0-4aa1-97c9-4489d205c5ed",
    "bus": "none",
    "address": "none"
  }
]
```

To mount the attached share, use the mount command with the virtiofs file system type, and the tag provided in the response body.

```
user@instance $ mount -t virtiofs $tag /mnt/mount/path
```

Detaching a Share

To detach a Manila share, first stop the instance, then use the `DELETE /servers/{server_id}/shares/{share_id}` API, specifying the share_id of the share you wish to detach.

```
$ openstack server remove share 9736bced-44f6-48fc-b913-f34c3ed95067 3d3aafde-
↪b4cb-45ab-8ac6-31ff93f69536
```

Listing Attached Shares

To list all shares attached to an instance, use the `GET /servers/{server_id}/shares` API.

```
$ openstack server share list 9736bced-44f6-48fc-b913-f34c3ed95067
+--------------------------------------+----------+--------------------------
↪-----------+
| Share ID                             | Status   | Tag                      ␣
↪           |
+--------------------------------------+----------+--------------------------
↪-----------+
| 3d3aafde-b4cb-45ab-8ac6-31ff93f69536 | inactive | mytag                    ␣
↪           |
| 894a530c-6fa0-4aa1-97c9-4489d205c5ed | inactive | 894a530c-6fa0-4aa1-97c9-
↪4489d205c5ed |
| 9238fc76-5b21-4b8e-80ef-26d74d192f71 | inactive | 9238fc76-5b21-4b8e-80ef-
↪26d74d192f71 |
+--------------------------------------+----------+--------------------------
↪-----------+
```

Showing Details of an Attached Share

To show the details of a specific share attached to an instance, use the `GET /servers/{server_id}/shares/{share_id}` API, and specify the `share_id` of the share you want to show.

```
$ openstack server share show 9736bced-44f6-48fc-b913-f34c3ed95067 3d3aafde-
↪b4cb-45ab-8ac6-31ff93f69536
+-----------------+------------------------------------------------------------
↪---------------------------+
| Field           | Value                                                      ␣
↪                           |
+-----------------+------------------------------------------------------------
↪---------------------------+
| Export Location | 192.168.122.76:/opt/stack/data/manila/mnt/share-25a777f7-
↪a582-465c-a94c-7293707cc5cb |
| Share ID        | 3d3aafde-b4cb-45ab-8ac6-31ff93f69536                       ␣
↪                           |
| Status          | inactive                                                   ␣
↪                           |
```

(continues on next page)

(continued from previous page)

```
| Tag              | mytag                                                                ␣
↪                  |
| UUID             | 8a8b42f4-7cd5-49f2-b89c-f27b2ed89cd5                                 ␣
↪                  |
+------------------+----------------------------------------------------------------------
↪--------------------------+
```

Notification of Share Attachment and Detachment

New notifications will be added for share attach and share detach. You can enable them using `include_share_mapping` configuration parameter. Then you can subscribe to these notifications to receive information about share attachment and detachment events.

Available versioned notifications: https://docs.openstack.org/nova/latest/reference/notifications.html

Manage Flavors

Admin users can use the **`openstack flavor`** command to customize and manage flavors. To see information for this command, run:

```
$ openstack flavor --help
Command "flavor" matches:
  flavor create
  flavor delete
  flavor list
  flavor set
  flavor show
  flavor unset
```

Note

Configuration rights can be delegated to additional users by redefining the access controls for `os_compute_api:os-flavor-manage:create`, `os_compute_api:os-flavor-manage:update` and `os_compute_api:os-flavor-manage:delete` in `/etc/nova/policy.yaml` on the `nova-api` server.

Note

Flavor customization can be limited by the hypervisor in use. For example the libvirt driver enables quotas on CPUs available to a VM, disk tuning, bandwidth I/O, watchdog behavior, random number generator device control, and instance VIF traffic control.

For information on the flavors and flavor extra specs, refer to *Flavors*.

Create a flavor

1. List flavors to show the ID and name, the amount of memory, the amount of disk space for the root partition and for the ephemeral partition, the swap, and the number of virtual CPUs for each flavor:

```
$ openstack flavor list
```

2. To create a flavor, specify a name, ID, RAM size, disk size, and the number of vCPUs for the flavor, as follows:

```
$ openstack flavor create FLAVOR_NAME --id FLAVOR_ID \
    --ram RAM_IN_MB --disk ROOT_DISK_IN_GB --vcpus NUMBER_OF_VCPUS
```

> **Note**
>
> Unique ID (integer or UUID) for the new flavor. If specifying auto, a UUID will be automatically generated.

Here is an example that creates a public `m1.extra_tiny` flavor that automatically gets an ID assigned, with 256 MB memory, no disk space, and one VCPU.

```
$ openstack flavor create --public m1.extra_tiny --id auto \
    --ram 256 --disk 0 --vcpus 1
```

3. If an individual user or group of users needs a custom flavor that you do not want other projects to have access to, you can create a private flavor.

```
$ openstack flavor create --private m1.extra_tiny --id auto \
    --ram 256 --disk 0 --vcpus 1
```

After you create a flavor, assign it to a project by specifying the flavor name or ID and the project ID:

```
$ openstack flavor set --project PROJECT_ID m1.extra_tiny
```

For a list of optional parameters, run this command:

```
$ openstack help flavor create
```

4. In addition, you can set or unset properties, commonly referred to as extra specs, for the existing flavor. The `extra_specs` metadata keys can influence the instance directly when it is launched. If a flavor sets the `quota:vif_outbound_peak=65536` extra spec, the instances outbound peak bandwidth I/O should be less than or equal to 512 Mbps. There are several aspects that can work for an instance including *CPU limits*, *Disk tuning*, *Bandwidth I/O*, *Watchdog behavior*, and *Random-number generator*. For information about available metadata keys, see *Flavors*.

For a list of optional parameters, run this command:

```
$ openstack flavor set --help
```

Modify a flavor

Only the description of flavors can be modified (starting from microversion 2.55). To modify the description of a flavor, specify the flavor name or ID and a new description as follows:

```
$ openstack --os-compute-api-version 2.55 flavor set --description
↪<DESCRIPTION> <FLAVOR>
```

Note

The only field that can be updated is the description field. Nova has historically intentionally not included an API to update a flavor because that would be confusing for instances already created with that flavor. Needing to change any other aspect of a flavor requires deleting and/or creating a new flavor.

Nova stores a serialized version of the flavor associated with an instance record in the `instance_extra` table. While nova supports updating flavor extra_specs it does not update the embedded flavor in existing instances. Nova does not update the embedded flavor as the extra_specs change may invalidate the current placement of the instance or alter the compute context that has been created for the instance by the virt driver. For this reason admins should avoid updating extra_specs for flavors used by existing instances. A resize can be used to update existing instances if required but as a resize performs a cold migration it is not transparent to a tenant.

Delete a flavor

To delete a flavor, specify the flavor name or ID as follows:

```
$ openstack flavor delete FLAVOR
```

Default Flavors

Previous versions of nova typically deployed with default flavors. This was removed from Newton. The following table lists the default flavors for Mitaka and earlier.

Flavor	VCPUs	Disk (in GB)	RAM (in MB)
m1.tiny	1	1	512
m1.small	1	20	2048
m1.medium	2	40	4096
m1.large	4	80	8192
m1.xlarge	8	160	16384

Injecting the administrator password

Compute can generate a random administrator (root) password and inject that password into an instance. If this feature is enabled, users can run **ssh** to an instance without an **ssh** keypair. The random password appears in the output of the **openstack server create** command. You can also view and set the admin password from the dashboard.

Password injection using the dashboard

For password injection display in the dashboard, please refer to the setting of `can_set_password` in Horizon doc

Password injection on libvirt-based hypervisors

For hypervisors that use the libvirt back end (such as KVM, QEMU, and LXC), admin password injection is disabled by default. To enable it, set this option in `/etc/nova/nova.conf`:

```
[libvirt]
inject_password=true
```

When enabled, Compute will modify the password of the admin account by editing the `/etc/shadow` file inside the virtual machine instance.

Note

Linux distribution guest only.

Note

Users can only use **ssh** to access the instance by using the admin password if the virtual machine image is a Linux distribution, and it has been configured to allow users to use **ssh** as the root user with password authorization. This is not the case for Ubuntu cloud images which, by default, does not allow users to use **ssh** to access the root account, or CentOS cloud images which, by default, does not allow **ssh** access to the instance with password.

Password injection and Windows images (all hypervisors)

For Windows virtual machines, configure the Windows image to retrieve the admin password on boot by installing an agent such as cloudbase-init.

Configure remote console access

OpenStack provides a number of different methods to interact with your guests: VNC, SPICE, Serial, RDP or MKS. If configured, these can be accessed by users through the OpenStack dashboard or the command line. This document outlines how these different technologies can be configured.

Overview

It is considered best practice to deploy only one of the consoles types and not all console types are supported by all compute drivers. Regardless of what option is chosen, a console proxy service is required. These proxy services are responsible for the following:

- Provide a bridge between the public network where the clients live and the private network where the servers with consoles live.
- Mediate token authentication.
- Transparently handle hypervisor-specific connection details to provide a uniform client experience.

For some combinations of compute driver and console driver, these proxy services are provided by the hypervisor or another service. For all others, nova provides services to handle this proxying. Consider a noVNC-based VNC console connection for example:

1. A user connects to the API and gets an `access_url` such as, `http://ip:port/?path=%3Ftoken%3Dxyz`.
2. The user pastes the URL in a browser or uses it as a client parameter.
3. The browser or client connects to the proxy.
4. The proxy authorizes the token for the user, and maps the token to the *private* host and port of the VNC server for an instance.

   The compute host specifies the address that the proxy should use to connect through the *vnc.server_proxyclient_address* option. In this way, the VNC proxy works as a bridge between the public network and private host network.
5. The proxy initiates the connection to VNC server and continues to proxy until the session ends.

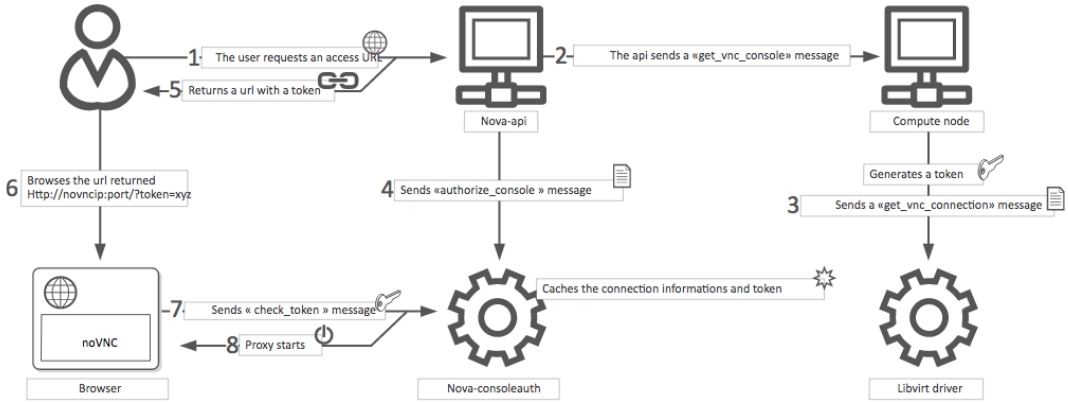
This means a typical deployment with noVNC-based VNC consoles will have the following components:

- One or more **nova-novncproxy** service. Supports browser-based noVNC clients. For simple deployments, this service typically runs on the same machine as the Compute API because it operates as a proxy between the public network and the private compute host network.
- One or more **nova-compute** services. Hosts the instances for which consoles are provided.

Todo

The below diagram references **nova-consoleauth** and needs to be updated.

This particular example is illustrated below.



Consoleauth configuration:

The consoleauth accepts following options:

- *consoleauth.token_ttl*
- *consoleauth.enforce_session_timeout*

```
[consoleauth]
token_ttl = 1000                    # default value is 600 second
enforce_session_timeout = True      # default is False
```

Supported consoles:

- *noVNC-based VNC console*
- *SPICE console*
- *Serial console*
- *MKS console*

noVNC-based VNC console

VNC is a graphical console with wide support among many hypervisors and clients. noVNC provides VNC support through a web browser.

Note

It has been reported that versions of noVNC older than 0.6 do not work with the **nova-novncproxy** service.

If using non-US key mappings, you need at least noVNC 1.0.0 for a fix.

If using VMware ESX/ESXi hypervisors, you need at least noVNC 1.1.0 for a fix.

Configuration

To enable the noVNC VNC console service, you must configure both the **nova-novncproxy** service and the **nova-compute** service. Most options are defined in the *vnc* group.

The **nova-novncproxy** service accepts the following options:

- *daemon*
- *ssl_only*
- *source_is_ipv6*
- *cert*
- *key*
- *web*
- *console.ssl_ciphers*
- *console.ssl_minimum_version*
- *vnc.novncproxy_host*
- *vnc.novncproxy_port*

If using the libvirt compute driver and enabling *VNC proxy security*, the following additional options are supported:

- *vnc.auth_schemes*

- *vnc.vencrypt_client_key*
- *vnc.vencrypt_client_cert*
- *vnc.vencrypt_ca_certs*

For example, to configure this via a `nova-novncproxy.conf` file:

```
[vnc]
novncproxy_host = 0.0.0.0
novncproxy_port = 6082
```

Note

This doesnt show configuration with security. For information on how to configure this, refer to *VNC proxy security* below.

The **nova-compute** service requires the following options to configure noVNC-based VNC console support:

- *vnc.enabled*
- *vnc.novncproxy_base_url*
- *vnc.server_listen*
- *vnc.server_proxyclient_address*

If using the VMware compute driver, the following additional options are supported:

- *vmware.vnc_port*
- *vmware.vnc_port_total*

For example, to configure this via a `nova.conf` file:

```
[vnc]
enabled = True
novncproxy_base_url = http://IP_ADDRESS:6082/vnc_auto.html
server_listen = 127.0.0.1
server_proxyclient_address = 127.0.0.1
```

Replace `IP_ADDRESS` with the IP address from which the proxy is accessible by the outside world. For example, this may be the management interface IP address of the controller or the VIP.

VNC proxy security

Deploy the public-facing interface of the VNC proxy with HTTPS to prevent attacks from malicious parties on the network between the tenant user and proxy server. When using HTTPS, the TLS encryption only applies to data between the tenant user and proxy server. The data between the proxy server and Compute node instance will still be unencrypted. To provide protection for the latter, it is necessary to enable the VeNCrypt authentication scheme for VNC in both the Compute nodes and noVNC proxy server hosts.

QEMU/KVM Compute node configuration

Ensure each Compute node running QEMU/KVM with libvirt has a set of certificates issued to it. The following is a list of the required certificates:

- `/etc/pki/libvirt-vnc/server-cert.pem`

  An x509 certificate to be presented **by the VNC server**. The `CommonName` should match the **primary hostname of the compute node**. Use of `subjectAltName` is also permitted if there is a need to use multiple hostnames or IP addresses to access the same Compute node.

- `/etc/pki/libvirt-vnc/server-key.pem`

  The private key used to generate the `server-cert.pem` file.

- `/etc/pki/libvirt-vnc/ca-cert.pem`

  The authority certificate used to sign `server-cert.pem` and sign the VNC proxy server certificates.

The certificates must have v3 basic constraints[2] present to indicate the permitted key use and purpose data.

We recommend using a dedicated certificate authority solely for the VNC service. This authority may be a child of the master certificate authority used for the OpenStack deployment. This is because libvirt does not currently have a mechanism to restrict what certificates can be presented by the proxy server.

For further details on certificate creation, consult the QEMU manual page documentation on VNC server certificate setup[1].

Configure libvirt to enable the VeNCrypt authentication scheme for the VNC server. In `/etc/libvirt/qemu.conf`, uncomment the following settings:

- `vnc_tls=1`

  This instructs libvirt to enable the VeNCrypt authentication scheme when launching QEMU, passing it the certificates shown above.

- `vnc_tls_x509_verify=1`

  This instructs QEMU to require that all VNC clients present a valid x509 certificate. Assuming a dedicated certificate authority is used for the VNC service, this ensures that only approved VNC proxy servers can connect to the Compute nodes.

Make sure to provide correct permissions to the certificate files for the process which creates instance. Please follow the libvirt wiki page[3] for the same.

After editing `qemu.conf`, the `libvirtd` service must be restarted:

```
$ systemctl restart libvirtd.service
```

Changes will not apply to any existing running guests on the Compute node, so this configuration should be done before launching any instances.

[2] https://tools.ietf.org/html/rfc3280#section-4.2.1.10
[1] https://qemu.weilnetz.de/doc/4.2/qemu-doc.html#vnc_005fsec_005fcertificate_005fverify
[3] https://wiki.libvirt.org/page/VNCTLSSetup#Changes_to_be_made_on_the_virtualisation_host_server

noVNC proxy server configuration

The noVNC proxy server initially only supports the `none` authentication scheme, which does no checking. Therefore, it is necessary to enable the `vencrypt` authentication scheme by editing the `nova.conf` file to set.

```
[vnc]
auth_schemes=vencrypt,none
```

The *vnc.auth_schemes* values should be listed in order of preference. If enabling VeNCrypt on an existing deployment which already has instances running, the noVNC proxy server must initially be allowed to use `vencrypt` and `none`. Once it is confirmed that all Compute nodes have VeNCrypt enabled for VNC, it is possible to remove the `none` option from the list of the *vnc.auth_schemes* values.

At that point, the noVNC proxy will refuse to connect to any Compute node that does not offer VeNCrypt.

As well as enabling the authentication scheme, it is necessary to provide certificates to the noVNC proxy.

- `/etc/pki/nova-novncproxy/client-cert.pem`

  An x509 certificate to be presented **to the VNC server**. While libvirt/QEMU will not currently do any validation of the `CommonName` field, future versions will allow for setting up access controls based on the `CommonName`. The `CommonName` field should match the **primary hostname of the controller node**. If using a HA deployment, the `Organization` field can also be configured to a value that is common across all console proxy instances in the deployment. This avoids the need to modify each compute nodes whitelist every time a console proxy instance is added or removed.

- `/etc/pki/nova-novncproxy/client-key.pem`

  The private key used to generate the `client-cert.pem` file.

- `/etc/pki/nova-novncproxy/ca-cert.pem`

  The certificate authority cert used to sign `client-cert.pem` and sign the compute node VNC server certificates.

The certificates must have v3 basic constraints[Page 266, 2] present to indicate the permitted key use and purpose data.

Once the certificates have been created, the noVNC console proxy service must be told where to find them. This requires editing `nova.conf` to set.

```
[vnc]
vencrypt_client_key=/etc/pki/nova-novncproxy/client-key.pem
vencrypt_client_cert=/etc/pki/nova-novncproxy/client-cert.pem
vencrypt_ca_certs=/etc/pki/nova-novncproxy/ca-cert.pem
```

SPICE console

The VNC protocol is fairly limited, lacking support for multiple monitors, bi-directional audio, reliable cut-and-paste, video streaming and more. SPICE is a new protocol that aims to address the limitations in VNC and provide good remote desktop support.

SPICE support in OpenStack Compute shares a similar architecture to the VNC implementation. The OpenStack dashboard uses a SPICE-HTML5 widget in its console tab that communicates with the **`nova-spicehtml5proxy`** service by using SPICE-over-websockets. The **`nova-spicehtml5proxy`** service communicates directly with the hypervisor process by using SPICE.

Configuration

Important

VNC must be explicitly disabled to get access to the SPICE console. Set the *vnc.enabled* option to `False` to disable the VNC console.

To enable the SPICE console service, you must configure both the **nova-spicehtml5proxy** service and the **nova-compute** service. Most options are defined in the *spice* group.

The **nova-spicehtml5proxy** service accepts the following options.

- *daemon*
- *ssl_only*
- *source_is_ipv6*
- *cert*
- *key*
- *web*
- *console.ssl_ciphers*
- *console.ssl_minimum_version*
- *spice.html5proxy_host*
- *spice.html5proxy_port*

For example, to configure this via a `nova-spicehtml5proxy.conf` file:

```
[spice]
html5proxy_host = 0.0.0.0
html5proxy_port = 6082
```

The **nova-compute** service requires the following options to configure SPICE console support.

- *spice.enabled*
- *spice.agent_enabled*
- *spice.html5proxy_base_url*
- *spice.server_listen*
- *spice.server_proxyclient_address*

For example, to configure this via a `nova.conf` file:

```
[spice]
agent_enabled = False
enabled = True
html5proxy_base_url = http://IP_ADDRESS:6082/spice_auto.html
server_listen = 127.0.0.1
server_proxyclient_address = 127.0.0.1
```

Replace `IP_ADDRESS` with the IP address from which the proxy is accessible by the outside world. For example, this may be the management interface IP address of the controller or the VIP.

Optionally, the **`nova-compute`** service supports the following additional options to configure compression settings (algorithms and modes) for SPICE consoles.

- *`spice.image_compression`*
- *`spice.jpeg_compression`*
- *`spice.zlib_compression`*
- *`spice.playback_compression`*
- *`spice.streaming_mode`*

As well as the following option to require that connections be protected by TLS:

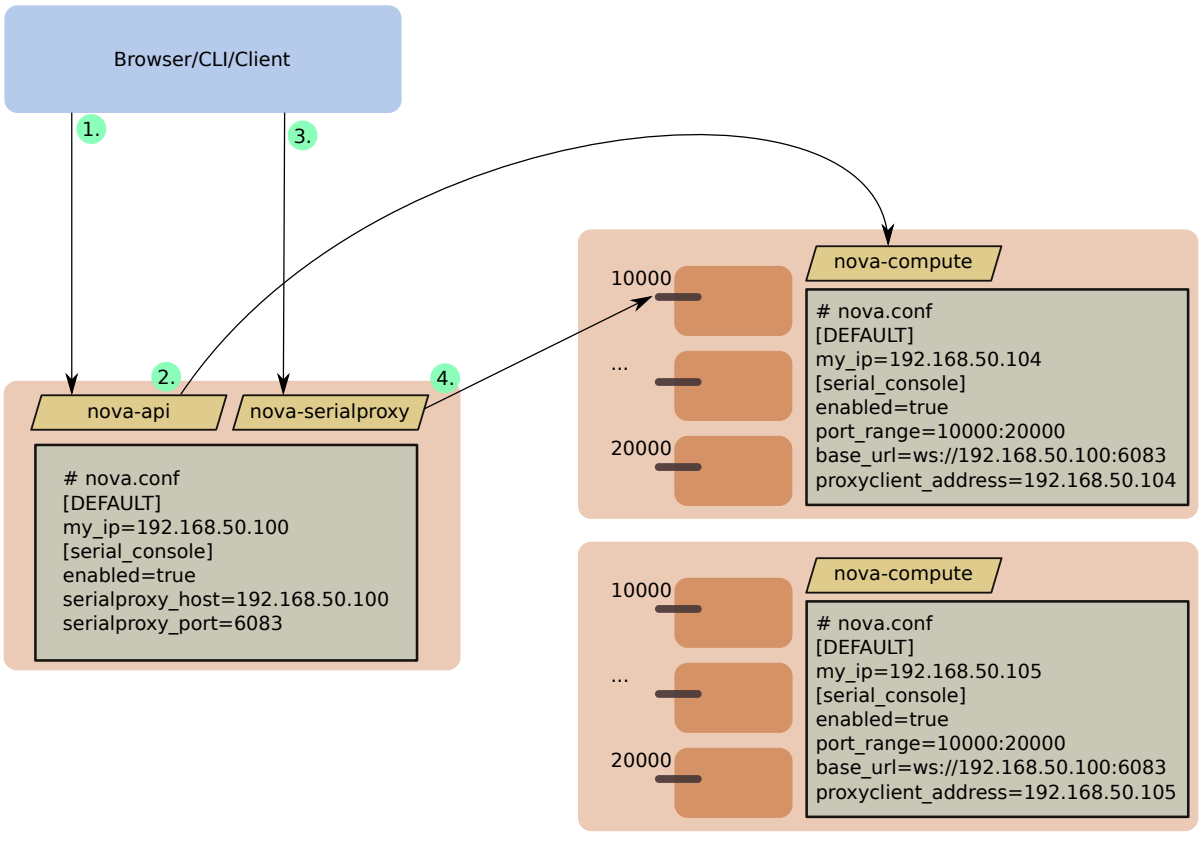
- *`spice.require_secure`*

Serial console

Serial consoles provide an alternative to graphical consoles like VNC or SPICE. They work a little differently to graphical consoles so an example is beneficial. The example below uses these nodes:

- controller node with IP `192.168.50.100`
- compute node 1 with IP `192.168.50.104`
- compute node 2 with IP `192.168.50.105`

Heres the general flow of actions:



1. The user requests a serial console connection string for an instance from the REST API.

2. The Compute API service asks the **nova-compute** service, which manages that instance, to fulfill that request.
3. That connection string gets used by the user to connect to the **nova-serialproxy** service.
4. The **nova-serialproxy** service then proxies the console interaction to the port of the compute node where the instance is running. That port gets forwarded by the hypervisor (or ironic conductor, for ironic) to the guest.

Configuration

To enable the serial console service, you must configure both the **nova-serialproxy** service and the **nova-compute** service. Most options are defined in the *serial_console* group.

The **nova-serialproxy** service accepts the following options.

- *daemon*
- *ssl_only*
- *source_is_ipv6*
- *cert*
- *key*
- *web*
- *console.ssl_ciphers*
- *console.ssl_minimum_version*
- *serial_console.serialproxy_host*
- *serial_console.serialproxy_port*

For example, to configure this via a `nova-serialproxy.conf` file:

```
[serial_console]
serialproxy_host = 0.0.0.0
serialproxy_port = 6083
```

The **nova-compute** service requires the following options to configure serial console support.

- *serial_console.enabled*
- *serial_console.base_url*
- *serial_console.proxyclient_address*
- *serial_console.port_range*

For example, to configure this via a `nova.conf` file:

```
[serial_console]
enabled = True
base_url = ws://IP_ADDRESS:6083/
proxyclient_address = 127.0.0.1
port_range = 10000:20000
```

Replace `IP_ADDRESS` with the IP address from which the proxy is accessible by the outside world. For example, this may be the management interface IP address of the controller or the VIP.

There are some things to keep in mind when configuring these options:

- *serial_console.serialproxy_host* is the address the **nova-serialproxy** service listens to for incoming connections.
- *serial_console.serialproxy_port* must be the same value as the port in the URI of *serial_console.base_url*.
- The URL defined in *serial_console.base_url* will form part of the response the user will get when asking for a serial console connection string. This means it needs to be an URL the user can connect to.
- *serial_console.proxyclient_address* will be used by the **nova-serialproxy** service to determine where to connect to for proxying the console interaction.

MKS console

MKS is the protocol used for accessing the console of a virtual machine running on VMware vSphere. It is very similar to VNC. Due to the architecture of the VMware vSphere hypervisor, it is not necessary to run a console proxy service.

Configuration

To enable the MKS console service, only the **nova-compute** service must be configured. All options are defined in the *mks* group.

The **nova-compute** service requires the following options to configure MKS console support.

- *mks.enabled*
- *mks.mksproxy_base_url*

For example, to configure this via a `nova.conf` file:

```
[mks]
enabled = True
mksproxy_base_url = https://127.0.0.1:6090/
```

About nova-consoleauth

The now-removed **nova-consoleauth** service was previously used to provide a shared service to manage token authentication that the client proxies outlined below could leverage. Token authentication was moved to the database in 18.0.0 (Rocky) and the service was removed in 20.0.0 (Train).

Frequently Asked Questions

- **Q: I want VNC support in the OpenStack dashboard. What services do I need?**

  A: You need `nova-novncproxy` and correctly configured compute hosts.

- **Q: My VNC proxy worked fine during my all-in-one test, but now it doesnt work on multi host. Why?**

  A: The default options work for an all-in-one install, but changes must be made on your compute hosts once you start to build a cluster. As an example, suppose you have two servers:

```
PROXYSERVER (public_ip=172.24.1.1, management_ip=192.168.1.1)
COMPUTESERVER (management_ip=192.168.1.2)
```

Your `nova-compute` configuration file must set the following values:

```
[vnc]
# These flags help construct a connection data structure
server_proxyclient_address=192.168.1.2
novncproxy_base_url=http://172.24.1.1:6080/vnc_auto.html

# This is the address where the underlying vncserver (not the proxy)
# will listen for connections.
server_listen=192.168.1.2
```

Note

`novncproxy_base_url` uses a public IP; this is the URL that is ultimately returned to clients, which generally do not have access to your private network. Your PROXYSERVER must be able to reach `server_proxyclient_address`, because that is the address over which the VNC connection is proxied.

- **Q: My noVNC does not work with recent versions of web browsers. Why?**

  A: Make sure you have installed `python-numpy`, which is required to support a newer version of the WebSocket protocol (HyBi-07+).

- **Q: How do I adjust the dimensions of the VNC window image in the OpenStack dashboard?**

  A: These values are hard-coded in a Django HTML template. To alter them, edit the `_detail_vnc.html` template file. The location of this file varies based on Linux distribution. On Ubuntu 14.04, the file is at `/usr/share/pyshared/horizon/dashboards/nova/instances/templates/instances/_detail_vnc.html`.

  Modify the `width` and `height` options, as follows:

```
<iframe src="{{ vnc_url }}" width="720" height="430"></iframe>
```

- **Q: My noVNC connections failed with ValidationError: Origin header protocol does not match. Why?**

  A: Make sure the `base_url` match your TLS setting. If you are using https console connections, make sure that the value of `novncproxy_base_url` is set explicitly where the `nova-novncproxy` service is running.

- **Q: How do I know which nova config file to update to set a particular config option?**

  A: First, find out which nova-service is responsible for the change you want to make, using `ps -aux | grep nova`. Once the service is found, check the status of the service via systemctl. In the status output, associated conf files with respective paths will be listed.

References

Compute schedulers

Compute uses the `nova-scheduler` service to determine how to dispatch compute requests. For example, the `nova-scheduler` service determines on which host or node a VM should launch. You can configure the scheduler through a variety of options.

In the default configuration, this scheduler considers hosts that meet all the following criteria:

- Are in the requested *Availability Zone* (`map_az_to_placement_aggregate`) placement pre filter.
- Can service the request meaning the nova-compute service handling the target node is available and not disabled (`ComputeFilter`).
- Satisfy the extra specs associated with the instance type (`ComputeCapabilitiesFilter`).
- Satisfy any architecture, hypervisor type, or virtual machine mode properties specified on the instances image properties (`ImagePropertiesFilter`).
- Are on a different host than other instances of a group (if requested) (`ServerGroupAntiAffinityFilter`).
- Are in a set of group hosts (if requested) (`ServerGroupAffinityFilter`).

The scheduler chooses a new host when an instance is migrated, resized, evacuated or unshelved after being shelve offloaded.

When evacuating instances from a host, the scheduler service honors the target host defined by the administrator on the **`nova evacuate`** command. If a target is not defined by the administrator, the scheduler determines the target host. For information about instance evacuation, see *Evacuate instances*.

Prefilters

As of the Rocky release, the scheduling process includes a prefilter step to increase the efficiency of subsequent stages. These *prefilters* are largely optional and serve to augment the request that is sent to placement to reduce the set of candidate compute hosts based on attributes that placement is able to answer for us ahead of time. In addition to the prefilters listed here, also see *Tenant Isolation with Placement* and *Availability Zones with Placement*.

Compute Image Type Support

Added in version 20.0.0: (Train)

Starting in the Train release, there is a prefilter available for excluding compute nodes that do not support the `disk_format` of the image used in a boot request. This behavior is enabled by setting *`scheduler.query_placement_for_image_type_support`* to `True`. For example, the libvirt driver, when using ceph as an ephemeral backend, does not support `qcow2` images (without an expensive conversion step). In this case (and especially if you have a mix of ceph and non-ceph backed computes), enabling this feature will ensure that the scheduler does not send requests to boot a `qcow2` image to computes backed by ceph.

Compute Disabled Status Support

Added in version 20.0.0: (Train)

Starting in the Train release, there is a mandatory pre-filter which will exclude disabled compute nodes similar to (but does not fully replace) the *ComputeFilter*. Compute node resource providers with the `COMPUTE_STATUS_DISABLED` trait will be excluded as scheduling candidates. The trait is managed by the `nova-compute` service and should mirror the `disabled` status on the related compute service record in the os-services API. For example, if a compute services status is `disabled`, the related compute node resource provider(s) for that service should have the `COMPUTE_STATUS_DISABLED` trait. When the service status is `enabled` the `COMPUTE_STATUS_DISABLED` trait shall be removed.

If the compute service is down when the status is changed, the trait will be synchronized by the compute service when it is restarted. Similarly, if an error occurs when trying to add or remove the trait on a given resource provider, the trait will be synchronized when the `update_available_resource` periodic task runs - which is controlled by the *`update_resources_interval`* configuration option.

Isolate Aggregates

Added in version 20.0.0: (Train)

Starting in the Train release, there is an optional placement pre-request filter *Filtering hosts by isolating aggregates* When enabled, the traits required in the servers flavor and image must be at least those required in an aggregates metadata in order for the server to be eligible to boot on hosts in that aggregate.

The Filter Scheduler

Changed in version 23.0.0: (Wallaby)

Support for custom scheduler drivers was removed. Only the filter scheduler is now supported by nova.

Novas scheduler, known as the *filter scheduler*, supports filtering and weighting to make informed decisions on where a new instance should be created.

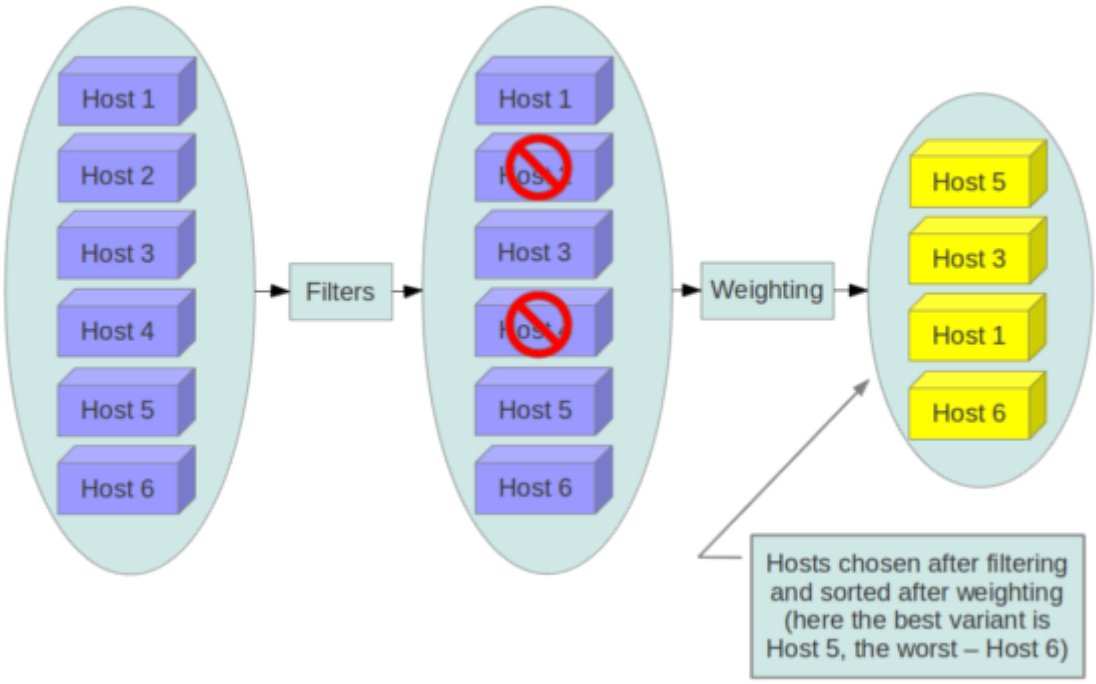
When the scheduler receives a request for a resource, it first applies filters to determine which hosts are eligible for consideration when dispatching a resource. Filters are binary: either a host is accepted by the filter, or it is rejected. Hosts that are accepted by the filter are then processed by a different algorithm to decide which hosts to use for that request, described in the *Weights* section.

Filtering

The *`filter_scheduler.available_filters`* config option provides the Compute service with the list of the filters that are available for use by the scheduler. The default setting specifies all of the filters that are included with the Compute service. This configuration option can be specified multiple times. For example, if you implemented your own custom filter in Python called `myfilter.MyFilter` and you wanted to use both the built-in filters and your custom filter, your `nova.conf` file would contain:

```
[filter_scheduler]
available_filters = nova.scheduler.filters.all_filters
available_filters = myfilter.MyFilter
```

The *`filter_scheduler.enabled_filters`* configuration option in `nova.conf` defines the list of filters that are applied by the `nova-scheduler` service.



Filters

The following sections describe the available compute filters.

Filters are configured using the following config options:

- *filter_scheduler.available_filters* - Defines filter classes made available to the scheduler. This setting can be used multiple times.
- *filter_scheduler.enabled_filters* - Of the available filters, defines those that the scheduler uses by default.

Each filter selects hosts in a different way and has different costs. The order of *filter_scheduler.enabled_filters* affects scheduling performance. The general suggestion is to filter out invalid hosts as soon as possible to avoid unnecessary costs. We can sort *filter_scheduler.enabled_filters* items by their costs in reverse order. For example, `ComputeFilter` is better before any resource calculating filters like `NUMATopologyFilter`.

`AggregateImagePropertiesIsolation`

Changed in version 12.0.0: (Liberty)

Prior to 12.0.0 Liberty, it was possible to specify and use arbitrary metadata with this filter. Starting in Liberty, nova only parses standard metadata. If you wish to use arbitrary metadata, consider using the *AggregateInstanceExtraSpecsFilter* filter instead.

Matches properties defined in an images metadata against those of aggregates to determine host matches:

- If a host belongs to an aggregate and the aggregate defines one or more metadata that matches an images properties, that host is a candidate to boot the images instance.
- If a host does not belong to any aggregate, it can boot instances from all images.

For example, the following aggregate `myWinAgg` has the Windows operating system as metadata (named windows):

```
$ openstack aggregate show myWinAgg
+-------------------+----------------------------+
| Field             | Value                      |
+-------------------+----------------------------+
| availability_zone | zone1                      |
| created_at        | 2017-01-01T15:36:44.000000 |
| deleted           | False                      |
| deleted_at        | None                       |
| hosts             | ['sf-devel']               |
| id                | 1                          |
| name              | myWinAgg                   |
| properties        | os_distro='windows'        |
| updated_at        | None                       |
+-------------------+----------------------------+
```

In this example, because the following Win-2012 image has the `windows` property, it boots on the `sf-devel` host (all other filters being equal):

```
$ openstack image show Win-2012
+------------------+------------------------------------------------------+
| Field            | Value                                                |
+------------------+------------------------------------------------------+
| checksum         | ee1eca47dc88f4879d8a229cc70a07c6                     |
| container_format | bare                                                 |
| created_at       | 2016-12-13T09:30:30Z                                 |
| disk_format      | qcow2                                                |
| ...              |                                                      |
| name             | Win-2012                                             |
| ...              |                                                      |
| properties       | os_distro='windows'                                  |
| ...              |                                                      |
```

You can configure the `AggregateImagePropertiesIsolation` filter by using the following options in the `nova.conf` file:

- *filter_scheduler.aggregate_image_properties_isolation_namespace*
- *filter_scheduler.aggregate_image_properties_isolation_separator*

Note

This filter has limitations as described in bug 1677217 which are addressed in placement *Filtering hosts by isolating aggregates* request filter.

Refer to *Host aggregates* for more information.

AggregateInstanceExtraSpecsFilter

Matches properties defined in extra specs for an instance type against admin-defined properties on a host aggregate. Works with specifications that are scoped with `aggregate_instance_extra_specs`. Multiple values can be given, as a comma-separated list. For backward compatibility, also works with non-scoped specifications; this action is highly discouraged because it conflicts with *ComputeCapabilitiesFilter* filter when you enable both filters.

Refer to *Host aggregates* for more information.

AggregateIoOpsFilter

Filters host by disk allocation with a per-aggregate `max_io_ops_per_host` value. If the per-aggregate value is not found, the value falls back to the global setting defined by the *`filter_scheduler.max_io_ops_per_host`* config option. If the host is in more than one aggregate and more than one value is found, the minimum value will be used.

Refer to *Host aggregates* and *IoOpsFilter* for more information.

AggregateMultiTenancyIsolation

Ensures hosts in tenant-isolated host aggregates will only be available to a specified set of tenants. If a host is in an aggregate that has the `filter_tenant_id` metadata key, the host can build instances from only that tenant or comma-separated list of tenants. A host can be in different aggregates. If a host does not belong to an aggregate with the metadata key, the host can build instances from all tenants. This does not restrict the tenant from creating servers on hosts outside the tenant-isolated aggregate.

For example, consider there are two available hosts for scheduling, `HostA` and `HostB`. `HostB` is in an aggregate isolated to tenant `X`. A server create request from tenant `X` will result in either `HostA` *or* `HostB` as candidates during scheduling. A server create request from another tenant `Y` will result in only `HostA` being a scheduling candidate since `HostA` is not part of the tenant-isolated aggregate.

AggregateNumInstancesFilter

Filters host in an aggregate by number of instances with a per-aggregate `max_instances_per_host` value. If the per-aggregate value is not found, the value falls back to the global setting defined by the *`filter_scheduler.max_instances_per_host`* config option. If the host is in more than one aggregate and thus more than one value is found, the minimum value will be used.

Refer to *Host aggregates* and *NumInstancesFilter* for more information.

AggregateTypeAffinityFilter

Filters hosts in an aggregate if the name of the instances flavor matches that of the `instance_type` key set in the aggregates metadata or if the `instance_type` key is not set.

The value of the `instance_type` metadata entry is a string that may contain either a single `instance_type` name or a comma-separated list of `instance_type` names, such as `m1.nano` or `m1.nano,m1.small`.

Note

Instance types are a historical name for flavors.

Refer to *Host aggregates* for more information.

AllHostsFilter

This is a no-op filter. It does not eliminate any of the available hosts.

ComputeCapabilitiesFilter

Filters hosts by matching properties defined in flavor extra specs against compute capabilities. If an extra specs key contains a colon (`:`), anything before the colon is treated as a namespace and anything after the colon is treated as the key to be matched. If a namespace is present and is not `capabilities`, the filter ignores the namespace. For example `capabilities:cpu_info:features` is a valid scope format. For backward compatibility, the filter also treats the extra specs key as the key to be matched if no namespace is present; this action is highly discouraged because it conflicts with *AggregateInstanceExtraSpecsFilter* filter when you enable both filters.

The extra specifications can have an operator at the beginning of the value string of a key/value pair. If there is no operator specified, then a default operator of `s==` is used. Valid operators are:

- = (equal to or greater than as a number; same as vcpus case)
- == (equal to as a number)
- `!=` (not equal to as a number)
- >= (greater than or equal to as a number)
- <= (less than or equal to as a number)
- `s==` (equal to as a string)
- `s!=` (not equal to as a string)
- `s>=` (greater than or equal to as a string)
- `s>` (greater than as a string)
- `s<=` (less than or equal to as a string)
- `s<` (less than as a string)
- `<in>` (substring)
- `<all-in>` (all elements contained in collection)
- `<or>` (find one of these)

Examples are: `>= 5`, `s== 2.1.0`, `<in> gcc`, `<all-in> aes mmx`, and `<or> fpu <or> gpu`

Some of attributes that can be used as useful key and their values contains:

- `free_ram_mb` (compared with a number, values like `>= 4096`)
- `free_disk_mb` (compared with a number, values like `>= 10240`)
- `host` (compared with a string, values like `<in> compute`, `s== compute_01`)
- `hypervisor_type` (compared with a string, values like `s== QEMU`, `s== ironic`)
- `hypervisor_version` (compared with a number, values like `>= 1005003`, `== 2000000`)
- `num_instances` (compared with a number, values like `<= 10`)

- `num_io_ops` (compared with a number, values like <= `5`)
- `vcpus_total` (compared with a number, values like = `48`, >=`24`)
- `vcpus_used` (compared with a number, values like = `0`, <= `10`)

Some virt drivers support reporting CPU traits to the Placement service. With that feature available, you should consider using traits in flavors instead of `ComputeCapabilitiesFilter` because traits provide consistent naming for CPU features in some virt drivers and querying traits is efficient. For more details, refer to *Feature Support Matrix*, *Required traits*, *Forbidden traits* and Report CPU features to the Placement service.

Also refer to *Compute capabilities as traits*.

ComputeFilter

Passes all hosts that are operational and enabled.

In general, you should always enable this filter.

DifferentHostFilter

Schedules the instance on a different host from a set of instances. To take advantage of this filter, the requester must pass a scheduler hint, using `different_host` as the key and a list of instance UUIDs as the value. This filter is the opposite of the `SameHostFilter`.

For example, when using the **`openstack server create`** command, use the `--hint` flag:

```
$ openstack server create \
  --image cedef40a-ed67-4d10-800e-17455edce175 --flavor 1 \
  --hint different_host=a0cf03a5-d921-4877-bb5c-86d26cf818e1 \
  --hint different_host=8c19174f-4220-44f0-824a-cd1eeef10287 \
  server-1
```

With the API, use the `os:scheduler_hints` key. For example:

```
{
    "server": {
        "name": "server-1",
        "imageRef": "cedef40a-ed67-4d10-800e-17455edce175",
        "flavorRef": "1"
    },
    "os:scheduler_hints": {
        "different_host": [
            "a0cf03a5-d921-4877-bb5c-86d26cf818e1",
            "8c19174f-4220-44f0-824a-cd1eeef10287"
        ]
    }
}
```

ImagePropertiesFilter

Filters hosts based on properties defined on the instances image. It passes hosts that can support the specified image properties contained in the instance. Properties include the architecture, hypervisor type, hypervisor version, and virtual machine mode.

For example, an instance might require a host that runs an ARM-based processor, and QEMU as the hypervisor. You can decorate an image with these properties by using:

```
$ openstack image set --architecture arm --property img_hv_type=qemu \
  img-uuid
```

The image properties that the filter checks for are:

hw_architecture
: Describes the machine architecture required by the image. Examples are `i686`, `x86_64`, `arm`, and `ppc64`.

  Changed in version 12.0.0: (Liberty)

  This was previously called `architecture`.

img_hv_type
: Describes the hypervisor required by the image. Examples are `qemu`.

  Note

  `qemu` is used for both QEMU and KVM hypervisor types.

  Changed in version 12.0.0: (Liberty)

  This was previously called `hypervisor_type`.

img_hv_requested_version
: Describes the hypervisor version required by the image. The property is supported for HyperV hypervisor type only. It can be used to enable support for multiple hypervisor versions, and to prevent instances with newer HyperV tools from being provisioned on an older version of a hypervisor. If available, the property value is compared to the hypervisor version of the compute host.

  To filter the hosts by the hypervisor version, add the `img_hv_requested_version` property on the image as metadata and pass an operator and a required hypervisor version as its value:

  ```
  $ openstack image set --property hypervisor_type=qemu --property \
    hypervisor_version_requires=">=6000" img-uuid
  ```

  Changed in version 12.0.0: (Liberty)

  This was previously called `hypervisor_version_requires`.

hw_vm_mode
: describes the hypervisor application binary interface (ABI) required by the image. Examples are `xen` for Xen 3.0 paravirtual ABI, `hvm` for native ABI, and `exe` for container virt executable ABI.

  Changed in version 12.0.0: (Liberty)

  This was previously called `vm_mode`.

IsolatedHostsFilter

Allows the admin to define a special (isolated) set of images and a special (isolated) set of hosts, such that the isolated images can only run on the isolated hosts, and the isolated hosts can only run isolated images. The flag `restrict_isolated_hosts_to_isolated_images` can be used to force isolated hosts to only run isolated images.

The logic within the filter depends on the `restrict_isolated_hosts_to_isolated_images` config option, which defaults to True. When True, a volume-backed instance will not be put on an isolated host. When False, a volume-backed instance can go on any host, isolated or not.

The admin must specify the isolated set of images and hosts using the *filter_scheduler.isolated_hosts* and *filter_scheduler.isolated_images* config options. For example:

```
[filter_scheduler]
isolated_hosts = server1, server2
isolated_images = 342b492c-128f-4a42-8d3a-c5088cf27d13, ebd267a6-ca86-4d6c-
↪9a0e-bd132d6b7d09
```

You can also specify that isolated host only be used for specific isolated images using the *filter_scheduler.restrict_isolated_hosts_to_isolated_images* config option.

IoOpsFilter

Filters hosts by concurrent I/O operations on it. Hosts with too many concurrent I/O operations will be filtered out. The *filter_scheduler.max_io_ops_per_host* option specifies the maximum number of I/O intensive instances allowed to run on a host. A host will be ignored by the scheduler if more than *filter_scheduler.max_io_ops_per_host* instances in build, resize, snapshot, migrate, rescue or unshelve task states are running on it.

JsonFilter

Warning

This filter is not enabled by default and not comprehensively tested, and thus could fail to work as expected in non-obvious ways. Furthermore, the filter variables are based on attributes of the HostState class which could change from release to release so usage of this filter is generally not recommended. Consider using other filters such as the *ImagePropertiesFilter* or *traits-based scheduling*.

Allows a user to construct a custom filter by passing a scheduler hint in JSON format. The following operators are supported:

- =
- <
- >
- in
- <=
- >=
- not

- or
- and

Unlike most other filters that rely on information provided via scheduler hints, this filter filters on attributes in the HostState class such as the following variables:

- $free_ram_mb
- $free_disk_mb
- $hypervisor_hostname
- $total_usable_ram_mb
- $vcpus_total
- $vcpus_used

Using the **openstack server create** command, use the --hint flag:

```
$ openstack server create --image 827d564a-e636-4fc4-a376-d36f7ebe1747 \
  --flavor 1 --hint query='[">=","$free_ram_mb",1024]' server1
```

With the API, use the os:scheduler_hints key:

```
{
    "server": {
        "name": "server-1",
        "imageRef": "cedef40a-ed67-4d10-800e-17455edce175",
        "flavorRef": "1"
    },
    "os:scheduler_hints": {
        "query": "[\">=\",\"$free_ram_mb\",1024]"
    }
}
```

MetricsFilter

Use in collaboration with the MetricsWeigher weigher. Filters hosts that do not report the metrics specified in *metrics.weight_setting*, thus ensuring the metrics weigher will not fail due to these hosts.

NUMATopologyFilter

Filters hosts based on the NUMA topology that was specified for the instance through the use of flavor extra_specs in combination with the image properties, as described in detail in *CPU topologies*. The filter will try to match the exact NUMA cells of the instance to those of the host. It will consider the standard over-subscription limits for each host NUMA cell, and provide limits to the compute host accordingly.

This filter is essential if using instances with features that rely on NUMA, such as instance NUMA topologies or CPU pinning.

Note

If instance has no topology defined, it will be considered for any host. If instance has a topology defined, it will be considered only for NUMA capable hosts.

NumInstancesFilter

Filters hosts based on the number of instances running on them. Hosts that have more instances running than specified by the *filter_scheduler.max_instances_per_host* config option are filtered out.

PciPassthroughFilter

The filter schedules instances on a host if the host has devices that meet the device requests in the `extra_specs` attribute for the flavor.

This filter is essential if using instances with PCI device requests or where SR-IOV-based networking is in use on hosts.

SameHostFilter

Schedules an instance on the same host as all other instances in a set of instances. To take advantage of this filter, the requester must pass a scheduler hint, using `same_host` as the key and a list of instance UUIDs as the value. This filter is the opposite of the `DifferentHostFilter`.

For example, when using the **`openstack server create`** command, use the `--hint` flag:

```
$ openstack server create \
  --image cedef40a-ed67-4d10-800e-17455edce175 --flavor 1 \
  --hint same_host=a0cf03a5-d921-4877-bb5c-86d26cf818e1 \
  --hint same_host=8c19174f-4220-44f0-824a-cd1eeef10287 \
  server-1
```

With the API, use the `os:scheduler_hints` key:

```
{
    "server": {
        "name": "server-1",
        "imageRef": "cedef40a-ed67-4d10-800e-17455edce175",
        "flavorRef": "1"
    },
    "os:scheduler_hints": {
        "same_host": [
            "a0cf03a5-d921-4877-bb5c-86d26cf818e1",
            "8c19174f-4220-44f0-824a-cd1eeef10287"
        ]
    }
}
```

ServerGroupAffinityFilter

Restricts instances belonging to a server group to the same host(s). To take advantage of this filter, the requester must create a server group with an `affinity` policy, and pass a scheduler hint, using `group` as the key and the server group UUID as the value.

For example, when using the **`openstack server create`** command, use the `--hint` flag:

```
$ openstack server group create --policy affinity group-1
$ openstack server create --image IMAGE_ID --flavor 1 \
    --hint group=SERVER_GROUP_UUID server-1
```

For more information on server groups, refer to *Server Groups*.

ServerGroupAntiAffinityFilter

Restricts instances belonging to a server group to separate hosts. To take advantage of this filter, the requester must create a server group with an `anti-affinity` policy, and pass a scheduler hint, using `group` as the key and the server group UUID as the value.

For example, when using the **`openstack server create`** command, use the `--hint` flag:

```
$ openstack server group create --policy anti-affinity group-1
$ openstack server create --image IMAGE_ID --flavor 1 \
    --hint group=SERVER_GROUP_UUID server-1
```

For more information on server groups, refer to *Server Groups*.

SimpleCIDRAffinityFilter

Todo

Does this filter still work with neutron?

Schedules the instance based on host IP subnet range. To take advantage of this filter, the requester must specify a range of valid IP address in CIDR format, by passing two scheduler hints:

`build_near_host_ip`
: The first IP address in the subnet (for example, `192.168.1.1`)

`cidr`
: The CIDR that corresponds to the subnet (for example, `/24`)

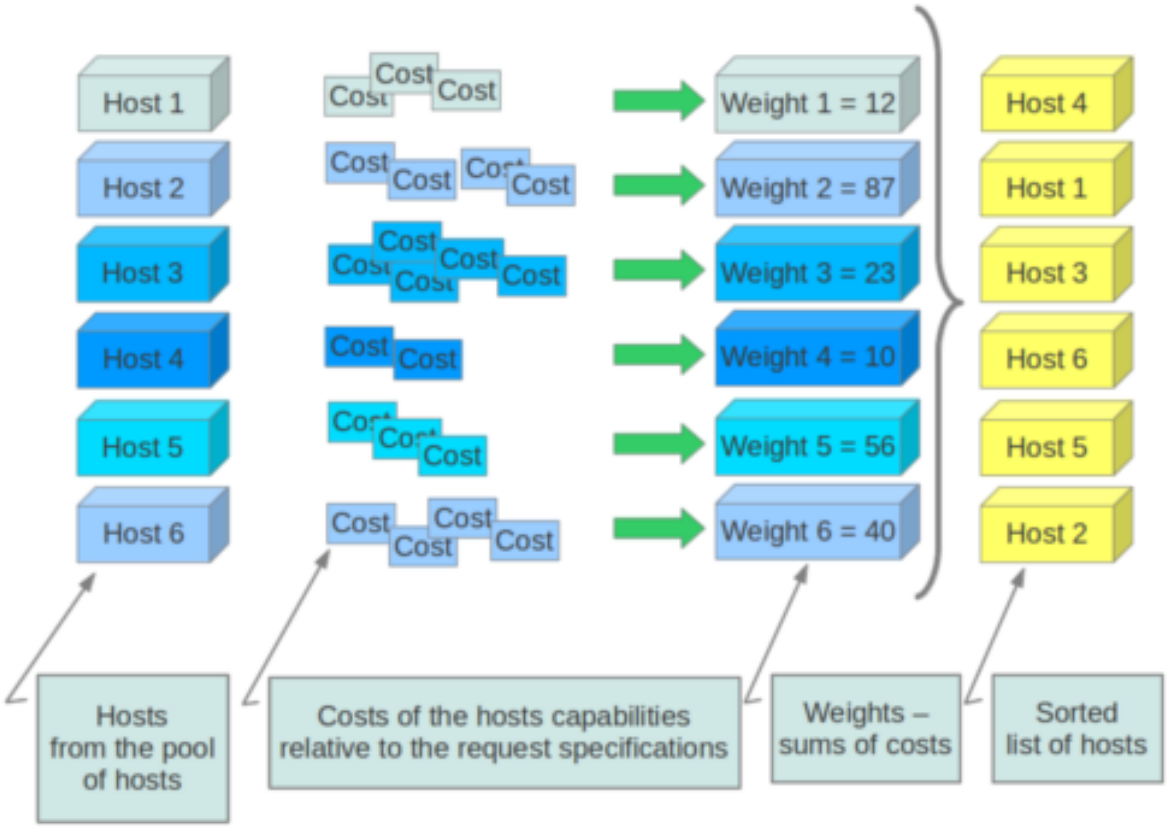
When using the **`openstack server create`** command, use the `--hint` flag. For example, to specify the IP subnet `192.168.1.1/24`:

```
$ openstack server create \
  --image cedef40a-ed67-4d10-800e-17455edce175 --flavor 1 \
  --hint build_near_host_ip=192.168.1.1 --hint cidr=/24 \
  server-1
```

With the API, use the `os:scheduler_hints` key:

```
{
    "server": {
        "name": "server-1",
        "imageRef": "cedef40a-ed67-4d10-800e-17455edce175",
        "flavorRef": "1"
    },
    "os:scheduler_hints": {
        "build_near_host_ip": "192.168.1.1",
        "cidr": "24"
    }
}
```

Weights



When resourcing instances, the filter scheduler filters and weights each host in the list of acceptable hosts. Each time the scheduler selects a host, it virtually consumes resources on it and subsequent selections are adjusted accordingly. This process is useful when the customer asks for the same large amount of instances because a weight is computed for each requested instance.

In order to prioritize one weigher against another, all the weighers have to define a multiplier that will be applied before computing the weight for a node. All the weights are normalized beforehand so that the multiplier can be applied easily.Therefore the final weight for the object will be:

```
weight = w1_multiplier * norm(w1) + w2_multiplier * norm(w2) + ...
```

Hosts are weighted based on the following config options:

- *filter_scheduler.host_subset_size*
- *filter_scheduler.weight_classes*

RAMWeigher

Compute weight based on available RAM on the compute node. Sort with the largest weight winning. If the multiplier, *filter_scheduler.ram_weight_multiplier*, is negative, the host with least RAM available will win (useful for stacking hosts, instead of spreading).

Starting with the Stein release, if per-aggregate value with the key `ram_weight_multiplier` is found, this value would be chosen as the ram weight multiplier. Otherwise, it will fall back to the *filter_scheduler.ram_weight_multiplier*. If more than one value is found for a host in aggregate metadata, the minimum value will be used.

CPUWeigher

Compute weight based on available vCPUs on the compute node. Sort with the largest weight winning. If the multiplier, *filter_scheduler.cpu_weight_multiplier*, is negative, the host with least CPUs available will win (useful for stacking hosts, instead of spreading).

Starting with the Stein release, if per-aggregate value with the key `cpu_weight_multiplier` is found, this value would be chosen as the cpu weight multiplier. Otherwise, it will fall back to the *filter_scheduler.cpu_weight_multiplier*. If more than one value is found for a host in aggregate metadata, the minimum value will be used.

DiskWeigher

Hosts are weighted and sorted by free disk space with the largest weight winning. If the multiplier is negative, the host with less disk space available will win (useful for stacking hosts, instead of spreading).

Starting with the Stein release, if per-aggregate value with the key `disk_weight_multiplier` is found, this value would be chosen as the disk weight multiplier. Otherwise, it will fall back to the *filter_scheduler.disk_weight_multiplier*. If more than one value is found for a host in aggregate metadata, the minimum value will be used.

MetricsWeigher

This weigher can compute the weight based on the compute node hosts various metrics. The to-be weighed metrics and their weighing ratio are specified using the *metrics.weight_setting* config option. For example:

```
[metrics]
weight_setting = name1=1.0, name2=-1.0
```

You can specify the metrics that are required, along with the weight of those that are not and are not available using the *metrics.required* and *metrics.weight_of_unavailable* config options, respectively.

Starting with the Stein release, if per-aggregate value with the key `metrics_weight_multiplier` is found, this value would be chosen as the metrics weight multiplier. Otherwise, it will fall back to the *metrics.weight_multiplier*. If more than one value is found for a host in aggregate metadata, the minimum value will be used.

IoOpsWeigher

The weigher can compute the weight based on the compute node hosts workload. This is calculated by examining the number of instances in the `building` `vm_state` or in one of the following `task_states`: `resize_migrating`, `rebuilding`, `resize_prep`, `image_snapshot`, `image_backup`, `rescuing`, or `unshelving`. The default is to preferably choose light workload compute hosts. If the multiplier is positive, the weigher prefers choosing heavy workload compute hosts, the weighing has the opposite effect of the default.

Starting with the Stein release, if per-aggregate value with the key `io_ops_weight_multiplier` is found, this value would be chosen as the IO ops weight multiplier. Otherwise, it will fall back to the *filter_scheduler.io_ops_weight_multiplier*. If more than one value is found for a host in aggregate metadata, the minimum value will be used.

PCIWeigher

Compute a weighting based on the number of PCI devices on the host and the number of PCI devices requested by the instance. For example, given three hosts - one with a single PCI device, one with many PCI devices, and one with no PCI devices - nova should prioritise these differently based on the demands of the instance. If the instance requests a single PCI device, then the first of the hosts should be preferred. Similarly, if the instance requests multiple PCI devices, then the second of these hosts would be preferred. Finally, if the instance does not request a PCI device, then the last of these hosts should be preferred.

For this to be of any value, at least one of the *PciPassthroughFilter* or *NUMATopologyFilter* filters must be enabled.

Starting with the Stein release, if per-aggregate value with the key `pci_weight_multiplier` is found, this value would be chosen as the pci weight multiplier. Otherwise, it will fall back to the *filter_scheduler.pci_weight_multiplier*. If more than one value is found for a host in aggregate metadata, the minimum value will be used.

Important

Only positive values are allowed for the multiplier of this weigher as a negative value would force non-PCI instances away from non-PCI hosts, thus, causing future scheduling issues.

ServerGroupSoftAffinityWeigher

The weigher can compute the weight based on the number of instances that run on the same server group. The largest weight defines the preferred host for the new instance. For the multiplier only a positive value is allowed for the calculation.

Starting with the Stein release, if per-aggregate value with the key `soft_affinity_weight_multiplier` is found, this value would be chosen as the soft affinity weight multiplier. Otherwise, it will fall back to the *filter_scheduler.soft_affinity_weight_multiplier*. If more than one value is found for a host in aggregate metadata, the minimum value will be used.

ServerGroupSoftAntiAffinityWeigher

The weigher can compute the weight based on the number of instances that run on the same server group as a negative value. The largest weight defines the preferred host for the new instance. For the multiplier only a positive value is allowed for the calculation.

Starting with the Stein release, if per-aggregate value with the key `soft_anti_affinity_weight_multiplier` is found, this value would be chosen as the soft anti-affinity weight multiplier. Otherwise, it will fall back to the *filter_scheduler.soft_anti_affinity_weight_multiplier*. If more than one value is found for a host in aggregate metadata, the minimum value will be used.

BuildFailureWeigher

Weigh hosts by the number of recent failed boot attempts. It considers the build failure counter and can negatively weigh hosts with recent failures. This avoids taking computes fully out of rotation.

Starting with the Stein release, if per-aggregate value with the key `build_failure_weight_multiplier` is found, this value would be chosen as the build failure weight multiplier. Otherwise, it will fall back to the *filter_scheduler.build_failure_weight_multiplier*. If more than one value is found for a host in aggregate metadata, the minimum value will be used.

Important

The *filter_scheduler.build_failure_weight_multiplier* option defaults to a very high value. This is intended to offset weight given by other enabled weighers due to available resources, giving this weigher priority. However, not all build failures imply a problem with the host itself - it could be user error - but the failure will still be counted. If you find hosts are frequently reporting build failures and effectively being excluded during scheduling, you may wish to lower the value of the multiplier.

CrossCellWeigher

Added in version 21.0.0: (Ussuri)

Weighs hosts based on which cell they are in. Local cells are preferred when moving an instance.

If per-aggregate value with the key `cross_cell_move_weight_multiplier` is found, this value would be chosen as the cross-cell move weight multiplier. Otherwise, it will fall back to the *filter_scheduler.cross_cell_move_weight_multiplier*. If more than one value is found for a host in aggregate metadata, the minimum value will be used.

HypervisorVersionWeigher

Added in version 28.0.0: (Bobcat)

Weigh hosts by their relative hypervisor version reported by the virt driver.

While the hypervisor_version filed for all virt drivers is an int, each nova virt driver uses a different algorithm to convert the hypervisor-specific version sequence into an int. As such the values are not directly comparable between hosts with different hypervisors.

For example, the ironic virt driver uses the ironic API micro-version as the hypervisor version for a given node. The libvirt driver uses the libvirt version i.e. Libvirt `7.1.123` becomes `700100123` vs Ironic `1.82` becomes 1.

If you have a mixed virt driver deployment in the ironic vs non-ironic case nothing special needs to be done. ironic nodes are scheduled using custom resource classes so ironic flavors will never match non-ironic compute nodes.

If a deployment has multiple non-ironic virt drivers it is recommended to use aggregates to group hosts by virt driver. While this is not strictly required, it is desirable to avoid bias towards one virt driver. see *Filtering hosts by isolating aggregates* and *AggregateImagePropertiesIsolation* for more information.

The default behavior of the HypervisorVersionWeigher is to select newer hosts. If you prefer to invert the behavior set the *filter_scheduler.hypervisor_version_weight_multiplier* option to a negative number and the weighing has the opposite effect of the default.

NumInstancesWeigher

Added in version 28.0.0: (Bobcat)

This weigher compares hosts and orders them based on their number of instances respectively. By default the weigher is doing nothing but you can change its behaviour by modifying the value of *filter_scheduler.num_instances_weight_multiplier*. A positive value will favor hosts with a larger number of instances (packing strategy) while a negative value will follow a spread strategy that will favor hosts with the lesser number of instances.

ImagePropertiesWeigher

Added in version 31.0.0: (Epoxy)

This weigher compares hosts and orders them based on the existing instances image properties respectively. By default the weigher is doing nothing but you can change its behaviour by modifying the value of *filter_scheduler.image_props_weight_multiplier*. A positive value will favor hosts with the same image properties (packing strategy) while a negative value will follow a spread strategy that will favor hosts not already having instances with those image properties.

You can also use *filter_scheduler.image_props_weight_setting* config option for defining the exact properties you would like to weigh. For example, if you configure `os_distro` to 2 and `hw_machine_type` to 0, then the latter property wont be weighed while the former will count twice. Say you configure `os_distro=10,os_secure_boot=1,os_require_quiesce=0`, then when requesting an instance with an image using those properties, then, for each of the instances already running on the host having an image using at least one of those properties, a match of the same `os_distro` value (eg. `windows` or `linux`) would count 10 times more than a match of the same `os_secure_boot` value (eg. `true` or `false`), while any matches about the same `os_require_quiesce` value wouldnt count. If you define *filter_scheduler.image_props_weight_setting* then any property from the image used for booting wouldnt be counted if not provided in the option value. The resulted host weight would then be multiplied by the value of *filter_scheduler.image_props_weight_multiplier*.

Note

The weigher compares the values of the image properties as strings. If some image properties are lists (eg. hw_numa_nodes), then if the values are ordered differently, then the weigher will consider them as different values.

Utilization-aware scheduling

Warning

This feature is poorly tested and may not work as expected. It may be removed in a future release. Use at your own risk.

It is possible to schedule instances using advanced scheduling decisions. These decisions are made based on enhanced usage statistics encompassing data like memory cache utilization, memory bandwidth utilization, or network bandwidth utilization. This is disabled by default. The administrator can configure how the metrics are weighted in the configuration file by using the *metrics.weight_setting* config option. For example to configure `metric1` with `ratio1` and `metric2` with `ratio2`:

```
[metrics]
weight_setting = "metric1=ratio1, metric2=ratio2"
```

Allocation ratios

Allocation ratios allow for the overcommit of host resources. The following configuration options exist to control allocation ratios per compute node to support this overcommit of resources:

- *cpu_allocation_ratio* allows overriding the `VCPU` inventory allocation ratio for a compute node
- *ram_allocation_ratio* allows overriding the `MEMORY_MB` inventory allocation ratio for a compute node
- *disk_allocation_ratio* allows overriding the `DISK_GB` inventory allocation ratio for a compute node

Prior to the 19.0.0 Stein release, if left unset, the `cpu_allocation_ratio` defaults to 16.0, the `ram_allocation_ratio` defaults to 1.5, and the `disk_allocation_ratio` defaults to 1.0.

Starting with the 19.0.0 Stein release, the following configuration options control the initial allocation ratio values for a compute node:

- *initial_cpu_allocation_ratio* the initial VCPU inventory allocation ratio for a new compute node record, defaults to 16.0
- *initial_ram_allocation_ratio* the initial MEMORY_MB inventory allocation ratio for a new compute node record, defaults to 1.5
- *initial_disk_allocation_ratio* the initial DISK_GB inventory allocation ratio for a new compute node record, defaults to 1.0

Starting with the 27.0.0 Antelope release, the following default values are used for the initial allocation ratio values for a compute node:

- *initial_cpu_allocation_ratio* the initial VCPU inventory allocation ratio for a new compute node record, defaults to 4.0
- *initial_ram_allocation_ratio* the initial MEMORY_MB inventory allocation ratio for a new compute node record, defaults to 1.0
- *initial_disk_allocation_ratio* the initial DISK_GB inventory allocation ratio for a new compute node record, defaults to 1.0

Scheduling considerations

The allocation ratio configuration is used both during reporting of compute node resource provider inventory to the placement service and during scheduling.

Usage scenarios

Since allocation ratios can be set via nova configuration and the placement API, it can be confusing to know which should be used. This really depends on your scenario. A few common scenarios are detailed here.

1. When the deployer wants to **always** set an override value for a resource on a compute node, the deployer should ensure that the *DEFAULT.cpu_allocation_ratio*, *DEFAULT.ram_allocation_ratio* and *DEFAULT.disk_allocation_ratio* configuration options are set to a non-None value. This will make the `nova-compute` service overwrite any externally-set allocation ratio values set via the placement REST API.

2. When the deployer wants to set an **initial** value for a compute node allocation ratio but wants to allow an admin to adjust this afterwards without making any configuration file changes, the deployer should set the *DEFAULT.initial_cpu_allocation_ratio*, *DEFAULT.initial_ram_allocation_ratio* and *DEFAULT.initial_disk_allocation_ratio* configuration options and then manage the allocation ratios using the placement REST API (or osc-placement command line interface). For example:

   ```
   $ openstack resource provider inventory set \
     --resource VCPU:allocation_ratio=1.0 \
     --amend 815a5634-86fb-4e1e-8824-8a631fee3e06
   ```

3. When the deployer wants to **always** use the placement API to set allocation ratios, then the deployer should ensure that the *DEFAULT.cpu_allocation_ratio*, *DEFAULT.ram_allocation_ratio* and *DEFAULT.disk_allocation_ratio* configuration options are set to a None and then manage the allocation ratios using the placement REST API (or osc-placement command line interface).

   This scenario is the workaround for bug 1804125.

Changed in version 19.0.0: (Stein)

The *DEFAULT.initial_cpu_allocation_ratio*, *DEFAULT.initial_ram_allocation_ratio* and *DEFAULT.initial_disk_allocation_ratio* configuration options were introduced in Stein. Prior to this release, setting any of *DEFAULT.cpu_allocation_ratio*, *DEFAULT.ram_allocation_ratio* or *DEFAULT.disk_allocation_ratio* to a non-null value would ensure the user-configured value was always overridden.

Hypervisor-specific considerations

Nova provides three configuration options that can be used to set aside some number of resources that will not be consumed by an instance, whether these resources are overcommitted or not:

- *reserved_host_cpus*,
- *reserved_host_memory_mb*
- *reserved_host_disk_mb*

Some virt drivers may benefit from the use of these options to account for hypervisor-specific overhead.

Cells considerations

By default cells are enabled for scheduling new instances but they can be disabled (new schedules to the cell are blocked). This may be useful for users while performing cell maintenance, failures or other interventions. It is to be noted that creating pre-disabled cells and enabling/disabling existing cells should either be followed by a restart or SIGHUP of the nova-scheduler service for the changes to take effect.

Command-line interface

The **nova-manage** command-line client supports the cell-disable related commands. To enable or disable a cell, use **nova-manage cell_v2 update_cell** and to create pre-disabled cells, use **nova-manage cell_v2 create_cell**. See the *Cells v2 Commands* man page for details on command usage.

Compute capabilities as traits

Added in version 19.0.0: (Stein)

The `nova-compute` service will report certain `COMPUTE_*` traits based on its compute driver capabilities to the placement service. The traits will be associated with the resource provider for that compute service. These traits can be used during scheduling by configuring flavors with *Required traits* or *Forbidden traits*. For example, if you have a host aggregate with a set of compute nodes that support multi-attach volumes, you can restrict a flavor to that aggregate by adding the `trait:COMPUTE_VOLUME_MULTI_ATTACH=required` extra spec to the flavor and then restrict the flavor to the aggregate *as normal*.

Here is an example of a libvirt compute node resource provider that is exposing some CPU features as traits, driver capabilities as traits, and a custom trait denoted by the `CUSTOM_` prefix:

```
$ openstack --os-placement-api-version 1.6 resource provider trait list \
> d9b3dbc4-50e2-42dd-be98-522f6edaab3f --sort-column name
+---------------------------------------+
| name                                  |
+---------------------------------------+
| COMPUTE_DEVICE_TAGGING                |
| COMPUTE_NET_ATTACH_INTERFACE          |
| COMPUTE_NET_ATTACH_INTERFACE_WITH_TAG |
| COMPUTE_TRUSTED_CERTS                 |
| COMPUTE_VOLUME_ATTACH_WITH_TAG        |
| COMPUTE_VOLUME_EXTEND                 |
| COMPUTE_VOLUME_MULTI_ATTACH           |
| CUSTOM_IMAGE_TYPE_RBD                 |
| HW_CPU_X86_MMX                        |
| HW_CPU_X86_SSE                        |
| HW_CPU_X86_SSE2                       |
| HW_CPU_X86_SVM                        |
+---------------------------------------+
```

Rules

There are some rules associated with capability-defined traits.

1. The compute service owns these traits and will add/remove them when the `nova-compute` service starts and when the `update_available_resource` periodic task runs, with run intervals controlled by config option *`update_resources_interval`*.

2. The compute service will not remove any custom traits set on the resource provider externally, such as the `CUSTOM_IMAGE_TYPE_RBD` trait in the example above.
3. If compute-owned traits are removed from the resource provider externally, for example by running `openstack resource provider trait delete <rp_uuid>`, the compute service will add its traits again on restart or SIGHUP.
4. If a compute trait is set on the resource provider externally which is not supported by the driver, for example by adding the `COMPUTE_VOLUME_EXTEND` trait when the driver does not support that capability, the compute service will automatically remove the unsupported trait on restart or SIGHUP.
5. Compute capability traits are standard traits defined in the os-traits library.

Further information on capabilities and traits can be found in the *Technical Reference Deep Dives section*.

Writing Your Own Filter

To create **your own filter**, you must inherit from `BaseHostFilter` and implement one method: `host_passes`. This method should return `True` if a host passes the filter and return `False` elsewhere. It takes two parameters:

- the `HostState` object allows to get attributes of the host
- the `RequestSpec` object describes the user request, including the flavor, the image and the scheduler hints

For further details about each of those objects and their corresponding attributes, refer to the codebase (at least by looking at the other filters code) or ask for help in the `#openstack-nova` IRC channel.

In addition, if your custom filter uses non-standard extra specs, you must register validators for these extra specs. Examples of validators can be found in the `nova.api.validation.extra_specs` module. These should be registered via the `nova.api.extra_spec_validator` entrypoint.

The module containing your custom filter(s) must be packaged and available in the same environment(s) that the nova controllers, or specifically the **`nova-scheduler`** and Compute API services, are available in. As an example, consider the following sample package, which is the minimal structure for a standard, setuptools-based Python package:

```
acmefilter/
    acmefilter/
        __init__.py
        validators.py
    setup.py
```

Where `__init__.py` contains:

```
from oslo_log import log as logging
from nova.scheduler import filters

LOG = logging.getLogger(__name__)

class AcmeFilter(filters.BaseHostFilter):

    def host_passes(self, host_state, spec_obj):
        extra_spec = spec_obj.flavor.extra_specs.get('acme:foo')
        LOG.info("Extra spec value was '%s'", extra_spec)
```

(continues on next page)

(continued from previous page)

```
        # do meaningful stuff here...

        return True
```

`validators.py` contains:

```
from nova.api.validation.extra_specs import base

def register():
    validators = [
        base.ExtraSpecValidator(
            name='acme:foo',
            description='My custom extra spec.'
            value={
                'type': str,
                'enum': [
                    'bar',
                    'baz',
                ],
            },
        ),
    ]

    return validators
```

`setup.py` contains:

```
from setuptools import setup

setup(
    name='acmefilter',
    version='0.1',
    description='My custom filter',
    packages=[
        'acmefilter'
    ],
    entry_points={
        'nova.api.extra_spec_validators': [
            'acme = acmefilter.validators',
        ],
    },
)
```

To enable this, you would set the following in `nova.conf`:

```
[filter_scheduler]
available_filters = nova.scheduler.filters.all_filters
available_filters = acmefilter.AcmeFilter
enabled_filters = ComputeFilter,AcmeFilter
```

Note

You **must** add custom filters to the list of available filters using the *filter_scheduler.available_filters* config option in addition to enabling them via the *filter_scheduler.enabled_filters* config option. The default `nova.scheduler.filters.all_filters` value for the former only includes the filters shipped with nova.

With these settings, all of the standard nova filters and the custom `AcmeFilter` filter are available to the scheduler, but just the `ComputeFilter` and `AcmeFilter` will be used on each request.

Writing your own weigher

To create your own weigher, you must inherit from `BaseHostFilter` A weigher can implement both the `weight_multiplier` and `_weight_object` methods or just implement the `weight_objects` method. `weight_objects` method is overridden only if you need access to all objects in order to calculate weights, and it just return a list of weights, and not modify the weight of the object directly, since final weights are normalized and computed by `weight.BaseWeightHandler`.

Config drives

Note

This section provides deployment information about the config drive feature. For end-user information about the config drive feature and instance metadata in general, refer to the *user guide*.

Config drives are special drives that are attached to an instance when it boots. The instance can mount this drive and read files from it to get information that is normally available through *the metadata service*.

There are many use cases for the config drive. One such use case is to pass a networking configuration when you do not use DHCP to assign IP addresses to instances. For example, you might pass the IP address configuration for the instance through the config drive, which the instance can mount and access before you configure the network settings for the instance. Another common reason to use config drives is load. If running something like the OpenStack puppet providers in your instances, they can hit the *metadata servers* every fifteen minutes, simultaneously for every instance you have. They are just checking in, and building facts, but its not insignificant load. With a config drive, that becomes a local (cached) disk read. Finally, using a config drive means youre not dependent on the metadata service being up, reachable, or performing well to do things like reboot your instance that runs cloud-init at the beginning.

Any modern guest operating system that is capable of mounting an ISO 9660 or VFAT file system can use the config drive.

Requirements and guidelines

To use the config drive, you must follow the following requirements for the compute host and image.

Compute host requirements

The following virt drivers support the config drive: libvirt and VMware. The Bare Metal service also supports the config drive.

- To use config drives with libvirt or VMware, you must first install the **genisoimage** package on each compute host. Use the *mkisofs_cmd* config option to set the path where you install the **genisoimage** program. If **genisoimage** is in the same path as the **nova-compute** service, you do not need to set this flag.
- To use config drives with the Bare Metal service, you do not need to prepare anything.

Image requirements

An image built with a recent version of the cloud-init package can automatically access metadata passed through the config drive. The cloud-init package version 0.7.1 works with Ubuntu, Fedora based images (such as Red Hat Enterprise Linux) and openSUSE based images (such as SUSE Linux Enterprise Server). If an image does not have the cloud-init package installed, you must customize the image to run a script that mounts the config drive on boot, reads the data from the drive, and takes appropriate action such as adding the public key to an account. For more details about how data is organized on the config drive, refer to the *user guide*.

Configuration

The **nova-compute** service accepts the following config drive-related options:

- *api.config_drive_skip_versions*
- *force_config_drive*
- *config_drive_format*

For example, to ensure nova always provides a config drive to instances but versions `2018-08-27` (Rocky) and `2017-02-22` (Ocata) are skipped, add the following to `nova.conf`:

```
[DEFAULT]
force_config_drive = True

[api]
config_drive_skip_versions = 2018-08-27 2017-02-22
```

Note

The `img_config_drive` image metadata property can be used to force enable the config drive. In addition, users can explicitly request a config drive when booting instances. For more information, refer to the *user guide*.

Image Caching

Nova supports caching base images on compute nodes when using a supported virt driver.

What is Image Caching?

In order to understand what image caching is and why it is beneficial, it helps to be familiar with the process by which an instance is booted from a given base image. When a new instance is created on a compute node, the following general steps are performed by the compute manager in conjunction with the virt driver:

1. Download the base image from glance
2. Copy or COW the base image to create a new root disk image for the instance
3. Boot the instance using the new root disk image

The first step involves downloading the entire base image to the local disk on the compute node, which could involve many gigabytes of network traffic, storage, and many minutes of latency between the start of the boot process and actually running the instance. When the virt driver supports image caching, step #1 above may be skipped if the base image is already present on the compute node. This is most often the case when another instance has been booted on that node from the same base image recently. If present, the download operation can be skipped, which greatly reduces the time-to-boot for the second and subsequent instances that use the same base image, as well as avoids load on the glance server and the network connection.

By default, the compute node will periodically scan the images it has cached, looking for base images that are not used by any instances on the node that are older than a configured lifetime (24 hours by default). Those unused images are deleted from the cache directory until they are needed again.

For more information about configuring image cache behavior, see the documentation for the configuration options in the *image_cache* group.

Note

Some ephemeral backend drivers may not use or need image caching, or may not behave in the same way as others. For example, when using the `rbd` backend with the `libvirt` driver and a shared pool with glance, images are COWd at the storage level and thus need not be downloaded (and thus cached) at the compute node at all.

Image Caching Resource Accounting

Generally the size of the image cache is not part of the data Nova includes when reporting available or consumed disk space. This means that when `nova-compute` reports 100G of total disk space, the scheduler will assume that 100G of instances may be placed there. Usually disk is the most plentiful resource and thus the last to be exhausted, so this is often not problematic. However, if many instances are booted from distinct images, all of which need to be cached in addition to the disk space used by the instances themselves, Nova may overcommit the disk unintentionally by failing to consider the size of the image cache.

There are two approaches to addressing this situation:

1. **Mount the image cache as a separate filesystem**. This will cause Nova to report the amount of disk space available purely to instances, independent of how much is consumed by the cache. Nova will continue to disregard the size of the image cache and, if the cache space is exhausted, builds will fail. However, available disk space for instances will be correctly reported by `nova-compute` and accurately considered by the scheduler.

2. **Enable optional reserved disk amount behavior**. The configuration workaround *workarounds.reserve_disk_resource_for_image_cache* will cause `nova-compute` to periodically update the reserved disk amount to include the statically configured value, as well as the amount currently consumed by the image cache. This will cause the scheduler to see the available disk space decrease as the image cache grows. This is not updated synchronously and thus is not a perfect solution, but should vastly increase the schedulers visibility resulting in better decisions. (Note this solution is currently libvirt-specific)

As above, not all backends and virt drivers use image caching, and thus a third option may be to consider alternative infrastructure to eliminate this problem altogether.

Image pre-caching

It may be beneficial to pre-cache images on compute nodes in order to achieve low time-to-boot latency for new instances immediately. This is often useful when rolling out a new version of an application where downtime is important and having the new images already available on the compute nodes is critical.

Nova provides (since the Ussuri release) a mechanism to request that images be cached without having to boot an actual instance on a node. This best-effort service operates at the host aggregate level in order to provide an efficient way to indicate that a large number of computes should receive a given set of images. If the computes that should pre-cache an image are not already in a defined host aggregate, that must be done first.

For information on how to perform aggregate-based image pre-caching, see the *Image Caching* section of the Host aggregates documentation.

Metadata service

Note

This section provides deployment information about the metadata service. For end-user information about the metadata service and instance metadata in general, refer to the *user guide*.

The metadata service provides a way for instances to retrieve instance-specific data. Instances access the metadata service at `http://169.254.169.254`. The metadata service supports two sets of APIs - an OpenStack metadata API and an EC2-compatible API - and also exposes vendordata and user data. Both the OpenStack metadata and EC2-compatible APIs are versioned by date.

The metadata service can be run globally, or on a per-cell basis. A detailed comparison is provided in the *cells V2 guide*.

Changed in version 19.0.0: The ability to run the nova metadata API service on a per-cell basis was added in Stein. For versions prior to this release, you should not use the standalone **`nova-api-metadata`** application for multiple cells.

Guests access the service at `169.254.169.254` or at `fe80::a9fe:a9fe`.

Changed in version 22.0.0: Starting with the Victoria release the metadata service is accessible over IPv6 at the link-local address `fe80::a9fe:a9fe`.

The networking service, neutron, is responsible for intercepting these requests and adding HTTP headers which uniquely identify the source of the request before forwarding it to the metadata API server. For the Open vSwitch and Linux Bridge backends provided with neutron, the flow looks something like so:

1. Instance sends a HTTP request for metadata to `169.254.169.254`.

2. This request either hits the router or DHCP namespace depending on the route in the instance
3. The metadata proxy service in the namespace adds the following info to the request:
   - Instance IP (`X-Forwarded-For` header)
   - Router or Network-ID (`X-Neutron-Network-Id` or `X-Neutron-Router-Id` header)
4. The metadata proxy service sends this request to the metadata agent (outside the namespace) via a UNIX domain socket.
5. The **`neutron-metadata-agent`** application forwards the request to the nova metadata API service by adding some new headers (instance ID and Tenant ID) to the request.

This flow may vary if a different networking backend is used.

Neutron and nova must be configured to communicate together with a shared secret. Neutron uses this secret to sign the Instance-ID header of the metadata request to prevent spoofing. This secret is configured through the *neutron.metadata_proxy_shared_secret* config option in nova and the equivalent `metadata_proxy_shared_secret` config option in neutron.

Configuration

The **`nova-api`** application accepts the following metadata service-related options:

- *neutron.service_metadata_proxy*
- *neutron.metadata_proxy_shared_secret*
- *api.metadata_cache_expiration*
- *api.local_metadata_per_cell*
- *api.dhcp_domain*

Note

This list excludes configuration options related to the vendordata feature. Refer to *vendordata feature documentation* for information on configuring this.

For example, to configure the **`nova-api`** application to serve the metadata API, without SSL, using the `StaticJSON` vendordata provider, add the following to a `nova-api.conf` file:

```
[neutron]
service_metadata_proxy = True

[api]
dhcp_domain =
metadata_cache_expiration = 15
local_metadata_per_cell = False
vendordata_providers = StaticJSON
vendordata_jsonfile_path = /etc/nova/vendor_data.json
```

Note

This does not include configuration options that are not metadata-specific but are nonetheless required.

Configuring the application to use the `DynamicJSON` vendordata provider is more involved and is not covered here.

The **`nova-api-metadata`** application accepts almost the same options:

- *`neutron.service_metadata_proxy`*
- *`neutron.metadata_proxy_shared_secret`*
- *`api.metadata_cache_expiration`*
- *`api.local_metadata_per_cell`*
- *`api.dhcp_domain`*

Note

This list excludes configuration options related to the vendordata feature. Refer to *vendordata feature documentation* for information on configuring this.

For example, to configure the **`nova-api-metadata`** application to serve the metadata API, without SSL, add the following to a `nova-api.conf` file:

```
[neutron]
service_metadata_proxy = True

[api]
dhcp_domain =
metadata_cache_expiration = 15
local_metadata_per_cell = False
```

Note

This does not include configuration options that are not metadata-specific but are nonetheless required.

For information about configuring the neutron side of the metadata service, refer to the neutron configuration guide

Config drives

Config drives are special drives that are attached to an instance when it boots. The instance can mount this drive and read files from it to get information that is normally available through the metadata service. For more information, refer to *Config drives* and the *user guide*.

Vendordata

Vendordata provides a way to pass vendor or deployment-specific information to instances. For more information, refer to *Vendordata* and the *user guide*.

User data

User data is a blob of data that the user can specify when they launch an instance. For more information, refer to *the user guide*.

Manage Unified Limits Quotas

> **Note**
>
> This section provides deployment information about the quota feature. For end-user information about quotas, including information about the type of quotas available, refer to the *user guide*.

Since the **Nova 28.0.0 (2023.2 Bobcat)** release, it is recommended to use Keystone unified limits for Nova quota limits.

For information about legacy quota limits, see the legacy quota documentation.

Quotas

To prevent system capacities from being exhausted without notification, you can set up quotas. Quotas are operational limits. The number of servers allowed for each project can be controlled so that cloud resources are optimized, for example. Quotas can be enforced at both the global (default) level and at the project level.

Unified limits

Unified limits is a modern quota system in which quota limits are centralized in the Keystone identity service. There are three steps for quota enforcement in this model:

1. Quota limits are retrieved by calling the Keystone unified limits API
2. Quota usage is counted from the Placement API service
3. Quota is enforced locally using the oslo.limit limit enforcement library

In unified limits, the terminology is a bit different from legacy quotas:

- A **registered limit** is a global or default limit that applies to all projects
- A **limit** is a project-scoped limit that applies to a particular project

Cloud operators will need to manage their quota limits in the Keystone service by calling the API directly or by using the OpenStackClient (OSC) registered limit and limit commands.

Roles

By default Keystone API policy, a user must have the following roles and scopes in order to perform actions with unified limits.

Action	Role	Scope
List registered limits	*	*
Get registered limit	*	*
Create registered limit	admin	system=all
Update registered limit	admin	system=all
Delete registered limit	admin	system=all
List limits	*	*
Get limit	*	*
Create limit	admin	system=all
Update limit	admin	system=all
Delete limit	admin	system=all

Configuration

To enable unified limits quotas, some Nova configuration of the Compute API and **nova-conductor** services is necessary.

Set the quota driver to the `nova.quota.UnifiedLimitsDriver`:

```
[quota]
driver = nova.quota.UnifiedLimitsDriver
```

Add a configuration section for oslo.limit:

```
[oslo_limit]
username = nova
user_domain_name = $SERVICE_DOMAIN_NAME
auth_url = $KEYSTONE_SERVICE_URI
auth_type = password
password = $SERVICE_PASSWORD
system_scope = all
endpoint_id = $SERVICE_ENDPOINT_ID
```

Note

The Nova service endpoint ID can be obtained by `openstack endpoint list --service nova -f value -c ID`

Ensure that the `nova` service user has the `reader` role with `system` scope:

```
openstack role add --user nova --user-domain $SERVICE_DOMAIN_NAME \
  --system all reader
```

Setting quota limits on resources

Any resource that can be requested in the cloud must have a registered limit set. Quota checks on cloud resources that do not have registered limits will continue to fail until registered limits are set because oslo.limit considers an unregistered resource to have a limit of 0.

Types of quota

Unified limit resource names for resources that are tracked as resource classes in the Placement API service follow the naming pattern of the `class:` prefix followed by the name of the resource class. For example: class:VCPU, class:PCPU, class:MEMORY_MB, class:DISK_GB, class:VGPU.

Quota Name	Description
class:VCPU	Number of shared CPU cores (VCPUs) allowed per project
class:PCPU	Number of dedicated CPU cores (PCPUs) allowed per project
servers	Number of instances allowed per project
server_key_pairs	Number of key pairs allowed per user
server_metadata_it	Number of metadata items allowed per instance
class:MEMORY_M	Megabytes of instance ram allowed per project
server_groups	Number of server groups per project
server_group_mem	Number of servers per server group
class:DISK_GB	Gigabytes of instance disk allowed per project
class:$RESOURCE	Any resource class in the Placement API service can have a quota limit specified for it (example: class:VGPU)

OpenStack CLI commands

For full OpenStackClient documentation, see https://docs.openstack.org/python-openstackclient/latest/index.html.

Registered Limits

To list default limits for Nova:

```
openstack registered limit list --service nova
```

To show details about a default limit:

```
openstack registered limit show $REGISTERED_LIMIT_ID
```

To create a default limit:

```
openstack registered limit create --service nova --default-limit $LIMIT \
  $RESOURCE
```

To update a default limit:

```
openstack registered limit set --default-limit $LIMIT $REGISTERED_LIMIT_ID
```

To delete a default limit:

```
openstack registered limit delete $REGISTERED_LIMIT_ID
```

Limits

To list project limits for Nova:

```
openstack limit list --service nova
```

To list limits for a particular project:

```
openstack limit list --service nova --project $PROJECT_ID
```

To show details about a project limit:

```
openstack limit show $LIMIT_ID
```

To create a project limit:

```
openstack limit create --service nova --project $PROJECT_ID \
  --resource-limit $LIMIT $RESOURCE
```

To update a project limit:

```
openstack limit set --resource-limit $LIMIT $LIMIT_ID
```

To delete a project limit:

```
openstack limit delete $LIMIT_ID
```

Quota enforcement

When enforcing limits for a given resource and project, the following checks are made in order:

1. Limits (project-specific)

   Depending on the resource, is there a project-specific limit on the resource in Keystone limits? If so, use that as the limit. If not, proceed to check the registered default limit.

2. Registered limits (default)

   Depending on the resource, is there a default limit on the resource in Keystone limits? If so, use that as the limit. If not, oslo.limit will consider the limit as 0, the quota check will fail, and a quota limit exceeded exception will be raised.

Warning

Every resource that can be requested in the cloud **must** at a minimum have a registered limit set. Any resource that does **not** have a registered limit set will fail quota enforcement because oslo.limit considers an unregistered resource to have a limit of **0**.

Rechecking quota

If *quota.recheck_quota* = True (this is the default), Nova will perform a second quota check after allocating resources. The first quota check is performed before resources are allocated. Rechecking quota ensures that quota limits are strictly enforced and prevents any possibility of resource allocation going over the quota limit in the event of racing parallel API requests.

It can be disabled by setting *quota.recheck_quota* = False if strict quota enforcement is not important to the operator.

Quota usage from Placement

With unified limits quotas, it is required that quota resource usage is counted from the Placement API service. As such, the *quota.count_usage_from_placement* configuration option is ignored when *quota.driver* is set to `nova.quota.UnifiedLimitsDriver`.

There are some things to note when quota resource usage is counted from the Placement API service:

- Counted usage will not be accurate in an environment where multiple Nova deployments are sharing a Placement deployment because currently Placement has no way of partitioning resource providers between different Nova deployments. Operators who are running multiple Nova deployments that share a Placement deployment should not use the `nova.quota.UnifiedLimitsDriver`.
- Behavior will be different for resizes. During a resize, resource allocations are held on both the source and destination (even on the same host, see https://bugs.launchpad.net/nova/+bug/1790204) until the resize is confirmed or reverted. Quota usage will be inflated for servers in this state.
- The `populate_queued_for_delete` and `populate_user_id` online data migrations must be completed before usage can be counted from Placement. Until the data migration is complete, the system will fall back to legacy quota usage counting from cell databases depending on the result of an EXISTS database query during each quota check. Use `nova-manage db online_data_migrations` to run online data migrations.
- Behavior will be different for unscheduled servers in `ERROR` state. A server in `ERROR` state that has never been scheduled to a compute host will not have Placement allocations, so it will not consume quota usage for cores and ram.
- Behavior will be different for servers in `SHELVED_OFFLOADED` state. A server in `SHELVED_OFFLOADED` state will not have Placement allocations, so it will not consume quota usage for cores and ram. Note that because of this, it will be possible for a request to unshelve a server to be rejected if the user does not have enough quota available to support the cores and ram needed by the server to be unshelved.

Migration to unified limits quotas

There is a nova-manage command available to help with moving from legacy Nova database quotas to Keystone unified limits quotas. The command will read quota limits from the Nova database and call the Keystone API to create the corresponding unified limits.

```
$ nova-manage limits migrate_to_unified_limits -h
usage: nova-manage limits migrate_to_unified_limits
[-h] [--project-id <project-id>] [--region-id <region-id>] [--verbose]
[--dry-run]
```

(continues on next page)

(continued from previous page)

```
Copy quota limits from the Nova API database to Keystone.

options:
  -h, --help            show this help message and exit
  --project-id <project-id>
                        Project ID for which to migrate quota limits
  --region-id <region-id>
                        Region ID for which to migrate quota limits
  --verbose             Provide verbose output during execution.
  --dry-run             Show what limits would be created without actually
                        creating them.
```

Important

Per-user quota limits will **not** be copied into Keystone because per-user quotas are not supported in unified limits.

Require or ignore resources

The *quota.unified_limits_resource_strategy* and *quota.unified_limits_resource_list* configuration options are available for operators to specify which cloud resources they will require to have registered limits set in Keystone. The default strategy is `require` and the default resource list contains the `servers` resource.

When `unified_limits_resource_strategy = require`, if a resource in `unified_limits_resource_list` is requested and has no registered limit set, the quota limit for that resource will be considered to be 0 and all requests to allocate that resource will be rejected for being over quota. Any resource not in the list will be considered to have unlimited quota.

When `unified_limits_resource_strategy = ignore`, if a resource in `unified_limits_resource_list` is requested and has no registered limit set, the quota limit for that resource will be considered to be unlimited and all requests to allocate that resource will be accepted. Any resource not in the list will be considered to have 0 quota.

The options should be configured for the Compute API and **nova-conductor** services. The **nova-conductor** service performs quota enforcement when *quota.recheck_quota* is `True` (the default).

The `unified_limits_resource_list` list can also be set to an empty list.

Example configuration values:

```
[quota]
unified_limits_resource_strategy = require
unified_limits_resource_list = servers,class:VCPU,class:MEMORY_MB,class:DISK_
↪GB
```

Networking with neutron

While nova uses the OpenStack Networking service (neutron) to provide network connectivity for instances, nova itself provides some additional features not possible with neutron alone. These are described below.

SR-IOV

Changed in version 2014.2: The feature described below was first introduced in the Juno release.

The SR-IOV specification defines a standardized mechanism to virtualize PCIe devices. This mechanism can virtualize a single PCIe Ethernet controller to appear as multiple PCIe devices. Each device can be directly assigned to an instance, bypassing the hypervisor and virtual switch layer. As a result, users are able to achieve low latency and near-line wire speed.

A full guide on configuring and using SR-IOV is provided in the OpenStack Networking service documentation

Note

Nova only supports PCI addresses where the fields are restricted to the following maximum value:

- domain - 0xFFFF
- bus - 0xFF
- slot - 0x1F
- function - 0x7

Nova will ignore PCI devices reported by the hypervisor if the address is outside of these ranges.

Added in version 25.0.0: For information on creating servers with remotely-managed SR-IOV network interfaces of SmartNIC DPUs, refer to the relevant section in Networking Guide.

Limitations

- Only VFs are supported and they must be tagged in the Nova Compute configuration in the *pci.device_spec* option as `remote_managed: "true"`. There is no auto-discovery of this based on vendor and product IDs;
- Either VF or its respective PF must expose a PCI VPD capability with a unique card serial number according to the PCI/PCIe specifications (see the Libvirt docs to get an example of how VPD data is represented and what to expect). If this is not the case, those devices will not appear in allocation pools;
- Only the Libvirt driver is capable of supporting this feature at the time of writing;
- The support for VPD capability handling in Libvirt was added in release 7.9.0 - older versions are not supported by this feature;
- All compute nodes must be upgraded to the Yoga release in order for scheduling of nodes with `VNIC_TYPE_REMOTE_MANAGED` ports to succeed;
- The same limitations apply to operations like live migration as with legacy SR-IOV ports;
- Clearing a VLAN by programming VLAN 0 must not result in errors in the VF kernel driver at the compute host. Before v8.1.0 Libvirt clears a VLAN by programming VLAN 0 before passing a VF

through to the guest which may result in an error depending on your driver and kernel version (see, for example, this bug which discusses a case relevant to one driver). As of Libvirt v8.1.0, EPERM errors encountered while programming VLAN 0 are ignored if VLAN clearing is not explicitly requested in the device XML (i.e. VLAN 0 is not specified explicitly).

NUMA Affinity

Added in version 18.0.0: The feature described below was first introduced in the Rocky release.

Important

The functionality described below is currently only supported by the libvirt/KVM driver.

As described in *CPU topologies*, NUMA is a computer architecture where memory accesses to certain regions of system memory can have higher latencies than other regions, depending on the CPU(s) your process is running on. This effect extends to devices connected to the PCIe bus, a concept known as NUMA I/O. Many Network Interface Cards (NICs) connect using the PCIe interface, meaning they are susceptible to the ill-effects of poor NUMA affinitization. As a result, NUMA locality must be considered when creating an instance where high dataplane performance is a requirement.

Fortunately, nova provides functionality to ensure NUMA affinitization is provided for instances using neutron. How this works depends on the type of port you are trying to use.

For SR-IOV ports, virtual functions, which are PCI devices, are attached to the instance. This means the instance can benefit from the NUMA affinity guarantees provided for PCI devices. This happens automatically and is described in detail in *PCI-NUMA affinity policies*.

For all other types of ports, some manual configuration is required.

1. Identify the type of network(s) you wish to provide NUMA affinity for.

   - If a network is an L2-type network (`provider:network_type` of `flat` or `vlan`), affinity of the network to given NUMA node(s) can vary depending on value of the `provider:physical_network` attribute of the network, commonly referred to as the *physnet* of the network. This is because most neutron drivers map each *physnet* to a different bridge, to which multiple NICs are attached, or to a different (logical) NIC.
   - If a network is an L3-type networks (`provider:network_type` of `vxlan`, `gre` or `geneve`), all traffic will use the device to which the *endpoint IP* is assigned. This means all L3 networks on a given host will have affinity to the same NUMA node(s). Refer to the neutron documentation for more information.

2. Determine the NUMA affinity of the NICs attached to the given network(s).

   How this should be achieved varies depending on the switching solution used and whether the network is a L2-type network or an L3-type networks.

   Consider an L2-type network using the Linux Bridge mechanism driver. As noted in the neutron documentation, *physnets* are mapped to interfaces using the `[linux_bridge] physical_interface_mappings` configuration option. For example:

   ```
   [linux_bridge]
   physical_interface_mappings = provider:PROVIDER_INTERFACE
   ```

Once you have the device name, you can query *sysfs* to retrieve the NUMA affinity for this device. For example:

```
$ cat /sys/class/net/PROVIDER_INTERFACE/device/numa_node
```

For an L3-type network using the Linux Bridge mechanism driver, the device used will be configured using protocol-specific endpoint IP configuration option. For VXLAN, this is the `[vxlan] local_ip` option. For example:

```
[vxlan]
local_ip = OVERLAY_INTERFACE_IP_ADDRESS
```

Once you have the IP address in question, you can use **`ip`** to identify the device that has been assigned this IP address and from there can query the NUMA affinity using *sysfs* as above.

Note

The example provided above is merely that: an example. How one should identify this information can vary massively depending on the driver used, whether bonding is used, the type of network used, etc.

3. Configure NUMA affinity in `nova.conf`.

   Once you have identified the NUMA affinity of the devices used for your networks, you need to configure this in `nova.conf`. As before, how this should be achieved varies depending on the type of network.

   For L2-type networks, NUMA affinity is defined based on the `provider:physical_network` attribute of the network. There are two configuration options that must be set:

   `[neutron] physnets`
   : This should be set to the list of physnets for which you wish to provide NUMA affinity. Refer to the *documentation* for more information.

   `[neutron_physnet_{physnet}] numa_nodes`
   : This should be set to the list of NUMA node(s) that networks with the given `{physnet}` should be affinitized to.

   For L3-type networks, NUMA affinity is defined globally for all tunneled networks on a given host. There is only one configuration option that must be set:

   `[neutron_tunnel] numa_nodes`
   : This should be set to a list of one or NUMA nodes to which instances using tunneled networks will be affinitized.

4. Configure a NUMA topology for instance flavor(s)

   For network NUMA affinity to have any effect, the instance must have a NUMA topology itself. This can be configured explicitly, using the `hw:numa_nodes` extra spec, or implicitly through the use of CPU pinning (`hw:cpu_policy=dedicated`) or PCI devices. For more information, refer to *CPU topologies*.

Examples

Take an example for deployment using L2-type networks first.

```
[neutron]
physnets = foo,bar

[neutron_physnet_foo]
numa_nodes = 0

[neutron_physnet_bar]
numa_nodes = 2, 3
```

This configuration will ensure instances using one or more L2-type networks with `provider:physical_network=foo` must be scheduled on host cores from NUMA nodes 0, while instances using one or more networks with `provider:physical_network=bar` must be scheduled on host cores from both NUMA nodes 2 and 3. For the latter case, it will be necessary to split the guest across two or more host NUMA nodes using the *hw:numa_nodes* extra spec, as discussed *here*.

Now, take an example for a deployment using L3 networks.

```
[neutron_tunnel]
numa_nodes = 0
```

This is much simpler as all tunneled traffic uses the same logical interface. As with the L2-type networks, this configuration will ensure instances using one or more L3-type networks must be scheduled on host cores from NUMA node 0. It is also possible to define more than one NUMA node, in which case the instance must be split across these nodes.

virtio-net Multiqueue

Added in version 12.0.0: (Liberty)

Changed in version 25.0.0: (Yoga)

Support for configuring multiqueue via the `hw:vif_multiqueue_enabled` flavor extra spec was introduced in the Yoga (25.0.0) release.

Important

The functionality described below is currently only supported by the libvirt/KVM driver.

Virtual NICs using the virtio-net driver support the multiqueue feature. By default, these vNICs will only use a single virtio-net TX/RX queue pair, meaning guests will not transmit or receive packets in parallel. As a result, the scale of the protocol stack in a guest may be restricted as the network performance will not scale as the number of vCPUs increases and per-queue data processing limits in the underlying vSwitch are encountered. The solution to this issue is to enable virtio-net multiqueue, which can allow the guest instances to increase the total network throughput by scaling the number of receive and transmit queue pairs with CPU count.

Multiqueue virtio-net isnt always necessary, but it can provide a significant performance benefit when:

- Traffic packets are relatively large.

- The guest is active on many connections at the same time, with traffic running between guests, guest to host, or guest to an external system.
- The number of queues is equal to the number of vCPUs. This is because multi-queue support optimizes RX interrupt affinity and TX queue selection in order to make a specific queue private to a specific vCPU.

However, while the virtio-net multiqueue feature will often provide a welcome performance benefit, it has some limitations and therefore should not be unconditionally enabled:

- Enabling virtio-net multiqueue increases the total network throughput, but in parallel it also increases the CPU consumption.
- Enabling virtio-net multiqueue in the host QEMU config does not enable the functionality in the guest OS. The guest OS administrator needs to manually turn it on for each guest NIC that requires this feature, using **ethtool**.
- In case the number of vNICs in a guest instance is proportional to the number of vCPUs, enabling the multiqueue feature is less important.

Having considered these points, multiqueue can be enabled or explicitly disabled using either the *hw:vif_multiqueue_enabled* flavor extra spec or equivalent `hw_vif_multiqueue_enabled` image metadata property. For example, to enable virtio-net multiqueue for a chosen flavor:

```
$ openstack flavor set --property hw:vif_multiqueue_enabled=true $FLAVOR
```

Alternatively, to explicitly disable multiqueue for a chosen image:

```
$ openstack image set --property hw_vif_multiqueue_enabled=false $IMAGE
```

Note

If both the flavor extra spec and image metadata property are provided, their values must match or an error will be raised.

Once the guest has started, you must enable multiqueue using **ethtool**. For example:

```
$ ethtool -L $devname combined $N
```

where `$devname` is the name of the network device, and `$N` is the number of TX/RX queue pairs to configure corresponding to the number of instance vCPUs. Alternatively, you can configure this persistently using udev. For example, to configure four TX/RX queue pairs for network device `eth0`:

```
# cat /etc/udev/rules.d/50-ethtool.rules
ACTION=="add", SUBSYSTEM=="net", NAME=="eth0", RUN+="/sbin/ethtool -L eth0␣
↪combined 4"
```

For more information on this feature, refer to the original spec.

Security hardening

OpenStack Compute can be integrated with various third-party technologies to increase security. For more information, see the OpenStack Security Guide.

Encrypt Compute metadata traffic

Enabling SSL encryption

OpenStack supports encrypting Compute metadata traffic with HTTPS. Enable SSL encryption in the `metadata_agent.ini` file.

1. Enable the HTTPS protocol.

```
nova_metadata_protocol = https
```

2. Determine whether insecure SSL connections are accepted for Compute metadata server requests. The default value is `False`.

```
nova_metadata_insecure = False
```

3. Specify the path to the client certificate.

```
nova_client_cert = PATH_TO_CERT
```

4. Specify the path to the private key.

```
nova_client_priv_key = PATH_TO_KEY
```

Securing live migration streams with QEMU-native TLS

It is strongly recommended to secure all the different live migration streams of a nova instancei.e. guest RAM, device state, and disks (via NBD) when using non-shared storage. For further details on how to set this up, refer to the *Secure live migration with QEMU-native TLS* document.

Mitigation for MDS (Microarchitectural Data Sampling) security flaws

It is strongly recommended to patch all compute nodes and nova instances against the processor-related security flaws, such as MDS (and other previous vulnerabilities). For details on applying mitigation for the MDS flaws, refer to *Mitigation for MDS (Microarchitectural Data Sampling) Security Flaws*.

Vendordata

Note

This section provides deployment information about the vendordata feature. For end-user information about the vendordata feature and instance metadata in general, refer to the *user guide*.

The *vendordata* feature provides a way to pass vendor or deployment-specific information to instances. This can be accessed by users using *the metadata service* or with *config drives*.

There are two vendordata modules provided with nova: `StaticJSON` and `DynamicJSON`.

StaticJSON

The `StaticJSON` module includes the contents of a static JSON file loaded from disk. This can be used for things which dont change between instances, such as the location of the corporate puppet server. It is the default provider.

Configuration

The service you must configure to enable the `StaticJSON` vendordata module depends on how guests are accessing vendordata. If using the metadata service, configuration applies to either the compute API or metadata API depending on the deployment, while if using config drives, configuration applies to **`nova-compute`**. However, configuration is otherwise the same and the following options apply:

- *`api.vendordata_providers`*
- *`api.vendordata_jsonfile_path`*

Refer to the *metadata service* and *config drive* documentation for more information on how to configure the required services.

DynamicJSON

The `DynamicJSON` module can make a request to an external REST service to determine what metadata to add to an instance. This is how we recommend you generate things like Active Directory tokens which change per instance.

When used, the `DynamicJSON` module will make a request to any REST services listed in the *`api.vendordata_dynamic_targets`* configuration option. There can be more than one of these but note that they will be queried once per metadata request from the instance which can mean a lot of traffic depending on your configuration and the configuration of the instance.

The following data is passed to your REST service as a JSON encoded POST:

Key	Description
`project-id`	The ID of the project that owns this instance.
`instance-id`	The UUID of this instance.
`image-id`	The ID of the image used to boot this instance.
`user-data`	As specified by the user at boot time.
`hostname`	The hostname of the instance.
`metadata`	As specified by the user at boot time.

Metadata fetched from the REST service will appear in the metadata service at a new file called `vendordata2.json`, with a path (either in the metadata service URL or in the config drive) like this:

```
openstack/latest/vendor_data2.json
```

For each dynamic target, there will be an entry in the JSON file named after that target. For example:

```
{
    "testing": {
        "value1": 1,
        "value2": 2,
        "value3": "three"
```

(continues on next page)

(continued from previous page)

```
    }
}
```

The novajoin project provides a dynamic vendordata service to manage host instantiation in an IPA server.

Deployment considerations

Nova provides authentication to external metadata services in order to provide some level of certainty that the request came from nova. This is done by providing a service token with the request you can then just deploy your metadata service with the keystone authentication WSGI middleware. This is configured using the keystone authentication parameters in the *vendordata_dynamic_auth* configuration group.

Configuration

As with `StaticJSON`, the service you must configure to enable the `DynamicJSON` vendordata module depends on how guests are accessing vendordata. If using the metadata service, configuration applies to either the compute API or metadata API depending on the deployment, while if using config drives, configuration applies to **`nova-compute`**. However, configuration is otherwise the same and the following options apply:

- *api.vendordata_providers*
- *api.vendordata_dynamic_ssl_certfile*
- *api.vendordata_dynamic_connect_timeout*
- *api.vendordata_dynamic_read_timeout*
- *api.vendordata_dynamic_failure_fatal*
- *api.vendordata_dynamic_targets*

Refer to the *metadata service* and *config drive* documentation for more information on how to configure the required services.

In addition, there are also many options related to authentication. These are provided by keystone but are listed below for completeness:

- *vendordata_dynamic_auth.cafile*
- *vendordata_dynamic_auth.certfile*
- *vendordata_dynamic_auth.keyfile*
- *vendordata_dynamic_auth.insecure*
- *vendordata_dynamic_auth.timeout*
- *vendordata_dynamic_auth.collect_timing*
- *vendordata_dynamic_auth.split_loggers*
- *vendordata_dynamic_auth.auth_type*
- *vendordata_dynamic_auth.auth_section*
- *vendordata_dynamic_auth.auth_url*
- *vendordata_dynamic_auth.system_scope*

- *vendordata_dynamic_auth.domain_id*
- *vendordata_dynamic_auth.domain_name*
- *vendordata_dynamic_auth.project_id*
- *vendordata_dynamic_auth.project_name*
- *vendordata_dynamic_auth.project_domain_id*
- *vendordata_dynamic_auth.project_domain_name*
- *vendordata_dynamic_auth.trust_id*
- *vendordata_dynamic_auth.default_domain_id*
- *vendordata_dynamic_auth.default_domain_name*
- *vendordata_dynamic_auth.user_id*
- *vendordata_dynamic_auth.username*
- *vendordata_dynamic_auth.user_domain_id*
- *vendordata_dynamic_auth.user_domain_name*
- *vendordata_dynamic_auth.password*
- *vendordata_dynamic_auth.tenant_id*
- *vendordata_dynamic_auth.tenant_name*

Refer to the keystone documentation for information on configuring these.

References

- Michael Stills talk from the Queens summit in Sydney, Metadata, User Data, Vendor Data, oh my!
- Michaels blog post on deploying a simple vendordata service which provides more details and sample code to supplement the documentation above.

Notifications

Like many other OpenStack services, nova emits notifications to the message bus with the `Notifier` class provided by oslo.messaging. From the notification consumer point of view, a notification consists of two parts: an envelope with a fixed structure defined by oslo.messaging and a payload defined by the service emitting the notification. The envelope format is the following:

```
{
    "priority": <string, selected from a predefined list by the sender>,
    "event_type": <string, defined by the sender>,
    "timestamp": <string, the isotime of when the notification emitted>,
    "publisher_id": <string, defined by the sender>,
    "message_id": <uuid, generated by oslo>,
    "payload": <json serialized dict, defined by the sender>
}
```

There are two types of notifications in nova: legacy notifications which have an unversioned payload and newer notifications which have a versioned payload.

Legacy (unversioned) notifications

The unversioned notifications exist from the early days of nova and have mostly grown organically. The structure of the payload of the unversioned notifications is defined in the code that emits the notification and no documentation or enforced backward compatibility contract exists for that format.

Nova code uses the `nova.rpc.get_notifier` call to get a configured oslo.messaging `Notifier` object and it uses the oslo-provided functions on the `Notifier` object to emit notifications. The configuration of the returned `Notifier` object depends on the parameters of the `get_notifier` call and the value of the oslo.messaging configuration options *oslo_messaging_notifications.driver* and *oslo_messaging_notifications.topics*.

Versioned notifications

The versioned notification concept was created to fix the shortcomings of the unversioned notifications. The envelope structure of the emitted notification is the same as in the unversioned notification case as it is provided by oslo.messaging. However, the payload is not a free-form dictionary but a serialized oslo versionedobjects object.

For example the wire format of the `service.update` notification looks like the following:

```
{
    "priority": "INFO",
    "payload": {
        "nova_object.namespace": "nova",
        "nova_object.name": "ServiceStatusPayload",
        "nova_object.version": "1.0",
        "nova_object.data": {
            "host": "host1",
            "disabled": false,
            "last_seen_up": null,
            "binary": "nova-compute",
            "topic": "compute",
            "disabled_reason": null,
            "report_count": 1,
            "forced_down": false,
            "version": 2
        }
    },
    "event_type": "service.update",
    "publisher_id": "nova-compute:host1"
}
```

The serialized oslo.versionedobject as a payload provides a version number to the consumer so the consumer can detect if the structure of the payload has changed. Nova provides the following contract regarding the versioned notification payload:

- The payload version defined by the `nova_object.version` field of the payload will be increased if and only if the syntax or the semantics of the `nova_object.data` field of the payload is changed.
- A minor version bump indicates a backward compatible change which means that only new fields are added to the payload so a well written consumer can still consume the new payload without any change.

- A major version bump indicates a backward incompatible change of the payload which can mean removed fields, type change, etc in the payload.
- There is an additional field, `nova_object.name`, for every payload alongside the `nova_object.data` and `nova_object.version` fields. This field contains the name of the nova internal representation of the payload type. Client code should not depend on this name.

A presentation from the Train summit goes over the background and usage of versioned notifications, and provides a demo.

Configuration

The *notifications.notification_format* config option can be used to specify which notifications are emitted by nova.

The versioned notifications are emitted to a different topic than the legacy notifications. By default they are emitted to `versioned_notifications` but this can be configured using the *notifications.versioned_notifications_topics* config option.

There are notification configuration options in nova which are specific for certain notification types like *notifications.notify_on_state_change*, *notifications.default_level*, etc.

Notifications can be disabled entirely by setting the *oslo_messaging_notifications.driver* config option to `noop`.

Reference

A list of all currently supported versioned notifications can be found in *Available versioned notifications*.

3.4.1.4 Advanced configuration

OpenStack clouds run on platforms that differ greatly in the capabilities that they provide. By default, the Compute service seeks to abstract the underlying hardware that it runs on, rather than exposing specifics about the underlying host platforms. This abstraction manifests itself in many ways. For example, rather than exposing the types and topologies of CPUs running on hosts, the service exposes a number of generic CPUs (virtual CPUs, or vCPUs) and allows for overcommitting of these. In a similar manner, rather than exposing the individual types of network devices available on hosts, generic software-powered network ports are provided. These features are designed to allow high resource utilization and allows the service to provide a generic cost-effective and highly scalable cloud upon which to build applications.

This abstraction is beneficial for most workloads. However, there are some workloads where determinism and per-instance performance are important, if not vital. In these cases, instances can be expected to deliver near-native performance. The Compute service provides features to improve individual instance for these kind of workloads.

Important

In deployments older than Train, or in mixed Stein/Train deployments with a rolling upgrade in progress, unless *specifically enabled*, live migration is not possible for instances with a NUMA topology when using the libvirt driver. A NUMA topology may be specified explicitly or can be added implicitly due to the use of CPU pinning or huge pages. Refer to bug #1289064 for more information. As of Train, live migration of instances with a NUMA topology when using the libvirt driver is fully supported.

Attaching physical PCI devices to guests

The PCI passthrough feature in OpenStack allows full access and direct control of a physical PCI device in guests. This mechanism is generic for any kind of PCI device, and runs with a Network Interface Card (NIC), Graphics Processing Unit (GPU), or any other devices that can be attached to a PCI bus. Correct driver installation is the only requirement for the guest to properly use the devices.

Some PCI devices provide Single Root I/O Virtualization and Sharing (SR-IOV) capabilities. When SR-IOV is used, a physical device is virtualized and appears as multiple PCI devices. Virtual PCI devices are assigned to the same or different guests. In the case of PCI passthrough, the full physical device is assigned to only one guest and cannot be shared.

PCI devices are requested through flavor extra specs, specifically via the *pci_passthrough:alias* flavor extra spec. This guide demonstrates how to enable PCI passthrough for a type of PCI device with a vendor ID of `8086` and a product ID of `154d` - an Intel X520 Network Adapter - by mapping them to the alias `a1`. You should adjust the instructions for other devices with potentially different capabilities.

Note

For information on creating servers with SR-IOV network interfaces, refer to the Networking Guide.

Limitations

- Attaching SR-IOV ports to existing servers was not supported until the 22.0.0 Victoria release. Due to various bugs in libvirt and qemu we recommend to use at least libvirt version 6.0.0 and at least qemu version 4.2.
- Cold migration (resize) of servers with SR-IOV devices attached was not supported until the 14.0.0 Newton release, see bug 1512800 for details.

Note

Nova only supports PCI addresses where the fields are restricted to the following maximum value:

- domain - 0xFFFF
- bus - 0xFF
- slot - 0x1F
- function - 0x7

Nova will ignore PCI devices reported by the hypervisor if the address is outside of these ranges.

Changed in version 26.0.0: (Zed): PCI passthrough device inventories now can be tracked in Placement. For more information, refer to *PCI tracking in Placement*.

Changed in version 26.0.0: (Zed): The nova-compute service will refuse to start if both the parent PF and its children VFs are configured in *pci.device_spec*. For more information, refer to *PCI tracking in Placement*.

Changed in version 26.0.0: (Zed): The nova-compute service will refuse to start with *pci.device_spec* configuration that uses the `devname` field.

Changed in version 27.0.0: (2023.1 Antelope): Nova provides Placement based scheduling support for servers with flavor based PCI requests. This support is disable by default.

Changed in version 31.0.0: (2025.1 Epoxy):

- Add managed tag to define if the PCI device is managed (attached/detached from the host) by libvirt. This is required to support SR-IOV devices using the new kernel variant driver interface.
- Add a live_migratable tag to define whether a PCI device supports live migration.
- Add a live_migratable tag to alias definitions to allow requesting either a live-migratable or non-live-migratable device.

Enabling PCI passthrough

Configure compute host

To enable PCI passthrough on an x86, Linux-based compute node, the following are required:

- VT-d enabled in the BIOS
- IOMMU enabled on the host OS, e.g. by adding the `intel_iommu=on` or `amd_iommu=on` parameter to the kernel parameters
- Assignable PCIe devices

Configure `nova-compute`

Once PCI passthrough has been configured for the host, **`nova-compute`** must be configured to allow the PCI device to pass through to VMs. This is done using the *`pci.device_spec`* option. For example, assuming our sample PCI device has a PCI address of `41:00.0` on each host:

```
[pci]
device_spec = { "address": "0000:41:00.0" }
```

Refer to *`pci.device_spec`* for syntax information.

Alternatively, to enable passthrough of all devices with the same product and vendor ID:

```
[pci]
device_spec = { "vendor_id": "8086", "product_id": "154d" }
```

If using vendor and product IDs, all PCI devices matching the `vendor_id` and `product_id` are added to the pool of PCI devices available for passthrough to VMs.

In addition, it is necessary to configure the *`pci.alias`* option, which is a JSON-style configuration option that allows you to map a given device type, identified by the standard PCI `vendor_id` and (optional) `product_id` fields, to an arbitrary name or *alias*. This alias can then be used to request a PCI device using the *`pci_passthrough:alias`* flavor extra spec, as discussed previously. For our sample device with a vendor ID of `0x8086` and a product ID of `0x154d`, this would be:

```
[pci]
alias = { "vendor_id":"8086", "product_id":"154d", "device_type":"type-PF",
↪"name":"a1" }
```

Its important to note the addition of the `device_type` field. This is necessary because this PCI device supports SR-IOV. The `nova-compute` service categorizes devices into one of three types, depending on the capabilities the devices report:

type-PF
The device supports SR-IOV and is the parent or root device.

type-VF
The device is a child device of a device that supports SR-IOV.

type-PCI
The device does not support SR-IOV.

By default, it is only possible to attach `type-PCI` devices using PCI passthrough. If you wish to attach `type-PF` or `type-VF` devices, you must specify the `device_type` field in the config option. If the device was a device that did not support SR-IOV, the `device_type` field could be omitted.

Refer to *pci.alias* for syntax information.

Important

This option must also be configured on controller nodes. This is discussed later in this document.

Once configured, restart the **nova-compute** service.

Special Tags

When specified in *pci.device_spec* some tags have special meaning:

physical_network
Associates a device with a physical network label which corresponds to the `physical_network` attribute of a network segment object in Neutron. For virtual networks such as overlays a value of `null` should be specified as follows: `"physical_network": null`. In the case of physical networks, this tag is used to supply the metadata necessary for identifying a switched fabric to which a PCI device belongs and associate the port with the correct network segment in the networking backend. Besides typical SR-IOV scenarios, this tag can be used for remote-managed devices in conjunction with the `remote_managed` tag.

Note

The use of `"physical_network": null` is only supported in single segment networks. This is due to Nova not supporting multisegment networks for SR-IOV ports. See bug 1983570 for details.

remote_managed
Used to specify whether a PCI device is managed remotely or not. By default, devices are implicitly tagged as `"remote_managed": "false"` but and they must be tagged as `"remote_managed": "true"` if ports with `VNIC_TYPE_REMOTE_MANAGED` are intended to be used. Once that is done, those PCI devices will not be available for allocation for regular PCI passthrough use. Specifying `"remote_managed": "true"` is only valid for SR-IOV VFs and specifying it for PFs is prohibited.

Important

It is recommended that PCI VFs that are meant to be remote-managed (e.g. the ones provided by SmartNIC DPUs) are tagged as remote-managed in order to prevent them from being allocated for regular PCI passthrough since they have to be programmed accordingly at the host that has

access to the NIC switch control plane. If this is not done, instances requesting regular SR-IOV ports may get a device that will not be configured correctly and will not be usable for sending network traffic.

Important

For the Libvirt virt driver, clearing a VLAN by programming VLAN 0 must not result in errors in the VF kernel driver at the compute host. Before v8.1.0 Libvirt clears a VLAN before passing a VF through to the guest which may result in an error depending on your driver and kernel version (see, for example, this bug which discusses a case relevant to one driver). As of Libvirt v8.1.0, EPERM errors encountered while programming a VLAN are ignored if VLAN clearing is not explicitly requested in the device XML.

`trusted`
: If a port is requested to be trusted by specifying an extra option during port creation via `--binding-profile trusted=true`, only devices tagged as `trusted: "true"` will be allocated to instances. Nova will then configure those devices as trusted by the network controller through its PF device driver. The specific set of features allowed by the trusted mode of a VF will differ depending on the network controller itself, its firmware version and what a PF device driver version allows to pass to the NIC. Common features to be affected by this tag are changing the VF MAC address, enabling promiscuous mode or multicast promiscuous mode.

Important

While the `trusted tag` does not directly conflict with the `remote_managed` tag, network controllers in SmartNIC DPUs may prohibit setting the `trusted` mode on a VF via a PF device driver in the first place. It is recommended to test specific devices, drivers and firmware versions before assuming this feature can be used.

`managed`
: Users must specify whether the PCI device is managed by libvirt to allow detachment from the host and assignment to the guest, or vice versa. The managed mode of a device depends on the specific device and the support provided by its driver.

  - `managed='yes'` means that nova will let libvirt to detach the device from the host before attaching it to the guest and re-attach it to the host after the guest is deleted.
  - `managed='no'` means that Nova will not request libvirt to attach or detach the device from the host. Instead, Nova assumes that the operator has pre-configured the host so that the devices are already bound to vfio-pci or an appropriate variant driver. This setup allows the devices to be directly usable by QEMU without requiring any additional operations to enable passthrough.

Note

If not set, the default value is managed=yes to preserve the existing behavior, primarily for upgrade purposes.

> **Warning**
>
> Incorrect configuration of this parameter may result in compute node crashes.

Configure `nova-scheduler`

The **`nova-scheduler`** service must be configured to enable the `PciPassthroughFilter`. To do this, add this filter to the list of filters specified in *`filter_scheduler.enabled_filters`* and set *`filter_scheduler.available_filters`* to the default of `nova.scheduler.filters.all_filters`. For example:

```
[filter_scheduler]
enabled_filters = ...,PciPassthroughFilter
available_filters = nova.scheduler.filters.all_filters
```

Once done, restart the **`nova-scheduler`** service.

Configure `nova-api`

It is necessary to also configure the *`pci.alias`* config option on the controller. This configuration should match the configuration found on the compute nodes. For example:

```
[pci]
alias = { "vendor_id":"8086", "product_id":"154d", "device_type":"type-PF",
↪"name":"a1", "numa_policy":"preferred" }
```

Refer to *`pci.alias`* for syntax information. Refer to *Affinity* for `numa_policy` information.

Once configured, restart the Compute API service.

Configuring a flavor or image

Once the alias has been configured, it can be used for an flavor extra spec. For example, to request two of the PCI devices referenced by alias `a1`, run:

```
$ openstack flavor set m1.large --property "pci_passthrough:alias"="a1:2"
```

For more information about the syntax for `pci_passthrough:alias`, refer to *the documentation*.

PCI-NUMA affinity policies

By default, the libvirt driver enforces strict NUMA affinity for PCI devices, be they PCI passthrough devices or neutron SR-IOV interfaces. This means that by default a PCI device must be allocated from the same host NUMA node as at least one of the instances CPUs. This isnt always necessary, however, and you can configure this policy using the *`hw:pci_numa_affinity_policy`* flavor extra spec or equivalent image metadata property. There are three possible values allowed:

required
: This policy means that nova will boot instances with PCI devices **only** if at least one of the NUMA nodes of the instance is associated with these PCI devices. It means that if NUMA node info for some PCI devices could not be determined, those PCI devices wouldnt be consumable by the instance. This provides maximum performance.

socket
: This policy means that the PCI device must be affined to the same host socket as at least one of the guest NUMA nodes. For example, consider a system with two sockets, each with two NUMA nodes, numbered node 0 and node 1 on socket 0, and node 2 and node 3 on socket 1. There is a PCI device affined to node 0. An PCI instance with two guest NUMA nodes and the `socket` policy can be affined to either:

  - node 0 and node 1
  - node 0 and node 2
  - node 0 and node 3
  - node 1 and node 2
  - node 1 and node 3

  The instance cannot be affined to node 2 and node 3, as neither of those are on the same socket as the PCI device. If the other nodes are consumed by other instances and only nodes 2 and 3 are available, the instance will not boot.

preferred
: This policy means that `nova-scheduler` will choose a compute host with minimal consideration for the NUMA affinity of PCI devices. `nova-compute` will attempt a best effort selection of PCI devices based on NUMA affinity, however, if this is not possible then `nova-compute` will fall back to scheduling on a NUMA node that is not associated with the PCI device.

legacy
: This is the default policy and it describes the current nova behavior. Usually we have information about association of PCI devices with NUMA nodes. However, some PCI devices do not provide such information. The `legacy` value will mean that nova will boot instances with PCI device if either:

  - The PCI device is associated with at least one NUMA nodes on which the instance will be booted
  - There is no information about PCI-NUMA affinity available

For example, to configure a flavor to use the `preferred` PCI NUMA affinity policy for any neutron SR-IOV interfaces attached by the user:

```
$ openstack flavor set $FLAVOR \
    --property hw:pci_numa_affinity_policy=preferred
```

You can also configure this for PCI passthrough devices by specifying the policy in the alias configuration via *pci.alias*. For more information, refer to *the documentation*.

PCI tracking in Placement

Note

The feature described below are optional and disabled by default in nova 26.0.0. (Zed). The legacy PCI tracker code path is still supported and enabled. The Placement PCI tracking can be enabled via the *pci.report_in_placement* configuration.

Warning

Please note that once it is enabled on a given compute host **it cannot be disabled there any more**.

Warning

If you configure more than 8 PCI devices per compute with the same product_id or resource_class then placement needs configuration tuning to keep the scheduling speed acceptable. Please read the following two release notes:

- https://github.com/openstack/placement/blob/master/releasenotes/notes/bug-2070257-allocation-candidates-generation-limit-and-strategy.yaml-e73796898163fb55.yaml
- https://github.com/openstack/placement/blob/master/releasenotes/notes/bug-2126751-optimize_for_wide_provider_trees-b50b7813fd0d9dd2.yaml

Since nova 26.0.0 (Zed) PCI passthrough device inventories are tracked in Placement. If a PCI device exists on the hypervisor and matches one of the device specifications configured via *pci.device_spec* then Placement will have a representation of the device. Each PCI device of type `type-PCI` and `type-PF` will be modeled as a Placement resource provider (RP) with the name `<hypervisor_hostname>_<pci_address>`. A devices with type `type-VF` is represented by its parent PCI device, the PF, as resource provider.

By default nova will use `CUSTOM_PCI_<vendor_id>_<product_id>` as the resource class in PCI inventories in Placement. However the name of the resource class can be customized via the `resource_class` tag in the *pci.device_spec* option. There is also a new `traits` tag in that configuration that allows specifying a list of placement traits to be added to the resource provider representing the matching PCI devices.

Note

In nova 26.0.0 (Zed) the Placement resource tracking of PCI devices does not support SR-IOV devices intended to be consumed via Neutron ports and therefore having `physical_network` tag in *pci.device_spec*. Such devices are supported via the legacy PCI tracker code path in Nova.

Note

Having different resource class or traits configuration for VFs under the same parent PF is not supported and the nova-compute service will refuse to start with such configuration.

Important

While nova supported configuring both the PF and its children VFs for PCI passthrough in the past, it only allowed consuming either the parent PF or its children VFs. Since 26.0.0. (Zed) the nova-compute service will enforce the same rule for the configuration as well and will refuse to start if both the parent PF and its VFs are configured.

Important

While nova supported configuring PCI devices by device name via the `devname` parameter in *pci.device_spec* in the past, this proved to be problematic as the netdev name of a PCI device could change for multiple reasons during hypervisor reboot. So since nova 26.0.0 (Zed) the nova-compute service will refuse to start with such configuration. It is suggested to use the PCI address of the device instead.

Important

While nova supported configuring *pci.alias* where an alias name is repeated and therefore associated to multiple alias specifications, such configuration is not supported when PCI tracking in Placement is enabled.

The nova-compute service makes sure that existing instances with PCI allocations in the nova DB will have a corresponding PCI allocation in placement. This allocation healing also acts on any new instances regardless of the status of the scheduling part of this feature to make sure that the nova DB and placement are in sync. There is one limitation of the healing logic. It assumes that there is no in-progress migration when the nova-compute service is upgraded. If there is an in-progress migration then the PCI allocation on the source host of the migration will not be healed. The placement view will be consistent after such migration is completed or reverted.

Reconfiguring the PCI devices on the hypervisor or changing the *pci.device_spec* configuration option and restarting the nova-compute service is supported in the following cases:

- new devices are added
- devices without allocation are removed

Removing a device that has allocations is not supported. If a device having any allocation is removed then the nova-compute service will keep the device and the allocation exists in the nova DB and in placement and logs a warning. If a device with any allocation is reconfigured in a way that an allocated PF is removed and VFs from the same PF is configured (or vice versa) then nova-compute will refuse to start as it would create a situation where both the PF and its VFs are made available for consumption.

Since nova 27.0.0 (2023.1 Antelope) scheduling and allocation of PCI devices in Placement can also be enabled via *filter_scheduler.pci_in_placement* config option set in the nova-api, nova-scheduler, and nova-conductor configuration. Please note that this should only be enabled after all the computes in the system is configured to report PCI inventory in Placement via enabling *pci.report_in_placement*. In Antelope flavor based PCI requests are support but Neutron port base PCI requests are not handled in Placement.

If you are upgrading from an earlier version with already existing servers with PCI usage then you must enable *pci.report_in_placement* first on all your computes having PCI allocations and then restart the nova-compute service, before you enable *filter_scheduler.pci_in_placement*. The compute service will heal the missing PCI allocation in placement during startup and will continue healing missing allocations for future servers until the scheduling support is enabled.

If a flavor requests multiple `type-VF` devices via *pci_passthrough:alias* then it is important to consider the value of *group_policy* as well. The value `none` allows nova to select VFs from the same parent PF to fulfill the request. The value `isolate` restricts nova to select each VF from a different parent PF to fulfill the request. If *group_policy* is not provided in such flavor then it will defaulted to `none`.

Symmetrically with the `resource_class` and `traits` fields of *pci.device_spec* the *pci.alias* configuration option supports requesting devices by Placement resource class name via the `resource_class` field and also support requesting traits to be present on the selected devices via the `traits` field in the alias. If the `resource_class` field is not specified in the alias then it is defaulted by nova to `CUSTOM_PCI_<vendor_id>_<product_id>`. Either the `product_id` and `vendor_id` or the `resource_class` field must be provided in each alias.

For deeper technical details please read the nova specification.

Support for multiple types of VFs

SR-IOV devices, such as GPUs, can be configured to provide VFs with various characteristics under the same vendor ID and product ID.

To enable Nova to model this, if you configure the VFs with different resource allocations, you will need to use separate resource_classes for each.

This can be achieved by following the steps below:

- Enable PCI in Placement: This is necessary to track PCI devices with custom resource classes in the placement service.
- Define Device Specifications: Use a custom resource class to represent a specific VF type and ensure that the VFs existing on the hypervisor are matched via the VFs PCI address.
- Specify Type-Specific Flavors: Define flavors with an alias that matches the resource class to ensure proper allocation.

Examples:

Note

The following example demonstrates device specifications and alias configurations, utilizing resource classes as part of the PCI in placement feature.

```
[pci]
device_spec = { "vendor_id": "10de", "product_id": "25b6", "address":
↪"0000:25:00.4", "resource_class": "CUSTOM_A16_16A", "managed": "no" }
device_spec = { "vendor_id": "10de", "product_id": "25b6", "address":
↪"0000:25:00.5", "resource_class": "CUSTOM_A16_8A", "managed": "no" }
alias = { "device_type": "type-VF", "resource_class": "CUSTOM_A16_16A", "name
↪": "A16_16A" }
alias = { "device_type": "type-VF", "resource_class": "CUSTOM_A16_8A", "name
↪": "A16_8A" }
```

Configuring Live Migration for PCI devices

Live migration of instances with PCI devices requires specific configuration at both the device and alias levels to ensure that the migration can succeed. This section explains how to configure PCI passthrough to support live migration.

Configuring PCI Device Specification

Administrators must explicitly define whether a PCI device support live migration. This is done by adding the `live_migratable` attribute to the device specification in the *`pci.device_spec`* configuration.

Note

Of course, this requires hardware support, as well as proper system and hypervisor configuration.

Example Configuration:

```
[pci]
dev_spec = {'vendor_id': '8086', 'product_id': '1515', 'live_migratable': 'yes
↪'}
dev_spec = {'vendor_id': '8086', 'product_id': '1516', 'live_migratable': 'no
↪'}
```

Configuring PCI Aliases for Users

PCI devices can be requested through flavor exta_specs.. To request a live migratable PCI device, the PCI alias definition in the *`pci.alias`* configuration must include the `live_migratable` key.

Example Configuration:

```
[pci]
alias = {'name': 'vf_live', 'vendor_id': '8086', 'product_id': '1515',
↪'device_type': 'type-VF', 'live_migratable': 'yes'}
alias = {'name': 'vf_no_migrate', 'vendor_id': '8086', 'product_id': '1516',
↪'device_type': 'type-VF', 'live_migratable': 'no'}
```

Virtual IOMMU support

With provided *`hw:viommu_model`* flavor extra spec or equivalent image metadata property `hw_viommu_model` and with the guest CPU architecture and OS allows, we can enable vIOMMU in libvirt driver.

Note

Enable vIOMMU might introduce significant performance overhead. You can see performance comparison table from AMD vIOMMU session on KVM Forum 2021. For the above reason, vIOMMU should only be enabled for workflow that require it.

Here are four possible values allowed for `hw:viommu_model` (and `hw_viommu_model`):

virtio
: Supported on Libvirt since 8.3.0, for Q35 and ARM virt guests.

smmuv3
: Supported on Libvirt since 5.5.0, for ARM virt guests.

intel
: Supported for Q35 guests.

auto
: This option will translate to `virtio` if Libvirt supported, else `intel` on X86 (Q35) and `smmuv3` on AArch64.

For the viommu attributes:

- `intremap`, `caching_mode`, and `iotlb` options for viommu (These attributes are driver attributes defined in Libvirt IOMMU Domain) will directly enabled.
- `eim` will directly enabled if machine type is Q35. `eim` is driver attribute defined in Libvirt IOMMU Domain.

Note

eim(Extended Interrupt Mode) attribute (with possible values on and off) can be used to configure Extended Interrupt Mode. A q35 domain with split I/O APIC (as described in hypervisor features), and both interrupt remapping and EIM turned on for the IOMMU, will be able to use more than 255 vCPUs. Since 3.4.0 (QEMU/KVM only).

- `aw_bits` attribute can used to set the address width to allow mapping larger iova addresses in the guest. Since Qemu current supported values are 39 and 48, we directly set this to larger width (48) if Libvirt supported. `aw_bits` is driver attribute defined in Libvirt IOMMU Domain.

Known Issues

A known issue exists where the `live_migratable` flag is ignored for devices that include the `physical_network` tag. As a result, instances using such devices do not behave as non-live migratable, and instead, they continue to migrate using the legacy VIF unplug/live migrate/VIF plug procedure.

Example configuration where the live_migratable flag is ignored:

```
[pci]
device_spec = { "vendor_id":"8086", "product_id":"10ca", "address": "0000:06:
↪", "physical_network": "physnet2", "live_migratable": false}
```

A fix for this issue is planned in a follow-up for the **Epoxy** release. The upstream bug report is here.

One-Time-Use Devices

Certain devices may need attention after they are released from one user and before they are attached to another. This is especially true of direct passthrough devices because the instance has full control over them while attached, and Nova doesnt know specifics about the device itself, unlike regular more cloudy resources. Examples include:

- Securely erasing NVMe devices to ensure data residue is not passed from one user to the other unintentionally
- Reinstalling known-good firmware to the device to avoid a hijack attack
- Updating firmware to the latest release before each user
- Checking a property of the device to determine if it needs repair or replacement before giving it to another user (i.e. NVMe write-wear indicator)
- Some custom behavior, reset, etc

Novas scope does not cover the above, but it does support a feature that makes it easier for the operator to orchestrate tasks like this. By marking a device as one time use (hereafter referred to as OTU), Nova will allocate a device once, after which it will remain in a reserved state to avoid being allocated to another instance. After the operators workflow is performed and the device should be returned to the pool of available resources, the reserved flag can be dropped and Nova will consider it usable again.

Note

This feature requires *PCI tracking in Placement* in order to work. The compute configuration is required, but the transitional scheduler config is optional (during transition but required for safety).

A device can be marked as OTU by adding a tag in the `device_spec` like this:

```
device_spec = {"address": "0000:00:1.0", "one_time_use": true}
```

By marking the device as such, Nova will set the `reserved` inventory value on the placement provider to fully cover the device (i.e. `reserved=total` at the point at which the instance is assigned the PCI device on the compute node. When the instance is deleted, the `used` value will return to zero but `reserved` will remain. It is the operators responsibility to return the `reserved` value to zero when the device is ready for re-assignment.

The best way to handle this would be to listen to Novas notifications for the `instance.delete.end` event so that the post-processing workflow can happen immediately. However, since notifications could be dropped or missed, regular polling should be performed. Providers that represent devices that Nova is applying the OTU behavior to will have the `HW_PCI_ONE_TIME_USE` trait, making it easier to identify them. For example:

```
$ openstack resource provider list --required HW_PCI_ONE_TIME_USE
+--------------------------------------+--------------------+------------+----
↪----------------------------------+----------------------------------------+
| uuid                                 | name               | generation |␣
↪root_provider_uuid                  | parent_provider_uuid                   ␣
↪|
+--------------------------------------+--------------------+------------+----
↪----------------------------------+----------------------------------------+
| b9e67d7d-43db-49c7-8ce8-803cad08e656 | jammy_0000:00:01.0 |         39 |␣
↪2ee402e8-c5c6-4586-9ac7-58e7594d27d1 | 2ee402e8-c5c6-4586-9ac7-58e7594d27d1␣
↪|
+--------------------------------------+--------------------+------------+----
↪----------------------------------+----------------------------------------+
```

Will find all such providers. For each of those, checking the inventory to find ones with `used=0` and `reserved=1` will identify devices in need of processing. To use the above example:

```
$ openstack resource provider inventory list b9e67d7d-43db-49c7-8ce8-
↪803cad08e656
+----------------------+------------------+----------+----------+----------+--
↪---------+-------+------+
| resource_class       | allocation_ratio | min_unit | max_unit | reserved |␣
↪step_size | total | used |
+----------------------+------------------+----------+----------+----------+--
```

(continues on next page)

(continued from previous page)

```
↪---------+-------+------+
| CUSTOM_PCI_1B36_0100 |               1.0 |        1 |        1 |         1 | ␣
↪       1 |     1 |    0 |
+----------------------+-------------------+----------+----------+-----------+--
↪---------+-------+------+
```

To return the above device back to the pool of allocatable resources, we can set the reserved count back to zero:

```
$ openstack resource provider inventory set --amend \
    --resource CUSTOM_PCI_1B36_0100:reserved=0 \
    b9e67d7d-43db-49c7-8ce8-803cad08e656
+----------------------+-------------------+----------+----------+-----------+--
↪---------+-------+
| resource_class       | allocation_ratio | min_unit | max_unit | reserved |␣
↪step_size | total |
+----------------------+-------------------+----------+----------+-----------+--
↪---------+-------+
| CUSTOM_PCI_1B36_0100 |               1.0 |        1 |        1 |         0 | ␣
↪       1 |     1 |
+----------------------+-------------------+----------+----------+-----------+--
↪---------+-------+
```

CPU topologies

The NUMA topology and CPU pinning features in OpenStack provide high-level control over how instances run on hypervisor CPUs and the topology of virtual CPUs available to instances. These features help minimize latency and maximize performance.

Important

In deployments older than Train, or in mixed Stein/Train deployments with a rolling upgrade in progress, unless *specifically enabled*, live migration is not possible for instances with a NUMA topology when using the libvirt driver. A NUMA topology may be specified explicitly or can be added implicitly due to the use of CPU pinning or huge pages. Refer to bug #1289064 for more information. As of Train, live migration of instances with a NUMA topology when using the libvirt driver is fully supported.

SMP, NUMA, and SMT

Symmetric multiprocessing (SMP)
: SMP is a design found in many modern multi-core systems. In an SMP system, there are two or more CPUs and these CPUs are connected by some interconnect. This provides CPUs with equal access to system resources like memory and input/output ports.

Non-uniform memory access (NUMA)
: NUMA is a derivative of the SMP design that is found in many multi-socket systems. In a NUMA system, system memory is divided into cells or nodes that are associated with particular CPUs. Requests for memory on other nodes are possible through an interconnect bus. However, bandwidth

across this shared bus is limited. As a result, competition for this resource can incur performance penalties.

Simultaneous Multi-Threading (SMT)
SMT is a design complementary to SMP. Whereas CPUs in SMP systems share a bus and some memory, CPUs in SMT systems share many more components. CPUs that share components are known as thread siblings. All CPUs appear as usable CPUs on the system and can execute workloads in parallel. However, as with NUMA, threads compete for shared resources.

Non-Uniform I/O Access (NUMA I/O)
In a NUMA system, I/O to a device mapped to a local memory region is more efficient than I/O to a remote device. A device connected to the same socket providing the CPU and memory offers lower latencies for I/O operations due to its physical proximity. This generally manifests itself in devices connected to the PCIe bus, such as NICs or vGPUs, but applies to any device support memory-mapped I/O.

In OpenStack, SMP CPUs are known as *cores*, NUMA cells or nodes are known as *sockets*, and SMT CPUs are known as *threads*. For example, a quad-socket, eight core system with Hyper-Threading would have four sockets, eight cores per socket and two threads per core, for a total of 64 CPUs.

PCPU and VCPU

PCPU
Resource class representing an amount of dedicated CPUs for a single guest.

VCPU
Resource class representing a unit of CPU resources for a single guest approximating the processing power of a single physical processor.

Customizing instance NUMA placement policies

Important

The functionality described below is currently only supported by the libvirt/KVM driver.

When running workloads on NUMA hosts, it is important that the vCPUs executing processes are on the same NUMA node as the memory used by these processes. This ensures all memory accesses are local to the node and thus do not consume the limited cross-node memory bandwidth, adding latency to memory accesses. Similarly, large pages are assigned from memory and benefit from the same performance improvements as memory allocated using standard pages. Thus, they also should be local. Finally, PCI devices are directly associated with specific NUMA nodes for the purposes of DMA. Instances that use PCI or SR-IOV devices should be placed on the NUMA node associated with these devices.

NUMA topology can exist on both the physical hardware of the host and the virtual hardware of the instance. In OpenStack, when booting a process, the hypervisor driver looks at the NUMA topology field of both the instance and the host it is being booted on, and uses that information to generate an appropriate configuration.

By default, an instance floats across all NUMA nodes on a host. NUMA awareness can be enabled implicitly through the use of huge pages or pinned CPUs or explicitly through the use of flavor extra specs or image metadata. If the instance has requested a specific NUMA topology, compute will try to pin the vCPUs of different NUMA cells on the instance to the corresponding NUMA cells on the host. It will also expose the NUMA topology of the instance to the guest OS.

In all cases where NUMA awareness is used, the `NUMATopologyFilter` filter must be enabled. Details on this filter are provided in *Compute schedulers*.

The hosts NUMA node(s) used are chosen based on some logic and controlled by `packing_host_numa_cells_allocation_strategy` configuration variable in nova.conf. By default `packing_host_numa_cells_allocation_strategy` variable is set to `True`. It leads to attempt to chose NUMA node(s) with less amount of free resources (or in other words **more used** NUMA nodes) first. It is so-called pack strategy - we try to place as much as possible load at **more used** hosts NUMA node until it will be completely exhausted. And only after we will choose **most used** hosts NUMA node from the rest available nodes on host. Spread strategy is reverse to pack strategy. The NUMA node(s) with **more free** resources will be used first. So spread strategy will try to balance load between all NUMA nodes and keep number of free resources on all NUMA nodes as more equal as possible.

Caution

Hosts NUMA nodes are placed in list and list is sorted based on strategy chosen and resource available in each NUMA node. Sorts are performed on same list one after another, so the last sort implemented is the sort with most priority.

The python performed so-called stable sort. It means that each sort executed on same list will change order of list items only if items property we sort on differs. If this properties in all lists items are equal than elements order will not changed.

Sorts are performed on hosts NUMA nodes list in the following order:

- sort based on available memory on node(first sort-less priority)
- sort based on cpu usage (in case of shared CPUs requested by guest VM topology) or free pinned cpus otherwise.
- sort based on number of free PCI device on node(last sort-top priority)

Top sorting priority is for hosts NUMA nodes with PCI devices attached. If VM requested PCI device(s) logic **always** puts hosts NUMA nodes with more PCI devices at the beginning of the hosts NUMA nodes list. If PCI devices isnt requested by VM than NUMA nodes with no (or less) PCI device available will be placed at the beginning of the list.

Caution

The described logic for PCI devices is used **both** for pack and spread strategies. It is done to keep backward compatibility with previous nova versions.

During pack logic implementation rest (two) sorts are performed with sort order to move NUMA nodes with more available resources (CPUs and memory) at the END of hosts NUMA nodes list. Sort based on memory is the first sort implemented and has least priority.

During spread logic implementation rest (two) sorts are performed with sort order to move NUMA nodes with more available resources (CPUs and memory) at the BEGINNING of hosts NUMA nodes list. Sort based on memory is the first sort implemented and has least priority.

Finally resulting list (after all sorts) is passed next and attempts to place VMs NUMA node to hosts NUMA node are performed starting from the first hosts NUMA node in list.

Caution

Inadequate per-node resources will result in scheduling failures. Resources that are specific to a node include not only CPUs and memory, but also PCI and SR-IOV resources. It is not possible to use multiple resources from different nodes without requesting a multi-node layout. As such, it may be necessary to ensure PCI or SR-IOV resources are associated with the same NUMA node or force a multi-node layout.

When used, NUMA awareness allows the operating system of the instance to intelligently schedule the workloads that it runs and minimize cross-node memory bandwidth. To configure guest NUMA nodes, you can use the *hw:numa_nodes* flavor extra spec. For example, to restrict an instances vCPUs to a single host NUMA node, run:

```
$ openstack flavor set $FLAVOR --property hw:numa_nodes=1
```

Some workloads have very demanding requirements for memory access latency or bandwidth that exceed the memory bandwidth available from a single NUMA node. For such workloads, it is beneficial to spread the instance across multiple host NUMA nodes, even if the instances RAM/vCPUs could theoretically fit on a single NUMA node. To force an instances vCPUs to spread across two host NUMA nodes, run:

```
$ openstack flavor set $FLAVOR --property hw:numa_nodes=2
```

The allocation of instance vCPUs and memory from different host NUMA nodes can be configured. This allows for asymmetric allocation of vCPUs and memory, which can be important for some workloads. You can configure the allocation of instance vCPUs and memory across each **guest** NUMA node using the *hw:numa_cpus.{num}* and *hw:numa_mem.{num}* extra specs respectively. For example, to spread the 6 vCPUs and 6 GB of memory of an instance across two NUMA nodes and create an asymmetric 1:2 vCPU and memory mapping between the two nodes, run:

```
$ openstack flavor set $FLAVOR --property hw:numa_nodes=2
# configure guest node 0
$ openstack flavor set $FLAVOR \
  --property hw:numa_cpus.0=0,1 \
  --property hw:numa_mem.0=2048
# configure guest node 1
$ openstack flavor set $FLAVOR \
  --property hw:numa_cpus.1=2,3,4,5 \
  --property hw:numa_mem.1=4096
```

Note

The {num} parameter is an index of *guest* NUMA nodes and may not correspond to *host* NUMA nodes. For example, on a platform with two NUMA nodes, the scheduler may opt to place guest NUMA node 0, as referenced in hw:numa_mem.0 on host NUMA node 1 and vice versa. Similarly, the CPUs bitmask specified in the value for hw:numa_cpus.{num} refer to *guest* vCPUs and may not correspond to *host* CPUs. As such, this feature cannot be used to constrain instances to specific host CPUs or NUMA nodes.

Warning

If the combined values of `hw:numa_cpus.{num}` or `hw:numa_mem.{num}` are greater than the available number of CPUs or memory respectively, an exception will be raised.

For more information about the syntax for `hw:numa_nodes`, `hw:numa_cpus.N` and `hw:num_mem.N`, refer to *Extra Specs*.

Customizing instance CPU pinning policies

Important

The functionality described below is currently only supported by the libvirt/KVM driver and requires *some host configuration* for this to work.

Note

There is no correlation required between the NUMA topology exposed in the instance and how the instance is actually pinned on the host. This is by design. See this invalid bug for more information.

By default, instance vCPU processes are not assigned to any particular host CPU, instead, they float across host CPUs like any other process. This allows for features like overcommitting of CPUs. In heavily contended systems, this provides optimal system performance at the expense of performance and latency for individual instances.

Some workloads require real-time or near real-time behavior, which is not possible with the latency introduced by the default CPU policy. For such workloads, it is beneficial to control which host CPUs are bound to an instances vCPUs. This process is known as pinning. No instance with pinned CPUs can use the CPUs of another pinned instance, thus preventing resource contention between instances.

CPU pinning policies can be used to determine whether an instance should be pinned or not. They can be configured using the *`hw:cpu_policy`* extra spec and equivalent image metadata property. There are three policies: `dedicated`, `mixed` and `shared` (the default). The `dedicated` CPU policy is used to specify that all CPUs of an instance should use pinned CPUs. To configure a flavor to use the `dedicated` CPU policy, run:

```
$ openstack flavor set $FLAVOR --property hw:cpu_policy=dedicated
```

This works by ensuring `PCPU` allocations are used instead of `VCPU` allocations. As such, it is also possible to request this resource type explicitly. To configure this, run:

```
$ openstack flavor set $FLAVOR --property resources:PCPU=N
```

(where `N` is the number of vCPUs defined in the flavor).

Note

It is not currently possible to request `PCPU` and `VCPU` resources in the same instance.

The `shared` CPU policy is used to specify that an instance **should not** use pinned CPUs. To configure a flavor to use the `shared` CPU policy, run:

```
$ openstack flavor set $FLAVOR --property hw:cpu_policy=shared
```

The `mixed` CPU policy is used to specify that an instance use pinned CPUs along with unpinned CPUs. The instance pinned CPU could be specified in the *`hw:cpu_dedicated_mask`* or, if *real-time* is enabled, in the *`hw:cpu_realtime_mask`* extra spec. For example, to configure a flavor to use the `mixed` CPU policy with 4 vCPUs in total and the first 2 vCPUs as pinned CPUs, run:

```
$ openstack flavor set $FLAVOR \
  --vcpus=4 \
  --property hw:cpu_policy=mixed \
  --property hw:cpu_dedicated_mask=0-1
```

To configure a flavor to use the `mixed` CPU policy with 4 vCPUs in total and the first 2 vCPUs as pinned **real-time** CPUs, run:

```
$ openstack flavor set $FLAVOR \
  --vcpus=4 \
  --property hw:cpu_policy=mixed \
  --property hw:cpu_realtime=yes \
  --property hw:cpu_realtime_mask=0-1
```

Note

For more information about the syntax for `hw:cpu_policy`, `hw:cpu_dedicated_mask`, `hw:realtime_cpu` and `hw:cpu_realtime_mask`, refer to *Extra Specs*

Note

For more information about real-time functionality, refer to the *documentation*.

It is also possible to configure the CPU policy via image metadata. This can be useful when packaging applications that require real-time or near real-time behavior by ensuring instances created with a given image are always pinned regardless of flavor. To configure an image to use the `dedicated` CPU policy, run:

```
$ openstack image set $IMAGE --property hw_cpu_policy=dedicated
```

Likewise, to configure an image to use the `shared` CPU policy, run:

```
$ openstack image set $IMAGE --property hw_cpu_policy=shared
```

Note

For more information about image metadata, refer to the Image metadata guide.

Important

Flavor-based policies take precedence over image-based policies. For example, if a flavor specifies a CPU policy of `dedicated` then that policy will be used. If the flavor specifies a CPU policy of `shared` and the image specifies no policy or a policy of `shared` then the `shared` policy will be used. However, the flavor specifies a CPU policy of `shared` and the image specifies a policy of `dedicated`, or vice versa, an exception will be raised. This is by design. Image metadata is often configurable by non-admin users, while flavors are only configurable by admins. By setting a `shared` policy through flavor extra-specs, administrators can prevent users configuring CPU policies in images and impacting resource utilization.

Customizing instance CPU thread pinning policies

Important

The functionality described below requires the use of pinned instances and is therefore currently only supported by the libvirt/KVM driver and requires *some host configuration* for this to work.

When running pinned instances on SMT hosts, it may also be necessary to consider the impact that thread siblings can have on the instance workload. The presence of an SMT implementation like Intel Hyper-Threading can boost performance by up to 30% for some workloads. However, thread siblings share a number of components and contention on these components can diminish performance for other workloads. For this reason, it is also possible to explicitly request hosts with or without SMT.

To configure whether an instance should be placed on a host with SMT or not, a CPU thread policy may be specified. For workloads where sharing benefits performance, you can request hosts **with** SMT. To configure this, run:

```
$ openstack flavor set $FLAVOR \
  --property hw:cpu_policy=dedicated \
  --property hw:cpu_thread_policy=require
```

This will ensure the instance gets scheduled to a host with SMT by requesting hosts that report the `HW_CPU_HYPERTHREADING` trait. It is also possible to request this trait explicitly. To configure this, run:

```
$ openstack flavor set $FLAVOR \
  --property resources:PCPU=N \
  --property trait:HW_CPU_HYPERTHREADING=required
```

For other workloads where performance is impacted by contention for resources, you can request hosts **without** SMT. To configure this, run:

```
$ openstack flavor set $FLAVOR \
  --property hw:cpu_policy=dedicated \
  --property hw:cpu_thread_policy=isolate
```

This will ensure the instance gets scheduled to a host without SMT by requesting hosts that **do not** report the `HW_CPU_HYPERTHREADING` trait. It is also possible to request this trait explicitly. To configure this, run:

```
$ openstack flavor set $FLAVOR \
  --property resources:PCPU=N \
  --property trait:HW_CPU_HYPERTHREADING=forbidden
```

Finally, for workloads where performance is minimally impacted, you may use thread siblings if available and fallback to not using them if necessary. This is the default, but it can be set explicitly:

```
$ openstack flavor set $FLAVOR \
  --property hw:cpu_policy=dedicated \
  --property hw:cpu_thread_policy=prefer
```

This does not utilize traits and, as such, there is no trait-based equivalent.

Note

For more information about the syntax for `hw:cpu_thread_policy`, refer to *Extra Specs*.

As with CPU policies, it also possible to configure the CPU thread policy via image metadata. This can be useful when packaging applications that require real-time or near real-time behavior by ensuring instances created with a given image are always pinned regardless of flavor. To configure an image to use the `require` CPU policy, run:

```
$ openstack image set $IMAGE \
  --property hw_cpu_policy=dedicated \
  --property hw_cpu_thread_policy=require
```

Likewise, to configure an image to use the `isolate` CPU thread policy, run:

```
$ openstack image set $IMAGE \
  --property hw_cpu_policy=dedicated \
  --property hw_cpu_thread_policy=isolate
```

Finally, to configure an image to use the `prefer` CPU thread policy, run:

```
$ openstack image set $IMAGE \
  --property hw_cpu_policy=dedicated \
  --property hw_cpu_thread_policy=prefer
```

If the flavor does not specify a CPU thread policy then the CPU thread policy specified by the image (if any) will be used. If both the flavor and image specify a CPU thread policy then they must specify the same policy, otherwise an exception will be raised.

Note

For more information about image metadata, refer to the Image metadata guide.

Customizing instance emulator thread pinning policies

Important

The functionality described below requires the use of pinned instances and is therefore currently only supported by the libvirt/KVM driver and requires *some host configuration* for this to work.

In addition to the work of the guest OS and applications running in an instance, there is a small amount of overhead associated with the underlying hypervisor. By default, these overhead tasks - known collectively as emulator threads - run on the same host CPUs as the instance itself and will result in a minor performance penalty for the instance. This is not usually an issue, however, for things like real-time instances, it may not be acceptable for emulator thread to steal time from instance CPUs.

Emulator thread policies can be used to ensure emulator threads are run on cores separate from those used by the instance. There are two policies: `isolate` and `share`. The default is to run the emulator threads on the same core. The `isolate` emulator thread policy is used to specify that emulator threads for a given instance should be run on their own unique core, chosen from one of the host cores listed in *compute.cpu_dedicated_set*. To configure a flavor to use the `isolate` emulator thread policy, run:

```
$ openstack flavor set $FLAVOR \
  --property hw:cpu_policy=dedicated \
  --property hw:emulator_threads_policy=isolate
```

The `share` policy is used to specify that emulator threads from a given instance should be run on the pool of host cores listed in *compute.cpu_shared_set* if configured, else across all pCPUs of the instance. To configure a flavor to use the `share` emulator thread policy, run:

```
$ openstack flavor set $FLAVOR \
  --property hw:cpu_policy=dedicated \
  --property hw:emulator_threads_policy=share
```

The above behavior can be summarized in this helpful table:

	compute.cpu_shared_set set	*compute.cpu_shared_set* unset
hw:emulator_treads_pol: unset (default)	Pinned to all of the instances pCPUs	Pinned to all of the instances pCPUs
hw:emulator_threads_po: = share	Pinned to *compute.cpu_shared_set*	Pinned to all of the instances pCPUs
hw:emulator_threads_po: = isolate	Pinned to a single pCPU distinct from the instances pCPUs	Pinned to a single pCPU distinct from the instances pCPUs

Note

For more information about the syntax for `hw:emulator_threads_policy`, refer to *hw:emulator_threads_policy*.

Customizing instance CPU topologies

Important

The functionality described below is currently only supported by the libvirt/KVM driver.

Note

Currently it also works with libvirt/QEMU driver but we dont recommend it in production use cases. This is because vCPUs are actually running in one thread on host in qemu TCG (Tiny Code Generator), which is the backend for libvirt/QEMU driver. Work to enable full multi-threading support for TCG (a.k.a. MTTCG) is on going in QEMU community. Please see this MTTCG project page for detail.

In addition to configuring how an instance is scheduled on host CPUs, it is possible to configure how CPUs are represented in the instance itself. By default, when instance NUMA placement is not specified, a topology of N sockets, each with one core and one thread, is used for an instance, where N corresponds to the number of instance vCPUs requested. When instance NUMA placement is specified, the number of sockets is fixed to the number of host NUMA nodes to use and the total number of instance CPUs is split over these sockets.

Some workloads benefit from a custom topology. For example, in some operating systems, a different license may be needed depending on the number of CPU sockets. To configure a flavor to use two sockets, run:

```
$ openstack flavor set $FLAVOR --property hw:cpu_sockets=2
```

Similarly, to configure a flavor to use one core and one thread, run:

```
$ openstack flavor set $FLAVOR \
  --property hw:cpu_cores=1 \
  --property hw:cpu_threads=1
```

Caution

If specifying all values, the product of sockets multiplied by cores multiplied by threads must equal the number of instance vCPUs. If specifying any one of these values or the multiple of two values, the values must be a factor of the number of instance vCPUs to prevent an exception. For example, specifying `hw:cpu_sockets=2` on a host with an odd number of cores fails. Similarly, specifying `hw:cpu_cores=2` and `hw:cpu_threads=4` on a host with ten cores fails.

For more information about the syntax for `hw:cpu_sockets`, `hw:cpu_cores` and `hw:cpu_threads`, refer to *Extra Specs*.

It is also possible to set upper limits on the number of sockets, cores, and threads used. Unlike the hard values above, it is not necessary for this exact number to used because it only provides a limit. This can be used to provide some flexibility in scheduling, while ensuring certain limits are not exceeded. For example, to ensure no more than two sockets, eight cores and one thread are defined in the instance topology, run:

```
$ openstack flavor set $FLAVOR \
  --property hw:cpu_max_sockets=2 \
  --property hw:cpu_max_cores=8 \
  --property hw:cpu_max_threads=1
```

For more information about the syntax for `hw:cpu_max_sockets`, `hw:cpu_max_cores`, and `hw:cpu_max_threads`, refer to *Extra Specs*.

Applications are frequently packaged as images. For applications that prefer certain CPU topologies, configure image metadata to hint that created instances should have a given topology regardless of flavor. To configure an image to request a two-socket, four-core per socket topology, run:

```
$ openstack image set $IMAGE \
  --property hw_cpu_sockets=2 \
  --property hw_cpu_cores=4
```

To constrain instances to a given limit of sockets, cores or threads, use the `max_` variants. To configure an image to have a maximum of two sockets and a maximum of one thread, run:

```
$ openstack image set $IMAGE \
  --property hw_cpu_max_sockets=2 \
  --property hw_cpu_max_threads=1
```

The value specified in the flavor is treated as the absolute limit. The image limits are not permitted to exceed the flavor limits, they can only be equal to or lower than what the flavor defines. By setting a `max` value for sockets, cores, or threads, administrators can prevent users configuring topologies that might, for example, incur an additional licensing fees.

For more information about image metadata, refer to the Image metadata guide.

Configuring libvirt compute nodes for CPU pinning

Changed in version 20.0.0: Prior to 20.0.0 (Train), it was not necessary to explicitly configure hosts for pinned instances. However, it was not possible to place pinned instances on the same host as unpinned CPUs, which typically meant hosts had to be grouped into host aggregates. If this was not done, unpinned instances would continue floating across all enabled host CPUs, even those that some instance CPUs were pinned to. Starting in 20.0.0, it is necessary to explicitly identify the host cores that should be used for pinned instances.

Nova treats host CPUs used for unpinned instances differently from those used by pinned instances. The former are tracked in placement using the `VCPU` resource type and can be overallocated, while the latter are tracked using the `PCPU` resource type. By default, nova will report all host CPUs as `VCPU` inventory, however, this can be configured using the *`compute.cpu_shared_set`* config option, to specify which host CPUs should be used for `VCPU` inventory, and the *`compute.cpu_dedicated_set`* config option, to specify which host CPUs should be used for `PCPU` inventory.

Consider a compute node with a total of 24 host physical CPU cores with hyperthreading enabled. The operator wishes to reserve 1 physical CPU core and its thread sibling for host processing (not for guest instance use). Furthermore, the operator wishes to use 8 host physical CPU cores and their thread siblings for dedicated guest CPU resources. The remaining 15 host physical CPU cores and their thread siblings will be used for shared guest vCPU usage, with an 8:1 allocation ratio for those physical processors used for shared guest CPU resources.

The operator could configure `nova.conf` like so:

```
[DEFAULT]
cpu_allocation_ratio=8.0

[compute]
cpu_dedicated_set=2-17
cpu_shared_set=18-47
```

The virt driver will construct a provider tree containing a single resource provider representing the compute node and report inventory of `PCPU` and `VCPU` for this single provider accordingly:

```
COMPUTE NODE provider
    PCPU:
        total: 16
        reserved: 0
        min_unit: 1
        max_unit: 16
        step_size: 1
        allocation_ratio: 1.0
    VCPU:
        total: 30
        reserved: 0
        min_unit: 1
        max_unit: 30
        step_size: 1
        allocation_ratio: 8.0
```

Instances using the `dedicated` CPU policy or an explicit `PCPU` resource request, `PCPU` inventory will be consumed. Instances using the `shared` CPU policy, meanwhile, will consume `VCPU` inventory.

Note

`PCPU` and `VCPU` allocations are currently combined to calculate the value for the `cores` quota class.

Configuring CPU power management for dedicated cores

Changed in version 27.0.0: This feature was only introduced by the 2023.1 Antelope release

Important

The functionality described below is currently only supported by the libvirt/KVM driver.

For power saving reasons, operators can decide to turn down the power usage of CPU cores whether they are in use or not. For obvious reasons, Nova only allows to change the power consumption of a dedicated CPU core and not a shared one. Accordingly, usage of this feature relies on the reading of *`compute.cpu_dedicated_set`* config option to know which CPU cores to handle. The main action to enable the power management of dedicated cores is to set *`libvirt.cpu_power_management`* config option to `True`.

By default, if this option is enabled, Nova will lookup the dedicated cores and power them down at the compute service startup. Then, once an instance starts by being attached to a dedicated core, this below

core will be powered up right before the libvirt guest starts. On the other way, once an instance is stopped, migrated or deleted, then the corresponding dedicated core will be powered down.

There are two distinct strategies for powering up or down :

- the default is to offline the CPU core and online it when needed.
- an alternative strategy is to use two distinct CPU governors for the up state and the down state.

The strategy can be chosen using *libvirt.cpu_power_management_strategy* config option. `cpu_state` supports the first online/offline strategy, while `governor` sets the alternative strategy. We default to turning off the cores as it provides you the best power savings while there could be other tools outside Nova to manage the governor, like tuned. That being said, we also provide a way to automatically change the governors on the fly, as explained below.

Important

Some OS platforms dont support `cpufreq` resources in sysfs, so the `governor` strategy could be not available. Please verify if your OS supports scaling govenors before modifying the configuration option.

If the strategy is set to `governor`, a couple of config options are provided to define which exact CPU governor to use for each of the up and down states :

- *libvirt.cpu_power_governor_low* will define the governor to use for the powerdown state (defaults to `powersave`)
- *libvirt.cpu_power_governor_high* will define the governor to use for the powerup state (defaults to `performance`)

Important

This is the responsibility of the operator to ensure that the govenors defined by the configuration options are currently supported by the OS underlying kernel that runs the compute service.

As a side note, we recommend the `schedutil` governor as an alternative for the high-power state (if the kernel supports it) as the CPU frequency is dynamically set based on CPU task states. Other governors may be worth to be tested, including `conservative` and `ondemand` which are quite a bit more power consuming than `schedutil` but more efficient than `performance`. See Linux kernel docs for further explanations.

As an example, a `nova.conf` part of configuration would look like:

```
[compute]
cpu_dedicated_set=2-17

[libvirt]
cpu_power_management=True
cpu_power_management_strategy=cpu_state
```

Warning

The CPU core #0 has a special meaning in most of the recent Linux kernels. This is always highly discouraged to use it for CPU pinning but please refrain to have it power managed or you could have surprises if Nova turns it off!

One last important note : you can decide to change the CPU management strategy during the compute lifecycle, or you can currently already manage the CPU states. For ensuring that Nova can correctly manage the CPU performances, we added a couple of checks at startup that refuse to start nova-compute service if those arbitrary rules arent enforced :

- if the operator opts for `cpu_state` strategy, then all dedicated CPU governors *MUST* be identical.
- if they decide using `governor`, then all dedicated CPU cores *MUST* be online.

Real Time

Added in version 13.0.0: (Mitaka)

Nova supports configuring real-time policies for instances. This builds upon the improved performance offered by *CPU pinning* by providing stronger guarantees for worst case scheduler latency for vCPUs.

Enabling Real-Time

Currently the creation of real-time instances is only supported when using the libvirt compute driver with a *`libvirt.virt_type`* of `kvm` or `qemu`. It requires extensive configuration of the host and this document provides but a rough overview of the changes required. Configuration will vary depending on your hardware, BIOS configuration, host and guest OS and application.

BIOS configuration

Configure your host BIOS as recommended in the rt-wiki page. The most important steps are:

- Disable power management, including CPU sleep states
- Disable SMT (hyper-threading) or any option related to logical processors

These are standard steps used in benchmarking as both sets of features can result in non-deterministic behavior.

OS configuration

This is inherently specific to the distro used, however, there are some common steps:

- Install the real-time (preemptible) kernel (`PREEMPT_RT_FULL`) and real-time KVM modules
- Configure hugepages
- Isolate host cores to be used for instances from the kernel
- Disable features like CPU frequency scaling (e.g. P-States on Intel processors)

RHEL and RHEL-derived distros like CentOS provide packages in their repositories to accomplish. The `kernel-rt` and `kernel-rt-kvm` packages will provide the real-time kernel and real-time KVM module, respectively, while the `tuned-profiles-realtime` package will provide tuned profiles to configure the host for real-time workloads. You should refer to your distro documentation for more information.

Validation

Once your BIOS and the host OS have been configured, you can validate real-time readiness using the `hwlatdetect` and `rteval` utilities. On RHEL and RHEL-derived hosts, you can install these using the `rt-tests` package. More information about the `rteval` tool can be found here.

Configuring a flavor or image

Changed in version 22.0.0: (Victoria)

Previously, it was necessary to specify *hw:cpu_realtime_mask* when realtime mode was enabled via *hw:cpu_realtime*. Starting in Victoria, it is possible to omit this when an emulator thread policy is configured using the *hw:emulator_threads_policy* extra spec, thus allowing all guest cores to be allocated as real-time cores.

Changed in version 22.0.0: (Victoria)

Previously, a leading caret was necessary when specifying the value for *hw:cpu_realtime_mask* and omitting it would be equivalent to not setting the mask, resulting in a failure to spawn the instance.

Compared to configuring the host, configuring the guest is relatively trivial and merely requires a combination of flavor extra specs and image metadata properties, along with a suitable real-time guest OS.

Enable real-time by setting the *hw:cpu_realtime* flavor extra spec to `yes` or a truthy value. When this is configured, it is necessary to specify where guest overhead processes should be scheduled to. This can be accomplished in one of three ways. Firstly, the *hw:cpu_realtime_mask* extra spec or equivalent image metadata property can be used to indicate which guest cores should be scheduled as real-time cores, leaving the remainder to be scheduled as non-real-time cores and to handle overhead processes. For example, to allocate the first two cores of an 8 core instance as the non-real-time cores:

```
$ openstack flavor set $FLAVOR \
    --property hw:cpu_realtime=yes \
    --property hw:cpu_realtime_mask=2-7  # so 0,1 are non-real-time
```

In this configuration, any non-real-time cores configured will have an implicit `dedicated` *CPU pinning policy* applied. It is possible to apply a `shared` policy for these non-real-time cores by specifying the `mixed` *CPU pinning policy* via the *hw:cpu_policy* extra spec. This can be useful to increase resource utilization of the host. For example:

```
$ openstack flavor set $FLAVOR \
    --property hw:cpu_policy=mixed \
    --property hw:cpu_realtime=yes \
    --property hw:cpu_realtime_mask=2-7  # so 0,1 are non-real-time and␣
↪unpinned
```

Finally, you can explicitly *offload guest overhead processes to another host core* using the *hw:emulator_threads_policy* extra spec. For example:

```
$ openstack flavor set $FLAVOR \
    --property hw:cpu_realtime=yes \
    --property hw:emulator_thread_policy=share
```

Note

Emulator thread pinning requires additional host configuration. Refer to *the documentation* for more information.

In addition to configuring the instance CPUs, it is also likely that you will need to configure guest huge pages. For information on how to configure these, refer to *the documentation*

References

- Libvirt real time instances (spec)
- The Real Time Linux collaborative project
- Deploying Real Time OpenStack

Huge pages

The huge page feature in OpenStack provides important performance improvements for applications that are highly memory IO-bound.

Note

Huge pages may also be referred to hugepages or large pages, depending on the source. These terms are synonyms.

Pages, the TLB and huge pages

Pages
: Physical memory is segmented into a series of contiguous regions called pages. Each page contains a number of bytes, referred to as the page size. The system retrieves memory by accessing entire pages, rather than byte by byte.

Translation Lookaside Buffer (TLB)
: A TLB is used to map the virtual addresses of pages to the physical addresses in actual memory. The TLB is a cache and is not limitless, storing only the most recent or frequently accessed pages. During normal operation, processes will sometimes attempt to retrieve pages that are not stored in the cache. This is known as a TLB miss and results in a delay as the processor iterates through the pages themselves to find the missing address mapping.

Huge Pages
: The standard page size in x86 systems is 4 kB. This is optimal for general purpose computing but larger page sizes - 2 MB and 1 GB - are also available. These larger page sizes are known as huge pages. Huge pages result in less efficient memory usage as a process will not generally use all memory available in each page. However, use of huge pages will result in fewer overall pages and a reduced risk of TLB misses. For processes that have significant memory requirements or are memory intensive, the benefits of huge pages frequently outweigh the drawbacks.

Persistent Huge Pages
: On Linux hosts, persistent huge pages are huge pages that are reserved upfront. The HugeTLB provides for the mechanism for this upfront configuration of huge pages. The HugeTLB allows for

the allocation of varying quantities of different huge page sizes. Allocation can be made at boot time or run time. Refer to the Linux hugetlbfs guide for more information.

Transparent Huge Pages (THP)
On Linux hosts, transparent huge pages are huge pages that are automatically provisioned based on process requests. Transparent huge pages are provisioned on a best effort basis, attempting to provision 2 MB huge pages if available but falling back to 4 kB small pages if not. However, no upfront configuration is necessary. Refer to the Linux THP guide for more information.

Enabling huge pages on the host

Important

Huge pages may not be used on a host configured for file-backed memory. See *File-backed memory* for details

Persistent huge pages are required owing to their guaranteed availability. However, persistent huge pages are not enabled by default in most environments. The steps for enabling huge pages differ from platform to platform and only the steps for Linux hosts are described here. On Linux hosts, the number of persistent huge pages on the host can be queried by checking `/proc/meminfo`:

```
$ grep Huge /proc/meminfo
AnonHugePages:         0 kB
ShmemHugePages:        0 kB
HugePages_Total:       0
HugePages_Free:        0
HugePages_Rsvd:        0
HugePages_Surp:        0
Hugepagesize:       2048 kB
```

In this instance, there are 0 persistent huge pages (`HugePages_Total`) and 0 transparent huge pages (`AnonHugePages`) allocated. Huge pages can be allocated at boot time or run time. Huge pages require a contiguous area of memory - memory that gets increasingly fragmented the long a host is running. Identifying contiguous areas of memory is an issue for all huge page sizes, but it is particularly problematic for larger huge page sizes such as 1 GB huge pages. Allocating huge pages at boot time will ensure the correct number of huge pages is always available, while allocating them at run time can fail if memory has become too fragmented.

To allocate huge pages at run time, the kernel boot parameters must be extended to include some huge page-specific parameters. This can be achieved by modifying `/etc/default/grub` and appending the `hugepagesz`, `hugepages`, and `transparent_hugepages=never` arguments to `GRUB_CMDLINE_LINUX`. To allocate, for example, 2048 persistent 2 MB huge pages at boot time, run:

```
# echo 'GRUB_CMDLINE_LINUX="$GRUB_CMDLINE_LINUX hugepagesz=2M hugepages=2048␣
↪transparent_hugepage=never"' >> /etc/default/grub
$ grep GRUB_CMDLINE_LINUX /etc/default/grub
GRUB_CMDLINE_LINUX="..."
GRUB_CMDLINE_LINUX="$GRUB_CMDLINE_LINUX hugepagesz=2M hugepages=2048␣
↪transparent_hugepage=never"
```

Important

Persistent huge pages are not usable by standard host OS processes. Ensure enough free, non-huge page memory is reserved for these processes.

Reboot the host, then validate that huge pages are now available:

```
$ grep "Huge" /proc/meminfo
AnonHugePages:         0 kB
ShmemHugePages:        0 kB
HugePages_Total:    2048
HugePages_Free:     2048
HugePages_Rsvd:        0
HugePages_Surp:        0
Hugepagesize:       2048 kB
```

There are now 2048 2 MB huge pages totalling 4 GB of huge pages. These huge pages must be mounted. On most platforms, this happens automatically. To verify that the huge pages are mounted, run:

```
# mount | grep huge
hugetlbfs on /dev/hugepages type hugetlbfs (rw)
```

In this instance, the huge pages are mounted at `/dev/hugepages`. This mount point varies from platform to platform. If the above command did not return anything, the hugepages must be mounted manually. To mount the huge pages at `/dev/hugepages`, run:

```
# mkdir -p /dev/hugepages
# mount -t hugetlbfs hugetlbfs /dev/hugepages
```

There are many more ways to configure huge pages, including allocating huge pages at run time, specifying varying allocations for different huge page sizes, or allocating huge pages from memory affinitized to different NUMA nodes. For more information on configuring huge pages on Linux hosts, refer to the Linux hugetlbfs guide.

Customizing instance huge pages allocations

Important

The functionality described below is currently only supported by the libvirt/KVM driver.

Important

For performance reasons, configuring huge pages for an instance will implicitly result in a NUMA topology being configured for the instance. Configuring a NUMA topology for an instance requires enablement of `NUMATopologyFilter`. Refer to *CPU topologies* for more information.

By default, an instance does not use huge pages for its underlying memory. However, huge pages can bring important or required performance improvements for some workloads. Huge pages must be requested

explicitly through the use of flavor extra specs or image metadata. To request an instance use huge pages, you can use the *hw:mem_page_size* flavor extra spec:

```
$ openstack flavor set m1.large --property hw:mem_page_size=large
```

Different platforms offer different huge page sizes. For example: x86-based platforms offer 2 MB and 1 GB huge page sizes. Specific huge page sizes can be also be requested, with or without a unit suffix. The unit suffix must be one of: Kb(it), Kib(it), Mb(it), Mib(it), Gb(it), Gib(it), Tb(it), Tib(it), KB, KiB, MB, MiB, GB, GiB, TB, TiB. Where a unit suffix is not provided, Kilobytes are assumed. To request an instance to use 2 MB huge pages, run one of:

```
$ openstack flavor set m1.large --property hw:mem_page_size=2MB
```

```
$ openstack flavor set m1.large --property hw:mem_page_size=2048
```

Enabling huge pages for an instance can have negative consequences for other instances by consuming limited huge pages resources. To explicitly request an instance use small pages, run:

```
$ openstack flavor set m1.large --property hw:mem_page_size=small
```

Note

Explicitly requesting any page size will still result in a NUMA topology being applied to the instance, as described earlier in this document.

Finally, to leave the decision of huge or small pages to the compute driver, run:

```
$ openstack flavor set m1.large --property hw:mem_page_size=any
```

For more information about the syntax for `hw:mem_page_size`, refer to *hw:mem_page_size*.

Applications are frequently packaged as images. For applications that require the IO performance improvements that huge pages provides, configure image metadata to ensure instances always request the specific page size regardless of flavor. To configure an image to use 1 GB huge pages, run:

```
$ openstack image set [IMAGE_ID]  --property hw_mem_page_size=1GB
```

If the flavor specifies a numerical page size or a page size of small the image is not allowed to specify a page size and if it does an exception will be raised. If the flavor specifies a page size of `any` or `large` then any page size specified in the image will be used. By setting a `small` page size in the flavor, administrators can prevent users requesting huge pages in flavors and impacting resource utilization. To configure this page size, run:

```
$ openstack flavor set m1.large --property hw:mem_page_size=small
```

Note

Explicitly requesting any page size will still result in a NUMA topology being applied to the instance, as described earlier in this document.

For more information about image metadata, refer to the Image metadata guide.

Attaching virtual GPU devices to guests

Important

The functionality described below is only supported by the libvirt/KVM driver.

The virtual GPU feature in Nova allows a deployment to provide specific GPU types for instances using physical GPUs that can provide virtual devices.

For example, a single Intel GVT-g or a NVIDIA GRID vGPU physical Graphics Processing Unit (pGPU) can be virtualized as multiple virtual Graphics Processing Units (vGPUs) if the hypervisor supports the hardware driver and has the capability to create guests using those virtual devices.

This feature is highly dependent on the version of libvirt and the physical devices present on the host. In addition, the vendors vGPU driver software must be installed and configured on the host at the same time.

Caveats are mentioned in the *Caveats* section.

To enable virtual GPUs, follow the steps below:

1. *Enable GPU types (Compute)*
2. *Configure a flavor (Controller)*

Enable GPU types (Compute)

1. For NVIDIA GPUs that support SR-IOV, enable the virtual functions.

   ```
   $ /usr/lib/nvidia/sriov-manage -e slot:bus:domain.function
   ```

   For example, to enable the virtual functions for the GPU with slot `0000`, bus `41`, domain `00`, and function `0`:

   ```
   $ /usr/lib/nvidia/sriov-manage -e 0000:41:00.0
   ```

   You may want to automate this process as it has to be done on each boot of the host.

   Given an example `systemd` template unit file named `nvidia-sriov-manage@.service`:

   ```
   [Unit]
   After = nvidia-vgpu-mgr.service
   After = nvidia-vgpud.service
   Description = Enable Nvidia GPU virtual functions

   [Service]
   Type = oneshot
   User = root
   Group = root
   ExecStart = /usr/lib/nvidia/sriov-manage -e %i
   # Give a reasonable amount of time for the server to start up/shut down
   TimeoutSec = 120
   # This creates a specific slice which all services will operate from
   #  The accounting options give us the ability to see resource usage
   ```

(continues on next page)

(continued from previous page)

```
#  through the `systemd-cgtop` command.
Slice = system.slice
# Set Accounting
CPUAccounting = True
BlockIOAccounting = True
MemoryAccounting = True
TasksAccounting = True
RemainAfterExit = True
ExecStartPre = /usr/bin/sleep 30

[Install]
WantedBy = multi-user.target
```

To enable the virtual functions for the GPU with slot `0000`, bus `41`, domain `00`, and function `0`:

```
$ systemctl enable nvidia-sriov-manage@0000:41:00.0.service
```

Note

This is only an example and it is important to consult the relevant vendor documentation for the specific devices that you have.

2. Specify which specific GPU type(s) the instances would get.

   Edit *devices.enabled_mdev_types*:

   ```
   [devices]
   enabled_mdev_types = nvidia-35
   ```

   If you want to support more than a single GPU type, you need to provide a separate configuration section for each device. For example:

   ```
   [devices]
   enabled_mdev_types = nvidia-35, nvidia-36

   [mdev_nvidia-35]
   device_addresses = 0000:84:00.0,0000:85:00.0

   [mdev_nvidia-36]
   device_addresses = 0000:86:00.0
   ```

   where you have to define which physical GPUs are supported per GPU type.

   If the same PCI address is provided for two different types, nova-compute will refuse to start and issue a specific error in the logs.

   To know which specific type(s) to mention, please refer to *How to discover a GPU type*.

   Changed in version 21.0.0: Supporting multiple GPU types is only supported by the Ussuri release and later versions.

3. Restart the `nova-compute` service.

Warning

Changing the type is possible but since existing physical GPUs cant address multiple guests having different types, that will make Nova return you a NoValidHost if existing instances with the original type still exist. Accordingly, its highly recommended to instead deploy the new type to new compute nodes that dont already have workloads and rebuild instances on the nodes that need to change types.

Configure a flavor (Controller)

Configure a flavor to request one virtual GPU:

```
$ openstack flavor set vgpu_1 --property "resources:VGPU=1"
```

Note

As of the Queens release, all hypervisors that support virtual GPUs only accept a single virtual GPU per instance.

The enabled vGPU types on the compute hosts are not exposed to API users. Flavors configured for vGPU support can be tied to host aggregates as a means to properly schedule those flavors onto the compute hosts that support them. See *Host aggregates* for more information.

Create instances with virtual GPU devices

The `nova-scheduler` selects a destination host that has vGPU devices available by calling the Placement API for a specific VGPU resource class provided by compute nodes.

```
$ openstack server create --flavor vgpu_1 --image cirros-0.3.5-x86_64-uec --
↪wait test-vgpu
```

How to discover a GPU type

Virtual GPUs are seen as mediated devices. Physical PCI devices (the graphic card here) supporting virtual GPUs propose mediated device (mdev) types. Since mediated devices are supported by the Linux kernel through sysfs files after installing the vendors virtual GPUs driver software, you can see the required properties as follows:

```
$ ls /sys/class/mdev_bus/*/mdev_supported_types
/sys/class/mdev_bus/0000:84:00.0/mdev_supported_types:
nvidia-35  nvidia-36  nvidia-37  nvidia-38  nvidia-39  nvidia-40  nvidia-41 ␣
↪nvidia-42  nvidia-43  nvidia-44  nvidia-45

/sys/class/mdev_bus/0000:85:00.0/mdev_supported_types:
nvidia-35  nvidia-36  nvidia-37  nvidia-38  nvidia-39  nvidia-40  nvidia-41 ␣
↪nvidia-42  nvidia-43  nvidia-44  nvidia-45

/sys/class/mdev_bus/0000:86:00.0/mdev_supported_types:
nvidia-35  nvidia-36  nvidia-37  nvidia-38  nvidia-39  nvidia-40  nvidia-41 ␣
```

(continues on next page)

(continued from previous page)

```
↪nvidia-42  nvidia-43  nvidia-44  nvidia-45

/sys/class/mdev_bus/0000:87:00.0/mdev_supported_types:
nvidia-35  nvidia-36  nvidia-37  nvidia-38  nvidia-39  nvidia-40  nvidia-41 ␣
↪nvidia-42  nvidia-43  nvidia-44  nvidia-45
```

Checking allocations and inventories for virtual GPUs

Note

The information below is only valid from the 19.0.0 Stein release. Before this release, inventories and allocations related to a `VGPU` resource class are still on the root resource provider related to the compute node. If upgrading from Rocky and using the libvirt driver, `VGPU` inventory and allocations are moved to child resource providers that represent actual physical GPUs.

The examples you will see are using the osc-placement plugin for OpenStackClient. For details on specific commands, see its documentation.

1. Get the list of resource providers

```
$ openstack resource provider list
+--------------------------------------+-----------------------------------
↪----------------------+------------+
| uuid                                 | name                              ␣
↪                      | generation |
+--------------------------------------+-----------------------------------
↪----------------------+------------+
| 5958a366-3cad-416a-a2c9-cfbb5a472287 | virtlab606.
↪xxxxxxxxxxxxxxxxxxxxxxxxx                    |          7 |
| fc9b9287-ef5e-4408-aced-d5577560160c | virtlab606.
↪xxxxxxxxxxxxxxxxxxxxxxxxx_pci_0000_86_00_0 |          2 |
| e2f8607b-0683-4141-a8af-f5e20682e28c | virtlab606.
↪xxxxxxxxxxxxxxxxxxxxxxxxx_pci_0000_85_00_0 |          3 |
| 85dd4837-76f9-41f2-9f19-df386017d8a0 | virtlab606.
↪xxxxxxxxxxxxxxxxxxxxxxxxx_pci_0000_87_00_0 |          2 |
| 7033d860-8d8a-4963-8555-0aa902a08653 | virtlab606.
↪xxxxxxxxxxxxxxxxxxxxxxxxx_pci_0000_84_00_0 |          2 |
+--------------------------------------+-----------------------------------
↪----------------------+------------+
```

   In this example, we see the root resource provider `5958a366-3cad-416a-a2c9-cfbb5a472287` with four other resource providers that are its children and where each of them corresponds to a single physical GPU.

2. Check the inventory of each resource provider to see resource classes

```
$ openstack resource provider inventory list 5958a366-3cad-416a-a2c9-
↪cfbb5a472287
+----------------+------------------+----------+----------+-----------+---
```

(continues on next page)

(continued from previous page)

```
↪-------+-------+
| resource_class | allocation_ratio | max_unit | reserved | step_size |␣
↪min_unit | total |
+----------------+------------------+----------+----------+-----------+---
↪-------+-------+
| VCPU           |             16.0 |       48 |        0 |         1 |␣
↪     1 |    48 |
| MEMORY_MB      |              1.5 |    65442 |      512 |         1 |␣
↪     1 | 65442 |
| DISK_GB        |              1.0 |       49 |        0 |         1 |␣
↪     1 |    49 |
+----------------+------------------+----------+----------+-----------+---
↪-------+-------+
$ openstack resource provider inventory list e2f8607b-0683-4141-a8af-
↪f5e20682e28c
+----------------+------------------+----------+----------+-----------+---
↪-------+-------+
| resource_class | allocation_ratio | max_unit | reserved | step_size |␣
↪min_unit | total |
+----------------+------------------+----------+----------+-----------+---
↪-------+-------+
| VGPU           |              1.0 |       16 |        0 |         1 |␣
↪     1 |    16 |
+----------------+------------------+----------+----------+-----------+---
↪-------+-------+
```

Here you can see a `VGPU` inventory on the child resource provider while other resource class inventories are still located on the root resource provider.

3. Check allocations for each server that is using virtual GPUs

```
$ openstack server list
+--------------------------------------+-------+--------+-----------------
↪--------------------------------------+--------------------------+----
↪----+
| ID                                   | Name  | Status | Networks       ␣
↪                                     | Image                    |␣
↪Flavor |
+--------------------------------------+-------+--------+-----------------
↪--------------------------------------+--------------------------+----
↪----+
| 5294f726-33d5-472a-bef1-9e19bb41626d | vgpu2 | ACTIVE | private=10.0.0.
↪14, fd45:cdad:c431:0:f816:3eff:fe78:a748 | cirros-0.4.0-x86_64-disk |␣
↪vgpu   |
| a6811fc2-cec8-4f1d-baea-e2c6339a9697 | vgpu1 | ACTIVE | private=10.0.0.
↪34, fd45:cdad:c431:0:f816:3eff:fe54:cc8f | cirros-0.4.0-x86_64-disk |␣
↪vgpu   |
+--------------------------------------+-------+--------+-----------------
↪--------------------------------------+--------------------------+----
↪----+
```

(continues on next page)

(continued from previous page)

```
$ openstack resource provider allocation show 5294f726-33d5-472a-bef1-
↪9e19bb41626d
+--------------------------------------+------------+----------------------
↪----------------------+
| resource_provider                    | generation | resources            ␣
↪                      |
+--------------------------------------+------------+----------------------
↪----------------------+
| 5958a366-3cad-416a-a2c9-cfbb5a472287 |          8 | {u'VCPU': 1, u
↪'MEMORY_MB': 512, u'DISK_GB': 1} |
| 7033d860-8d8a-4963-8555-0aa902a08653 |          3 | {u'VGPU': 1}         ␣
↪                      |
+--------------------------------------+------------+----------------------
↪----------------------+

$ openstack resource provider allocation show a6811fc2-cec8-4f1d-baea-
↪e2c6339a9697
+--------------------------------------+------------+----------------------
↪----------------------+
| resource_provider                    | generation | resources            ␣
↪                      |
+--------------------------------------+------------+----------------------
↪----------------------+
| e2f8607b-0683-4141-a8af-f5e20682e28c |          3 | {u'VGPU': 1}         ␣
↪                      |
| 5958a366-3cad-416a-a2c9-cfbb5a472287 |          8 | {u'VCPU': 1, u
↪'MEMORY_MB': 512, u'DISK_GB': 1} |
+--------------------------------------+------------+----------------------
↪----------------------+
```

In this example, two servers were created using a flavor asking for 1 `VGPU`, so when looking at the allocations for each consumer UUID (which is the server UUID), you can see that VGPU allocation is against the child resource provider while other allocations are for the root resource provider. Here, that means that the virtual GPU used by `a6811fc2-cec8-4f1d-baea-e2c6339a9697` is actually provided by the physical GPU having the PCI ID `0000:85:00.0`.

(Optional) Provide custom traits for multiple GPU types

Since operators want to support different GPU types per compute, it would be nice to have flavors asking for a specific GPU type. This is now possible using custom traits by decorating child Resource Providers that correspond to physical GPUs.

Note

Possible improvements in a future release could consist of providing automatic tagging of Resource Providers with standard traits corresponding to versioned mapping of public GPU types. For the moment, this has to be done manually.

1. Get the list of resource providers

See *Checking allocations and inventories for virtual GPUs* first for getting the list of Resource Providers that support a `VGPU` resource class.

2. Define custom traits that will correspond for each to a GPU type

```
$ openstack --os-placement-api-version 1.6 trait create CUSTOM_NVIDIA_11
```

In this example, we ask to create a custom trait named `CUSTOM_NVIDIA_11`.

3. Add the corresponding trait to the Resource Provider matching the GPU

```
$ openstack --os-placement-api-version 1.6 resource provider trait set \
    --trait CUSTOM_NVIDIA_11 e2f8607b-0683-4141-a8af-f5e20682e28c
```

In this case, the trait `CUSTOM_NVIDIA_11` will be added to the Resource Provider with the UUID `e2f8607b-0683-4141-a8af-f5e20682e28c` that corresponds to the PCI address `0000:85:00:0` as shown above.

4. Amend the flavor to add a requested trait

```
$ openstack flavor set --property trait:CUSTOM_NVIDIA_11=required vgpu_1
```

In this example, we add the `CUSTOM_NVIDIA_11` trait as a required information for the `vgpu_1` flavor we created earlier.

This will allow the Placement service to only return the Resource Providers matching this trait so only the GPUs that were decorated with will be checked for this flavor.

Caveats

Note

This information is correct as of the 17.0.0 Queens release. Where improvements have been made or issues fixed, they are noted per item.

- After installing the NVIDIA driver on compute nodes, if `mdev` are not visible but VF devices are present under a path like `/sys/bus/pci/devices/0000:25:00.4/nvidia`, this indicates that the **kernel variant driver** is in use.

  This most likely occurs on **Ubuntu Noble** or **RHEL 10**.

  Changed in version 31.0.0: Please refer to the PCI passthrough documentation for proper configuration.

- When using recent nVidia GPU architectures like Ampere or newer GPUs which have SR-IOV feature, Nova cant know how many vGPUs can be used by a specific type. You then need to create virtual functions and then provide the list of the virtual functions per GPUs that can be used by setting `device_addresses`.

  Changed in version 29.0.0: By the 2024.1 Caracal release, if you use those hardware, you need to provide a new configuration option named `max_instances` in the related mdev type group (eg. `mdev_nvidia-35`) where the value of that option would be the number of vGPUs that the type can create.

As an example for the A40-2Q nVidia GPU type which can create up to 24 vGPUs, please provide the below configuration :

```
[devices]
enabled_mdev_types = nvidia-558

[mdev_nvidia-558]
max_instances = 24
```

As a side note, you can see that we dont use `device_addresses`ăin the `mdev_nvidia-558` section, as we dont need to tell which exact virtual functions we want to use for that type.

- When live-migrating an instance using vGPUs, the libvirt guest domain XML isnt updated with the new mediated device UUID to use for the target.

  Changed in version 29.0.0: In the 2024.1 Caracal release, Nova now supports vGPU live-migrations. In order to do this, both the source and target compute service need to have minimum versions of libvirt-8.6.0, QEMU-8.1.0 and Linux kernel 5.18.0. You need to ensure that either you use only single common vGPU type between two computes. Where multiple mdev types are configured on the source and destination host, custom traits or custom resource classes must be configured, reported by the host and requested by the instance to make sure that the Placement API correctly returns the supported GPU using the right vGPU type for a migration. Last but not least, if you want to live-migrate nVidia mediated devices, you need to update *libvirt.live_migration_downtime*, *libvirt.live_migration_downtime_steps* and *libvirt.live_migration_downtime_delay*:

  ```
  live_migration_downtime = 500000
  live_migration_downtime_steps = 3
  live_migration_downtime_delay = 3
  ```

  You can see an example of a working live-migration here.

- Suspending a guest that has vGPUs doesnt yet work because of a libvirt limitation (it cant hot-unplug mediated devices from a guest). Workarounds using other instance actions (like snapshotting the instance or shelving it) are recommended until libvirt gains mdev hot-unplug support. If a user attempts to suspend the instance, the libvirt driver will raise an exception that will cause the instance to be set back to ACTIVE. The `suspend` action in the `os-instance-actions` API will have an *Error* state.

  Changed in version 25.0.0: This has been resolved in the Yoga release. See bug 1948705.

- Resizing an instance with a new flavor that has vGPU resources doesnt allocate those vGPUs to the instance (the instance is created without vGPU resources). The proposed workaround is to rebuild the instance after resizing it. The rebuild operation allocates vGPUS to the instance.

  Changed in version 21.0.0: This has been resolved in the Ussuri release. See bug 1778563.

- Cold migrating an instance to another host will have the same problem as resize. If you want to migrate an instance, make sure to rebuild it after the migration.

  Changed in version 21.0.0: This has been resolved in the Ussuri release. See bug 1778563.

- Rescue images do not use vGPUs. An instance being rescued does not keep its vGPUs during rescue. During that time, another instance can receive those vGPUs. This is a known issue. The recommended workaround is to rebuild an instance immediately after rescue. However, rebuilding the rescued instance only helps if there are other free vGPUs on the host.

Changed in version 18.0.0: This has been resolved in the Rocky release. See bug 1762688.

For nested vGPUs:

Note

This information is correct as of the 21.0.0 Ussuri release. Where improvements have been made or issues fixed, they are noted per item.

- If creating servers with a flavor asking for vGPUs and the user wants multi-create (i.e. say max 2) then the scheduler could be returning a NoValidHosts exception even if each physical GPU can support at least one specific instance, if the total wanted capacity is not supported by only one physical GPU. (See bug 1874664.)

  For example, creating servers with a flavor asking for vGPUs, if two children RPs have 4 vGPU inventories each:

  - You can ask for a flavor with 2 vGPU with max 2.
  - But you cant ask for a flavor with 4 vGPU and max 2.

File-backed memory

Important

As of the 18.0.0 Rocky release, the functionality described below is only supported by the libvirt/KVM driver.

The file-backed memory feature in Openstack allows a Nova node to serve guest memory from a file backing store. This mechanism uses the libvirt file memory source, causing guest instance memory to be allocated as files within the libvirt memory backing directory.

Since instance performance will be related to the speed of the backing store, this feature works best when used with very fast block devices or virtual file systems - such as flash or RAM devices.

When configured, `nova-compute` will report the capacity configured for file-backed memory to placement in place of the total system memory capacity. This allows the node to run more instances than would normally fit within system memory.

When available in libvirt and qemu, instance memory will be discarded by qemu at shutdown by calling `madvise(MADV_REMOVE)`, to avoid flushing any dirty memory to the backing store on exit.

To enable file-backed memory, follow the steps below:

1. *Configure the backing store*
2. *Configure Nova Compute for file-backed memory*

Important

It is not possible to live migrate from a node running a version of OpenStack that does not support file-backed memory to a node with file backed memory enabled. It is recommended that all Nova compute nodes are upgraded to Rocky before enabling file-backed memory.

Prerequisites and Limitations

Libvirt
File-backed memory requires libvirt version 4.0.0 or newer. Discard capability requires libvirt version 4.4.0 or newer.

Qemu
File-backed memory requires qemu version 2.6.0 or newer. Discard capability requires qemu version 2.10.0 or newer.

Memory overcommit
File-backed memory is not compatible with memory overcommit. *ram_allocation_ratio* must be set to `1.0` in `nova.conf`, and the host must not be added to a *host aggregate* with `ram_allocation_ratio` set to anything but `1.0`.

Reserved memory
When configured, file-backed memory is reported as total system memory to placement, with RAM used as cache. Reserved memory corresponds to disk space not set aside for file-backed memory. *reserved_host_memory_mb* should be set to `0` in `nova.conf`.

Huge pages
File-backed memory is not compatible with huge pages. Instances with huge pages configured will not start on a host with file-backed memory enabled. It is recommended to use host aggregates to ensure instances configured for huge pages are not placed on hosts with file-backed memory configured.

Handling these limitations could be optimized with a scheduler filter in the future.

Configure the backing store

Note

`/dev/sdb` and the `ext4` filesystem are used here as an example. This will differ between environments.

Note

`/var/lib/libvirt/qemu/ram` is the default location. The value can be set via `memory_backing_dir` in `/etc/libvirt/qemu.conf`, and the mountpoint must match the value configured there.

By default, Libvirt with qemu/KVM allocates memory within `/var/lib/libvirt/qemu/ram/`. To utilize this, you need to have the backing store mounted at (or above) this location.

1. Create a filesystem on the backing device

```
# mkfs.ext4 /dev/sdb
```

2. Mount the backing device

   Add the backing device to `/etc/fstab` for automatic mounting to `/var/lib/libvirt/qemu/ram`

   Mount the device

```
# mount /dev/sdb /var/lib/libvirt/qemu/ram
```

Configure Nova Compute for file-backed memory

1. Enable File-backed memory in `nova-compute`

   Configure Nova to utilize file-backed memory with the capacity of the backing store in MiB. 1048576 MiB (1 TiB) is used in this example.

   Edit `/etc/nova/nova.conf`

   ```
   [libvirt]
   file_backed_memory=1048576
   ```

2. Restart the `nova-compute` service

Using ports with resource request

Starting from microversion 2.72 nova supports creating servers with neutron ports having resource request visible as a admin-only port attribute `resource_request`. For example a neutron port has resource request if it has a QoS minimum bandwidth rule attached.

The Quality of Service (QoS): Guaranteed Bandwidth document describes how to configure neutron to use this feature.

Resource allocation

Nova collects and combines the resource request from each port in a boot request and sends one allocation candidate request to placement during scheduling so placement will make sure that the resource request of the ports are fulfilled. At the end of the scheduling nova allocates one candidate in placement. Therefore the requested resources for each port from a single boot request will be allocated under the servers allocation in placement.

Resource Group policy

Nova represents the resource request of each neutron port as a separate Granular Resource Request group when querying placement for allocation candidates. When a server create request includes more than one port with resource requests then more than one group will be used in the allocation candidate query. In this case placement requires to define the `group_policy`. Today it is only possible via the `group_policy` key of the flavor extra_spec. The possible values are `isolate` and `none`.

When the policy is set to `isolate` then each request group and therefore the resource request of each neutron port will be fulfilled from separate resource providers. In case of neutron ports with `vnic_type=direct` or `vnic_type=macvtap` this means that each port will use a virtual function from different physical functions.

When the policy is set to `none` then the resource request of the neutron ports can be fulfilled from overlapping resource providers. In case of neutron ports with `vnic_type=direct` or `vnic_type=macvtap` this means the ports may use virtual functions from the same physical function.

For neutron ports with `vnic_type=normal` the group policy defines the collocation policy on OVS bridge level so `group_policy=none` is a reasonable default value in this case.

If the `group_policy` is missing from the flavor then the server create request will fail with No valid host was found and a warning describing the missing policy will be logged.

Virt driver support

Supporting neutron ports with `vnic_type=direct` or `vnic_type=macvtap` depends on the capability of the virt driver. For the supported virt drivers see the Support matrix

If the virt driver on the compute host does not support the needed capability then the PCI claim will fail on the host and re-schedule will be triggered. It is suggested not to configure bandwidth inventory in the neutron agents on these compute hosts to avoid unnecessary reschedule.

Extended resource request

It is expected that neutron 20.0.0 (Yoga) will implement an extended resource request format via the `port-resource-request-groups` neutron API extension. As of nova 24.0.0 (Xena), nova already supports this extension if every nova-compute service is upgraded to Xena version and the *`upgrade_levels.compute`* configuration does not prevent the computes from using the latest RPC version.

The extended resource request allows a single Neutron port to request resources in more than one request groups. This also means that using just one port in a server create request would require a group policy to be provided in the flavor. Today the only case when a single port generates more than one request groups is when that port has QoS policy with both minimum bandwidth and minimum packet rate rules. Due to the placement resource model of these features in this case the two request groups will always be fulfilled from separate resource providers and therefore neither the `group_policy=none` nor the `group_policy=isolate` flavor extra specs will result in any additional restriction on the placement of the resources. In the multi port case the Resource Group policy section above still applies.

Using ports vnic_type=vdpa

Added in version 23.0.0: (Wallaby)

Introduced support for vDPA.

Added in version 26.0.0: (Zed)

Added support for all instance move operations, and the interface attach/detach, and suspend/resume operations.

Important

The functionality described below is only supported by the libvirt/KVM virt driver.

The kernel vDPA (virtio Data Path Acceleration) framework provides a vendor independent framework for offloading data-plane processing to software or hardware virtio device backends. While the kernel vDPA framework supports many types of vDPA devices, at this time nova only support `virtio-net` devices using the `vhost-vdpa` front-end driver. Support for `virtio-blk` or `virtio-gpu` may be added in the future but is not currently planned for any specific release.

vDPA device tracking

When implementing support for vDPA based neutron ports one of the first decisions nova had to make was how to model the availability of vDPA devices and the capability to virtualize vDPA devices. As the initial use-case for this technology was to offload networking to hardware offload OVS via neutron ports the decision was made to extend the existing PCI tracker that is used for SR-IOV and pci-passthrough to

support vDPA devices. As a result a simplification was made to assume that the parent device of a vDPA device is an SR-IOV Virtual Function (VF). As a result software only vDPA device such as those created by the kernel `vdpa-sim` sample module are not supported.

To make vDPA device available to be scheduled to guests the operator should include the device using the PCI address or vendor ID and product ID of the parent VF in the PCI `device_spec`. See: pci-passthrough for details.

Nova will not create the VFs or vDPA devices automatically. It is expected that the operator will allocate them before starting the nova-compute agent. While no specific mechanisms is prescribed to do this udev rules or systemd service files are generally the recommended approach to ensure the devices are created consistently across reboots.

Note

As vDPA is an offload only for the data plane and not the control plane a vDPA control plane is required to properly support vDPA device passthrough. At the time of writing only hardware offloaded OVS is supported when using vDPA with nova. Because of this vDPA devices cannot be requested using the PCI alias. While nova could allow vDPA devices to be requested by the flavor using a PCI alias we would not be able to correctly configure the device as there would be no suitable control plane. For this reason vDPA devices are currently only consumable via neutron ports.

Virt driver support

Supporting neutron ports with `vnic_type=vdpa` depends on the capability of the virt driver. At this time only the `libvirt` virt driver with KVM is fully supported. QEMU may also work but is untested.

vDPA support depends on kernel 5.7+, Libvirt 6.9.0+ and QEMU 5.1+.

vDPA lifecycle operations

To boot a VM with vDPA ports they must first be created in neutron. To do this the normal SR-IOV workflow is used where by the port is first created in neutron and passed into nova as part of the server create request.

```
openstack port create --network <my network> --vnic-type vdpa vdpa-port
openstack server create --flavor <my-flavor> --image <my-image> --port <vdpa-
↪port uuid> vdpa-vm
```

vDPA live migration

At this time QEMU and the `vhost-vdpa` kernel module do not support transparent live migration of vm with vdpa ports. To enable live migration of VMs with vDPA interfaces the existing SR-IOV hotplug live migration procedure has been extended to include `vnic_type='vdpa'` interfaces.

Attaching virtual persistent memory to guests

Added in version 20.0.0: (Train)

Starting in the 20.0.0 (Train) release, the virtual persistent memory (vPMEM) feature in Nova allows a deployment using the libvirt compute driver to provide vPMEMs for instances using physical persistent memory (PMEM) that can provide virtual devices.

PMEM must be partitioned into PMEM namespaces for applications to use. This vPMEM feature only uses PMEM namespaces in `devdax` mode as QEMU vPMEM backends. If you want to dive into related notions, the document NVDIMM Linux kernel document is recommended.

To enable vPMEMs, follow the steps below.

Dependencies

The following are required to support the vPMEM feature:

- Persistent Memory Hardware

  One such product is Intelő Optane DC Persistent Memory. ipmctl is used to configure it.

- Linux Kernel version >= 4.18 with the following modules loaded:

  `dax_pmem`, `nd_pmem`, `device_dax`, `nd_btt`

Note

NVDIMM support is present in the Linux Kernel v4.0 or newer. It is recommended to use Kernel version 4.2 or later since NVDIMM support is enabled by default. We met some bugs in older versions, and we have done all verification works with OpenStack on 4.18 version, so 4.18 version and newer will probably guarantee its functionality.

- QEMU version >= 3.1.0
- Libvirt version >= 5.0.0
- ndctl version >= 62
- daxio version >= 1.6

The vPMEM feature has been verified under the software and hardware listed above.

Configure PMEM namespaces (Compute)

1. Create PMEM namespaces as vPMEM backends using the ndctl utility.

   For example, to create a 30GiB namespace named `ns3`:

```
$ sudo ndctl create-namespace -s 30G -m devdax -M mem -n ns3
{
  "dev":"namespace1.0",
  "mode":"devdax",
  "map":"mem",
  "size":"30.00 GiB (32.21 GB)",
  "uuid":"937e9269-512b-4f65-9ac6-b74b61075c11",
  "raw_uuid":"17760832-a062-4aef-9d3b-95ea32038066",
  "daxregion":{
    "id":1,
    "size":"30.00 GiB (32.21 GB)",
    "align":2097152,
    "devices":[
    {
      "chardev":"dax1.0",
```

(continues on next page)

(continued from previous page)

```
      "size":"30.00 GiB (32.21 GB)"
    }
    ]
  },
  "name":"ns3",
  "numa_node":1
}
```

Then list the available PMEM namespaces on the host:

```
$ ndctl list -X
[
  {
    ...
    "size":6440353792,
    ...
    "name":"ns0",
    ...
  },
  {
    ...
    "size":6440353792,
    ...
    "name":"ns1",
    ...
  },
  {
    ...
    "size":6440353792,
    ...
    "name":"ns2",
    ...
  },
  {
    ...
    "size":32210157568,
    ...
    "name":"ns3",
    ...
  }
]
```

2. Specify which PMEM namespaces should be available to instances.

   Edit *libvirt.pmem_namespaces*:

```
[libvirt]
# pmem_namespaces=$LABEL:$NSNAME[|$NSNAME][,$LABEL:$NSNAME[|$NSNAME]]
pmem_namespaces = 6GB:ns0|ns1|ns2,LARGE:ns3
```

   Configured PMEM namespaces must have already been created on the host as described above.

The conf syntax allows the admin to associate one or more namespace `$NSNAME`s with an arbitrary `$LABEL` that can subsequently be used in a flavor to request one of those namespaces. It is recommended, but not required, for namespaces under a single `$LABEL` to be the same size.

3. Restart the `nova-compute` service.

   Nova will invoke ndctl to identify the configured PMEM namespaces, and report vPMEM resources to placement.

Configure a flavor

Specify a comma-separated list of the `$LABEL`s from *`libvirt.pmem_namespaces`* to the flavors `hw:pmem` property. Note that multiple instances of the same label are permitted:

```
$ openstack flavor set --property hw:pmem='6GB' my_flavor
$ openstack flavor set --property hw:pmem='6GB,LARGE' my_flavor_large
$ openstack flavor set --property hw:pmem='6GB,6GB' m1.medium
```

Note

If a NUMA topology is specified, all vPMEM devices will be put on guest NUMA node 0; otherwise nova will generate one NUMA node automatically for the guest.

Based on the above examples, an `openstack server create` request with `my_flavor_large` will spawn an instance with two vPMEMs. One, corresponding to the `LARGE` label, will be `ns3`; the other, corresponding to the `6G` label, will be arbitrarily chosen from `ns0`, `ns1`, or `ns2`.

Note

Using vPMEM inside a virtual machine requires the following:

- Guest kernel version 4.18 or higher;
- The `dax_pmem`, `nd_pmem`, `device_dax`, and `nd_btt` kernel modules;
- The ndctl utility.

Note

When resizing an instance with vPMEMs, the vPMEM data wont be migrated.

Verify inventories and allocations

This section describes how to check that:

- vPMEM inventories were created correctly in placement, validating the *configuration described above*.
- allocations were created correctly in placement for instances spawned from *flavors configured with vPMEMs*.

Note

Inventories and allocations related to vPMEM resource classes are on the root resource provider related to the compute node.

1. Get the list of resource providers

```
$ openstack resource provider list
+--------------------------------------+--------+------------+
| uuid                                 | name   | generation |
+--------------------------------------+--------+------------+
| 1bc545f9-891f-4930-ab2b-88a56078f4be | host-1 |         47 |
| 7d994aef-680d-43d4-9325-a67c807e648e | host-2 |         67 |
+--------------------------------------+--------+------------+
```

2. Check the inventory of each resource provider to see resource classes

   Each `$LABEL` configured in *`libvirt.pmem_namespaces`* is used to generate a resource class named `CUSTOM_PMEM_NAMESPACE_$LABEL`. Nova will report to Placement the number of vPMEM namespaces configured for each `$LABEL`. For example, assuming `host-1` was configured as described above:

```
$ openstack resource provider inventory list 1bc545f9-891f-4930-ab2b-
↪88a56078f4be
+-----------------------------+------------------+----------+----------+--
↪---------+----------+--------+
| resource_class              | allocation_ratio | max_unit | reserved |␣
↪step_size | min_unit |  total |
+-----------------------------+------------------+----------+----------+--
↪---------+----------+--------+
| VCPU                        |             16.0 |       64 |        0 | ␣
↪       1 |        1 |     64 |
| MEMORY_MB                   |              1.5 |   190604 |      512 | ␣
↪       1 |        1 | 190604 |
| CUSTOM_PMEM_NAMESPACE_LARGE |              1.0 |        1 |        0 | ␣
↪       1 |        1 |      1 |
| CUSTOM_PMEM_NAMESPACE_6GB   |              1.0 |        3 |        0 | ␣
↪       1 |        1 |      3 |
| DISK_GB                     |              1.0 |      439 |        0 | ␣
↪       1 |        1 |    439 |
+-----------------------------+------------------+----------+----------+--
↪---------+----------+--------+
```

   Here you can see the vPMEM resource classes prefixed with `CUSTOM_PMEM_NAMESPACE_`. The `LARGE` label was configured with one namespace (`ns3`), so it has an inventory of 1. Since the `6GB` label was configured with three namespaces (`ns0`, `ns1`, and `ns2`), the `CUSTOM_PMEM_NAMESPACE_6GB` inventory has a `total` and `max_unit` of `3`.

3. Check allocations for each server that is using vPMEMs

```
$ openstack server list
+--------------------------------------+----------------------+--------+--
```

(continues on next page)

(continued from previous page)

```
↪----------------+--------------+-----------------+
| ID                                   | Name                | Status |␣
↪Networks          | Image         | Flavor          |
+--------------------------------------+---------------------+--------+--
↪----------------+--------------+-----------------+
| 41d3e139-de5c-40fd-9d82-016b72f2ba1d | server-with-2-vpmems | ACTIVE |␣
↪private=10.0.0.24 | ubuntu-bionic | my_flavor_large |
| a616a7f6-b285-4adf-a885-dd8426dd9e6a | server-with-1-vpmem  | ACTIVE |␣
↪private=10.0.0.13 | ubuntu-bionic | my_flavor       |
+--------------------------------------+---------------------+--------+--
↪----------------+--------------+-----------------+

$ openstack resource provider allocation show 41d3e139-de5c-40fd-9d82-
↪016b72f2ba1d
+--------------------------------------+------------+----------------------
↪-------------------------------------------------------------------------
↪--------------------------+
| resource_provider                    | generation | resources            ␣
↪                                                                          ␣
↪                          |
+--------------------------------------+------------+----------------------
↪-------------------------------------------------------------------------
↪--------------------------+
| 1bc545f9-891f-4930-ab2b-88a56078f4be |         49 | {u'MEMORY_MB':␣
↪32768, u'VCPU': 16, u'DISK_GB': 20, u'CUSTOM_PMEM_NAMESPACE_6GB': 1, u
↪'CUSTOM_PMEM_NAMESPACE_LARGE': 1} |
+--------------------------------------+------------+----------------------
↪-------------------------------------------------------------------------
↪--------------------------+

$ openstack resource provider allocation show a616a7f6-b285-4adf-a885-
↪dd8426dd9e6a
+--------------------------------------+------------+----------------------
↪-------------------------------------------------------+
| resource_provider                    | generation | resources            ␣
↪                                                       |
+--------------------------------------+------------+----------------------
↪-------------------------------------------------------+
| 1bc545f9-891f-4930-ab2b-88a56078f4be |         49 | {u'MEMORY_MB': 8192,
↪ u'VCPU': 8, u'DISK_GB': 20, u'CUSTOM_PMEM_NAMESPACE_6GB': 1} |
+--------------------------------------+------------+----------------------
↪-------------------------------------------------------+
```

In this example, two servers were created. `server-with-2-vpmems` used `my_flavor_large` asking for one `6GB` vPMEM and one `LARGE` vPMEM. `server-with-1-vpmem` used `my_flavor` asking for a single `6GB` vPMEM.

Emulated Trusted Platform Module (vTPM)

Added in version 22.0.0: (Victoria)

Starting in the 22.0.0 (Victoria) release, Nova supports adding an emulated virtual Trusted Platform Module (vTPM) to guests.

Enabling vTPM

The following are required on each compute host wishing to support the vTPM feature:

- Currently vTPM is only supported when using the libvirt compute driver with a *libvirt.virt_type* of `kvm` or `qemu`.
- A key manager service, such as barbican, must be configured to store secrets used to encrypt the virtual device files at rest.
- The swtpm binary and associated libraries.
- Set the *libvirt.swtpm_enabled* config option to `True`. This will enable support for both TPM version 1.2 and 2.0.

With the above requirements satisfied, verify vTPM support by inspecting the traits on the compute nodes resource provider:

```
$ COMPUTE_UUID=$(openstack resource provider list --name $HOST -f value -c␣
↪uuid)
$ openstack resource provider trait list $COMPUTE_UUID | grep SECURITY_TPM
| COMPUTE_SECURITY_TPM_1_2 |
| COMPUTE_SECURITY_TPM_2_0 |
```

Configuring a flavor or image

A vTPM can be requested on a server via flavor extra specs or image metadata properties. There are two versions supported - 1.2 and 2.0 - and two models - TPM Interface Specification (TIS) and Command-Response Buffer (CRB). The CRB model is only supported with version 2.0.

Flavor extra_specs	Image metadata	Description
`hw:tpm_versio`	`hw_tpm_vers`	Specify the TPM version, `1.2` or `2.0`. Required if requesting a vTPM.
`hw:tpm_model`	`hw_tpm_mode`	Specify the TPM model, `tpm-tis` (the default) or `tpm-crb` (only valid with version `2.0`.

For example, to configure a flavor to use the TPM 2.0 with the CRB model:

```
$ openstack flavor set $FLAVOR \
    --property hw:tpm_version=2.0 \
    --property hw:tpm_model=tpm-crb
```

Scheduling will fail if flavor and image supply conflicting values, or if model `tpm-crb` is requested with version `1.2`.

Upon successful boot, the server should see a TPM device such as `/dev/tpm0` which can be used in the same manner as a hardware TPM.

Limitations

- Only server operations performed by the server owner are supported, as the users credentials are required to unlock the virtual device files on the host. Thus the admin may need to decide whether to grant the user additional policy roles; if not, those operations are effectively disabled.
- Live migration, evacuation, shelving and rescuing of servers with vTPMs is not currently supported.

Security

With a hardware TPM, the root of trust is a secret known only to the TPM user. In contrast, an emulated TPM comprises a file on disk which the libvirt daemon must be able to present to the guest. At rest, this file is encrypted using a passphrase stored in a key manager service. The passphrase in the key manager is associated with the credentials of the owner of the server (the user who initially created it). The passphrase is retrieved and used by libvirt to unlock the emulated TPM data any time the server is booted.

Although the above mechanism uses a libvirt secret that is both `private` (cant be displayed via the libvirt API or `virsh`) and `ephemeral` (exists only in memory, never on disk), it is theoretically possible for a sufficiently privileged user to retrieve the secret and/or vTPM data from memory.

A full analysis and discussion of security issues related to emulated TPM is beyond the scope of this document.

References

- TCG PC Client Specific TPM Interface Specification (TIS)
- TCG PC Client Platform TPM Profile (PTP) Specification
- QEMU docs on tpm
- Libvirt XML to request emulated TPM device
- Libvirt secret for usage type "vtpm"

UEFI

Added in version 17.0.0: (Queens)

Nova supports configuring a UEFI bootloader for guests. This brings about important advantages over legacy BIOS bootloaders and allows for features such as *Secure Boot*.

Enabling UEFI

Currently the configuration of UEFI guest bootloaders is only supported when using the libvirt compute driver with a *`libvirt.virt_type`* of `kvm` or `qemu`. When using the libvirt compute driver with AArch64-based guests, UEFI is automatically enabled as AArch64 does not support BIOS.

Todo

Update this once compute drivers start reporting a trait indicating UEFI bootloader support.

Configuring a flavor or image

Configuring a UEFI bootloader varies depending on the compute driver in use.

Libvirt

UEFI support is enabled by default on AArch64-based guests. For other guest architectures, you can request UEFI support with libvirt by setting the `hw_firmware_type` image property to `uefi`. For example:

```
$ openstack image set --property hw_firmware_type=uefi $IMAGE
```

References

- Open Virtual Machine Firmware (OVMF) Status Report
- Anatomy of a boot, a QEMU perspective

Secure Boot

Added in version 14.0.0: (Newton)

Changed in version 23.0.0: (Wallaby)

Added support for Secure Boot to the libvirt driver.

Nova supports configuring UEFI Secure Boot for guests. Secure Boot aims to ensure no unsigned kernel code runs on a machine.

Enabling Secure Boot

Currently the configuration of UEFI guest bootloaders is only supported when using the libvirt compute driver with a *`libvirt.virt_type`* of `kvm` or `qemu`. In both cases, it requires the guests also be configured with a *UEFI bootloader*.

With these requirements satisfied, you can verify UEFI Secure Boot support by inspecting the traits on the compute nodes resource provider:

```
$ COMPUTE_UUID=$(openstack resource provider list --name $HOST -f value -c␣
↪uuid)
$ openstack resource provider trait list $COMPUTE_UUID | grep COMPUTE_
↪SECURITY_UEFI_SECURE_BOOT
| COMPUTE_SECURITY_UEFI_SECURE_BOOT |
```

Configuring a flavor or image

Configuring UEFI Secure Boot for guests varies depending on the compute driver in use. In all cases, a *UEFI guest bootloader* must be configured for the guest but there are also additional requirements depending on the compute driver in use.

Libvirt

As the name would suggest, UEFI Secure Boot requires that a UEFI bootloader be configured for guests. When this is done, UEFI Secure Boot support can be configured using the `os:secure_boot` extra spec or equivalent image metadata property. For example, to configure an image that meets both of these requirements:

```
$ openstack image set \
    --property hw_firmware_type=uefi \
    --property os_secure_boot=required \
    $IMAGE
```

Note

On x86_64 hosts, enabling secure boot also requires configuring use of the Q35 machine type. This can be configured on a per-guest basis using the `hw_machine_type` image metadata property or automatically for all guests created on a host using the `libvirt.hw_machine_type` config option.

It is also possible to explicitly request that secure boot be disabled. This is the default behavior, so this request is typically useful when an admin wishes to explicitly prevent a user requesting secure boot by uploading their own image with relevant image properties. For example, to disable secure boot via the flavor:

```
$ openstack flavor set --property os:secure_boot=disabled $FLAVOR
```

Finally, it is possible to request that secure boot be enabled if the host supports it. This is only possible via the image metadata property. When this is requested, secure boot will only be enabled if the host supports this feature and the other constraints, namely that a UEFI guest bootloader is configured, are met. For example:

```
$ openstack image set --property os_secure_boot=optional $IMAGE
```

Note

If both the image metadata property and flavor extra spec are provided, they must match. If they do not, an error will be raised.

References

- Allow Secure Boot (SB) for QEMU- and KVM-based guests (spec)
- Securing Secure Boot with System Management Mode

AMD SEV (Secure Encrypted Virtualization)

Added in version 20.0.0: (Train)

Secure Encrypted Virtualization (SEV) is a technology from AMD which enables the memory for a VM to be encrypted with a key unique to the VM. SEV is particularly applicable to cloud computing since it can reduce the amount of trust VMs need to place in the hypervisor and administrator of their host system.

Enabling SEV

First the operator will need to ensure the following prerequisites are met:

- Currently SEV is only supported when using the libvirt compute driver with a *libvirt.virt_type* of `kvm` or `qemu`.
- At least one of the Nova compute hosts must be AMD hardware capable of supporting SEV. It is entirely possible for the compute plane to be a mix of hardware which can and cannot support SEV, although as per the section on *Permanent limitations* below, the maximum number of simultaneously running guests with SEV will be limited by the quantity and quality of SEV-capable hardware available.

In order for users to be able to use SEV, the operator will need to perform the following steps:

- Ensure that sufficient memory is reserved on the SEV compute hosts for host-level services to function correctly at all times. This is particularly important when hosting SEV-enabled guests, since they pin pages in RAM, preventing any memory overcommit which may be in normal operation on other compute hosts.

  It is recommended to achieve this by configuring an `rlimit` at the `/machine.slice` top-level `cgroup` on the host, with all VMs placed inside that. (For extreme detail, see this discussion on the spec.)

  An alternative approach is to configure the *reserved_host_memory_mb* option in the `[DEFAULT]` section of `nova.conf`, based on the expected maximum number of SEV guests simultaneously running on the host, and the details provided in an earlier version of the AMD SEV spec regarding memory region sizes, which cover how to calculate it correctly.

  See the Memory Locking and Accounting section of the AMD SEV spec and previous discussion for further details.

- A cloud administrator will need to define one or more SEV-enabled flavors *as described below*, unless it is sufficient for users to define SEV-enabled images.

Additionally the cloud operator should consider the following optional steps:

- Configure the *libvirt.num_memory_encrypted_guests* option in `nova.conf` to represent the number of guests an SEV compute node can host concurrently with memory encrypted at the hardware level. For example:

  ```
  [libvirt]
  num_memory_encrypted_guests = 15
  ```

  This option exists because on AMD SEV-capable hardware, the memory controller has a fixed number of slots for holding encryption keys, one per guest. For example, at the time of writing, earlier generations of hardware only have 15 slots, thereby limiting the number of SEV guests

which can be run concurrently to 15. Nova needs to track how many slots are available and used in order to avoid attempting to exceed that limit in the hardware.

Since version 8.0.0, libvirt exposes maximum number of SEV guests which can run concurrently in its host, so the limit is automatically detected using this feature. So it is not necessary to configure this option.

However in case an older version of libvirt is used, it is not possible for Nova to programmatically detect the correct value and Nova imposes no limit. So this configuration option serves as a stop-gap, allowing the cloud operator the option of providing this value manually.

This option has been deprecated and will be removed in a future release.

Note

If libvirt older than 8.0.0 is used, operators should carefully weigh the benefits vs. the risk when deciding whether to use the default of `None` or manually impose a limit. The benefits of using the default are a) immediate convenience since nothing needs to be done now, and b) convenience later when upgrading compute hosts to future versions of libvirt, since again nothing will need to be done for the correct limit to be automatically imposed. However the risk is that until auto-detection is implemented, users may be able to attempt to launch guests with encrypted memory on hosts which have already reached the maximum number of guests simultaneously running with encrypted memory. This risk may be mitigated by other limitations which operators can impose, for example if the smallest RAM footprint of any flavor imposes a maximum number of simultaneously running guests which is less than or equal to the SEV limit.

- Configure *`ram_allocation_ratio`* on all SEV-capable compute hosts to `1.0`. Use of SEV requires locking guest memory, meaning it is not possible to overcommit host memory.

  Alternatively, you can explicitly configure small pages for instances using the *`hw:mem_page_size`* flavor extra spec and equivalent image metadata property. For more information, see *Huge pages*.

- Configure *`libvirt.hw_machine_type`* on all SEV-capable compute hosts to include `x86_64=q35`, so that all x86_64 images use the `q35` machine type by default. (Currently Nova defaults to the `pc` machine type for the `x86_64` architecture, although it is expected that this will change in the future.)

  Changing the default from `pc` to `q35` makes the creation and configuration of images by users more convenient by removing the need for the `hw_machine_type` property to be set to `q35` on every image for which SEV booting is desired.

Caution

Consider carefully whether to set this option. It is particularly important since a limitation of the implementation prevents the user from receiving an error message with a helpful explanation if they try to boot an SEV guest when neither this configuration option nor the image property are set to select a `q35` machine type.

On the other hand, setting it to `q35` may have other undesirable side-effects on other images which were expecting to be booted with `pc`, so it is suggested to set it on a single compute node or aggregate, and perform careful testing of typical images before rolling out the setting to all SEV-capable compute hosts.

Configuring a flavor or image

Once an operator has covered the above steps, users can launch SEV instances either by requesting a flavor for which the operator set the *hw:mem_encryption* extra spec to `True`, or by using an image with the `hw_mem_encryption` property set to `True`. For example, to enable SEV for a flavor:

```
$ openstack flavor set FLAVOR-NAME \
    --property hw:mem_encryption=true
```

It is also possible to use SEV-ES, instead of SEV, by setting the *hw:mem_encryption_model* extra spec to `amd-sev-es`, or by using an image with the `hw_mem_encryption_model` property set to `amd-sev-es`. In case the extra spec and the property are unset or set to `amd-sev` then SEV is used.

In all cases, SEV instances can only be booted from images which have the `hw_firmware_type` property set to `uefi`, and only when the machine type is set to `q35`. This can be set per image by setting the image property `hw_machine_type=q35`, or per compute node by the operator via *libvirt.hw_machine_type* as explained above.

Limitations

Impermanent limitations

The following limitations may be removed in the future as the hardware, firmware, and various layers of software receive new features:

- SEV-encrypted VMs cannot yet be live-migrated or suspended, therefore they will need to be fully shut down before migrating off an SEV host, e.g. if maintenance is required on the host.
- SEV-encrypted VMs cannot contain directly accessible host devices (PCI passthrough). So for example mdev vGPU support will not currently work. However technologies based on vhost-user should work fine.
- The boot disk of SEV-encrypted VMs can only be `virtio`. (`virtio-blk` is typically the default for libvirt disks on x86, but can also be explicitly set e.g. via the image property `hw_disk_bus=virtio`). Valid alternatives for the disk include using `hw_disk_bus=scsi` with `hw_scsi_model=virtio-scsi` , or `hw_disk_bus=sata`.

Permanent limitations

The following limitations are expected long-term:

- The number of SEV guests allowed to run concurrently will always be limited. On the first generation of EPYC machines it will be limited to 15 guests; however this limit becomes much higher with the second generation (Rome).
- The operating system running in an encrypted virtual machine must contain SEV support.

Non-limitations

For the sake of eliminating any doubt, the following actions are *not* expected to be limited when SEV encryption is used:

- Cold migration or shelve, since they power off the VM before the operation at which point there is no encrypted memory (although this could change since there is work underway to add support for PMEM)

- Snapshot, since it only snapshots the disk
- `nova evacuate` (despite the name, more akin to resurrection than evacuation), since this is only initiated when the VM is no longer running
- Attaching any volumes, as long as they do not require attaching via an IDE bus
- Use of spice / VNC / serial / RDP consoles
- *VM guest virtual NUMA*

References

- libvirt driver launching AMD SEV-encrypted instances (spec)

Managing Resource Providers Using Config Files

In order to facilitate management of resource provider information in the Placement API, Nova provides a method for admins to add custom inventory and traits to resource providers using YAML files.

Note

Only `CUSTOM_*` resource classes and traits may be managed this way.

Placing Files

Nova-compute will search for `*.yaml` files in the path specified in *`compute.provider_config_location`*. These files will be loaded and validated for errors on nova-compute startup. If there are any errors in the files, nova-compute will fail to start up.

Administrators should ensure that provider config files have appropriate permissions and ownership. See the specification and admin guide for more details.

Note

The files are loaded once at nova-compute startup and any changes or new files will not be recognized until the next nova-compute startup.

Examples

Resource providers to target can be identified by either UUID or name. In addition, the value `$COMPUTE_NODE` can be used in the UUID field to identify all nodes managed by the service.

If an entry does not include any additional inventory or traits, it will be logged at load time but otherwise ignored. In the case of a resource provider being identified by both `$COMPUTE_NODE` and individual UUID/name, the values in the `$COMPUTE_NODE` entry will be ignored for *that provider* only if the explicit entry includes inventory or traits.

Note

In the case that a resource provider is identified more than once by explicit UUID/name, the nova-compute service will fail to start. This is a global requirement across all supplied `provider.yaml`

files.

```yaml
meta:
  schema_version: '1.0'
providers:
  - identification:
      name: 'EXAMPLE_RESOURCE_PROVIDER'
      # Additional valid identification examples:
      # uuid: '$COMPUTE_NODE'
      # uuid: '5213b75d-9260-42a6-b236-f39b0fd10561'
    inventories:
      additional:
        - CUSTOM_EXAMPLE_RESOURCE_CLASS:
            total: 100
            reserved: 0
            min_unit: 1
            max_unit: 10
            step_size: 1
            allocation_ratio: 1.0
    traits:
      additional:
        - 'CUSTOM_EXAMPLE_TRAIT'
```

Schema Example

```yaml
type: object
properties:
  # This property is used to track where the provider.yaml file originated.
  # It is reserved for internal use and should never be set in a provider.yaml
  # file supplied by an end user.
  __source_file:
    not: {}
  meta:
    type: object
    properties:
      # Version ($Major, $minor) of the schema must successfully parse
      # documents conforming to ($Major, 0..N). Any breaking schema change
      # (e.g. removing fields, adding new required fields, imposing a stricter
      # pattern on a value, etc.) must bump $Major.
      schema_version:
        type: string
        pattern: '^1\.([0-9]|[1-9][0-9]+)$'
    required:
      - schema_version
    additionalProperties: true
  providers:
    type: array
    items:
      type: object
```

(continues on next page)

(continued from previous page)

```
      properties:
        identification:
          $ref: '#/provider_definitions/provider_identification'
        inventories:
          $ref: '#/provider_definitions/provider_inventories'
        traits:
          $ref: '#/provider_definitions/provider_traits'
      required:
        - identification
      additionalProperties: true
required:
  - meta
additionalProperties: true

provider_definitions:
  provider_identification:
    # Identify a single provider to configure. Exactly one identification
    # method should be used. Currently `uuid` or `name` are supported, but
    # future versions may support others.
    # The uuid can be set to the sentinel value `$COMPUTE_NODE` which will
    # cause the consuming compute service to apply the configuration to
    # to all compute node root providers it manages that are not otherwise
    # specified using a uuid or name.
    type: object
    properties:
      uuid:
        oneOf:
            # TODO(sean-k-mooney): replace this with type uuid when we can␣
↪depend
            # on a version of the jsonschema lib that implements draft 8 or␣
↪later
            # of the jsonschema spec.
          - type: string
            pattern: '^[0-9A-Fa-f]{8}-[0-9A-Fa-f]{4}-[0-9A-Fa-f]{4}-[0-9A-Fa-
↪f]{4}-[0-9A-Fa-f]{12}$'
          - type: string
            const: '$COMPUTE_NODE'
      name:
        type: string
        minLength: 1
    # This introduces the possibility of an unsupported key name being used to
    # get by schema validation, but is necessary to support forward
    # compatibility with new identification methods. This should be checked
    # after schema validation.
    minProperties: 1
    maxProperties: 1
    additionalProperties: false
  provider_inventories:
    # Allows the admin to specify various adjectives to create and manage
```

(continues on next page)

(continued from previous page)

```
    # providers' inventories. This list of adjectives can be extended in the
    # future as the schema evolves to meet new use cases. As of v1.0, only one
    # adjective, `additional`, is supported.
    type: object
    properties:
      additional:
        type: array
        items:
          patternProperties:
            # Allows any key name matching the resource class pattern,
            # check to prevent conflicts with virt driver owned resources␣
↪classes
            # will be done after schema validation.
            ^[A-Z0-9_]{1,255}$:
              type: object
              properties:
                # Any optional properties not populated will be given a␣
↪default value by
                # placement. If overriding a pre-existing provider values␣
↪will not be
                # preserved from the existing inventory.
                total:
                  type: integer
                reserved:
                  type: integer
                min_unit:
                  type: integer
                max_unit:
                  type: integer
                step_size:
                  type: integer
                allocation_ratio:
                  type: number
              required:
                - total
              # The defined properties reflect the current placement data
              # model. While defining those in the schema and not allowing
              # additional properties means we will need to bump the schema
              # version if they change, that is likely to be part of a large
              # change that may have other impacts anyway. The benefit of
              # stricter validation of property names outweighs the (small)
              # chance of having to bump the schema version as described␣
↪above.
              additionalProperties: false
          # This ensures only keys matching the pattern above are allowed
          additionalProperties: false
    additionalProperties: true
  provider_traits:
    # Allows the admin to specify various adjectives to create and manage
```

(continues on next page)

(continued from previous page)

```
    # providers' traits. This list of adjectives can be extended in the
    # future as the schema evolves to meet new use cases. As of v1.0, only one
    # adjective, `additional`, is supported.
    type: object
    properties:
      additional:
        type: array
        items:
          # Allows any value matching the trait pattern here, additional
          # validation will be done after schema validation.
          type: string
          pattern: '^[A-Z0-9_]{1,255}$'
    additionalProperties: true
```

Note

When creating a `provider.yaml` config file it is recommended to use the schema provided by nova to validate the config using a simple jsonschema validator rather than starting the nova compute agent to enable faster iteration.

Compute Node Identification

Nova requires that compute nodes maintain a constant and consistent identity during their lifecycle. With the exception of the ironic driver, starting in the 2023.1 release, this is achieved by use of a file containing the node unique identifier that is persisted on disk. Prior to 2023.1, a combination of the compute nodes hostname and the *`host`* value in the configuration file were used.

The 2023.1 and later compute node identification file must remain unchanged during the lifecycle of the compute node. Changing the value or removing the file will result in a failure to start and may require advanced techniques for recovery. The file is read once at `nova-compute` startup, at which point it is validated for formatting and the corresponding node is located or created in the database.

Note

Even after 2023.1, the compute nodes hostname may not be changed after the initial registration with the controller nodes, it is just not used as the primary method for identification.

The behavior of `nova-compute` is different when using the ironic driver, as the (UUID-based) identity and mapping of compute nodes to compute manager service hosts is dynamic. In that case, no single node identity is maintained by the compute host and thus no identity file is read or written. Thus none of the sections below apply to hosts with *`compute_driver`* set to `ironic`.

Self-provisioning of the node identity

By default, `nova-compute` will automatically generate and write a UUID to disk the first time it starts up, and will use that going forward as its stable identity. Using the *`state_path`* (which is `/var/lib/nova` on most systems), a `compute_id` file will be created with a generated UUID.

Since this file (and its parent directory) is writable by nova, it may be desirable to move this to one of the

other locations that nova looks for the identification file.

Deployment provisioning of the node identity

In addition to the location mentioned above, nova will also search the parent directories of any config file in use (either the defaults or provided on the command line) for a `compute_id` file. Thus, a deployment tool may, on most systems, pre-provision the nodes UUID by writing one to `/etc/nova/compute_id`.

The contents of the file should be a single UUID in canonical textual representation with no additional whitespace or other characters. The following should work on most Linux systems:

```
$ uuidgen > /etc/nova/compute_id
```

Note

Do not execute the above command blindly in every run of a deployment tool, as that will result in overwriting the `compute_id` file each time, which *will* prevent nova from working properly.

Upgrading from pre-2023.1

Before release 2023.1, `nova-compute` only used the hostname (combined with *`host`*, if set) to identify its compute node objects in the database. When upgrading from a prior release, the compute node will perform a one-time migration of the hostname-matched compute node UUID to the `compute_id` file in the *`state_path`* location.

Note

It is imperative that you allow the above migration to run and complete on compute nodes that are being upgraded. Skipping this step by pre-provisioning a `compute_id` file before the upgrade will **not** work and will be equivalent to changing the compute node UUID after it has already been created once.

Resource Limits

Nova supports configuring limits on individual resources including CPU, memory, disk and network. These limits can be used to enforce basic Quality-of-Service (QoS) policies on such resources.

Note

Hypervisor-enforced resource limits are distinct from API-enforced user and project quotas. For information on the latter, refer to quotas.

Warning

This feature is poorly tested and poorly maintained. It may no longer work as expected. Where possible, consider using the QoS policies provided by other services, such as Cinder and Neutron.

Configuring resource limits

Resource quota enforcement support is specific to the virt driver in use on compute hosts.

libvirt

The libvirt driver supports CPU, disk and VIF limits. Unfortunately all of these work quite differently, as discussed below.

CPU limits

Libvirt enforces CPU limits in terms of *shares* and *quotas*, configured via *quota:cpu_shares* and *quota:cpu_period* / *quota:cpu_quota*, respectively. Both are implemented using the cgroups cpu controller. Note that allowed values for *shares* are platform dependent.

CPU shares are a proportional weighted share of total CPU resources relative to other instances. It does not limit CPU usage if CPUs are not busy. There is no unit and the value is purely relative to other instances, so an instance configured with value of 2048 will get twice as much CPU time as a VM configured with the value 1024. For example, to configure a CPU share of 1024 for a flavor:

```
$ openstack flavor set $FLAVOR --property quota:cpu_shares=1024
```

The CPU quotas require both a period and quota. The CPU period specifies the enforcement interval in microseconds, while the CPU quota specifies the maximum allowed bandwidth in microseconds that the each vCPU of the instance can consume. The CPU period must be in the range 1000 (1mS) to 1,000,000 (1s) or 0 (disabled). The CPU quota must be in the range 1000 (1mS) to 2^64 or 0 (disabled). Where the CPU quota exceeds the CPU period, this means the guest vCPU process is able to consume multiple pCPUs worth of bandwidth. For example, to limit each guest vCPU to 1 pCPU worth of runtime per period:

```
$ openstack flavor set $FLAVOR \
    --property quota:cpu_period=1000 \
    --property quota:cpu_quota=1000
```

To limit each guest vCPU to 2 pCPUs worth of runtime per period:

```
$ openstack flavor set $FLAVOR \
    --property quota:cpu_period=1000 \
    --property quota:cpu_quota=2000
```

Finally, to limit each guest vCPU to 0.5 pCPUs worth of runtime per period:

```
$ openstack flavor set $FLAVOR \
    --property quota:cpu_period=1000 \
    --property quota:cpu_quota=500
```

Note

Smaller periods will ensure a consistent latency response at the expense of burst capacity.

CPU shares and CPU quotas can work hand-in-hand. For example, if two instances were configured with *quota:cpu_shares*=1024 and *quota:cpu_period*=100000 (100mS) for both, then configuring

both with a *quota:cpu_quota*=75000 (75mS) will result in them sharing a host CPU equally, with both getting exactly 50mS of CPU time. If instead only one instance gets *quota:cpu_quota*=75000 (75mS) while the other gets *quota:cpu_quota*=25000 (25mS), then the first will get 3/4 of the time per period.

Memory Limits

The libvirt driver does not support memory limits.

Disk I/O Limits

Libvirt enforces disk limits through maximum disk read, write and total bytes per second, using the *quota:disk_read_bytes_sec*, *quota:disk_write_bytes_sec* and *quota:disk_total_bytes_sec* extra specs, respectively. It can also enforce disk limits through maximum disk read, write and total I/O operations per second, using the *quota:disk_read_iops_sec*, *quota:disk_write_iops_sec* and *quota:disk_total_iops_sec* extra specs, respectively. For example, to set a maximum disk write of 10 MB/sec for a flavor:

```
$ openstack flavor set $FLAVOR \
    --property quota:disk_write_bytes_sec=10485760
```

Network bandwidth limits

Warning

These limits are enforced via libvirt and will only work where the network is connect to the instance using a tap interface. It will not work for things like *SR-IOV VFs*. Neutrons QoS policies should be preferred wherever possible.

Libvirt enforces network bandwidth limits through inbound and outbound average, using the *quota:vif_inbound_average* and *quota:vif_outbound_average* extra specs, respectively. In addition, optional *peak* values, which specifies the maximum rate at which a bridge can send data (kB/s), and *burst* values, which specifies the amount of bytes that can be burst at peak speed (kilobytes), can be specified for both inbound and outbound traffic, using the *quota:vif_inbound_peak* / *quota:vif_outbound_peak* and *quota:vif_inbound_burst* / *quota:vif_outbound_burst* extra specs, respectively.

For example, to configure **outbound** traffic to an average of 262 Mbit/s (32768 kB/s), a peak of 524 Mbit/s, and burst of 65536 kilobytes:

```
$ openstack flavor set $FLAVOR \
    --property quota:vif_outbound_average=32768 \
    --property quota:vif_outbound_peak=65536 \
    --property quota:vif_outbound_burst=65536
```

Note

The speed limit values in above example are specified in kilobytes/second, while the burst value is in kilobytes.

VMWare

In contrast to libvirt, the VMWare virt driver enforces resource limits using consistent terminology, specifically through relative allocation levels, hard upper limits and minimum reservations configured via, for example, the *quota:cpu_shares_level* / *quota:cpu_shares_share*, *quota:cpu_limit*, and *quota:cpu_reservation* extra specs, respectively.

Allocation levels can be specified using one of `high`, `normal`, `low`, or `custom`. When `custom` is specified, the number of shares must be specified using e.g. *quota:cpu_shares_share*. There is no unit and the values are relative to other instances on the host. The upper limits and reservations, by comparison, are measure in resource-specific units, such as MHz for CPUs and will ensure that the instance never used more than or gets less than the specified amount of the resource.

CPU limits

CPU limits are configured via the *quota:cpu_shares_level* / *quota:cpu_shares_share*, *quota:cpu_limit*, and *quota:cpu_reservation* extra specs.

For example, to configure a CPU allocation level of `custom` with 1024 shares:

```
$ openstack flavor set $FLAVOR \
    --quota:cpu_shares_level=custom \
    --quota:cpu_shares_share=1024
```

To configure a minimum CPU allocation of 1024 MHz and a maximum of 2048 MHz:

```
$ openstack flavor set $FLAVOR \
    --quota:cpu_reservation=1024 \
    --quota:cpu_limit=2048
```

Memory limits

Memory limits are configured via the *quota:memory_shares_level* / *quota:memory_shares_share*, *quota:memory_limit*, and *quota:memory_reservation* extra specs.

For example, to configure a memory allocation level of `custom` with 1024 shares:

```
$ openstack flavor set $FLAVOR \
    --quota:memory_shares_level=custom \
    --quota:memory_shares_share=1024
```

To configure a minimum memory allocation of 1024 MB and a maximum of 2048 MB:

```
$ openstack flavor set $FLAVOR \
    --quota:memory_reservation=1024 \
    --quota:memory_limit=2048
```

Disk I/O limits

Disk I/O limits are configured via the *quota:disk_io_shares_level* / *quota:disk_io_shares_share*, *quota:disk_io_limit*, and *quota:disk_io_reservation* extra specs.

For example, to configure a disk I/O allocation level of `custom` with 1024 shares:

```
$ openstack flavor set $FLAVOR \
    --quota:disk_io_shares_level=custom \
    --quota:disk_io_shares_share=1024
```

To configure a minimum disk I/O allocation of 1024 MB and a maximum of 2048 MB:

```
$ openstack flavor set $FLAVOR \
    --quota:disk_io_reservation=1024 \
    --quota:disk_io_limit=2048
```

Network bandwidth limits

Network bandwidth limits are configured via the *quota:vif_shares_level* / *quota:vif_shares_share*, *quota:vif_limit*, and *quota:vif_reservation* extra specs.

For example, to configure a network bandwidth allocation level of `custom` with 1024 shares:

```
$ openstack flavor set $FLAVOR \
    --quota:vif_shares_level=custom \
    --quota:vif_shares_share=1024
```

To configure a minimum bandwidth allocation of 1024 Mbits/sec and a maximum of 2048 Mbits/sec:

```
$ openstack flavor set $FLAVOR \
    --quota:vif_reservation=1024 \
    --quota:vif_limit=2048
```

CPU models

Nova allows you to configure features of the virtual CPU that are exposed to instances. The combined set of CPU features is collectively referred to as the *CPU model*. Use cases include:

- To maximize performance of instances by exposing new host CPU features to the guest
- To ensure a consistent default behavior across all machines, removing reliance on system defaults.

To configure the virtual CPU, you can configure a *CPU mode*, configure one or more *named CPU models*, and explicitly request *CPU feature flags*.

The Effective Virtual CPU configuration in Nova presentation from the 2018 Berlin Summit provides a good overview of this topic.

Note

It is also possible to configure the topology of the CPU. This is discussed in *CPU topologies*.

Important

The functionality described below is currently only supported by the libvirt driver.

CPU modes

The first step in configuring the guest CPU is configuring the CPU *mode*. The CPU mode determines whether the CPU model is configured manually based on admin configuration or is automatically configured based on the host CPU. The CPU mode is configured using the *libvirt.cpu_mode* config option. This option can accepts one of the following values: `none`, `host-passthrough`, `host-model`, and `custom`.

Host model

If *cpu_mode=host-model*, libvirt requests the *named CPU model* that most closely matches the host and requests additional CPU flags to complete the match. This CPU model has a number of advantages:

- It provides almost all of the host CPU features to the guest, thus providing close to the maximum functionality and performance possible.
- It auto-adds critical guest CPU flags for mitigation from certain security flaws, *provided* the CPU microcode, kernel, QEMU, and libvirt are all updated.
- It computes live migration compatibility, with the caveat that live migration in both directions is not always possible.

In general, using `host-model` is a safe choice if your compute node CPUs are largely identical. However, if your compute nodes span multiple processor generations, you may be better advised to select a `custom` CPU model.

The `host-model` CPU mode is the effective default for the KVM & QEMU hypervisors (*libvirt.virt_type*=kvm/qemu) on x86-64 hosts. This default is provided by libvirt itself.

Note

As noted above, live migration is not always possible in both directions when using `host-model`. During live migration, the source CPU model definition is transferred to the destination host as-is. This results in the migrated guest on the destination seeing exactly the same CPU model as on source even if the destination compute host is capable of providing more CPU features. However, shutting down and restarting the guest may result in a different hardware configuration for the guest, as per the new capabilities of the destination compute.

Host passthrough

If *cpu_mode=host-passthrough*, libvirt tells KVM to pass through the host CPU with no modifications. In comparison to `host-model` which simply matches feature flags, `host-passthrough` ensures every last detail of the host CPU is matched. This gives the best performance, and can be important to some apps which check low level CPU details, but it comes at a cost with respect to migration.

In `host-passthrough` mode, the guest can only be live-migrated to a target host that matches the source host extremely closely. This includes the physical CPU model and running microcode, and may even include the running kernel. Use this mode only if your compute nodes have a very large degree of homogeneity (i.e. substantially all of your compute nodes use the exact same CPU generation and model), and you make sure to only live-migrate between hosts with exactly matching kernel versions. Failure to do so will result in an inability to support any form of live migration.

Note

The reason for that it is necessary for the CPU microcode versions to match is that hardware performance counters are exposed to an instance and it is likely that they may vary between different CPU models. There may also be other reasons due to security fixes for some hardware security flaws being included in CPU microcode.

Custom

If *cpu_mode=custom*, you can explicitly specify an ordered list of one or more supported named CPU models using the *libvirt.cpu_models* configuration option. This accepts any named CPU model that is valid for the given host, as discussed in *CPU models* below. When more than one CPU model is provided, it is expected that the list will be ordered so that the more common and less advanced CPU models are listed first.

In selecting the `custom` mode, along with a named CPU model that matches the oldest of your compute node CPUs, you can ensure that live migration between compute nodes will always be possible. However, you should ensure that the CPU model you select passes the correct CPU feature flags to the guest.

If you need to further tweak your CPU feature flags in the `custom` mode, see *CPU feature flags*.

Note

If *libvirt.cpu_models* is configured, the CPU models in the list needs to be compatible with the host CPU. Also, if *libvirt.cpu_model_extra_flags* is configured, all flags needs to be compatible with the host CPU. If incompatible CPU models or flags are specified, nova service will raise an error and fail to start.

None

If *cpu_mode=none*, libvirt does not specify a CPU model. Instead, the hypervisor chooses the default model.

The `none` CPU model is the default for all non-KVM/QEMU hypervisors. (*libvirt.virt_type*!= `kvm` / `qemu`)

CPU models

When *libvirt.cpu_mode* is set to `custom`, it is possible to configure one or more explicit CPU models that should be used. These CPU model names are shorthand for a set of feature flags. The libvirt KVM driver provides a number of standard CPU model names. These models are defined in `/usr/share/libvirt/cpu_map/*.xml`. You can inspect these files to determine which models are supported by your local installation. For example, consider a host that provides the following (incomplete) set of CPU models:

```
$ ls /usr/share/libvirt/cpu_map/x86_*.xml -1
...
/usr/share/libvirt/cpu_map/x86_Broadwell-IBRS.xml
/usr/share/libvirt/cpu_map/x86_Broadwell-noTSX-IBRS.xml
/usr/share/libvirt/cpu_map/x86_Broadwell-noTSX.xml
/usr/share/libvirt/cpu_map/x86_Broadwell.xml
```

(continues on next page)

(continued from previous page)

```
/usr/share/libvirt/cpu_map/x86_Haswell-IBRS.xml
/usr/share/libvirt/cpu_map/x86_Haswell-noTSX-IBRS.xml
/usr/share/libvirt/cpu_map/x86_Haswell-noTSX.xml
/usr/share/libvirt/cpu_map/x86_Haswell.xml
/usr/share/libvirt/cpu_map/x86_Icelake-Client-noTSX.xml
/usr/share/libvirt/cpu_map/x86_Icelake-Client.xml
/usr/share/libvirt/cpu_map/x86_Icelake-Server-noTSX.xml
/usr/share/libvirt/cpu_map/x86_Icelake-Server.xml
/usr/share/libvirt/cpu_map/x86_IvyBridge-IBRS.xml
/usr/share/libvirt/cpu_map/x86_IvyBridge.xml
/usr/share/libvirt/cpu_map/x86_SandyBridge-IBRS.xml
/usr/share/libvirt/cpu_map/x86_SandyBridge.xml
/usr/share/libvirt/cpu_map/x86_Skylake-Client-IBRS.xml
/usr/share/libvirt/cpu_map/x86_Skylake-Client-noTSX-IBRS.xml
/usr/share/libvirt/cpu_map/x86_Skylake-Client.xml
/usr/share/libvirt/cpu_map/x86_Skylake-Server-IBRS.xml
/usr/share/libvirt/cpu_map/x86_Skylake-Server-noTSX-IBRS.xml
/usr/share/libvirt/cpu_map/x86_Skylake-Server.xml
...
```

Each of these files contains information about the feature set provided by the CPU model. For example:

```
$ cat /usr/share/libvirt/cpu_map/x86_SandyBridge-IBRS.xml
<cpus>
  <model name='SandyBridge-IBRS'>
    <decode host='on' guest='on'/>
    <signature family='6' model='42'/> <!-- 0206a0 -->
    <signature family='6' model='45'/> <!-- 0206d0 -->
    <vendor name='Intel'/>
    <feature name='aes'/>
    <feature name='apic'/>
    ...
  </model>
</cpus>
```

You can also list these CPU models using `virsh cpu-models ARCH`. For example:

```
$ virsh cpu-models x86_64
...
SandyBridge
SandyBridge-IBRS
IvyBridge
IvyBridge-IBRS
Haswell-noTSX
Haswell-noTSX-IBRS
Haswell
Haswell-IBRS
Broadwell-noTSX
Broadwell-noTSX-IBRS
Broadwell
```

(continues on next page)

(continued from previous page)

```
Broadwell-IBRS
Skylake-Client
Skylake-Client-IBRS
Skylake-Client-noTSX-IBRS
Skylake-Server
Skylake-Server-IBRS
Skylake-Server-noTSX-IBRS
Icelake-Client
Icelake-Client-noTSX
Icelake-Server
Icelake-Server-noTSX
...
```

By settings *cpu_mode=custom*, it is possible to list one or more of these CPU models in the *libvirt.cpu_models* config option in `nova.conf`. For example:

```
[libvirt]
cpu_mode = custom
cpu_models = IvyBridge
```

Typically you will only need to list a single model here, but it can be useful to list multiple CPU models to support requesting CPU feature flags via traits. To do this, simply list the additional CPU models in order of oldest (and therefore most widely supported) to newest. For example:

```
[libvirt]
cpu_mode = custom
cpu_models = Penryn,IvyBridge,Haswell,Broadwell,Skylake-Client
```

More details on how to request CPU feature flags and why you might wish to specify multiple CPU models are provided in *CPU feature flags* below.

CPU feature flags

Added in version 18.0.0: (Rocky)

Regardless of your configured *libvirt.cpu_mode*, it is also possible to selectively enable additional feature flags. This can be accomplished using the *libvirt.cpu_model_extra_flags* config option. For example, suppose you have configured a custom CPU model of `IvyBridge`, which normally does not enable the `pcid` feature flag, but you do want to pass `pcid` into your guest instances. In this case, you could configure the following in `nova.conf` to enable this flag.

```
[libvirt]
cpu_mode = custom
cpu_models = IvyBridge
cpu_model_extra_flags = pcid
```

An end user can also specify required CPU features through traits. When specified, the libvirt driver will select the first CPU model in the *libvirt.cpu_models* list that can provide the requested feature traits. If no CPU feature traits are specified then the instance will be configured with the first CPU model in the list.

Consider the following `nova.conf`:

```
[libvirt]
cpu_mode = custom
cpu_models = Penryn,IvyBridge,Haswell,Broadwell,Skylake-Client
```

These different CPU models support different feature flags and are correctly configured in order of oldest (and therefore most widely supported) to newest. If the user explicitly required the `avx` and `avx2` CPU features, the latter of which is only found of Haswell-generation processors or newer, then they could request them using the *trait{group}:HW_CPU_X86_AVX* and *trait{group}:HW_CPU_X86_AVX2* flavor extra specs. For example:

```
$ openstack flavor set $FLAVOR \
    --property trait:HW_CPU_X86_AVX=required \
    --property trait:HW_CPU_X86_AVX2=required
```

As `Haswell` is the first CPU model supporting both of these CPU features, the instance would be configured with this model.

Mitigation for MDS (Microarchitectural Data Sampling) Security Flaws

In May 2019, four new microprocessor flaws, known as MDS and also referred to as RIDL and Fallout or ZombieLoad, were discovered. These flaws affect unpatched Nova compute nodes and instances running on Intel x86_64 CPUs.

Resolution

To get mitigation for the said MDS security flaws, a new CPU flag, `md-clear`, needs to be exposed to the Nova instances. This can be done as follows.

1. Update the following components to the versions from your Linux distribution that have fixes for the MDS flaws, on all compute nodes with Intel x86_64 CPUs:
   - `microcode_ctl`
   - `kernel`
   - `qemu-system-x86`
   - `libvirt`
2. When using the libvirt driver, ensure that the CPU flag `md-clear` is exposed to the Nova instances. This can be done in one of three ways, depending on your configured CPU mode:
   1. *libvirt.cpu_mode*=host-model

      When using the `host-model` CPU mode, the `md-clear` CPU flag will be passed through to the Nova guests automatically.

      This mode is the default, when *libvirt.virt_type*=kvm|qemu is set in `/etc/nova/nova-cpu.conf` on compute nodes.
   2. *libvirt.cpu_mode*=host-passthrough

      When using the `host-passthrough` CPU mode, the `md-clear` CPU flag will be passed through to the Nova guests automatically.
   3. *libvirt.cpu_mode*=custom

When using the `custom` CPU mode, you must *explicitly* enable the CPU flag `md-clear` to the Nova instances, in addition to the flags required for previous vulnerabilities, using the *libvirt.cpu_model_extra_flags*. For example:

```
[libvirt]
cpu_mode = custom
cpu_models = IvyBridge
cpu_model_extra_flags = spec-ctrl,ssbd,md-clear
```

3. Reboot the compute node for the fixes to take effect.

   To minimize workload downtime, you may wish to live migrate all guests to another compute node first.

Once the above steps have been taken on every vulnerable compute node in the deployment, each running guest in the cluster must be fully powered down, and cold-booted (i.e. an explicit stop followed by a start), in order to activate the new CPU models. This can be done by the guest administrators at a time of their choosing.

Validation

After applying relevant updates, administrators can check the kernels `sysfs` interface to see what mitigation is in place, by running the following command on the host:

```
# cat /sys/devices/system/cpu/vulnerabilities/mds
Mitigation: Clear CPU buffers; SMT vulnerable
```

To unpack the message Mitigation: Clear CPU buffers; SMT vulnerable:

- `Mitigation: Clear CPU buffers` means you have the CPU buffer clearing mitigation enabled, which is mechanism to invoke a flush of various exploitable CPU buffers by invoking a CPU instruction called VERW.
- `SMT vulnerable` means, depending on your workload, you may still be vulnerable to SMT-related problems. You need to evaluate whether your workloads need SMT (also called Hyper-Threading) to be disabled or not. Refer to the guidance from your Linux distribution and processor vendor.

To see the other possible values for `/sys/devices/system/cpu/vulnerabilities/mds`, refer to the MDS system information section in Linux kernels documentation for MDS.

On the host, validate that KVM is capable of exposing the `md-clear` flag to guests:

```
# virsh domcapabilities kvm | grep md-clear
<feature policy='require' name='md-clear'/>
```

More information can be found on the Diagnosis tab of this security notice document.

Performance Impact

Refer to this section titled Performance Impact and Disabling MDS from this security notice document, under the *Resolve* tab.

Note

Although the article referred to is from Red Hat, the findings and recommendations about performance impact apply for other distributions also.

Other libvirt features

The libvirt driver supports a large number of additional features that dont warrant their own section. These are gathered here.

Guest agent support

Guest agents enable optional access between compute nodes and guests through a socket, using the QMP protocol.

To enable this feature, you must set `hw_qemu_guest_agent=yes` as a metadata parameter on the image you wish to use to create the guest-agent-capable instances from. You can explicitly disable the feature by setting `hw_qemu_guest_agent=no` in the image metadata.

Watchdog behavior

Changed in version 15.0.0: (Ocata)

Add support for the `disabled` option.

A virtual watchdog device can be used to keep an eye on the guest server and carry out a configured action if the server hangs. The watchdog uses the i6300esb device (emulating a PCI Intel 6300ESB). Watchdog behavior can be configured using the *hw:watchdog_action* flavor extra spec or equivalent image metadata property. If neither the extra spec not the image metadata property are specified, the watchdog is disabled.

For example, to enable the watchdog and configure it to forcefully reset the guest in the event of a hang, run:

```
$ openstack flavor set $FLAVOR --property hw:watchdog_action=reset
```

Note

Watchdog behavior set using the image metadata property will override behavior set using the flavor extra spec.

Random number generator

Changed in version 21.0.0: (Ussuri)

Random number generators are now enabled by default for instances.

Operating systems require good sources of entropy for things like cryptographic software. If a random-number generator device has been added to the instance through its image properties, the device can be enabled and configured using the *hw_rng:allowed*, *hw_rng:rate_bytes* and *hw_rng:rate_period* flavor extra specs.

To configure for example a byte rate of 5 bytes per period and a period of 1000 mSec (1 second), run:

```
$ openstack flavor set $FLAVOR \
    --property hw_rng:rate_bytes=5 \
    --property hw_rng:rate_period=1000
```

Alternatively, to disable the random number generator, run:

```
$ openstack flavor set $FLAVOR --property hw_rng:allowed=false
```

The presence of separate byte rate and rate period configurables is intentional. As noted in the QEMU docs, a smaller rate and larger period minimizes the opportunity for malicious guests to starve other guests of entropy but at the cost of responsiveness. Conversely, larger rates and smaller periods will increase the burst rate but at the potential cost of warping resource consumption in favour of a greedy guest.

Performance Monitoring Unit (vPMU)

Added in version 20.0.0: (Train)

If nova is deployed with the libvirt virt driver and *libvirt.virt_type* is set to `qemu` or `kvm`, a virtual performance monitoring unit (vPMU) can be enabled or disabled for an instance using the *hw:pmu* flavor extra spec or `hw_pmu` image metadata property. If the vPMU is not explicitly enabled or disabled via the flavor or image, its presence is left to QEMU to decide.

For example, to explicitly disable the vPMU, run:

```
$ openstack flavor set FLAVOR-NAME --property hw:pmu=false
```

The vPMU is used by tools like `perf` in the guest to provide more accurate information for profiling application and monitoring guest performance. For *real time* workloads, the emulation of a vPMU can introduce additional latency which would be undesirable. If the telemetry it provides is not required, the vPMU can be disabled. For most workloads the default of unset (enabled) will be correct.

Hiding hypervisor signature

Added in version 18.0.0: (Rocky)

Changed in version 21.0.0: (Ussuri)

Prior to the Ussuri release, this was called `hide_hypervisor_id`. An alias is provided to provide backwards compatibility.

Some hypervisors add a signature to their guests. While the presence of the signature can enable some paravirtualization features on the guest, it can also have the effect of preventing some drivers from loading. You can hide this signature by setting the *hw:hide_hypervisor_id* to true.

For example, to hide your signature from the guest OS, run:

```
$ openstack flavor set $FLAVOR --property hw:hide_hypervisor_id=true
```

Locked memory allocation

Added in version 26.0.0: (Zed)

Locking memory marks the guest memory allocations as unmovable and unswappable. It is implicitly enabled in a number of cases such as SEV or realtime guests but can also be enabled explicitly using the `hw:locked_memory` extra spec (or use `hw_locked_memory` image property). `hw:locked_memory`

(also `hw_locked_memory` image property) accept boolean values in string format like true or false value. It will raise `FlavorImageLockedMemoryConflict` exception if both flavor and image property are specified but with different boolean values. This will only be allowed if you have also set `hw:mem_page_size`, so we can ensure that the scheduler can actually account for this correctly and prevent out of memory events. Otherwise, will raise `LockMemoryForbidden` exception.

```
$ openstack flavor set FLAVOR-NAME \
    --property hw:locked_memory=BOOLEAN_VALUE
```

Note

This is currently only supported by the libvirt driver.

3.4.1.5 Maintenance

Once you are running nova, the following information is extremely useful.

- *Upgrades*: How nova is designed to be upgraded for minimal service impact, and the order you should do them in.

Troubleshoot Compute

Common problems for Compute typically involve misconfigured networking or credentials that are not sourced properly in the environment. Also, most flat networking configurations do not enable **`ping`** or **`ssh`** from a compute node to the instances that run on that node. Another common problem is trying to run 32-bit images on a 64-bit compute node. This section shows you how to troubleshoot Compute.

Todo

Move the sections below into sub-pages for readability.

Orphaned resource allocations

Problem

There are orphaned resource allocations in the placement service which can cause resource providers to:

- Appear to the scheduler to be more utilized than they really are
- Prevent deletion of compute services

One scenario in which this could happen is a compute service host is having problems so the administrator forces it down and evacuates servers from it. Note that in this case evacuates refers to the server `evacuate` action, not live migrating all servers from the running compute service. Assume the compute host is down and fenced.

In this case, the servers have allocations tracked in placement against both the down source compute node and their current destination compute host. For example, here is a server *vm1* which has been evacuated from node *devstack1* to node *devstack2*:

```
$ openstack --os-compute-api-version 2.53 compute service list --service nova-
↪compute
```

(continues on next page)

(continued from previous page)

```
+--------------------------------------+--------------+-----------+------+----
↪-----+-------+----------------------------+
| ID                                   | Binary       | Host      | Zone |␣
↪Status  | State | Updated At                 |
+--------------------------------------+--------------+-----------+------+----
↪-----+-------+----------------------------+
| e3c18c2d-9488-4863-b728-f3f292ec5da8 | nova-compute | devstack1 | nova |␣
↪enabled | down  | 2019-10-25T20:13:51.000000 |
| 50a20add-cc49-46bd-af96-9bb4e9247398 | nova-compute | devstack2 | nova |␣
↪enabled | up    | 2019-10-25T20:13:52.000000 |
| b92afb2e-cd00-4074-803e-fff9aa379c2f | nova-compute | devstack3 | nova |␣
↪enabled | up    | 2019-10-25T20:13:53.000000 |
+--------------------------------------+--------------+-----------+------+----
↪-----+-------+----------------------------+
$ vm1=$(openstack server show vm1 -f value -c id)
$ openstack server show $vm1 -f value -c OS-EXT-SRV-ATTR:host
devstack2
```

The server now has allocations against both *devstack1* and *devstack2* resource providers in the placement service:

```
$ devstack1=$(openstack resource provider list --name devstack1 -f value -c␣
↪uuid)
$ devstack2=$(openstack resource provider list --name devstack2 -f value -c␣
↪uuid)
$ openstack resource provider show --allocations $devstack1
+-------------+-----------------------------------------------------------------
↪----------------------------------------+
| Field       | Value                                                           ␣
↪                                       |
+-------------+-----------------------------------------------------------------
↪----------------------------------------+
| uuid        | 9546fce4-9fb5-4b35-b277-72ff125ad787                            ␣
↪                                       |
| name        | devstack1                                                       ␣
↪                                       |
| generation  | 6                                                               ␣
↪                                       |
| allocations | {u'a1e6e0b2-9028-4166-b79b-c177ff70fbb7': {u'resources': {u
↪'VCPU': 1, u'MEMORY_MB': 512, u'DISK_GB': 1}}} |
+-------------+-----------------------------------------------------------------
↪----------------------------------------+
$ openstack resource provider show --allocations $devstack2
+-------------+-----------------------------------------------------------------
↪----------------------------------------+
| Field       | Value                                                           ␣
↪                                       |
+-------------+-----------------------------------------------------------------
↪----------------------------------------+
| uuid        | 52d0182d-d466-4210-8f0d-29466bb54feb                            ␣
```

(continues on next page)

(continued from previous page)

```
↪                                                    |
| name          | devstack2                                                    ␣
↪                                                    |
| generation    | 3                                                            ␣
↪                                                    |
| allocations | {u'a1e6e0b2-9028-4166-b79b-c177ff70fbb7': {u'resources': {u
↪'VCPU': 1, u'MEMORY_MB': 512, u'DISK_GB': 1}}} |
+-------------+------------------------------------------------------------------
↪--------------------------------------------+
$ openstack --os-placement-api-version 1.12 resource provider allocation show
↪$vm1
+--------------------------------------+------------+------------------------
↪----------------------+----------------------------------+-----------------
↪-----------------+
| resource_provider                    | generation | resources              ␣
↪                      | project_id                       | user_id          ␣
↪                 |
+--------------------------------------+------------+------------------------
↪----------------------+----------------------------------+-----------------
↪-----------------+
| 9546fce4-9fb5-4b35-b277-72ff125ad787 |          6 | {u'VCPU': 1, u'MEMORY_MB
↪': 512, u'DISK_GB': 1} | 2f3bffc5db2b47deb40808a4ed2d7c7a |␣
↪2206168427c54d92ae2b2572bb0da9af |
| 52d0182d-d466-4210-8f0d-29466bb54feb |          3 | {u'VCPU': 1, u'MEMORY_MB
↪': 512, u'DISK_GB': 1} | 2f3bffc5db2b47deb40808a4ed2d7c7a |␣
↪2206168427c54d92ae2b2572bb0da9af |
+--------------------------------------+------------+------------------------
↪----------------------+----------------------------------+-----------------
↪-----------------+
```

One way to find all servers that were evacuated from *devstack1* is:

```
$ nova migration-list --source-compute devstack1 --migration-type evacuation
+----+--------------------------------------+-------------+-----------+-------
↪---------+-------------+------------+-------------+----------------------------
↪----------+----------+------------+------------+
| Id | UUID                                 | Source Node | Dest Node |␣
↪Source Compute | Dest Compute | Dest Host   | Status | Instance UUID        ␣
↪                | Old Flavor | New Flavor | Created At                 |␣
↪Updated At                  | Type       |
+----+--------------------------------------+-------------+-----------+-------
↪---------+-------------+------------+-------------+----------------------------
↪----------+----------+------------+------------+
| 1  | 8a823ba3-e2e9-4f17-bac5-88ceea496b99 | devstack1   | devstack2 |␣
↪devstack1      | devstack2    | 192.168.0.1 | done   | a1e6e0b2-9028-4166-
↪b79b-c177ff70fbb7 | None       | None       | 2019-10-25T17:46:35.000000 |␣
↪2019-10-25T17:46:37.000000 | evacuation |
+----+--------------------------------------+-------------+-----------+-------
```

(continues on next page)

(continued from previous page)

```
↪--------+-------------+-------------+--------+--------------------------
↪---------+-----------+-----------+---------------------------+----------
↪------------------+------------+
```

Trying to delete the resource provider for *devstack1* will fail while there are allocations against it:

```
$ openstack resource provider delete $devstack1
Unable to delete resource provider 9546fce4-9fb5-4b35-b277-72ff125ad787:␣
↪Resource provider has allocations. (HTTP 409)
```

Solution

Using the example resources above, remove the allocation for server *vm1* from the *devstack1* resource provider. If you have osc-placement 1.8.0 or newer, you can use the **openstack resource provider allocation unset** command to remove the allocations for consumer *vm1* from resource provider *devstack1*:

```
$ openstack --os-placement-api-version 1.12 resource provider allocation \
    unset --provider $devstack1 $vm1
+--------------------------------------+------------+--------------------------
↪----------------------+----------------------------------+-----------------
↪-----------------+
| resource_provider                    | generation | resources                ␣
↪                      | project_id                       | user_id          ␣
↪                 |
+--------------------------------------+------------+--------------------------
↪----------------------+----------------------------------+-----------------
↪-----------------+
| 52d0182d-d466-4210-8f0d-29466bb54feb |          4 | {u'VCPU': 1, u'MEMORY_MB
↪': 512, u'DISK_GB': 1} | 2f3bffc5db2b47deb40808a4ed2d7c7a |␣
↪2206168427c54d92ae2b2572bb0da9af |
+--------------------------------------+------------+--------------------------
↪----------------------+----------------------------------+-----------------
↪-----------------+
```

If you have *osc-placement* 1.7.x or older, the `unset` command is not available and you must instead overwrite the allocations. Note that we do not use **openstack resource provider allocation delete** here because that will remove the allocations for the server from all resource providers, including *devstack2* where it is now running; instead, we use **openstack resource provider allocation set** to overwrite the allocations and only retain the *devstack2* provider allocations. If you do remove all allocations for a given server, you can heal them later. See *Using heal_allocations* for details.

```
$ openstack --os-placement-api-version 1.12 resource provider allocation set
↪$vm1 \
    --project-id 2f3bffc5db2b47deb40808a4ed2d7c7a \
    --user-id 2206168427c54d92ae2b2572bb0da9af \
    --allocation rp=52d0182d-d466-4210-8f0d-29466bb54feb,VCPU=1 \
    --allocation rp=52d0182d-d466-4210-8f0d-29466bb54feb,MEMORY_MB=512 \
    --allocation rp=52d0182d-d466-4210-8f0d-29466bb54feb,DISK_GB=1
+--------------------------------------+------------+--------------------------
```

(continues on next page)

(continued from previous page)

```
↪----------------------+----------------------------------+----------------
↪-----------------+
| resource_provider                    | generation | resources              ␣
↪                       | project_id                       | user_id        ␣
↪                 |
+--------------------------------------+------------+------------------------
↪----------------------+----------------------------------+----------------
↪-----------------+
| 52d0182d-d466-4210-8f0d-29466bb54feb |          4 | {u'VCPU': 1, u'MEMORY_MB
↪': 512, u'DISK_GB': 1} | 2f3bffc5db2b47deb40808a4ed2d7c7a |␣
↪2206168427c54d92ae2b2572bb0da9af |
+--------------------------------------+------------+------------------------
↪----------------------+----------------------------------+----------------
↪-----------------+
```

Once the *devstack1* resource provider allocations have been removed using either of the approaches above, the *devstack1* resource provider can be deleted:

```
$ openstack resource provider delete $devstack1
```

And the related compute service if desired:

```
$ openstack --os-compute-api-version 2.53 compute service delete e3c18c2d-
↪9488-4863-b728-f3f292ec5da8
```

For more details on the resource provider commands used in this guide, refer to the osc-placement plugin documentation.

Using heal_allocations

If you have a particularly troubling allocation consumer and just want to delete its allocations from all providers, you can use the **openstack resource provider allocation delete** command and then heal the allocations for the consumer using the *heal_allocations command*. For example:

```
$ openstack resource provider allocation delete $vm1
$ nova-manage placement heal_allocations --verbose --instance $vm1
Looking for instances in cell: 04879596-d893-401c-b2a6-3d3aa096089d(cell1)
Found 1 candidate instances.
Successfully created allocations for instance a1e6e0b2-9028-4166-b79b-
↪c177ff70fbb7.
Processed 1 instances.
$ openstack resource provider allocation show $vm1
+--------------------------------------+------------+------------------------
↪----------------------+
| resource_provider                    | generation | resources              ␣
↪                       |
+--------------------------------------+------------+------------------------
↪----------------------+
| 52d0182d-d466-4210-8f0d-29466bb54feb |          5 | {u'VCPU': 1, u'MEMORY_MB
↪': 512, u'DISK_GB': 1} |
```

(continues on next page)

(continued from previous page)

```
+--------------------------------------+------------+------------------------
↪----------------------+
```

Note that deleting allocations and then relying on `heal_allocations` may not always be the best solution since healing allocations does not account for some things:

- Migration-based allocations would be lost if manually deleted during a resize. These are allocations tracked by the migration resource record on the source compute service during a migration.
- Healing allocations only partially support nested allocations. Nested allocations due to Neutron ports having QoS policies are supported since 20.0.0 (Train) release. But nested allocations due to vGPU or Cyborg device profile requests in the flavor are not supported. Also if you are using provider.yaml files on compute hosts to define additional resources, if those resources are defined on child resource providers then instances using such resources are not supported.

If you do use the `heal_allocations` command to cleanup allocations for a specific trouble instance, it is recommended to take note of what the allocations were before you remove them in case you need to reset them manually later. Use the **`openstack resource provider allocation show`** command to get allocations for a consumer before deleting them, e.g.:

```
$ openstack --os-placement-api-version 1.12 resource provider allocation show
↪$vm1
```

Using placement audit

If you have a situation where orphaned allocations exist for an instance that was deleted in the past, example log message:

```
Instance <uuid> has allocations against this compute host but is not found in␣
↪the database.
```

you can use the *nova-manage placement audit* tool to have it find and optionally delete orphaned placement allocations. This tool will call the placement API to modify allocations.

To list all allocations that are unrelated to an existing instance or migration UUID:

```
$ nova-manage placement audit --verbose
```

To delete all allocations on all resource providers that are unrelated to an existing instance or migration UUID:

```
$ nova-manage placement audit --verbose --delete
```

To delete all allocations on a specific resource provider that are unrelated to an existing instance or migration UUID:

```
$ nova-manage placement audit --verbose --delete --resource_provider <uuid>
```

Rebuild placement DB

Problem

You have somehow changed a nova cell database and the `compute_nodes` table entries are now reporting different uuids to the placement service but placement already has `resource_providers` table entries with the same names as those computes so the resource providers in placement and the compute nodes in the nova database are not synchronized. Maybe this happens as a result of restoring the nova cell database from a backup where the compute hosts have not changed but they are using different uuids.

Nova reports compute node inventory to placement using the `hypervisor_hostname` and uuid of the `compute_nodes` table to the placement `resource_providers` table, which has a unique constraint on the name (hostname in this case) and uuid. Trying to create a new resource provider with a new uuid but the same name as an existing provider results in a 409 error from placement, such as in bug 1817833.

Solution

Warning

This is likely a last resort when *all* computes and resource providers are not synchronized and it is simpler to just rebuild the placement database from the current state of nova. This may, however, not work when using placement for more advanced features such as ports with minimum bandwidth guarantees or accelerators. Obviously testing first in a pre-production environment is ideal.

These are the steps at a high level:

1. Make a backup of the existing placement database in case these steps fail and you need to start over.
2. Recreate the placement database and run the schema migrations to initialize the placement database.
3. Either restart or wait for the *`update_resources_interval`* on the `nova-compute` services to report resource providers and their inventory to placement.
4. Run the *nova-manage placement heal_allocations* command to report allocations to placement for the existing instances in nova.
5. Run the *nova-manage placement sync_aggregates* command to synchronize nova host aggregates to placement resource provider aggregates.

Once complete, test your deployment as usual, e.g. running Tempest integration and/or Rally tests, creating, migrating and deleting a server, etc.

Affinity policy violated with parallel requests

Problem

Parallel server create requests for affinity or anti-affinity land on the same host and servers go to the `ACTIVE` state even though the affinity or anti-affinity policy was violated.

Solution

There are two ways to avoid anti-/affinity policy violations among multiple server create requests.

Create multiple servers as a single request

Use the multi-create API with the `min_count` parameter set or the multi-create CLI with the `--min` option set to the desired number of servers.

This works because when the batch of requests is visible to `nova-scheduler` at the same time as a group, it will be able to choose compute hosts that satisfy the anti-/affinity constraint and will send them to the same hosts or different hosts accordingly.

Adjust Nova configuration settings

When requests are made separately and the scheduler cannot consider the batch of requests at the same time as a group, anti-/affinity races are handled by what is called the late affinity check in `nova-compute`. Once a server lands on a compute host, if the request involves a server group, `nova-compute` contacts the API database (via `nova-conductor`) to retrieve the server group and then it checks whether the affinity policy has been violated. If the policy has been violated, `nova-compute` initiates a reschedule of the server create request. Note that this means the deployment must have *`scheduler.max_attempts`* set greater than `1` (default is `3`) to handle races.

An ideal configuration for multiple cells will minimize *upcalls* from the cells to the API database. This is how devstack, for example, is configured in the CI gate. The cell conductors do not set *`api_database.connection`* and `nova-compute` sets *`workarounds.disable_group_policy_check_upcall`* to `True`.

However, if a deployment needs to handle racing affinity requests, it needs to configure cell conductors to have access to the API database, for example:

```
[api_database]
connection = mysql+pymysql://root:a@127.0.0.1/nova_api?charset=utf8
```

The deployment also needs to configure `nova-compute` services not to disable the group policy check upcall by either not setting (use the default) *`workarounds.disable_group_policy_check_upcall`* or setting it to `False`, for example:

```
[workarounds]
disable_group_policy_check_upcall = False
```

With these settings, anti-/affinity policy should not be violated even when parallel server create requests are racing.

Future work is needed to add anti-/affinity support to the placement service in order to eliminate the need for the late affinity check in `nova-compute`.

Compute service logging

Compute stores a log file for each service in `/var/log/nova`. For example, `nova-compute.log` is the log for the `nova-compute` service. You can set the following options to format log strings for the `nova.log` module in the `nova.conf` file:

- `logging_context_format_string`

- `logging_default_format_string`

If the log level is set to `debug`, you can also specify `logging_debug_format_suffix` to append extra formatting. For information about what variables are available for the formatter, see Formatter Objects.

You have two logging options for OpenStack Compute based on configuration settings. In `nova.conf`, include the `logfile` option to enable logging. Alternatively you can set `use_syslog = 1` so that the nova daemon logs to syslog.

Guru Meditation reports

A Guru Meditation report is sent by the Compute service upon receipt of the `SIGUSR2` signal (`SIGUSR1` before Mitaka). This report is a general-purpose error report that includes details about the current state of the service. The error report is sent to `stderr`.

For example, if you redirect error output to `nova-compute-err.log` using **`nova-compute 2>/var/log/nova/nova-compute-err.log`**, resulting in the process ID 8675, you can then run:

```
# kill -USR2 8675
```

This command triggers the Guru Meditation report to be printed to `/var/log/nova/nova-compute-err.log`.

For the WSGI-based compute API and metadata API services, using signals is not trivial due to the web servers own signal handling. An alternative to the signal-based approach that works equally well for freestanding and hosted entry points is to use a file-based trigger.

Configure the service to trigger the GMR by the modification time changes of a file or directory.

```
[oslo_reports]
file_event_handler=/var/lib/nova
```

Then the report can be triggered by touching the file or directory. The GMRb will be emitted in the same place where the service logs normally.

```
touch /var/lib/nova
```

Note that some web servers freeze the request handler processes when there is no HTTP request to be handled. This prevent the file system monitoring loop to detect the change. So after touching the file make a HTTP request to the given WSGI application.

```
openstack compute service list
```

For more details and a complete working example you can check openstack-must-gather.

The report has the following sections:

- Package: Displays information about the package to which the process belongs, including version information.
- Threads: Displays stack traces and thread IDs for each of the threads within the process.
- Green Threads: Displays stack traces for each of the green threads within the process (green threads do not have thread IDs).
- Configuration: Lists all configuration options currently accessible through the CONF object for the current process.

For more information, see *Guru Meditation Reports*.

Common errors and fixes for Compute

The ask.openstack.org site offers a place to ask and answer questions, and you can also mark questions as frequently asked questions. This section describes some errors people have posted previously. Bugs are constantly being fixed, so online resources are a great way to get the most up-to-date errors and fixes.

Credential errors, 401, and 403 forbidden errors

Problem

Missing credentials cause a `403 forbidden` error.

Solution

To resolve this issue, use one of these methods:

1. Manual method

   Gets the `novarc` file from the project ZIP file, saves existing credentials in case of override, and manually sources the `novarc` file.

2. Script method

   Generates `novarc` from the project ZIP file and sources it for you.

When you run `nova-api` the first time, it generates the certificate authority information, including `openssl.cnf`. If you start the CA services before this, you might not be able to create your ZIP file. Restart the services. When your CA information is available, create your ZIP file.

Also, check your HTTP proxy settings to see whether they cause problems with `novarc` creation.

Live migration permission issues

Problem

When live migrating an instance, you may see errors like the below:

```
libvirtError: operation failed: Failed to connect to remote libvirt URI
qemu+ssh://stack@cld6b16/system: Cannot recv data: Host key verification
failed.: Connection reset by peer
```

Solution

Ensure you have completed all the steps outlined in *Configure SSH between compute nodes*. In particular, its important to note that the `libvirt` process runs as `root` even though it may be connecting to a different user (`stack` in the above example). You can ensure everything is correctly configured by attempting to connect to the remote host via the `root` user. Using the above example once again:

```
$ su - -c 'ssh stack@cld6b16'
```

Instance errors

Problem

Sometimes a particular instance shows `pending` or you cannot SSH to it. Sometimes the image itself is the problem. For example, when you use flat manager networking, you do not have a DHCP server and certain images do not support interface injection; you cannot connect to them.

Solution

To fix instance errors use an image that does support this method, such as Ubuntu, which obtains an IP address correctly with FlatManager network settings.

To troubleshoot other possible problems with an instance, such as an instance that stays in a spawning state, check the directory for the particular instance under `/var/lib/nova/instances` on the `nova-compute` host and make sure that these files are present:

- `libvirt.xml`
- `disk`
- `disk-raw`
- `kernel`
- `ramdisk`
- `console.log`, after the instance starts.

If any files are missing, empty, or very small, the `nova-compute` service did not successfully download the images from the Image service.

Also check `nova-compute.log` for exceptions. Sometimes they do not appear in the console output.

Next, check the log file for the instance in the `/var/log/libvirt/qemu` directory to see if it exists and has any useful error messages in it.

Finally, from the `/var/lib/nova/instances` directory for the instance, see if this command returns an error:

```
# virsh create libvirt.xml
```

Empty log output for Linux instances

Problem

You can view the log output of running instances from either the *Log* tab of the dashboard or the output of **`nova console-log`**. In some cases, the log output of a running Linux instance will be empty or only display a single character (for example, the `?` character).

This occurs when the Compute service attempts to retrieve the log output of the instance via a serial console while the instance itself is not configured to send output to the console.

Solution

To rectify this, append the following parameters to kernel arguments specified in the instances boot loader:

```
console=tty0 console=ttyS0,115200n8
```

Upon rebooting, the instance will be configured to send output to the Compute service.

Reset the state of an instance

Problem

Instances can remain in an intermediate state, such as `deleting`.

Solution

You can use the **`nova reset-state`** command to manually reset the state of an instance to an error state. You can then delete the instance. For example:

```
$ nova reset-state c6bbbf26-b40a-47e7-8d5c-eb17bf65c485
$ openstack server delete c6bbbf26-b40a-47e7-8d5c-eb17bf65c485
```

You can also use the `--active` parameter to force the instance back to an active state instead of an error state. For example:

```
$ nova reset-state --active c6bbbf26-b40a-47e7-8d5c-eb17bf65c485
```

Injection problems

Problem

Instances may boot slowly, or do not boot. File injection can cause this problem.

Solution

To disable injection in libvirt, set the following in `nova.conf`:

```
[libvirt]
inject_partition = -2
```

Note

If you have not enabled the config drive and you want to make user-specified files available from the metadata server for to improve performance and avoid boot failure if injection fails, you must disable injection.

Cannot find suitable emulator for x86_64

Problem

When you attempt to create a VM, the error shows the VM is in the `BUILD` then `ERROR` state.

Solution

On the KVM host, run **`cat /proc/cpuinfo`**. Make sure the `vmx` or `svm` flags are set.

Follow the instructions in the *Enable KVM* section in the Nova Configuration Reference to enable hardware virtualization support in your BIOS.

Failed to attach volume after detaching

Problem

Failed to attach a volume after detaching the same volume.

Solution

You must change the device name on the **`nova-attach`** command. The VM might not clean up after a **`nova-detach`** command runs. This example shows how the **`nova-attach`** command fails when you use the `vdb`, `vdc`, or `vdd` device names:

```
# ls -al /dev/disk/by-path/
total 0
drwxr-xr-x 2 root root 200 2012-08-29 17:33 .
drwxr-xr-x 5 root root 100 2012-08-29 17:33 ..
lrwxrwxrwx 1 root root 9 2012-08-29 17:33 pci-0000:00:04.0-virtio-pci-virtio0␣
↪-> ../../vda
lrwxrwxrwx 1 root root 10 2012-08-29 17:33 pci-0000:00:04.0-virtio-pci-
↪virtio0-part1 -> ../../vda1
lrwxrwxrwx 1 root root 10 2012-08-29 17:33 pci-0000:00:04.0-virtio-pci-
↪virtio0-part2 -> ../../vda2
lrwxrwxrwx 1 root root 10 2012-08-29 17:33 pci-0000:00:04.0-virtio-pci-
↪virtio0-part5 -> ../../vda5
lrwxrwxrwx 1 root root 9 2012-08-29 17:33 pci-0000:00:06.0-virtio-pci-virtio2␣
↪-> ../../vdb
lrwxrwxrwx 1 root root 9 2012-08-29 17:33 pci-0000:00:08.0-virtio-pci-virtio3␣
↪-> ../../vdc
lrwxrwxrwx 1 root root 9 2012-08-29 17:33 pci-0000:00:09.0-virtio-pci-virtio4␣
↪-> ../../vdd
lrwxrwxrwx 1 root root 10 2012-08-29 17:33 pci-0000:00:09.0-virtio-pci-
↪virtio4-part1 -> ../../vdd1
```

You might also have this problem after attaching and detaching the same volume from the same VM with the same mount point multiple times. In this case, restart the KVM host.

Failed to attach volume, systool is not installed

Problem

This warning and error occurs if you do not have the required `sysfsutils` package installed on the compute node:

```
WARNING nova.virt.libvirt.utils [req-1200f887-c82b-4e7c-a891-fac2e3735dbb\
admin admin|req-1200f887-c82b-4e7c-a891-fac2e3735dbb admin admin] systool\
```

(continues on next page)

(continued from previous page)

```
is not installed
ERROR nova.compute.manager [req-1200f887-c82b-4e7c-a891-fac2e3735dbb admin\
admin|req-1200f887-c82b-4e7c-a891-fac2e3735dbb admin admin]
[instance: df834b5a-8c3f-477a-be9b-47c97626555c|instance: df834b5a-8c3f-47\
7a-be9b-47c97626555c]
Failed to attach volume 13d5c633-903a-4764-a5a0-3336945b1db1 at /dev/vdk.
```

Solution

Install the `sysfsutils` package on the compute node. For example:

```
# apt-get install sysfsutils
```

Failed to connect volume in FC SAN

Problem

The compute node failed to connect to a volume in a Fibre Channel (FC) SAN configuration. The WWN may not be zoned correctly in your FC SAN that links the compute host to the storage array:

```
ERROR nova.compute.manager [req-2ddd5297-e405-44ab-aed3-152cd2cfb8c2 admin\
demo|req-2ddd5297-e405-44ab-aed3-152cd2cfb8c2 admin demo] [instance: 60ebd\
6c7-c1e3-4bf0-8ef0-f07aa4c3d5f3|instance: 60ebd6c7-c1e3-4bf0-8ef0-f07aa4c3\
d5f3]
Failed to connect to volume 6f6a6a9c-dfcf-4c8d-b1a8-4445ff883200 while\
attaching at /dev/vdjTRACE nova.compute.manager [instance: 60ebd6c7-c1e3-4\
bf0-8ef0-f07aa4c3d5f3|instance: 60ebd6c7-c1e3-4bf0-8ef0-f07aa4c3d5f3]
Traceback (most recent call last):...f07aa4c3d5f3\] ClientException: The\
server has either erred or is incapable of performing the requested\
operation.(HTTP 500)(Request-ID: req-71e5132b-21aa-46ee-b3cc-19b5b4ab2f00)
```

Solution

The network administrator must configure the FC SAN fabric by correctly zoning the WWN (port names) from your compute node HBAs.

Multipath call failed exit

Problem

Multipath call failed exit. This warning occurs in the Compute log if you do not have the optional `multipath-tools` package installed on the compute node. This is an optional package and the volume attachment does work without the multipath tools installed. If the `multipath-tools` package is installed on the compute node, it is used to perform the volume attachment. The IDs in your message are unique to your system.

```
WARNING nova.storage.linuxscsi [req-cac861e3-8b29-4143-8f1b-705d0084e571 \
admin admin|req-cac861e3-8b29-4143-8f1b-705d0084e571 admin admin] \
Multipath call failed exit (96)
```

Solution

Install the `multipath-tools` package on the compute node. For example:

```
# apt-get install multipath-tools
```

Failed to Attach Volume, Missing sg_scan

Problem

Failed to attach volume to an instance, `sg_scan` file not found. This error occurs when the sg3-utils package is not installed on the compute node. The IDs in your message are unique to your system:

```
ERROR nova.compute.manager [req-cf2679fd-dd9e-4909-807f-48fe9bda3642 admin␣
↪admin|req-cf2679fd-dd9e-4909-807f-48fe9bda3642 admin admin]
[instance: 7d7c92e0-49fa-4a8e-87c7-73f22a9585d5|instance:  7d7c92e0-49fa-4a8e-
↪87c7-73f22a9585d5]
Failed to attach volume  4cc104c4-ac92-4bd6-9b95-c6686746414a at /dev/
↪vdcTRACE nova.compute.manager
[instance:  7d7c92e0-49fa-4a8e-87c7-73f22a9585d5|instance: 7d7c92e0-49fa-4a8e-
↪87c7-73f22a9585d5]
Stdout: '/usr/local/bin/nova-rootwrap: Executable not found: /usr/bin/sg_scan'
```

Solution

Install the `sg3-utils` package on the compute node. For example:

```
# apt-get install sg3-utils
```

Requested microversions are ignored

Problem

When making a request with a microversion beyond 2.1, for example:

```
$ openstack --os-compute-api-version 2.15 server group create \
  --policy soft-anti-affinity my-soft-anti-group
```

It fails saying that soft-anti-affinity is not a valid policy, even thought it is allowed with the 2.15 microversion.

Solution

Ensure the `compute` endpoint in the identity service catalog is pointing at `/v2.1` instead of `/v2`. The former route supports microversions, while the latter route is considered the legacy v2.0 compatibility-mode route which renders all requests as if they were made on the legacy v2.0 API.

Evacuate instances

If a hardware malfunction or other error causes a cloud compute node to fail, you can evacuate instances to make them available again.

To preserve user data on the server disk, configure shared storage on the target host. When you evacuate the instance, Compute detects whether shared storage is available on the target host. Also, you must validate that the current VM host is not operational. Otherwise, the evacuation fails.

There are two different ways to evacuate instances from a failed compute node. The first one using the **`nova evacuate`** command can be used to evacuate a single instance from a failed node. In some cases where the node in question hosted many instances it might be easier to use **`nova host-evacuate`** to evacuate them all in one shot.

Evacuate a single instance

The procedure below explains how to evacuate a single instance from a failed compute node. Please be aware that these steps describe a post failure scenario and should not be used if the instance is still up and running.

1. To find a host for the evacuated instance, list all hosts:

   ```
   $ openstack host list
   ```

2. Evacuate the instance. You can use the `--password PWD` option to pass the instance password to the command. If you do not specify a password, the command generates and prints one after it finishes successfully. The following command evacuates a server from a failed host to `HOST_B`.

   ```
   $ nova evacuate EVACUATED_SERVER_NAME HOST_B
   ```

   The command rebuilds the instance from the original image or volume and returns a password. The command preserves the original configuration, which includes the instance ID, name, uid, IP address, and so on.

   ```
   +-----------+--------------+
   | Property  |    Value     |
   +-----------+--------------+
   | adminPass | kRAJpErnT4xZ |
   +-----------+--------------+
   ```

   Optionally you can omit the `HOST_B` parameter and let the scheduler choose a new target host.

3. To preserve the user disk data on the evacuated server, deploy Compute with a shared file system. To configure your system, see *Configure live migrations*. The following example does not change the password.

   ```
   $ nova evacuate EVACUATED_SERVER_NAME HOST_B --on-shared-storage
   ```

   Note

   Starting with the 2.14 compute API version, one no longer needs to specify `--on-shared-storage` even if the server is on a compute host which is using shared storage. The compute service will automatically detect if it is running on shared storage.

Evacuate all instances

The procedure below explains how to evacuate all instances from a failed compute node. Please note that this method should not be used if the host still has instances up and running.

1. To find a host for the evacuated instances, list all hosts:

```
$ openstack host list
```

2. Evacuate all instances from `FAILED_HOST` to `TARGET_HOST`:

```
$ nova host-evacuate --target_host TARGET_HOST FAILED_HOST
```

   The option `--target_host` is optional and can be omitted to let the scheduler decide where to place the instances.

   The above argument `FAILED_HOST` can also be a pattern to search for instead of an exact hypervisor hostname but it is recommended to use a fully qualified domain name to make sure no hypervisor host is getting evacuated by mistake. As long as you are not using a pattern you might want to use the `--strict` flag which got introduced in version 10.2.0 to make sure nova matches the `FAILED_HOST` exactly.

Note

```
+------+--------+--------------+
| Name | Status | Task State   |
+------+--------+--------------+
| vm_1 | ACTIVE | powering-off |
+------+--------+--------------+
```

If the instance task state is not None, evacuation will be possible. However, depending on the ongoing operation, there may be clean up required in other services which the instance was using, such as neutron, cinder, glance, or the storage backend.

Migrate instances

Note

This documentation is about cold migration. For live migration usage, see *Live-migrate instances*.

When you want to move an instance from one compute host to another, you can migrate the instance. The migration operation, which is also known as the cold migration operation to distinguish it from the live migration operation, functions similarly to *the resize operation* with the main difference being that a cold migration does not change the flavor of the instance. As with resize, the scheduler chooses the destination compute host based on its settings. This process does not assume that the instance has shared storage available on the target host. If you are using SSH tunneling, you must ensure that each node is configured with SSH key authentication so that the Compute service can use SSH to move disks to other nodes. For more information, see *Configure SSH between compute nodes*.

To list the VMs you want to migrate, run:

```
$ openstack server list
```

Once you have the name or UUID of the server you wish to migrate, migrate it using the **openstack server migrate** command:

```
$ openstack server migrate SERVER
```

Once an instance has successfully migrated, you can use the **openstack server migrate confirm** command to confirm it:

```
$ openstack server migrate confirm SERVER
```

Alternatively, you can use the **openstack server migrate revert** command to revert the migration and restore the instance to its previous host:

```
$ openstack server migrate revert SERVER
```

Note

You can configure automatic confirmation of migrations and resizes. Refer to the *resize_confirm_window* option for more information.

Example

To migrate an instance and watch the status, use this example script:

```
#!/bin/bash

# Provide usage
usage() {
    echo "Usage: $0 VM_ID"
    exit 1
}

[[ $# -eq 0 ]] && usage
VM_ID=$1

# Show the details for the VM
echo "Instance details:"
openstack server show ${VM_ID}

# Migrate the VM to an alternate hypervisor
echo -n "Migrating instance to alternate host "
openstack server migrate ${VM_ID}
while [[ "$(openstack server show ${VM_ID} -f value -c status)" != "VERIFY_
↪RESIZE" ]]; do
    echo -n "."
    sleep 2
done
openstack server migrate confirm ${VM_ID}
```

(continues on next page)

(continued from previous page)

```
echo " instance migrated and resized."

# Show the details for the migrated VM
echo "Migrated instance details:"
openstack server show ${VM_ID}

# Pause to allow users to examine VM details
read -p "Pausing, press <enter> to exit."
```

Note

If you see the following error, it means you are either running the command with the wrong credentials, such as a non-admin user, or the `policy.yaml` file prevents migration for your user:

```
Policy doesn't allow os_compute_api:os-migrate-server:migrate to be␣
↪performed. (HTTP 403)
```

Note

If you see the following error, similar to this message, SSH tunneling was not set up between the compute nodes:

```
ProcessExecutionError: Unexpected error while running command.
Stderr: u Host key verification failed.\r\n
```

The instance is booted from a new host, but preserves its configuration including instance ID, name, IP address, any metadata, and other properties.

Use snapshots to migrate instances

This guide can be used to migrate an instance between different clouds.

To use snapshots to migrate instances from OpenStack projects to clouds, complete these steps.

In the source project:

1. *Create a snapshot of the instance*
2. *Download the snapshot as an image*

In the destination project:

1. *Import the snapshot to the new environment*
2. *Boot a new instance from the snapshot*

Note

Some cloud providers allow only administrators to perform this task.

Create a snapshot of the instance

1. Shut down the source VM before you take the snapshot to ensure that all data is flushed to disk. If necessary, list the instances to view the instance name:

```
$ openstack server list
+--------------------------------------+------------+--------+------------
↪------+--------------------+-------------------------+
| ID                                   | Name       | Status | Networks  ␣
↪      | Image              | Flavor                  |
+--------------------------------------+------------+--------+------------
↪------+--------------------+-------------------------+
| d0d1b7d9-a6a5-41d3-96ab-07975aadd7fb | myInstance | ACTIVE | private=10.
↪0.0.3 | ubuntu-16.04-amd64 | general.micro.tmp.linux |
+--------------------------------------+------------+--------+------------
↪------+--------------------+-------------------------+
```

2. Use the **openstack server stop** command to shut down the instance:

```
$ openstack server stop myInstance
```

3. Use the **openstack server list** command to confirm that the instance shows a SHUTOFF status:

```
$ openstack server list
+--------------------------------------+------------+---------+-----------
↪-------+--------------------+-------------------------+
| ID                                   | Name       | Status  | Networks ␣
↪       | Image              | Flavor                  |
+--------------------------------------+------------+---------+-----------
↪-------+--------------------+-------------------------+
| d0d1b7d9-a6a5-41d3-96ab-07975aadd7fb | myInstance | SHUTOFF |␣
↪private=10.0.0.3 | ubuntu-16.04-amd64 | general.micro.tmp.linux |
+--------------------------------------+------------+---------+-----------
↪-------+--------------------+-------------------------+
```

4. Use the **openstack server image create** command to take a snapshot:

```
$ openstack server image create --name myInstanceSnapshot myInstance
```

   If snapshot operations routinely fail because the user token times out while uploading a large disk image, consider configuring nova to use *service user tokens*.

5. Use the **openstack image list** command to check the status until the status is ACTIVE:

```
$ openstack image list
+--------------------------------------+-------------------------+------
↪--+
| ID                                   | Name                    |␣
↪Status |
+--------------------------------------+-------------------------+------
↪--+
| ab567a44-b670-4d22-8ead-80050dfcd280 | myInstanceSnapshot      |␣
```

(continues on next page)

(continued from previous page)

```
↪active |
+--------------------------------------+----------------------------+------
↪--+
```

Download the snapshot as an image

1. Get the image ID:

```
$ openstack image list
+--------------------------------------+----------------------------+------
↪--+
| ID                                   | Name                       |␣
↪Status |
+--------------------------------------+----------------------------+------
↪--+
| ab567a44-b670-4d22-8ead-80050dfcd280 | myInstanceSnapshot         |␣
↪active |
+--------------------------------------+----------------------------+------
↪--+
```

2. Download the snapshot by using the image ID that was returned in the previous step:

```
$ openstack image save --file snapshot.raw ab567a44-b670-4d22-8ead-
↪80050dfcd280
```

> **Note**
>
> The **`openstack image save`** command requires the image ID and cannot use the image name. Check there is sufficient space on the destination file system for the image file.

3. Make the image available to the new environment, either through HTTP or direct upload to a machine (`scp`).

Import the snapshot to the new environment

In the new project or cloud environment, import the snapshot:

```
$ openstack image create --container-format bare --disk-format qcow2 \
  --file snapshot.raw myInstanceSnapshot
```

Boot a new instance from the snapshot

In the new project or cloud environment, use the snapshot to create the new instance:

```
$ openstack server create --flavor m1.tiny --image myInstanceSnapshot␣
↪myNewInstance
```

Upgrades

Nova aims to provide upgrades with minimal downtime.

Firstly, the data plane. There should be no VM downtime when you upgrade Nova. Nova has had this since the early days.

Secondly, we want no downtime during upgrades of the Nova control plane. This document is trying to describe how we can achieve that.

Once we have introduced the key concepts relating to upgrade, we will introduce the process needed for a no downtime upgrade of nova.

Minimal Downtime Upgrade Process

Plan your upgrade

- Read and ensure you understand the release notes for the next release.
- You should ensure all required steps from the previous upgrade have been completed, such as data migrations.
- Make a backup of your database. Nova does not support downgrading of the database. Hence, in case of upgrade failure, restoring database from backup is the only choice.
- During upgrade be aware that there will be additional load on nova-conductor. You may find you need to add extra nova-conductor workers to deal with the additional upgrade related load.

Rolling upgrade process

To reduce downtime, the compute services can be upgraded in a rolling fashion. It means upgrading a few services at a time. This results in a condition where both old (N) and new (N+1) nova-compute services co-exist for a certain time period (or even N with N+2 upgraded nova-compute services, see below). Note that, there is no upgrade of the hypervisor here, this is just upgrading the nova services. If reduced downtime is not a concern (or lower complexity is desired), all services may be taken down and restarted at the same time.

Important

As of OpenStack 2023.1 (Antelope), Nova supports the coexistence of N and N-2 (Yoga) **`nova-compute`** or **`nova-conductor`** services in the same deployment. The `nova-conductor` service will fail to start when a `nova-compute` service that is older than the support envelope is detected. This varies by release and the support envelope will be explained in the release notes. Similarly, in a *deployment with multiple cells*, neither the super conductor service nor any per-cell conductor service will start if any other conductor service in the deployment is older than the N-2 release.

Releases older than 2023.1 will only support rolling upgrades for a single release difference between **`nova-compute`** and **`nova-conductor`** services.

1. Before maintenance window:
   - Start the process with the controller node. Install the code for the next version of Nova, either in a venv or a separate control plane node, including all the python dependencies.
   - Using the newly installed nova code, run the DB sync. First run `nova-manage api_db sync`, then `nova-manage db sync`. `nova-manage db sync` should be run for all cell

databases, including `cell0`. If necessary, the `--config-file` argument can be used to point to the correct `nova.conf` file for the given cell.

These schema change operations should have minimal or no effect on performance, and should not cause any operations to fail.

- At this point, new columns and tables may exist in the database. These DB schema changes are done in a way that both the N and N+1 release can perform operations against the same schema.

2. During maintenance window:

   - Several nova services rely on the external placement service being at the latest level. Therefore, you must upgrade placement before any nova services. See the placement upgrade notes for more details on upgrading the placement service.
   - For maximum safety (no failed API operations), gracefully shutdown all the services (i.e. SIG_TERM) except nova-compute.
   - Before restarting services with new code, perform the release-specific readiness check with `nova-status upgrade check`. See the *nova-status upgrade check* for more details on status check.
   - Start all services on the new code, with `[upgrade_levels]compute=auto` in nova.conf. It is safest to start nova-conductor first and nova-api last. Note that you may use a static alias name instead of `auto`, such as `[upgrade_levels]compute=<release_name>`. Also note that this step is only required if compute services are not upgraded in lock-step with the control services.
   - If desired, gracefully shutdown nova-compute (i.e. SIG_TERM) services in small batches, then start the new version of the code with: `[upgrade_levels]compute=auto`. If this batch-based approach is used, only a few compute nodes will have any delayed API actions, and to ensure there is enough capacity online to service any boot requests that happen during this time.

3. After maintenance window:

   - Once all services are running the new code, double check in the DB that there are no old orphaned service records using `nova service-list`.
   - Now that all services are upgraded, we need to send the SIG_HUP signal, so all the services clear any cached service version data. When a new service starts, it automatically detects which version of the compute RPC protocol to use, and it can decide if it is safe to do any online data migrations. Note, if you used a static value for the upgrade_level, such as `[upgrade_levels]compute=<release_name>`, you must update nova.conf to remove that configuration value and do a full service restart.
   - Now all the services are upgraded and signaled, the system is able to use the latest version of the RPC protocol and can access all of the features in the new release.
   - Once all the services are running the latest version of the code, and all the services are aware they all have been upgraded, it is safe to transform the data in the database into its new format. While some of this work happens on demand when the system reads a database row that needs updating, we must get all the data transformed into the current version before the next upgrade. Additionally, some data may not be transformed automatically so performing the data migration is necessary to avoid performance degradation due to compatibility routines.

- This process can put significant extra write load on the database. Complete all online data migrations using: `nova-manage db online_data_migrations --max-count <number>`. Note that you can use the `--max-count` argument to reduce the load this operation will place on the database, which allows you to run a small chunk of the migrations until all of the work is done. The chunk size you should use depends on your infrastructure and how much additional load you can impose on the database. To reduce load, perform smaller batches with delays between chunks. To reduce time to completion, run larger batches. Each time it is run, the command will show a summary of completed and remaining records. If using the `--max-count` option, the command should be rerun while it returns exit status 1 (which indicates that some migrations took effect, and more work may remain to be done), even if some migrations produce errors. If all possible migrations have completed and some are still producing errors, exit status 2 will be returned. In this case, the cause of the errors should be investigated and resolved. Migrations should be considered successfully completed only when the command returns exit status 0.
- At this point, you must also ensure you update the configuration, to stop using any deprecated features or options, and perform any required work to transition to alternative features. All deprecated options are supported for at least one cycle, but should be removed before your next upgrade is performed.

Current Database Upgrade Types

Currently Nova has two types of database upgrades that are in use.

- Schema Migrations
- Data Migrations

Nova does not support database downgrades.

Schema Migrations

Schema migrations are defined in `nova/db/main/migrations/versions` and `nova/db/api/migrations/versions`. They are the routines that transform our database structure, which should be additive and able to be applied to a running system before service code has been upgraded.

For information on developing your own schema migrations as part of a feature or bugfix, refer to *Database migrations*.

Note

The API database migrations should be assumed to run before the migrations for the main/cell databases. This is because the former contains information about how to find and connect to the latter. Some management commands that operate on multiple cells will attempt to list and iterate over cell mapping records, which require a functioning API database schema.

Data Migrations

Online data migrations occur in two places:

1. Inline migrations that occur as part of normal run-time activity as data is read in the old format and written in the new format

2. Background online migrations that are performed using `nova-manage` to complete transformations that will not occur incidentally due to normal runtime activity.

An example of online data migrations are the flavor migrations done as part of Nova object version 1.18. This included a transient migration of flavor storage from one database location to another.

For information on developing your own schema migrations as part of a feature or bugfix, refer to *Database migrations*.

Migration policy

The following guidelines for schema and data migrations are followed in order to ease upgrades:

- Additive schema migrations - In general, almost all schema migrations should be additive. Put simply, they should only create elements like columns, indices, and tables.
- Subtractive schema migrations - To remove an element like a column or table during the N release cycle:
  1. The element must be deprecated and retained for backward compatibility. (This allows for graceful upgrade from N to N+1.)
  2. Data migration, by the objects layer, must completely migrate data from the old version of the schema to the new version.
  3. The column can then be removed with a migration at the start of N+2.
- All schema migrations should be idempotent. For example, a migration should check if an element exists in the schema before attempting to add it. This logic comes for free in the autogenerated workflow of the online migrations.
- Constraints - When adding a foreign or unique key constraint, the schema migration code needs to handle possible problems with data before applying the constraint. (Example: A unique constraint must clean up duplicate records before applying said constraint.)
- Data migrations - As mentioned above, data migrations will be done in an online fashion by custom code in the object layer that handles moving data between the old and new portions of the schema. In addition, for each type of data migration performed, there should exist a nova-manage option for an operator to manually request that rows be migrated.

Concepts

Here are the key concepts you need to know before reading the section on the upgrade process:

RPC version pinning
Through careful RPC versioning, newer nodes are able to talk to older nova-compute nodes. When upgrading control plane nodes, we can pin them at an older version of the compute RPC API, until all the compute nodes are able to be upgraded. https://wiki.openstack.org/wiki/RpcMajorVersionUpdates

> **Note**
>
> The procedure for rolling upgrades with multiple cells v2 cells is not yet determined.

Online Configuration Reload
During the upgrade, we pin new serves at the older RPC version. When all services are updated

to use newer code, we need to unpin them so we are able to use any new functionality. To avoid having to restart the service, using the current SIGHUP signal handling, or otherwise, ideally we need a way to update the currently running process to use the latest configuration.

Graceful service shutdown

Many nova services are python processes listening for messages on a AMQP queue, including nova-compute. When sending the process the SIGTERM the process stops getting new work from its queue, completes any outstanding work, then terminates. During this process, messages can be left on the queue for when the python process starts back up. This gives us a way to shutdown a service using older code, and start up a service using newer code with minimal impact. If its a service that can have multiple workers, like nova-conductor, you can usually add the new workers before the graceful shutdown of the old workers. In the case of singleton services, like nova-compute, some actions could be delayed during the restart, but ideally no actions should fail due to the restart.

> **Note**
>
> While this is true for the RabbitMQ RPC backend, we need to confirm what happens for other RPC backends.

API load balancer draining

When upgrading API nodes, you can make your load balancer only send new connections to the newer API nodes, allowing for a seamless update of your API nodes.

Expand/Contract DB Migrations

Modern databases are able to make many schema changes while you are still writing to the database. Taking this a step further, we can make all DB changes by first adding the new structures, expanding. Then you can slowly move all the data into a new location and format. Once that is complete, you can drop bits of the scheme that are no long needed, i.e. contract. This happens multiple cycles after we have stopped using a particular piece of schema, and can happen in a schema migration without affecting runtime code.

Online Data Migrations using objects

Since Kilo, we have moved all data migration into the DB objects code. When trying to migrate data in the database from the old format to the new format, this is done in the object code when reading or saving things that are in the old format. For records that are not updated, you need to run a background process to convert those records into the newer format. This process must be completed before you contract the database schema.

DB prune deleted rows

Currently resources are soft deleted in the main database, so users are able to track instances in the DB that are created and destroyed in production. However, most people have a data retention policy, of say 30 days or 90 days after which they will want to delete those entries. Not deleting those entries affects DB performance as indices grow very large and data migrations take longer as there is more data to migrate.

nova-conductor object backports

RPC pinning ensures new services can talk to the older services method signatures. But many of the parameters are objects that may well be too new for the old service to understand, so you are able to send the object back to the nova-conductor to be downgraded to a version the older service can understand.

Testing

We use the grenade jobs to test upgrades. The current tests only cover the existing upgrade process where old computes can run with new control plane but control plane is turned off for DB migrations.

Recover from a failed compute node

If you deploy Compute with a shared file system, you can use several methods to quickly recover from a node failure. This section discusses manual recovery.

Evacuate instances

If a hardware malfunction or other error causes the cloud compute node to fail, you can use the **nova evacuate** command to evacuate instances. See *evacuate instances* for more information on using the command.

Manual recovery

To manually recover a failed compute node:

1. Identify the VMs on the affected hosts by using a combination of the **openstack server list** and **openstack server show** commands.
2. Query the Compute database for the status of the host. This example converts an EC2 API instance ID to an OpenStack ID. If you use the **nova** commands, you can substitute the ID directly. This example output is truncated:

```
mysql> SELECT * FROM instances WHERE id = CONV('15b9', 16, 10) \G;
*************************** 1. row ***************************
created_at: 2012-06-19 00:48:11
updated_at: 2012-07-03 00:35:11
deleted_at: NULL
...
id: 5561
...
power_state: 5
vm_state: shutoff
...
hostname: at3-ui02
host: np-rcc54
...
uuid: 3f57699a-e773-4650-a443-b4b37eed5a06
...
task_state: NULL
...
```

> **Note**
>
> Find the credentials for your database in `/etc/nova.conf` file.

3. Decide to which compute host to move the affected VM. Run this database command to move the VM to that host:

```
mysql> UPDATE instances SET host = 'np-rcc46' WHERE uuid = '3f57699a-e773-
↪4650-a443-b4b37eed5a06';
```

4. If you use a hypervisor that relies on libvirt, such as KVM, update the `libvirt.xml` file in `/var/lib/nova/instances/[instance ID]` with these changes:
   - Change the `DHCPSERVER` value to the host IP address of the new compute host.
   - Update the VNC IP to `0.0.0.0`.
5. Reboot the VM:

```
$ openstack server reboot 3f57699a-e773-4650-a443-b4b37eed5a06
```

Typically, the database update and **`openstack server reboot`** command recover a VM from a failed host. However, if problems persist, try one of these actions:

- Use **`virsh`** to recreate the network filter configuration.
- Restart Compute services.
- Update the `vm_state` and `power_state` fields in the Compute database.

Recover from a UID/GID mismatch

Sometimes when you run Compute with a shared file system or an automated configuration tool, files on your compute node might use the wrong UID or GID. This UID or GID mismatch can prevent you from running live migrations or starting virtual machines.

This procedure runs on `nova-compute` hosts, based on the KVM hypervisor:

1. Set the nova UID to the same number in `/etc/passwd` on all hosts. For example, set the UID to `112`.

   Note

   Choose UIDs or GIDs that are not in use for other users or groups.

2. Set the `libvirt-qemu` UID to the same number in the `/etc/passwd` file on all hosts. For example, set the UID to `119`.
3. Set the `nova` group to the same number in the `/etc/group` file on all hosts. For example, set the group to `120`.
4. Set the `libvirtd` group to the same number in the `/etc/group` file on all hosts. For example, set the group to `119`.
5. Stop the services on the compute node.
6. Change all files that the nova user or group owns. For example:

```
# find / -uid 108 -exec chown nova {} \;
# note the 108 here is the old nova UID before the change
# find / -gid 120 -exec chgrp nova {} \;
```

7. Repeat all steps for the `libvirt-qemu` files, if required.

8. Restart the services.
9. To verify that all files use the correct IDs, run the **find** command.

Recover cloud after disaster

This section describes how to manage your cloud after a disaster and back up persistent storage volumes. Backups are mandatory, even outside of disaster scenarios.

For a definition of a disaster recovery plan (DRP), see https://en.wikipedia.org/wiki/Disaster_Recovery_Plan.

A disk crash, network loss, or power failure can affect several components in your cloud architecture. The worst disaster for a cloud is a power loss. A power loss affects these components:

- A cloud controller (`nova-api`, `nova-conductor`, `nova-scheduler`)
- A compute node (`nova-compute`)
- A storage area network (SAN) used by OpenStack Block Storage (`cinder-volumes`)

Before a power loss:

- Create an active iSCSI session from the SAN to the cloud controller (used for the `cinder-volumes` LVMs VG).
- Create an active iSCSI session from the cloud controller to the compute node (managed by `cinder-volume`).
- Create an iSCSI session for every volume (so 14 EBS volumes requires 14 iSCSI sessions).
- Create `iptables` or `ebtables` rules from the cloud controller to the compute node. This allows access from the cloud controller to the running instance.
- Save the current state of the database, the current state of the running instances, and the attached volumes (mount point, volume ID, volume status, etc), at least from the cloud controller to the compute node.

After power resumes and all hardware components restart:

- The iSCSI session from the SAN to the cloud no longer exists.
- The iSCSI session from the cloud controller to the compute node no longer exists.
- Instances stop running.

  Instances are not lost because neither `destroy` nor `terminate` ran. The files for the instances remain on the compute node.
- The database does not update.

Begin recovery

Warning

Do not add any steps or change the order of steps in this procedure.

1. Check the current relationship between the volume and its instance, so that you can recreate the attachment.

Use the **openstack volume list** command to get this information. Note that the **openstack** client can get volume information from OpenStack Block Storage.

2. Update the database to clean the stalled state. Do this for every volume by using these queries:

```
mysql> use cinder;
mysql> update volumes set mountpoint=NULL;
mysql> update volumes set status="available" where status <>"error_
↪deleting";
mysql> update volumes set attach_status="detached";
mysql> update volumes set instance_id=0;
```

Use **openstack volume list** command to list all volumes.

3. Restart the instances by using the **openstack server reboot INSTANCE** command.

Important

Some instances completely reboot and become reachable, while some might stop at the plymouth stage. This is expected behavior. DO NOT reboot a second time.

Instance state at this stage depends on whether you added an `/etc/fstab` entry for that volume. Images built with the cloud-init package remain in a `pending` state, while others skip the missing volume and start. You perform this step to ask Compute to reboot every instance so that the stored state is preserved. It does not matter if not all instances come up successfully. For more information about cloud-init, see help.ubuntu.com/community/CloudInit/.

4. If required, run the **openstack server add volume** command to reattach the volumes to their respective instances. This example uses a file of listed volumes to reattach them:

```
#!/bin/bash

while read line; do
    volume=`echo $line | $CUT -f 1 -d " "`
    instance=`echo $line | $CUT -f 2 -d " "`
    mount_point=`echo $line | $CUT -f 3 -d " "`
        echo "ATTACHING VOLUME FOR INSTANCE - $instance"
    openstack server add volume $instance $volume $mount_point
    sleep 2
done < $volumes_tmp_file
```

Instances that were stopped at the plymouth stage now automatically continue booting and start normally. Instances that previously started successfully can now see the volume.

5. Log in to the instances with SSH and reboot them.

If some services depend on the volume or if a volume has an entry in fstab, you can now restart the instance. Restart directly from the instance itself and not through **nova**:

```
# shutdown -r now
```

When you plan for and complete a disaster recovery, follow these tips:

- Use the `errors=remount` option in the `fstab` file to prevent data corruption.

In the event of an I/O error, this option prevents writes to the disk. Add this configuration option into the cinder-volume server that performs the iSCSI connection to the SAN and into the instances `fstab` files.

- Do not add the entry for the SANs disks to the cinder-volumes `fstab` file.

  Some systems hang on that step, which means you could lose access to your cloud-controller. To re-run the session manually, run this command before performing the mount:

```
# iscsiadm -m discovery -t st -p $SAN_IP $ iscsiadm -m node --
↪target-name $IQN -p $SAN_IP -l
```

- On your instances, if you have the whole `/home/` directory on the disk, leave a users directory with the users bash files and the `authorized_keys` file instead of emptying the `/home/` directory and mapping the disk on it.

  This action enables you to connect to the instance without the volume attached, if you allow only connections through public keys.

To reproduce the power loss, connect to the compute node that runs that instance and close the iSCSI session. Do not detach the volume by using the **`openstack server remove volume`** command. You must manually close the iSCSI session. This example closes an iSCSI session with the number `15`:

```
# iscsiadm -m session -u -r 15
```

Do not forget the `-r` option. Otherwise, all sessions close.

Warning

There is potential for data loss while running instances during this procedure. If you are using Liberty or earlier, ensure you have the correct patch and set the options appropriately.

hw_machine_type - Configuring and updating QEMU instance machine types

Added in version 12.0.0: (Liberty)

Changed in version 23.0.0: (Wallaby)

The libvirt driver now records the machine type of an instance at start up allowing the `[libvirt]hw_machine_type` configurable to change over time without impacting existing instances.

Added `nova-manage` commands to control the machine_type of an instance.

Changed in version 25.0.0: (Yoga)

Added `nova-manage` commands to set the image properties of an instance.

Note

The following only applies to environments using libvirt compute hosts.

Introduction

QEMUs machine type concept can be thought of as a virtual chipset that provides certain default devices (e.g. PCIe graphics card, Ethernet controller, SATA controller, etc). QEMU supports two main variants of machine type for x86 hosts: (a) `pc`, which corresponds to Intels I440FX chipset (released in 1996) and (b) `q35`, which corresponds to Intels 82Q35 chipset (released in 2007). For AArch64 hosts, the machine type is called: `virt`.

The `pc` machine type is considered legacy, and does not support many modern features. Although at this time of writing, upstream QEMU has not reached an agreement to remove new versioned variants of the `pc` machine type, some long-term stable Linux distributions (CentOS, RHEL, possibly others) are moving to support `q35` only.

Configure

For end users the machine type of an instance is controlled by the selection of an image with the hw_machine_type image metadata property set.

```
$ openstack image set --property hw_machine_type=q35 $IMAGE
```

The libvirt virt driver supports the configuration of a per compute host default machine type via the *`libvirt.hw_machine_type`* option. Providing a default machine type per host architecture to be used when no corresponding `hw_machine_type` image property is provided for the instance.

When this option is not defined the libvirt driver relies on the following hardcoded dictionary of default machine types per architecture:

```
default_mtypes = {
    obj_fields.Architecture.ARMV7: "virt",
    obj_fields.Architecture.AARCH64: "virt",
    obj_fields.Architecture.S390: "s390-ccw-virtio",
    obj_fields.Architecture.S390X: "s390-ccw-virtio",
    obj_fields.Architecture.I686: "pc",
    obj_fields.Architecture.X86_64: "pc",
}
```

Update

Prior to the Wallaby (23.0.0) release the *`libvirt.hw_machine_type`* option had to remain static once set for the lifetime of a deployment. This was due to the machine type of instances without a `hw_machine_type` image property using the newly configured machine types after a hard reboot or migration This could in turn break the internal ABI of the instance when changing between underlying machine types such as `pc` to `q35`.

From the Wallaby (23.0.0) release it is now possible to change the *`libvirt.hw_machine_type`* config once all instances have a machine type recorded within the system metadata of the instance.

To allow this the libvirt driver will now attempt to record the machine type for any instance that doesnt already have it recorded during start up of the compute service or initial spawn of an instance. This should ensure a machine type is recorded for all instances after an upgrade to Wallaby that are not in a `SHELVED_OFFLOADED` state.

To record a machine type for instances in a `SHELVED_OFFLOADED` state after an upgrade to Wallaby a new **`nova-manage`** command has been introduced to initially record the machine type of an instance.

```
$ nova-manage libvirt update_machine_type $instance $machine_type
```

This command can also be used later to update the specific machine type used by the instance. An additional **nova-manage** command is also available to fetch the machine type of a specific instance:

```
$ nova-manage libvirt get_machine_type $instance
```

To confirm that all instances within an environment or a specific cell have had a machine type recorded another **nova-manage** command can be used:

```
$ nova-manage libvirt list_unset_machine_type
```

The logic behind this command is also used by a new **nova-status** upgrade check that will fail with a warning when instances without a machine type set exist in an environment.

```
$ nova-status upgrade check
```

Once it has been verified that all instances within the environment or specific cell have had a machine type recorded then the *libvirt.hw_machine_type* can be updated without impacting existing instances.

Device bus and model image properties

Added in version 25.0.0: (Yoga)

Device bus and model types defined as image properties associated with an instance are always used when launching instances with the libvirt driver. Support for each device bus and model is dependent on the machine type used and version of QEMU available on the underlying compute host. As such, any changes to the machine type of an instance or version of QEMU on a host might suddenly invalidate the stored device bus or model image properties.

It is now possible to change the stored image properties of an instance without having to rebuild the instance.

To show the stored image properties of an instance:

```
$ nova-manage image_property show $instance_uuid $property
```

To update the stored image properties of an instance:

```
$ nova-manage image_property set \
    $instance_uuid --property $property_name=$property_value
```

hw_emulation_architecture - Configuring QEMU instance emulation architecture

Added in version 25.0.0: (Yoga)

The libvirt driver now allows for handling of specific cpu architectures when defined within the image metadata properties, to be emulated through QEMU.

Added `hw_emulation_architecture` as an available image_meta property.

Note

The following only applies to environments using libvirt compute hosts. and should be considered experimental in its entirety, during its first release as a feature.

Introduction

This capability is to fill a need with environments that do not have the capability to support the various cpu architectures that are present today with physical hardware. A small subset of architectures that are supported both within libvirt and QEMU have been selected as prime candidates for emulation support.

While support has been added for the below base architectures, this does not guarantee that every subset or custom operating system that leverages one of these architectures will function.

Configure

QEMU Binary Support

To ensure that libvirt and QEMU can properly handle the level of cpu emulation desired by the end-user, you are required to install the specific `qemu-system-XXX`, `qemu-efi-arm`, `qemu-efi-aarch64` binaries on the compute nodes that will be providing support.

Console Support

Consideration need to be made in regards to which architectures you want to support, as there are limitations on support through spice, novnc, and serial. All testing and validation has been done to ensure that spice and serial connections function as expected.

- `AARCH64` - Spice & Serial
- `S390X` - Serial
- `PPC64LE` - Spice & Serial
- `MIPSEL` - untested

Supported Emulated Architectures

The supported emulated architectures require specific image meta properties to be set in order to trigger the proper settings to be configured by libvirtd.

For end users the emulation architecture of an instance is controlled by the selection of an image with the `hw_emulation_architecture` image metadata property set.

AARCH64

`Tested and Validated as functional`

```
$ openstack image set --property hw_emulation_architecture=aarch64 $IMAGE
$ openstack image set --property hw_machine_type=virt $IMAGE
$ openstack image set --property hw_firmware_type=uefi $IMAGE
```

S390x

Tested and Validated as functional

```
$ openstack image set --property hw_emulation_architecture=s390x $IMAGE
$ openstack image set --property hw_machine_type=s390-ccw-virtio $IMAGE
$ openstack image set --property hw_video_model=virtio $IMAGE
```

PPC64LE

Tested and Validated as functional

```
$ openstack image set --property hw_emulation_architecture=ppc64le $IMAGE
$ openstack image set --property hw_machine_type=pseries $IMAGE
```

MIPSEL

Testing and validation is ongoing to overcome PCI issues

Note

Support is currently impacted, one current method for support is manually patching and compiling as defined in libvirt bug XML error: No PCI buses available.

```
$ openstack image set --property hw_emulation_architecture=mipsel $IMAGE
$ openstack image set --property hw_machine_type=virt $IMAGE
```

Soft Delete and Shadow Tables

Nova has two unrelated features which are called `soft delete`:

Soft delete instances that can be restored

After an instance delete request, the actual delete is delayed by a configurable amount of time (config option *reclaim_instance_interval*). During the delay, the instance is marked to be in state `SOFT_DELETED` and can be restored (**`openstack server restore`**) by an admin in order to gracefully handle human mistakes. If the instance is not restored during the configured delay, a periodic job actually deletes the instance.

This feature is optional and by default off.

See also:

- Delete, Restore in API Guide: Server Concepts
- config reference: *reclaim_instance_interval*

Soft delete database rows to shadow tables

At an actual instance delete, no DB record is deleted. Instead the records are marked as deleted (for example `instances.deleted` in Nova cell databases). This preserves historic information for debugging and audit uses. But it also leads to accumulation of data in Nova cell DB tables, which may have an effect on Nova DB performance as documented in DB prune deleted rows.

The records marked as deleted can be cleaned up in multiple stages. First you can move them to so-called shadow tables (tables with prefix `shadow_` in Nova cell databases). This is called *archiving the deleted rows*. Nova does not query shadow tables, therefore data moved to the shadow tables no longer affect DB performance. However storage space is still consumed. Then you can actually delete the information from the shadow tables. This is called *DB purge*.

These operations can be performed by nova-manage:

- https://docs.openstack.org/nova/latest/cli/nova-manage.html#db-archive-deleted-rows
- https://docs.openstack.org/nova/latest/cli/nova-manage.html#db-purge

This feature is not optional. Every long-running deployment should regularly archive and purge the deleted rows. For example via a cron job to regularly call **`nova-manage db archive_deleted_rows`** and **`nova-manage db purge`**. The tradeoffs between data retention, DB performance and storage needs should be considered.

In the Mitaka release there was an agreement between Nova developers that its not desirable to provide shadow tables for every table in the Nova database, documented in a spec.

Therefore not all information about an instance is preserved in the shadow tables. Since then new shadow tables are not introduced.

3.4.2 Flavors

In OpenStack, flavors define the compute, memory, and storage capacity of nova computing instances. To put it simply, a flavor is an available hardware configuration for a server. It defines the *size* of a virtual server that can be launched.

> **Note**
>
> Flavors can also determine on which compute host a flavor can be used to launch an instance. For information about customizing flavors, refer to *Manage Flavors*.

3.4.2.1 Overview

A flavor consists of the following parameters:

Flavor ID
: Unique ID (integer or UUID) for the new flavor. This property is required. If specifying auto, a UUID will be automatically generated.

Name
: Name for the new flavor. This property is required.

  Historically, names were given a format `XX.SIZE_NAME`. These are typically not required, though some third party tools may rely on it.

VCPUs
: Number of virtual CPUs to use. This property is required.

Memory MB
Amount of RAM to use (in megabytes). This property is required.

Root Disk GB
Amount of disk space (in gigabytes) to use for the root (/) partition. This property is required.

The root disk is an ephemeral disk that the base image is copied into. When booting from a persistent volume it is not used. The `0` size is a special case which uses the native base image size as the size of the ephemeral root volume. However, in this case the scheduler cannot select the compute host based on the virtual image size. As a result, `0` should only be used for volume booted instances or for testing purposes. Volume-backed instances can be enforced for flavors with zero root disk via the `os_compute_api:servers:create:zero_disk_flavor` policy rule.

Ephemeral Disk GB
Amount of disk space (in gigabytes) to use for the ephemeral partition. This property is optional. If unspecified, the value is `0` by default.

Ephemeral disks offer machine local disk storage linked to the lifecycle of a VM instance. When a VM is terminated, all data on the ephemeral disk is lost. Ephemeral disks are not included in any snapshots.

Swap
Amount of swap space (in megabytes) to use. This property is optional. If unspecified, the value is `0` by default.

RXTX Factor (DEPRECATED)
This value was only applicable when using the `xen` compute driver with the `nova-network` network driver. Since `nova-network` has been removed, this no longer applies and should not be specified. It will likely be removed in a future release. `neutron` users should refer to the neutron QoS documentation

Is Public
Boolean value that defines whether the flavor is available to all users or private to the project it was created in. This property is optional. In unspecified, the value is `True` by default.

By default, a flavor is public and available to all projects. Private flavors are only accessible to those on the access list for a given project and are invisible to other projects.

Extra Specs
Key and value pairs that define on which compute nodes a flavor can run. These are optional.

Extra specs are generally used as scheduler hints for more advanced instance configuration. The key-value pairs used must correspond to well-known options. For more information on the standardized extra specs available, *see below*

Description
A free form description of the flavor. Limited to 65535 characters in length. Only printable characters are allowed. Available starting in microversion 2.55.

Extra Specs

Todo

This is now documented in *Extra Specs*, so this should be removed and the documentation moved to those specs.

Hardware video RAM

Specify `hw_video:ram_max_mb` to control the maximum RAM for the video image. Used in conjunction with the `hw_video_ram` image property. `hw_video_ram` must be less than or equal to `hw_video:ram_max_mb`.

This is currently supported by the libvirt and the vmware drivers.

See https://libvirt.org/formatdomain.html#elementsVideo for more information on how this is used to set the `vram` attribute with the libvirt driver.

See https://pubs.vmware.com/vi-sdk/visdk250/ReferenceGuide/vim.vm.device.VirtualVideoCard.html for more information on how this is used to set the `videoRamSizeInKB` attribute with the vmware driver.

Secure Boot

Secure Boot can help ensure the bootloader used for your instances is trusted, preventing a possible attack vector.

```
$ openstack flavor set FLAVOR-NAME \
    --property os:secure_boot=SECURE_BOOT_OPTION
```

Valid `SECURE_BOOT_OPTION` values are:

- `required`: Enable Secure Boot for instances running with this flavor.
- `disabled` or `optional`: (default) Disable Secure Boot for instances running with this flavor.

Note

Supported by the libvirt driver.

Changed in version 23.0.0: (Wallaby)

Added support for secure boot to the libvirt driver.

Custom resource classes and standard resource classes to override

Specify custom resource classes to require or override quantity values of standard resource classes.

The syntax of the extra spec is `resources:<resource_class_name>=VALUE` (`VALUE` is integer). The name of custom resource classes must start with `CUSTOM_`. Standard resource classes to override are `VCPU`, `MEMORY_MB` or `DISK_GB`. In this case, you can disable scheduling based on standard resource classes by setting the value to `0`.

For example:

- `resources:CUSTOM_BAREMETAL_SMALL=1`
- `resources:VCPU=0`

See Create flavors for use with the Bare Metal service for more examples.

Added in version 16.0.0: (Pike)

Required traits

Required traits allow specifying a server to build on a compute node with the set of traits specified in the flavor. The traits are associated with the resource provider that represents the compute node in the Placement API. See the resource provider traits API reference for more details: https://docs.openstack.org/api-ref/placement/#resource-provider-traits

The syntax of the extra spec is `trait:<trait_name>=required`, for example:

- `trait:HW_CPU_X86_AVX2=required`
- `trait:STORAGE_DISK_SSD=required`

The scheduler will pass required traits to the `GET /allocation_candidates` endpoint in the Placement API to include only resource providers that can satisfy the required traits. In 17.0.0 the only valid value is `required`. In 18.0.0 `forbidden` is added (see below). Any other value will be considered invalid.

Traits can be managed using the osc-placement plugin.

Added in version 17.0.0: (Queens)

Forbidden traits

Forbidden traits are similar to required traits, described above, but instead of specifying the set of traits that must be satisfied by a compute node, forbidden traits must **not** be present.

The syntax of the extra spec is `trait:<trait_name>=forbidden`, for example:

- `trait:HW_CPU_X86_AVX2=forbidden`
- `trait:STORAGE_DISK_SSD=forbidden`

Traits can be managed using the osc-placement plugin.

Added in version 18.0.0: (Rocky)

Numbered groupings of resource classes and traits

Specify numbered groupings of resource classes and traits.

The syntax is as follows (`N` and `VALUE` are integers):

`resources`*`N`*`:<`*`resource_class_name`*`>=`*`VALUE`
`trait`*`N`*`:<`*`trait_name`*`>=required`

A given numbered `resources` or `trait` key may be repeated to specify multiple resources/traits in the same grouping, just as with the un-numbered syntax.

Specify inter-group affinity policy via the `group_policy` key, which may have the following values:

- `isolate`: Different numbered request groups will be satisfied by *different* providers.
- `none`: Different numbered request groups may be satisfied by different providers *or* common providers.

Note

If more than one group is specified then the `group_policy` is mandatory in the request. However such groups might come from other sources than flavor extra_spec (e.g. from Neutron ports with QoS minimum bandwidth policy). If the flavor does not specify any groups and `group_policy` but more than one group is coming from other sources then nova will default the `group_policy` to `none` to avoid scheduler failure.

For example, to create a server with the following VFs:

- One SR-IOV virtual function (VF) on NET1 with bandwidth 10000 bytes/sec

- One SR-IOV virtual function (VF) on NET2 with bandwidth 20000 bytes/sec on a *different* NIC with SSL acceleration

It is specified in the extra specs as follows:

```
resources1:SRIOV_NET_VF=1
resources1:NET_EGRESS_BYTES_SEC=10000
trait1:CUSTOM_PHYSNET_NET1=required
resources2:SRIOV_NET_VF=1
resources2:NET_EGRESS_BYTES_SEC:20000
trait2:CUSTOM_PHYSNET_NET2=required
trait2:HW_NIC_ACCEL_SSL=required
group_policy=isolate
```

See Granular Resource Request Syntax for more details.

Added in version 18.0.0: (Rocky)

3.4.3 Unified Limits Quotas

Since the **Nova 28.0.0 (2023.2 Bobcat)** release, it is recommended to use Keystone unified limits for Nova quota limits.

For information about legacy quota limits, see the legacy quota documentation.

Nova uses a quota system for setting limits on resources such as number of instances or amount of CPU that a specific project or user can use.

Quota limits are set by admin and retrieved for enforcement using the Keystone unified limits API.

3.4.3.1 Types of quota

Unified limit resource names for resources that are tracked as resource classes in the Placement API service follow the naming pattern of the `class:` prefix followed by the name of the resource class. For example: class:VCPU, class:PCPU, class:MEMORY_MB, class:DISK_GB, class:VGPU.

Quota name	Description
class:VCPU	Number of shared CPU cores (VCPUs) allowed per project
class:PCPU	Number of dedicated CPU cores (PCPUs) allowed per project
servers	Number of instances allowed per project
server_key_pairs	Number of key pairs allowed per user
server_metadata_it	Number of metadata items allowed per instance
class:MEMORY_M	Megabytes of instance ram allowed per project
server_groups	Number of server groups per project
server_group_mem	Number of servers per server group
class:DISK_GB	Gigabytes of instance disk allowed per project
class:$RESOURCE	Any resource class in the Placement API service can have a quota limit specified for it (example: class:VGPU)

3.4.3.2 OpenStack CLI commands

For full OpenStackClient documentation, see https://docs.openstack.org/python-openstackclient/latest/index.html.

To list default limits for Nova:

```
openstack registered limit list --service nova
```

For example:

```
$ openstack registered limit list --service nova
+----------------------------------+----------------------------------+-------
↪-----------------------------+--------------+-------------+-----------+
| ID                               | Service ID                       |␣
↪Resource Name                 | Default Limit | Description | Region␣
↪ID |
+----------------------------------+----------------------------------+-------
↪-----------------------------+--------------+-------------+-----------+
| be6dfeebb7c340e8b93b602d41fbff9b | 8b22bf8a66fa4524a522b2a21865bbf2 |␣
↪servers                       |            10 | None        | None    ␣
↪ |
| 8a658096236549788e61f4fcbd5a4a12 | 8b22bf8a66fa4524a522b2a21865bbf2 |␣
↪class:VCPU                    |            20 | None        | None    ␣
↪ |
| 63890db7d6a14401ba55e7f7022b95d0 | 8b22bf8a66fa4524a522b2a21865bbf2 |␣
↪class:MEMORY_MB               |         51200 | None        | None    ␣
↪ |
| 221ba1c19d2c4272952663828d659013 | 8b22bf8a66fa4524a522b2a21865bbf2 |␣
↪server_metadata_items         |           128 | None        | None    ␣
↪ |
| a32a9080be6b4a5481c16a91fe329e6f | 8b22bf8a66fa4524a522b2a21865bbf2 |␣
↪server_key_pairs              |           100 | None        | None    ␣
↪ |
| 86408bb7a0e542b18404ec7d348da820 | 8b22bf8a66fa4524a522b2a21865bbf2 |␣
↪server_groups                 |            10 | None        | None    ␣
↪ |
| 17c4552c5aad4afca4813f37530fc897 | 8b22bf8a66fa4524a522b2a21865bbf2 |␣
↪server_group_members          |            10 | None        | None    ␣
↪ |
+----------------------------------+----------------------------------+-------
↪-----------------------------+--------------+-------------+-----------+
```

To show details about a default limit:

```
openstack registered limit show $REGISTERED_LIMIT_ID
```

For example:

```
$ openstack registered limit show 8a658096236549788e61f4fcbd5a4a12
+--------------+----------------------------------+
| Field        | Value                            |
```

(continues on next page)

(continued from previous page)

```
+--------------+----------------------------------+
| default_limit | 20                               |
| description   | None                             |
| id            | 8a658096236549788e61f4fcbd5a4a12 |
| region_id     | None                             |
| resource_name | class:VCPU                       |
| service_id    | 8b22bf8a66fa4524a522b2a21865bbf2 |
+--------------+----------------------------------+
```

To list project limits for Nova:

```
openstack limit list --service nova
```

For example:

```
$ openstack limit list --service nova
+----------------------------------+----------------------------------+-------
↪---------------------------+--------------+----------------+-------------+-
↪----------+
| ID                               | Project ID                       |␣
↪Service ID                      | Resource Name | Resource Limit |␣
↪Description | Region ID |
+----------------------------------+----------------------------------+-------
↪---------------------------+--------------+----------------+-------------+-
↪----------+
| 8b3364b2241e4090aaaa49355c7a5b56 | 5cd3281595a9497ba87209701cd9f3f2 |␣
↪8b22bf8a66fa4524a522b2a21865bbf2 | class:VCPU    |              5 | None    ␣
↪    | None      |
+----------------------------------+----------------------------------+-------
↪---------------------------+--------------+----------------+-------------+-
↪----------+
```

To list limits for a particular project:

```
openstack limit list --service nova --project $PROJECT_ID
```

To show details about a project limit:

```
openstack limit show $LIMIT_ID
```

For example:

```
$ openstack limit show 8b3364b2241e4090aaaa49355c7a5b56
+---------------+----------------------------------+
| Field         | Value                            |
+---------------+----------------------------------+
| description   | None                             |
| domain_id     | None                             |
| id            | 8b3364b2241e4090aaaa49355c7a5b56 |
| project_id    | 5cd3281595a9497ba87209701cd9f3f2 |
| region_id     | None                             |
```

(continues on next page)

(continued from previous page)

```
| resource_limit | 5                                |
| resource_name  | class:VCPU                       |
| service_id     | 8b22bf8a66fa4524a522b2a21865bbf2 |
+----------------+----------------------------------+
```

3.5 Reference Material

- *Nova CLI Command References*: the complete command reference for all the daemons and admin tools that come with nova.
- *Configuration Guide*: Information on configuring the system, including role-based access control policy rules.

3.5.1 Command-line Utilities

In this section you will find information on Novas command line utilities.

3.5.1.1 Nova Management Commands

These commands are used to manage existing installations. They are designed to be run by operators in an environment where they have direct access to the nova database.

nova-manage

Synopsis

```
nova-manage <category> [<action> [<options>...]]
```

Description

nova-manage controls cloud computing instances by managing various admin-only aspects of Nova.

The standard pattern for executing a **nova-manage** command is:

```
nova-manage <category> <command> [<args>]
```

Run without arguments to see a list of available command categories:

```
nova-manage
```

You can also run with a category argument such as db to see a list of all commands in that category:

```
nova-manage db
```

Options

These options apply to all commands and may be given in any order, before or after commands. Individual commands may provide additional options. Options without an argument can be combined after a single dash.

-h, --help

Show a help message and exit

--config-dir <dir>

Path to a config directory to pull `*.conf` files from. This file set is sorted, so as to provide a predictable parse order if individual options are over-ridden. The set is parsed after the file(s) specified via previous *--config-file*, arguments hence over-ridden options in the directory take precedence. This option must be set from the command-line.

--config-file <path>

Path to a config file to use. Multiple config files can be specified, with values in later files taking precedence. Defaults to None. This option must be set from the command-line.

--log-config-append <path>, **--log-config** <path>, **--log_config** <path>

The name of a logging configuration file. This file is appended to any existing logging configuration files. For details about logging configuration files, see the Python logging module documentation. Note that when logging configuration files are used then all logging configuration is set in the configuration file and other logging configuration options are ignored (for example, *--log-date-format*).

--log-date-format <format>

Defines the format string for `%(asctime)s` in log records. Default: None. This option is ignored if *--log-config-append* is set.

--log-dir <dir>, **--logdir** <dir>

The base directory used for relative log_file paths. This option is ignored if *--log-config-append* is set.

--log-file PATH, **--logfile** <path>

Name of log file to send logging output to. If no default is set, logging will go to stderr as defined by use_stderr. This option is ignored if *--log-config-append* is set.

--syslog-log-facility SYSLOG_LOG_FACILITY

Syslog facility to receive log lines. This option is ignored if *--log-config-append* is set.

--use-journal

Enable journald for logging. If running in a systemd environment you may wish to enable journal support. Doing so will use the journal native protocol which includes structured metadata in addition to log messages. This option is ignored if *--log-config-append* is set.

--nouse-journal

The inverse of *--use-journal*.

--use-json

Use JSON formatting for logging. This option is ignored if *--log-config-append* is set.

--nouse-json

The inverse of *--use-json*.

--use-syslog

Use syslog for logging. Existing syslog format is DEPRECATED and will be changed later to honor RFC5424. This option is ignored if *--log-config-append* is set.

--nouse-syslog

The inverse of *--use-syslog*.

--watch-log-file

Uses logging handler designed to watch file system. When log file is moved or removed this handler will open a new log file with specified path instantaneously. It makes sense only if *--log-file* option is specified and Linux platform is used. This option is ignored if *--log-config-append* is set.

--nowatch-log-file

The inverse of *--watch-log-file*.

--debug, -d

If enabled, the logging level will be set to DEBUG instead of the default INFO level.

--nodebug

The inverse of *--debug*.

--post-mortem

Allow post-mortem debugging.

--nopost-mortem

The inverse of *--post-mortem*.

--version

Show programs version number and exit

Database Commands

db version

```
nova-manage db version
```

Print the current main database version.

db sync

```
nova-manage db sync [--local_cell] [VERSION]
```

Upgrade the main database schema up to the most recent version or VERSION if specified. By default, this command will also attempt to upgrade the schema for the cell0 database if it is mapped. If *--local_cell* is specified, then only the main database in the current cell is upgraded. The local database connection is determined by *database.connection* in the configuration file, passed to nova-manage using the --config-file option(s).

Refer to the **nova-manage cells_v2 map_cell0** or **nova-manage cells_v2 simple_cell_setup** commands for more details on mapping the cell0 database.

This command should be run **after nova-manage api_db sync**.

Options

--local_cell

Only sync db in the local cell: do not attempt to fan-out to all cells.

Return codes

Return code	Description
0	Successfully synced database schema.
1	Failed to access cell0.

Changed in version 20.0.0: (Train)

Removed support for the legacy `--version <version>` argument.

Changed in version 24.0.0: (Xena)

Migrated versioning engine to alembic. The optional `VERSION` argument is now expected to be an alembic-based version. sqlalchemy-migrate-based versions will be rejected.

db archive_deleted_rows

```
nova-manage db archive_deleted_rows [--max_rows <rows>] [--verbose]
  [--until-complete] [--before <date>] [--purge] [--all-cells] [--task-log]
  [--sleep]
```

Move deleted rows from production tables to shadow tables. Note that the corresponding rows in the `instance_mappings`, `request_specs` and `instance_group_member` tables of the API database are purged when instance records are archived and thus, *api_database.connection* is required in the config file.

If automating, this should be run continuously while the result is 1, stopping at 0, or use the *--until-complete* option.

Changed in version 24.0.0: (Xena)

Added *--task-log*, *--sleep* options.

Options

--max_rows <rows>

Maximum number of deleted rows to archive. Defaults to 1000. Note that this number does not include the corresponding rows, if any, that are removed from the API database for deleted instances.

--before <date>

Archive rows that have been deleted before <date>. Accepts date strings in the default format output by the `date` command, as well as `YYYY-MM-DD[HH:mm:ss]`. For example:

```
# Purge shadow table rows older than a specific date
nova-manage db archive_deleted_rows --before 2015-10-21
# or
nova-manage db archive_deleted_rows --before "Oct 21 2015"
# Times are also accepted
nova-manage db archive_deleted_rows --before "2015-10-21 12:00"
```

Note that relative dates (such as `yesterday`) are not supported natively. The `date` command can be helpful here:

```
# Archive deleted rows more than one month old
nova-manage db archive_deleted_rows --before "$(date -d 'now - 1 month')"
```

--verbose

Print how many rows were archived per table.

--until-complete

Run continuously until all deleted rows are archived. Use *--max_rows* as a batch size for each iteration.

--purge

Purge all data from shadow tables after archive completes.

--all-cells

Run command across all cells.

--task-log

Also archive `task_log` table records. Note that `task_log` records are never deleted, so archiving them will move all of the `task_log` records up to now into the shadow tables. It is recommended to also specify the *--before* option to avoid races for those consuming `task_log` record data via the /os-instance_usage_audit_log API (example: Telemetry).

--sleep

The amount of time in seconds to sleep between batches when *--until-complete* is used. Defaults to 0.

Return codes

Return code	Description
0	Nothing was archived.
1	Some number of rows were archived.
2	Invalid value for *--max_rows*.
3	No connection to the API database could be established using *api_database.connection*.
4	Invalid value for *--before*.
255	An unexpected error occurred.

db purge

```
nova-manage db purge [--all] [--before <date>] [--verbose] [--all-cells]
```

Delete rows from shadow tables. For *--all-cells* to work, the API database connection information must be configured.

Added in version 18.0.0: (Rocky)

Options

--all

Purge all rows in the shadow tables.

--before <date>

Delete archived rows that were deleted from Nova before <date>. Accepts date strings in the default format output by the `date` command, as well as `YYYY-MM-DD[HH:mm:ss]`. For example:

```
# Purge shadow table rows deleted before specified date
nova-manage db purge --before 2015-10-21
# or
nova-manage db purge --before "Oct 21 2015"
# Times are also accepted
nova-manage db purge --before "2015-10-21 12:00"
```

Note that relative dates (such as `yesterday`) are not supported natively. The `date` command can be helpful here:

```
# Archive deleted rows more than one month old
nova-manage db purge --before "$(date -d 'now - 1 month')"
```

--verbose

Print information about purged records.

--all-cells

Run against all cell databases.

Return codes

Return code	Description
0	Rows were deleted.
1	Required arguments were not provided.
2	Invalid value for *--before*.
3	Nothing was purged.
4	No connection to the API database could be established using *api_database.connection*.

db online_data_migrations

```
nova-manage db online_data_migrations [--max-count <count>]
```

Perform data migration to update all live data.

This command should be called after upgrading database schema and nova services on all controller nodes. If it exits with partial updates (exit status 1) it should be called again, even if some updates initially generated errors, because some updates may depend on others having completed. If it exits with status 2, intervention is required to resolve the issue causing remaining updates to fail. It should be considered successfully completed only when the exit status is 0.

For example:

```
$ nova-manage db online_data_migrations
Running batches of 50 until complete
2 rows matched query migrate_instances_add_request_spec, 0 migrated
2 rows matched query populate_queued_for_delete, 2 migrated
+-----------------------------------------+--------------+-----------+
|                Migration                | Total Needed | Completed |
+-----------------------------------------+--------------+-----------+
|       create_incomplete_consumers       |      0       |     0     |
|    migrate_instances_add_request_spec   |      2       |     0     |
|     migrate_quota_classes_to_api_db     |      0       |     0     |
|      migrate_quota_limits_to_api_db     |      0       |     0     |
|        migration_migrate_to_uuid        |      0       |     0     |
|   populate_missing_availability_zones   |      0       |     0     |
|        populate_queued_for_delete       |      2       |     2     |
|              populate_uuids             |      0       |     0     |
+-----------------------------------------+--------------+-----------+
```

In the above example, the `migrate_instances_add_request_spec` migration found two candidate records but did not need to perform any kind of data migration for either of them. In the case of the `populate_queued_for_delete` migration, two candidate records were found which did require a data migration. Since *`--max-count`* defaults to 50 and only two records were migrated with no more candidates remaining, the command completed successfully with exit code 0.

Added in version 13.0.0: (Mitaka)

Options

`--max-count` <count>

Controls the maximum number of objects to migrate in a given call. If not specified, migration will occur in batches of 50 until fully complete.

Return codes

Return code	Description
0	No (further) updates are possible.
1	Some updates were completed successfully. Note that not all updates may have succeeded.
2	Some updates generated errors and no other migrations were able to take effect in the last batch attempted.
127	Invalid input was provided.

db ironic_compute_node_move

```
nova-manage db ironic_compute_node_move --ironic-node-uuid <uuid> --
↪destination-host <host>
```

Move ironic nodes, along with any associated instances, between nova-compute services.

This is useful when migrating away from using peer_list and multiple hash ring balanced nova-compute servers to the new ironic shard system.

First you must turn off the nova-compute service that currently manages the Ironic host. Second you mark that nova-compute service as forced down via the Nova API. Third, you ensure the new nova-compute service is correctly configured to target the appropriate shard (and optionally also a conductor group). Finally, most Ironic nodes should now move to the new service, but any Ironic nodes with instances on them will need to be manually moved to their new Ironic service by using this nova-manage command.

Added in version 28.0.0: (2023.2 Bobcat)

Options

--ironic-node-uuid <uuid>

Ironic node uuid to be moved (which is also the Nova compute node uuid and the uuid of corresponding resource provider in Placement).

The Nova compute service that currently manages this Ironic node must first be marked a forced down via the Nova API, in a similar way to a down hypervisor that is about to have its VMs evacuated to a replacement hypervisor.

--destination-host <host>

Destination ironic nova-compute service CONF.host.

API Database Commands

api_db version

```
nova-manage api_db version
```

Print the current API database version.

Added in version 2015.1.0: (Kilo)

api_db sync

```
nova-manage api_db sync [VERSION]
```

Upgrade the API database schema up to the most recent version or `VERSION` if specified. This command does not create the API database, it runs schema migration scripts. The API database connection is determined by *api_database.connection* in the configuration file passed to nova-manage.

This command should be run before `nova-manage db sync`.

Added in version 2015.1.0: (Kilo)

Changed in version 18.0.0: (Rocky)

Added support for upgrading the optional placement database if `[placement_database]/connection` is configured.

Changed in version 20.0.0: (Train)

Removed support for upgrading the optional placement database as placement is now a separate project.

Removed support for the legacy `--version <version>` argument.

Changed in version 24.0.0: (Xena)

Migrated versioning engine to alembic. The optional `VERSION` argument is now expected to be an alembic-based version. sqlalchemy-migrate-based versions will be rejected.

Cells v2 Commands

cell_v2 simple_cell_setup

```
nova-manage cell_v2 simple_cell_setup [--transport-url <transport_url>]
```

Setup a fresh cells v2 environment. If *--transport-url* is not specified, it will use the one defined by *transport_url* in the configuration file.

Added in version 14.0.0: (Newton)

Options

--transport-url <transport_url>

The transport url for the cell message queue.

Return codes

Return code	Description
0	Setup is completed.
1	No hosts are reporting, meaning none can be mapped, or if the transport URL is missing or invalid.

cell_v2 map_cell0

```
nova-manage cell_v2 map_cell0 [--database_connection <database_connection>]
```

Create a cell mapping to the database connection for the cell0 database. If a database_connection is not specified, it will use the one defined by *database.connection* in the configuration file passed to nova-manage. The cell0 database is used for instances that have not been scheduled to any cell. This generally applies to instances that have encountered an error before they have been scheduled.

Added in version 14.0.0: (Newton)

Options

--database_connection <database_connection>

The database connection URL for `cell0`. This is optional. If not provided, a standard database connection will be used based on the main database connection from nova configuration.

Return codes

Return code	Description
0	`cell0` is created successfully or has already been set up.

cell_v2 map_instances

```
nova-manage cell_v2 map_instances --cell_uuid <cell_uuid>
  [--max-count <max_count>] [--reset]
```

Map instances to the provided cell. Instances in the nova database will be queried from oldest to newest and mapped to the provided cell. A *--max-count* can be set on the number of instance to map in a single run. Repeated runs of the command will start from where the last run finished so it is not necessary to increase *--max-count* to finish. A *--reset* option can be passed which will reset the marker, thus making the command start from the beginning as opposed to the default behavior of starting from where the last run finished.

If *--max-count* is not specified, all instances in the cell will be mapped in batches of 50. If you have a large number of instances, consider specifying a custom value and run the command until it exits with 0.

Added in version 12.0.0: (Liberty)

Options

--cell_uuid <cell_uuid>

Unmigrated instances will be mapped to the cell with the UUID provided.

--max-count <max_count>

Maximum number of instances to map. If not set, all instances in the cell will be mapped in batches of 50. If you have a large number of instances, consider specifying a custom value and run the command until it exits with 0.

--reset

The command will start from the beginning as opposed to the default behavior of starting from where the last run finished.

Return codes

Return code	Description
0	All instances have been mapped.
1	There are still instances to be mapped.
127	Invalid value for *--max-count*.
255	An unexpected error occurred.

cell_v2 map_cell_and_hosts

```
nova-manage cell_v2 map_cell_and_hosts [--name <cell_name>]
  [--transport-url <transport_url>] [--verbose]
```

Create a cell mapping to the database connection and message queue transport URL, and map hosts to that cell. The database connection comes from the *database.connection* defined in the configuration file passed to nova-manage. If *--transport-url* is not specified, it will use the one defined by *transport_url* in the configuration file. This command is idempotent (can be run multiple times), and the verbose option will print out the resulting cell mapping UUID.

Added in version 13.0.0: (Mitaka)

Options

--transport-url <transport_url>

The transport url for the cell message queue.

--name <cell_name>

The name of the cell.

--verbose

Output the cell mapping uuid for any newly mapped hosts.

Return codes

Return code	Description
0	Successful completion.
1	The transport url is missing or invalid

cell_v2 verify_instance

```
nova-manage cell_v2 verify_instance --uuid <instance_uuid> [--quiet]
```

Verify instance mapping to a cell. This command is useful to determine if the cells v2 environment is properly setup, specifically in terms of the cell, host, and instance mapping records required.

Added in version 14.0.0: (Newton)

Options

--uuid <instance_uuid>

The instance UUID to verify.

--quiet

Do not print anything.

Return codes

Return code	Description
0	The instance was successfully mapped to a cell.
1	The instance is not mapped to a cell. See the `map_instances` command.
2	The cell mapping is missing. See the `map_cell_and_hosts` command if you are upgrading from a cells v1 environment, and the `simple_cell_setup` command if you are upgrading from a non-cells v1 environment.
3	The instance is a deleted instance that still has an instance mapping.
4	The instance is an archived instance that still has an instance mapping.

cell_v2 create_cell

```
nova-manage cell_v2 create_cell [--name <cell_name>]
  [--transport-url <transport_url>]
  [--database_connection <database_connection>] [--verbose] [--disabled]
```

Create a cell mapping to the database connection and message queue transport URL. If a database_connection is not specified, it will use the one defined by *database.connection* in the configuration file passed to nova-manage. If *--transport-url* is not specified, it will use the one defined by *transport_url* in the configuration file. The verbose option will print out the resulting cell mapping UUID. All the cells created are by default enabled. However passing the *--disabled* option can create a pre-disabled cell, meaning no scheduling will happen to this cell.

Added in version 15.0.0: (Ocata)

Changed in version 18.0.0: (Rocky)

Added *--disabled* option.

Options

--name <cell_name>

The name of the cell.

--database_connection <database_connection>

The database URL for the cell database.

--transport-url <transport_url>

The transport url for the cell message queue.

--verbose

Output the UUID of the created cell.

--disabled

Create a pre-disabled cell.

Return codes

Return code	Description
0	The cell mapping was successfully created.
1	The transport URL or database connection was missing or invalid.
2	Another cell is already using the provided transport URL and/or database connection combination.

cell_v2 discover_hosts

```
nova-manage cell_v2 discover_hosts [--cell_uuid <cell_uuid>] [--verbose]
  [--strict] [--by-service]
```

Searches cells, or a single cell, and maps found hosts. This command will check the database for each cell (or a single one if passed in) and map any hosts which are not currently mapped. If a host is already mapped, nothing will be done. You need to re-run this command each time you add a batch of compute hosts to a cell (otherwise the scheduler will never place instances there and the API will not list the new hosts). If *--strict* is specified, the command will only return 0 if an unmapped host was discovered and mapped successfully. If *--by-service* is specified, this command will look in the appropriate cell(s) for any nova-compute services and ensure there are host mappings for them. This is less efficient and is only necessary when using compute drivers that may manage zero or more actual compute nodes at any given time (currently only ironic).

This command should be run once after all compute hosts have been deployed and should not be run in parallel. When run in parallel, the commands will collide with each other trying to map the same hosts in the database at the same time.

Added in version 14.0.0: (Newton)

Changed in version 16.0.0: (Pike)

Added *--strict* option.

Changed in version 18.0.0: (Rocky)

Added *--by-service* option.

Options

--cell_uuid <cell_uuid>

If provided only this cell will be searched for new hosts to map.

--verbose

Provide detailed output when discovering hosts.

--strict

Considered successful (exit code 0) only when an unmapped host is discovered. Any other outcome will be considered a failure (non-zero exit code).

--by-service

Discover hosts by service instead of compute node.

Return codes

Return code	Description
0	Hosts were successfully mapped or no hosts needed to be mapped. If *--strict* is specified, returns 0 only if an unmapped host was discovered and mapped.
1	If *--strict* is specified and no unmapped hosts were found. Also returns 1 if an exception was raised while running.
2	The command was aborted because of a duplicate host mapping found. This means the command collided with another running `discover_hosts` command or scheduler periodic task and is safe to retry.

cell_v2 list_cells

```
nova-manage cell_v2 list_cells [--verbose]
```

By default the cell name, UUID, disabled state, masked transport URL and database connection details are shown. Use the *--verbose* option to see transport URL and database connection with their sensitive details.

Added in version 15.0.0: (Ocata)

Changed in version 18.0.0: (Rocky)

Added the `disabled` column to output.

Options

--verbose

Show sensitive details, such as passwords.

Return codes

Return code	Description
0	Success.

cell_v2 delete_cell

```
nova-manage cell_v2 delete_cell [--force] --cell_uuid <cell_uuid>
```

Delete a cell by the given UUID.

Added in version 15.0.0: (Ocata)

Options

--force

Delete hosts and instance_mappings that belong to the cell as well.

--cell_uuid <cell_uuid>

The UUID of the cell to delete.

Return codes

Return code	Description
0	An empty cell was found and deleted successfully or a cell that has hosts was found and the cell, hosts and the instance_mappings were deleted successfully with *--force* option (this happens if there are no living instances).
1	A cell with the provided UUID could not be found.
2	Host mappings were found for the cell, meaning the cell is not empty, and the *--force* option was not provided.
3	There are active instances mapped to the cell (cell not empty).
4	There are (inactive) instances mapped to the cell and the *--force* option was not provided.

cell_v2 list_hosts

```
nova-manage cell_v2 list_hosts [--cell_uuid <cell_uuid>]
```

Lists the hosts in one or all v2 cells. By default hosts in all v2 cells are listed. Use the *--cell_uuid* option to list hosts in a specific cell.

Added in version 17.0.0: (Queens)

Options

--cell_uuid <cell_uuid>

The UUID of the cell.

Return codes

Return code	Description
0	Success.
1	The cell indicated by *--cell_uuid* was not found.

cell_v2 update_cell

```
nova-manage cell_v2 update_cell --cell_uuid <cell_uuid>
  [--name <cell_name>] [--transport-url <transport_url>]
  [--database_connection <database_connection>] [--disable] [--enable]
```

Updates the properties of a cell by the given uuid. If a database_connection is not specified, it will attempt to use the one defined by *database.connection* in the configuration file. If a transport_url is not specified, it will attempt to use the one defined by *transport_url* in the configuration file.

Note

Updating the `transport_url` or `database_connection` fields on a running system will NOT result in all nodes immediately using the new values. Use caution when changing these values.

The scheduler will not notice that a cell has been enabled/disabled until it is restarted or sent the SIGHUP signal.

Added in version 16.0.0: (Pike)

Changed in version 18.0.0: (Rocky)

Added *--enable*, *--disable* options.

Options

--cell_uuid <cell_uuid>

The UUID of the cell to update.

--name <cell_name>

Set the cell name.

--transport-url <transport_url>

Set the cell `transport_url`. Note that running nodes will not see the change until restarted or the `SIGHUP` signal is sent.

--database_connection <database_connection>

Set the cell `database_connection`. Note that running nodes will not see the change until restarted or the `SIGHUP` signal is sent.

--disable

Disables the cell. Note that the scheduling will be blocked to this cell until it is enabled and the `nova-scheduler` service is restarted or the `SIGHUP` signal is sent.

--enable

Enables the cell. Note that the `nova-scheduler` service will not see the change until it is restarted or the `SIGHUP` signal is sent.

Return codes

Return code	Description
0	Success.
1	The cell was not found by the provided UUID.
2	The specified properties could not be set.
3	The provided *--transport-url* or/and *--database_connection* parameters were same as another cell.
4	An attempt was made to disable and enable a cell at the same time.
5	An attempt was made to disable or enable cell0.

cell_v2 delete_host

```
nova-manage cell_v2 delete_host --cell_uuid <cell_uuid> --host <host>
```

Delete a host by the given host name and the given cell UUID.

Added in version 17.0.0: (Queens)

Note

The scheduler caches host-to-cell mapping information so when deleting a host the scheduler may need to be restarted or sent the SIGHUP signal.

Options

--cell_uuid <cell_uuid>

The UUID of the cell.

--host <host>

The host to delete.

Return codes

Return code	Description
0	The empty host was found and deleted successfully
1	A cell with the specified UUID could not be found.
2	A host with the specified name could not be found
3	The host with the specified name is not in a cell with the specified UUID.
4	The host with the specified name has instances (host not empty).

Placement Commands

placement heal_allocations

```
nova-manage placement heal_allocations [--max-count <max_count>]
  [--verbose] [--skip-port-allocations] [--dry-run]
  [--instance <instance_uuid>] [--cell <cell_uuid] [--force]
```

Iterates over non-cell0 cells looking for instances which do not have allocations in the Placement service and which are not undergoing a task state transition. For each instance found, allocations are created against the compute node resource provider for that instance based on the flavor associated with the instance.

Note

Nested allocations are only partially supported. Nested allocations due to Neutron ports having QoS policies are supported since 20.0.0 (Train) release. But nested allocations due to vGPU or Cyborg device profile requests in the flavor are not supported. Also if you are using provider.yaml files on compute hosts to define additional resources, if those resources are defined on child resource providers then instances using such resources are not supported.

Also if the instance has any port attached that has resource request (e.g. Quality of Service (QoS): Guaranteed Bandwidth) but the corresponding allocation is not found then the allocation is created against the network device resource providers according to the resource request of that port. It is possible that the missing allocation cannot be created either due to not having enough resource inventory on the host the instance resides on or because more than one resource provider could fulfill the request. In this case the instance needs to be manually deleted or the port needs to be detached. When nova supports migrating instances with guaranteed bandwidth ports, migration will heal missing allocations for these instances.

Before the allocations for the ports are persisted in placement nova-manage tries to update each port in neutron to refer to the resource provider UUID which provides the requested resources. If any of the port updates fail in neutron or the allocation update fails in placement the command tries to roll back the partial updates to the ports. If the roll back fails then the process stops with exit code 7 and the admin needs to do the rollback in neutron manually according to the description in the exit code section.

There is also a special case handled for instances that *do* have allocations created before Placement API microversion 1.8 where project_id and user_id values were required. For those types of allocations, the project_id and user_id are updated using the values from the instance.

This command requires that the *api_database.connection* and *placement* configuration options are set. Placement API >= 1.28 is required.

Added in version 18.0.0: (Rocky)

Changed in version 20.0.0: (Train)

Added *--dry-run*, *--instance*, and *--skip-port-allocations* options.

Changed in version 21.0.0: (Ussuri)

Added *--cell* option.

Changed in version 22.0.0: (Victoria)

Added *--force* option.

Changed in version 25.0.0: (Yoga)

Added support for healing port allocations if port-resource-request-groups neutron API extension is enabled and therefore ports can request multiple group of resources e.g. by using both guaranteed minimum bandwidth and guaranteed minimum packet rate QoS policy rules.

Options

--max-count <max_count>

Maximum number of instances to process. If not specified, all instances in each cell will be mapped in batches of 50. If you have a large number of instances, consider specifying a custom value and run the command until it exits with 0 or 4.

--verbose

Provide verbose output during execution.

--dry-run

Runs the command and prints output but does not commit any changes. The return code should be 4.

--instance <instance_uuid>

UUID of a specific instance to process. If specified *--max-count* has no effect. Mutually exclusive with *--cell*.

--skip-port-allocations

Skip the healing of the resource allocations of bound ports. E.g. healing bandwidth resource allocation for ports having minimum QoS policy rules attached. If your deployment does not use such a feature then the performance impact of querying neutron ports for each instance can be avoided with this flag.

--cell <cell_uuid>

Heal allocations within a specific cell. Mutually exclusive with *--instance*.

--force

Force heal allocations. Requires the *--instance* argument.

Return codes

Return code	Description
0	Command completed successfully and allocations were created.
1	*--max-count* was reached and there are more instances to process.
2	Unable to find a compute node record for a given instance.
3	Unable to create (or update) allocations for an instance against its compute node resource provider.
4	Command completed successfully but no allocations were created.
5	Unable to query ports from neutron
6	Unable to update ports in neutron
7	Cannot roll back neutron port updates. Manual steps needed. The error message will indicate which neutron ports need to be changed to clean up `binding:profile` of the port: `$ openstack port unset <port_uuid> --binding-profile allocation`
127	Invalid input.
255	An unexpected error occurred.

placement sync_aggregates

```
nova-manage placement sync_aggregates [--verbose]
```

Mirrors compute host aggregates to resource provider aggregates in the Placement service. Requires the *api_database* and *placement* sections of the nova configuration file to be populated.

Specify *--verbose* to get detailed progress output during execution.

Note

Depending on the size of your deployment and the number of compute hosts in aggregates, this command could cause a non-negligible amount of traffic to the placement service and therefore is recommended to be run during maintenance windows.

Added in version 18.0.0: (Rocky)

Options

--verbose

Provide verbose output during execution.

Return codes

Return code	Description
0	Successful run
1	A host was found with more than one matching compute node record
2	An unexpected error occurred while working with the placement API
3	Failed updating provider aggregates in placement
4	Host mappings not found for one or more host aggregate members
5	Compute node records not found for one or more hosts
6	Resource provider not found by uuid for a given host
255	An unexpected error occurred.

placement audit

```
nova-manage placement audit [--verbose] [--delete]
  [--resource_provider <uuid>]
```

Iterates over all the Resource Providers (or just one if you provide the UUID) and then verifies if the compute allocations are either related to an existing instance or a migration UUID. If not, it will tell which allocations are orphaned.

This command requires that the *api_database.connection* and *placement* configuration options are set. Placement API >= 1.14 is required.

Added in version 21.0.0: (Ussuri)

Options

--verbose

Provide verbose output during execution.

--resource_provider <provider_uuid>

UUID of a specific resource provider to verify.

--delete

Deletes orphaned allocations that were found.

Return codes

Return code	Description
0	No orphaned allocations were found
1	An unexpected error occurred
3	Orphaned allocations were found
4	All found orphaned allocations were deleted
127	Invalid input

Volume Attachment Commands

volume_attachment get_connector

```
nova-manage volume_attachment get_connector
```

Show the host connector for this compute host.

When called with the `--json` switch this dumps a JSON string containing the connector information for the current host, which can be saved to a file and used as input for the **nova-manage volume_attachment refresh** command.

Added in version 24.0.0: (Xena)

Return codes

Return code	Description
0	Success
1	An unexpected error occurred

volume_attachment show

```
nova-manage volume_attachment show [INSTANCE_UUID] [VOLUME_ID]
```

Show the details of a the volume attachment between `VOLUME_ID` and `INSTANCE_UUID`.

Added in version 24.0.0: (Xena)

Return codes

Return code	Description
0	Success
1	An unexpected error occurred
2	Instance not found
3	Instance is not attached to volume

volume_attachment refresh

```
nova-manage volume_attachment refresh [INSTANCE_UUID] [VOLUME_ID] [CONNECTOR_
↪PATH]
```

Refresh the connection info associated with a given volume attachment.

The instance must be attached to the volume, have a `vm_state` of `stopped` and not be `locked`.

`CONNECTOR_PATH` should be the path to a JSON-formatted file containing up to date connector information for the compute currently hosting the instance as generated using the **nova-manage volume_attachment get_connector** command.

Added in version 24.0.0: (Xena)

Return codes

Return code	Description
0	Success
1	An unexpected error occurred
2	Connector path does not exist
3	Failed to open connector path
4	Instance does not exist
5	Instance state invalid (must be stopped and unlocked)
6	Volume is not attached to the instance
7	Connector host is not correct

Libvirt Commands

libvirt get_machine_type

```
nova-manage libvirt get_machine_type [INSTANCE_UUID]
```

Fetch and display the recorded machine type of a libvirt instance identified by `INSTANCE_UUID`.

Added in version 23.0.0: (Wallaby)

Return codes

Return code	Description
0	Successfully completed
1	An unexpected error occurred
2	Unable to find instance or instance mapping
3	No machine type found for instance

libvirt update_machine_type

```
nova-manage libvirt update_machine_type \
    [INSTANCE_UUID] [MACHINE_TYPE] [--force]
```

Set or update the recorded machine type of instance `INSTANCE_UUID` to machine type `MACHINE_TYPE`.

The following criteria must be met when using this command:

- The instance must have a `vm_state` of `STOPPED`, `SHELVED` or `SHELVED_OFFLOADED`.
- The machine type must be supported. The supported list includes alias and versioned types of `pc`, `pc-i440fx`, `pc-q35`, `q35`, `virt` or `s390-ccw-virtio`.
- The update will not move the instance between underlying machine types. For example, `pc` to `q35`.
- The update will not move the instance between an alias and versioned machine type or vice versa. For example, `pc` to `pc-1.2.3` or `pc-1.2.3` to `pc`.

A `--force` flag is provided to skip the above checks but caution should be taken as this could easily lead to the underlying ABI of the instance changing when moving between machine types.

Added in version 23.0.0: (Wallaby)

Options

--force

Skip machine type compatibility checks and force machine type update.

Return codes

Return code	Description
0	Update completed successfully
1	An unexpected error occurred
2	Unable to find instance or instance mapping
3	The instance has an invalid `vm_state`
4	The proposed update of the machine type is invalid
5	The provided machine type is unsupported

libvirt list_unset_machine_type

```
nova-manage libvirt list_unset_machine_type [--cell-uuid <cell-uuid>]
```

List the UUID of any instance without `hw_machine_type` set.

This command is useful for operators attempting to determine when it is safe to change the *libvirt.hw_machine_type* option within an environment.

Added in version 23.0.0: (Wallaby)

Options

--cell_uuid <cell_uuid>

The UUID of the cell to list instances from.

Return codes

Return code	Description
0	Completed successfully, no instances found without `hw_machine_type` set
1	An unexpected error occurred
2	Unable to find cell mapping
3	Instances found without `hw_machine_type` set

Image Property Commands

image_property show

```
nova-manage image_property show [INSTANCE_UUID] [IMAGE_PROPERTY]
```

Fetch and display the recorded image property `IMAGE_PROPERTY` of an instance identified by `INSTANCE_UUID`.

Added in version 25.0.0: (Yoga)

Return codes

Return code	Description
0	Successfully completed
1	An unexpected error occurred
2	Unable to find instance or instance mapping
3	No image property found for instance

image_property set

```
nova-manage image_property set \
    [INSTANCE_UUID] [--property] [IMAGE_PROPERTY]=[VALUE]
```

Set or update the recorded image property `IMAGE_PROPERTY` of instance `INSTANCE_UUID` to value `VALUE`.

The following criteria must be met when using this command:

- The instance must have a `vm_state` of `STOPPED`, `SHELVED` or `SHELVED_OFFLOADED`.

This command is useful for operators who need to update stored instance image properties that have become invalidated by a change of instance machine type, for example.

Added in version 25.0.0: (Yoga)

Options

`--property`

Image property to set using the format name=value. For example: `--property hw_disk_bus=virtio --property hw_cdrom_bus=sata`.

Return codes

Return code	Description
0	Update completed successfully
1	An unexpected error occurred
2	Unable to find instance or instance mapping
3	The instance has an invalid `vm_state`
4	The provided image property name is invalid
5	The provided image property value is invalid

Limits Commands

limits migrate_to_unified_limits

```
nova-manage limits migrate_to_unified_limits [--project-id <project-id>]
[--region-id <region-id>] [--verbose] [--dry-run] [--quiet]
[--no-embedded-flavor-scan]
```

Migrate quota limits from the Nova database to unified limits in Keystone.

This command is useful for operators to migrate from legacy quotas to unified limits. Limits are migrated by copying them from the Nova database to Keystone by creating them using the Keystone API.

The Nova configuration file used by `nova-manage` must have a *`keystone_authtoken`* section that contains authentication settings in order for the Keystone API calls to succeed. As an example:

```
[keystone_authtoken]
project_domain_name = Default
project_name = service
user_domain_name = Default
username = nova
auth_url = http://127.0.0.1/identity
auth_type = password
password = <password>
```

By default Keystone policy configuration, access to create, update, and delete in the unified limits API is restricted to callers with the `admin` role. You will need to ensure that the user configured under *`keystone_authtoken`* has the necessary role and scope.

Warning

The `limits migrate_to_unified_limits` command will create limits only for resources that exist in the legacy quota system and any resource that does not have a unified limit in Keystone will use a quota limit of **0**.

For resource classes that are allocated by the placement service and have no default limit set, you will need to create default limits manually. The most common example is class:DISK_GB. All Nova API requests that need to allocate DISK_GB will fail quota enforcement until a default limit for it is set in Keystone.

See the *unified limits documentation* about creating limits using the OpenStackClient.

Added in version 28.0.0: (2023.2 Bobcat)

Changed in version 31.0.0: (2025.1 Epoxy)

Added flavor scanning for resource classes missing limits along with the quiet and no-embedded-flavor-scan options.

Options

`--project-id` `<project-id>`

The project ID for which to migrate quota limits.

`--region-id` `<region-id>`

The region ID for which to migrate quota limits.

`--verbose`

Provide verbose output during execution.

`--dry-run`

Show what limits would be created without actually creating them. Flavors will still be scanned for resource classes missing limits.

--quiet

Do not output anything during execution.

--no-embedded-flavor-scan

Do not scan instances embedded flavors for resource classes missing limits.

Return codes

Return code	Description
0	Command completed successfully
1	An unexpected error occurred
2	Failed to connect to the database
3	Missing registered limits were identified

See Also

nova-policy(1), *nova-status(1)*

Bugs

- Nova bugs are managed at Launchpad

nova-policy

Synopsis

```
nova-policy [<options>...]
```

Description

nova-policy is a tool that allows for inspection of policy file configuration. It provides a way to identify the actions available for a user. It does not require a running deployment: validation runs against the policy files typically located at `/etc/nova/policy.yaml` and in the `/etc/nova/policy.d` directory. These paths are configurable via the `[oslo_config] policy_file` and `[oslo_config] policy_dirs` configuration options, respectively.

Options

General options

--config-dir DIR

Path to a config directory to pull **.conf* files from. This file set is sorted, so as to provide a predictable parse order if individual options are over-ridden. The set is parsed after the file(s) specified via previous config-file, arguments hence over-ridden options in the directory take precedence. This option must be set from the command-line.

--config-file PATH

Path to a config file to use. Multiple config files can be specified, with values in later files taking precedence. Defaults to None. This option must be set from the command-line.

--debug, -d

Set the logging level to DEBUG instead of the default INFO level.

--log-config-append PATH, **--log-config** PATH, **--log_config** PATH

The name of a logging configuration file. This file is appended to any existing logging configuration files. For details about logging configuration files, see the Python logging module documentation. Note that when logging configuration files are used then all logging configuration is set in the configuration file and other logging configuration options are ignored (for example, log-date-format).

--log-date-format DATE_FORMAT

Defines the format string for %(asctime)s in log records. Default: None . This option is ignored if log_config_append is set.

--log-dir LOG_DIR, **--logdir** LOG_DIR

(Optional) The base directory used for relative log_file paths. This option is ignored if log_config_append is set.

--log-file PATH, **--logfile** PATH

(Optional) Name of log file to send logging output to. If no default is set, logging will go to stderr as defined by use_stderr. This option is ignored if log_config_append is set.

--nodebug

The inverse of *--debug*.

--nouse-journal

The inverse of *--use-journal*.

--nouse-json

The inverse of *--use-json*.

--nouse-syslog

The inverse of *--use-syslog*.

--nowatch-log-file

The inverse of *--watch-log-file*.

--syslog-log-facility SYSLOG_LOG_FACILITY

Syslog facility to receive log lines. This option is ignored if log_config_append is set.

--use-journal

Enable journald for logging. If running in a systemd environment you may wish to enable journal support. Doing so will use the journal native protocol which includes structured metadata in addition to log messages.This option is ignored if log_config_append is set.

--use-json

Use JSON formatting for logging. This option is ignored if log_config_append is set.

--use-syslog

Use syslog for logging. Existing syslog format is DEPRECATED and will be changed later to honor RFC5424. This option is ignored if log_config_append is set.

--version

Show programs version number and exit

--watch-log-file

Uses logging handler designed to watch file system. When log file is moved or removed this handler will open a new log file with specified path instantaneously. It makes sense only if log_file option is specified and Linux platform is used. This option is ignored if log_config_append is set.

User options

--os-roles <auth-roles>

Defaults to `$OS_ROLES`.

--os-tenant-id <auth-tenant-id>

Defaults to `$OS_TENANT_ID`.

--os-user-id <auth-user-id>

Defaults to `$OS_USER_ID`.

Commands

policy check

```
nova-policy policy check [-h] [--api-name <name>]
                         [--target <target> [<target>...]
```

Prints all passing policy rules for the given user.

Options

--api-name <name>

Return only the passing policy rules containing the given API name. If unspecified, all passing policy rules will be returned.

--target <target> [<target>...]

The target(s) against which the policy rule authorization will be tested. The available targets are: `project_id`, `user_id`, `quota_class`, `availability_zone`, `instance_id`. When `instance_id` is used, the other targets will be overwritten. If unspecified, the given user will be considered as the target.

Files

- `/etc/nova/nova.conf`
- `/etc/nova/policy.yaml`
- `/etc/nova/policy.d/`

See Also

nova-manage(1), *nova-status(1)*

Bugs

- Nova bugs are managed at Launchpad

nova-status

Synopsis

```
nova-status <category> [<action> [<options>...]]
```

Description

nova-status is a tool that provides routines for checking the status of a Nova deployment.

Options

The standard pattern for executing a **nova-status** command is:

```
nova-status <category> <command> [<args>]
```

Run without arguments to see a list of available command categories:

```
nova-status
```

Categories are:

- `upgrade`

Detailed descriptions are below.

You can also run with a category argument such as `upgrade` to see a list of all commands in that category:

```
nova-status upgrade
```

These sections describe the available categories and arguments for **nova-status**.

Upgrade

nova-status upgrade check

Performs a release-specific readiness check before restarting services with new code. This command expects to have complete configuration and access to databases and services within a cell. For example, this check may query the Nova API database and one or more cell databases. It may also make requests to other services such as the Placement REST API via the Keystone service catalog.

Return Codes

Return code	Description
0	All upgrade readiness checks passed successfully and there is nothing to do.
1	At least one check encountered an issue and requires further investigation. This is considered a warning but the upgrade may be OK.
2	There was an upgrade status check failure that needs to be investigated. This should be considered something that stops an upgrade.
255	An unexpected error occurred.

History of Checks

15.0.0 (Ocata)

- Checks are added for cells v2 so `nova-status upgrade check` should be run *after* running the `nova-manage cell_v2 simple_cell_setup` command.
- Checks are added for the Placement API such that there is an endpoint in the Keystone service catalog, the service is running and the check can make a successful request to the endpoint. The command also checks to see that there are compute node resource providers checking in with the Placement service. More information on the Placement service can be found at Placement API.

16.0.0 (Pike)

- Checks for the Placement API are modified to require version 1.4, that is needed in Pike and further for nova-scheduler to work correctly.

17.0.0 (Queens)

- Checks for the Placement API are modified to require version 1.17.

18.0.0 (Rocky)

- Checks for the Placement API are modified to require version 1.28.
- Checks that ironic instances have had their embedded flavors migrated to use custom resource classes.
- Checks for `nova-osapi_compute` service versions that are less than 15 across all cell mappings which might cause issues when querying instances depending on how the **nova-api** service is configured. See https://bugs.launchpad.net/nova/+bug/1759316 for details.
- Checks that existing instances have been migrated to have a matching request spec in the API DB.

19.0.0 (Stein)

- Checks for the Placement API are modified to require version 1.30.
- Checks are added for the **nova-consoleauth** service to warn and provide additional instructions to set **[workarounds]enable_consoleauth = True** while performing a live/rolling upgrade.
- The Resource Providers upgrade check was removed since the placement service code is being extracted from nova and the related tables are no longer used in the `nova_api` database.
- The API Service Version upgrade check was removed since the corresponding code for that check was removed in Stein.

20.0.0 (Train)

- Checks for the Placement API are modified to require version 1.32.
- Checks to ensure block-storage (cinder) API version 3.44 is available in order to support multi-attach volumes. If `[cinder]/auth_type` is not configured this is a no-op check.
- The **nova-consoleauth** service upgrade check was removed since the service was removed in Train.
- The `Request Spec Migration` check was removed.

21.0.0 (Ussuri)

- Checks for the Placement API are modified to require version 1.35.
- Checks for the policy files are not automatically overwritten with new defaults. This check has been dropped in 26.0.0 (Zed) release.

22.0.0 (Victoria)

- Checks for the policy files is not JSON-formatted.

23.0.0 (Wallaby)

- Checks for computes older than the previous major release
- Checks for any instances without `hw_machine_type` set.

24.0.0 (Xena)

- Checks for the Placement API are modified to require version 1.36.

See Also

nova-manage(1), *nova-policy(1)*

Bugs

- Nova bugs are managed at Launchpad

3.5.1.2 Service Daemons

The service daemons make up a functioning nova environment. All of these are expected to be started by an init system, expect to read a nova.conf file, and daemonize correctly after starting up.

nova-compute

Synopsis

```
nova-compute [<options>...]
```

Description

nova-compute is a server daemon that serves the Nova Compute service, which is responsible for building a disk image, launching an instance via the underlying virtualization driver, responding to calls to check the instances state, attaching persistent storage, and terminating the instance.

Options

General options

--config-dir DIR

Path to a config directory to pull **.conf* files from. This file set is sorted, so as to provide a predictable parse order if individual options are over-ridden. The set is parsed after the file(s) specified via previous config-file, arguments hence over-ridden options in the directory take precedence. This option must be set from the command-line.

--config-file PATH

Path to a config file to use. Multiple config files can be specified, with values in later files taking precedence. Defaults to None. This option must be set from the command-line.

--debug, -d

Set the logging level to DEBUG instead of the default INFO level.

--log-config-append PATH, **--log-config** PATH, **--log_config** PATH

The name of a logging configuration file. This file is appended to any existing logging configuration files. For details about logging configuration files, see the Python logging module documentation. Note that when logging configuration files are used then all logging configuration is set in the configuration file and other logging configuration options are ignored (for example, log-date-format).

--log-date-format DATE_FORMAT

Defines the format string for %(asctime)s in log records. Default: None . This option is ignored if log_config_append is set.

--log-dir LOG_DIR, **--logdir** LOG_DIR

(Optional) The base directory used for relative log_file paths. This option is ignored if log_config_append is set.

--log-file PATH, **--logfile** PATH

(Optional) Name of log file to send logging output to. If no default is set, logging will go to stderr as defined by use_stderr. This option is ignored if log_config_append is set.

--nodebug

The inverse of *--debug*.

--nouse-journal

The inverse of *--use-journal*.

--nouse-json

The inverse of *--use-json*.

--nouse-syslog

The inverse of *--use-syslog*.

--nowatch-log-file

The inverse of *--watch-log-file*.

--syslog-log-facility SYSLOG_LOG_FACILITY

Syslog facility to receive log lines. This option is ignored if log_config_append is set.

--use-journal

Enable journald for logging. If running in a systemd environment you may wish to enable journal support. Doing so will use the journal native protocol which includes structured metadata in addition to log messages.This option is ignored if log_config_append is set.

--use-json

Use JSON formatting for logging. This option is ignored if log_config_append is set.

--use-syslog

Use syslog for logging. Existing syslog format is DEPRECATED and will be changed later to honor RFC5424. This option is ignored if log_config_append is set.

--version

Show programs version number and exit

--watch-log-file

Uses logging handler designed to watch file system. When log file is moved or removed this handler will open a new log file with specified path instantaneously. It makes sense only if log_file option is specified and Linux platform is used. This option is ignored if log_config_append is set.

Files

- `/etc/nova/nova.conf`
- `/etc/nova/policy.yaml`
- `/etc/nova/policy.d/`
- `/etc/nova/rootwrap.conf`
- `/etc/nova/rootwrap.d/`
- `/etc/nova/compute_id`
- `/var/lib/nova/compute_id`

See Also

nova-conductor(1), *nova-manage(1)*, *nova-rootwrap(1)*, *nova-scheduler(1)*, *nova-status(1)*

Bugs

- Nova bugs are managed at Launchpad

nova-conductor

Synopsis

```
nova-conductor [<options>...]
```

Description

nova-conductor is a server daemon that serves the Nova Conductor service, which provides coordination and database query support for nova.

Options

General options

--config-dir DIR

Path to a config directory to pull **.conf* files from. This file set is sorted, so as to provide a predictable parse order if individual options are over-ridden. The set is parsed after the file(s) specified via previous config-file, arguments hence over-ridden options in the directory take precedence. This option must be set from the command-line.

--config-file PATH

Path to a config file to use. Multiple config files can be specified, with values in later files taking precedence. Defaults to None. This option must be set from the command-line.

--debug, -d

Set the logging level to DEBUG instead of the default INFO level.

--log-config-append PATH, **--log-config** PATH, **--log_config** PATH

The name of a logging configuration file. This file is appended to any existing logging configuration files. For details about logging configuration files, see the Python logging module documentation. Note that when logging configuration files are used then all logging configuration is set in the configuration file and other logging configuration options are ignored (for example, log-date-format).

--log-date-format DATE_FORMAT

Defines the format string for %(asctime)s in log records. Default: None . This option is ignored if log_config_append is set.

--log-dir LOG_DIR, **--logdir** LOG_DIR

(Optional) The base directory used for relative log_file paths. This option is ignored if log_config_append is set.

--log-file PATH, **--logfile** PATH

(Optional) Name of log file to send logging output to. If no default is set, logging will go to stderr as defined by use_stderr. This option is ignored if log_config_append is set.

--nodebug

The inverse of *--debug*.

--nouse-journal

The inverse of *--use-journal*.

--nouse-json

The inverse of *--use-json*.

--nouse-syslog

The inverse of *--use-syslog*.

--nowatch-log-file

The inverse of *--watch-log-file*.

--syslog-log-facility SYSLOG_LOG_FACILITY

Syslog facility to receive log lines. This option is ignored if log_config_append is set.

--use-journal

Enable journald for logging. If running in a systemd environment you may wish to enable journal support. Doing so will use the journal native protocol which includes structured metadata in addition to log messages.This option is ignored if log_config_append is set.

--use-json

Use JSON formatting for logging. This option is ignored if log_config_append is set.

--use-syslog

Use syslog for logging. Existing syslog format is DEPRECATED and will be changed later to honor RFC5424. This option is ignored if log_config_append is set.

--version

Show programs version number and exit

--watch-log-file

Uses logging handler designed to watch file system. When log file is moved or removed this handler will open a new log file with specified path instantaneously. It makes sense only if log_file option is specified and Linux platform is used. This option is ignored if log_config_append is set.

Files

- `/etc/nova/nova.conf`

See Also

nova-compute(1), *nova-manage(1)*, *nova-rootwrap(1)*, *nova-scheduler(1)*, *nova-status(1)*

Bugs

- Nova bugs are managed at Launchpad

nova-novncproxy

Synopsis

```
nova-novncproxy [<options>...]
```

Description

nova-novncproxy is a server daemon that serves the Nova noVNC Websocket Proxy service, which provides a websocket proxy that is compatible with OpenStack Nova noVNC consoles.

Options

General options

--config-dir DIR

Path to a config directory to pull **.conf* files from. This file set is sorted, so as to provide a predictable parse order if individual options are over-ridden. The set is parsed after the file(s) specified via previous config-file, arguments hence over-ridden options in the directory take precedence. This option must be set from the command-line.

--config-file PATH

Path to a config file to use. Multiple config files can be specified, with values in later files taking precedence. Defaults to None. This option must be set from the command-line.

--debug, -d

Set the logging level to DEBUG instead of the default INFO level.

--log-config-append PATH, **--log-config** PATH, **--log_config** PATH

The name of a logging configuration file. This file is appended to any existing logging configuration files. For details about logging configuration files, see the Python logging module documentation. Note that when logging configuration files are used then all logging configuration is set in the configuration file and other logging configuration options are ignored (for example, log-date-format).

--log-date-format DATE_FORMAT

Defines the format string for %(asctime)s in log records. Default: None . This option is ignored if log_config_append is set.

--log-dir LOG_DIR, **--logdir** LOG_DIR

(Optional) The base directory used for relative log_file paths. This option is ignored if log_config_append is set.

--log-file PATH, **--logfile** PATH

(Optional) Name of log file to send logging output to. If no default is set, logging will go to stderr as defined by use_stderr. This option is ignored if log_config_append is set.

--nodebug

The inverse of *--debug*.

--nouse-journal

The inverse of *--use-journal*.

--nouse-json

The inverse of *--use-json*.

--nouse-syslog

The inverse of *--use-syslog*.

--nowatch-log-file

The inverse of *--watch-log-file*.

--syslog-log-facility SYSLOG_LOG_FACILITY

Syslog facility to receive log lines. This option is ignored if log_config_append is set.

--use-journal

Enable journald for logging. If running in a systemd environment you may wish to enable journal support. Doing so will use the journal native protocol which includes structured metadata in addition to log messages.This option is ignored if log_config_append is set.

--use-json

Use JSON formatting for logging. This option is ignored if log_config_append is set.

--use-syslog

Use syslog for logging. Existing syslog format is DEPRECATED and will be changed later to honor RFC5424. This option is ignored if log_config_append is set.

--version

Show programs version number and exit

--watch-log-file

Uses logging handler designed to watch file system. When log file is moved or removed this handler will open a new log file with specified path instantaneously. It makes sense only if log_file option is specified and Linux platform is used. This option is ignored if log_config_append is set.

Websockify options

--cert CERT

Path to SSL certificate file.

--daemon

Run as a background process.

--key KEY

SSL key file (if separate from cert).

--nodaemon

The inverse of *--daemon*.

--nosource_is_ipv6

The inverse of *--source_is_ipv6*.

--nossl_only

The inverse of *--ssl_only*.

--record RECORD

Filename that will be used for storing websocket frames received and sent by a proxy service (like VNC, spice, serial) running on this host. If this is not set, no recording will be done.

--source_is_ipv6

Set to True if source host is addressed with IPv6.

--ssl_only

Disallow non-encrypted connections.

--web WEB

Path to directory with content which will be served by a web server.

VNC options

--vnc-auth_schemes VNC_AUTH_SCHEMES

The authentication schemes to use with the compute node. Control what RFB authentication schemes are permitted for connections between the proxy and the compute host. If multiple schemes are enabled, the first matching scheme will be used, thus the strongest schemes should be listed first.

--vnc-novncproxy_host VNC_NOVNCPROXY_HOST

IP address that the noVNC console proxy should bind to. The VNC proxy is an OpenStack component that enables compute service users to access their instances through VNC clients. noVNC provides VNC support through a websocket-based client. This option sets the private address to which the noVNC console proxy service should bind to.

--vnc-novncproxy_port VNC_NOVNCPROXY_PORT

Port that the noVNC console proxy should bind to. The VNC proxy is an OpenStack component that enables compute service users to access their instances through VNC clients. noVNC provides VNC support through a websocket-based client. This option sets the private port to which the noVNC console proxy service should bind to.

--vnc-vencrypt_ca_certs VNC_VENCRYPT_CA_CERTS

The path to the CA certificate PEM file The fully qualified path to a PEM file containing one or more x509 certificates for the certificate authorities used by the compute node VNC server.

--vnc-vencrypt_client_cert VNC_VENCRYPT_CLIENT_CERT

The path to the client key file (for x509) The fully qualified path to a PEM file containing the x509 certificate which the VNC proxy server presents to the compute node during VNC authentication.

--vnc-vencrypt_client_key VNC_VENCRYPT_CLIENT_KEY

The path to the client certificate PEM file (for x509) The fully qualified path to a PEM file containing the private key which the VNC proxy server presents to the compute node during VNC authentication.

Files

- `/etc/nova/nova.conf`
- `/etc/nova/rootwrap.conf`
- `/etc/nova/rootwrap.d/`

See Also

nova-serialproxy(1), *nova-spicehtml5proxy(1)*

Bugs

- Nova bugs are managed at Launchpad

nova-scheduler

Synopsis

```
nova-scheduler [<options>...]
```

Description

nova-scheduler is a server daemon that serves the Nova Scheduler service, which is responsible for picking a compute node to run a given instance on.

Options

General options

--config-dir DIR

Path to a config directory to pull **.conf* files from. This file set is sorted, so as to provide a predictable parse order if individual options are over-ridden. The set is parsed after the file(s) specified via previous config-file, arguments hence over-ridden options in the directory take precedence. This option must be set from the command-line.

--config-file PATH

Path to a config file to use. Multiple config files can be specified, with values in later files taking precedence. Defaults to None. This option must be set from the command-line.

--debug, -d

Set the logging level to DEBUG instead of the default INFO level.

--log-config-append PATH, **--log-config** PATH, **--log_config** PATH

The name of a logging configuration file. This file is appended to any existing logging configuration files. For details about logging configuration files, see the Python logging module documentation. Note that when logging configuration files are used then all logging configuration is set in the configuration file and other logging configuration options are ignored (for example, log-date-format).

--log-date-format DATE_FORMAT

Defines the format string for %(asctime)s in log records. Default: None . This option is ignored if log_config_append is set.

--log-dir LOG_DIR, **--logdir** LOG_DIR

(Optional) The base directory used for relative log_file paths. This option is ignored if log_config_append is set.

--log-file PATH, **--logfile** PATH

(Optional) Name of log file to send logging output to. If no default is set, logging will go to stderr as defined by use_stderr. This option is ignored if log_config_append is set.

--nodebug

The inverse of *--debug*.

--nouse-journal

The inverse of *--use-journal*.

--nouse-json

The inverse of *--use-json*.

--nouse-syslog

The inverse of *--use-syslog*.

--nowatch-log-file

The inverse of *--watch-log-file*.

--syslog-log-facility SYSLOG_LOG_FACILITY

Syslog facility to receive log lines. This option is ignored if log_config_append is set.

--use-journal

Enable journald for logging. If running in a systemd environment you may wish to enable journal support. Doing so will use the journal native protocol which includes structured metadata in addition to log messages.This option is ignored if log_config_append is set.

--use-json

Use JSON formatting for logging. This option is ignored if log_config_append is set.

--use-syslog

Use syslog for logging. Existing syslog format is DEPRECATED and will be changed later to honor RFC5424. This option is ignored if log_config_append is set.

--version

Show programs version number and exit

--watch-log-file

Uses logging handler designed to watch file system. When log file is moved or removed this handler will open a new log file with specified path instantaneously. It makes sense only if log_file option is specified and Linux platform is used. This option is ignored if log_config_append is set.

Files

- `/etc/nova/nova.conf`
- `/etc/nova/rootwrap.conf`
- `/etc/nova/rootwrap.d/`

See Also

nova-compute(1), *nova-conductor(1)*

Bugs

- Nova bugs are managed at Launchpad

nova-serialproxy

Synopsis

```
nova-serialproxy [<options>...]
```

Description

nova-serialproxy is a server daemon that serves the Nova Serial Websocket Proxy service, which provides a websocket proxy that is compatible with OpenStack Nova serial ports.

Options

General options

--config-dir DIR

Path to a config directory to pull **.conf* files from. This file set is sorted, so as to provide a predictable parse order if individual options are over-ridden. The set is parsed after the file(s) specified via previous config-file, arguments hence over-ridden options in the directory take precedence. This option must be set from the command-line.

--config-file PATH

Path to a config file to use. Multiple config files can be specified, with values in later files taking precedence. Defaults to None. This option must be set from the command-line.

--debug, -d

Set the logging level to DEBUG instead of the default INFO level.

--log-config-append PATH, **--log-config** PATH, **--log_config** PATH

The name of a logging configuration file. This file is appended to any existing logging configuration files. For details about logging configuration files, see the Python logging module documentation. Note that when logging configuration files are used then all logging configuration is set in the configuration file and other logging configuration options are ignored (for example, log-date-format).

--log-date-format DATE_FORMAT

Defines the format string for %(asctime)s in log records. Default: None . This option is ignored if log_config_append is set.

--log-dir LOG_DIR, **--logdir** LOG_DIR

(Optional) The base directory used for relative log_file paths. This option is ignored if log_config_append is set.

--log-file PATH, **--logfile** PATH

(Optional) Name of log file to send logging output to. If no default is set, logging will go to stderr as defined by use_stderr. This option is ignored if log_config_append is set.

--nodebug

The inverse of *--debug*.

--nouse-journal

The inverse of *--use-journal*.

--nouse-json

The inverse of *--use-json*.

--nouse-syslog

The inverse of *--use-syslog*.

--nowatch-log-file

The inverse of *--watch-log-file*.

--syslog-log-facility SYSLOG_LOG_FACILITY

Syslog facility to receive log lines. This option is ignored if log_config_append is set.

--use-journal

Enable journald for logging. If running in a systemd environment you may wish to enable journal support. Doing so will use the journal native protocol which includes structured metadata in addition to log messages.This option is ignored if log_config_append is set.

--use-json

Use JSON formatting for logging. This option is ignored if log_config_append is set.

--use-syslog

Use syslog for logging. Existing syslog format is DEPRECATED and will be changed later to honor RFC5424. This option is ignored if log_config_append is set.

--version

Show programs version number and exit

--watch-log-file

Uses logging handler designed to watch file system. When log file is moved or removed this handler will open a new log file with specified path instantaneously. It makes sense only if log_file option is specified and Linux platform is used. This option is ignored if log_config_append is set.

Websockify options

--cert CERT

Path to SSL certificate file.

--daemon

Run as a background process.

--key KEY

SSL key file (if separate from cert).

--nodaemon

The inverse of *--daemon*.

--nosource_is_ipv6

The inverse of *--source_is_ipv6*.

--nossl_only

The inverse of *--ssl_only*.

--record RECORD

Filename that will be used for storing websocket frames received and sent by a proxy service (like VNC, spice, serial) running on this host. If this is not set, no recording will be done.

--source_is_ipv6

Set to True if source host is addressed with IPv6.

--ssl_only

Disallow non-encrypted connections.

--web WEB

Path to directory with content which will be served by a web server.

Serial options

--serial_console-serialproxy_host SERIAL_CONSOLE_SERIALPROXY_HOST

The IP address which is used by the `nova-serialproxy` service to listen for incoming requests. The `nova-serialproxy` service listens on this IP address for incoming connection requests to instances which expose serial console.

--serial_console-serialproxy_port SERIAL_CONSOLE_SERIALPROXY_PORT

The port number which is used by the `nova-serialproxy` service to listen for incoming requests. The `nova-serialproxy` service listens on this port number for incoming connection requests to instances which expose serial console.

Files

- `/etc/nova/nova.conf`
- `/etc/nova/rootwrap.conf`
- `/etc/nova/rootwrap.d/`

See Also

nova-novncproxy(1), *nova-spicehtml5proxy(1)*

Bugs

- Nova bugs are managed at Launchpad

nova-spicehtml5proxy

Synopsis

```
nova-spicehtml5proxy [<options>...]
```

Description

nova-spicehtml5proxy is a server daemon that serves the Nova SPICE HTML5 Websocket Proxy service, which provides a websocket proxy that is compatible with OpenStack Nova SPICE HTML5 consoles.

Options

General options

--config-dir DIR

Path to a config directory to pull **.conf* files from. This file set is sorted, so as to provide a predictable parse order if individual options are over-ridden. The set is parsed after the file(s) specified via previous config-file, arguments hence over-ridden options in the directory take precedence. This option must be set from the command-line.

--config-file PATH

Path to a config file to use. Multiple config files can be specified, with values in later files taking precedence. Defaults to None. This option must be set from the command-line.

--debug, -d

Set the logging level to DEBUG instead of the default INFO level.

--log-config-append PATH, **--log-config** PATH, **--log_config** PATH

The name of a logging configuration file. This file is appended to any existing logging configuration files. For details about logging configuration files, see the Python logging module documentation. Note that when logging configuration files are used then all logging configuration is set in the configuration file and other logging configuration options are ignored (for example, log-date-format).

--log-date-format DATE_FORMAT

Defines the format string for %(asctime)s in log records. Default: None . This option is ignored if log_config_append is set.

--log-dir LOG_DIR, **--logdir** LOG_DIR

(Optional) The base directory used for relative log_file paths. This option is ignored if log_config_append is set.

--log-file PATH, **--logfile** PATH

(Optional) Name of log file to send logging output to. If no default is set, logging will go to stderr as defined by use_stderr. This option is ignored if log_config_append is set.

--nodebug

The inverse of *--debug*.

--nouse-journal

The inverse of *--use-journal*.

--nouse-json

The inverse of *--use-json*.

--nouse-syslog

The inverse of *--use-syslog*.

--nowatch-log-file

The inverse of *--watch-log-file*.

--syslog-log-facility SYSLOG_LOG_FACILITY

Syslog facility to receive log lines. This option is ignored if log_config_append is set.

--use-journal

Enable journald for logging. If running in a systemd environment you may wish to enable journal support. Doing so will use the journal native protocol which includes structured metadata in addition to log messages.This option is ignored if log_config_append is set.

--use-json

Use JSON formatting for logging. This option is ignored if log_config_append is set.

--use-syslog

Use syslog for logging. Existing syslog format is DEPRECATED and will be changed later to honor RFC5424. This option is ignored if log_config_append is set.

--version

Show programs version number and exit

--watch-log-file

Uses logging handler designed to watch file system. When log file is moved or removed this handler will open a new log file with specified path instantaneously. It makes sense only if log_file option is specified and Linux platform is used. This option is ignored if log_config_append is set.

Websockify options

--cert CERT

Path to SSL certificate file.

--daemon

Run as a background process.

--key KEY

SSL key file (if separate from cert).

--nodaemon

The inverse of *--daemon*.

--nosource_is_ipv6

The inverse of *--source_is_ipv6*.

--nossl_only

The inverse of *--ssl_only*.

--record RECORD

Filename that will be used for storing websocket frames received and sent by a proxy service (like VNC, spice, serial) running on this host. If this is not set, no recording will be done.

--source_is_ipv6

Set to True if source host is addressed with IPv6.

--ssl_only

Disallow non-encrypted connections.

--web WEB

Path to directory with content which will be served by a web server.

Spice options

--spice-html5proxy_host SPICE_HTML5PROXY_HOST

IP address or a hostname on which the `nova-spicehtml5proxy` service listens for incoming requests. This option depends on the `[spice] html5proxy_base_url` option in `nova.conf`. The `nova-spicehtml5proxy` service must be listening on a host that is accessible from the HTML5 client.

--spice-html5proxy_port SPICE_HTML5PROXY_PORT

Port on which the `nova-spicehtml5proxy` service listens for incoming requests. This option depends on the `[spice] html5proxy_base_url` option in `nova.conf`. The `nova-spicehtml5proxy` service must be listening on a port that is accessible from the HTML5 client.

Files

- `/etc/nova/nova.conf`
- `/etc/nova/rootwrap.conf`
- `/etc/nova/rootwrap.d/`

See Also

nova-novncproxy(1), *nova-serialproxy(1)*

Bugs

- Nova bugs are managed at Launchpad

3.5.1.3 WSGI Services

Starting in the 2025.2 release, the only way to deploy the compute and metadata APIs is via WSGI (uwsgi or apache/mod_wsgi). Refer to *Using WSGI with Nova* for more information.

3.5.1.4 Additional Tools

There are a few additional cli tools which nova services call when appropriate. This should not need to be called directly by operators, but they are documented for completeness and debugging if something goes wrong.

nova-rootwrap

Synopsis

```
nova-rootwrap CONFIG_FILE COMMAND
```

Description

nova-rootwrap is an application that filters which commands nova is allowed to run as another user.

To use this, you should set the following in `nova.conf`:

```
rootwrap_config=/etc/nova/rootwrap.conf
```

You also need to let the nova user run **nova-rootwrap** as root in `sudoers`:

```
nova ALL = (root) NOPASSWD: /usr/bin/nova-rootwrap /etc/nova/rootwrap.conf *
```

To make allowed commands node-specific, your packaging should only install `{compute,network}.filters` respectively on compute and network nodes, i.e. API nodes should not have any of those files installed.

Note

nova-rootwrap is being slowly deprecated and replaced by `oslo.privsep`, and will eventually be removed.

Files

- `/etc/nova/nova.conf`
- `/etc/nova/rootwrap.conf`
- `/etc/nova/rootwrap.d/`

See Also

nova-compute(1)

Bugs

- Nova bugs are managed at Launchpad

3.5.2 Configuration Guide

The static configuration for nova lives in two main files: `nova.conf` and `policy.yaml`. These are described below. For a bigger picture view on configuring nova to solve specific problems, refer to the *Nova Admin Guide*.

3.5.2.1 Configuration

Nova, like most OpenStack projects, uses INI-style configuration files to configure various services and utilities. This functionality is provided by the oslo.config project. *oslo.config* supports loading configuration from both individual configuration files and a directory of configuration files. By default, nova will search the below directories for two config files - `nova.conf` and `{prog}.conf`, where `prog` corresponds to the name of the service or utility being configured such as **`nova-compute`** - and two config directories - `nova.conf.d` and `{prog}.conf.d`:

- `${HOME}/.nova`
- `${HOME}`
- `/etc/nova`
- `/etc`
- `${SNAP_COMMON}/etc/nova/`
- `${SNAP}/etc/nova/`

Where a matching file is found, all other directories will be skipped. This behavior can be overridden by using the `--config-file` and `--config-dir` options provided for each executable.

More information on how you can use the configuration options to configure services and what configuration options are available can be found below.

- *Configuration Guide*: Detailed configuration guides for various parts of your Nova system. Helpful reference for setting up specific hypervisor backends.
- *Config Reference*: A complete reference of all configuration options available in the `nova.conf` file.

Configuration Options

The following is an overview of all available configuration options in Nova.

DEFAULT

`run_external_periodic_tasks`

> **Type**
> boolean

Default
`True`

Some periodic tasks can be run in a separate process. Should we run them here?

`backdoor_port`

Type
string

Default
<None>

Enable eventlet backdoor. Acceptable values are 0, <port>, and <start>:<end>, where 0 results in listening on a random tcp port number; <port> results in listening on the specified port number (and not enabling backdoor if that port is in use); and <start>:<end> results in listening on the smallest unused port number within the specified range of port numbers. The chosen port is displayed in the services log file.

Warning

This option is deprecated for removal. Its value may be silently ignored in the future.

Reason
The backdoor_port option is deprecated and will be removed in a future release.

`backdoor_socket`

Type
string

Default
<None>

Enable eventlet backdoor, using the provided path as a unix socket that can receive connections. This option is mutually exclusive with backdoor_port in that only one should be provided. If both are provided then the existence of this option overrides the usage of that option. Inside the path {pid} will be replaced with the PID of the current process.

Warning

This option is deprecated for removal. Its value may be silently ignored in the future.

Reason
The backdoor_socket option is deprecated and will be removed in a future release.

`log_options`

Type
boolean

Default
`True`

Enables or disables logging values of all registered options when starting a service (at DEBUG level).

`graceful_shutdown_timeout`

Type
integer

Default
`60`

Specify a timeout after which a gracefully shutdown server will exit. Zero value means endless wait.

`debug`

Type
boolean

Default
`False`

Mutable
This option can be changed without restarting.

If set to true, the logging level will be set to DEBUG instead of the default INFO level.

`log_config_append`

Type
string

Default
<None>

Mutable
This option can be changed without restarting.

The name of a logging configuration file. This file is appended to any existing logging configuration files. For details about logging configuration files, see the Python logging module documentation. Note that when logging configuration files are used then all logging configuration is set in the configuration file and other logging configuration options are ignored (for example, log-date-format).

Table 9: Deprecated Variations

Group	Name
DEFAULT	log-config
DEFAULT	log_config

`log_date_format`

Type
string

Default
`%Y-%m-%d %H:%M:%S`

Defines the format string for %(asctime)s in log records. Default: the value above . This option is ignored if log_config_append is set.

`log_file`

Type
string

Default
<None>

(Optional) Name of log file to send logging output to. If no default is set, logging will go to stderr as defined by use_stderr. This option is ignored if log_config_append is set.

Table 10: Deprecated Variations

Group	Name
DEFAULT	logfile

`log_dir`

Type
string

Default
<None>

(Optional) The base directory used for relative log_file paths. This option is ignored if log_config_append is set.

Table 11: Deprecated Variations

Group	Name
DEFAULT	logdir

`use_syslog`

Type
boolean

Default
`False`

Use syslog for logging. Existing syslog format is DEPRECATED and will be changed later to honor RFC5424. This option is ignored if log_config_append is set.

`use_journal`

Type
boolean

Default
`False`

Enable journald for logging. If running in a systemd environment you may wish to enable journal support. Doing so will use the journal native protocol which includes structured metadata in addition to log messages.This option is ignored if log_config_append is set.

`syslog_log_facility`

Type
string

Default
`LOG_USER`

Syslog facility to receive log lines. This option is ignored if log_config_append is set.

`use_json`

Type
boolean

Default
`False`

Use JSON formatting for logging. This option is ignored if log_config_append is set.

`use_stderr`

Type
boolean

Default
`False`

Log output to standard error. This option is ignored if log_config_append is set.

`log_color`

Type
boolean

Default
`False`

(Optional) Set the color key according to log levels. This option takes effect only when logging to stderr or stdout is used. This option is ignored if log_config_append is set.

`log_rotate_interval`

Type
integer

Default
1

The amount of time before the log files are rotated. This option is ignored unless log_rotation_type is set to interval.

`log_rotate_interval_type`

Type
string

Default
`days`

Valid Values
Seconds, Minutes, Hours, Days, Weekday, Midnight

Rotation interval type. The time of the last file change (or the time when the service was started) is used when scheduling the next rotation.

`max_logfile_count`

Type
integer

Default
`30`

Maximum number of rotated log files.

`max_logfile_size_mb`

Type
integer

Default
`200`

Log file maximum size in MB. This option is ignored if log_rotation_type is not set to size.

`log_rotation_type`

Type
string

Default
`none`

Valid Values
interval, size, none

Log rotation type.

Possible values

interval
Rotate logs at predefined time intervals.

size
Rotate logs once they reach a predefined size.

none
Do not rotate log files.

`logging_context_format_string`

Type
string

Default
```
%(asctime)s.%(msecs)03d %(process)d %(levelname)s %(name)s
[%(global_request_id)s %(request_id)s %(user_identity)s]
%(instance)s%(message)s
```

Format string to use for log messages with context. Used by oslo_log.formatters.ContextFormatter

`logging_default_format_string`

Type
string

Default
```
%(asctime)s.%(msecs)03d %(process)d %(levelname)s %(name)s [-]
%(instance)s%(message)s
```

Format string to use for log messages when context is undefined. Used by oslo_log.formatters.ContextFormatter

`logging_debug_format_suffix`

Type
string

Default
```
%(funcName)s %(pathname)s:%(lineno)d
```

Additional data to append to log message when logging level for the message is DEBUG. Used by oslo_log.formatters.ContextFormatter

`logging_exception_prefix`

Type
string

Default
```
%(asctime)s.%(msecs)03d %(process)d ERROR %(name)s
%(instance)s
```

Prefix each line of exception output with this format. Used by oslo_log.formatters.ContextFormatter

`logging_user_identity_format`

Type
string

Default
```
%(user)s %(project)s %(domain)s %(system_scope)s
%(user_domain)s %(project_domain)s
```

Defines the format string for %(user_identity)s that is used in logging_context_format_string. Used by oslo_log.formatters.ContextFormatter

`default_log_levels`

Type
list

Default
```
['amqp=WARN', 'boto=WARN', 'sqlalchemy=WARN', 'suds=INFO',
'oslo.messaging=INFO', 'oslo_messaging=INFO', 'iso8601=WARN',
'requests.packages.urllib3.connectionpool=WARN', 'urllib3.
connectionpool=WARN', 'websocket=WARN', 'requests.packages.
urllib3.util.retry=WARN', 'urllib3.util.retry=WARN',
'keystonemiddleware=WARN', 'routes.middleware=WARN',
```

```
'stevedore=WARN', 'taskflow=WARN', 'keystoneauth=WARN', 'oslo.
cache=INFO', 'oslo_policy=INFO', 'dogpile.core.dogpile=INFO',
'glanceclient=WARN', 'oslo.privsep.daemon=INFO']
```

List of package logging levels in logger=LEVEL pairs. This option is ignored if log_config_append is set.

publish_errors

Type
boolean

Default
`False`

Enables or disables publication of error events.

instance_format

Type
string

Default
`"[instance: %(uuid)s] "`

The format for an instance that is passed with the log message.

instance_uuid_format

Type
string

Default
`"[instance: %(uuid)s] "`

The format for an instance UUID that is passed with the log message.

rate_limit_interval

Type
integer

Default
`0`

Interval, number of seconds, of log rate limiting.

rate_limit_burst

Type
integer

Default
`0`

Maximum number of logged messages per rate_limit_interval.

rate_limit_except_level

Type
string

Default
`CRITICAL`

Valid Values
CRITICAL, ERROR, INFO, WARNING, DEBUG,

Log level name used by rate limiting. Logs with level greater or equal to rate_limit_except_level are not filtered. An empty string means that all levels are filtered.

`fatal_deprecations`

Type
boolean

Default
`False`

Enables or disables fatal status of deprecations.

`internal_service_availability_zone`

Type
string

Default
`internal`

Availability zone for internal services.

This option determines the availability zone for the various internal nova services, such as nova-scheduler, nova-conductor, etc.

Possible values:

- Any string representing an existing availability zone name.

`default_availability_zone`

Type
string

Default
`nova`

Default availability zone for compute services.

This option determines the default availability zone for nova-compute services, which will be used if the service(s) do not belong to aggregates with availability zone metadata.

Possible values:

- Any string representing an existing availability zone name.

`default_schedule_zone`

Type
string

Default
`<None>`

Default availability zone for instances.

This option determines the default availability zone for instances, which will be used when a user does not specify one when creating an instance. The instance(s) will be bound to this availability zone for their lifetime.

Possible values:

- Any string representing an existing availability zone name.
- None, which means that the instance can move from one availability zone to another during its lifetime if it is moved from one compute node to another.

Related options:

- `[cinder]/cross_az_attach`

password_length

Type
integer

Default
12

Minimum Value
0

Length of generated instance admin passwords.

instance_usage_audit_period

Type
string

Default
month

Time period to generate instance usages for. It is possible to define optional offset to given period by appending @ character followed by a number defining offset.

Possible values:

- period, example: `hour`, `day`, `month` or ``year`
- period with offset, example: `month@15` will result in monthly audits starting on 15th day of month.

use_rootwrap_daemon

Type
boolean

Default
False

Start and use a daemon that can run the commands that need to be run with root privileges. This option is usually enabled on nodes that run nova compute processes.

rootwrap_config

Type
string

Default
`/etc/nova/rootwrap.conf`

Path to the rootwrap configuration file.

Goal of the root wrapper is to allow a service-specific unprivileged user to run a number of actions as the root user in the safest manner possible. The configuration file used here must match the one defined in the sudoers entry.

`tempdir`

Type
string

Default
`<None>`

Explicitly specify the temporary working directory.

`default_green_pool_size`

Type
integer

Default
`1000`

Minimum Value
100

The total number of coroutines that can be run via novas default greenthread pool concurrently, defaults to 1000, min value is 100. It is only used if the service is running in Eventlet mode.

Warning

This option is deprecated for removal since 32.0.0. Its value may be silently ignored in the future.

Reason
This option is only used if the service is running in Eventlet mode. When that mode is removed this config option will be removed too.

`default_thread_pool_size`

Type
integer

Default
`10`

Minimum Value
1

The total number of threads that can be run via novas default thread pool concurrently. It is only used if the service is running in native threading mode.

`cell_worker_thread_pool_size`

Type
integer

Default
5

Minimum Value
1

The number of tasks that can run concurrently, one for each cell, for operations requires cross cell data gathering a.k.a scatter-gather, like listing instances across multiple cells. This is only used if the service is running in native thread mode.

`thread_pool_statistic_period`

Type
integer

Default
-1

Minimum Value
-1

When new work is submitted to any of the thread pools nova logs the statistics of the pool (work executed, threads available, work queued, etc). This parameter defines how frequently such logging happens from a specific pool in seconds. A value of 60 means that statistic will be logged from a pool maximum once every 60 seconds. The value 0 means that logging happens every time work is submitted to the pool. The value -1 means the logging is disabled.

`compute_driver`

Type
string

Default
<None>

Defines which driver to use for controlling virtualization.

Possible values:

- `libvirt.LibvirtDriver`
- `fake.FakeDriver`
- `ironic.IronicDriver`
- `vmwareapi.VMwareVCDriver`
- `zvm.ZVMDriver`

`allow_resize_to_same_host`

Type
boolean

Default
`False`

Allow destination machine to match source for resize. Useful when testing in single-host environments. By default it is not allowed to resize to the same host. Setting this option to true will add the same host to the destination options. Also set to true if you allow the ServerGroupAffinityFilter and need to resize. For changes to this option to take effect, the nova-api service needs to be restarted.

`non_inheritable_image_properties`

Type
list

Default
`['cache_in_nova', 'bittorrent']`

Image properties that should not be inherited from the instance when taking a snapshot.

This option gives an opportunity to select which image-properties should not be inherited by newly created snapshots.

Note

The following image properties are *never* inherited regardless of whether they are listed in this configuration option or not:

- cinder_encryption_key_id
- cinder_encryption_key_deletion_policy
- img_signature
- img_signature_hash_method
- img_signature_key_type
- img_signature_certificate_uuid

Possible values:

- A comma-separated list whose item is an image property. Usually only the image properties that are only needed by base images can be included here, since the snapshots that are created from the base images dont need them.
- Default list: cache_in_nova, bittorrent

`max_local_block_devices`

Type
integer

Default
3

Maximum number of devices that will result in a local image being created on the hypervisor node.

A negative number means unlimited. Setting `max_local_block_devices` to 0 means that any request that attempts to create a local disk will fail. This option is meant to limit the number of local discs (so root local disc that is the result of `imageRef` being used when creating a server, and any other ephemeral and swap disks). 0 does not mean that images will be automatically converted

to volumes and boot instances from volumes - it just means that all requests that attempt to create a local disk will fail.

Possible values:

- 0: Creating a local disk is not allowed.
- Negative number: Allows unlimited number of local discs.
- Positive number: Allows only these many number of local discs.

`compute_monitors`

Type
list

Default
`[]`

A comma-separated list of monitors that can be used for getting compute metrics. You can use the alias/name from the setuptools entry points for nova.compute.monitors.* namespaces. If no namespace is supplied, the cpu. namespace is assumed for backwards-compatibility.

NOTE: Only one monitor per namespace (For example: cpu) can be loaded at a time.

Possible values:

- An empty list will disable the feature (Default).
- An example value that would enable the CPU bandwidth monitor that uses the virt driver variant:

```
compute_monitors = cpu.virt_driver
```

`default_ephemeral_format`

Type
string

Default
<None>

The default format an ephemeral_volume will be formatted with on creation.

Possible values:

- `ext2`
- `ext3`
- `ext4`
- `xfs`
- `ntfs` (only for Windows guests)

`vif_plugging_is_fatal`

Type
boolean

Default
`True`

Determine if instance should boot or fail on VIF plugging timeout.

Nova sends a port update to Neutron after an instance has been scheduled, providing Neutron with the necessary information to finish setup of the port. Once completed, Neutron notifies Nova that it has finished setting up the port, at which point Nova resumes the boot of the instance since network connectivity is now supposed to be present. A timeout will occur if the reply is not received after a given interval.

This option determines what Nova does when the VIF plugging timeout event happens. When enabled, the instance will error out. When disabled, the instance will continue to boot on the assumption that the port is ready.

Possible values:

- True: Instances should fail after VIF plugging timeout
- False: Instances should continue booting after VIF plugging timeout

`vif_plugging_timeout`

Type
integer

Default
`300`

Minimum Value
0

Timeout for Neutron VIF plugging event message arrival.

Number of seconds to wait for Neutron vif plugging events to arrive before continuing or failing (see vif_plugging_is_fatal).

If you are hitting timeout failures at scale, consider running rootwrap in daemon mode in the neutron agent via the `[agent]/root_helper_daemon` neutron configuration option.

Related options:

- vif_plugging_is_fatal - If `vif_plugging_timeout` is set to zero and `vif_plugging_is_fatal` is False, events should not be expected to arrive at all.

`arq_binding_timeout`

Type
integer

Default
`300`

Minimum Value
1

Timeout for Accelerator Request (ARQ) bind event message arrival.

Number of seconds to wait for ARQ bind resolution event to arrive. The event indicates that every ARQ for an instance has either bound successfully or failed to bind. If it does not arrive, instance bringup is aborted with an exception.

`injected_network_template`

Type
string

Default
`$pybasedir/nova/virt/interfaces.template`

Path to /etc/network/interfaces template.

The path to a template file for the /etc/network/interfaces-style file, which will be populated by nova and subsequently used by cloudinit. This provides a method to configure network connectivity in environments without a DHCP server.

The template will be rendered using Jinja2 template engine, and receive a top-level key called `interfaces`. This key will contain a list of dictionaries, one for each interface.

Refer to the cloudinit documentation for more information:

https://cloudinit.readthedocs.io/en/latest/topics/datasources.html

Possible values:

- A path to a Jinja2-formatted template for a Debian /etc/network/interfaces file. This applies even if using a non Debian-derived guest.

Related options:

- `flat_inject`: This must be set to `True` to ensure nova embeds network configuration information in the metadata provided through the config drive.

`preallocate_images`

Type
string

Default
`none`

Valid Values
none, space

The image preallocation mode to use.

Image preallocation allows storage for instance images to be allocated up front when the instance is initially provisioned. This ensures immediate feedback is given if enough space isnt available. In addition, it should significantly improve performance on writes to new blocks and may even improve I/O performance to prewritten blocks due to reduced fragmentation.

Possible values

none
No storage provisioning is done up front

space
Storage is fully allocated at instance start

`use_cow_images`

Type
boolean

Default
`True`

Enable use of copy-on-write (cow) images.

QEMU/KVM allow the use of qcow2 as backing files. By disabling this, backing files will not be used.

`force_raw_images`

Type
boolean

Default
`True`

Force conversion of backing images to raw format.

Possible values:

- True: Backing image files will be converted to raw image format
- False: Backing image files will not be converted

Related options:

- `compute_driver`: Only the libvirt driver uses this option.
- `[libvirt]/images_type`: If images_type is rbd, setting this option to False is not allowed. See the bug https://bugs.launchpad.net/nova/+bug/1816686 for more details.

`virt_mkfs`

Type
multi-valued

Default
`''`

Name of the mkfs commands for ephemeral device.

The format is <os_type>=<mkfs command>

`resize_fs_using_block_device`

Type
boolean

Default
`False`

Enable resizing of filesystems via a block device.

If enabled, attempt to resize the filesystem by accessing the image over a block device. This is done by the host and may not be necessary if the image contains a recent version of cloud-init. Possible mechanisms require the nbd driver (for qcow and raw), or loop (for raw).

`timeout_nbd`

Type
integer

Default
10

Minimum Value
0

Amount of time, in seconds, to wait for NBD device start up.

`pointer_model`

Type
string

Default
`usbtablet`

Valid Values
ps2mouse, usbtablet, <None>

Generic property to specify the pointer type.

Input devices allow interaction with a graphical framebuffer. For example to provide a graphic tablet for absolute cursor movement.

If set, either the `hw_input_bus` or `hw_pointer_model` image metadata properties will take precedence over this configuration option.

Related options:

- usbtablet must be configured with VNC enabled or SPICE enabled and SPICE agent disabled. When used with libvirt the instance mode should be configured as HVM.

Possible values

ps2mouse
Uses relative movement. Mouse connected by PS2

usbtablet
Uses absolute movement. Tablet connect by USB

<None>
Uses default behavior provided by drivers (mouse on PS2 for libvirt x86)

`reimage_timeout_per_gb`

Type
integer

Default
20

Minimum Value
1

Timeout for reimaging a volume.

Number of seconds to wait for volume-reimaged events to arrive before continuing or failing.

This is a per gigabyte time which has a default value of 20 seconds and will be multiplied by the GB size of image. Eg: an image of 6 GB will have a timeout of 20 * 6 = 120 seconds. Try increasing the timeout if the image copy per GB takes more time and you are hitting timeout failures.

vcpu_pin_set

Type
string

Default
<None>

Mask of host CPUs that can be used for `VCPU` resources.

The behavior of this option depends on the definition of the `[compute] cpu_dedicated_set` option and affects the behavior of the `[compute] cpu_shared_set` option.

- If `[compute] cpu_dedicated_set` is defined, defining this option will result in an error.
- If `[compute] cpu_dedicated_set` is not defined, this option will be used to determine inventory for `VCPU` resources and to limit the host CPUs that both pinned and unpinned instances can be scheduled to, overriding the `[compute] cpu_shared_set` option.

Possible values:

- A comma-separated list of physical CPU numbers that virtual CPUs can be allocated from. Each element should be either a single CPU number, a range of CPU numbers, or a caret followed by a CPU number to be excluded from a previous range. For example:

```
vcpu_pin_set = "4-12,^8,15"
```

Related options:

- `[compute] cpu_dedicated_set`
- `[compute] cpu_shared_set`

Warning

This option is deprecated for removal since 20.0.0. Its value may be silently ignored in the future.

Reason
This option has been superseded by the `[compute] cpu_dedicated_set` and `[compute] cpu_shared_set` options, which allow things like the co-existence of pinned and unpinned instances on the same host (for the libvirt driver).

reserved_huge_pages

Type
unknown type

Default
<None>

Number of huge/large memory pages to reserve per NUMA host cell.

Possible values:

- A list of valid key=value which reflect NUMA node ID, page size (Default unit is KiB) and number of pages to be reserved. For example:

```
reserved_huge_pages = node:0,size:2048,count:64
reserved_huge_pages = node:1,size:1GB,count:1
```

In this example we are reserving on NUMA node 0 64 pages of 2MiB and on NUMA node 1 1 page of 1GiB.

`reserved_host_disk_mb`

Type
integer

Default
`0`

Minimum Value
0

Amount of disk resources in MB to make them always available to host. The disk usage gets reported back to the scheduler from nova-compute running on the compute nodes. To prevent the disk resources from being considered as available, this option can be used to reserve disk space for that host.

Possible values:

- Any positive integer representing amount of disk in MB to reserve for the host.

`reserved_host_memory_mb`

Type
integer

Default
`512`

Minimum Value
0

Amount of memory in MB to reserve for the host so that it is always available to host processes. The host resources usage is reported back to the scheduler continuously from nova-compute running on the compute node. To prevent the host memory from being considered as available, this option is used to reserve memory for the host.

Possible values:

- Any positive integer representing amount of memory in MB to reserve for the host.

`reserved_host_cpus`

Type
integer

Default
`0`

Minimum Value
0

Number of host CPUs to reserve for host processes.

The host resources usage is reported back to the scheduler continuously from nova-compute running on the compute node. This value is used to determine the `reserved` value reported to placement.

This option cannot be set if the `[compute] cpu_shared_set` or `[compute] cpu_dedicated_set` config options have been defined. When these options are defined, any host CPUs not included in these values are considered reserved for the host.

Possible values:

- Any positive integer representing number of physical CPUs to reserve for the host.

Related options:

- `[compute] cpu_shared_set`
- `[compute] cpu_dedicated_set`

`cpu_allocation_ratio`

Type
floating point

Default
<None>

Minimum Value
0.0

Virtual CPU to physical CPU allocation ratio.

This option is used to influence the hosts selected by the Placement API by configuring the allocation ratio for `VCPU` inventory.

Note

This option does not affect `PCPU` inventory, which cannot be overcommitted.

Note

If this option is set to something *other than* `None` or `0.0`, the allocation ratio will be overwritten by the value of this option, otherwise, the allocation ratio will not change. Once set to a non-default value, it is not possible to unset the config to get back to the default behavior. If you want to reset back to the initial value, explicitly specify it to the value of `initial_cpu_allocation_ratio`.

Possible values:

- Any valid positive integer or float value

Related options:

- `initial_cpu_allocation_ratio`

`ram_allocation_ratio`

Type
floating point

Default
<None>

Minimum Value
0.0

Virtual RAM to physical RAM allocation ratio.

This option is used to influence the hosts selected by the Placement API by configuring the allocation ratio for `MEMORY_MB` inventory.

Note

If this option is set to something *other than* `None` or `0.0`, the allocation ratio will be overwritten by the value of this option, otherwise, the allocation ratio will not change. Once set to a non-default value, it is not possible to unset the config to get back to the default behavior. If you want to reset back to the initial value, explicitly specify it to the value of `initial_ram_allocation_ratio`.

Possible values:

- Any valid positive integer or float value

Related options:

- `initial_ram_allocation_ratio`

`disk_allocation_ratio`

Type
floating point

Default
<None>

Minimum Value
0.0

Virtual disk to physical disk allocation ratio.

This option is used to influence the hosts selected by the Placement API by configuring the allocation ratio for `DISK_GB` inventory.

When configured, a ratio greater than 1.0 will result in over-subscription of the available physical disk, which can be useful for more efficiently packing instances created with images that do not use the entire virtual disk, such as sparse or compressed images. It can be set to a value between 0.0 and 1.0 in order to preserve a percentage of the disk for uses other than instances.

Note

If the value is set to >1, we recommend keeping track of the free disk space, as the value approaching `0` may result in the incorrect functioning of instances using it at the moment.

Note

If this option is set to something *other than* `None` or `0.0`, the allocation ratio will be overwritten by the value of this option, otherwise, the allocation ratio will not change. Once set to a non-default value, it is not possible to unset the config to get back to the default behavior. If you want to reset back to the initial value, explicitly specify it to the value of `initial_disk_allocation_ratio`.

Possible values:

- Any valid positive integer or float value

Related options:

- `initial_disk_allocation_ratio`

`initial_cpu_allocation_ratio`

Type
floating point

Default
`4.0`

Minimum Value
0.0

Initial virtual CPU to physical CPU allocation ratio.

This is only used when initially creating the `computes_nodes` table record for a given nova-compute service.

See https://docs.openstack.org/nova/latest/admin/configuration/schedulers.html for more details and usage scenarios.

Related options:

- `cpu_allocation_ratio`

`initial_ram_allocation_ratio`

Type
floating point

Default
`1.0`

Minimum Value
0.0

Initial virtual RAM to physical RAM allocation ratio.

This is only used when initially creating the `computes_nodes` table record for a given nova-compute service.

See https://docs.openstack.org/nova/latest/admin/configuration/schedulers.html for more details and usage scenarios.

Related options:

- `ram_allocation_ratio`

`initial_disk_allocation_ratio`

Type
floating point

Default
`1.0`

Minimum Value
0.0

Initial virtual disk to physical disk allocation ratio.

This is only used when initially creating the `computes_nodes` table record for a given nova-compute service.

See https://docs.openstack.org/nova/latest/admin/configuration/schedulers.html for more details and usage scenarios.

Related options:

- `disk_allocation_ratio`

`console_host`

Type
string

Default
`<current_hostname>`

This option has a sample default set, which means that its actual default value may vary from the one documented above.

Console proxy host to be used to connect to instances on this host. It is the publicly visible name for the console host.

Possible values:

- Current hostname (default) or any string representing hostname.

`default_access_ip_network_name`

Type
string

Default
`<None>`

Name of the network to be used to set access IPs for instances. If there are multiple IPs to choose from, an arbitrary one will be chosen.

Possible values:

- None (default)
- Any string representing network name.

`instances_path`

Type
string

Default
`$state_path/instances`

This option has a sample default set, which means that its actual default value may vary from the one documented above.

Specifies where instances are stored on the hypervisors disk. It can point to locally attached storage or a directory on NFS.

Possible values:

- $state_path/instances where state_path is a config option that specifies the top-level directory for maintaining novas state. (default) or Any string representing directory path.

Related options:

- `[workarounds]/ensure_libvirt_rbd_instance_dir_cleanup`

`instance_usage_audit`

Type
boolean

Default
`False`

This option enables periodic compute.instance.exists notifications. Each compute node must be configured to generate system usage data. These notifications are consumed by OpenStack Telemetry service.

`live_migration_retry_count`

Type
integer

Default
`30`

Minimum Value
0

Advanced Option
Intended for advanced users and not used by the majority of users, and might have a significant effect on stability and/or performance.

This option controls the maximum number of attempts to plug VIFs on the destination host. Historically this could fail due to rate limiting in iptables. Operators should not need to modify this value from its default.

Possible values:

- Any positive integer representing retry count.

`resume_guests_state_on_host_boot`

Type
boolean

Default
`False`

This option specifies whether to start guests that were running before the host rebooted. It ensures that all of the instances on a Nova compute node resume their state each time the compute node boots or restarts.

`network_allocate_retries`

Type
integer

Default
`0`

Minimum Value
0

Number of times to retry network allocation. It is required to attempt network allocation retries if the virtual interface plug fails.

Possible values:

- Any positive integer representing retry count.

`max_concurrent_builds`

Type
integer

Default
`10`

Minimum Value
0

Limits the maximum number of instance builds to run concurrently by nova-compute. Compute service can attempt to build an infinite number of instances, if asked to do so. This limit is enforced to avoid building unlimited instance concurrently on a compute node. This value can be set per compute node.

Possible Values:

- 0 : treated as unlimited.
- Any positive integer representing maximum concurrent builds.

`max_concurrent_snapshots`

Type
integer

Default
`5`

Minimum Value
0

Maximum number of instance snapshot operations to run concurrently. This limit is enforced to prevent snapshots overwhelming the host/network/storage and causing failure. This value can be set per compute node.

Possible Values:

- 0 : treated as unlimited.

- Any positive integer representing maximum concurrent snapshots.

`max_concurrent_live_migrations`

Type
integer

Default
1

Minimum Value
0

Maximum number of live migrations to run concurrently. This limit is enforced to avoid outbound live migrations overwhelming the host/network and causing failures. It is not recommended that you change this unless you are very sure that doing so is safe and stable in your environment.

Possible values:

- `0`: Deprecated since 33.0.0 (2026.1 Gazpacho). This value was previously documented as meaning unlimited but the actual implementation used maximum 1000 greenthreads. Since this release, the implementation keep using 1000 greenthreads in eventlet mode and will use 5 native threads in threading mode. In the future release when eventlet support is removed, 0 as a valid value will also be removed.
- Any positive integer representing maximum number of live migrations to run concurrently.

`block_device_allocate_retries`

Type
integer

Default
`60`

Minimum Value
0

The number of times to check for a volume to be available before attaching it during server create.

When creating a server with block device mappings where `source_type` is one of `blank`, `image` or `snapshot` and the `destination_type` is `volume`, the `nova-compute` service will create a volume and then attach it to the server. Before the volume can be attached, it must be in status available. This option controls how many times to check for the created volume to be available before it is attached.

If the operation times out, the volume will be deleted if the block device mapping `delete_on_termination` value is True.

It is recommended to configure the image cache in the block storage service to speed up this operation. See https://docs.openstack.org/cinder/latest/admin/blockstorage-image-volume-cache.html for details.

Possible values:

- 60 (default)
- If value is 0, then one attempt is made.
- For any value > 0, total attempts are (value + 1)

Related options:

- `block_device_allocate_retries_interval` - controls the interval between checks

`sync_power_state_pool_size`

Type
integer

Default
`5`

Number of threads available for use to sync instance power states.

This option can be used to reduce the number of concurrent requests made to the hypervisor or system with real instance power states for performance reasons, for example, with Ironic.

Possible values:

- Any positive integer representing threads count.

`sync_power_state_interval`

Type
integer

Default
`600`

Interval to sync power states between the database and the hypervisor.

The interval that Nova checks the actual virtual machine power state and the power state that Nova has in its database. If a user powers down their VM, Nova updates the API to report the VM has been powered down. Should something turn on the VM unexpectedly, Nova will turn the VM back off to keep the system in the expected state.

Possible values:

- 0: Will run at the default periodic interval.
- Any value < 0: Disables the option.
- Any positive integer in seconds.

Related options:

- If `handle_virt_lifecycle_events` in the `workarounds` group is false and this option is negative, then instances that get out of sync between the hypervisor and the Nova database will have to be synchronized manually.

`heal_instance_info_cache_interval`

Type
integer

Default
`-1`

Interval between instance network information cache updates.

Number of seconds after which each compute node runs the task of querying Neutron for all of its instances networking information, then updates the Nova db with that information. Nova will not update its cache periodically if this option is set to <= 0. Nova will still react to network-changed

external events to update its cache. Each in tree neutron backend is sending network-changed external events to update novas view. So in these deployment scenarios this periodic is safe to be turned off. Out of tree neutron backends might not send this event and if the cache is not up to date, then the metadata service and nova-api endpoints will be proxying incorrect network data about the instance. So for these backends it is not recommended to turn the periodic off.

Possible values:

- Any positive integer in seconds.
- Any value <=0 will disable the sync.

`reclaim_instance_interval`

Type
integer

Default
`0`

Interval for reclaiming deleted instances.

A value greater than 0 will enable SOFT_DELETE of instances. This option decides whether the server to be deleted will be put into the SOFT_DELETED state. If this value is greater than 0, the deleted server will not be deleted immediately, instead it will be put into a queue until its too old (deleted time greater than the value of reclaim_instance_interval). The server can be recovered from the delete queue by using the restore action. If the deleted server remains longer than the value of reclaim_instance_interval, it will be deleted by a periodic task in the compute service automatically.

Note that this option is read from both the API and compute nodes, and must be set globally otherwise servers could be put into a soft deleted state in the API and never actually reclaimed (deleted) on the compute node.

Note

When using this option, you should also configure the `[cinder]` auth options, e.g. `auth_type`, `auth_url`, `username`, etc. Since the reclaim happens in a periodic task, there is no user token to cleanup volumes attached to any SOFT_DELETED servers so nova must be configured with administrator role access to cleanup those resources in cinder.

Possible values:

- Any positive integer(in seconds) greater than 0 will enable this option.
- Any value <=0 will disable the option.

Related options:

- [cinder] auth options for cleaning up volumes attached to servers during the reclaim process

`volume_usage_poll_interval`

Type
integer

Default
`0`

Interval for gathering volume usages.

This option updates the volume usage cache for every volume_usage_poll_interval number of seconds.

Possible values:

- Any positive integer(in seconds) greater than 0 will enable this option.
- Any value <=0 will disable the option.

`shelved_poll_interval`

Type
integer

Default
`3600`

Interval for polling shelved instances to offload.

The periodic task runs for every shelved_poll_interval number of seconds and checks if there are any shelved instances. If it finds a shelved instance, based on the shelved_offload_time config value it offloads the shelved instances. Check shelved_offload_time config option description for details.

Possible values:

- Any value <= 0: Disables the option.
- Any positive integer in seconds.

Related options:

- `shelved_offload_time`

`shelved_offload_time`

Type
integer

Default
`0`

Time before a shelved instance is eligible for removal from a host.

By default this option is set to 0 and the shelved instance will be removed from the hypervisor immediately after shelve operation. Otherwise, the instance will be kept for the value of shelved_offload_time(in seconds) so that during the time period the unshelve action will be faster, then the periodic task will remove the instance from hypervisor after shelved_offload_time passes.

Possible values:

- **0: Instance will be immediately offloaded after being**
  shelved.
- Any value < 0: An instance will never offload.
- Any positive integer in seconds: The instance will exist for the specified number of seconds before being offloaded.

`instance_delete_interval`

Type
integer

Default
`300`

Interval for retrying failed instance file deletes.

This option depends on maximum_instance_delete_attempts. This option specifies how often to retry deletes whereas maximum_instance_delete_attempts specifies the maximum number of retry attempts that can be made.

Possible values:

- 0: Will run at the default periodic interval.
- Any value < 0: Disables the option.
- Any positive integer in seconds.

Related options:

- `maximum_instance_delete_attempts` from instance_cleaning_opts group.

`block_device_allocate_retries_interval`

Type
integer

Default
3

Minimum Value
0

Interval (in seconds) between block device allocation retries on failures.

This option allows the user to specify the time interval between consecutive retries. The `block_device_allocate_retries` option specifies the maximum number of retries.

Possible values:

- 0: Disables the option.
- Any positive integer in seconds enables the option.

Related options:

- `block_device_allocate_retries` - controls the number of retries

`scheduler_instance_sync_interval`

Type
integer

Default
`120`

Interval between sending the scheduler a list of current instance UUIDs to verify that its view of instances is in sync with nova.

If the CONF option scheduler_tracks_instance_changes is False, the sync calls will not be made. So, changing this option will have no effect.

If the out of sync situations are not very common, this interval can be increased to lower the number of RPC messages being sent. Likewise, if sync issues turn out to be a problem, the interval can be lowered to check more frequently.

Possible values:

- 0: Will run at the default periodic interval.
- Any value < 0: Disables the option.
- Any positive integer in seconds.

Related options:

- This option has no impact if `scheduler_tracks_instance_changes` is set to False.

`update_resources_interval`

Type
integer

Default
`0`

Interval for updating compute resources.

This option specifies how often the update_available_resource periodic task should run. A number less than 0 means to disable the task completely. Leaving this at the default of 0 will cause this to run at the default periodic interval. Setting it to any positive value will cause it to run at approximately that number of seconds.

Possible values:

- 0: Will run at the default periodic interval.
- Any value < 0: Disables the option.
- Any positive integer in seconds.

`reboot_timeout`

Type
integer

Default
`0`

Minimum Value
0

Time interval after which an instance is hard rebooted automatically.

When doing a soft reboot, it is possible that a guest kernel is completely hung in a way that causes the soft reboot task to not ever finish. Setting this option to a time period in seconds will automatically hard reboot an instance if it has been stuck in a rebooting state longer than N seconds.

Possible values:

- 0: Disables the option (default).

- Any positive integer in seconds: Enables the option.

`instance_build_timeout`

Type
integer

Default
`0`

Minimum Value
0

Maximum time in seconds that an instance can take to build.

If this timer expires, instance status will be changed to ERROR. Enabling this option will make sure an instance will not be stuck in BUILD state for a longer period.

Possible values:

- 0: Disables the option (default)
- Any positive integer in seconds: Enables the option.

`rescue_timeout`

Type
integer

Default
`0`

Minimum Value
0

Interval to wait before un-rescuing an instance stuck in RESCUE.

Possible values:

- 0: Disables the option (default)
- Any positive integer in seconds: Enables the option.

`resize_confirm_window`

Type
integer

Default
`0`

Minimum Value
0

Automatically confirm resizes after N seconds.

Resize functionality will save the existing server before resizing. After the resize completes, user is requested to confirm the resize. The user has the opportunity to either confirm or revert all changes. Confirm resize removes the original server and changes server status from resized to active. Setting this option to a time period (in seconds) will automatically confirm the resize if the server is in resized state longer than that time.

Possible values:

- 0: Disables the option (default)
- Any positive integer in seconds: Enables the option.

`shutdown_timeout`

Type
integer

Default
`60`

Minimum Value
0

Total time to wait in seconds for an instance to perform a clean shutdown.

It determines the overall period (in seconds) a VM is allowed to perform a clean shutdown. While performing stop, rescue and shelve, rebuild operations, configuring this option gives the VM a chance to perform a controlled shutdown before the instance is powered off. The default timeout is 60 seconds. A value of 0 (zero) means the guest will be powered off immediately with no opportunity for guest OS clean-up.

The timeout value can be overridden on a per image basis by means of os_shutdown_timeout that is an image metadata setting allowing different types of operating systems to specify how much time they need to shut down cleanly.

Possible values:

- A positive integer or 0 (default value is 60).

`running_deleted_instance_action`

Type
string

Default
`reap`

Valid Values
reap, log, shutdown, noop

The compute service periodically checks for instances that have been deleted in the database but remain running on the compute node. The above option enables action to be taken when such instances are identified.

Related options:

- `running_deleted_instance_poll_interval`
- `running_deleted_instance_timeout`

Possible values

reap
Powers down the instances and deletes them

log
Logs warning message about deletion of the resource

shutdown
Powers down instances and marks them as non-bootable which can be later used for debugging/analysis

noop
Takes no action

`running_deleted_instance_poll_interval`

Type
integer

Default
`1800`

Time interval in seconds to wait between runs for the clean up action. If set to 0, above check will be disabled. If running_deleted_instance _action is set to log or reap, a value greater than 0 must be set.

Possible values:

- Any positive integer in seconds enables the option.
- 0: Disables the option.
- 1800: Default value.

Related options:

- running_deleted_instance_action

`running_deleted_instance_timeout`

Type
integer

Default
`0`

Time interval in seconds to wait for the instances that have been marked as deleted in database to be eligible for cleanup.

Possible values:

- Any positive integer in seconds(default is 0).

Related options:

- running_deleted_instance_action

`maximum_instance_delete_attempts`

Type
integer

Default
`5`

Minimum Value
1

The number of times to attempt to reap an instances files.

This option specifies the maximum number of retry attempts that can be made.

Possible values:

- Any positive integer defines how many attempts are made.

Related options:

- `[DEFAULT] instance_delete_interval` can be used to disable this option.

`osapi_compute_unique_server_name_scope`

Type
string

Default
''

Valid Values
, project, global

Sets the scope of the check for unique instance names.

The default doesnt check for unique names. If a scope for the name check is set, a launch of a new instance or an update of an existing instance with a duplicate name will result in an InstanceExists error. The uniqueness is case-insensitive. Setting this option can increase the usability for end users as they dont have to distinguish among instances with the same name by their IDs.

Possible values

An empty value means that no uniqueness check is done and duplicate names are possible

project
The instance name check is done only for instances within the same project

global
The instance name check is done for all instances regardless of the project

`enable_new_services`

Type
boolean

Default
`True`

Enable new nova-compute services on this host automatically.

When a new nova-compute service starts up, it gets registered in the database as an enabled service. Sometimes it can be useful to register new compute services in disabled state and then enabled them at a later point in time. This option only sets this behavior for nova-compute services, it does not auto-disable other services like nova-conductor, nova-scheduler, or nova-osapi_compute.

Possible values:

- `True`: Each new compute service is enabled as soon as it registers itself.

- `False`: Compute services must be enabled via an os-services REST API call or with the CLI with `nova service-enable <hostname> <binary>`, otherwise they are not ready to use.

`instance_name_template`

Type
string

Default
`instance-%08x`

Template string to be used to generate instance names.

This template controls the creation of the database name of an instance. This is *not* the display name you enter when creating an instance (via Horizon or CLI). For a new deployment it is advisable to change the default value (which uses the database autoincrement) to another value which makes use of the attributes of an instance, like `instance-%(uuid)s`. If you already have instances in your deployment when you change this, your deployment will break.

Possible values:

- A string which either uses the instance database ID (like the default)
- A string with a list of named database columns, for example `%(id)d` or `%(uuid)s` or `%(hostname)s`.

`migrate_max_retries`

Type
integer

Default
-1

Minimum Value
-1

Number of times to retry live-migration before failing.

Possible values:

- If == -1, try until out of hosts (default)
- If == 0, only try once, no retries
- Integer greater than 0

`config_drive_format`

Type
string

Default
`iso9660`

Valid Values
iso9660, vfat

Config drive format.

Config drive format that will contain metadata attached to the instance when it boots.

Related options:

- This option is meaningful when one of the following alternatives occur:
  1. `force_config_drive` option set to `true`
  2. the REST API call to create the instance contains an enable flag for config drive option
  3. the image used to create the instance requires a config drive, this is defined by `img_config_drive` property for that image.

Possible values

iso9660
A file system image standard that is widely supported across operating systems.

vfat
Provided for legacy reasons and to enable live migration with the libvirt driver and non-shared storage

Warning

This option is deprecated for removal since 19.0.0. Its value may be silently ignored in the future.

Reason
This option was originally added as a workaround for bug in libvirt, #1246201, that was resolved in libvirt v1.2.17. As a result, this option is no longer necessary or useful.

`force_config_drive`

Type
boolean

Default
`False`

Force injection to take place on a config drive

When this option is set to true config drive functionality will be forced enabled by default, otherwise users can still enable config drives via the REST API or image metadata properties. Launched instances are not affected by this option.

Possible values:

- **True: Force to use of config drive regardless the users input in the** REST API call.
- **False: Do not force use of config drive. Config drives can still be** enabled via the REST API or image metadata properties.

Related options:

- Use the mkisofs_cmd flag to set the path where you install the genisoimage program. If genisoimage is in same path as the nova-compute service, you do not need to set this flag.

`mkisofs_cmd`

Type
string

Default
`genisoimage`

Name or path of the tool used for ISO image creation.

Use the `mkisofs_cmd` flag to set the path where you install the `genisoimage` program. If `genisoimage` is on the system path, you do not need to change the default value.

Possible values:

- Name of the ISO image creator program, in case it is in the same directory as the nova-compute service
- Path to ISO image creator program

Related options:

- This option is meaningful when config drives are enabled.

`my_ip`

Type
string

Default
`<host_ipv4>`

This option has a sample default set, which means that its actual default value may vary from the one documented above.

The IP address which the host is using to connect to the management network.

Possible values:

- String with valid IP address. Default is IPv4 address of this host.

Related options:

- my_block_storage_ip
- my_shared_fs_storage_ip

`my_block_storage_ip`

Type
string

Default
`$my_ip`

The IP address which is used to connect to the block storage network.

Possible values:

- String with valid IP address. Default is IP address of this host.

Related options:

- my_ip - if my_block_storage_ip is not set, then my_ip value is used.

`my_shared_fs_storage_ip`

Type
string

Default
`$my_ip`

The IP address which is used to connect to the shared_fs storage (manila) network.

Possible values:

- String with valid IP address. Default is IP address of this host.

Related options:

- my_ip - if my_shared_fs_storage_ip is not set, then my_ip value is used.

`host`

Type
unknown type

Default
`<current_hostname>`

This option has a sample default set, which means that its actual default value may vary from the one documented above.

Hostname, FQDN or IP address of this host.

Used as:

- the oslo.messaging queue name for nova-compute worker
- we use this value for the binding_host sent to neutron. This means if you use a neutron agent, it should have the same value for host.
- cinder host attachment information

Must be valid within AMQP key.

Possible values:

- String with hostname, FQDN or IP address. Default is hostname of this host.

`flat_injected`

Type
boolean

Default
`False`

This option determines whether the network setup information is injected into the VM before it is booted. While it was originally designed to be used only by nova-network, it is also used by the vmware virt driver to control whether network information is injected into a VM. The libvirt virt driver also uses it when we use config_drive to configure network to control whether network information is injected into a VM.

`record`

Type
string

Default
<None>

Filename that will be used for storing websocket frames received and sent by a proxy service (like VNC, spice, serial) running on this host. If this is not set, no recording will be done.

`daemon`

Type
boolean

Default
`False`

Run as a background process.

`ssl_only`

Type
boolean

Default
`False`

Disallow non-encrypted connections.

Related options:

- cert
- key

`source_is_ipv6`

Type
boolean

Default
`False`

Set to True if source host is addressed with IPv6.

`cert`

Type
string

Default
`self.pem`

Path to SSL certificate file.

Related options:

- key
- ssl_only

- [console] ssl_ciphers
- [console] ssl_minimum_version

key

Type
string

Default
<None>

SSL key file (if separate from cert).

Related options:

- cert

web

Type
string

Default
/usr/share/spice-html5

Path to directory with content which will be served by a web server.

pybasedir

Type
string

Default
<Path>

This option has a sample default set, which means that its actual default value may vary from the one documented above.

The directory where the Nova python modules are installed.

This directory is used to store template files for networking and remote console access. It is also the default path for other config options which need to persist Nova internal data. It is very unlikely that you need to change this option from its default value.

Possible values:

- The full path to a directory.

Related options:

- state_path

state_path

Type
string

Default
$pybasedir

The top-level directory for maintaining Novas state.

This directory is used to store Novas internal state. It is used by a variety of other config options which derive from this. In some scenarios (for example migrations) it makes sense to use a storage location which is shared between multiple compute hosts (for example via NFS). Unless the option `instances_path` gets overwritten, this directory can grow very large.

Possible values:

- The full path to a directory. Defaults to value provided in `pybasedir`.

`long_rpc_timeout`

Type
integer

Default
`1800`

This option allows setting an alternate timeout value for RPC calls that have the potential to take a long time. If set, RPC calls to other services will use this value for the timeout (in seconds) instead of the global rpc_response_timeout value.

Operations with RPC calls that utilize this value:

- live migration
- scheduling
- enabling/disabling a compute service
- image pre-caching
- snapshot-based / cross-cell resize
- resize / cold migration
- volume attach

Related options:

- rpc_response_timeout

`report_interval`

Type
integer

Default
`10`

Number of seconds indicating how frequently the state of services on a given hypervisor is reported. Nova needs to know this to determine the overall health of the deployment.

Related Options:

- service_down_time report_interval should be less than service_down_time. If service_down_time is less than report_interval, services will routinely be considered down, because they report in too rarely.

`service_down_time`

Type
integer

Default
`60`

Maximum time in seconds since last check-in for up service

Each compute node periodically updates their database status based on the specified report interval. If the compute node hasnt updated the status for more than service_down_time, then the compute node is considered down.

Related Options:

- report_interval (service_down_time should not be less than report_interval)

`periodic_enable`

Type
boolean

Default
`True`

Enable periodic tasks.

If set to true, this option allows services to periodically run tasks on the manager.

In case of running multiple schedulers or conductors you may want to run periodic tasks on only one host - in this case disable this option for all hosts but one.

`periodic_fuzzy_delay`

Type
integer

Default
`60`

Minimum Value
0

Number of seconds to randomly delay when starting the periodic task scheduler to reduce stampeding.

When compute workers are restarted in unison across a cluster, they all end up running the periodic tasks at the same time causing problems for the external services. To mitigate this behavior, periodic_fuzzy_delay option allows you to introduce a random initial delay when starting the periodic task scheduler.

Possible Values:

- Any positive integer (in seconds)
- 0 : disable the random delay

`servicegroup_driver`

Type
string

Default
db

Valid Values
db, mc

This option specifies the driver to be used for the servicegroup service.

ServiceGroup API in nova enables checking status of a compute node. When a compute worker running the nova-compute daemon starts, it calls the join API to join the compute group. Services like nova scheduler can query the ServiceGroup API to check if a node is alive. Internally, the ServiceGroup client driver automatically updates the compute worker status. There are multiple backend implementations for this service: Database ServiceGroup driver and Memcache ServiceGroup driver.

Related Options:

- `service_down_time` (maximum time since last check-in for up service)

Possible values

db
Database ServiceGroup driver

mc
Memcache ServiceGroup driver

`executor_thread_pool_size`

Type
integer

Default
64

Size of executor thread pool when executor is threading or eventlet.

Table 12: Deprecated Variations

Group	Name
DEFAULT	rpc_thread_pool_size

`rpc_response_timeout`

Type
integer

Default
60

Seconds to wait for a response from a call.

`transport_url`

Type
string

Default
`rabbit://`

The network address and optional user credentials for connecting to the messaging backend, in URL format. The expected format is:

driver://[user:pass@]host:port[,[userN:passN@]hostN:portN]/virtual_host?query

Example: rabbit://rabbitmq:password@127.0.0.1:5672//

For full details on the fields in the URL see the documentation of oslo_messaging.TransportURL at https://docs.openstack.org/oslo.messaging/latest/reference/transport.html

`control_exchange`

Type
string

Default
`nova`

The default exchange under which topics are scoped. May be overridden by an exchange name specified in the transport_url option.

`rpc_ping_enabled`

Type
boolean

Default
`False`

Add an endpoint to answer to ping calls. Endpoint is named oslo_rpc_server_ping

api

Options under this group are used to define Nova API.

`config_drive_skip_versions`

Type
string

Default
`1.0 2007-01-19 2007-03-01 2007-08-29 2007-10-10 2007-12-15 2008-02-01 2008-09-01`

When gathering the existing metadata for a config drive, the EC2-style metadata is returned for all versions that dont appear in this option. As of the Liberty release, the available versions are:

- 1.0
- 2007-01-19
- 2007-03-01
- 2007-08-29
- 2007-10-10
- 2007-12-15

- 2008-02-01
- 2008-09-01
- 2009-04-04

The option is in the format of a single string, with each version separated by a space.

Possible values:

- Any string that represents zero or more versions, separated by spaces.

vendordata_providers

Type
list

Default
`['StaticJSON']`

A list of vendordata providers.

vendordata providers are how deployers can provide metadata via configdrive and metadata that is specific to their deployment.

For more information on the requirements for implementing a vendordata dynamic endpoint, please see the vendordata.rst file in the nova developer reference.

Related options:

- `vendordata_dynamic_targets`
- `vendordata_dynamic_ssl_certfile`
- `vendordata_dynamic_connect_timeout`
- `vendordata_dynamic_read_timeout`
- `vendordata_dynamic_failure_fatal`

vendordata_dynamic_targets

Type
list

Default
`[]`

A list of targets for the dynamic vendordata provider. These targets are of the form `<name>@<url>`.

The dynamic vendordata provider collects metadata by contacting external REST services and querying them for information about the instance. This behaviour is documented in the vendordata.rst file in the nova developer reference.

vendordata_dynamic_ssl_certfile

Type
string

Default
`''`

Path to an optional certificate file or CA bundle to verify dynamic vendordata REST services ssl certificates against.

Possible values:

- An empty string, or a path to a valid certificate file

Related options:

- vendordata_providers
- vendordata_dynamic_targets
- vendordata_dynamic_connect_timeout
- vendordata_dynamic_read_timeout
- vendordata_dynamic_failure_fatal

`vendordata_dynamic_connect_timeout`

Type
integer

Default
5

Minimum Value
3

Maximum wait time for an external REST service to connect.

Possible values:

- Any integer with a value greater than three (the TCP packet retransmission timeout). Note that instance start may be blocked during this wait time, so this value should be kept small.

Related options:

- vendordata_providers
- vendordata_dynamic_targets
- vendordata_dynamic_ssl_certfile
- vendordata_dynamic_read_timeout
- vendordata_dynamic_failure_fatal

`vendordata_dynamic_read_timeout`

Type
integer

Default
5

Minimum Value
0

Maximum wait time for an external REST service to return data once connected.

Possible values:

- Any integer. Note that instance start is blocked during this wait time, so this value should be kept small.

Related options:

- vendordata_providers
- vendordata_dynamic_targets
- vendordata_dynamic_ssl_certfile
- vendordata_dynamic_connect_timeout
- vendordata_dynamic_failure_fatal

`vendordata_dynamic_failure_fatal`

Type
boolean

Default
`False`

Should failures to fetch dynamic vendordata be fatal to instance boot?

Related options:

- vendordata_providers
- vendordata_dynamic_targets
- vendordata_dynamic_ssl_certfile
- vendordata_dynamic_connect_timeout
- vendordata_dynamic_read_timeout

`metadata_cache_expiration`

Type
integer

Default
`15`

Minimum Value
0

This option is the time (in seconds) to cache metadata. When set to 0, metadata caching is disabled entirely; this is generally not recommended for performance reasons. Increasing this setting should improve response times of the metadata API when under heavy load. Higher values may increase memory usage, and result in longer times for host metadata changes to take effect.

`local_metadata_per_cell`

Type
boolean

Default
`False`

Indicates that the nova-metadata API service has been deployed per-cell, so that we can have better performance and data isolation in a multi-cell deployment. Users should consider the use of

this configuration depending on how neutron is setup. If you have networks that span cells, you might need to run nova-metadata API service globally. If your networks are segmented along cell boundaries, then you can run nova-metadata API service per cell. When running nova-metadata API service per cell, you should also configure each Neutron metadata-agent to point to the corresponding nova-metadata API service.

dhcp_domain

Type
string

Default
`novalocal`

Domain name used to configure FQDN for instances.

Configure a fully-qualified domain name for instance hostnames. The value is suffixed to the instance hostname from the database to construct the hostname that appears in the metadata API. To disable this behavior (for example in order to correctly support microversions 2.94 FQDN hostnames), set this to the empty string.

Possible values:

- Any string that is a valid domain name.

vendordata_jsonfile_path

Type
string

Default
`<None>`

Cloud providers may store custom data in vendor data file that will then be available to the instances via the metadata service, and to the rendering of config-drive. The default class for this, JsonFileVendorData, loads this information from a JSON file, whose path is configured by this option. If there is no path set by this option, the class returns an empty dictionary.

Note that when using this to provide static vendor data to a configuration drive, the nova-compute service must be configured with this option and the file must be accessible from the nova-compute host.

Possible values:

- Any string representing the path to the data file, or an empty string (default).

max_limit

Type
integer

Default
`1000`

Minimum Value
0

As a query can potentially return many thousands of items, you can limit the maximum number of items in a single response by setting this option.

`compute_link_prefix`

Type
string

Default
<None>

This string is prepended to the normal URL that is returned in links to the OpenStack Compute API. If it is empty (the default), the URLs are returned unchanged.

Possible values:

- Any string, including an empty string (the default).

`glance_link_prefix`

Type
string

Default
<None>

This string is prepended to the normal URL that is returned in links to Glance resources. If it is empty (the default), the URLs are returned unchanged.

Possible values:

- Any string, including an empty string (the default).

`instance_list_per_project_cells`

Type
boolean

Default
`False`

When enabled, this will cause the API to only query cell databases in which the tenant has mapped instances. This requires an additional (fast) query in the API database before each list, but also (potentially) limits the number of cell databases that must be queried to provide the result. If you have a small number of cells, or tenants are likely to have instances in all cells, then this should be False. If you have many cells, especially if you confine tenants to a small subset of those cells, this should be True.

`instance_list_cells_batch_strategy`

Type
string

Default
`distributed`

Valid Values
distributed, fixed

This controls the method by which the API queries cell databases in smaller batches during large instance list operations. If batching is performed, a large instance list operation will request some fraction of the overall API limit from each cell database initially, and will re-request that same batch size as records are consumed (returned) from each cell as necessary. Larger batches mean

less chattiness between the API and the database, but potentially more wasted effort processing the results from the database which will not be returned to the user. Any strategy will yield a batch size of at least 100 records, to avoid a user causing many tiny database queries in their request.

Related options:

- instance_list_cells_batch_fixed_size
- max_limit

Possible values

distributed
: Divide the limit requested by the user by the number of cells in the system. This requires counting the cells in the system initially, which will not be refreshed until service restart or SIGHUP. The actual batch size will be increased by 10% over the result of ($limit / $num_cells).

fixed
: Request fixed-size batches from each cell, as defined by `instance_list_cells_batch_fixed_size`. If the limit is smaller than the batch size, the limit will be used instead. If you do not wish batching to be used at all, setting the fixed size equal to the `max_limit` value will cause only one request per cell database to be issued.

`instance_list_cells_batch_fixed_size`

Type
: integer

Default
: `100`

Minimum Value
: 100

This controls the batch size of instances requested from each cell database if `instance_list_cells_batch_strategy` is set to `fixed`. This integral value will define the limit issued to each cell every time a batch of instances is requested, regardless of the number of cells in the system or any other factors. Per the general logic called out in the documentation for `instance_list_cells_batch_strategy`, the minimum value for this is 100 records per batch.

Related options:

- instance_list_cells_batch_strategy
- max_limit

`list_records_by_skipping_down_cells`

Type
: boolean

Default
: `True`

When set to False, this will cause the API to return a 500 error if there is an infrastructure failure like non-responsive cells. If you want the API to skip the down cells and return the results from the up cells set this option to True.

Note that from API microversion 2.69 there could be transient conditions in the deployment where certain records are not available and the results could be partial for certain requests containing those records. In those cases this option will be ignored. See Handling Down Cells section of the Compute API guide (https://docs.openstack.org/api-guide/compute/down_cells.html) for more information.

`use_neutron_default_nets`

Type
boolean

Default
`False`

When True, the TenantNetworkController will query the Neutron API to get the default networks to use.

Related options:

- neutron_default_project_id

`neutron_default_project_id`

Type
string

Default
`default`

Tenant ID for getting the default network from Neutron API (also referred in some places as the project ID) to use.

Related options:

- use_neutron_default_nets

Table 13: Deprecated Variations

Group	Name
api	neutron_default_tenant_id

`enable_instance_password`

Type
boolean

Default
`True`

Enables returning of the instance password by the relevant server API calls such as create, rebuild, evacuate, or rescue. If the hypervisor does not support password injection, then the password returned will not be correct, so if your hypervisor does not support password injection, set this to False.

`response_validation`

Type
string

Default
`warn`

Valid Values
error, warn, ignore

Configure validation of API responses.

`warn` is the current recommendation for production environments. This is expected to change to `error` in a future release.

If you find it necessary to enable the `ignore` option, please report the issues you are seeing to the Nova team so we can improve our schemas.

Possible values

error
Raise a HTTP 500 (Server Error) for responses that fail response body schema validation

warn
Log a warning for responses that fail response body schema validation

ignore
Ignore response body schema validation failures

api_database

The *Nova API Database* is a separate database which is used for information which is used across *cells*. This database is mandatory since the Mitaka release (13.0.0).

This group should **not** be configured for the `nova-compute` service.

`sqlite_synchronous`

Type
boolean

Default
`True`

If True, SQLite uses synchronous mode.

`backend`

Type
string

Default
`sqlalchemy`

The back end to use for the database.

`connection`

Type
string

Default
<None>

The SQLAlchemy connection string to use to connect to the database.

`slave_connection`

Type
string

Default
<None>

The SQLAlchemy connection string to use to connect to the slave database.

`asyncio_connection`

Type
string

Default
<None>

The SQLAlchemy asyncio connection string to use to connect to the database.

`asyncio_slave_connection`

Type
string

Default
<None>

The SQLAlchemy asyncio connection string to use to connect to the slave database.

`synchronous_reader`

Type
boolean

Default
`True`

Whether or not to assume a reader context needs to guarantee it can read data committed by a writer assuming replication lag is present; defaults to True. When False, a reader context works the same as async_reader and will select the slave database if present. When using a galera cluster, this can be set to False only if you set mysql_wsrep_sync_wait to 1 (this will guarantee that the reader will wait until writesets are committed).Note that this may incur a performance degradation within the galera cluster. Note also that this parameter has no effect if you do not set any slave_connection.

`mysql_sql_mode`

Type
string

Default
`TRADITIONAL`

The SQL mode to be used for MySQL sessions. This option, including the default, overrides any server-set SQL mode. To use whatever SQL mode is set by the server configuration, set this to no value. Example: mysql_sql_mode=

`mysql_wsrep_sync_wait`

Type
integer

Default
<None>

For Galera only, configure wsrep_sync_wait causality checks on new connections. Default is None, meaning dont configure any setting.

`connection_recycle_time`

Type
integer

Default
`3600`

Connections which have been present in the connection pool longer than this number of seconds will be replaced with a new one the next time they are checked out from the pool.

`max_pool_size`

Type
integer

Default
`5`

Maximum number of SQL connections to keep open in a pool. Setting a value of 0 indicates no limit.

`max_retries`

Type
integer

Default
`10`

Maximum number of database connection retries during startup. Set to -1 to specify an infinite retry count.

`retry_interval`

Type
integer

Default
`10`

Interval between retries of opening a SQL connection.

`max_overflow`

Type
integer

Default
`50`

If set, use this value for max_overflow with SQLAlchemy.

`connection_debug`

Type
integer

Default
`0`

Minimum Value
0

Maximum Value
100

Verbosity of SQL debugging information: 0=None, 100=Everything.

`connection_trace`

Type
boolean

Default
`False`

Add Python stack traces to SQL as comment strings.

`pool_timeout`

Type
integer

Default
<None>

If set, use this value for pool_timeout with SQLAlchemy.

`db_retry_interval`

Type
integer

Default
1

Seconds between retries of a database transaction.

`db_inc_retry_interval`

Type
boolean

Default
`True`

If True, increases the interval between retries of a database operation up to db_max_retry_interval.

`db_max_retry_interval`

Type
integer

Default
10

If db_inc_retry_interval is set, the maximum seconds between retries of a database operation.

`db_max_retries`

Type
integer

Default
20

Maximum retries in case of connection error or deadlock error before error is raised. Set to -1 to specify an infinite retry count.

`connection_parameters`

Type
string

Default
''

Optional URL parameters to append onto the connection URL at connect time; specify as param1=value1&param2=value2&

barbican

`barbican_endpoint`

Type
string

Default
<None>

Use this endpoint to connect to Barbican, for example: http://localhost:9311/

`barbican_api_version`

Type
string

Default
<None>

Version of the Barbican API, for example: v1

`auth_endpoint`

Type
string

Default
http://localhost/identity/v3

Use this endpoint to connect to Keystone

Table 14: Deprecated Variations

Group	Name
key_manager	auth_url

`retry_delay`

Type
integer

Default
1

Number of seconds to wait before retrying poll for key creation completion

`number_of_retries`

Type
integer

Default
60

Number of times to retry poll for key creation completion

`verify_ssl`

Type
boolean

Default
True

Specifies if insecure TLS (https) requests. If False, the servers certificate will not be validated, if True, we can set the verify_ssl_path config meanwhile.

`verify_ssl_path`

Type
string

Default
<None>

A path to a bundle or CA certs to check against, or None for requests to attempt to locate and use certificates which verify_ssh is True. If verify_ssl is False, this is ignored.

`barbican_endpoint_type`

Type
string

Default
public

Valid Values
public, internal, admin

Specifies the type of endpoint.

`barbican_region_name`

Type
string

Default
<None>

Specifies the region of the chosen endpoint.

`send_service_user_token`

Type
boolean

Default
`False`

When True, if sending a user token to a REST API, also send a service token.

Nova often reuses the user token provided to the nova-api to talk to other REST APIs, such as Cinder, Glance and Neutron. It is possible that while the user token was valid when the request was made to Nova, the token may expire before it reaches the other service. To avoid any failures, and to make it clear it is Nova calling the service on the users behalf, we include a service token along with the user token. Should the users token have expired, a valid service token ensures the REST API request will still be accepted by the keystone middleware.

`cafile`

Type
string

Default
<None>

PEM encoded Certificate Authority to use when verifying HTTPs connections.

`certfile`

Type
string

Default
<None>

PEM encoded client certificate cert file

`keyfile`

Type
string

Default
<None>

PEM encoded client certificate key file

`insecure`

Type
boolean

Default
`False`

Verify HTTPS connections.

`timeout`

Type
integer

Default
<None>

Timeout value for http requests

`collect_timing`

Type
boolean

Default
`False`

Collect per-API call timing information.

`split_loggers`

Type
boolean

Default
`False`

Log requests to multiple loggers.

barbican_service_user

`cafile`

Type
string

Default
<None>

PEM encoded Certificate Authority to use when verifying HTTPs connections.

`certfile`

Type
string

Default
<None>

PEM encoded client certificate cert file

`keyfile`

Type
string

Default
<None>

PEM encoded client certificate key file

`insecure`

Type
boolean

Default
`False`

Verify HTTPS connections.

`timeout`

Type
integer

Default
<None>

Timeout value for http requests

`collect_timing`

Type
boolean

Default
`False`

Collect per-API call timing information.

`split_loggers`

Type
boolean

Default
`False`

Log requests to multiple loggers.

`auth_type`

Type
unknown type

Default
<None>

Authentication type to load

Table 15: Deprecated Variations

Group	Name
barbican_service_user	auth_plugin

`auth_section`

Type
unknown type

Default
<None>

Config Section from which to load plugin specific options

cache

`config_prefix`

Type
string

Default
`cache.oslo`

Prefix for building the configuration dictionary for the cache region. This should not need to be changed unless there is another dogpile.cache region with the same configuration name.

`expiration_time`

Type
integer

Default
`600`

Minimum Value
1

Default TTL, in seconds, for any cached item in the dogpile.cache region. This applies to any cached method that doesnt have an explicit cache expiration time defined for it.

`backend_expiration_time`

Type
integer

Default
<None>

Minimum Value
1

Expiration time in cache backend to purge expired records automatically. This should be greater than expiration_time and all cache_time options

`backend`

Type
string

Default
`dogpile.cache.null`

Valid Values
oslo_cache.memcache_pool, oslo_cache.dict, oslo_cache.etcd3gw, dogpile.cache.pymemcache, dogpile.cache.memcached, dogpile.cache.pylibmc, dogpile.cache.bmemcached, dogpile.cache.dbm, dogpile.cache.redis, dogpile.cache.redis_sentinel, dogpile.cache.memory, dogpile.cache.memory_pickle, dogpile.cache.null

Cache backend module. For eventlet-based or environments with hundreds of threaded servers, Memcache with pooling (oslo_cache.memcache_pool) is recommended. For environments with less than 100 threaded servers, Memcached (dogpile.cache.memcached) or Redis (dogpile.cache.redis) is recommended. Test environments with a single instance of the server can use the dogpile.cache.memory backend.

`backend_argument`

Type
multi-valued

Default
''

Arguments supplied to the backend module. Specify this option once per argument to be passed to the dogpile.cache backend. Example format: <argname>:<value>.

`proxies`

Type
list

Default
[]

Proxy classes to import that will affect the way the dogpile.cache backend functions. See the dogpile.cache documentation on changing-backend-behavior.

`enabled`

Type
boolean

Default
False

Global toggle for caching.

`debug_cache_backend`

Type
boolean

Default
False

Extra debugging from the cache backend (cache keys, get/set/delete/etc calls). This is only really useful if you need to see the specific cache-backend get/set/delete calls with the keys/values. Typically this should be left set to false.

`memcache_servers`

Type
list

Default
`['localhost:11211']`

Memcache servers in the format of host:port. This is used by backends dependent on Memcached.If `dogpile.cache.memcached` or `oslo_cache.memcache_pool` is used and a given host refer to an IPv6 or a given domain refer to IPv6 then you should prefix the given address with the address family (`inet6`) (e.g `inet6:[::1]:11211`, `inet6:[fd12:3456:789a:1::1]:11211`, `inet6:[controller-0.internalapi]:11211`). If the address family is not given then these backends will use the default `inet` address family which corresponds to IPv4

`memcache_dead_retry`

Type
integer

Default
`300`

Number of seconds memcached server is considered dead before it is tried again. (dogpile.cache.memcache and oslo_cache.memcache_pool backends only).

`memcache_socket_timeout`

Type
floating point

Default
`1.0`

Timeout in seconds for every call to a server. (dogpile.cache.memcache and oslo_cache.memcache_pool backends only).

`memcache_pool_maxsize`

Type
integer

Default
`10`

Max total number of open connections to every memcached server. (oslo_cache.memcache_pool backend only).

`memcache_pool_unused_timeout`

Type
integer

Default
`60`

Number of seconds a connection to memcached is held unused in the pool before it is closed. (oslo_cache.memcache_pool backend only).

`memcache_pool_connection_get_timeout`

Type
integer

Default
`10`

Number of seconds that an operation will wait to get a memcache client connection.

`memcache_pool_flush_on_reconnect`

Type
boolean

Default
`False`

Global toggle if memcache will be flushed on reconnect. (oslo_cache.memcache_pool backend only).

`memcache_sasl_enabled`

Type
boolean

Default
`False`

Enable the SASL(Simple Authentication and SecurityLayer) if the SASL_enable is true, else disable.

`memcache_username`

Type
string

Default
`<None>`

the user name for the memcached which SASL enabled

`memcache_password`

Type
string

Default
`<None>`

the password for the memcached which SASL enabled

`redis_server`

Type
string

Default
`localhost:6379`

Redis server in the format of host:port

`redis_db`

Type
integer

Default
`0`

Minimum Value
0

Database id in Redis server

`redis_username`

Type
string

Default
<None>

the user name for redis

`redis_password`

Type
string

Default
<None>

the password for redis

`redis_sentinels`

Type
list

Default
`['localhost:26379']`

Redis sentinel servers in the format of host:port

`redis_socket_timeout`

Type
floating point

Default
`1.0`

Timeout in seconds for every call to a server. (dogpile.cache.redis and dogpile.cache.redis_sentinel backends only).

`redis_sentinel_service_name`

Type
string

Default
`mymaster`

Service name of the redis sentinel cluster.

`tls_enabled`

Type
boolean

Default
`False`

Global toggle for TLS usage when communicating with the caching servers. Currently supported by `dogpile.cache.bmemcache`, `dogpile.cache.pymemcache`, `oslo_cache.memcache_pool`, `dogpile.cache.redis` and `dogpile.cache.redis_sentinel`.

`tls_cafile`

Type
string

Default
<None>

Path to a file of concatenated CA certificates in PEM format necessary to establish the caching servers authenticity. If tls_enabled is False, this option is ignored.

`tls_certfile`

Type
string

Default
<None>

Path to a single file in PEM format containing the clients certificate as well as any number of CA certificates needed to establish the certificates authenticity. This file is only required when client side authentication is necessary. If tls_enabled is False, this option is ignored.

`tls_keyfile`

Type
string

Default
<None>

Path to a single file containing the clients private key in. Otherwise the private key will be taken from the file specified in tls_certfile. If tls_enabled is False, this option is ignored.

`tls_allowed_ciphers`

Type
string

Default
<None>

Set the available ciphers for sockets created with the TLS context. It should be a string in the OpenSSL cipher list format. If not specified, all OpenSSL enabled ciphers will be available. Currently supported by `dogpile.cache.bmemcache`, `dogpile.cache.pymemcache` and `oslo_cache.memcache_pool`.

`enable_socket_keepalive`

Type
boolean

Default
`False`

Global toggle for the socket keepalive of dogpiles pymemcache backend

`socket_keepalive_idle`

Type
integer

Default
1

Minimum Value
0

The time (in seconds) the connection needs to remain idle before TCP starts sending keepalive probes. Should be a positive integer most greater than zero.

`socket_keepalive_interval`

Type
integer

Default
1

Minimum Value
0

The time (in seconds) between individual keepalive probes. Should be a positive integer greater than zero.

`socket_keepalive_count`

Type
integer

Default
1

Minimum Value
0

The maximum number of keepalive probes TCP should send before dropping the connection. Should be a positive integer greater than zero.

`enable_retry_client`

Type
boolean

Default
`False`

Enable retry client mechanisms to handle failure. Those mechanisms can be used to wrap all kind of pymemcache clients. The wrapper allows you to define how many attempts to make and how long to wait between attempts.

`retry_attempts`

Type
integer

Default
2

Minimum Value
1

Number of times to attempt an action before failing.

`retry_delay`

Type
floating point

Default
0

Number of seconds to sleep between each attempt.

`hashclient_retry_attempts`

Type
integer

Default
2

Minimum Value
1

Amount of times a client should be tried before it is marked dead and removed from the pool in the HashClients internal mechanisms.

`hashclient_retry_timeout`

Type
floating point

Default
1

Time in seconds that should pass between retry attempts in the HashClients internal mechanisms.

Table 16: Deprecated Variations

Group	Name
cache	hashclient_retry_delay

`hashclient_dead_timeout`

Type
floating point

Default
`60`

Time in seconds before attempting to add a node back in the pool in the HashClients internal mechanisms.

Table 17: Deprecated Variations

Group	Name
cache	dead_timeout

`enforce_fips_mode`

Type
boolean

Default
`False`

Global toggle for enforcing the OpenSSL FIPS mode. This feature requires Python support. This is available in Python 3.9 in all environments and may have been backported to older Python versions on select environments. If the Python executable used does not support OpenSSL FIPS mode, an exception will be raised. Currently supported by `dogpile.cache.bmemcache`, `dogpile.cache.pymemcache` and `oslo_cache.memcache_pool`.

cinder

`catalog_info`

Type
string

Default
`volumev3::publicURL`

Info to match when looking for cinder in the service catalog.

The `<service_name>` is optional and omitted by default since it should not be necessary in most deployments.

Possible values:

- Format is separated values of the form: <service_type>:<service_name>:<endpoint_type>

Note: Nova does not support the Cinder v2 API since the Nova 17.0.0 Queens release.

Related options:

- endpoint_template - Setting this option will override catalog_info

`endpoint_template`

Type
string

Default
<None>

If this option is set then it will override service catalog lookup with this template for cinder endpoint

Possible values:

- URL for cinder endpoint API e.g. http://localhost:8776/v3/%(project_id)s

Note: Nova does not support the Cinder v2 API since the Nova 17.0.0 Queens release.

Related options:

- catalog_info - If endpoint_template is not set, catalog_info will be used.

`os_region_name`

Type
string

Default
<None>

Region name of this node. This is used when picking the URL in the service catalog.

Possible values:

- Any string representing region name

`http_retries`

Type
integer

Default
3

Minimum Value
0

Number of times cinderclient should retry on any failed http call. 0 means connection is attempted only once. Setting it to any positive integer means that on failure connection is retried that many times e.g. setting it to 3 means total attempts to connect will be 4.

Possible values:

- Any integer value. 0 means connection is attempted only once

`cross_az_attach`

Type
boolean

Default
`True`

Allow attach between instance and volume in different availability zones.

If False, volumes attached to an instance must be in the same availability zone in Cinder as the instance availability zone in Nova.

This also means care should be taken when booting an instance from a volume where source is not volume because Nova will attempt to create a volume using the same availability zone as what is assigned to the instance.

If that AZ is not in Cinder (or `allow_availability_zone_fallback=False` in cinder.conf), the volume create request will fail and the instance will fail the build request.

By default there is no availability zone restriction on volume attach.

Related options:

- `[DEFAULT]/default_schedule_zone`

`debug`

Type
boolean

Default
`False`

Enable DEBUG logging with cinderclient and os_brick independently of the rest of Nova.

`cafile`

Type
string

Default
<None>

PEM encoded Certificate Authority to use when verifying HTTPs connections.

`certfile`

Type
string

Default
<None>

PEM encoded client certificate cert file

`keyfile`

Type
string

Default
<None>

PEM encoded client certificate key file

`insecure`

Type
boolean

Default
`False`

Verify HTTPS connections.

`timeout`

Type
integer

Default
<None>

Timeout value for http requests

`collect_timing`

Type
boolean

Default
`False`

Collect per-API call timing information.

`split_loggers`

Type
boolean

Default
`False`

Log requests to multiple loggers.

`auth_type`

Type
unknown type

Default
<None>

Authentication type to load

Table 18: Deprecated Variations

Group	Name
cinder	auth_plugin

`auth_section`

Type
unknown type

Default
<None>

Config Section from which to load plugin specific options

`auth_url`

Type
unknown type

Default
<None>

Authentication URL

`system_scope`

Type
unknown type

Default
<None>

Scope for system operations

`domain_id`

Type
unknown type

Default
<None>

Domain ID to scope to

`domain_name`

Type
unknown type

Default
<None>

Domain name to scope to

`project_id`

Type
unknown type

Default
<None>

Project ID to scope to

`project_name`

Type
unknown type

Default
<None>

Project name to scope to

`project_domain_id`

Type
unknown type

Default
<None>

Domain ID containing project

`project_domain_name`

Type
unknown type

Default
<None>

Domain name containing project

`trust_id`

Type
unknown type

Default
<None>

ID of the trust to use as a trustee use

`default_domain_id`

Type
unknown type

Default
<None>

Optional domain ID to use with v3 and v2 parameters. It will be used for both the user and project domain in v3 and ignored in v2 authentication.

`default_domain_name`

Type
unknown type

Default
<None>

Optional domain name to use with v3 API and v2 parameters. It will be used for both the user and project domain in v3 and ignored in v2 authentication.

`user_id`

Type
unknown type

Default
<None>

Users user ID

`username`

Type
unknown type

Default
<None>

Users username

Table 19: Deprecated Variations

Group	Name
cinder	user-name
cinder	user_name

`user_domain_id`

Type
unknown type

Default
<None>

Users domain ID

`user_domain_name`

Type
unknown type

Default
<None>

Users domain name

`password`

Type
unknown type

Default
<None>

Users password

`tenant_id`

Type
unknown type

Default
<None>

Tenant ID

`tenant_name`

Type
unknown type

Default
<None>

Tenant Name

compute

consecutive_build_service_disable_threshold

Type
integer

Default
10

Enables reporting of build failures to the scheduler.

Any nonzero value will enable sending build failure statistics to the scheduler for use by the BuildFailureWeigher.

Possible values:

- Any positive integer enables reporting build failures.
- Zero to disable reporting build failures.

Related options:

- [filter_scheduler]/build_failure_weight_multiplier

shutdown_retry_interval

Type
integer

Default
10

Minimum Value
1

Time to wait in seconds before resending an ACPI shutdown signal to instances.

The overall time to wait is set by `shutdown_timeout`.

Possible values:

- Any integer greater than 0 in seconds

Related options:

- `shutdown_timeout`

sharing_providers_max_uuids_per_request

Type
integer

Default
200

Minimum Value
1

Maximum number of aggregate UUIDs per API request. The default is 200.

In deployments with a large number of aggregates, a Request-Too-Long error may be raised by the web server or load balancer. This value allows setting the batch size to limit the query length.

Possible values:

- Any positive integer.

`resource_provider_association_refresh`

Type
integer

Default
`300`

Minimum Value
0

Mutable
This option can be changed without restarting.

Interval for updating nova-compute-side cache of the compute node resource providers inventories, aggregates, and traits.

This option specifies the number of seconds between attempts to update a providers inventories, aggregates and traits in the local cache of the compute node.

A value of zero disables cache refresh completely.

The cache can be cleared manually at any time by sending SIGHUP to the compute process, causing it to be repopulated the next time the data is accessed.

Possible values:

- Any positive integer in seconds, or zero to disable refresh.

`cpu_shared_set`

Type
string

Default
<None>

Mask of host CPUs that can be used for `VCPU` resources and offloaded emulator threads.

The behavior of this option depends on the definition of the deprecated `vcpu_pin_set` option.

- If `vcpu_pin_set` is not defined, `[compute] cpu_shared_set` will be used to provide `VCPU` inventory and to determine the host CPUs that unpinned instances can be scheduled to. It will also be used to determine the host CPUS that instance emulator threads should be offloaded to for instances configured with the `share` emulator thread policy (`hw:emulator_threads_policy=share`).
- If `vcpu_pin_set` is defined, `[compute] cpu_shared_set` will only be used to determine the host CPUs that instance emulator threads should be offloaded to for instances configured with the `share` emulator thread policy (`hw:emulator_threads_policy=share`). `vcpu_pin_set` will be used to provide `VCPU` inventory and to determine the host CPUs that both pinned and unpinned instances can be scheduled to.

This behavior will be simplified in a future release when `vcpu_pin_set` is removed.

Possible values:

- A comma-separated list of physical CPU numbers that instance VCPUs can be allocated from. Each element should be either a single CPU number, a range of CPU numbers, or a caret followed by a CPU number to be excluded from a previous range. For example:

```
cpu_shared_set = "4-12,^8,15"
```

Related options:

- `[compute] cpu_dedicated_set`: This is the counterpart option for defining where `PCPU` resources should be allocated from.
- `vcpu_pin_set`: A legacy option whose definition may change the behavior of this option.

`cpu_dedicated_set`

Type
string

Default
<None>

Mask of host CPUs that can be used for `PCPU` resources.

The behavior of this option affects the behavior of the deprecated `vcpu_pin_set` option.

- If this option is defined, defining `vcpu_pin_set` will result in an error.
- If this option is not defined, `vcpu_pin_set` will be used to determine inventory for `VCPU` resources and to limit the host CPUs that both pinned and unpinned instances can be scheduled to.

This behavior will be simplified in a future release when `vcpu_pin_set` is removed.

Possible values:

- A comma-separated list of physical CPU numbers that instance VCPUs can be allocated from. Each element should be either a single CPU number, a range of CPU numbers, or a caret followed by a CPU number to be excluded from a previous range. For example:

```
cpu_dedicated_set = "4-12,^8,15"
```

Related options:

- `[compute] cpu_shared_set`: This is the counterpart option for defining where `VCPU` resources should be allocated from.
- `vcpu_pin_set`: A legacy option that this option partially replaces.

`live_migration_wait_for_vif_plug`

Type
boolean

Default
`True`

Determine if the source compute host should wait for a `network-vif-plugged` event from the (neutron) networking service before starting the actual transfer of the guest to the destination compute host.

Note that this option is read on the destination host of a live migration. If you set this option the same on all of your compute hosts, which you should do if you use the same networking backend universally, you do not have to worry about this.

Before starting the transfer of the guest, some setup occurs on the destination compute host, including plugging virtual interfaces. Depending on the networking backend **on the destination host**, a `network-vif-plugged` event may be triggered and then received on the source compute host and the source compute can wait for that event to ensure networking is set up on the destination host before starting the guest transfer in the hypervisor.

Note

The compute service cannot reliably determine which types of virtual interfaces (`port.binding:vif_type`) will send `network-vif-plugged` events without an accompanying port `binding:host_id` change. Open vSwitch and linuxbridge should be OK, but OpenDaylight is at least one known backend that will not currently work in this case, see bug https://launchpad.net/bugs/1755890 for more details.

Possible values:

- True: wait for `network-vif-plugged` events before starting guest transfer
- False: do not wait for `network-vif-plugged` events before starting guest transfer (this is the legacy behavior)

Related options:

- [DEFAULT]/vif_plugging_is_fatal: if `live_migration_wait_for_vif_plug` is True and `vif_plugging_timeout` is greater than 0, and a timeout is reached, the live migration process will fail with an error but the guest transfer will not have started to the destination host
- [DEFAULT]/vif_plugging_timeout: if `live_migration_wait_for_vif_plug` is True, this controls the amount of time to wait before timing out and either failing if `vif_plugging_is_fatal` is True, or simply continuing with the live migration

`max_concurrent_disk_ops`

Type
integer

Default
`0`

Minimum Value
0

Number of concurrent disk-IO-intensive operations (glance image downloads, image format conversions, etc.) that we will do in parallel. If this is set too high then response time suffers. The default value of 0 means no limit.

`max_disk_devices_to_attach`

Type
integer

Default
`-1`

Minimum Value
-1

Maximum number of disk devices allowed to attach to a single server. Note that the number of disks supported by an server depends on the bus used. For example, the `ide` disk bus is limited to 4 attached devices. The configured maximum is enforced during server create, rebuild, evacuate, unshelve, live migrate, and attach volume.

Usually, disk bus is determined automatically from the device type or disk device, and the virtualization type. However, disk bus can also be specified via a block device mapping or an image property. See the `disk_bus` field in *Block Device Mapping in Nova* for more information about specifying disk bus in a block device mapping, and see https://docs.openstack.org/glance/latest/admin/useful-image-properties.html for more information about the `hw_disk_bus` image property.

Operators changing the `[compute]/max_disk_devices_to_attach` on a compute service that is hosting servers should be aware that it could cause rebuilds to fail, if the maximum is decreased lower than the number of devices already attached to servers. For example, if server A has 26 devices attached and an operators changes `[compute]/max_disk_devices_to_attach` to 20, a request to rebuild server A will fail and go into ERROR state because 26 devices are already attached and exceed the new configured maximum of 20.

Operators setting `[compute]/max_disk_devices_to_attach` should also be aware that during a cold migration, the configured maximum is only enforced in-place and the destination is not checked before the move. This means if an operator has set a maximum of 26 on compute host A and a maximum of 20 on compute host B, a cold migration of a server with 26 attached devices from compute host A to compute host B will succeed. Then, once the server is on compute host B, a subsequent request to rebuild the server will fail and go into ERROR state because 26 devices are already attached and exceed the configured maximum of 20 on compute host B.

The configured maximum is not enforced on shelved offloaded servers, as they have no compute host.

Warning

If this option is set to 0, the `nova-compute` service will fail to start, as 0 disk devices is an invalid configuration that would prevent instances from being able to boot.

Possible values:

- -1 means unlimited
- Any integer `>= 1` represents the maximum allowed. A value of 0 will cause the `nova-compute` service to fail to start, as 0 disk devices is an invalid configuration that would prevent instances from being able to boot.

`provider_config_location`

Type
string

Default
`/etc/nova/provider_config/`

Location of YAML files containing resource provider configuration data.

These files allow the operator to specify additional custom inventory and traits to assign to one or more resource providers.

Additional documentation is available here:

https://docs.openstack.org/nova/latest/admin/managing-resource-providers.html

`image_type_exclude_list`

Type
list

Default
`[]`

A list of image formats that should not be advertised as supported by this compute node.

In some situations, it may be desirable to have a compute node refuse to support an expensive or complex image format. This factors into the decisions made by the scheduler about which compute node to select when booted with a given image.

Possible values:

- Any glance image `disk_format` name (i.e. `raw`, `qcow2`, etc)

Related options:

- `[scheduler]query_placement_for_image_type_support` - enables filtering computes based on supported image types, which is required to be enabled for this to take effect.

`vmdk_allowed_types`

Type
list

Default
`['streamOptimized', 'monolithicSparse']`

A list of strings describing allowed VMDK create-type subformats that will be allowed. This is recommended to only include single-file-with-sparse-header variants to avoid potential host file exposure due to processing named extents. If this list is empty, then no form of VMDK image will be allowed.

`packing_host_numa_cells_allocation_strategy`

Type
boolean

Default
`False`

This option controls allocation strategy used to choose NUMA cells on host for placing VMs NUMA cells (for VMs with defined numa topology). By default hosts NUMA cell with more resources consumed will be chosen last for placing attempt. When the packing_host_numa_cells_allocation_strategy variable is set to `False`, hosts NUMA cell with more resources available will be used. When set to `True` cells with some usage will be packed with VMs cell until it will be completely exhausted, before a new free hosts cell will be used.

Possible values:

- `True`: Packing VMs NUMA cell on most used host NUMA cell.

- `False`: Spreading VMs NUMA cell on hosts NUMA cells with more resources available.

conductor

Options under this group are used to define Conductors communication, which manager should be act as a proxy between computes and database, and finally, how many worker processes will be used.

`workers`

Type
integer

Default
<None>

Number of workers for OpenStack Conductor service. The default will be the number of CPUs available.

console

Options under this group allow to tune the configuration of the console proxy service.

Note: in configuration of every compute is a `console_host` option, which allows to select the console proxy service to connect to.

`allowed_origins`

Type
list

Default
`[]`

Adds list of allowed origins to the console websocket proxy to allow connections from other origin hostnames. Websocket proxy matches the host header with the origin header to prevent cross-site requests. This list specifies if any there are values other than host are allowed in the origin header.

Possible values:

- A list where each element is an allowed origin hostnames, else an empty list

Table 20: Deprecated Variations

Group	Name
DEFAULT	console_allowed_origins

`ssl_ciphers`

Type
string

Default
<None>

OpenSSL cipher preference string that specifies what ciphers to allow for TLS connections from clients. For example:

```
ssl_ciphers = "kEECDH+aECDSA+AES:kEECDH+AES+aRSA:kEDH+aRSA+AES"
```

See the man page for the OpenSSL *ciphers* command for details of the cipher preference string format and allowed values:

```
https://docs.openssl.org/master/man1/openssl-ciphers/#cipher-list-format
```

Related options:

- [DEFAULT] cert
- [DEFAULT] key

ssl_minimum_version

Type
string

Default
`default`

Valid Values
default, tlsv1_1, tlsv1_2, tlsv1_3

Minimum allowed SSL/TLS protocol version.

Related options:

- [DEFAULT] cert
- [DEFAULT] key

Possible values

default
Use the underlying system OpenSSL defaults

tlsv1_1
Require TLS v1.1 or greater for TLS connections

tlsv1_2
Require TLS v1.2 or greater for TLS connections

tlsv1_3
Require TLS v1.3 or greater for TLS connections

consoleauth

token_ttl

Type
integer

Default
`600`

Minimum Value
0

The lifetime of a console auth token (in seconds).

A console auth token is used in authorizing console access for a user. Once the auth token time to live count has elapsed, the token is considered expired. Expired tokens are then deleted.

Table 21: Deprecated Variations

Group	Name
DEFAULT	console_token_ttl

`enforce_session_timeout`

Type
boolean

Default
`False`

Enable or disable enforce session timeout for VM console.

This allows operators to enforce a console session timeout. When set to True, Nova will automatically close the console session at the server end once token_ttl expires, providing enhanced control over console session duration.

cors

`allowed_origin`

Type
list

Default
<None>

Indicate whether this resource may be shared with the domain received in the requests origin header. Format: <protocol>://<host>[:<port>], no trailing slash. Example: https://horizon.example.com

`allow_credentials`

Type
boolean

Default
`True`

Indicate that the actual request can include user credentials

`expose_headers`

Type
list

Default
```
['X-Auth-Token', 'X-Openstack-Request-Id', 'X-Subject-Token',
'X-Service-Token', 'X-OpenStack-Nova-API-Version',
'OpenStack-API-Version']
```

Indicate which headers are safe to expose to the API. Defaults to HTTP Simple Headers.

`max_age`

Type
integer

Default
`3600`

Maximum cache age of CORS preflight requests.

`allow_methods`

Type
list

Default
`['GET', 'PUT', 'POST', 'DELETE', 'PATCH']`

Indicate which methods can be used during the actual request.

`allow_headers`

Type
list

Default
```
['X-Auth-Token', 'X-Openstack-Request-Id',
'X-Identity-Status', 'X-Roles', 'X-Service-Catalog',
'X-User-Id', 'X-Tenant-Id', 'X-OpenStack-Nova-API-Version',
'OpenStack-API-Version']
```

Indicate which header field names may be used during the actual request.

cyborg

Configuration options for Cyborg (accelerator as a service).

`cafile`

Type
string

Default
<None>

PEM encoded Certificate Authority to use when verifying HTTPs connections.

`certfile`

Type
string

Default
<None>

PEM encoded client certificate cert file

`keyfile`

Type
string

Default
<None>

PEM encoded client certificate key file

`insecure`

Type
boolean

Default
`False`

Verify HTTPS connections.

`timeout`

Type
integer

Default
<None>

Timeout value for http requests

`collect_timing`

Type
boolean

Default
`False`

Collect per-API call timing information.

`split_loggers`

Type
boolean

Default
`False`

Log requests to multiple loggers.

`service_type`

Type
string

Default
`accelerator`

The default service_type for endpoint URL discovery.

`service_name`

Type
string

Default
<None>

The default service_name for endpoint URL discovery.

`valid_interfaces`

Type
list

Default
`['internal', 'public']`

List of interfaces, in order of preference, for endpoint URL.

`region_name`

Type
string

Default
<None>

The default region_name for endpoint URL discovery.

`endpoint_override`

Type
string

Default
<None>

Always use this endpoint URL for requests for this client. NOTE: The unversioned endpoint should be specified here; to request a particular API version, use the *version*, *min-version*, and/or *max-version* options.

`connect_retries`

Type
integer

Default
<None>

The maximum number of retries that should be attempted for connection errors.

`connect_retry_delay`

Type
floating point

Default
<None>

Delay (in seconds) between two retries for connection errors. If not set, exponential retry starting with 0.5 seconds up to a maximum of 60 seconds is used.

`status_code_retries`

Type
integer

Default
<None>

The maximum number of retries that should be attempted for retriable HTTP status codes.

`status_code_retry_delay`

Type
floating point

Default
<None>

Delay (in seconds) between two retries for retriable status codes. If not set, exponential retry starting with 0.5 seconds up to a maximum of 60 seconds is used.

`retriable_status_codes`

Type
list

Default
<None>

List of retriable HTTP status codes that should be retried. If not set default to [503]

database

The *Nova Database* is the primary database which is used for information local to a *cell*.

This group should **not** be configured for the `nova-compute` service.

`sqlite_synchronous`

Type
boolean

Default
`True`

If True, SQLite uses synchronous mode.

`backend`

Type
string

Default
`sqlalchemy`

The back end to use for the database.

`connection`

Type
string

Default
<None>

The SQLAlchemy connection string to use to connect to the database.

`slave_connection`

Type
string

Default
<None>

The SQLAlchemy connection string to use to connect to the slave database.

`asyncio_connection`

Type
string

Default
<None>

The SQLAlchemy asyncio connection string to use to connect to the database.

`asyncio_slave_connection`

Type
string

Default
<None>

The SQLAlchemy asyncio connection string to use to connect to the slave database.

`synchronous_reader`

Type
boolean

Default
`True`

Whether or not to assume a reader context needs to guarantee it can read data committed by a writer assuming replication lag is present; defaults to True. When False, a reader context works the same as async_reader and will select the slave database if present. When using a galera cluster, this can be set to False only if you set mysql_wsrep_sync_wait to 1 (this will guarantee that the reader will wait until writesets are committed).Note that this may incur a performance degradation within the galera cluster. Note also that this parameter has no effect if you do not set any slave_connection.

`mysql_sql_mode`

Type
string

Default
`TRADITIONAL`

The SQL mode to be used for MySQL sessions. This option, including the default, overrides any server-set SQL mode. To use whatever SQL mode is set by the server configuration, set this to no value. Example: mysql_sql_mode=

`mysql_wsrep_sync_wait`

Type
integer

Default
<None>

For Galera only, configure wsrep_sync_wait causality checks on new connections. Default is None, meaning dont configure any setting.

`connection_recycle_time`

Type
integer

Default
`3600`

Connections which have been present in the connection pool longer than this number of seconds will be replaced with a new one the next time they are checked out from the pool.

`max_pool_size`

Type
integer

Default
`5`

Maximum number of SQL connections to keep open in a pool. Setting a value of 0 indicates no limit.

`max_retries`

Type
integer

Default
`10`

Maximum number of database connection retries during startup. Set to -1 to specify an infinite retry count.

`retry_interval`

Type
integer

Default
`10`

Interval between retries of opening a SQL connection.

`max_overflow`

Type
integer

Default
`50`

If set, use this value for max_overflow with SQLAlchemy.

`connection_debug`

Type
integer

Default
`0`

Minimum Value
0

Maximum Value
100

Verbosity of SQL debugging information: 0=None, 100=Everything.

`connection_trace`

Type
boolean

Default
`False`

Add Python stack traces to SQL as comment strings.

`pool_timeout`

Type
integer

Default
<None>

If set, use this value for pool_timeout with SQLAlchemy.

`db_retry_interval`

Type
integer

Default
1

Seconds between retries of a database transaction.

`db_inc_retry_interval`

Type
boolean

Default
`True`

If True, increases the interval between retries of a database operation up to db_max_retry_interval.

`db_max_retry_interval`

Type
integer

Default
`10`

If db_inc_retry_interval is set, the maximum seconds between retries of a database operation.

`db_max_retries`

Type
integer

Default
`20`

Maximum retries in case of connection error or deadlock error before error is raised. Set to -1 to specify an infinite retry count.

`connection_parameters`

Type
string

Default
`''`

Optional URL parameters to append onto the connection URL at connect time; specify as param1=value1&param2=value2&

devices

`enabled_mdev_types`

Type
list

Default
`[]`

The mdev types enabled in the compute node.

Some hardware (e.g. NVIDIA GRID K1) support different mdev types. User can use this option to specify a list of enabled mdev types that may be assigned to a guest instance.

If more than one single mdev type is provided, then for each *mdev type* an additional section, `[mdev_$(MDEV_TYPE)]`, must be added to the configuration file. Each section then can be configured with a single configuration option, `device_addresses`, which should be a list of PCI addresses corresponding to the physical GPU(s) or mdev-capable hardware to assign to this type. If *device_addresses* is not provided, then the related GPU type will be the default for all the found GPUs that arent used by other types.

If one or more sections are missing (meaning that a specific type is not wanted to use for at least one physical device), then Nova will only use the first type that was provided by `[devices]/enabled_mdev_types`.

If two or more sections are not set with `device_addresses` values, then only the first one will be used for defaulting all the non-defined GPUs to use this type.

If the same PCI address is provided for two different types, nova-compute will return an InvalidLibvirtMdevConfig exception at restart.

As an interim period, old configuration groups named `[vgpu_$(MDEV_TYPE)]` will be accepted. A valid configuration could then be:

```
[devices]
enabled_mdev_types = nvidia-35, nvidia-36

[mdev_nvidia-35]
device_addresses = 0000:84:00.0,0000:85:00.0

[vgpu_nvidia-36]
device_addresses = 0000:86:00.0
```

Another valid configuration could be:

```
[devices]
enabled_mdev_types = nvidia-35, nvidia-36

[mdev_nvidia-35]

[mdev_nvidia-36]
device_addresses = 0000:86:00.0
```

Table 22: Deprecated Variations

Group	Name
devices	enabled_vgpu_types

ephemeral_storage_encryption

`enabled`

Type
boolean

Default
`False`

Enables/disables LVM ephemeral storage encryption.

`cipher`

Type
string

Default
`aes-xts-plain64`

Cipher-mode string to be used.

The cipher and mode to be used to encrypt ephemeral storage. The set of cipher-mode combinations available depends on kernel support. According to the dm-crypt documentation, the cipher is expected to be in the format: <cipher>-<chainmode>-<ivmode>.

Possible values:

- Any crypto option listed in `/proc/crypto`.

`key_size`

Type
integer

Default
`512`

Minimum Value
1

Encryption key length in bits.

The bit length of the encryption key to be used to encrypt ephemeral storage. In XTS mode only half of the bits are used for encryption key.

`default_format`

Type
string

Default
`luks`

Valid Values
luks

Default ephemeral encryption format.

Only luks is supported at this time.

Note that this does not apply to LVM ephemeral storage encryption.

filter_scheduler

`host_subset_size`

Type
integer

Default
1

Minimum Value
1

Size of subset of best hosts selected by scheduler.

New instances will be scheduled on a host chosen randomly from a subset of the N best hosts, where N is the value set by this option.

Setting this to a value greater than 1 will reduce the chance that multiple scheduler processes handling similar requests will select the same host, creating a potential race condition. By selecting a host randomly from the N hosts that best fit the request, the chance of a conflict is reduced. However, the higher you set this value, the less optimal the chosen host may be for a given request.

Possible values:

- An integer, where the integer corresponds to the size of a host subset.

`max_io_ops_per_host`

Type
integer

Default
8

Minimum Value
0

The number of instances that can be actively performing IO on a host.

Instances performing IO includes those in the following states: build, resize, snapshot, migrate, rescue, unshelve.

Note that this setting only affects scheduling if the `IoOpsFilter` filter is enabled.

Possible values:

- An integer, where the integer corresponds to the max number of instances that can be actively performing IO on any given host.

Related options:

- `[filter_scheduler] enabled_filters`

`max_instances_per_host`

Type
integer

Default
50

Minimum Value
1

Maximum number of instances that can exist on a host.

If you need to limit the number of instances on any given host, set this option to the maximum number of instances you want to allow. The NumInstancesFilter and AggregateNumInstancesFilter will reject any host that has at least as many instances as this options value.

Note that this setting only affects scheduling if the `NumInstancesFilter` or `AggregateNumInstancesFilter` filter is enabled.

Possible values:

- An integer, where the integer corresponds to the max instances that can be scheduled on a host.

Related options:

- `[filter_scheduler] enabled_filters`

`track_instance_changes`

Type
boolean

Default
True

Enable querying of individual hosts for instance information.

The scheduler may need information about the instances on a host in order to evaluate its filters and weighers. The most common need for this information is for the (anti-)affinity filters, which need to choose a host based on the instances already running on a host.

If the configured filters and weighers do not need this information, disabling this option will improve performance. It may also be disabled when the tracking overhead proves too heavy, although this will cause classes requiring host usage data to query the database on each request instead.

Note

In a multi-cell (v2) setup where the cell MQ is separated from the top-level, computes cannot directly communicate with the scheduler. Thus, this option cannot be enabled in that scenario. See also the `[workarounds] disable_group_policy_check_upcall` option.

Related options:

- `[filter_scheduler] enabled_filters`
- `[workarounds] disable_group_policy_check_upcall`

`available_filters`

Type
multi-valued

Default
`nova.scheduler.filters.all_filters`

Filters that the scheduler can use.

An unordered list of the filter classes the nova scheduler may apply. Only the filters specified in the `[filter_scheduler] enabled_filters` option will be used, but any filter appearing in that option must also be included in this list.

By default, this is set to all filters that are included with nova.

Possible values:

- A list of zero or more strings, where each string corresponds to the name of a filter that may be used for selecting a host

Related options:

- `[filter_scheduler] enabled_filters`

`enabled_filters`

Type
list

Default
```
['ComputeFilter', 'ComputeCapabilitiesFilter',
'ImagePropertiesFilter', 'ServerGroupAntiAffinityFilter',
'ServerGroupAffinityFilter']
```

Filters that the scheduler will use.

An ordered list of filter class names that will be used for filtering hosts. These filters will be applied in the order they are listed so place your most restrictive filters first to make the filtering process more efficient.

All of the filters in this option *must* be present in the `[scheduler_filter] available_filter` option, or a `SchedulerHostFilterNotFound` exception will be raised.

Possible values:

- A list of zero or more strings, where each string corresponds to the name of a filter to be used for selecting a host

Related options:

- `[filter_scheduler] available_filters`

`weight_classes`

Type
list

Default
`['nova.scheduler.weights.all_weighers']`

Weighers that the scheduler will use.

Only hosts which pass the filters are weighed. The weight for any host starts at 0, and the weighers order these hosts by adding to or subtracting from the weight assigned by the previous weigher. Weights may become negative. An instance will be scheduled to one of the N most-weighted hosts, where N is `[filter_scheduler] host_subset_size`.

By default, this is set to all weighers that are included with Nova.

Possible values:

- A list of zero or more strings, where each string corresponds to the name of a weigher that will be used for selecting a host

`ram_weight_multiplier`

Type
floating point

Default
`1.0`

RAM weight multiplier ratio.

This option determines how hosts with more or less available RAM are weighed. A positive value will result in the scheduler preferring hosts with more available RAM, and a negative number will result in the scheduler preferring hosts with less available RAM. Another way to look at it is that positive values for this option will tend to spread instances across many hosts, while negative values will tend to fill up (stack) hosts as much as possible before scheduling to a less-used host. The absolute value, whether positive or negative, controls how strong the RAM weigher is relative to other weighers.

Note that this setting only affects scheduling if the `RAMWeigher` weigher is enabled.

Possible values:

- An integer or float value, where the value corresponds to the multiplier ratio for this weigher.

Related options:

- `[filter_scheduler] weight_classes`

`cpu_weight_multiplier`

Type
floating point

Default
`1.0`

CPU weight multiplier ratio.

Multiplier used for weighting free vCPUs. Negative numbers indicate stacking rather than spreading.

Note that this setting only affects scheduling if the `CPUWeigher` weigher is enabled.

Possible values:

- An integer or float value, where the value corresponds to the multiplier ratio for this weigher.

Related options:

- `[filter_scheduler] weight_classes`

`disk_weight_multiplier`

Type
floating point

Default
`1.0`

Disk weight multiplier ratio.

Multiplier used for weighing free disk space. Negative numbers mean to stack vs spread.

Note that this setting only affects scheduling if the `DiskWeigher` weigher is enabled.

Possible values:

- An integer or float value, where the value corresponds to the multiplier ratio for this weigher.

`hypervisor_version_weight_multiplier`

Type
floating point

Default
`1.0`

Hypervisor Version weight multiplier ratio.

The multiplier is used for weighting hosts based on the reported hypervisor version. Negative numbers indicate preferring older hosts, the default is to prefer newer hosts to aid with upgrades.

Possible values:

- An integer or float value, where the value corresponds to the multiplier ratio for this weigher.

Example:

- Strongly prefer older hosts

```
[filter_scheduler]
hypervisor_version_weight_multiplier=-1000
```

- Moderately prefer new hosts

```
[filter_scheduler]
hypervisor_version_weight_multiplier=2.5
```

- Disable weigher influence

```
[filter_scheduler]
hypervisor_version_weight_multiplier=0
```

Related options:

- `[filter_scheduler] weight_classes`

num_instances_weight_multiplier

Type
floating point

Default
`0.0`

Number of instances weight multiplier ratio.

The multiplier is used for weighting hosts based on the reported number of instances they have. Negative numbers indicate preferring hosts with fewer instances (i.e. choosing to spread instances), while positive numbers mean preferring hosts with more hosts (ie. choosing to pack). The default is 0.0 which means that you have to choose a strategy if you want to use it.

Possible values:

- An integer or float value, where the value corresponds to the multiplier ratio for this weigher.

Example:

- Strongly prefer to pack instances to hosts.

```
[filter_scheduler]
num_instances_weight_multiplier=1000
```

- Softly prefer to spread instances between hosts.

```
[filter_scheduler]
num_instances_weight_multiplier=1.0
```

- Disable weigher influence

```
[filter_scheduler]
num_instances_weight_multiplier=0
```

Related options:

- `[filter_scheduler] weight_classes`

`io_ops_weight_multiplier`

Type
floating point

Default
`-1.0`

IO operations weight multiplier ratio.

This option determines how hosts with differing workloads are weighed. Negative values, such as the default, will result in the scheduler preferring hosts with lighter workloads whereas positive values will prefer hosts with heavier workloads. Another way to look at it is that positive values for this option will tend to schedule instances onto hosts that are already busy, while negative values will tend to distribute the workload across more hosts. The absolute value, whether positive or negative, controls how strong the io_ops weigher is relative to other weighers.

Note that this setting only affects scheduling if the `IoOpsWeigher` weigher is enabled.

Possible values:

- An integer or float value, where the value corresponds to the multiplier ratio for this weigher.

Related options:

- `[filter_scheduler] weight_classes`

`image_props_weight_multiplier`

Type
floating point

Default
`0.0`

Image Properties weight multiplier ratio.

The multiplier is used for weighting hosts based on the reported image properties for the instances they have. A positive value will favor hosts with the same image properties (packing strategy) while a negative value will follow a spread strategy that will favor hosts not already having instances with those image properties. The default value of the multiplier is 0, which disables the weigher.

Possible values:

- An integer or float value, where the value corresponds to the multiplier ratio for this weigher.

Example:

- Strongly prefer to pack instances with related image properties.

```
[filter_scheduler]
image_props_weight_multiplier=1000
```

- Softly prefer to spread instances having same properties between hosts

```
[filter_scheduler]
image_props_weight_multiplier=-1.0
```

- Disable weigher influence

```
[filter_scheduler]
image_props_weight_multiplier=0
```

Related options:

- `[filter_scheduler] weight_classes`

`image_props_weight_setting`

Type
list

Default
`[]`

Mapping of image properties to weight modifier.

This setting specifies the properties to be weighed and the relative ratios for each property. This should be a list of key/value pairs, consisting of a series of one or more name=ratio pairs, separated by commas, where `name` is the name of the property to be weighed, and `ratio` is the relative weight for that metric.

Note that if the ratio is set to 0, the property value is ignored, and instead the weight will be set to the value of the `[filter_scheduler] image_props_weight_multiplier` option.

As an example, lets consider the case where this option is set to:

```
os_distro=1, hw_machine_type=-1
```

If an instance would boot with an image having `os_distro=windows` and `hw_machine_type=q35`, the final host weight will be:

(nb_inst(``os_distro=windows) * 1.0) +
(nb_inst(`hw_machine_type=q35`) * -1)“

where nb_inst(`prop=value`) would give me the number of instances having an image where `prop` is set to `value` (eg. the number of instances running with `os_distro=windows`)

Possible values:

- A list of zero or more key/value pairs separated by commas, where the key is a string representing the name of a property and the value is a numeric weight for that property. If any value is set to 0, the number of instances match is ignored for that specific property key. If no key/value pairs are provided, then the weigher will compare all the instances images with the requested image properties, all of them weighed evenly.

The overall host weight will be multiplied by the value of the
`[filter_scheduler] image_props_weight_multiplier` option.

Related options:

- `[filter_scheduler] image_props_weight_multiplier`

`pci_weight_multiplier`

Type
floating point

Default
1.0

Minimum Value
0.0

PCI device affinity weight multiplier.

The PCI device affinity weighter computes a weighting based on the number of PCI devices on the host and the number of PCI devices requested by the instance.

Note that this setting only affects scheduling if the `PCIWeigher` weigher and `NUMATopologyFilter` filter are enabled.

Possible values:

- A positive integer or float value, where the value corresponds to the multiplier ratio for this weigher.

Related options:

- `[filter_scheduler] weight_classes`

`soft_affinity_weight_multiplier`

Type
floating point

Default
1.0

Minimum Value
0.0

Multiplier used for weighing hosts for group soft-affinity.

Note that this setting only affects scheduling if the `ServerGroupSoftAffinityWeigher` weigher is enabled.

Possible values:

- A non-negative integer or float value, where the value corresponds to weight multiplier for hosts with group soft affinity.

Related options:

- `[filter_scheduler] weight_classes`

`soft_anti_affinity_weight_multiplier`

Type
floating point

Default
1.0

Minimum Value
0.0

Multiplier used for weighing hosts for group soft-anti-affinity.

Note that this setting only affects scheduling if the `ServerGroupSoftAntiAffinityWeigher` weigher is enabled.

Possible values:

- A non-negative integer or float value, where the value corresponds to weight multiplier for hosts with group soft anti-affinity.

Related options:

- `[filter_scheduler] weight_classes`

`build_failure_weight_multiplier`

Type
floating point

Default
`1000000.0`

Multiplier used for weighing hosts that have had recent build failures.

This option determines how much weight is placed on a compute node with recent build failures. Build failures may indicate a failing, misconfigured, or otherwise ailing compute node, and avoiding it during scheduling may be beneficial. The weight is inversely proportional to the number of recent build failures the compute node has experienced. This value should be set to some high value to offset weight given by other enabled weighers due to available resources. To disable weighing compute hosts by the number of recent failures, set this to zero.

Note that this setting only affects scheduling if the `BuildFailureWeigher` weigher is enabled.

Possible values:

- An integer or float value, where the value corresponds to the multiplier ratio for this weigher.

Related options:

- `[compute] consecutive_build_service_disable_threshold` - Must be nonzero for a compute to report data considered by this weigher.
- `[filter_scheduler] weight_classes`

`cross_cell_move_weight_multiplier`

Type
floating point

Default
`1000000.0`

Multiplier used for weighing hosts during a cross-cell move.

This option determines how much weight is placed on a host which is within the same source cell when moving a server, for example during cross-cell resize. By default, when moving an instance, the scheduler will prefer hosts within the same cell since cross-cell move operations can be slower and riskier due to the complicated nature of cross-cell migrations.

Note that this setting only affects scheduling if the `CrossCellWeigher` weigher is enabled. If your cloud is not configured to support cross-cell migrations, then this option has no effect.

The value of this configuration option can be overridden per host aggregate by setting the aggregate metadata key with the same name (`cross_cell_move_weight_multiplier`).

Possible values:

- An integer or float value, where the value corresponds to the multiplier ratio for this weigher. Positive values mean the weigher will prefer hosts within the same cell in which the instance is currently running. Negative values mean the weigher will prefer hosts in *other* cells from which the instance is currently running.

Related options:

- `[filter_scheduler] weight_classes`

`shuffle_best_same_weighed_hosts`

Type
boolean

Default
`False`

Enable spreading the instances between hosts with the same best weight.

Enabling it is beneficial for cases when `[filter_scheduler] host_subset_size` is 1 (default), but there is a large number of hosts with same maximal weight. This scenario is common in Ironic deployments where there are typically many baremetal nodes with identical weights returned to the scheduler. In such case enabling this option will reduce contention and chances for rescheduling events. At the same time it will make the instance packing (even in unweighed case) less dense.

`image_properties_default_architecture`

Type
string

Default
<None>

Valid Values
alpha, armv6, armv7l, armv7b, aarch64, cris, i686, ia64, lm32, m68k, microblaze, microblazeel, mips, mipsel, mips64, mips64el, openrisc, parisc, parisc64, ppc, ppcle, ppc64, ppc64le, ppcemb, s390, s390x, sh4, sh4eb, sparc, sparc64, unicore32, x86_64, xtensa, xtensaeb

The default architecture to be used when using the image properties filter.

When using the `ImagePropertiesFilter`, it is possible that you want to define a default architecture to make the user experience easier and avoid having something like x86_64 images landing on AARCH64 compute nodes because the user did not specify the `hw_architecture` property in Glance.

Possible values:

- CPU Architectures such as x86_64, aarch64, s390x.

`isolated_images`

Type
list

Default
`[]`

List of UUIDs for images that can only be run on certain hosts.

If there is a need to restrict some images to only run on certain designated hosts, list those image UUIDs here.

Note that this setting only affects scheduling if the `IsolatedHostsFilter` filter is enabled.

Possible values:

- A list of UUID strings, where each string corresponds to the UUID of an image

Related options:

- `[filter_scheduler] isolated_hosts`
- `[filter_scheduler] restrict_isolated_hosts_to_isolated_images`

`isolated_hosts`

Type
list

Default
`[]`

List of hosts that can only run certain images.

If there is a need to restrict some images to only run on certain designated hosts, list those host names here.

Note that this setting only affects scheduling if the `IsolatedHostsFilter` filter is enabled.

Possible values:

- A list of strings, where each string corresponds to the name of a host

Related options:

- `[filter_scheduler] isolated_images`
- `[filter_scheduler] restrict_isolated_hosts_to_isolated_images`

`restrict_isolated_hosts_to_isolated_images`

Type
boolean

Default
`True`

Prevent non-isolated images from being built on isolated hosts.

Note that this setting only affects scheduling if the `IsolatedHostsFilter` filter is enabled. Even then, this option doesnt affect the behavior of requests for isolated images, which will *always* be restricted to isolated hosts.

Related options:

- `[filter_scheduler] isolated_images`
- `[filter_scheduler] isolated_hosts`

`aggregate_image_properties_isolation_namespace`

Type
string

Default
<None>

Image property namespace for use in the host aggregate.

Images and hosts can be configured so that certain images can only be scheduled to hosts in a particular aggregate. This is done with metadata values set on the host aggregate that are identified by beginning with the value of this option. If the host is part of an aggregate with such a metadata key, the image in the request spec must have the value of that metadata in its properties in order for the scheduler to consider the host as acceptable.

Note that this setting only affects scheduling if the `AggregateImagePropertiesIsolation` filter is enabled.

Possible values:

- A string, where the string corresponds to an image property namespace

Related options:

- `[filter_scheduler] aggregate_image_properties_isolation_separator`

`aggregate_image_properties_isolation_separator`

Type
string

Default
.

Separator character(s) for image property namespace and name.

When using the aggregate_image_properties_isolation filter, the relevant metadata keys are prefixed with the namespace defined in the aggregate_image_properties_isolation_namespace configuration option plus a separator. This option defines the separator to be used.

Note that this setting only affects scheduling if the `AggregateImagePropertiesIsolation` filter is enabled.

Possible values:

- A string, where the string corresponds to an image property namespace separator character

Related options:

- `[filter_scheduler] aggregate_image_properties_isolation_namespace`

`pci_in_placement`

Type
boolean

Default
`False`

Enable scheduling and claiming PCI devices in Placement.

This can be enabled after `[pci]report_in_placement` is enabled on all compute hosts.

When enabled the scheduler queries Placement about the PCI device availability to select destination for a server with PCI request. The scheduler also allocates the selected PCI devices in Placement. Note that this logic does not replace the PCIPassthroughFilter but extends it. Note that this config option needs to be set in the configuration of nova-api, nova-scheduler, and all nova-conductor services.

- `[pci] report_in_placement`
- `[pci] alias`
- `[pci] device_spec`

glance

Configuration options for the Image service

`api_servers`

Type
list

Default
<None>

List of glance api servers endpoints available to nova.

https is used for ssl-based glance api servers.

NOTE: The preferred mechanism for endpoint discovery is via keystoneauth1 loading options. Only use api_servers if you need multiple endpoints and are unable to use a load balancer for some reason.

Possible values:

- A list of any fully qualified url of the form scheme://hostname:port[/path] (i.e. http://10.0.1.0:9292 or https://my.glance.server/image).

Warning

This option is deprecated for removal since 21.0.0. Its value may be silently ignored in the future.

Reason
Support for image service configuration via standard keystoneauth1 Adapter options was added in the 17.0.0 Queens release. The api_servers option was retained temporarily to allow consumers time to cut over to a real load balancing solution.

`num_retries`

Type
integer

Default
3

Minimum Value
0

Enable glance operation retries.

Specifies the number of retries when uploading / downloading an image to / from glance. 0 means no retries.

`verify_glance_signatures`

Type
boolean

Default
`False`

Enable image signature verification.

nova uses the image signature metadata from glance and verifies the signature of a signed image while downloading that image. If the image signature cannot be verified or if the image signature metadata is either incomplete or unavailable, then nova will not boot the image and instead will place the instance into an error state. This provides end users with stronger assurances of the integrity of the image data they are using to create servers.

Related options:

- The options in the *key_manager* group, as the key_manager is used for the signature validation.
- Both enable_certificate_validation and default_trusted_certificate_ids below depend on this option being enabled.

`enable_certificate_validation`

Type
boolean

Default
`False`

Enable certificate validation for image signature verification.

During image signature verification nova will first verify the validity of the images signing certificate using the set of trusted certificates associated with the instance. If certificate validation fails, signature verification will not be performed and the instance will be placed into an error state. This provides end users with stronger assurances that the image data is unmodified and trustworthy. If left disabled, image signature verification can still occur but the end user will not have any assurance that the signing certificate used to generate the image signature is still trustworthy.

Related options:

- This option only takes effect if verify_glance_signatures is enabled.
- The value of default_trusted_certificate_ids may be used when this option is enabled.

Warning

This option is deprecated for removal since 16.0.0. Its value may be silently ignored in the future.

Reason
This option is intended to ease the transition for deployments leveraging image signature verification. The intended state long-term is for signature verification and certificate validation to always happen together.

`default_trusted_certificate_ids`

Type
list

Default
`[]`

List of certificate IDs for certificates that should be trusted.

May be used as a default list of trusted certificate IDs for certificate validation. The value of this option will be ignored if the user provides a list of trusted certificate IDs with an instance API request. The value of this option will be persisted with the instance data if signature verification and certificate validation are enabled and if the user did not provide an alternative list. If left empty when certificate validation is enabled the user must provide a list of trusted certificate IDs otherwise certificate validation will fail.

Related options:

- The value of this option may be used if both verify_glance_signatures and enable_certificate_validation are enabled.

`enable_rbd_download`

Type
boolean

Default
`False`

Enable Glance image downloads directly via RBD.

Allow non-rbd computes using local storage to download and cache images from Ceph via rbd rather than the Glance API via http.

Note

This option should only be enabled when the compute itself is not also using Ceph as a backing store. For example with the libvirt driver it should only be enabled when *libvirt.images_type* is not set to `rbd`.

Related options:

- *glance.rbd_user*
- *glance.rbd_connect_timeout*
- *glance.rbd_pool*
- *glance.rbd_ceph_conf*
- *libvirt.images_type*

rbd_user

Type
string

Default
''

The RADOS client name for accessing Glance images stored as rbd volumes.

Related options:

- This option is only used if *glance.enable_rbd_download* is set to `True`.

rbd_connect_timeout

Type
integer

Default
5

The RADOS client timeout in seconds when initially connecting to the cluster.

Related options:

- This option is only used if *glance.enable_rbd_download* is set to `True`.

rbd_pool

Type
string

Default
''

The RADOS pool in which the Glance images are stored as rbd volumes.

Related options:

- This option is only used if *glance.enable_rbd_download* is set to `True`.

rbd_ceph_conf

Type
string

Default
''

Path to the ceph configuration file to use.

Related options:

- This option is only used if *glance.enable_rbd_download* is set to `True`.

debug

Type
boolean

Default
`False`

Enable or disable debug logging with glanceclient.

`cafile`

Type
string

Default
<None>

PEM encoded Certificate Authority to use when verifying HTTPs connections.

`certfile`

Type
string

Default
<None>

PEM encoded client certificate cert file

`keyfile`

Type
string

Default
<None>

PEM encoded client certificate key file

`insecure`

Type
boolean

Default
`False`

Verify HTTPS connections.

`timeout`

Type
integer

Default
<None>

Timeout value for http requests

`collect_timing`

Type
boolean

Default
`False`

Collect per-API call timing information.

`split_loggers`

Type
boolean

Default
`False`

Log requests to multiple loggers.

`service_type`

Type
string

Default
`image`

The default service_type for endpoint URL discovery.

`service_name`

Type
string

Default
<None>

The default service_name for endpoint URL discovery.

`valid_interfaces`

Type
list

Default
`['internal', 'public']`

List of interfaces, in order of preference, for endpoint URL.

`region_name`

Type
string

Default
<None>

The default region_name for endpoint URL discovery.

`endpoint_override`

Type
string

Default
<None>

Always use this endpoint URL for requests for this client. NOTE: The unversioned endpoint should be specified here; to request a particular API version, use the *version*, *min-version*, and/or *max-version* options.

`connect_retries`

Type
integer

Default
<None>

The maximum number of retries that should be attempted for connection errors.

`connect_retry_delay`

Type
floating point

Default
<None>

Delay (in seconds) between two retries for connection errors. If not set, exponential retry starting with 0.5 seconds up to a maximum of 60 seconds is used.

`status_code_retries`

Type
integer

Default
<None>

The maximum number of retries that should be attempted for retriable HTTP status codes.

`status_code_retry_delay`

Type
floating point

Default
<None>

Delay (in seconds) between two retries for retriable status codes. If not set, exponential retry starting with 0.5 seconds up to a maximum of 60 seconds is used.

`retriable_status_codes`

Type
list

Default
<None>

List of retriable HTTP status codes that should be retried. If not set default to [503]

guestfs

libguestfs is a set of tools for accessing and modifying virtual machine (VM) disk images. You can use this for viewing and editing files inside guests, scripting changes to VMs, monitoring disk used/free statistics, creating guests, P2V, V2V, performing backups, cloning VMs, building VMs, formatting disks and resizing disks.

debug

Type
boolean

Default
`False`

Enable/disables guestfs logging.

This configures guestfs to debug messages and push them to OpenStack logging system. When set to True, it traces libguestfs API calls and enable verbose debug messages. In order to use the above feature, libguestfs package must be installed.

Related options:

Since libguestfs access and modifies VMs managed by libvirt, below options should be set to give access to those VMs.

- `libvirt.inject_key`
- `libvirt.inject_partition`
- `libvirt.inject_password`

healthcheck

detailed

Type
boolean

Default
`False`

Show more detailed information as part of the response. Security note: Enabling this option may expose sensitive details about the service being monitored. Be sure to verify that it will not violate your security policies.

backends

Type
list

Default
`[]`

Additional backends that can perform health checks and report that information back as part of a request.

allowed_source_ranges

Type
list

Default
`[]`

A list of network addresses to limit source ip allowed to access healthcheck information. Any request from ip outside of these network addresses are ignored.

`ignore_proxied_requests`

Type
boolean

Default
`False`

Ignore requests with proxy headers.

`disable_by_file_path`

Type
string

Default
<None>

Check the presence of a file to determine if an application is running on a port. Used by DisableByFileHealthcheck plugin.

`disable_by_file_paths`

Type
list

Default
`[]`

Check the presence of a file based on a port to determine if an application is running on a port. Expects a port:path list of strings. Used by DisableByFilesPortsHealthcheck plugin.

`enable_by_file_paths`

Type
list

Default
`[]`

Check the presence of files. Used by EnableByFilesHealthcheck plugin.

image_cache

A collection of options specific to image caching.

`manager_interval`

Type
integer

Default
`2400`

Minimum Value
-1

Number of seconds to wait between runs of the image cache manager.

Note that when using shared storage for the `[DEFAULT]/instances_path` configuration option across multiple nova-compute services, this periodic could process a large number of instances.

Similarly, using a compute driver that manages a cluster (like vmwareapi.VMwareVCDriver) could result in processing a large number of instances. Therefore you may need to adjust the time interval for the anticipated load, or only run on one nova-compute service within a shared storage aggregate. Additional note, every time the image_cache_manager runs the timestamps of images in `[DEFAULT]/instances_path` are updated.

Possible values:

- 0: run at the default interval of 60 seconds (not recommended)
- -1: disable
- Any other value

Related options:

- `[DEFAULT]/compute_driver`
- `[DEFAULT]/instances_path`

Table 23: Deprecated Variations

Group	Name
DEFAULT	image_cache_manager_interval

`subdirectory_name`

Type
string

Default
`_base`

Location of cached images.

This is NOT the full path - just a folder name relative to $instances_path. For per-compute-host cached images, set to _base_$my_ip

Table 24: Deprecated Variations

Group	Name
DEFAULT	image_cache_subdirectory_name

`remove_unused_base_images`

Type
boolean

Default
`True`

Should unused base images be removed?

When there are no remaining instances on the hypervisor created from this base image or linked to it, the base image is considered unused.

Table 25: Deprecated Variations

Group	Name
DEFAULT	remove_unused_base_images

remove_unused_original_minimum_age_seconds

Type
integer

Default
86400

Unused unresized base images younger than this will not be removed.

Table 26: Deprecated Variations

Group	Name
DEFAULT	remove_unused_original_minimum_age_seconds

remove_unused_resized_minimum_age_seconds

Type
integer

Default
3600

Unused resized base images younger than this will not be removed.

Table 27: Deprecated Variations

Group	Name
libvirt	remove_unused_resized_minimum_age_seconds

precache_concurrency

Type
integer

Default
1

Minimum Value
1

Maximum number of compute hosts to trigger image precaching in parallel.

When an image precache request is made, compute nodes will be contacted to initiate the download. This number constrains the number of those that will happen in parallel. Higher numbers will cause more computes to work in parallel and may result in reduced time to complete the operation, but may also DDoS the image service. Lower numbers will result in more sequential operation, lower image service load, but likely longer runtime to completion.

ironic

Configuration options for Ironic driver (Bare Metal). If using the Ironic driver following options must be set:

- auth_type
- auth_url
- project_name
- username
- password
- project_domain_id or project_domain_name
- user_domain_id or user_domain_name

api_max_retries

Type
integer

Default
60

Minimum Value
0

The number of times to retry when a request conflicts. If set to 0, only try once, no retries.

Related options:

- api_retry_interval

api_retry_interval

Type
integer

Default
2

Minimum Value
0

The number of seconds to wait before retrying the request.

Related options:

- api_max_retries

serial_console_state_timeout

Type
integer

Default
10

Minimum Value
0

Timeout (seconds) to wait for node serial console state changed. Set to 0 to disable timeout.

`conductor_group`

Type
string

Default
<None>

Mutable
This option can be changed without restarting.

Case-insensitive key to limit the set of nodes that may be managed by this service to the set of nodes in Ironic which have a matching conductor_group property. If unset, all available nodes will be eligible to be managed by this service. Note that setting this to the empty string ("") will match the default conductor group, and is different than leaving the option unset.

Table 28: Deprecated Variations

Group	Name
ironic	partition_key

`shard`

Type
string

Default
<None>

Specify which ironic shard this nova-compute will manage. This allows you to shard Ironic nodes between compute services across conductors and conductor groups. When a shard is set, the peer_list configuration is ignored. We require that there is at most one nova-compute service for each shard.

`peer_list`

Type
list

Default
[]

List of hostnames for all nova-compute services (including this host) with this conductor_group config value. Nodes matching the conductor_group value will be distributed between all services specified here. If conductor_group is unset, this option is ignored.

Warning

This option is deprecated for removal since 28.0.0. Its value may be silently ignored in the future.

Reason
We do not recommend using nova-compute HA, please use passive failover of a single nova-compute service instead.

`cafile`

Type
string

Default
<None>

PEM encoded Certificate Authority to use when verifying HTTPs connections.

`certfile`

Type
string

Default
<None>

PEM encoded client certificate cert file

`keyfile`

Type
string

Default
<None>

PEM encoded client certificate key file

`insecure`

Type
boolean

Default
`False`

Verify HTTPS connections.

`timeout`

Type
integer

Default
<None>

Timeout value for http requests

`collect_timing`

Type
boolean

Default
`False`

Collect per-API call timing information.

`split_loggers`

Type
boolean

Default
`False`

Log requests to multiple loggers.

`auth_type`

Type
unknown type

Default
<None>

Authentication type to load

Table 29: Deprecated Variations

Group	Name
ironic	auth_plugin

`auth_section`

Type
unknown type

Default
<None>

Config Section from which to load plugin specific options

`auth_url`

Type
unknown type

Default
<None>

Authentication URL

`system_scope`

Type
unknown type

Default
<None>

Scope for system operations

`domain_id`

Type
unknown type

Default
<None>

Domain ID to scope to

`domain_name`

Type
unknown type

Default
<None>

Domain name to scope to

`project_id`

Type
unknown type

Default
<None>

Project ID to scope to

`project_name`

Type
unknown type

Default
<None>

Project name to scope to

`project_domain_id`

Type
unknown type

Default
<None>

Domain ID containing project

`project_domain_name`

Type
unknown type

Default
<None>

Domain name containing project

`trust_id`

Type
unknown type

Default
<None>

ID of the trust to use as a trustee use

`user_id`

Type
unknown type

Default
<None>

Users user ID

`username`

Type
unknown type

Default
<None>

Users username

Table 30: Deprecated Variations

Group	Name
ironic	user-name
ironic	user_name

`user_domain_id`

Type
unknown type

Default
<None>

Users domain ID

`user_domain_name`

Type
unknown type

Default
<None>

Users domain name

`password`

Type
unknown type

Default
<None>

Users password

`service_type`

Type
string

Default
`baremetal`

The default service_type for endpoint URL discovery.

`service_name`

Type
string

Default
<None>

The default service_name for endpoint URL discovery.

`valid_interfaces`

Type
list

Default
`['internal', 'public']`

List of interfaces, in order of preference, for endpoint URL.

`region_name`

Type
string

Default
<None>

The default region_name for endpoint URL discovery.

`endpoint_override`

Type
string

Default
<None>

Always use this endpoint URL for requests for this client. NOTE: The unversioned endpoint should be specified here; to request a particular API version, use the *version*, *min-version*, and/or *max-version* options.

`connect_retries`

Type
integer

Default
<None>

The maximum number of retries that should be attempted for connection errors.

`connect_retry_delay`

Type
floating point

Default
<None>

Delay (in seconds) between two retries for connection errors. If not set, exponential retry starting with 0.5 seconds up to a maximum of 60 seconds is used.

`status_code_retries`

Type
integer

Default
<None>

The maximum number of retries that should be attempted for retriable HTTP status codes.

`status_code_retry_delay`

Type
floating point

Default
<None>

Delay (in seconds) between two retries for retriable status codes. If not set, exponential retry starting with 0.5 seconds up to a maximum of 60 seconds is used.

`retriable_status_codes`

Type
list

Default
<None>

List of retriable HTTP status codes that should be retried. If not set default to [503]

key_manager

`fixed_key`

Type
string

Default
<None>

Fixed key returned by key manager, specified in hex.

Possible values:

- Empty string or a key in hex value

Table 31: Deprecated Variations

Group	Name
keymgr	fixed_key

backend

Type
string

Default
`barbican`

Specify the key manager implementation. Options are barbican and vault. Default is barbican. Will support the values earlier set using [key_manager]/api_class for some time.

Table 32: Deprecated Variations

Group	Name
key_manager	api_class

auth_type

Type
string

Default
<None>

The type of authentication credential to create. Possible values are token, password, keystone_token, and keystone_password. Required if no context is passed to the credential factory.

token

Type
string

Default
<None>

Token for authentication. Required for token and keystone_token auth_type if no context is passed to the credential factory.

username

Type
string

Default
<None>

Username for authentication. Required for password auth_type. Optional for the keystone_password auth_type.

`password`

Type
string

Default
<None>

Password for authentication. Required for password and keystone_password auth_type.

`auth_url`

Type
string

Default
<None>

Use this endpoint to connect to Keystone.

`user_id`

Type
string

Default
<None>

User ID for authentication. Optional for keystone_token and keystone_password auth_type.

`user_domain_id`

Type
string

Default
<None>

Users domain ID for authentication. Optional for keystone_token and keystone_password auth_type.

`user_domain_name`

Type
string

Default
<None>

Users domain name for authentication. Optional for keystone_token and keystone_password auth_type.

`trust_id`

Type
string

Default
<None>

Trust ID for trust scoping. Optional for keystone_token and keystone_password auth_type.

`domain_id`

Type
string

Default
<None>

Domain ID for domain scoping. Optional for keystone_token and keystone_password auth_type.

`domain_name`

Type
string

Default
<None>

Domain name for domain scoping. Optional for keystone_token and keystone_password auth_type.

`project_id`

Type
string

Default
<None>

Project ID for project scoping. Optional for keystone_token and keystone_password auth_type.

`project_name`

Type
string

Default
<None>

Project name for project scoping. Optional for keystone_token and keystone_password auth_type.

`project_domain_id`

Type
string

Default
<None>

Projects domain ID for project. Optional for keystone_token and keystone_password auth_type.

`project_domain_name`

Type
string

Default
<None>

Projects domain name for project. Optional for keystone_token and keystone_password auth_type.

`reauthenticate`

Type
boolean

Default
`True`

Allow fetching a new token if the current one is going to expire. Optional for keystone_token and keystone_password auth_type.

keystone

Configuration options for the identity service

`cafile`

Type
string

Default
<None>

PEM encoded Certificate Authority to use when verifying HTTPs connections.

`certfile`

Type
string

Default
<None>

PEM encoded client certificate cert file

`keyfile`

Type
string

Default
<None>

PEM encoded client certificate key file

`insecure`

Type
boolean

Default
`False`

Verify HTTPS connections.

`timeout`

Type
integer

Default
<None>

Timeout value for http requests

`collect_timing`

Type
boolean

Default
`False`

Collect per-API call timing information.

`split_loggers`

Type
boolean

Default
`False`

Log requests to multiple loggers.

`auth_type`

Type
unknown type

Default
<None>

Authentication type to load

Table 33: Deprecated Variations

Group	Name
keystone	auth_plugin

`auth_section`

Type
unknown type

Default
<None>

Config Section from which to load plugin specific options

`auth_url`

Type
unknown type

Default
<None>

Authentication URL

`system_scope`

Type
unknown type

Default
<None>

Scope for system operations

`domain_id`

Type
unknown type

Default
<None>

Domain ID to scope to

`domain_name`

Type
unknown type

Default
<None>

Domain name to scope to

`project_id`

Type
unknown type

Default
<None>

Project ID to scope to

`project_name`

Type
unknown type

Default
<None>

Project name to scope to

`project_domain_id`

Type
unknown type

Default
<None>

Domain ID containing project

`project_domain_name`

Type
unknown type

Default
<None>

Domain name containing project

`trust_id`

Type
unknown type

Default
<None>

ID of the trust to use as a trustee use

`default_domain_id`

Type
unknown type

Default
<None>

Optional domain ID to use with v3 and v2 parameters. It will be used for both the user and project domain in v3 and ignored in v2 authentication.

`default_domain_name`

Type
unknown type

Default
<None>

Optional domain name to use with v3 API and v2 parameters. It will be used for both the user and project domain in v3 and ignored in v2 authentication.

`user_id`

Type
unknown type

Default
<None>

Users user ID

`username`

Type
unknown type

Default
<None>

Users username

Table 34: Deprecated Variations

Group	Name
keystone	user-name
keystone	user_name

`user_domain_id`

Type
unknown type

Default
<None>

Users domain ID

`user_domain_name`

Type
unknown type

Default
<None>

Users domain name

`password`

Type
unknown type

Default
<None>

Users password

`tenant_id`

Type
unknown type

Default
<None>

Tenant ID

`tenant_name`

Type
unknown type

Default
<None>

Tenant Name

`service_type`

Type
string

Default
`identity`

The default service_type for endpoint URL discovery.

`service_name`

Type
string

Default
<None>

The default service_name for endpoint URL discovery.

`valid_interfaces`

Type
list

Default
`['internal', 'public']`

List of interfaces, in order of preference, for endpoint URL.

`region_name`

Type
string

Default
<None>

The default region_name for endpoint URL discovery.

`endpoint_override`

Type
string

Default
<None>

Always use this endpoint URL for requests for this client. NOTE: The unversioned endpoint should be specified here; to request a particular API version, use the *version*, *min-version*, and/or *max-version* options.

`connect_retries`

Type
integer

Default
<None>

The maximum number of retries that should be attempted for connection errors.

`connect_retry_delay`

Type
floating point

Default
<None>

Delay (in seconds) between two retries for connection errors. If not set, exponential retry starting with 0.5 seconds up to a maximum of 60 seconds is used.

`status_code_retries`

Type
integer

Default
<None>

The maximum number of retries that should be attempted for retriable HTTP status codes.

`status_code_retry_delay`

Type
floating point

Default
<None>

Delay (in seconds) between two retries for retriable status codes. If not set, exponential retry starting with 0.5 seconds up to a maximum of 60 seconds is used.

`retriable_status_codes`

Type
list

Default
<None>

List of retriable HTTP status codes that should be retried. If not set default to [503]

keystone_authtoken

`www_authenticate_uri`

Type
string

Default
<None>

Complete public Identity API endpoint. This endpoint should not be an admin endpoint, as it should be accessible by all end users. Unauthenticated clients are redirected to this endpoint to authenticate. Although this endpoint should ideally be unversioned, client support in the wild varies. If youre using a versioned v2 endpoint here, then this should *not* be the same endpoint the service user utilizes for validating tokens, because normal end users may not be able to reach that endpoint.

Table 35: Deprecated Variations

Group	Name
keystone_authtoken	auth_uri

`auth_uri`

Type
string

Default
<None>

Complete public Identity API endpoint. This endpoint should not be an admin endpoint, as it should be accessible by all end users. Unauthenticated clients are redirected to this endpoint to authenticate. Although this endpoint should ideally be unversioned, client support in the wild varies. If youre using a versioned v2 endpoint here, then this should *not* be the same endpoint the service user utilizes for validating tokens, because normal end users may not be able to reach that endpoint. This option is deprecated in favor of www_authenticate_uri and will be removed in the S release.

Warning

This option is deprecated for removal since Queens. Its value may be silently ignored in the future.

Reason
The auth_uri option is deprecated in favor of www_authenticate_uri and will be removed in the S release.

`auth_version`

Type
string

Default
<None>

API version of the Identity API endpoint.

`interface`

Type
string

Default
`internal`

Interface to use for the Identity API endpoint. Valid values are public, internal (default) or admin.

`delay_auth_decision`

Type
boolean

Default
`False`

Do not handle authorization requests within the middleware, but delegate the authorization decision to downstream WSGI components.

`http_connect_timeout`

Type
integer

Default
<None>

Request timeout value for communicating with Identity API server.

`http_request_max_retries`

Type
integer

Default
3

How many times are we trying to reconnect when communicating with Identity API Server.

`cache`

Type
string

Default
<None>

Request environment key where the Swift cache object is stored. When auth_token middleware is deployed with a Swift cache, use this option to have the middleware share a caching backend with swift. Otherwise, use the `memcached_servers` option instead.

`certfile`

Type
string

Default
<None>

Required if identity server requires client certificate

`keyfile`

Type
string

Default
<None>

Required if identity server requires client certificate

`cafile`

Type
string

Default
<None>

A PEM encoded Certificate Authority to use when verifying HTTPs connections. Defaults to system CAs.

`insecure`

Type
boolean

Default
`False`

Verify HTTPS connections.

`region_name`

Type
string

Default
<None>

The region in which the identity server can be found.

`memcached_servers`

Type
list

Default
<None>

Optionally specify a list of memcached server(s) to use for caching. If left undefined, tokens will instead be cached in-process.

Table 36: Deprecated Variations

Group	Name
keystone_authtoken	memcache_servers

`token_cache_time`

Type
integer

Default
`300`

In order to prevent excessive effort spent validating tokens, the middleware caches previously-seen tokens for a configurable duration (in seconds). Set to -1 to disable caching completely.

`memcache_security_strategy`

Type
string

Default
`None`

Valid Values
None, MAC, ENCRYPT

(Optional) If defined, indicate whether token data should be authenticated or authenticated and encrypted. If MAC, token data is authenticated (with HMAC) in the cache. If ENCRYPT, token data is encrypted and authenticated in the cache. If the value is not one of these options or empty, auth_token will raise an exception on initialization.

`memcache_secret_key`

Type
string

Default
<None>

(Optional, mandatory if memcache_security_strategy is defined) This string is used for key derivation.

`memcache_tls_enabled`

Type
boolean

Default
`False`

(Optional) Global toggle for TLS usage when comunicating with the caching servers.

`memcache_tls_cafile`

Type
string

Default
<None>

(Optional) Path to a file of concatenated CA certificates in PEM format necessary to establish the caching servers authenticity. If tls_enabled is False, this option is ignored.

`memcache_tls_certfile`

Type
string

Default
<None>

(Optional) Path to a single file in PEM format containing the clients certificate as well as any number of CA certificates needed to establish the certificates authenticity. This file is only required when client side authentication is necessary. If tls_enabled is False, this option is ignored.

`memcache_tls_keyfile`

Type
string

Default
<None>

(Optional) Path to a single file containing the clients private key in. Otherwhise the private key will be taken from the file specified in tls_certfile. If tls_enabled is False, this option is ignored.

`memcache_tls_allowed_ciphers`

Type
string

Default
<None>

(Optional) Set the available ciphers for sockets created with the TLS context. It should be a string in the OpenSSL cipher list format. If not specified, all OpenSSL enabled ciphers will be available.

`memcache_pool_dead_retry`

Type
integer

Default
300

(Optional) Number of seconds memcached server is considered dead before it is tried again.

`memcache_pool_maxsize`

Type
integer

Default
10

(Optional) Maximum total number of open connections to every memcached server.

`memcache_pool_socket_timeout`

Type
integer

Default
3

(Optional) Socket timeout in seconds for communicating with a memcached server.

`memcache_pool_unused_timeout`

Type
integer

Default
60

(Optional) Number of seconds a connection to memcached is held unused in the pool before it is closed.

`memcache_pool_conn_get_timeout`

Type
integer

Default
`10`

(Optional) Number of seconds that an operation will wait to get a memcached client connection from the pool.

`memcache_use_advanced_pool`

Type
boolean

Default
`True`

(Optional) Use the advanced (eventlet safe) memcached client pool.

`include_service_catalog`

Type
boolean

Default
`True`

(Optional) Indicate whether to set the X-Service-Catalog header. If False, middleware will not ask for service catalog on token validation and will not set the X-Service-Catalog header.

`enforce_token_bind`

Type
string

Default
`permissive`

Used to control the use and type of token binding. Can be set to: disabled to not check token binding. permissive (default) to validate binding information if the bind type is of a form known to the server and ignore it if not. strict like permissive but if the bind type is unknown the token will be rejected. required any form of token binding is needed to be allowed. Finally the name of a binding method that must be present in tokens.

`service_token_roles`

Type
list

Default
`['service']`

A choice of roles that must be present in a service token. Service tokens are allowed to request that an expired token can be used and so this check should tightly control that only actual services should be sending this token. Roles here are applied as an ANY check so any role in this list must be present. For backwards compatibility reasons this currently only affects the allow_expired check.

`service_token_roles_required`

Type
boolean

Default
`False`

For backwards compatibility reasons we must let valid service tokens pass that dont pass the service_token_roles check as valid. Setting this true will become the default in a future release and should be enabled if possible.

`service_type`

Type
string

Default
<None>

The name or type of the service as it appears in the service catalog. This is used to validate tokens that have restricted access rules.

`memcache_sasl_enabled`

Type
boolean

Default
`False`

Enable the SASL(Simple Authentication and Security Layer) if the SASL_enable is true, else disable.

`memcache_username`

Type
string

Default
`''`

the user name for the SASL

`memcache_password`

Type
string

Default
`''`

the username password for SASL

`auth_type`

Type
unknown type

Default
<None>

Authentication type to load

Table 37: Deprecated Variations

Group	Name
keystone_authtoken	auth_plugin

`auth_section`

Type
unknown type

Default
<None>

Config Section from which to load plugin specific options

libvirt

Libvirt options allows cloud administrator to configure related libvirt hypervisor driver to be used within an OpenStack deployment.

Almost all of the libvirt config options are influence by `virt_type` config which describes the virtualization type (or so called domain type) libvirt should use for specific features such as live migration, snapshot.

`rescue_image_id`

Type
string

Default
<None>

The ID of the image to boot from to rescue data from a corrupted instance.

If the rescue REST API operation doesnt provide an ID of an image to use, the image which is referenced by this ID is used. If this option is not set, the image from the instance is used.

Possible values:

- An ID of an image or nothing. If it points to an *Amazon Machine Image* (AMI), consider to set the config options `rescue_kernel_id` and `rescue_ramdisk_id` too. If nothing is set, the image of the instance is used.

Related options:

- `rescue_kernel_id`: If the chosen rescue image allows the separate definition of its kernel disk, the value of this option is used, if specified. This is the case when *Amazon*s AMI/AKI/ARI image format is used for the rescue image.
- `rescue_ramdisk_id`: If the chosen rescue image allows the separate definition of its RAM disk, the value of this option is used if, specified. This is the case when *Amazon*s AMI/AKI/ARI image format is used for the rescue image.

`rescue_kernel_id`

Type
string

Default
<None>

The ID of the kernel (AKI) image to use with the rescue image.

If the chosen rescue image allows the separate definition of its kernel disk, the value of this option is used, if specified. This is the case when *Amazon*s AMI/AKI/ARI image format is used for the rescue image.

Possible values:

- An ID of an kernel image or nothing. If nothing is specified, the kernel disk from the instance is used if it was launched with one.

Related options:

- `rescue_image_id`: If that option points to an image in *Amazon*s AMI/AKI/ARI image format, its useful to use `rescue_kernel_id` too.

`rescue_ramdisk_id`

Type
string

Default
<None>

The ID of the RAM disk (ARI) image to use with the rescue image.

If the chosen rescue image allows the separate definition of its RAM disk, the value of this option is used, if specified. This is the case when *Amazon*s AMI/AKI/ARI image format is used for the rescue image.

Possible values:

- An ID of a RAM disk image or nothing. If nothing is specified, the RAM disk from the instance is used if it was launched with one.

Related options:

- `rescue_image_id`: If that option points to an image in *Amazon*s AMI/AKI/ARI image format, its useful to use `rescue_ramdisk_id` too.

`virt_type`

Type
string

Default
kvm

Valid Values
kvm, lxc, qemu, parallels

Describes the virtualization type (or so called domain type) libvirt should use.

The choice of this type must match the underlying virtualization strategy you have chosen for this host.

Related options:

- `connection_uri`: depends on this

- `disk_prefix`: depends on this
- `cpu_mode`: depends on this
- `cpu_models`: depends on this
- `tb_cache_size`: depends on this

`connection_uri`

Type
string

Default
''

Overrides the default libvirt URI of the chosen virtualization type.

If set, Nova will use this URI to connect to libvirt.

Possible values:

- An URI like `qemu:///system`.

  This is only necessary if the URI differs to the commonly known URIs for the chosen virtualization type.

Related options:

- `virt_type`: Influences what is used as default value here.

`inject_password`

Type
boolean

Default
`False`

Allow the injection of an admin password for instance only at `create` and `rebuild` process.

There is no agent needed within the image to do this. If *libguestfs* is available on the host, it will be used. Otherwise *nbd* is used. The file system of the image will be mounted and the admin password, which is provided in the REST API call will be injected as password for the root user. If no root user is available, the instance wont be launched and an error is thrown. Be aware that the injection is *not* possible when the instance gets launched from a volume.

Linux distribution guest only.

Possible values:

- True: Allows the injection.
- False: Disallows the injection. Any via the REST API provided admin password will be silently ignored.

Related options:

- `inject_partition`: That option will decide about the discovery and usage of the file system. It also can disable the injection at all.

`inject_key`

Type
boolean

Default
`False`

Allow the injection of an SSH key at boot time.

There is no agent needed within the image to do this. If *libguestfs* is available on the host, it will be used. Otherwise *nbd* is used. The file system of the image will be mounted and the SSH key, which is provided in the REST API call will be injected as SSH key for the root user and appended to the `authorized_keys` of that user. The SELinux context will be set if necessary. Be aware that the injection is *not* possible when the instance gets launched from a volume.

This config option will enable directly modifying the instance disk and does not affect what cloud-init may do using data from config_drive option or the metadata service.

Linux distribution guest only.

Related options:

- `inject_partition`: That option will decide about the discovery and usage of the file system. It also can disable the injection at all.

`inject_partition`

Type
integer

Default
`-2`

Minimum Value
-2

Determines how the file system is chosen to inject data into it.

libguestfs is used to inject data. If libguestfs is not able to determine the root partition (because there are more or less than one root partition) or cannot mount the file system it will result in an error and the instance wont boot.

Possible values:

- -2 => disable the injection of data.
- -1 => find the root partition with the file system to mount with libguestfs
- 0 => The image is not partitioned
- >0 => The number of the partition to use for the injection

Linux distribution guest only.

Related options:

- `inject_key`: If this option allows the injection of a SSH key it depends on value greater or equal to -1 for `inject_partition`.
- `inject_password`: If this option allows the injection of an admin password it depends on value greater or equal to -1 for `inject_partition`.

- `[guestfs]/debug` You can enable the debug log level of libguestfs with this config option. A more verbose output will help in debugging issues.
- `virt_type`: If you use `lxc` as virt_type it will be treated as a single partition image

`live_migration_scheme`

Type
string

Default
<None>

URI scheme for live migration used by the source of live migration traffic.

Override the default libvirt live migration scheme (which is dependent on virt_type). If this option is set to None, nova will automatically choose a sensible default based on the hypervisor. It is not recommended that you change this unless you are very sure that hypervisor supports a particular scheme.

Related options:

- `virt_type`: This option is meaningful only when `virt_type` is set to *kvm* or *qemu*.
- `live_migration_uri`: If `live_migration_uri` value is not None, the scheme used for live migration is taken from `live_migration_uri` instead.

`live_migration_inbound_addr`

Type
unknown type

Default
<None>

IP address used as the live migration address for this host.

This option indicates the IP address which should be used as the target for live migration traffic when migrating to this hypervisor. This metadata is then used by the source of the live migration traffic to construct a migration URI.

If this option is set to None, the hostname of the migration target compute node will be used.

This option is useful in environments where the live-migration traffic can impact the network plane significantly. A separate network for live-migration traffic can then use this config option and avoids the impact on the management network.

`live_migration_uri`

Type
string

Default
<None>

Live migration target URI used by the source of live migration traffic.

Override the default libvirt live migration target URI (which is dependent on virt_type). Any included %s is replaced with the migration target hostname, or *live_migration_inbound_addr* if set.

If this option is set to None (which is the default), Nova will automatically generate the *live_migration_uri* value based on only 4 supported *virt_type* in following list:

- kvm: qemu+tcp://%s/system
- qemu: qemu+tcp://%s/system
- parallels: parallels+tcp://%s/system

Related options:

- `live_migration_inbound_addr`: If `live_migration_inbound_addr` value is not None and `live_migration_tunnelled` is False, the ip/hostname address of target compute node is used instead of `live_migration_uri` as the uri for live migration.
- `live_migration_scheme`: If `live_migration_uri` is not set, the scheme used for live migration is taken from `live_migration_scheme` instead.

Warning

This option is deprecated for removal since 15.0.0. Its value may be silently ignored in the future.

Reason

live_migration_uri is deprecated for removal in favor of two other options that allow to change live migration scheme and target URI: `live_migration_scheme` and `live_migration_inbound_addr` respectively.

`live_migration_tunnelled`

Type

boolean

Default

`False`

Enable tunnelled migration.

This option enables the tunnelled migration feature, where migration data is transported over the libvirtd connection. If enabled, we use the VIR_MIGRATE_TUNNELLED migration flag, avoiding the need to configure the network to allow direct hypervisor to hypervisor communication. If False, use the native transport. If not set, Nova will choose a sensible default based on, for example the availability of native encryption support in the hypervisor. Enabling this option will definitely impact performance massively.

Note that this option is NOT compatible with use of block migration.

Warning

This option is deprecated for removal since 23.0.0. Its value may be silently ignored in the future.

Reason

The tunnelled live migration has two inherent limitations: it cannot handle live migration of disks in a non-shared storage setup; and it

has a huge performance cost. Both these problems are solved by `live_migration_with_native_tls` (requires a pre-configured TLS environment), which is the recommended approach for securing all live migration streams.

`live_migration_bandwidth`

Type
integer

Default
`0`

Maximum bandwidth(in MiB/s) to be used during migration.

If set to 0, the hypervisor will choose a suitable default. Some hypervisors do not support this feature and will return an error if bandwidth is not 0. Please refer to the libvirt documentation for further details.

`live_migration_downtime`

Type
integer

Default
`500`

Minimum Value
100

Target maximum period of time Nova will try to keep the instance paused during the last part of the memory copy, in *milliseconds*.

Minimum downtime is 100ms. You can increase this value if you want to allow live-migrations to complete faster, or avoid live-migration timeout errors by allowing the guest to be paused for longer during the live-migration switch over. This value may be exceeded if there is any reduction on the transfer rate after the VM is paused.

Related options:

- live_migration_completion_timeout

`live_migration_downtime_steps`

Type
integer

Default
`10`

Minimum Value
3

Number of incremental steps to reach max downtime value.

Minimum number of steps is 3.

`live_migration_downtime_delay`

Type
integer

Default
75

Minimum Value
3

Time to wait, in seconds, between each step increase of the migration downtime.

Minimum delay is 3 seconds. Value is per GiB of guest RAM + disk to be transferred, with lower bound of a minimum of 2 GiB per device.

`live_migration_completion_timeout`

Type
integer

Default
800

Minimum Value
0

Mutable
This option can be changed without restarting.

Time to wait, in seconds, for migration to successfully complete transferring data before aborting the operation.

Value is per GiB of guest RAM + disk to be transferred, with lower bound of a minimum of 2 GiB. Should usually be larger than downtime delay * downtime steps. Set to 0 to disable timeouts.

Related options:

- live_migration_downtime
- live_migration_downtime_steps
- live_migration_downtime_delay

`live_migration_parallel_connections`

Type
integer

Default
1

Number of parallel connections to QEMU during live migrations.

Values above 1 will instruct hypervisor explicitly on amount of connections to use. Please note, that each connection can utilize up to 1 CPU core, especially when `live_migration_with_native_tls` is used. Therefore it is recommended to reserve CPUs using `cpu_shared_set`/`cpu_dedicated_set` or `reserved_host_cpus` multiplied by `cpu_allocation_ratio`.

Usage of `live_migration_parallel_connections` in combination with `live_migration_permit_post_copy` is supported only with QEMU>=10.1.0.

Related options:

- [compute] cpu_shared_set
- [compute] cpu_dedicated_set
- [DEFAULT] reserved_host_cpus
- [libvirt] live_migration_permit_post_copy

live_migration_timeout_action

Type
string

Default
abort

Valid Values
abort, force_complete

Mutable
This option can be changed without restarting.

This option will be used to determine what action will be taken against a VM after live_migration_completion_timeout expires. By default, the live migrate operation will be aborted after completion timeout. If it is set to force_complete, the compute service will either pause the VM or trigger post-copy depending on if post copy is enabled and available (live_migration_permit_post_copy is set to True).

Related options:

- live_migration_completion_timeout
- live_migration_permit_post_copy

live_migration_permit_post_copy

Type
boolean

Default
False

This option allows nova to switch an on-going live migration to post-copy mode, i.e., switch the active VM to the one on the destination node before the migration is complete, therefore ensuring an upper bound on the memory that needs to be transferred. Post-copy requires libvirt>=1.3.3 and QEMU>=2.5.0.

When permitted, post-copy mode will be automatically activated if we reach the timeout defined by live_migration_completion_timeout and live_migration_timeout_action is set to force_complete. Note if you change to no timeout or choose to use abort, i.e. live_migration_completion_timeout = 0, then there will be no automatic switch to post-copy.

The live-migration force complete API also uses post-copy when permitted. If post-copy mode is not available, force complete falls back to pausing the VM to ensure the live-migration operation will complete.

When using post-copy mode, if the source and destination hosts lose network connectivity, the VM being live-migrated will need to be rebooted. For more details, please see the Administration guide.

Usage of the option together with `live_migration_parallel_connections` is supported only with QEMU>=10.1.0. Otherwise VM will end up in SHUTOFF state on the destination host.

Related options:

- live_migration_permit_auto_converge
- live_migration_timeout_action
- live_migration_parallel_connections

`live_migration_permit_auto_converge`

Type
boolean

Default
`False`

This option allows nova to start live migration with auto converge on.

Auto converge throttles down CPU if a progress of on-going live migration is slow. Auto converge will only be used if this flag is set to True and post copy is not permitted or post copy is unavailable due to the version of libvirt and QEMU in use.

Related options:

- live_migration_permit_post_copy

`snapshot_image_format`

Type
string

Default
<None>

Valid Values
raw, qcow2, vmdk, vdi

Determine the snapshot image format when sending to the image service.

If set, this decides what format is used when sending the snapshot to the image service. If not set, defaults to same type as source image.

Possible values

raw
RAW disk format

qcow2
KVM default disk format

vmdk
VMWare default disk format

vdi
VirtualBox default disk format

`live_migration_with_native_tls`

Type
boolean

Default
`False`

Use QEMU-native TLS encryption when live migrating.

This option will allow both migration stream (guest RAM plus device state) *and* disk stream to be transported over native TLS, i.e. TLS support built into QEMU.

Prerequisite: TLS environment is configured correctly on all relevant Compute nodes. This means, Certificate Authority (CA), server, client certificates, their corresponding keys, and their file permissions are in place, and are validated.

Notes:

- To have encryption for migration stream and disk stream (also called: block migration), `live_migration_with_native_tls` is the preferred config attribute instead of `live_migration_tunnelled`.
- The `live_migration_tunnelled` will be deprecated in the long-term for two main reasons: (a) it incurs a huge performance penalty; and (b) it is not compatible with block migration. Therefore, if your compute nodes have at least libvirt 4.4.0 and QEMU 2.11.0, it is strongly recommended to use `live_migration_with_native_tls`.
- The `live_migration_tunnelled` and `live_migration_with_native_tls` should not be used at the same time.
- Unlike `live_migration_tunnelled`, the `live_migration_with_native_tls` *is* compatible with block migration. That is, with this option, NBD stream, over which disks are migrated to a target host, will be encrypted.

Related options:

`live_migration_tunnelled`: This transports migration stream (but not disk stream) over libvirtd.

`disk_prefix`

Type
string

Default
<None>

Override the default disk prefix for the devices attached to an instance.

If set, this is used to identify a free disk device name for a bus.

Possible values:

- Any prefix which will result in a valid disk device name like sda or hda for example. This is only necessary if the device names differ to the commonly known device name prefixes for a virtualization type such as: sd, xvd, uvd, vd.

Related options:

- `virt_type`: Influences which device type is used, which determines the default disk prefix.

`wait_soft_reboot_seconds`

Type
integer

Default
`120`

Number of seconds to wait for instance to shut down after soft reboot request is made. We fall back to hard reboot if instance does not shutdown within this window.

`cpu_mode`

Type
string

Default
<None>

Valid Values
host-model, host-passthrough, custom, none

Is used to set the CPU mode an instance should have.

If `virt_type="kvm|qemu"`, it will default to `host-model`, otherwise it will default to `none`.

Related options:

- `cpu_models`: This should be set ONLY when `cpu_mode` is set to `custom`. Otherwise, it would result in an error and the instance launch will fail.

Possible values

host-model
Clone the host CPU feature flags

host-passthrough
Use the host CPU model exactly

custom
Use the CPU model in `[libvirt]cpu_models`

none
Dont set a specific CPU model. For instances with `[libvirt] virt_type` as KVM/QEMU, the default CPU model from QEMU will be used, which provides a basic set of CPU features that are compatible with most hosts

`cpu_models`

Type
list

Default
`[]`

An ordered list of CPU models the host supports.

It is expected that the list is ordered so that the more common and less advanced CPU models are listed earlier. Here is an example: `SandyBridge,IvyBridge,Haswell,Broadwell`, the latter CPU models features is richer that the previous CPU model.

Possible values:

- The named CPU models can be found via `virsh cpu-models ARCH`, where ARCH is your host architecture.

Related options:

- `cpu_mode`: This should be set to `custom` ONLY when you want to configure (via `cpu_models`) a specific named CPU model. Otherwise, it would result in an error and the instance launch will fail.
- `virt_type`: Only the virtualization types `kvm` and `qemu` use this.

Note

Be careful to only specify models which can be fully supported in hardware.

Table 38: Deprecated Variations

Group	Name
libvirt	cpu_model

`cpu_model_extra_flags`

Type
list

Default
`[]`

Enable or disable guest CPU flags.

To explicitly enable or disable CPU flags, use the `+flag` or `-flag` notation the + sign will enable the CPU flag for the guest, while a - sign will disable it. If neither + nor - is specified, the flag will be enabled, which is the default behaviour. For example, if you specify the following (assuming the said CPU model and features are supported by the host hardware and software):

```
[libvirt]
cpu_mode = custom
cpu_models = Cascadelake-Server
cpu_model_extra_flags = -hle, -rtm, +ssbd, mtrr
```

Nova will disable the `hle` and `rtm` flags for the guest; and it will enable `ssbd` and `mttr` (because it was specified with neither + nor - prefix).

The CPU flags are case-insensitive. In the following example, the `pdpe1gb` flag will be disabled for the guest; `vmx` and `pcid` flags will be enabled:

```
[libvirt]
cpu_mode = custom
cpu_models = Haswell-noTSX-IBRS
cpu_model_extra_flags = -PDPE1GB, +VMX, pcid
```

Specifying extra CPU flags is valid in combination with all the three possible values of `cpu_mode` config attribute: `custom` (this also requires an explicit CPU model to be specified via the `cpu_models` config attribute), `host-model`, or `host-passthrough`.

There can be scenarios where you may need to configure extra CPU flags even for `host-passthrough` CPU mode, because sometimes QEMU may disable certain CPU features. An example of this is Intels invtsc (Invariable Time Stamp Counter) CPU flag if you need to expose this flag to a Nova instance, you need to explicitly enable it.

The possible values for `cpu_model_extra_flags` depends on the CPU model in use. Refer to `/usr/share/libvirt/cpu_map/*.xml` for possible CPU feature flags for a given CPU model.

A special note on a particular CPU flag: `pcid` (an Intel processor feature that alleviates guest performance degradation as a result of applying the Meltdown CVE fixes). When configuring this flag with the `custom` CPU mode, not all CPU models (as defined by QEMU and libvirt) need it:

- The only virtual CPU models that include the `pcid` capability are Intel Haswell, Broadwell, and Skylake variants.
- The libvirt / QEMU CPU models Nehalem, Westmere, SandyBridge, and IvyBridge will _not_ expose the `pcid` capability by default, even if the host CPUs by the same name include it. I.e. PCID needs to be explicitly specified when using the said virtual CPU models.

The libvirt drivers default CPU mode, `host-model`, will do the right thing with respect to handling PCID CPU flag for the guest *assuming* you are running updated processor microcode, host and guest kernel, libvirt, and QEMU. The other mode, `host-passthrough`, checks if PCID is available in the hardware, and if so directly passes it through to the Nova guests. Thus, in context of PCID, with either of these CPU modes (`host-model` or `host-passthrough`), there is no need to use the `cpu_model_extra_flags`.

Related options:

- cpu_mode
- cpu_models

`snapshots_directory`

Type
string

Default
`$instances_path/snapshots`

Location where libvirt driver will store snapshots before uploading them to image service

`disk_cachemodes`

Type
list

Default
`[]`

Specific cache modes to use for different disk types.

For example: file=directsync,block=none,network=writeback

For local or direct-attached storage, it is recommended that you use writethrough (default) mode, as it ensures data integrity and has acceptable I/O performance for applications running in the

guest, especially for read operations. However, caching mode none is recommended for remote NFS storage, because direct I/O operations (O_DIRECT) perform better than synchronous I/O operations (with O_SYNC). Caching mode none effectively turns all guest I/O operations into direct I/O operations on the host, which is the NFS client in this environment.

Possible cache modes:

- default: It Depends For Nova-managed disks, `none`, if the host file system is capable of Linuxs O_DIRECT semantics; otherwise `writeback`. For volume drivers, the default is driver-dependent: `none` for everything except for SMBFS and Virtuzzo (which use `writeback`).
- none: With caching mode set to none, the host page cache is disabled, but the disk write cache is enabled for the guest. In this mode, the write performance in the guest is optimal because write operations bypass the host page cache and go directly to the disk write cache. If the disk write cache is battery-backed, or if the applications or storage stack in the guest transfer data properly (either through fsync operations or file system barriers), then data integrity can be ensured. However, because the host page cache is disabled, the read performance in the guest would not be as good as in the modes where the host page cache is enabled, such as writethrough mode. Shareable disk devices, like for a multi-attachable block storage volume, will have their cache mode set to none regardless of configuration.
- writethrough: With caching set to writethrough mode, the host page cache is enabled, but the disk write cache is disabled for the guest. Consequently, this caching mode ensures data integrity even if the applications and storage stack in the guest do not transfer data to permanent storage properly (either through fsync operations or file system barriers). Because the host page cache is enabled in this mode, the read performance for applications running in the guest is generally better. However, the write performance might be reduced because the disk write cache is disabled.
- writeback: With caching set to writeback mode, both the host page cache and the disk write cache are enabled for the guest. Because of this, the I/O performance for applications running in the guest is good, but the data is not protected in a power failure. As a result, this caching mode is recommended only for temporary data where potential data loss is not a concern. NOTE: Certain backend disk mechanisms may provide safe writeback cache semantics. Specifically those that bypass the host page cache, such as QEMUs integrated RBD driver. Ceph documentation recommends setting this to writeback for maximum performance while maintaining data safety.
- directsync: Like writethrough, but it bypasses the host page cache.
- unsafe: Caching mode of unsafe ignores cache transfer operations completely. As its name implies, this caching mode should be used only for temporary data where data loss is not a concern. This mode can be useful for speeding up guest installations, but you should switch to another caching mode in production environments.

`rng_dev_path`

Type
string

Default
`/dev/urandom`

The path to an RNG (Random Number Generator) device that will be used as the source of entropy on the host. Since libvirt 1.3.4, any path (that returns random numbers when read) is accepted. The recommended source of entropy is `/dev/urandom` it is non-blocking, therefore relatively fast; and avoids the limitations of `/dev/random`, which is a legacy interface. For more details

(and comparison between different RNG sources), refer to the Usage section in the Linux kernel API documentation for `[u]random`: http://man7.org/linux/man-pages/man4/urandom.4.html and http://man7.org/linux/man-pages/man7/random.7.html.

`hw_machine_type`

Type
list

Default
<None>

For qemu or KVM guests, set this option to specify a default machine type per host architecture. You can find a list of supported machine types in your environment by checking the output of the **`virsh capabilities`** command. The format of the value for this config option is `host-arch=machine-type`. For example: `x86_64=machinetype1,armv7l=machinetype2`.

`sysinfo_serial`

Type
string

Default
`unique`

Valid Values
none, os, hardware, auto, unique

The data source used to the populate the host serial UUID exposed to guest in the virtual BIOS. All choices except `unique` will change the serial when migrating the instance to another host. Changing the choice of this option will also affect existing instances on this host once they are stopped and started again. It is recommended to use the default choice (`unique`) since that will not change when an instance is migrated. However, if you have a need for per-host serials in addition to per-instance serial numbers, then consider restricting flavors via host aggregates.

Possible values

none
A serial number entry is not added to the guest domain xml.

os
A UUID serial number is generated from the host `/etc/machine-id` file.

hardware
A UUID for the host hardware as reported by libvirt. This is typically from the host SMBIOS data, unless it has been overridden in `libvirtd.conf`.

auto
Uses the os source if possible, else hardware.

unique
Uses instance UUID as the serial number.

`mem_stats_period_seconds`

Type
integer

Default
10

A number of seconds to memory usage statistics period. Zero or negative value mean to disable memory usage statistics.

`uid_maps`

Type
list

Default
[]

List of uid targets and ranges.Syntax is guest-uid:host-uid:count. Maximum of 5 allowed.

`gid_maps`

Type
list

Default
[]

List of guid targets and ranges.Syntax is guest-gid:host-gid:count. Maximum of 5 allowed.

`realtime_scheduler_priority`

Type
integer

Default
1

In a realtime host context vCPUs for guest will run in that scheduling priority. Priority depends on the host kernel (usually 1-99)

`enabled_perf_events`

Type
list

Default
[]

Performance events to monitor and collect statistics for.

This will allow you to specify a list of events to monitor low-level performance of guests, and collect related statistics via the libvirt driver, which in turn uses the Linux kernels `perf` infrastructure. With this config attribute set, Nova will generate libvirt guest XML to monitor the specified events.

For example, to monitor the count of CPU cycles (total/elapsed) and the count of cache misses, enable them as follows:

```
[libvirt]
enabled_perf_events = cpu_clock, cache_misses
```

Possible values: A string list. The list of supported events can be found here. Note that Intel CMT events - `cmt`, `mbmbt` and `mbml` - are unsupported by recent Linux kernel versions (4.14+) and will be ignored by nova.

`num_pcie_ports`

Type
integer

Default
`0`

Minimum Value
0

Maximum Value
28

The number of PCIe ports an instance will get.

Libvirt allows a custom number of PCIe ports (pcie-root-port controllers) a target instance will get. Some will be used by default, rest will be available for hotplug use.

By default we have just 1-2 free ports which limits hotplug.

More info: https://github.com/qemu/qemu/blob/master/docs/pcie.txt

Due to QEMU limitations for aarch64/virt maximum value is set to 28.

Default value 0 moves calculating amount of ports to libvirt.

`file_backed_memory`

Type
integer

Default
`0`

Minimum Value
0

Available capacity in MiB for file-backed memory.

Set to 0 to disable file-backed memory.

When enabled, instances will create memory files in the directory specified in `/etc/libvirt/qemu.conf`s `memory_backing_dir` option. The default location is `/var/lib/libvirt/qemu/ram`.

When enabled, the value defined for this option is reported as the node memory capacity. Compute node system memory will be used as a cache for file-backed memory, via the kernels pagecache mechanism.

Note

This feature is not compatible with hugepages.

Note

This feature is not compatible with memory overcommit.

Related options:

- `virt_type` must be set to `kvm` or `qemu`.
- `ram_allocation_ratio` must be set to 1.0.

`num_memory_encrypted_guests`

Type
integer

Default
<None>

Minimum Value
0

Maximum number of guests with encrypted memory which can run concurrently on this compute host.

For now this is only relevant for AMD machines which support SEV (Secure Encrypted Virtualization). Such machines have a limited number of slots in their memory controller for storing encryption keys. Each running guest with encrypted memory will consume one of these slots.

The option may be reused for other equivalent technologies in the future. If the machine does not support memory encryption, the option will be ignored and inventory will be set to 0.

If the machine does support memory encryption and this option is not set, the driver detects maximum number of SEV guests from the libvirt API which is available since v8.0.0. Setting this option overrides the detected limit, unless the given value is not larger than the detected limit.

On the other hand, if an older version of libvirt is used, `None` means an effectively unlimited inventory, i.e. no limit will be imposed by Nova on the number of SEV guests which can be launched, even though the underlying hardware will enforce its own limit.

Note

It is recommended to read *the deployment documentations section on this option* before deciding whether to configure this setting or leave it at the default.

Related options:

- *`libvirt.virt_type`* must be set to `kvm`.
- Its recommended to consider including `x86_64=q35` in *`libvirt.hw_machine_type`*; see *Enabling SEV* for more on this.

Warning

This option is deprecated for removal since 32.0.0. Its value may be silently ignored in the future.

Reason
This option is effective for only SEV and has no effect for SEV-ES. Libvirt is capable to present maximum number of SEV guests and one of SEV-ES guests since 8.0.0 and this option is no longer necessary.

`device_detach_attempts`

Type
integer

Default
8

Minimum Value
1

Maximum number of attempts the driver tries to detach a device in libvirt.

Related options:

- *libvirt.device_detach_timeout*

`device_detach_timeout`

Type
integer

Default
20

Minimum Value
1

Maximum number of seconds the driver waits for the success or the failure event from libvirt for a given device detach attempt before it re-trigger the detach.

Related options:

- *libvirt.device_detach_attempts*

`tb_cache_size`

Type
integer

Default
<None>

Minimum Value
0

Qemu>=5.0.0 bumped the default tb-cache size to 1GiB(from 32MiB) and this made it difficult to run multiple guest VMs on systems running with lower memory. With Libvirt>=8.0.0 this config option can be used to configure lower tb-cache size.

Set it to > 0 to configure tb-cache for guest VMs.

Related options:

- `compute_driver` (libvirt)
- `virt_type` (qemu)

`migration_inbound_addr`

Type
string

Default
`$my_ip`

The address used as the migration address for this host.

This option indicates the IP address, hostname, or FQDN which should be used as the target for cold migration, resize, and evacuate traffic when moving to this hypervisor. This metadata is then used by the source of the migration traffic to construct the commands used to copy data (e.g. disk image) to the destination.

An included {default: the value above} is replaced with the hostname of the migration target hypervisor.

Related options:

- `my_ip`
- `live_migration_inbound_addr`

`images_type`

Type
string

Default
`default`

Valid Values
raw, flat, qcow2, lvm, rbd, ploop, default

VM Images format.

If default is specified, then use_cow_images flag is used instead of this one.

Related options:

- compute.use_cow_images
- images_volume_group
- [workarounds]/ensure_libvirt_rbd_instance_dir_cleanup
- compute.force_raw_images

`images_volume_group`

Type
string

Default
<None>

LVM Volume Group that is used for VM images, when you specify images_type=lvm

Related options:

- images_type

`sparse_logical_volumes`

Type
boolean

Default
`False`

Create sparse logical volumes (with virtualsize) if this flag is set to True.

Warning

This option is deprecated for removal since 18.0.0. Its value may be silently ignored in the future.

Reason
Sparse logical volumes is a feature that is not tested hence not supported. LVM logical volumes are preallocated by default. If you want thin provisioning, use Cinder thin-provisioned volumes.

`images_rbd_pool`

Type
string

Default
`rbd`

The RADOS pool in which rbd volumes are stored

`images_rbd_ceph_conf`

Type
string

Default
`''`

Path to the ceph configuration file to use

`images_rbd_glance_store_name`

Type
string

Default
`''`

The name of the Glance store that represents the rbd cluster in use by this node. If set, this will allow Nova to request that Glance copy an image from an existing non-local store into the one named by this option before booting so that proper Copy-on-Write behavior is maintained.

Related options:

- images_type - must be set to `rbd`
- images_rbd_glance_copy_poll_interval - controls the status poll frequency
- images_rbd_glance_copy_timeout - controls the overall copy timeout

`images_rbd_glance_copy_poll_interval`

Type
integer

Default
15

The interval in seconds with which to poll Glance after asking for it to copy an image to the local rbd store. This affects how often we ask Glance to report on copy completion, and thus should be short enough that we notice quickly, but not too aggressive that we generate undue load on the Glance server.

Related options:

- images_type - must be set to `rbd`
- images_rbd_glance_store_name - must be set to a store name

`images_rbd_glance_copy_timeout`

Type
integer

Default
600

The overall maximum time we will wait for Glance to complete an image copy to our local rbd store. This should be long enough to allow large images to be copied over the network link between our local store and the one where images typically reside. The downside of setting this too long is just to catch the case where the image copy is stalled or proceeding too slowly to be useful. Actual errors will be reported by Glance and noticed according to the poll interval.

Related options:

- images_type - must be set to `rbd`
- images_rbd_glance_store_name - must be set to a store name
- images_rbd_glance_copy_poll_interval - controls the failure time-to-notice

`hw_disk_discard`

Type
string

Default
<None>

Valid Values
ignore, unmap

Discard option for nova managed disks.

Requires:

- Libvirt >= 1.0.6
- Qemu >= 1.5 (raw format)
- Qemu >= 1.6 (qcow2 format)

`volume_clear`

Type
string

Default
`zero`

Valid Values
zero, shred, none

Method used to wipe ephemeral disks when they are deleted. Only takes effect if LVM is set as backing storage.

Related options:

- images_type - must be set to `lvm`
- volume_clear_size

Possible values

zero
Overwrite volumes with zeroes

shred
Overwrite volumes repeatedly

none
Do not wipe deleted volumes

`volume_clear_size`

Type
integer

Default
`0`

Minimum Value
0

Size of area in MiB, counting from the beginning of the allocated volume, that will be cleared using method set in `volume_clear` option.

Possible values:

- 0 - clear whole volume
- >0 - clear specified amount of MiB

Related options:

- images_type - must be set to `lvm`
- volume_clear - must be set and the value must be different than `none` for this option to have any impact

`snapshot_compression`

Type
boolean

Default
`False`

Enable snapshot compression for `qcow2` images.

Note: you can set `snapshot_image_format` to `qcow2` to force all snapshots to be in `qcow2` format, independently from their original image type.

Related options:

- snapshot_image_format

`use_virtio_for_bridges`

Type
boolean

Default
`True`

Use virtio for bridge interfaces with KVM/QEMU

`volume_use_multipath`

Type
boolean

Default
`False`

Use multipath connection of the iSCSI or FC volume

Volumes can be connected in the LibVirt as multipath devices. This will provide high availability and fault tolerance.

Table 39: Deprecated Variations

Group	Name
libvirt	iscsi_use_multipath

`volume_enforce_multipath`

Type
boolean

Default
`False`

Require multipathd when attaching a volume to an instance.

When enabled, attachment of volumes will be aborted when multipathd is not running. Otherwise, it will fallback to single path without error.

When enabled, the libvirt driver checks availability of mulitpathd when it is initialized, and the compute service fails to start if multipathd is not running.

Related options:

- volume_use_multipath must be True when this is True

`num_volume_scan_tries`

Type
integer

Default
5

Number of times to scan given storage protocol to find volume.

Table 40: Deprecated Variations

Group	Name
libvirt	num_iscsi_scan_tries

`num_aoe_discover_tries`

Type
integer

Default
3

Number of times to rediscover AoE target to find volume.

Nova provides support for block storage attaching to hosts via AOE (ATA over Ethernet). This option allows the user to specify the maximum number of retry attempts that can be made to discover the AoE device.

`iscsi_iface`

Type
string

Default
<None>

The iSCSI transport iface to use to connect to target in case offload support is desired.

Default format is of the form <transport_name>.<hwaddress>, where <transport_name> is one of (be2iscsi, bnx2i, cxgb3i, cxgb4i, qla4xxx, ocs, tcp) and <hwaddress> is the MAC address of the interface and can be generated via the iscsiadm -m iface command. Do not confuse the iscsi_iface parameter to be provided here with the actual transport name.

Table 41: Deprecated Variations

Group	Name
libvirt	iscsi_transport

`num_iser_scan_tries`

Type
integer

Default
5

Number of times to scan iSER target to find volume.

iSER is a server network protocol that extends iSCSI protocol to use Remote Direct Memory Access (RDMA). This option allows the user to specify the maximum number of scan attempts that can be made to find iSER volume.

`iser_use_multipath`

Type
boolean

Default
`False`

Use multipath connection of the iSER volume.

iSER volumes can be connected as multipath devices. This will provide high availability and fault tolerance.

`rbd_user`

Type
string

Default
<None>

The RADOS client name for accessing rbd(RADOS Block Devices) volumes.

Libvirt will refer to this user when connecting and authenticating with the Ceph RBD server.

`rbd_secret_uuid`

Type
string

Default
<None>

The libvirt UUID of the secret for the rbd_user volumes.

`rbd_connect_timeout`

Type
integer

Default
5

The RADOS client timeout in seconds when initially connecting to the cluster.

`rbd_destroy_volume_retry_interval`

Type
integer

Default
5

Minimum Value
0

Number of seconds to wait between each consecutive retry to destroy a RBD volume.

Related options:

- [libvirt]/images_type = rbd

`rbd_destroy_volume_retries`

Type
integer

Default
12

Minimum Value
0

Number of retries to destroy a RBD volume.

Related options:

- [libvirt]/images_type = rbd

`nfs_mount_point_base`

Type
string

Default
`$state_path/mnt`

Directory where the NFS volume is mounted on the compute node. The default is mnt directory of the location where novas Python module is installed.

NFS provides shared storage for the OpenStack Block Storage service.

Possible values:

- A string representing absolute path of mount point.

`nfs_mount_options`

Type
string

Default
<None>

Mount options passed to the NFS client. See section of the nfs man page for details.

Mount options controls the way the filesystem is mounted and how the NFS client behaves when accessing files on this mount point.

Possible values:

- Any string representing mount options separated by commas.
- Example string: vers=3,lookupcache=pos

`ceph_mount_point_base`

Type
string

Default
`$state_path/mnt`

Directory where the ceph volume for each manila share is mounted on the compute node. The default is mnt directory of the location where novas Python module is installed.

Possible values:

- A string representing absolute path of mount point.

`ceph_mount_options`

Type
list

Default
<None>

Mount options passed to the ceph client. See section of the ceph man page for details.

Mount options controls the way the filesystem is mounted and how the ceph client behaves when accessing files on this mount point.

Possible values:

- Any string representing mount options separated by commas.
- Example string: vers=3,lookupcache=pos

`quobyte_mount_point_base`

Type
string

Default
`$state_path/mnt`

Directory where the Quobyte volume is mounted on the compute node.

Nova supports Quobyte volume driver that enables storing Block Storage service volumes on a Quobyte storage back end. This Option specifies the path of the directory where Quobyte volume is mounted.

Possible values:

- A string representing absolute path of mount point.

Warning

This option is deprecated for removal since 31.0.0. Its value may be silently ignored in the future.

Reason
Quobyte volume driver in cinder was marked unsupported. Quobyte volume support will be removed from nova when the volume driver is removed from cinder.

`quobyte_client_cfg`

Type
string

Default
<None>

Path to a Quobyte Client configuration file.

Warning

This option is deprecated for removal since 31.0.0. Its value may be silently ignored in the future.

Reason
Quobyte volume driver in cinder was marked unsupported. Quobyte volume support will be removed from nova when the volume driver is removed from cinder.

`smbfs_mount_point_base`

Type
string

Default
`$state_path/mnt`

Directory where the SMBFS shares are mounted on the compute node.

Warning

This option is deprecated for removal since 31.0.0. Its value may be silently ignored in the future.

Reason
Windows SMB volume driver in cinder was marked unsupported. SMBFS volume support will be removed from nova when the volume driver is removed from cinder.

`smbfs_mount_options`

Type
string

Default
`''`

Mount options passed to the SMBFS client.

Provide SMBFS options as a single string containing all parameters. See mount.cifs man page for details. Note that the libvirt-qemu `uid` and `gid` must be specified.

Warning

This option is deprecated for removal since 31.0.0. Its value may be silently ignored in the future.

Reason
Windows SMB volume driver in cinder was marked unsupported. SMBFS volume support will be removed from nova when the volume driver is removed from cinder.

`remote_filesystem_transport`

Type
string

Default
`ssh`

Valid Values
ssh, rsync

libvirts transport method for remote file operations.

Because libvirt cannot use RPC to copy files over network to/from other compute nodes, other method must be used for:

- creating directory on remote host
- creating file on remote host
- removing file from remote host
- copying file to remote host

`vzstorage_mount_point_base`

Type
string

Default
`$state_path/mnt`

Directory where the Virtuozzo Storage clusters are mounted on the compute node.

This option defines non-standard mountpoint for Vzstorage cluster.

Related options:

- vzstorage_mount_* group of parameters

Warning

This option is deprecated for removal since 31.0.0. Its value may be silently ignored in the future.

Reason
Virtuozzo Storage volume driver in cinder was marked unsupported. Virtuozzo Storage volume support will be removed from nova when the volume driver is removed from cinder.

`vzstorage_mount_user`

Type
string

Default
`stack`

Mount owner user name.

This option defines the owner user of Vzstorage cluster mountpoint.

Related options:

- vzstorage_mount_* group of parameters

Warning

This option is deprecated for removal since 31.0.0. Its value may be silently ignored in the future.

Reason
Virtuozzo Storage volume driver in cinder was marked unsupported. Virtuozzo Storage volume support will be removed from nova when the volume driver is removed from cinder.

`vzstorage_mount_group`

Type
string

Default
`qemu`

Mount owner group name.

This option defines the owner group of Vzstorage cluster mountpoint.

Related options:

- vzstorage_mount_* group of parameters

`vzstorage_mount_perms`

Type
string

Default
`0770`

Mount access mode.

This option defines the access bits of Vzstorage cluster mountpoint, in the format similar to one of chmod(1) utility, like this: 0770. It consists of one to four digits ranging from 0 to 7, with missing lead digits assumed to be 0s.

Related options:

- vzstorage_mount_* group of parameters

`vzstorage_log_path`

Type
string

Default
`/var/log/vstorage/%(cluster_name)s/nova.log.gz`

Path to vzstorage client log.

This option defines the log of cluster operations, it should include %(cluster_name)s template to separate logs from multiple shares.

Related options:

- vzstorage_mount_opts may include more detailed logging options.

`vzstorage_cache_path`

Type
string

Default
`<None>`

Path to the SSD cache file.

You can attach an SSD drive to a client and configure the drive to store a local cache of frequently accessed data. By having a local cache on a clients SSD drive, you can increase the overall cluster performance by up to 10 and more times. WARNING! There is a lot of SSD models which are not server grade and may loose arbitrary set of data changes on power loss. Such SSDs should not be used in Vstorage and are dangerous as may lead to data corruptions and inconsistencies. Please consult with the manual on which SSD models are known to be safe or verify it using vstorage-hwflush-check(1) utility.

This option defines the path which should include %(cluster_name)s template to separate caches from multiple shares.

Related options:

- vzstorage_mount_opts may include more detailed cache options.

`vzstorage_mount_opts`

Type
list

Default
`[]`

Extra mount options for pstorage-mount

For full description of them, see https://static.openvz.org/vz-man/man1/pstorage-mount.1.gz.html Format is a python string representation of arguments list, like: [-v, -R, 500] Shouldnt include -c, -l, -C, -u, -g and -m as those have explicit vzstorage_* options.

Related options:

- All other vzstorage_* options

`rx_queue_size`

Type
unknown type

Default
<None>

Valid Values
256, 512, 1024

Configure virtio rx queue size.

This option is only usable for virtio-net device with vhost and vhost-user backend. Available only with QEMU/KVM. Requires libvirt v2.3 QEMU v2.7.

`tx_queue_size`

Type
unknown type

Default
<None>

Valid Values
256, 512, 1024

Configure virtio tx queue size.

This option is only usable for virtio-net device with vhost-user backend. Available only with QEMU/KVM. Requires libvirt v3.7 QEMU v2.10.

`max_queues`

Type
integer

Default
<None>

Minimum Value
1

The maximum number of virtio queue pairs that can be enabled when creating a multiqueue guest. The number of virtio queues allocated will be the lesser of the CPUs requested by the guest and the max value defined. By default, this value is set to none meaning the legacy limits based on the reported kernel major version will be used.

`num_nvme_discover_tries`

Type
integer

Default
5

Number of times to rediscover NVMe target to find volume

Nova provides support for block storage attaching to hosts via NVMe (Non-Volatile Memory Express). This option allows the user to specify the maximum number of retry attempts that can be made to discover the NVMe device.

`pmem_namespaces`

Type
list

Default
`[]`

Configure persistent memory(pmem) namespaces.

These namespaces must have been already created on the host. This config option is in the following format:

```
"$LABEL:$NSNAME[|$NSNAME][,$LABEL:$NSNAME[|$NSNAME]]"
```

- `$NSNAME` is the name of the pmem namespace.
- **`$LABEL` represents one resource class, this is used to generate**
  the resource class name as `CUSTOM_PMEM_NAMESPACE_$LABEL`.

For example:

```
[libvirt]
pmem_namespaces=128G:ns0|ns1|ns2|ns3,262144MB:ns4|ns5,MEDIUM:ns6|ns7
```

`swtpm_enabled`

Type
boolean

Default
`False`

Enable emulated TPM (Trusted Platform Module) in guests.

`swtpm_user`

Type
string

Default
`tss`

User that swtpm binary runs as.

When using emulated TPM, the `swtpm` binary will run to emulate a TPM device. The user this binary runs as depends on libvirt configuration, with `tss` being the default.

In order to support cold migration and resize, nova needs to know what user the swtpm binary is running as in order to ensure that files get the proper ownership after being moved between nodes.

Related options:

- `swtpm_group` must also be set.

`swtpm_group`

Type
string

Default
`tss`

Group that swtpm binary runs as.

When using emulated TPM, the `swtpm` binary will run to emulate a TPM device. The user this binary runs as depends on libvirt configuration, with `tss` being the default.

In order to support cold migration and resize, nova needs to know what group the swtpm binary is running as in order to ensure that files get the proper ownership after being moved between nodes.

Related options:

- `swtpm_user` must also be set.

`supported_tpm_secret_security`

Type
list

Default
`['user', 'host', 'deployment']`

The list of TPM security policies supported by this compute host. If a value is absent, it is not supported by this host, and any instance that requests it will not be scheduled on this host.

Possible values are:

- `user`: The Barbican secret is owned by the instance owner and cannot be accessed by anyone else. The Libvirt secret is private and non-persistent. The instance cannot be live-migrated or automatically resumed after host reboot.
- `host`: The Barbican secret is owned by the instance owner and cannot be accessed by anyone else. The Libvirt secret is public and persistent. It can be read by anyone with sufficient access on the host. The instance can be live-migrated and automatically resumed after host reboot.
- `deployment`: The Barbican secret is owned by the Nova service user. The Libvirt secret is private and non-persistent. The instance can be live-migrated and resumed automatically after host reboot.

`use_default_aio_mode_for_volumes`

Type
boolean

Default
`False`

With the NFS, FC, and iSCSI Cinder volume backends, Nova explicitly sets AIO mode `io=native` in the Libvirt guest XML. Operators may set this option to True in order to defer AIO mode selection to QEMU if forcing `io=native` is not desired.

`cpu_power_management`

Type
boolean

Default
`False`

Use libvirt to manage CPU cores performance.

`cpu_power_management_strategy`

Type
string

Default
`cpu_state`

Valid Values
cpu_state, governor

Tuning strategy to reduce CPU power consumption when unused

`cpu_power_governor_low`

Type
string

Default
`powersave`

Governor to use in order to reduce CPU power consumption

`cpu_power_governor_high`

Type
string

Default
`performance`

Governor to use in order to have best CPU performance

manila

`share_apply_policy_timeout`

Type
integer

Default
`10`

Timeout period for share policy application.

Maximum duration to await a response from the Manila service for the application of a share policy before experiencing a timeout. 0 means do not wait (0s).

Possible values:

- A positive integer or 0 (default value is 10).

`cafile`

Type
string

Default
<None>

PEM encoded Certificate Authority to use when verifying HTTPs connections.

`certfile`

Type
string

Default
<None>

PEM encoded client certificate cert file

`keyfile`

Type
string

Default
<None>

PEM encoded client certificate key file

`insecure`

Type
boolean

Default
`False`

Verify HTTPS connections.

`timeout`

Type
integer

Default
<None>

Timeout value for http requests

`collect_timing`

Type
boolean

Default
`False`

Collect per-API call timing information.

`split_loggers`

Type
boolean

Default
`False`

Log requests to multiple loggers.

`auth_type`

Type
unknown type

Default
<None>

Authentication type to load

Table 42: Deprecated Variations

Group	Name
manila	auth_plugin

`auth_section`

Type
unknown type

Default
<None>

Config Section from which to load plugin specific options

`auth_url`

Type
unknown type

Default
<None>

Authentication URL

`system_scope`

Type
unknown type

Default
<None>

Scope for system operations

`domain_id`

Type
unknown type

Default
<None>

Domain ID to scope to

`domain_name`

Type
unknown type

Default
<None>

Domain name to scope to

`project_id`

Type
unknown type

Default
<None>

Project ID to scope to

`project_name`

Type
unknown type

Default
<None>

Project name to scope to

`project_domain_id`

Type
unknown type

Default
<None>

Domain ID containing project

`project_domain_name`

Type
unknown type

Default
<None>

Domain name containing project

`trust_id`

Type
unknown type

Default
<None>

ID of the trust to use as a trustee use

`user_id`

Type
unknown type

Default
<None>

Users user ID

username

Type
unknown type

Default
<None>

Users username

Table 43: Deprecated Variations

Group	Name
manila	user-name
manila	user_name

user_domain_id

Type
unknown type

Default
<None>

Users domain ID

user_domain_name

Type
unknown type

Default
<None>

Users domain name

password

Type
unknown type

Default
<None>

Users password

metrics

Configuration options for metrics

Options under this group allow to adjust how values assigned to metrics are calculated.

weight_multiplier

Type
floating point

Default
`1.0`

Multiplier used for weighing hosts based on reported metrics.

When using metrics to weight the suitability of a host, you can use this option to change how the calculated weight influences the weight assigned to a host as follows:

- `>1.0`: increases the effect of the metric on overall weight
- `1.0`: no change to the calculated weight
- `>0.0,<1.0`: reduces the effect of the metric on overall weight
- `0.0`: the metric value is ignored, and the value of the `[metrics] weight_of_unavailable` option is returned instead
- `>-1.0,<0.0`: the effect is reduced and reversed
- `-1.0`: the effect is reversed
- `<-1.0`: the effect is increased proportionally and reversed

Possible values:

- An integer or float value, where the value corresponds to the multiplier ratio for this weigher.

Related options:

- `[filter_scheduler] weight_classes`
- `[metrics] weight_of_unavailable`

`weight_setting`

Type
list

Default
`[]`

Mapping of metric to weight modifier.

This setting specifies the metrics to be weighed and the relative ratios for each metric. This should be a single string value, consisting of a series of one or more name=ratio pairs, separated by commas, where `name` is the name of the metric to be weighed, and `ratio` is the relative weight for that metric.

Note that if the ratio is set to 0, the metric value is ignored, and instead the weight will be set to the value of the `[metrics] weight_of_unavailable` option.

As an example, lets consider the case where this option is set to:

```
name1=1.0, name2=-1.3
```

The final weight will be:

```
(name1.value * 1.0) + (name2.value * -1.3)
```

Possible values:

- A list of zero or more key/value pairs separated by commas, where the key is a string representing the name of a metric and the value is a numeric weight for that metric. If any value

is set to 0, the value is ignored and the weight will be set to the value of the `[metrics] weight_of_unavailable` option.

Related options:

- `[metrics] weight_of_unavailable`

`required`

Type
boolean

Default
`True`

Whether metrics are required.

This setting determines how any unavailable metrics are treated. If this option is set to True, any hosts for which a metric is unavailable will raise an exception, so it is recommended to also use the MetricFilter to filter out those hosts before weighing.

Possible values:

- A boolean value, where False ensures any metric being unavailable for a host will set the host weight to `[metrics] weight_of_unavailable`.

Related options:

- `[metrics] weight_of_unavailable`

`weight_of_unavailable`

Type
floating point

Default
`-10000.0`

Default weight for unavailable metrics.

When any of the following conditions are met, this value will be used in place of any actual metric value:

- One of the metrics named in `[metrics] weight_setting` is not available for a host, and the value of `required` is `False`.
- The ratio specified for a metric in `[metrics] weight_setting` is 0.
- The `[metrics] weight_multiplier` option is set to 0.

Possible values:

- An integer or float value, where the value corresponds to the multiplier ratio for this weigher.

Related options:

- `[metrics] weight_setting`
- `[metrics] required`
- `[metrics] weight_multiplier`

mks

Nova compute node uses WebMKS, a desktop sharing protocol to provide instance console access to VMs created by VMware hypervisors.

Related options:

Following options must be set to provide console access.

- mksproxy_base_url
- enabled

mksproxy_base_url

Type
URI

Default
`http://127.0.0.1:6090/`

Location of MKS web console proxy

The URL in the response points to a WebMKS proxy which starts proxying between client and corresponding vCenter server where instance runs. In order to use the web based console access, WebMKS proxy should be installed and configured

Possible values:

- Must be a valid URL of the form:`http://host:port/` or `https://host:port/`

enabled

Type
boolean

Default
`False`

Enables graphical console access for virtual machines.

neutron

Configuration options for neutron (network connectivity as a service).

ovs_bridge

Type
string

Default
`br-int`

Default name for the Open vSwitch integration bridge.

Specifies the name of an integration bridge interface used by OpenvSwitch. This option is only used if Neutron does not specify the OVS bridge name in port binding responses.

default_floating_pool

Type
string

Default
nova

Default name for the floating IP pool.

Specifies the name of floating IP pool used for allocating floating IPs. This option is only used if Neutron does not specify the floating IP pool name in port binding responses.

`extension_sync_interval`

Type
integer

Default
600

Minimum Value
0

Integer value representing the number of seconds to wait before querying Neutron for extensions. After this number of seconds the next time Nova needs to create a resource in Neutron it will requery Neutron for the extensions that it has loaded. Setting value to 0 will refresh the extensions with no wait.

`physnets`

Type
list

Default
[]

List of physnets present on this host.

For each *physnet* listed, an additional section, `[neutron_physnet_$PHYSNET]`, will be added to the configuration file. Each section must be configured with a single configuration option, `numa_nodes`, which should be a list of node IDs for all NUMA nodes this physnet is associated with. For example:

```
[neutron]
physnets = foo, bar

[neutron_physnet_foo]
numa_nodes = 0

[neutron_physnet_bar]
numa_nodes = 0,1
```

Any *physnet* that is not listed using this option will be treated as having no particular NUMA node affinity.

Tunnelled networks (VXLAN, GRE,) cannot be accounted for in this way and are instead configured using the `[neutron_tunnel]` group. For example:

```
[neutron_tunnel]
numa_nodes = 1
```

Related options:

- `[neutron_tunnel] numa_nodes` can be used to configure NUMA affinity for all tunneled networks
- `[neutron_physnet_$PHYSNET] numa_nodes` must be configured for each value of `$PHYSNET` specified by this option

`http_retries`

Type
integer

Default
3

Minimum Value
0

Number of times neutronclient should retry on any failed http call.

0 means connection is attempted only once. Setting it to any positive integer means that on failure connection is retried that many times e.g. setting it to 3 means total attempts to connect will be 4.

Possible values:

- Any integer value. 0 means connection is attempted only once

`service_metadata_proxy`

Type
boolean

Default
`False`

When set to True, this option indicates that Neutron will be used to proxy metadata requests and resolve instance ids. Otherwise, the instance ID must be passed to the metadata request in the X-Instance-ID header.

Related options:

- metadata_proxy_shared_secret

`metadata_proxy_shared_secret`

Type
string

Default
`''`

This option holds the shared secret string used to validate proxy requests to Neutron metadata requests. In order to be used, the X-Metadata-Provider-Signature header must be supplied in the request.

Related options:

- service_metadata_proxy

`cafile`

Type
string

Default
<None>

PEM encoded Certificate Authority to use when verifying HTTPs connections.

`certfile`

Type
string

Default
<None>

PEM encoded client certificate cert file

`keyfile`

Type
string

Default
<None>

PEM encoded client certificate key file

`insecure`

Type
boolean

Default
`False`

Verify HTTPS connections.

`timeout`

Type
integer

Default
<None>

Timeout value for http requests

`collect_timing`

Type
boolean

Default
`False`

Collect per-API call timing information.

`split_loggers`

Type
boolean

Default
`False`

Log requests to multiple loggers.

`auth_type`

Type
unknown type

Default
<None>

Authentication type to load

Table 44: Deprecated Variations

Group	Name
neutron	auth_plugin

`auth_section`

Type
unknown type

Default
<None>

Config Section from which to load plugin specific options

`auth_url`

Type
unknown type

Default
<None>

Authentication URL

`system_scope`

Type
unknown type

Default
<None>

Scope for system operations

`domain_id`

Type
unknown type

Default
<None>

Domain ID to scope to

`domain_name`

Type
unknown type

Default
<None>

Domain name to scope to

`project_id`

Type
unknown type

Default
<None>

Project ID to scope to

`project_name`

Type
unknown type

Default
<None>

Project name to scope to

`project_domain_id`

Type
unknown type

Default
<None>

Domain ID containing project

`project_domain_name`

Type
unknown type

Default
<None>

Domain name containing project

`trust_id`

Type
unknown type

Default
<None>

ID of the trust to use as a trustee use

`default_domain_id`

Type
unknown type

Default
<None>

Optional domain ID to use with v3 and v2 parameters. It will be used for both the user and project domain in v3 and ignored in v2 authentication.

`default_domain_name`

Type
unknown type

Default
<None>

Optional domain name to use with v3 API and v2 parameters. It will be used for both the user and project domain in v3 and ignored in v2 authentication.

`user_id`

Type
unknown type

Default
<None>

Users user ID

`username`

Type
unknown type

Default
<None>

Users username

Table 45: Deprecated Variations

Group	Name
neutron	user-name
neutron	user_name

`user_domain_id`

Type
unknown type

Default
<None>

Users domain ID

`user_domain_name`

Type
unknown type

Default
<None>

Users domain name

`password`

Type
unknown type

Default
<None>

Users password

`tenant_id`

Type
unknown type

Default
<None>

Tenant ID

`tenant_name`

Type
unknown type

Default
<None>

Tenant Name

`service_type`

Type
string

Default
`network`

The default service_type for endpoint URL discovery.

`service_name`

Type
string

Default
<None>

The default service_name for endpoint URL discovery.

`valid_interfaces`

Type
list

Default
`['internal', 'public']`

List of interfaces, in order of preference, for endpoint URL.

`region_name`

Type
string

Default
<None>

The default region_name for endpoint URL discovery.

`endpoint_override`

Type
string

Default
<None>

Always use this endpoint URL for requests for this client. NOTE: The unversioned endpoint should be specified here; to request a particular API version, use the *version*, *min-version*, and/or *max-version* options.

`connect_retries`

Type
integer

Default
<None>

The maximum number of retries that should be attempted for connection errors.

`connect_retry_delay`

Type
floating point

Default
<None>

Delay (in seconds) between two retries for connection errors. If not set, exponential retry starting with 0.5 seconds up to a maximum of 60 seconds is used.

`status_code_retries`

Type
integer

Default
<None>

The maximum number of retries that should be attempted for retriable HTTP status codes.

`status_code_retry_delay`

Type
floating point

Default
<None>

Delay (in seconds) between two retries for retriable status codes. If not set, exponential retry starting with 0.5 seconds up to a maximum of 60 seconds is used.

`retriable_status_codes`

Type
list

Default
<None>

List of retriable HTTP status codes that should be retried. If not set default to [503]

notifications

Most of the actions in Nova which manipulate the system state generate notifications which are posted to the messaging component (e.g. RabbitMQ) and can be consumed by any service outside the OpenStack. More technical details at https://docs.openstack.org/nova/latest/reference/notifications.html

`notify_on_state_change`

Type
string

Default
<None>

Valid Values
<None>, vm_state, vm_and_task_state

If set, send compute.instance.update notifications on instance state changes.

Please refer to https://docs.openstack.org/nova/latest/reference/notifications.html for additional information on notifications.

Possible values

<None>
no notifications

vm_state
Notifications are sent with VM state transition information in the `old_state` and `state` fields. The `old_task_state` and `new_task_state` fields will be set to the current task_state of the instance

vm_and_task_state
Notifications are sent with VM and task state transition information

Table 46: Deprecated Variations

Group	Name
DEFAULT	notify_on_state_change

`default_level`

Type
string

Default
`INFO`

Valid Values
DEBUG, INFO, WARN, ERROR, CRITICAL

Default notification level for outgoing notifications.

Table 47: Deprecated Variations

Group	Name
DEFAULT	default_notification_level

`notification_format`

Type
string

Default
`unversioned`

Valid Values
both, versioned, unversioned

Specifies which notification format shall be emitted by nova.

The versioned notification interface are in feature parity with the legacy interface and the versioned interface is actively developed so new consumers should used the versioned interface.

However, the legacy interface is heavily used by ceilometer and other mature OpenStack components so it remains the default.

Note that notifications can be completely disabled by setting `driver=noop` in the `[oslo_messaging_notifications]` group.

The list of versioned notifications is visible in https://docs.openstack.org/nova/latest/reference/notifications.html

Possible values

both
Both the legacy unversioned and the new versioned notifications are emitted

versioned
Only the new versioned notifications are emitted

unversioned
Only the legacy unversioned notifications are emitted

Table 48: Deprecated Variations

Group	Name
DEFAULT	notification_format

`versioned_notifications_topics`

Type
list

Default
`['versioned_notifications']`

Specifies the topics for the versioned notifications issued by nova.

The default value is fine for most deployments and rarely needs to be changed. However, if you have a third-party service that consumes versioned notifications, it might be worth getting a topic for that service. Nova will send a message containing a versioned notification payload to each topic queue in this list.

The list of versioned notifications is visible in https://docs.openstack.org/nova/latest/reference/notifications.html

`bdms_in_notifications`

Type
boolean

Default
`False`

If enabled, include block device information in the versioned notification payload. Sending block device information is disabled by default as providing that information can incur some overhead on the system since the information may need to be loaded from the database.

`include_share_mapping`

Type
boolean

Default
`False`

If enabled, include share mapping information in the versioned notification payload. Sending share mapping information is disabled by default as providing that information can incur some overhead on the system since the information may need to be loaded from the database.

os_brick

`lock_path`

Type
string

Default
<None>

Directory to use for os-brick lock files. Defaults to oslo_concurrency.lock_path which is a sensible default for compute nodes, but not for HCI deployments or controllers where Glance uses Cinder as a backend, as locks should use the same directory.

`wait_mpath_device_attempts`

Type
integer

Default
4

Minimum Value
1

Number of attempts for the multipath device to be ready for I/O after it was created. Readiness is checked with `multipath -C`. See related `wait_mpath_device_interval` config option.

`wait_mpath_device_interval`

Type
integer

Default
1

Minimum Value
1

Interval value to wait for multipath device to be ready for I/O. Max number of attempts is set in `wait_mpath_device_attempts`. Time in seconds to wait for each retry is `base ^ attempt * interval`, so for 4 attempts (1 attempt 3 retries) and 1 second interval will yield: 2, 4 and 8 seconds. Note that there is no wait before first attempt.

os_vif_linux_bridge

`use_ipv6`

Type
boolean

Default
`False`

Use IPv6

Table 49: Deprecated Variations

Group	Name
DEFAULT	use_ipv6

`iptables_top_regex`

Type
string

Default
''

Regular expression to match the iptables rule that should always be on the top.

Table 50: Deprecated Variations

Group	Name
DEFAULT	iptables_top_regex

`iptables_bottom_regex`

Type
string

Default
''

Regular expression to match the iptables rule that should always be on the bottom.

Table 51: Deprecated Variations

Group	Name
DEFAULT	iptables_bottom_regex

`iptables_drop_action`

Type
string

Default
DROP

The table that iptables to jump to when a packet is to be dropped.

Table 52: Deprecated Variations

Group	Name
DEFAULT	iptables_drop_action

`forward_bridge_interface`

Type
multi-valued

Default
all

An interface that bridges can forward to. If this is set to all then all traffic will be forwarded. Can be specified multiple times.

Table 53: Deprecated Variations

Group	Name
DEFAULT	forward_bridge_interface

`vlan_interface`

Type
string

Default
<None>

VLANs will bridge into this interface if set

Table 54: Deprecated Variations

Group	Name
DEFAULT	vlan_interface

`flat_interface`

Type
string

Default
<None>

FlatDhcp will bridge into this interface if set

Table 55: Deprecated Variations

Group	Name
DEFAULT	flat_interface

`network_device_mtu`

Type
integer

Default
`1500`

MTU setting for network interface.

Table 56: Deprecated Variations

Group	Name
DEFAULT	network_device_mtu

os_vif_noop

os_vif_ovs

network_device_mtu

Type
integer

Default
`1500`

MTU setting for network interface.

Table 57: Deprecated Variations

Group	Name
DEFAULT	network_device_mtu

ovs_vsctl_timeout

Type
integer

Default
`120`

Amount of time, in seconds, that ovs_vsctl should wait for a response from the database. 0 is to wait forever.

Table 58: Deprecated Variations

Group	Name
DEFAULT	ovs_vsctl_timeout

ovsdb_connection

Type
string

Default
`tcp:127.0.0.1:6640`

The connection string for the OVSDB backend. When executing commands using the native or vsctl ovsdb interface drivers this config option defines the ovsdb endpoint used.

ovsdb_interface

Type
string

Default
`native`

Valid Values
vsctl, native

The interface for interacting with the OVSDB

Warning

This option is deprecated for removal since 2.2.0. Its value may be silently ignored in the future.

Reason
os-vif has supported ovsdb access via python bindings since Stein (1.15.0), starting in Victoria (2.2.0) the ovs-vsctl driver is now deprecated for removal and in future releases it will be be removed.

`isolate_vif`

Type
boolean

Default
`False`

Controls if VIF should be isolated when plugged to the ovs bridge. This should only be set to True when using the neutron ovs ml2 agent.

`per_port_bridge`

Type
boolean

Default
`False`

Controls if VIF should be plugged into a per-port bridge. This is experimental and controls the plugging behavior when not using hybrid-plug.This is only used on linux and should be set to false in all other cases such as ironic smartnic ports.

`default_qos_type`

Type
string

Default
`linux-noop`

Valid Values
linux-htb, linux-hfsc, linux-sfq, linux-codel, linux-fq_codel, linux-noop

The default qos type to apply to ovs ports.
linux-noop is the default. ovs will not modify the qdisc on the port if linux-noop is specified. This allows operators to manage QOS out of band of OVS. For more information see the ovs man pages https://manpages.debian.org/testing/openvswitch-common/ovs-vswitchd.conf.db.5.en.html#type~4

Note: This will only be set when a port is first created on the ovs bridge to ensure that the qos type can be managed via neutron if required for bandwidth limiting and other use-cases.

oslo_concurrency

disable_process_locking

Type
boolean

Default
`False`

Enables or disables inter-process locks.

lock_path

Type
string

Default
<None>

Directory to use for lock files. For security, the specified directory should only be writable by the user running the processes that need locking. Defaults to environment variable OSLO_LOCK_PATH. If external locks are used, a lock path must be set.

oslo_limit

endpoint_id

Type
string

Default
<None>

The services endpoint id which is registered in Keystone.

endpoint_service_name

Type
string

Default
<None>

Service name for endpoint discovery

endpoint_service_type

Type
string

Default
<None>

Service type for endpoint discovery

endpoint_region_name

Type
string

Default
<None>

Region to which the endpoint belongs

`endpoint_interface`

Type
string

Default
publicURL

Valid Values
public, publicURL, internal, internalURL, admin, adminURL

The interface for endpoint discovery

`cafile`

Type
string

Default
<None>

PEM encoded Certificate Authority to use when verifying HTTPs connections.

`certfile`

Type
string

Default
<None>

PEM encoded client certificate cert file

`keyfile`

Type
string

Default
<None>

PEM encoded client certificate key file

`insecure`

Type
boolean

Default
False

Verify HTTPS connections.

`timeout`

Type
integer

Default
<None>

Timeout value for http requests

`collect_timing`

Type
boolean

Default
`False`

Collect per-API call timing information.

`split_loggers`

Type
boolean

Default
`False`

Log requests to multiple loggers.

`auth_url`

Type
unknown type

Default
<None>

Authentication URL

`system_scope`

Type
unknown type

Default
<None>

Scope for system operations

`domain_id`

Type
unknown type

Default
<None>

Domain ID to scope to

`domain_name`

Type
unknown type

Default
<None>

Domain name to scope to

`project_id`

Type
unknown type

Default
<None>

Project ID to scope to

`project_name`

Type
unknown type

Default
<None>

Project name to scope to

`project_domain_id`

Type
unknown type

Default
<None>

Domain ID containing project

`project_domain_name`

Type
unknown type

Default
<None>

Domain name containing project

`trust_id`

Type
unknown type

Default
<None>

ID of the trust to use as a trustee use

`default_domain_id`

Type
unknown type

Default
<None>

Optional domain ID to use with v3 and v2 parameters. It will be used for both the user and project domain in v3 and ignored in v2 authentication.

`default_domain_name`

Type
unknown type

Default
<None>

Optional domain name to use with v3 API and v2 parameters. It will be used for both the user and project domain in v3 and ignored in v2 authentication.

`user_id`

Type
unknown type

Default
<None>

Users user ID

`username`

Type
unknown type

Default
<None>

Users username

Table 59: Deprecated Variations

Group	Name
oslo_limit	user-name
oslo_limit	user_name

`user_domain_id`

Type
unknown type

Default
<None>

Users domain ID

`user_domain_name`

Type
unknown type

Default
<None>

Users domain name

`password`

Type
unknown type

Default
<None>

Users password

`tenant_id`

Type
unknown type

Default
<None>

Tenant ID

`tenant_name`

Type
unknown type

Default
<None>

Tenant Name

`service_type`

Type
string

Default
<None>

The default service_type for endpoint URL discovery.

`service_name`

Type
string

Default
<None>

The default service_name for endpoint URL discovery.

`valid_interfaces`

Type
list

Default
<None>

List of interfaces, in order of preference, for endpoint URL.

`region_name`

Type
string

Default
<None>

The default region_name for endpoint URL discovery.

`endpoint_override`

Type
string

Default
<None>

Always use this endpoint URL for requests for this client. NOTE: The unversioned endpoint should be specified here; to request a particular API version, use the *version*, *min-version*, and/or *max-version* options.

`version`

Type
string

Default
<None>

Minimum Major API version within a given Major API version for endpoint URL discovery. Mutually exclusive with min_version and max_version

`min_version`

Type
string

Default
<None>

The minimum major version of a given API, intended to be used as the lower bound of a range with max_version. Mutually exclusive with version. If min_version is given with no max_version it is as if max version is latest.

`max_version`

Type
string

Default
<None>

The maximum major version of a given API, intended to be used as the upper bound of a range with min_version. Mutually exclusive with version.

`connect_retries`

Type
integer

Default
<None>

The maximum number of retries that should be attempted for connection errors.

`connect_retry_delay`

Type
floating point

Default
<None>

Delay (in seconds) between two retries for connection errors. If not set, exponential retry starting with 0.5 seconds up to a maximum of 60 seconds is used.

`status_code_retries`

Type
integer

Default
<None>

The maximum number of retries that should be attempted for retriable HTTP status codes.

`status_code_retry_delay`

Type
floating point

Default
<None>

Delay (in seconds) between two retries for retriable status codes. If not set, exponential retry starting with 0.5 seconds up to a maximum of 60 seconds is used.

`retriable_status_codes`

Type
list

Default
<None>

List of retriable HTTP status codes that should be retried. If not set default to [503]

oslo_messaging_kafka

`kafka_max_fetch_bytes`

Type
integer

Default
1048576

Max fetch bytes of Kafka consumer

`kafka_consumer_timeout`

Type
floating point

Default
`1.0`

Default timeout(s) for Kafka consumers

`consumer_group`

Type
string

Default
`oslo_messaging_consumer`

Group id for Kafka consumer. Consumers in one group will coordinate message consumption

`producer_batch_timeout`

Type
floating point

Default
`0.0`

Upper bound on the delay for KafkaProducer batching in seconds

`producer_batch_size`

Type
integer

Default
`16384`

Size of batch for the producer async send

`compression_codec`

Type
string

Default
`none`

Valid Values
none, gzip, snappy, lz4, zstd

The compression codec for all data generated by the producer. If not set, compression will not be used. Note that the allowed values of this depend on the kafka version

`enable_auto_commit`

Type
boolean

Default
`False`

Enable asynchronous consumer commits

`max_poll_records`

Type
integer

Default
500

The maximum number of records returned in a poll call

`security_protocol`

Type
string

Default
PLAINTEXT

Valid Values
PLAINTEXT, SASL_PLAINTEXT, SSL, SASL_SSL

Protocol used to communicate with brokers

`sasl_mechanism`

Type
string

Default
PLAIN

Mechanism when security protocol is SASL

`ssl_cafile`

Type
string

Default
''

CA certificate PEM file used to verify the server certificate

`ssl_client_cert_file`

Type
string

Default
''

Client certificate PEM file used for authentication.

`ssl_client_key_file`

Type
string

Default
''

Client key PEM file used for authentication.

`ssl_client_key_password`

Type
string

Default
''

Client key password file used for authentication.

oslo_messaging_notifications

`driver`

Type
multi-valued

Default
''

The Drivers(s) to handle sending notifications. Possible values are messaging, messagingv2, routing, log, test, noop

`transport_url`

Type
string

Default
<None>

A URL representing the messaging driver to use for notifications. If not set, we fall back to the same configuration used for RPC.

`topics`

Type
list

Default
['notifications']

AMQP topic used for OpenStack notifications.

`retry`

Type
integer

Default
-1

The maximum number of attempts to re-send a notification message which failed to be delivered due to a recoverable error. 0 - No retry, -1 - indefinite

oslo_messaging_rabbit

amqp_durable_queues

Type
boolean

Default
`False`

Use durable queues in AMQP. If rabbit_quorum_queue is enabled, queues will be durable and this value will be ignored.

amqp_auto_delete

Type
boolean

Default
`False`

Auto-delete queues in AMQP.

rpc_conn_pool_size

Type
integer

Default
`30`

Minimum Value
1

Size of RPC connection pool.

conn_pool_min_size

Type
integer

Default
`2`

The pool size limit for connections expiration policy

conn_pool_ttl

Type
integer

Default
`1200`

The time-to-live in sec of idle connections in the pool

ssl

Type
boolean

Default
`False`

Connect over SSL.

`ssl_version`

Type
string

Default
`''`

SSL version to use (valid only if SSL enabled). Valid values are TLSv1 and SSLv23. SSLv2, SSLv3, TLSv1_1, and TLSv1_2 may be available on some distributions.

`ssl_key_file`

Type
string

Default
`''`

SSL key file (valid only if SSL enabled).

`ssl_cert_file`

Type
string

Default
`''`

SSL cert file (valid only if SSL enabled).

`ssl_ca_file`

Type
string

Default
`''`

SSL certification authority file (valid only if SSL enabled).

`ssl_enforce_fips_mode`

Type
boolean

Default
`False`

Global toggle for enforcing the OpenSSL FIPS mode. This feature requires Python support. This is available in Python 3.9 in all environments and may have been backported to older Python versions on select environments. If the Python executable used does not support OpenSSL FIPS mode, an exception will be raised.

`heartbeat_in_pthread`

Type
boolean

Default
`False`

(DEPRECATED) It is recommend not to use this option anymore. Run the health check heartbeat thread through a native python thread by default. If this option is equal to False then the health check heartbeat will inherit the execution model from the parent process. For example if the parent process has monkey patched the stdlib by using eventlet/greenlet then the heartbeat will be run through a green thread. This option should be set to True only for the wsgi services.

Warning

This option is deprecated for removal. Its value may be silently ignored in the future.

Reason
The option is related to Eventlet which will be removed. In addition this has never worked as expected with services using eventlet for core service framework.

`kombu_reconnect_delay`

Type
floating point

Default
`1.0`

Minimum Value
0.0

Maximum Value
4.5

How long to wait (in seconds) before reconnecting in response to an AMQP consumer cancel notification.

`kombu_reconnect_splay`

Type
floating point

Default
`0.0`

Minimum Value
0.0

Random time to wait for when reconnecting in response to an AMQP consumer cancel notification.

`kombu_compression`

Type
string

Default
<None>

EXPERIMENTAL: Possible values are: gzip, bz2. If not set compression will not be used. This option may not be available in future versions.

`kombu_missing_consumer_retry_timeout`

Type
integer

Default
60

How long to wait a missing client before abandoning to send it its replies. This value should not be longer than rpc_response_timeout.

Table 60: Deprecated Variations

Group	Name
oslo_messaging_rabbit	kombu_reconnect_timeout

`kombu_failover_strategy`

Type
string

Default
round-robin

Valid Values
round-robin, shuffle

Determines how the next RabbitMQ node is chosen in case the one we are currently connected to becomes unavailable. Takes effect only if more than one RabbitMQ node is provided in config.

`rabbit_login_method`

Type
string

Default
AMQPLAIN

Valid Values
PLAIN, AMQPLAIN, EXTERNAL, RABBIT-CR-DEMO

The RabbitMQ login method.

`rabbit_retry_interval`

Type
integer

Default
1

Minimum Value
1

How frequently to retry connecting with RabbitMQ.

`rabbit_retry_backoff`

Type
integer

Default
2

Minimum Value
0

How long to backoff for between retries when connecting to RabbitMQ.

`rabbit_interval_max`

Type
integer

Default
30

Minimum Value
1

Maximum interval of RabbitMQ connection retries.

`rabbit_ha_queues`

Type
boolean

Default
`False`

Try to use HA queues in RabbitMQ (x-ha-policy: all). If you change this option, you must wipe the RabbitMQ database. In RabbitMQ 3.0, queue mirroring is no longer controlled by the x-ha-policy argument when declaring a queue. If you just want to make sure that all queues (except those with auto-generated names) are mirrored across all nodes, run: rabbitmqctl set_policy HA ^(?!amq.).* {ha-mode: all}

`rabbit_quorum_queue`

Type
boolean

Default
`False`

Use quorum queues in RabbitMQ (x-queue-type: quorum). The quorum queue is a modern queue type for RabbitMQ implementing a durable, replicated FIFO queue based on the Raft consensus algorithm. It is available as of RabbitMQ 3.8.0. If set this option will conflict with the HA queues (`rabbit_ha_queues`) aka mirrored queues, in other words the HA queues should be disabled. Quorum queues are also durable by default so the amqp_durable_queues option is ignored when this option is enabled.

`rabbit_transient_quorum_queue`

Type
boolean

Default
`False`

Use quorum queues for transients queues in RabbitMQ. Enabling this option will then make sure those queues are also using quorum kind of rabbit queues, which are HA by default.

`rabbit_quorum_delivery_limit`

Type
integer

Default
`0`

Each time a message is redelivered to a consumer, a counter is incremented. Once the redelivery count exceeds the delivery limit the message gets dropped or dead-lettered (if a DLX exchange has been configured) Used only when rabbit_quorum_queue is enabled, Default 0 which means dont set a limit.

`rabbit_quorum_max_memory_length`

Type
integer

Default
`0`

By default all messages are maintained in memory if a quorum queue grows in length it can put memory pressure on a cluster. This option can limit the number of messages in the quorum queue. Used only when rabbit_quorum_queue is enabled, Default 0 which means dont set a limit.

`rabbit_quorum_max_memory_bytes`

Type
integer

Default
`0`

By default all messages are maintained in memory if a quorum queue grows in length it can put memory pressure on a cluster. This option can limit the number of memory bytes used by the quorum queue. Used only when rabbit_quorum_queue is enabled, Default 0 which means dont set a limit.

`rabbit_transient_queues_ttl`

Type
integer

Default
`1800`

Minimum Value
0

Positive integer representing duration in seconds for queue TTL (x-expires). Queues which are unused for the duration of the TTL are automatically deleted. The parameter affects only reply

and fanout queues. Setting 0 as value will disable the x-expires. If doing so, make sure you have a rabbitmq policy to delete the queues or you deployment will create an infinite number of queue over time.In case rabbit_stream_fanout is set to True, this option will control data retention policy (x-max-age) for messages in the fanout queue rather then the queue duration itself. So the oldest data in the stream queue will be discarded from it once reaching TTL Setting to 0 will disable x-max-age for stream which make stream grow indefinitely filling up the diskspace

`rabbit_qos_prefetch_count`

Type
integer

Default
`0`

Specifies the number of messages to prefetch. Setting to zero allows unlimited messages.

`heartbeat_timeout_threshold`

Type
integer

Default
`60`

Number of seconds after which the Rabbit broker is considered down if heartbeats keep-alive fails (0 disables heartbeat).

`heartbeat_rate`

Type
integer

Default
`3`

How often times during the heartbeat_timeout_threshold we check the heartbeat.

`direct_mandatory_flag`

Type
boolean

Default
`True`

(DEPRECATED) Enable/Disable the RabbitMQ mandatory flag for direct send. The direct send is used as reply, so the MessageUndeliverable exception is raised in case the client queue does not exist.MessageUndeliverable exception will be used to loop for a timeout to lets a chance to sender to recover.This flag is deprecated and it will not be possible to deactivate this functionality anymore

Warning

This option is deprecated for removal. Its value may be silently ignored in the future.

Reason
Mandatory flag no longer deactivable.

`enable_cancel_on_failover`

Type
boolean

Default
`False`

Enable x-cancel-on-ha-failover flag so that rabbitmq server will cancel and notify consumerswhen queue is down

`use_queue_manager`

Type
boolean

Default
`False`

Should we use consistant queue names or random ones

`hostname`

Type
string

Default
`node1.example.com`

This option has a sample default set, which means that its actual default value may vary from the one documented above.

Hostname used by queue manager. Defaults to the value returned by socket.gethostname().

`processname`

Type
string

Default
`nova-api`

This option has a sample default set, which means that its actual default value may vary from the one documented above.

Process name used by queue manager

`rabbit_stream_fanout`

Type
boolean

Default
`False`

Use stream queues in RabbitMQ (x-queue-type: stream). Streams are a new persistent and replicated data structure (queue type) in RabbitMQ which models an append-only log with non-destructive consumer semantics. It is available as of RabbitMQ 3.9.0. If set this option will replace all fanout queues with only one stream queue.

oslo_middleware

max_request_body_size

Type
integer

Default
`114688`

The maximum body size for each request, in bytes.

enable_proxy_headers_parsing

Type
boolean

Default
`False`

Whether the application is behind a proxy or not. This determines if the middleware should parse the headers or not.

http_basic_auth_user_file

Type
string

Default
`/etc/htpasswd`

HTTP basic auth password file.

oslo_policy

enforce_scope

Type
boolean

Default
`True`

This option controls whether or not to enforce scope when evaluating policies. If `True`, the scope of the token used in the request is compared to the `scope_types` of the policy being enforced. If the scopes do not match, an `InvalidScope` exception will be raised. If `False`, a message will be logged informing operators that policies are being invoked with mismatching scope.

Warning

This option is deprecated for removal. Its value may be silently ignored in the future.

Reason
This configuration was added temporarily to facilitate a smooth transition to the new RBAC. OpenStack will always enforce scope checks. This configuration option is deprecated and will be removed in the 2025.2 cycle.

`enforce_new_defaults`

Type
boolean

Default
`True`

This option controls whether or not to use old deprecated defaults when evaluating policies. If `True`, the old deprecated defaults are not going to be evaluated. This means if any existing token is allowed for old defaults but is disallowed for new defaults, it will be disallowed. It is encouraged to enable this flag along with the `enforce_scope` flag so that you can get the benefits of new defaults and `scope_type` together. If `False`, the deprecated policy check string is logically ORd with the new policy check string, allowing for a graceful upgrade experience between releases with new policies, which is the default behavior.

`policy_file`

Type
string

Default
`policy.yaml`

The relative or absolute path of a file that maps roles to permissions for a given service. Relative paths must be specified in relation to the configuration file setting this option.

`policy_default_rule`

Type
string

Default
`default`

Default rule. Enforced when a requested rule is not found.

`policy_dirs`

Type
multi-valued

Default
`policy.d`

Directories where policy configuration files are stored. They can be relative to any directory in the search path defined by the config_dir option, or absolute paths. The file defined by policy_file must exist for these directories to be searched. Missing or empty directories are ignored.

`remote_content_type`

Type
string

Default
`application/x-www-form-urlencoded`

Valid Values
application/x-www-form-urlencoded, application/json

Content Type to send and receive data for REST based policy check

`remote_ssl_verify_server_crt`

Type
boolean

Default
`False`

server identity verification for REST based policy check

`remote_ssl_ca_crt_file`

Type
string

Default
<None>

Absolute path to ca cert file for REST based policy check

`remote_ssl_client_crt_file`

Type
string

Default
<None>

Absolute path to client cert for REST based policy check

`remote_ssl_client_key_file`

Type
string

Default
<None>

Absolute path client key file REST based policy check

`remote_timeout`

Type
floating point

Default
`60`

Minimum Value
0

Timeout in seconds for REST based policy check

oslo_reports

`log_dir`

Type
string

Default
<None>

Path to a log directory where to create a file

`file_event_handler`

Type
string

Default
<None>

The path to a file to watch for changes to trigger the reports, instead of signals. Setting this option disables the signal trigger for the reports. If application is running as a WSGI application it is recommended to use this instead of signals.

`file_event_handler_interval`

Type
integer

Default
1

How many seconds to wait between polls when file_event_handler is set

oslo_versionedobjects

`fatal_exception_format_errors`

Type
boolean

Default
`False`

Make exception message format errors fatal

pci

`alias`

Type
multi-valued

Default
''

An alias for a PCI passthrough device requirement.

This allows users to specify the alias in the extra specs for a flavor, without needing to repeat all the PCI property requirements.

This should be configured for the `nova-api` service and, assuming you wish to use move operations, for each `nova-compute` service.

Possible Values:

- A JSON dictionary which describe a PCI device. It should take the following format:

```
alias = {
  "name": "<name>",
  ["product_id": "<id>"],
  ["vendor_id": "<id>"],
  "device_type": "<type>",
  ["numa_policy": "<policy>"],
  ["resource_class": "<resource_class>"],
  ["traits": "<traits>"]
  ["live_migratable": "<live_migratable>"],
}
```

Note that `[...]` indicates optional field.

For example:

```
alias = {
  "name": "QuickAssist",
  "product_id": "0443",
  "vendor_id": "8086",
  "device_type": "type-PCI",
  "numa_policy": "required"
}
```

This defines an alias for the Intel QuickAssist card. (multi valued).

Another example which matches a single device but by its placement resource class is:

```
alias = {
  "name": "A16_16A",
  "device_type": "type-VF",
  "resource_class": "GPU_VF",
  "traits": "blue, big"
}
```

Yet another scenario where multiple devices with different `vendor_id` and `product_id` values but which are functionally the same can be achieved using a custom resource class in the `device_spec` which we request here. A list of traits may be used for further refinement:

```
alias = {
  "name": "NVME256G",
  "device_type": "type-PCI",
  "resource_class": "CUSTOM_NVME256G",
  "traits": "nvme-with-crypto-erase",
}
```

Valid key values are :

`name`
: Name of the PCI alias.

`product_id`
: Product ID of the device in hexadecimal.

`vendor_id`
: Vendor ID of the device in hexadecimal.

`device_type`
: Type of PCI device. Valid values are: `type-PCI`, `type-PF` and `type-VF`. Note that `"device_type": "type-PF"` **must** be specified if you wish to passthrough a device that supports SR-IOV in its entirety.

`numa_policy`
: Required NUMA affinity of device. Valid values are: `legacy`, `preferred`, `required`, and `socket`.

`resource_class`
: The optional Placement resource class name that is used to track the requested PCI devices in Placement. It can be a standard resource class from the `os-resource-classes` lib. Or it can be an arbitrary string. If it is an non-standard resource class then Nova will normalize it to a proper Placement resource class by making it upper case, replacing any consecutive character outside of `[A-Z0-9_]` with a single _, and prefixing the name with `CUSTOM_` if not yet prefixed. The maximum allowed length is 255 character including the prefix. If `resource_class` is not provided Nova will generate it from `vendor_id` and `product_id` values of the alias in the form of `CUSTOM_PCI_{vendor_id}_{product_id}`. The `resource_class` requested in the alias is matched against the `resource_class` defined in the `[pci]device_spec`. This field can only be used only if `[filter_scheduler]pci_in_placement` is enabled. Either the product_id and vendor_id or the resource_class field must be provided in each alias.

`traits`
: An optional comma separated list of Placement trait names requested to be present on the resource provider that fulfills this alias. Each trait can be a standard trait from `os-traits` lib or it can be an arbitrary string. If it is a non-standard trait then Nova will normalize the trait name by making it upper case, replacing any consecutive character outside of `[A-Z0-9_]` with a single _, and prefixing the name with `CUSTOM_` if not yet prefixed. The maximum allowed length of a trait name is 255 character including the prefix. Every trait in `traits` requested in the alias ensured to be in the list of traits provided in the `traits` field of the `[pci]device_spec` when scheduling the request. This field can only be used only if `[filter_scheduler]pci_in_placement` is enabled. **NOTE**: An alias must include either a `vendor_id`/`product_id` pair or a `resource_class`. An alias with only `traits` is not allowed.

`live_migratable`
: Specify if live-migratable devices are desired. May have boolean-like string values case-insensitive values: yes or no.

  - `live_migratable='yes'` means that the user wants a device(s) allowing live migration to a similar device(s) on another host.
  - `live_migratable='no'` This explicitly indicates that the user requires a non-live migratable device, making migration impossible.
  - If not specified, the default is `live_migratable=None`, meaning that either a live migratable or non-live migratable device will be picked automatically. However, in such cases, migration will **not** be possible.

- Supports multiple aliases by repeating the option (not by specifying a list value):

```
alias = {
  "name": "QuickAssist-1",
  "product_id": "0443",
  "vendor_id": "8086",
  "device_type": "type-PCI",
  "numa_policy": "required"
}
alias = {
  "name": "QuickAssist-2",
  "product_id": "0444",
  "vendor_id": "8086",
  "device_type": "type-PCI",
  "numa_policy": "required",
  "live_migratable": "yes",
}
```

Table 61: Deprecated Variations

Group	Name
DEFAULT	pci_alias

device_spec

Type
multi-valued

Default
''

Specify the PCI devices available to VMs.

Possible values:

- A JSON dictionary which describe a PCI device. It should take the following format:

```
["vendor_id": "<id>",] ["product_id": "<id>",]
["address": "[[[[<domain>]:]<bus>]:][<slot>][.[<function>]]" |
 "devname": "<name>",]
{"<tag>": "<tag_value>",}
```

Where [indicates zero or one occurrences, { indicates zero or multiple occurrences, and | mutually exclusive options. Note that any missing fields are automatically wildcarded.

Valid key values are :

vendor_id
Vendor ID of the device in hexadecimal.

product_id
Product ID of the device in hexadecimal.

address
PCI address of the device. Both traditional glob style and regular expression syntax is

supported. Please note that the address fields are restricted to the following maximum values:

- domain - 0xFFFF
- bus - 0xFF
- slot - 0x1F
- function - 0x7

devname
Device name of the device (for e.g. interface name). Not all PCI devices have a name.

<tag>
Additional <tag> and <tag_value> used for specifying PCI devices. Supported <tag> values are :

- physical_network
- trusted
- remote_managed - a VF is managed remotely by an off-path networking backend. May have boolean-like string values case-insensitive values: true or false. By default, false is assumed for all devices. Using this option requires a networking service backend capable of handling those devices. PCI devices are also required to have a PCI VPD capability with a card serial number (either on a VF itself on its corresponding PF), otherwise they will be ignored and not available for allocation.
- managed - Specify if the PCI device is managed by libvirt. May have boolean-like string values case-insensitive values: yes or no. By default, yes is assumed for all devices.
  - managed='yes' means that nova will use libvirt to detach the device from the host before attaching it to the guest and re-attach it to the host after the guest is deleted.
  - managed='no' means that nova will not request libvirt to detach / attach the device from / to the host. In this case nova assumes that the operator configured the host in a way that these VFs are not attached to the host.

    Warning: Incorrect configuration of this parameter may result in compute node crashes.

- live_migratable - Specify if the PCI device is live_migratable by libvirt. May have boolean-like string values case-insensitive values: yes or no. By default, no is assumed for all devices.
  - live_migratable='yes' means that the device can be live migrated. Of course, this requires hardware support, as well as proper system and hypervisor configuration.
  - live_migratable='no' means that the device cannot be live migrated.
- resource_class - optional Placement resource class name to be used to track the matching PCI devices in Placement when [pci]report_in_placement is True. It can be a standard resource class from the os-resource-classes lib. Or can be any string. In that case Nova will normalize it to a proper Placement resource class by making it upper case, replacing any consecutive character outside of [A-Z0-9_]

with a single _, and prefixing the name with `CUSTOM_` if not yet prefixed. The maximum allowed length is 255 character including the prefix. If `resource_class` is not provided Nova will generate it from the PCI devices `vendor_id` and `product_id` in the form of `CUSTOM_PCI_{vendor_id}_{product_id}`. The `resource_class` can be requested from a `[pci]alias`

- `traits` - optional comma separated list of Placement trait names to report on the resource provider that will represent the matching PCI device. Each trait can be a standard trait from `os-traits` lib or can be any string. If it is not a standard trait then Nova will normalize the trait name by making it upper case, replacing any consecutive character outside of `[A-Z0-9_]` with a single _, and prefixing the name with `CUSTOM_` if not yet prefixed. The maximum allowed length of a trait name is 255 character including the prefix. Any trait from `traits` can be requested from a `[pci]alias`.

Valid examples are:

```
device_spec = {"devname":"eth0",
               "physical_network":"physnet"}
device_spec = {"address":"*:0a:00.*"}
device_spec = {"address":":0a:00.",
               "physical_network":"physnet1"}
device_spec = {"vendor_id":"1137",
               "product_id":"0071"}
device_spec = {"vendor_id":"1137",
               "product_id":"0071",
               "address": "0000:0a:00.1",
               "physical_network":"physnet1"}
device_spec = {"address":{"domain": ".*",
                          "bus": "02", "slot": "01",
                          "function": "[2-7]"},
               "physical_network":"physnet1"}
device_spec = {"address":{"domain": ".*",
                          "bus": "02", "slot": "0[1-2]",
                          "function": ".*"},
               "physical_network":"physnet1"}
device_spec = {"devname": "eth0", "physical_network":"physnet1",
               "trusted": "true"}
device_spec = {"vendor_id":"a2d6",
               "product_id":"15b3",
               "remote_managed": "true"}
device_spec = {"vendor_id":"a2d6",
               "product_id":"15b3",
               "address": "0000:82:00.0",
               "physical_network":"physnet1",
               "remote_managed": "true"}
device_spec = {"vendor_id":"1002",
               "product_id":"6929",
               "address": "0000:82:00.0",
               "resource_class": "PGPU",
               "traits": "HW_GPU_API_VULKAN,my-awesome-gpu"}
device_spec = {"vendor_id":"10de",
```

(continues on next page)

(continued from previous page)

```
                "product_id":"25b6",
                "address": "0000:25:00.4",
                "managed": "no"}
device_spec = {"vendor_id":"10de",
                "product_id":"25b6",
                "address": "0000:25:00.4",
                "resource_class": "CUSTOM_A16_16A",
                "managed": "no"}
```

The following are invalid, as they specify mutually exclusive options:

```
device_spec = {"devname":"eth0",
                "physical_network":"physnet",
                "address":"*:0a:00.*"}
```

The following example is invalid because it specifies the `remote_managed` tag for a PF - it will result in an error during config validation at the Nova Compute service startup:

```
device_spec = {"address": "0000:82:00.0",
                "product_id": "a2d6",
                "vendor_id": "15b3",
                "physical_network": null,
                "remote_managed": "true"}
```

- A JSON list of JSON dictionaries corresponding to the above format. For example:

```
device_spec = [{"product_id":"0001", "vendor_id":"8086"},
               {"product_id":"0002", "vendor_id":"8086"}]
```

Table 62: Deprecated Variations

Group	Name
pci	passthrough_whitelist
DEFAULT	pci_passthrough_whitelist

`report_in_placement`

Type
boolean

Default
`False`

Enable PCI resource inventory reporting to Placement. If it is enabled then the nova-compute service will report PCI resource inventories to Placement according to the [pci]device_spec configuration and the PCI devices reported by the hypervisor. Once it is enabled it cannot be disabled any more. In a future release the default of this config will be change to True.

Related options:

- [pci]device_spec: to define which PCI devices nova are allowed to track and assign to guests.

placement

cafile

Type
string

Default
<None>

PEM encoded Certificate Authority to use when verifying HTTPs connections.

certfile

Type
string

Default
<None>

PEM encoded client certificate cert file

keyfile

Type
string

Default
<None>

PEM encoded client certificate key file

insecure

Type
boolean

Default
False

Verify HTTPS connections.

timeout

Type
integer

Default
<None>

Timeout value for http requests

collect_timing

Type
boolean

Default
False

Collect per-API call timing information.

`split_loggers`

Type
boolean

Default
`False`

Log requests to multiple loggers.

`auth_type`

Type
unknown type

Default
<None>

Authentication type to load

Table 63: Deprecated Variations

Group	Name
placement	auth_plugin

`auth_section`

Type
unknown type

Default
<None>

Config Section from which to load plugin specific options

`auth_url`

Type
unknown type

Default
<None>

Authentication URL

`system_scope`

Type
unknown type

Default
<None>

Scope for system operations

`domain_id`

Type
unknown type

Default
<None>

Domain ID to scope to

`domain_name`

Type
unknown type

Default
<None>

Domain name to scope to

`project_id`

Type
unknown type

Default
<None>

Project ID to scope to

`project_name`

Type
unknown type

Default
<None>

Project name to scope to

`project_domain_id`

Type
unknown type

Default
<None>

Domain ID containing project

`project_domain_name`

Type
unknown type

Default
<None>

Domain name containing project

`trust_id`

Type
unknown type

Default
<None>

ID of the trust to use as a trustee use

`default_domain_id`

Type
unknown type

Default
<None>

Optional domain ID to use with v3 and v2 parameters. It will be used for both the user and project domain in v3 and ignored in v2 authentication.

`default_domain_name`

Type
unknown type

Default
<None>

Optional domain name to use with v3 API and v2 parameters. It will be used for both the user and project domain in v3 and ignored in v2 authentication.

`user_id`

Type
unknown type

Default
<None>

Users user ID

`username`

Type
unknown type

Default
<None>

Users username

Table 64: Deprecated Variations

Group	Name
placement	user-name
placement	user_name

`user_domain_id`

Type
unknown type

Default
<None>

Users domain ID

`user_domain_name`

Type
unknown type

Default
<None>

Users domain name

`password`

Type
unknown type

Default
<None>

Users password

`tenant_id`

Type
unknown type

Default
<None>

Tenant ID

`tenant_name`

Type
unknown type

Default
<None>

Tenant Name

`service_type`

Type
string

Default
`placement`

The default service_type for endpoint URL discovery.

`service_name`

Type
string

Default
<None>

The default service_name for endpoint URL discovery.

`valid_interfaces`

Type
list

Default
`['internal', 'public']`

List of interfaces, in order of preference, for endpoint URL.

`region_name`

Type
string

Default
<None>

The default region_name for endpoint URL discovery.

`endpoint_override`

Type
string

Default
<None>

Always use this endpoint URL for requests for this client. NOTE: The unversioned endpoint should be specified here; to request a particular API version, use the *version*, *min-version*, and/or *max-version* options.

`connect_retries`

Type
integer

Default
<None>

The maximum number of retries that should be attempted for connection errors.

`connect_retry_delay`

Type
floating point

Default
<None>

Delay (in seconds) between two retries for connection errors. If not set, exponential retry starting with 0.5 seconds up to a maximum of 60 seconds is used.

`status_code_retries`

Type
integer

Default
<None>

The maximum number of retries that should be attempted for retriable HTTP status codes.

`status_code_retry_delay`

Type
floating point

Default
<None>

Delay (in seconds) between two retries for retriable status codes. If not set, exponential retry starting with 0.5 seconds up to a maximum of 60 seconds is used.

`retriable_status_codes`

Type
list

Default
<None>

List of retriable HTTP status codes that should be retried. If not set default to [503]

privsep

Configuration options for the oslo.privsep daemon. Note that this group name can be changed by the consuming service. Check the services docs to see if this is the case.

`user`

Type
string

Default
<None>

User that the privsep daemon should run as.

`group`

Type
string

Default
<None>

Group that the privsep daemon should run as.

`capabilities`

Type
unknown type

Default
[]

List of Linux capabilities retained by the privsep daemon.

`thread_pool_size`

Type
integer

Default
`multiprocessing.cpu_count()`

Minimum Value
1

This option has a sample default set, which means that its actual default value may vary from the one documented above.

The number of threads available for privsep to concurrently run processes. Defaults to the number of CPU cores in the system.

`helper_command`

Type
string

Default
<None>

Command to invoke to start the privsep daemon if not using the fork method. If not specified, a default is generated using sudo privsep-helper and arguments designed to recreate the current configuration. This command must accept suitable privsep_context and privsep_sock_path arguments.

`logger_name`

Type
string

Default
`oslo_privsep.daemon`

Logger name to use for this privsep context. By default all contexts log with oslo_privsep.daemon.

`log_daemon_traceback`

Type
boolean

Default
`False`

Print the exception traceback happened in the daemon in the client logger

profiler

`enabled`

Type
boolean

Default
`False`

Enable the profiling for all services on this node.

Default value is False (fully disable the profiling feature).

Possible values:

- True: Enables the feature
- False: Disables the feature. The profiling cannot be started via this project operations. If the profiling is triggered by another project, this project part will be empty.

Table 65: Deprecated Variations

Group	Name
profiler	profiler_enabled

`trace_sqlalchemy`

Type
boolean

Default
`False`

Enable SQL requests profiling in services.

Default value is False (SQL requests wont be traced).

Possible values:

- True: Enables SQL requests profiling. Each SQL query will be part of the trace and can the be analyzed by how much time was spent for that.
- False: Disables SQL requests profiling. The spent time is only shown on a higher level of operations. Single SQL queries cannot be analyzed this way.

`trace_requests`

Type
boolean

Default
`False`

Enable python requests package profiling.

Supported drivers: jaeger+otlp

Default value is False.

Possible values:

- True: Enables requests profiling.
- False: Disables requests profiling.

`hmac_keys`

Type
string

Default
`SECRET_KEY`

Secret key(s) to use for encrypting context data for performance profiling.

This string value should have the following format: <key1>[,<key2>,<keyn>], where each key is some random string. A user who triggers the profiling via the REST API has to set one of these keys in the headers of the REST API call to include profiling results of this node for this particular project.

Both enabled flag and hmac_keys config options should be set to enable profiling. Also, to generate correct profiling information across all services at least one key needs to be consistent between OpenStack projects. This ensures it can be used from client side to generate the trace, containing information from all possible resources.

`connection_string`

Type
string

Default
`messaging://`

Connection string for a notifier backend.

Default value is `messaging://` which sets the notifier to oslo_messaging.

Examples of possible values:

- `messaging://` - use oslo_messaging driver for sending spans.
- `redis://127.0.0.1:6379` - use redis driver for sending spans.
- `mongodb://127.0.0.1:27017` - use mongodb driver for sending spans.
- `elasticsearch://127.0.0.1:9200` - use elasticsearch driver for sending spans.
- `jaeger://127.0.0.1:6831` - use jaeger tracing as driver for sending spans.

`es_doc_type`

Type
string

Default
`notification`

Document type for notification indexing in elasticsearch.

`es_scroll_time`

Type
string

Default
`2m`

This parameter is a time value parameter (for example: es_scroll_time=2m), indicating for how long the nodes that participate in the search will maintain relevant resources in order to continue and support it.

`es_scroll_size`

Type
integer

Default
`10000`

Elasticsearch splits large requests in batches. This parameter defines maximum size of each batch (for example: es_scroll_size=10000).

`socket_timeout`

Type
floating point

Default
`0.1`

Redissentinel provides a timeout option on the connections. This parameter defines that timeout (for example: socket_timeout=0.1).

`sentinel_service_name`

Type
string

Default
`mymaster`

Redissentinel uses a service name to identify a master redis service. This parameter defines the name (for example: `sentinal_service_name=mymaster`).

`filter_error_trace`

Type
boolean

Default
`False`

Enable filter traces that contain error/exception to a separated place.

Default value is set to False.

Possible values:

- True: Enable filter traces that contain error/exception.
- False: Disable the filter.

profiler_jaeger

`service_name_prefix`

Type
string

Default
<None>

Set service name prefix to Jaeger service name.

`process_tags`

Type
dict

Default
`{}`

Set process tracer tags.

profiler_otlp

`service_name_prefix`

Type
string

Default
<None>

Set service name prefix to OTLP exporters.

quota

Quota options allow to manage quotas in openstack deployment.

`instances`

Type
integer

Default
`10`

Minimum Value
-1

The number of instances allowed per project.

Possible Values

- A positive integer or 0.
- -1 to disable the quota.

Table 66: Deprecated Variations

Group	Name
DEFAULT	quota_instances

`cores`

Type
integer

Default
`20`

Minimum Value
-1

The number of instance cores or vCPUs allowed per project.

Possible values:

- A positive integer or 0.
- -1 to disable the quota.

Table 67: Deprecated Variations

Group	Name
DEFAULT	quota_cores

`ram`

Type
integer

Default
`51200`

Minimum Value
-1

The number of megabytes of instance RAM allowed per project.

Possible values:

- A positive integer or 0.
- -1 to disable the quota.

Table 68: Deprecated Variations

Group	Name
DEFAULT	quota_ram

`metadata_items`

Type
integer

Default
`128`

Minimum Value
-1

The number of metadata items allowed per instance.

Users can associate metadata with an instance during instance creation. This metadata takes the form of key-value pairs.

Possible values:

- A positive integer or 0.

- -1 to disable the quota.

Table 69: Deprecated Variations

Group	Name
DEFAULT	quota_metadata_items

`injected_files`

Type
integer

Default
5

Minimum Value
-1

The number of injected files allowed.

File injection allows users to customize the personality of an instance by injecting data into it upon boot. Only text file injection is permitted: binary or ZIP files are not accepted. During file injection, any existing files that match specified files are renamed to include `.bak` extension appended with a timestamp.

Possible values:

- A positive integer or 0.
- -1 to disable the quota.

Table 70: Deprecated Variations

Group	Name
DEFAULT	quota_injected_files

`injected_file_content_bytes`

Type
integer

Default
10240

Minimum Value
-1

The number of bytes allowed per injected file.

Possible values:

- A positive integer or 0.
- -1 to disable the quota.

Table 71: Deprecated Variations

Group	Name
DEFAULT	quota_injected_file_content_bytes

`injected_file_path_length`

Type
integer

Default
255

Minimum Value
-1

The maximum allowed injected file path length.

Possible values:

- A positive integer or 0.
- -1 to disable the quota.

Table 72: Deprecated Variations

Group	Name
DEFAULT	quota_injected_file_path_length

`key_pairs`

Type
integer

Default
100

Minimum Value
-1

The maximum number of key pairs allowed per user.

Users can create at least one key pair for each project and use the key pair for multiple instances that belong to that project.

Possible values:

- A positive integer or 0.
- -1 to disable the quota.

Table 73: Deprecated Variations

Group	Name
DEFAULT	quota_key_pairs

`server_groups`

Type
integer

Default
`10`

Minimum Value
-1

The maximum number of server groups per project.

Server groups are used to control the affinity and anti-affinity scheduling policy for a group of servers or instances. Reducing the quota will not affect any existing group, but new servers will not be allowed into groups that have become over quota.

Possible values:

- A positive integer or 0.
- -1 to disable the quota.

Table 74: Deprecated Variations

Group	Name
DEFAULT	quota_server_groups

`server_group_members`

Type
integer

Default
`10`

Minimum Value
-1

The maximum number of servers per server group.

Possible values:

- A positive integer or 0.
- -1 to disable the quota.

Table 75: Deprecated Variations

Group	Name
DEFAULT	quota_server_group_members

`driver`

Type
string

Default
`nova.quota.DbQuotaDriver`

Valid Values
nova.quota.DbQuotaDriver, nova.quota.NoopQuotaDriver, nova.quota.UnifiedLimitsDriver

Provides abstraction for quota checks. Users can configure a specific driver to use for quota checks.

Possible values

nova.quota.DbQuotaDriver
(deprecated) Stores quota limit information in the database and relies on the `quota_*` configuration options for default quota limit values. Counts quota usage on-demand.

nova.quota.NoopQuotaDriver
Ignores quota and treats all resources as unlimited.

nova.quota.UnifiedLimitsDriver
Uses Keystone unified limits to store quota limit information and relies on resource usage counting from Placement. Counts quota usage on-demand. Resources missing unified limits in Keystone will be treated as a quota limit of 0, so it is important to ensure all resources have registered limits in Keystone. The `nova-manage limits migrate_to_unified_limits` command can be used to copy existing quota limits from the Nova database to Keystone unified limits via the Keystone API. Alternatively, unified limits can be created manually using the OpenStackClient or by calling the Keystone API directly.

`recheck_quota`

Type
boolean

Default
`True`

Recheck quota after resource creation to prevent allowing quota to be exceeded.

This defaults to True (recheck quota after resource creation) but can be set to False to avoid additional load if allowing quota to be exceeded because of racing requests is considered acceptable. For example, when set to False, if a user makes highly parallel REST API requests to create servers, it will be possible for them to create more servers than their allowed quota during the race. If their quota is 10 servers, they might be able to create 50 during the burst. After the burst, they will not be able to create any more servers but they will be able to keep their 50 servers until they delete them.

The initial quota check is done before resources are created, so if multiple parallel requests arrive at the same time, all could pass the quota check and create resources, potentially exceeding quota. When recheck_quota is True, quota will be checked a second time after resources have been created and if the resource is over quota, it will be deleted and OverQuota will be raised, usually resulting in a 403 response to the REST API user. This makes it impossible for a user to exceed their quota with the caveat that it will, however, be possible for a REST API user to be rejected with a 403 response in the event of a collision close to reaching their quota limit, even if the user has enough quota available when they made the request.

`count_usage_from_placement`

Type
boolean

Default
`False`

Enable the counting of quota usage from the placement service.

Starting in Train, it is possible to count quota usage for cores and ram from the placement service and instances from the API database instead of counting from cell databases.

This works well if there is only one Nova deployment running per placement deployment. However, if an operator is running more than one Nova deployment sharing a placement deployment, they should not set this option to True because currently the placement service has no way to partition resource providers per Nova deployment. When this option is left as the default or set to False, Nova will use the legacy counting method to count quota usage for instances, cores, and ram from its cell databases.

Note that quota usage behavior related to resizes will be affected if this option is set to True. Placement resource allocations are claimed on the destination while holding allocations on the source during a resize, until the resize is confirmed or reverted. During this time, when the server is in VERIFY_RESIZE state, quota usage will reflect resource consumption on both the source and the destination. This can be beneficial as it reserves space for a revert of a downsize, but it also means quota usage will be inflated until a resize is confirmed or reverted.

Behavior will also be different for unscheduled servers in ERROR state. A server in ERROR state that has never been scheduled to a compute host will not have placement allocations, so it will not consume quota usage for cores and ram.

Behavior will be different for servers in SHELVED_OFFLOADED state. A server in SHELVED_OFFLOADED state will not have placement allocations, so it will not consume quota usage for cores and ram. Note that because of this, it will be possible for a request to unshelve a server to be rejected if the user does not have enough quota available to support the cores and ram needed by the server to be unshelved.

The `populate_queued_for_delete` and `populate_user_id` online data migrations must be completed before usage can be counted from placement. Until the data migration is complete, the system will fall back to legacy quota usage counting from cell databases depending on the result of an EXISTS database query during each quota check, if this configuration option is set to True. Operators who want to avoid the performance hit from the EXISTS queries should wait to set this configuration option to True until after they have completed their online data migrations via `nova-manage db online_data_migrations`.

`unified_limits_resource_strategy`

Type
string

Default
`require`

Valid Values
require, ignore

Specify the semantics of the `unified_limits_resource_list`.

When the quota driver is set to the `UnifiedLimitsDriver`, resources may be specified to ether require registered limits set in Keystone or ignore if they do not have registered limits set.

When set to `require`, if a resource in `unified_limits_resource_list` is requested and has no registered limit set, the quota limit for that resource will be considered to be 0 and all requests to allocate that resource will be rejected for being over quota.

When set to `ignore`, if a resource in `unified_limits_resource_list` is requested and has no registered limit set, the quota limit for that resource will be considered to be unlimited and all requests to allocate that resource will be accepted.

Related options:

- `unified_limits_resource_list`: This must contain either resources for which to require registered limits set or resources to ignore if they do not have registered limits set. It can also be set to an empty list.

Possible values

require
: Require the resources in `unified_limits_resource_list` to have registered limits set in Keystone

ignore
: Ignore the resources in `unified_limits_resource_list` if they do not have registered limits set in Keystone

`unified_limits_resource_list`

Type
: list

Default
: `['servers']`

Specify a list of resources to require or ignore registered limits.

When the quota driver is set to the `UnifiedLimitsDriver`, require or ignore resources in this list to have registered limits set in Keystone.

When `unified_limits_resource_strategy` is `require`, if a resource in this list is requested and has no registered limit set, the quota limit for that resource will be considered to be 0 and all requests to allocate that resource will be rejected for being over quota.

When `unified_limits_resource_strategy` is `ignore`, if a resource in this list is requested and has no registered limit set, the quota limit for that resource will be considered to be unlimited and all requests to allocate that resource will be accepted.

The list can also be set to an empty list.

Valid list item values are:

- `servers`
- `class:<Placement resource class name>`
- `server_key_pairs`
- `server_groups`
- `server_group_members`
- `server_metadata_items`

- `server_injected_files`
- `server_injected_file_content_bytes`
- `server_injected_file_path_bytes`

Related options:

- `unified_limits_resource_strategy`: This must be set to `require` or `ignore`

scheduler

`max_attempts`

Type
integer

Default
3

Minimum Value
1

The maximum number of schedule attempts.

This is the maximum number of attempts that will be made for a given instance build/move operation. It limits the number of alternate hosts returned by the scheduler. When that list of hosts is exhausted, a `MaxRetriesExceeded` exception is raised and the instance is set to an error state.

Possible values:

- A positive integer, where the integer corresponds to the max number of attempts that can be made when building or moving an instance.

`discover_hosts_in_cells_interval`

Type
integer

Default
-1

Minimum Value
-1

Periodic task interval.

This value controls how often (in seconds) the scheduler should attempt to discover new hosts that have been added to cells. If negative (the default), no automatic discovery will occur.

Deployments where compute nodes come and go frequently may want this enabled, where others may prefer to manually discover hosts when one is added to avoid any overhead from constantly checking. If enabled, every time this runs, we will select any unmapped hosts out of each cell database on every run.

Possible values:

- An integer, where the integer corresponds to periodic task interval in seconds. 0 uses the default interval (60 seconds). A negative value disables periodic tasks.

`max_placement_results`

Type
integer

Default
`1000`

Minimum Value
1

The maximum number of placement results to request.

This setting determines the maximum limit on results received from the placement service during a scheduling operation. It effectively limits the number of hosts that may be considered for scheduling requests that match a large number of candidates.

A value of 1 (the minimum) will effectively defer scheduling to the placement service strictly on will it fit grounds. A higher value will put an upper cap on the number of results the scheduler will consider during the filtering and weighing process. Large deployments may need to set this lower than the total number of hosts available to limit memory consumption, network traffic, etc. of the scheduler.

Possible values:

- An integer, where the integer corresponds to the number of placement results to return.

`workers`

Type
integer

Default
<None>

Minimum Value
0

Number of workers for the nova-scheduler service.

Defaults to the number of CPUs available.

Possible values:

- An integer, where the integer corresponds to the number of worker processes.

`query_placement_for_routed_network_aggregates`

Type
boolean

Default
`False`

Enable the scheduler to filter compute hosts affined to routed network segment aggregates.

See https://docs.openstack.org/neutron/latest/admin/config-routed-networks.html for details.

`limit_tenants_to_placement_aggregate`

Type
boolean

Default
`False`

Restrict tenants to specific placement aggregates.

This setting causes the scheduler to look up a host aggregate with the metadata key of `filter_tenant_id` set to the project of an incoming request, and request results from placement be limited to that aggregate. Multiple tenants may be added to a single aggregate by appending a serial number to the key, such as `filter_tenant_id:123`.

The matching aggregate UUID must be mirrored in placement for proper operation. If the aggregate does not match one in placement, the result will be the same as not finding any suitable hosts for the request.

If no host aggregate with the tenant id is found and `[scheduler] placement_aggregate_required_for_tenants = False`, the request will not be restricted to only aggregates matching the tenant. If no host aggregate with the tenant id is found and `[scheduler] placement_aggregate_required_for_tenants = True`, the result will be the same as not finding any suitable hosts for the request.

Possible values:

- A boolean value.

Related options:

- `[scheduler] placement_aggregate_required_for_tenants`

`placement_aggregate_required_for_tenants`

Type
boolean

Default
`False`

Require a placement aggregate association for all tenants.

This setting, when limit_tenants_to_placement_aggregate=True, will control whether or not a tenant with no aggregate affinity will be allowed to schedule to any available node. If aggregates are used to limit some tenants but not all, then this should be False. If all tenants should be confined via aggregate, then this should be True to prevent them from receiving unrestricted scheduling to any available node.

Possible values:

- A boolean value.

Related options:

- `[scheduler] placement_aggregate_required_for_tenants`

`query_placement_for_image_type_support`

Type
boolean

Default
`False`

Use placement to determine host support for the instances image type.

This setting causes the scheduler to ask placement only for compute hosts that support the `disk_format` of the image used in the request.

Possible values:

- A boolean value.

`enable_isolated_aggregate_filtering`

Type
boolean

Default
`False`

Restrict use of aggregates to instances with matching metadata.

This setting allows the scheduler to restrict hosts in aggregates based on matching required traits in the aggregate metadata and the instance flavor/image. If an aggregate is configured with a property with key `trait:$TRAIT_NAME` and value `required`, the instance flavor extra_specs and/or image metadata must also contain `trait:$TRAIT_NAME=required` to be eligible to be scheduled to hosts in that aggregate. More technical details at https://docs.openstack.org/nova/latest/reference/isolate-aggregates.html

Possible values:

- A boolean value.

`image_metadata_prefilter`

Type
boolean

Default
`False`

Use placement to filter hosts based on image metadata.

This setting causes the scheduler to transform well known image metadata properties into placement required traits to filter host based on image metadata. This feature requires host support and is currently supported by the following compute drivers:

- `libvirt.LibvirtDriver` (since Ussuri (21.0.0))

Possible values:

- A boolean value.

Related options:

- `[compute] compute_driver`

serial_console

The serial console feature allows you to connect to a guest in case a graphical console like VNC, RDP or SPICE is not available. This is only currently supported for the libvirt, Ironic and hyper-v drivers.

`enabled`

Type
boolean

Default
`False`

Enable the serial console feature.

In order to use this feature, the service `nova-serialproxy` needs to run. This service is typically executed on the controller node.

`port_range`

Type
string

Default
`10000:20000`

A range of TCP ports a guest can use for its backend.

Each instance which gets created will use one port out of this range. If the range is not big enough to provide another port for an new instance, this instance wont get launched.

Possible values:

- Each string which passes the regex `^\d+:\d+$` For example `10000:20000`. Be sure that the first port number is lower than the second port number and that both are in range from 0 to 65535.

`base_url`

Type
URI

Default
`ws://127.0.0.1:6083/`

The URL an end user would use to connect to the `nova-serialproxy` service.

The `nova-serialproxy` service is called with this token enriched URL and establishes the connection to the proper instance.

Related options:

- The IP address must be identical to the address to which the `nova-serialproxy` service is listening (see option `serialproxy_host` in this section).
- The port must be the same as in the option `serialproxy_port` of this section.
- If you choose to use a secured websocket connection, then start this option with `wss://` instead of the unsecured `ws://`. The options `cert` and `key` in the `[DEFAULT]` section have to be set for that.

`proxyclient_address`

Type
string

Default
`127.0.0.1`

The IP address to which proxy clients (like `nova-serialproxy`) should connect to get the serial console of an instance.

This is typically the IP address of the host of a `nova-compute` service.

`serialproxy_host`

Type
string

Default
`0.0.0.0`

The IP address which is used by the `nova-serialproxy` service to listen for incoming requests.

The `nova-serialproxy` service listens on this IP address for incoming connection requests to instances which expose serial console.

Related options:

- Ensure that this is the same IP address which is defined in the option `base_url` of this section or use `0.0.0.0` to listen on all addresses.

`serialproxy_port`

Type
port number

Default
`6083`

Minimum Value
0

Maximum Value
65535

The port number which is used by the `nova-serialproxy` service to listen for incoming requests.

The `nova-serialproxy` service listens on this port number for incoming connection requests to instances which expose serial console.

Related options:

- Ensure that this is the same port number which is defined in the option `base_url` of this section.

service_user

Configuration options for service to service authentication using a service token. These options allow sending a service token along with the users token when contacting external REST APIs.

`send_service_user_token`

Type
boolean

Default
`False`

When True, if sending a user token to a REST API, also send a service token.

Nova often reuses the user token provided to the nova-api to talk to other REST APIs, such as Cinder, Glance and Neutron. It is possible that while the user token was valid when the request was made to Nova, the token may expire before it reaches the other service. To avoid any failures, and to make it clear it is Nova calling the service on the users behalf, we include a service token along with the user token. Should the users token have expired, a valid service token ensures the REST API request will still be accepted by the keystone middleware.

`cafile`

Type
string

Default
`<None>`

PEM encoded Certificate Authority to use when verifying HTTPs connections.

`certfile`

Type
string

Default
`<None>`

PEM encoded client certificate cert file

`keyfile`

Type
string

Default
`<None>`

PEM encoded client certificate key file

`insecure`

Type
boolean

Default
`False`

Verify HTTPS connections.

`timeout`

Type
integer

Default
`<None>`

Timeout value for http requests

`collect_timing`

Type
boolean

Default
`False`

Collect per-API call timing information.

`split_loggers`

Type
boolean

Default
`False`

Log requests to multiple loggers.

`auth_type`

Type
unknown type

Default
<None>

Authentication type to load

Table 76: Deprecated Variations

Group	Name
service_user	auth_plugin

`auth_section`

Type
unknown type

Default
<None>

Config Section from which to load plugin specific options

`auth_url`

Type
unknown type

Default
<None>

Authentication URL

`system_scope`

Type
unknown type

Default
<None>

Scope for system operations

`domain_id`

Type
unknown type

Default
<None>

Domain ID to scope to

`domain_name`

Type
unknown type

Default
<None>

Domain name to scope to

`project_id`

Type
unknown type

Default
<None>

Project ID to scope to

`project_name`

Type
unknown type

Default
<None>

Project name to scope to

`project_domain_id`

Type
unknown type

Default
<None>

Domain ID containing project

`project_domain_name`

Type
unknown type

Default
<None>

Domain name containing project

`trust_id`

Type
unknown type

Default
<None>

ID of the trust to use as a trustee use

`default_domain_id`

Type
unknown type

Default
<None>

Optional domain ID to use with v3 and v2 parameters. It will be used for both the user and project domain in v3 and ignored in v2 authentication.

`default_domain_name`

Type
unknown type

Default
<None>

Optional domain name to use with v3 API and v2 parameters. It will be used for both the user and project domain in v3 and ignored in v2 authentication.

`user_id`

Type
unknown type

Default
<None>

Users user ID

`username`

Type
unknown type

Default
<None>

Users username

Table 77: Deprecated Variations

Group	Name
service_user	user-name
service_user	user_name

`user_domain_id`

Type
unknown type

Default
<None>

Users domain ID

`user_domain_name`

Type
unknown type

Default
<None>

Users domain name

`password`

Type
unknown type

Default
<None>

Users password

`tenant_id`

Type
unknown type

Default
<None>

Tenant ID

`tenant_name`

Type
unknown type

Default
<None>

Tenant Name

spice

SPICE console feature allows you to connect to a guest virtual machine. SPICE is a replacement for fairly limited VNC protocol.

Following requirements must be met in order to use SPICE:

- Virtualization driver must be libvirt
- spice.enabled set to True
- vnc.enabled set to False

- update html5proxy_base_url
- update server_proxyclient_address

`enabled`

Type
boolean

Default
`False`

Enable SPICE related features.

Related options:

- VNC must be explicitly disabled to get access to the SPICE console. Set the enabled option to False in the [vnc] section to disable the VNC console.

`agent_enabled`

Type
boolean

Default
`True`

Enable the SPICE guest agent support on the instances.

The Spice agent works with the Spice protocol to offer a better guest console experience. However, the Spice console can still be used without the Spice Agent. With the Spice agent installed the following features are enabled:

- Copy & Paste of text and images between the guest and client machine
- Automatic adjustment of resolution when the client screen changes - e.g. if you make the Spice console full screen the guest resolution will adjust to match it rather than letterboxing.
- Better mouse integration - The mouse can be captured and released without needing to click inside the console or press keys to release it. The performance of mouse movement is also improved.

`image_compression`

Type
string

Default
<None>

Valid Values
auto_glz, auto_lz, quic, glz, lz, off

Advanced Option
Intended for advanced users and not used by the majority of users, and might have a significant effect on stability and/or performance.

Configure the SPICE image compression (lossless).

Possible values

auto_glz
enable image compression mode to choose between glz and quic algorithm, based on image properties

auto_lz
enable image compression mode to choose between lz and quic algorithm, based on image properties

quic
enable image compression based on the SFALIC algorithm

glz
enable image compression using lz with history based global dictionary

lz
enable image compression with the Lempel-Ziv algorithm

off
disable image compression

`jpeg_compression`

Type
string

Default
<None>

Valid Values
auto, never, always

Advanced Option
Intended for advanced users and not used by the majority of users, and might have a significant effect on stability and/or performance.

Configure the SPICE wan image compression (lossy for slow links).

Possible values

auto
enable JPEG image compression automatically

never
disable JPEG image compression

always
enable JPEG image compression

`zlib_compression`

Type
string

Default
<None>

Valid Values
auto, never, always

Advanced Option
Intended for advanced users and not used by the majority of users, and might have a significant effect on stability and/or performance.

Configure the SPICE wan image compression (lossless for slow links).

Possible values

auto
enable zlib image compression automatically

never
disable zlib image compression

always
enable zlib image compression

`playback_compression`

Type
boolean

Default
<None>

Advanced Option
Intended for advanced users and not used by the majority of users, and might have a significant effect on stability and/or performance.

Enable the SPICE audio stream compression (using celt).

`streaming_mode`

Type
string

Default
<None>

Valid Values
filter, all, off

Advanced Option
Intended for advanced users and not used by the majority of users, and might have a significant effect on stability and/or performance.

Configure the SPICE video stream detection and (lossy) compression.

Possible values

filter
SPICE server adds additional filters to decide if video streaming should be activated

all
any fast-refreshing window can be encoded into a video stream

off
no video detection and (lossy) compression is performed

`html5proxy_base_url`

Type
URI

Default
`http://127.0.0.1:6082/spice_auto.html`

Location of the SPICE HTML5 console proxy.

End user would use this URL to connect to the *nova-spicehtml5proxy'* service. This service will forward request to the console of an instance.

In order to use SPICE console, the service `nova-spicehtml5proxy` should be running. This service is typically launched on the controller node.

Possible values:

- Must be a valid URL of the form: `http://host:port/spice_auto.html` where host is the node running `nova-spicehtml5proxy` and the port is typically 6082. Consider not using default value as it is not well defined for any real deployment.

Related options:

- This option depends on `html5proxy_host` and `html5proxy_port` options. The access URL returned by the compute node must have the host and port where the `nova-spicehtml5proxy` service is listening.

`spice_direct_proxy_base_url`

Type
URI

Default
`http://127.0.0.1:13002/nova`

Location of a SPICE protocol native console proxy.

A user can retrieve a virt-viewer style .vv connection configuration file by accessing this URL with the attached token when a console is created.

Possible values:

- Must be a valid URL of the form: `http://host:port/nova` where host is the node running the SPICE protocol native proxy and the port is typically 13002. Note that the port component is optional if you are using the default port for HTTP or HTTPS. Consider not using the default value as it is not well defined for any real deployment.

`server_listen`

Type
string

Default
`127.0.0.1`

The address where the SPICE server running on the instances should listen.

Typically, the nova-spicehtml5proxy proxy client runs on the controller node and connects over the private network to this address on the compute node(s).

Possible values:

- IP address to listen on.

server_proxyclient_address

Type
string

Default
127.0.0.1

The address used by nova-spicehtml5proxy client to connect to instance console.

Typically, the nova-spicehtml5proxy proxy client runs on the controller node and connects over the private network to this address on the compute node(s).

Possible values:

- Any valid IP address on the compute node.

Related options:

- This option depends on the server_listen option. The proxy client must be able to access the address specified in server_listen using the value of this option.

require_secure

Type
boolean

Default
False

Whether to require secure TLS connections to SPICE consoles.

If youre providing direct access to SPICE consoles instead of using the HTML5 proxy, you may wish those connections to be encrypted. If so, set this value to True.

Note that use of secure consoles requires that you setup TLS certificates on each hypervisor.

Possible values:

- False: console traffic is not encrypted.
- True: console traffic is required to be protected by TLS.

html5proxy_host

Type
host address

Default
0.0.0.0

IP address or a hostname on which the nova-spicehtml5proxy service listens for incoming requests.

Related options:

- This option depends on the `html5proxy_base_url` option. The `nova-spicehtml5proxy` service must be listening on a host that is accessible from the HTML5 client.

`html5proxy_port`

Type
port number

Default
`6082`

Minimum Value
0

Maximum Value
65535

Port on which the `nova-spicehtml5proxy` service listens for incoming requests.

Related options:

- This option depends on the `html5proxy_base_url` option. The `nova-spicehtml5proxy` service must be listening on a port that is accessible from the HTML5 client.

upgrade_levels

upgrade_levels options are used to set version cap for RPC messages sent between different nova services.

By default all services send messages using the latest version they know about.

The compute upgrade level is an important part of rolling upgrades where old and new nova-compute services run side by side.

The other options can largely be ignored, and are only kept to help with a possible future backport issue.

`compute`

Type
string

Default
`<None>`

Compute RPC API version cap.

By default, we always send messages using the most recent version the client knows about.

Where you have old and new compute services running, you should set this to the lowest deployed version. This is to guarantee that all services never send messages that one of the compute nodes cant understand. Note that we only support upgrading from release N to release N+1.

Set this option to auto if you want to let the compute RPC module automatically determine what version to use based on the service versions in the deployment.

Possible values:

- By default send the latest version the client knows about
- auto: Automatically determines what version to use based on the service versions in the deployment.

- A string representing a version number in the format N.N; for example, possible values might be 1.12 or 2.0.
- An OpenStack release name, in lower case, such as mitaka or liberty.

`scheduler`

Type
string

Default
<None>

Scheduler RPC API version cap.

Possible values:

- By default send the latest version the client knows about
- A string representing a version number in the format N.N; for example, possible values might be 1.12 or 2.0.
- An OpenStack release name, in lower case, such as mitaka or liberty.

`conductor`

Type
string

Default
<None>

Conductor RPC API version cap.

Possible values:

- By default send the latest version the client knows about
- A string representing a version number in the format N.N; for example, possible values might be 1.12 or 2.0.
- An OpenStack release name, in lower case, such as mitaka or liberty.

`baseapi`

Type
string

Default
<None>

Base API RPC API version cap.

Possible values:

- By default send the latest version the client knows about
- A string representing a version number in the format N.N; for example, possible values might be 1.12 or 2.0.
- An OpenStack release name, in lower case, such as mitaka or liberty.

vault

root_token_id

Type
string

Default
<None>

root token for vault

approle_role_id

Type
string

Default
<None>

AppRole role_id for authentication with vault

approle_secret_id

Type
string

Default
<None>

AppRole secret_id for authentication with vault

kv_mountpoint

Type
string

Default
secret

Mountpoint of KV store in Vault to use, for example: secret

kv_path

Type
string

Default
<None>

Path relative to root of KV store in Vault to use.

kv_version

Type
integer

Default
2

Version of KV store in Vault to use, for example: 2

`vault_url`

Type
string

Default
`http://127.0.0.1:8200`

Use this endpoint to connect to Vault, for example: http://127.0.0.1:8200

`ssl_ca_crt_file`

Type
string

Default
<None>

Absolute path to ca cert file

`use_ssl`

Type
boolean

Default
`False`

SSL Enabled/Disabled

`namespace`

Type
string

Default
<None>

Vault Namespace to use for all requests to Vault. Vault Namespaces feature is available only in Vault Enterprise

`timeout`

Type
floating point

Default
`60`

Timeout (in seconds) in each request to Vault

vendordata_dynamic_auth

Options within this group control the authentication of the vendordata subsystem of the metadata API server (and config drive) with external systems.

`cafile`

Type
string

Default
<None>

PEM encoded Certificate Authority to use when verifying HTTPs connections.

`certfile`

Type
string

Default
<None>

PEM encoded client certificate cert file

`keyfile`

Type
string

Default
<None>

PEM encoded client certificate key file

`insecure`

Type
boolean

Default
`False`

Verify HTTPS connections.

`timeout`

Type
integer

Default
<None>

Timeout value for http requests

`collect_timing`

Type
boolean

Default
`False`

Collect per-API call timing information.

`split_loggers`

Type
boolean

Default
`False`

Log requests to multiple loggers.

`auth_type`

Type
unknown type

Default
<None>

Authentication type to load

Table 78: Deprecated Variations

Group	Name
vendordata_dynamic_auth	auth_plugin

`auth_section`

Type
unknown type

Default
<None>

Config Section from which to load plugin specific options

`auth_url`

Type
unknown type

Default
<None>

Authentication URL

`system_scope`

Type
unknown type

Default
<None>

Scope for system operations

`domain_id`

Type
unknown type

Default
<None>

Domain ID to scope to

`domain_name`

Type
unknown type

Default
<None>

Domain name to scope to

`project_id`

Type
unknown type

Default
<None>

Project ID to scope to

`project_name`

Type
unknown type

Default
<None>

Project name to scope to

`project_domain_id`

Type
unknown type

Default
<None>

Domain ID containing project

`project_domain_name`

Type
unknown type

Default
<None>

Domain name containing project

`trust_id`

Type
unknown type

Default
<None>

ID of the trust to use as a trustee use

`default_domain_id`

Type
unknown type

Default
<None>

Optional domain ID to use with v3 and v2 parameters. It will be used for both the user and project domain in v3 and ignored in v2 authentication.

`default_domain_name`

Type
unknown type

Default
<None>

Optional domain name to use with v3 API and v2 parameters. It will be used for both the user and project domain in v3 and ignored in v2 authentication.

`user_id`

Type
unknown type

Default
<None>

Users user ID

`username`

Type
unknown type

Default
<None>

Users username

Table 79: Deprecated Variations

Group	Name
vendordata_dynamic_auth	user-name
vendordata_dynamic_auth	user_name

`user_domain_id`

Type
unknown type

Default
<None>

Users domain ID

`user_domain_name`

Type
unknown type

Default
<None>

Users domain name

`password`

Type
unknown type

Default
<None>

Users password

`tenant_id`

Type
unknown type

Default
<None>

Tenant ID

`tenant_name`

Type
unknown type

Default
<None>

Tenant Name

vmware

Related options: Following options must be set in order to launch VMware-based virtual machines.

- compute_driver: Must use vmwareapi.VMwareVCDriver.
- vmware.host_username
- vmware.host_password
- vmware.cluster_name

`integration_bridge`

Type
string

Default
<None>

This option should be configured only when using the NSX-MH Neutron plugin. This is the name of the integration bridge on the ESXi server or host. This should not be set for any other Neutron plugin. Hence the default value is not set.

Possible values:

- Any valid string representing the name of the integration bridge

`console_delay_seconds`

Type
integer

Default
<None>

Minimum Value
0

Set this value if affected by an increased network latency causing repeated characters when typing in a remote console.

`serial_port_service_uri`

Type
string

Default
<None>

Identifies the remote system where the serial port traffic will be sent.

This option adds a virtual serial port which sends console output to a configurable service URI. At the service URI address there will be virtual serial port concentrator that will collect console logs. If this is not set, no serial ports will be added to the created VMs.

Possible values:

- Any valid URI

`serial_port_proxy_uri`

Type
URI

Default
<None>

Identifies a proxy service that provides network access to the serial_port_service_uri.

Possible values:

- Any valid URI (The scheme is telnet or telnets.)

Related options:

This option is ignored if serial_port_service_uri is not specified.

- serial_port_service_uri

`serial_log_dir`

Type
string

Default
`/opt/vmware/vspc`

Specifies the directory where the Virtual Serial Port Concentrator is storing console log files. It should match the serial_log_dir config value of VSPC.

`host_ip`

Type
host address

Default
<None>

Hostname or IP address for connection to VMware vCenter host.

`host_port`

Type
port number

Default
`443`

Minimum Value
0

Maximum Value
65535

Port for connection to VMware vCenter host.

`host_username`

Type
string

Default
<None>

Username for connection to VMware vCenter host.

`host_password`

Type
string

Default
<None>

Password for connection to VMware vCenter host.

`ca_file`

Type
string

Default
<None>

Specifies the CA bundle file to be used in verifying the vCenter server certificate.

`insecure`

Type
boolean

Default
`False`

If true, the vCenter server certificate is not verified. If false, then the default CA truststore is used for verification.

Related options:

- ca_file: This option is ignored if ca_file is set.

`cluster_name`

Type
string

Default
<None>

Name of a VMware Cluster ComputeResource.

`datastore_regex`

Type
string

Default
<None>

Regular expression pattern to match the name of datastore.

The datastore_regex setting specifies the datastores to use with Compute. For example, datastore_regex=nas.* selects all the data stores that have a name starting with nas.

NOTE: If no regex is given, it just picks the datastore with the most freespace.

Possible values:

- Any matching regular expression to a datastore must be given

`task_poll_interval`

Type
floating point

Default
`0.5`

Time interval in seconds to poll remote tasks invoked on VMware VC server.

`api_retry_count`

Type
integer

Default
10

Minimum Value
0

Number of times VMware vCenter server API must be retried on connection failures, e.g. socket error, etc.

`vnc_port`

Type
port number

Default
5900

Minimum Value
0

Maximum Value
65535

This option specifies VNC starting port.

Every VM created by ESX host has an option of enabling VNC client for remote connection. Above option vnc_port helps you to set default starting port for the VNC client.

Possible values:

- Any valid port number within 5900 -(5900 + vnc_port_total)

Related options:

Below options should be set to enable VNC client.

- vnc.enabled = True
- vnc_port_total

`vnc_port_total`

Type
integer

Default
10000

Minimum Value
0

Total number of VNC ports.

`vnc_keymap`

Type
string

Default
en-us

Keymap for VNC.

The keyboard mapping (keymap) determines which keyboard layout a VNC session should use by default.

Possible values:

- A keyboard layout which is supported by the underlying hypervisor on this node. This is usually an IETF language tag (for example en-us).

`use_linked_clone`

Type
boolean

Default
`True`

This option enables/disables the use of linked clone.

The ESX hypervisor requires a copy of the VMDK file in order to boot up a virtual machine. The compute driver must download the VMDK via HTTP from the OpenStack Image service to a datastore that is visible to the hypervisor and cache it. Subsequent virtual machines that need the VMDK use the cached version and dont have to copy the file again from the OpenStack Image service.

If set to false, even with a cached VMDK, there is still a copy operation from the cache location to the hypervisor file directory in the shared datastore. If set to true, the above copy operation is avoided as it creates copy of the virtual machine that shares virtual disks with its parent VM.

`connection_pool_size`

Type
integer

Default
`10`

Minimum Value
10

This option sets the http connection pool size

The connection pool size is the maximum number of connections from nova to vSphere. It should only be increased if there are warnings indicating that the connection pool is full, otherwise, the default should suffice.

`pbm_enabled`

Type
boolean

Default
`False`

This option enables or disables storage policy based placement of instances.

Related options:

- pbm_default_policy

`pbm_wsdl_location`

Type
string

Default
<None>

This option specifies the PBM service WSDL file location URL.

Setting this will disable storage policy based placement of instances.

Possible values:

- Any valid file path e.g file:///opt/SDK/spbm/wsdl/pbmService.wsdl

`pbm_default_policy`

Type
string

Default
<None>

This option specifies the default policy to be used.

If pbm_enabled is set and there is no defined storage policy for the specific request, then this policy will be used.

Possible values:

- Any valid storage policy such as VSAN default storage policy

Related options:

- pbm_enabled

`maximum_objects`

Type
integer

Default
100

Minimum Value
0

This option specifies the limit on the maximum number of objects to return in a single result.

A positive value will cause the operation to suspend the retrieval when the count of objects reaches the specified limit. The server may still limit the count to something less than the configured value. Any remaining objects may be retrieved with additional requests.

`cache_prefix`

Type
string

Default
<None>

This option adds a prefix to the folder where cached images are stored

This is not the full path - just a folder prefix. This should only be used when a datastore cache is shared between compute nodes.

Note: This should only be used when the compute nodes are running on same host or they have a shared file system.

Possible values:

- Any string representing the cache prefix to the folder

vnc

Virtual Network Computer (VNC) can be used to provide remote desktop console access to instances for tenants and/or administrators.

enabled

Type
boolean

Default
`True`

Enable VNC related features.

Guests will get created with graphical devices to support this. Clients (for example Horizon) can then establish a VNC connection to the guest.

Table 80: Deprecated Variations

Group	Name
DEFAULT	vnc_enabled

server_listen

Type
host address

Default
`127.0.0.1`

The IP address or hostname on which an instance should listen to for incoming VNC connection requests on this node.

server_proxyclient_address

Type
host address

Default
`127.0.0.1`

Private, internal IP address or hostname of VNC console proxy.

The VNC proxy is an OpenStack component that enables compute service users to access their instances through VNC clients.

This option sets the private address to which proxy clients, such as `nova-novncproxy`, should connect to.

`novncproxy_base_url`

Type
URI

Default
`http://127.0.0.1:6080/vnc_auto.html`

Public address of noVNC VNC console proxy.

The VNC proxy is an OpenStack component that enables compute service users to access their instances through VNC clients. noVNC provides VNC support through a websocket-based client.

This option sets the public base URL to which client systems will connect. noVNC clients can use this address to connect to the noVNC instance and, by extension, the VNC sessions.

If using noVNC >= 1.0.0, you should use `vnc_lite.html` instead of `vnc_auto.html`.

You can also supply extra request arguments which will be passed to the backend. This might be useful to move console URL to subpath, for example: `http://127.0.0.1/novnc/vnc_auto.html?path=novnc`

Related options:

- novncproxy_host
- novncproxy_port

Table 81: Deprecated Variations

Group	Name
DEFAULT	novncproxy_base_url

`novncproxy_host`

Type
string

Default
`0.0.0.0`

IP address that the noVNC console proxy should bind to.

The VNC proxy is an OpenStack component that enables compute service users to access their instances through VNC clients. noVNC provides VNC support through a websocket-based client.

This option sets the private address to which the noVNC console proxy service should bind to.

Related options:

- novncproxy_port
- novncproxy_base_url

Table 82: Deprecated Variations

Group	Name
DEFAULT	novncproxy_host

novncproxy_port

Type
port number

Default
6080

Minimum Value
0

Maximum Value
65535

Port that the noVNC console proxy should bind to.

The VNC proxy is an OpenStack component that enables compute service users to access their instances through VNC clients. noVNC provides VNC support through a websocket-based client.

This option sets the private port to which the noVNC console proxy service should bind to.

Related options:

- novncproxy_host
- novncproxy_base_url

Table 83: Deprecated Variations

Group	Name
DEFAULT	novncproxy_port

auth_schemes

Type
list

Default
['none']

The authentication schemes to use with the compute node.

Control what RFB authentication schemes are permitted for connections between the proxy and the compute host. If multiple schemes are enabled, the first matching scheme will be used, thus the strongest schemes should be listed first.

Related options:

- [vnc]vencrypt_client_key, [vnc]vencrypt_client_cert: must also be set

vencrypt_client_key

Type
string

Default
<None>

The path to the client certificate PEM file (for x509)

The fully qualified path to a PEM file containing the private key which the VNC proxy server presents to the compute node during VNC authentication.

Related options:

- `vnc.auth_schemes`: must include `vencrypt`
- `vnc.vencrypt_client_cert`: must also be set

`vencrypt_client_cert`

Type
string

Default
<None>

The path to the client key file (for x509)

The fully qualified path to a PEM file containing the x509 certificate which the VNC proxy server presents to the compute node during VNC authentication.

Related options:

- `vnc.auth_schemes`: must include `vencrypt`
- `vnc.vencrypt_client_key`: must also be set

`vencrypt_ca_certs`

Type
string

Default
<None>

The path to the CA certificate PEM file

The fully qualified path to a PEM file containing one or more x509 certificates for the certificate authorities used by the compute node VNC server.

Related options:

- `vnc.auth_schemes`: must include `vencrypt`

workarounds

A collection of workarounds used to mitigate bugs or issues found in system tools (e.g. Libvirt or QEMU) or Nova itself under certain conditions. These should only be enabled in exceptional circumstances. All options are linked against bug IDs, where more information on the issue can be found.

`disable_rootwrap`

Type
boolean

Default
`False`

Use sudo instead of rootwrap.

Allow fallback to sudo for performance reasons.

For more information, refer to the bug report:

https://bugs.launchpad.net/nova/+bug/1415106

Possible values:

- True: Use sudo instead of rootwrap
- False: Use rootwrap as usual

Interdependencies to other options:

- Any options that affect rootwrap will be ignored.

`disable_libvirt_livesnapshot`

Type
boolean

Default
`False`

Disable live snapshots when using the libvirt driver.

Live snapshots allow the snapshot of the disk to happen without an interruption to the guest, using coordination with a guest agent to quiesce the filesystem.

When using libvirt 1.2.2 live snapshots fail intermittently under load (likely related to concurrent libvirt/qemu operations). This config option provides a mechanism to disable live snapshot, in favor of cold snapshot, while this is resolved. Cold snapshot causes an instance outage while the guest is going through the snapshotting process.

For more information, refer to the bug report:

https://bugs.launchpad.net/nova/+bug/1334398

Possible values:

- True: Live snapshot is disabled when using libvirt
- False: Live snapshots are always used when snapshotting (as long as there is a new enough libvirt and the backend storage supports it)

Warning

This option is deprecated for removal since 19.0.0. Its value may be silently ignored in the future.

Reason
This option was added to work around issues with libvirt 1.2.2. We no longer support this version of libvirt, which means this workaround is no longer necessary. It will be removed in a future release.

`handle_virt_lifecycle_events`

Type
boolean

Default
`True`

Enable handling of events emitted from compute drivers.

Many compute drivers emit lifecycle events, which are events that occur when, for example, an instance is starting or stopping. If the instance is going through task state changes due to an API operation, like resize, the events are ignored.

This is an advanced feature which allows the hypervisor to signal to the compute service that an unexpected state change has occurred in an instance and that the instance can be shutdown automatically. Unfortunately, this can race in some conditions, for example in reboot operations or when the compute service or when host is rebooted (planned or due to an outage). If such races are common, then it is advisable to disable this feature.

Care should be taken when this feature is disabled and sync_power_state_interval is set to a negative value. In this case, any instances that get out of sync between the hypervisor and the Nova database will have to be synchronized manually.

For more information, refer to the bug report: https://bugs.launchpad.net/bugs/1444630

Interdependencies to other options:

- If `sync_power_state_interval` is negative and this feature is disabled, then instances that get out of sync between the hypervisor and the Nova database will have to be synchronized manually.

`disable_group_policy_check_upcall`

Type
boolean

Default
`False`

Disable the server group policy check upcall in compute.

In order to detect races with server group affinity policy, the compute service attempts to validate that the policy was not violated by the scheduler. It does this by making an upcall to the API database to list the instances in the server group for one that it is booting, which violates our api/cell isolation goals. Eventually this will be solved by proper affinity guarantees in the scheduler and placement service, but until then, this late check is needed to ensure proper affinity policy.

Operators that desire api/cell isolation over this check should enable this flag, which will avoid making that upcall from compute.

Related options:

- [filter_scheduler]/track_instance_changes also relies on upcalls from the compute service to the scheduler service.

`enable_numa_live_migration`

Type
boolean

Default
`False`

Enable live migration of instances with NUMA topologies.

Live migration of instances with NUMA topologies when using the libvirt driver is only supported in deployments that have been fully upgraded to Train. In previous versions, or in mixed Stein/Train deployments with a rolling upgrade in progress, live migration of instances with NUMA topologies is disabled by default when using the libvirt driver. This includes live migration of instances with CPU pinning or hugepages. CPU pinning and huge page information for such instances is not currently re-calculated, as noted in bug #1289064. This means that if instances were already present on the destination host, the migrated instance could be placed on the same dedicated cores as these instances or use hugepages allocated for another instance. Alternately, if the host platforms were not homogeneous, the instance could be assigned to non-existent cores or be inadvertently split across host NUMA nodes.

Despite these known issues, there may be cases where live migration is necessary. By enabling this option, operators that are aware of the issues and are willing to manually work around them can enable live migration support for these instances.

Related options:

- `compute_driver`: Only the libvirt driver is affected.

Warning

This option is deprecated for removal since 20.0.0. Its value may be silently ignored in the future.

Reason
This option was added to mitigate known issues when live migrating instances with a NUMA topology with the libvirt driver. Those issues are resolved in Train. Clouds using the libvirt driver and fully upgraded to Train support NUMA-aware live migration. This option will be removed in a future release.

`ensure_libvirt_rbd_instance_dir_cleanup`

Type
boolean

Default
`False`

Ensure the instance directory is removed during clean up when using rbd.

When enabled this workaround will ensure that the instance directory is always removed during cleanup on hosts using `[libvirt]/images_type=rbd`. This avoids the following bugs with evacuation and revert resize clean up that lead to the instance directory remaining on the host:

https://bugs.launchpad.net/nova/+bug/1414895

https://bugs.launchpad.net/nova/+bug/1761062

Both of these bugs can then result in `DestinationDiskExists` errors being raised if the instances ever attempt to return to the host.

Warning

Operators will need to ensure that the instance directory itself, specified by `[DEFAULT]/instances_path`, is not shared between computes before enabling this workaround otherwise the console.log, kernels, ramdisks and any additional files being used by the running instance will be lost.

Related options:

- `compute_driver` (libvirt)
- `[libvirt]/images_type` (rbd)
- `instances_path`

`disable_fallback_pcpu_query`

Type
boolean

Default
`False`

Disable fallback request for VCPU allocations when using pinned instances.

Starting in Train, compute nodes using the libvirt virt driver can report `PCPU` inventory and will use this for pinned instances. The scheduler will automatically translate requests using the legacy CPU pinning-related flavor extra specs, `hw:cpu_policy` and `hw:cpu_thread_policy`, their image metadata property equivalents, and the emulator threads pinning flavor extra spec, `hw:emulator_threads_policy`, to new placement requests. However, compute nodes require additional configuration in order to report `PCPU` inventory and this configuration may not be present immediately after an upgrade. To ensure pinned instances can be created without this additional configuration, the scheduler will make a second request to placement for old-style `VCPU`-based allocations and fallback to these allocation candidates if necessary. This has a slight performance impact and is not necessary on new or upgraded deployments where the new configuration has been set on all hosts. By setting this option, the second lookup is disabled and the scheduler will only request `PCPU`-based allocations.

Warning

This option is deprecated for removal since 20.0.0. Its value may be silently ignored in the future.

`never_download_image_if_on_rbd`

Type
boolean

Default
`False`

When booting from an image on a ceph-backed compute node, if the image does not already reside on the ceph cluster (as would be the case if glance is also using the same cluster), nova will download the image from glance and upload it to ceph itself. If using multiple ceph clusters, this may cause nova to unintentionally duplicate the image in a non-COW-able way in the local ceph deployment, wasting space.

For more information, refer to the bug report:

https://bugs.launchpad.net/nova/+bug/1858877

Enabling this option will cause nova to *refuse* to boot an instance if it would require downloading the image from glance and uploading it to ceph itself.

Related options:

- `compute_driver` (libvirt)
- `[libvirt]/images_type` (rbd)

`reserve_disk_resource_for_image_cache`

Type
boolean

Default
`False`

If it is set to True then the libvirt driver will reserve DISK_GB resource for the images stored in the image cache. If the *DEFAULT.instances_path* is on different disk partition than the image cache directory then the driver will not reserve resource for the cache.

Such disk reservation is done by a periodic task in the resource tracker that runs every *update_resources_interval* seconds. So the reservation is not updated immediately when an image is cached.

Related options:

- *DEFAULT.instances_path*
- *image_cache.subdirectory_name*
- *update_resources_interval*

`libvirt_disable_apic`

Type
boolean

Default
`False`

With some kernels initializing the guest apic can result in a kernel hang that renders the guest unusable. This happens as a result of a kernel bug. In most cases the correct fix it to update the guest image kernel to one that is patched however in some cases this is not possible. This workaround allows the emulation of an apic to be disabled per host however it is not recommended to use outside of a CI or developer cloud.

`wait_for_vif_plugged_event_during_hard_reboot`

Type
list

Default
`[]`

The libvirt virt driver implements power on and hard reboot by tearing down every vif of the instance being rebooted then plug them again. By default nova does not wait for network-vif-plugged event from neutron before it lets the instance run. This can cause the instance to requests the IP via DHCP before the neutron backend has a chance to set up the networking backend after the vif plug.

This flag defines which vifs nova expects network-vif-plugged events from during hard reboot. The possible values are neutron port vnic types:

- normal
- direct
- macvtap
- baremetal
- direct-physical
- virtio-forwarder
- smart-nic
- vdpa
- accelerator-direct
- accelerator-direct-physical
- remote-managed

Adding a `vnic_type` to this configuration makes Nova wait for a network-vif-plugged event for each of the instances vifs having the specific `vnic_type` before unpausing the instance, similarly to how new instance creation works.

Please note that not all neutron networking backends send plug time events, for certain `vnic_type` therefore this config is empty by default.

The ml2/ovs and the networking-odl backends are known to send plug time events for ports with `normal` `vnic_type` so it is safe to add `normal` to this config if you are using only those backends in the compute host.

The neutron in-tree SRIOV backend does not reliably send network-vif-plugged event during plug time for ports with `direct` vnic_type and never sends that event for port with `direct-physical` vnic_type during plug time. For other `vnic_type` and backend pairs, please consult the developers of the backend.

Related options:

- *DEFAULT.vif_plugging_timeout*

`enable_qemu_monitor_announce_self`

Type
boolean

Default
`False`

If it is set to True the libvirt driver will try as a best effort to send the announce-self command to the QEMU monitor so that it generates RARP frames to update network switches in the post live migration phase on the destination.

Please note that this causes the domain to be considered tainted by libvirt.

Related options:

- *DEFAULT.compute_driver* (libvirt)

qemu_monitor_announce_self_count

Type
integer

Default
3

Minimum Value
1

The total number of times to send the announce_self command to the QEMU monitor when enable_qemu_monitor_announce_self is enabled.

Related options:

- *WORKAROUNDS.enable_qemu_monitor_announce_self* (libvirt)

qemu_monitor_announce_self_interval

Type
integer

Default
1

Minimum Value
1

The number of seconds to wait before re-sending the announce_self command to the QEMU monitor.

Related options:

- *WORKAROUNDS.enable_qemu_monitor_announce_self* (libvirt)

disable_compute_service_check_for_ffu

Type
boolean

Default
`False`

If this is set, the normal safety check for old compute services will be treated as a warning instead of an error. This is only to be enabled to facilitate a Fast-Forward upgrade where new control

services are being started before compute nodes have been able to update their service record. In an FFU, the service records in the database will be more than one version old until the compute nodes start up, but control services need to be online first.

`unified_limits_count_pcpu_as_vcpu`

Type
boolean

Default
`False`

When using unified limits, use VCPU + PCPU for VCPU quota usage.

If the deployment is configured to use unified limits via `[quota]driver=nova.quota.UnifiedLimitsDriver`, by default VCPU resources are counted independently from PCPU resources, consistent with how they are represented in the placement service.

Legacy quota behavior counts PCPU as VCPU and returns the sum of VCPU + PCPU usage as the usage count for VCPU. Operators relying on the aggregation of VCPU and PCPU resource usage counts should set this option to True.

Related options:

- *quota.driver*

`skip_cpu_compare_on_dest`

Type
boolean

Default
`False`

With the libvirt driver, during live migration, skip comparing guest CPU with the destination host. When using QEMU >= 2.9 and libvirt >= 4.4.0, libvirt will do the correct thing with respect to checking CPU compatibility on the destination host during live migration.

`skip_cpu_compare_at_startup`

Type
boolean

Default
`False`

This will skip the CPU comparison call at the startup of Compute service and lets libvirt handle it.

`skip_hypervisor_version_check_on_lm`

Type
boolean

Default
`False`

When this is enabled, it will skip version-checking of hypervisors during live migration.

`skip_reserve_in_use_ironic_nodes`

Type
boolean

Default
`False`

This may be useful if you use the Ironic driver, but dont have automatic cleaning enabled in Ironic. Nova, by default, will mark Ironic nodes as reserved as soon as they are in use. When you free the Ironic node (by deleting the nova instance) it takes a while for Nova to un-reserve that Ironic node in placement. Usually this is a good idea, because it avoids placement providing an Ironic as a valid candidate when it is still being cleaned. However, if you dont use automatic cleaning, it can cause an extra delay before and Ironic node is available for building a new Nova instance.

`disable_deep_image_inspection`

Type
boolean

Default
`False`

This disables the additional deep image inspection that the compute node does when downloading from glance. This includes backing-file, data-file, and known-features detection *before* passing the image to qemu-img. Generally, this inspection should be enabled for maximum safety, but this workaround option allows disabling it if there is a compatibility concern.

wsgi

Options under this group are used to configure WSGI (Web Server Gateway Interface). WSGI is used to serve API requests.

`api_paste_config`

Type
string

Default
`api-paste.ini`

This option represents a file name for the paste.deploy config for nova-api.

Possible values:

- A string representing file name for the paste.deploy config.

Table 84: Deprecated Variations

Group	Name
DEFAULT	api_paste_config

`secure_proxy_ssl_header`

Type
string

Default
<None>

This option specifies the HTTP header used to determine the protocol scheme for the original request, even if it was removed by a SSL terminating proxy.

Possible values:

- None (default) - the request scheme is not influenced by any HTTP headers
- Valid HTTP header, like `HTTP_X_FORWARDED_PROTO`

WARNING: Do not set this unless you know what you are doing.

Make sure ALL of the following are true before setting this (assuming the values from the example above):

- Your API is behind a proxy.
- Your proxy strips the X-Forwarded-Proto header from all incoming requests. In other words, if end users include that header in their requests, the proxy will discard it.
- Your proxy sets the X-Forwarded-Proto header and sends it to API, but only for requests that originally come in via HTTPS.

If any of those are not true, you should keep this setting set to None.

Table 85: Deprecated Variations

Group	Name
DEFAULT	secure_proxy_ssl_header

Warning

This option is deprecated for removal since 31.0.0. Its value may be silently ignored in the future.

Reason
The functionality of this parameter is duplicate of the http_proxy_to_wsgi middleware of oslo.middleware and will be completely replaced.

zvm

zvm options allows cloud administrator to configure related z/VM hypervisor driver to be used within an OpenStack deployment.

zVM options are used when the compute_driver is set to use zVM (compute_driver=zvm.ZVMDriver)

`cloud_connector_url`

Type
URI

Default
`http://zvm.example.org:8080/`

This option has a sample default set, which means that its actual default value may vary from the one documented above.

URL to be used to communicate with z/VM Cloud Connector.

`ca_file`

Type
string

Default
<None>

CA certificate file to be verified in httpd server with TLS enabled

A string, it must be a path to a CA bundle to use.

`image_tmp_path`

Type
string

Default
`$state_path/images`

This option has a sample default set, which means that its actual default value may vary from the one documented above.

The path at which images will be stored (snapshot, deploy, etc).

Images used for deploy and images captured via snapshot need to be stored on the local disk of the compute host. This configuration identifies the directory location.

Possible values:
A file system path on the host running the compute service.

`reachable_timeout`

Type
integer

Default
`300`

Timeout (seconds) to wait for an instance to start.

The z/VM driver relies on communication between the instance and cloud connector. After an instance is created, it must have enough time to wait for all the network info to be written into the user directory. The driver will keep rechecking network status to the instance with the timeout value, If setting network failed, it will notify the user that starting the instance failed and put the instance in ERROR state. The underlying z/VM guest will then be deleted.

Possible Values:
Any positive integer. Recommended to be at least 300 seconds (5 minutes), but it will vary depending on instance and system load. A value of 0 is used for debug. In this case the underlying z/VM guest will not be deleted when the instance is marked in ERROR state.

3.5.2.2 Policy

Nova, like most OpenStack projects, uses a policy language to restrict permissions on REST API actions. This functionality is provided by the oslo.policy project. *oslo.policy* supports loading policy configuration from both an individual configuration file, which defaults to `policy.yaml`, and one or more directories of configuration files, which defaults to `policy.d`. These must be located in the same directory as the `nova.conf` file(s). This behavior can be overridden by setting the *oslo_policy.policy_file* and *oslo_policy.policy_dirs* configuration options.

More information on how novas policy configuration works and about what policies are available can be found below.

- *Policy Concepts*: Starting in the Ussuri release, Nova API policy defines new default roles with system scope capabilities. These new changes improve the security level and manageability of Nova API as they are richer in terms of handling access at system and project level token with Read and Write roles.
- *Policy Reference*: A complete reference of all policy points in nova and what they impact.

Understanding Nova Policies

Warning

JSON formatted policy file is deprecated since Nova 22.0.0(Victoria). Use YAML formatted file. Use oslopolicy-convert-json-to-yaml tool to convert the existing JSON to YAML formatted policy file in backward compatible way.

Nova supports a rich policy system that has evolved significantly over its lifetime. Initially, this took the form of a large, mostly hand-written `policy.yaml` file but, starting in the Newton (14.0.0) release, policy defaults have been defined in the codebase, requiring the `policy.yaml` file only to override these defaults.

In the Ussuri (21.0.0) release, further work was undertaken to address some issues that had been identified:

1. No global vs project admin. The `admin_only` role is used for the global admin that is able to make almost any change to Nova, and see all details of the Nova system. The rule passes for any user with an admin role, it doesnt matter which project is used.
2. No read-only roles. Since several APIs tend to share a single policy rule for read and write actions, they did not provide the granularity necessary for read-only access roles.
3. The `admin_or_owner` role did not work as expected. For most APIs with `admin_or_owner`, the project authentication happened in a separate component than API in Nova that did not honor changes to policy. As a result, policy could not override hard-coded in-project checks.

Keystone comes with `admin`, `manager`, `member` and `reader` roles by default. Please refer to this document for more information about these new defaults. In addition, keystone supports a new system scope concept that makes it easier to protect deployment level resources from project or system level resources. Please refer to this document and system scope specification to understand the scope concept.

In the Nova 25.0.0 (Yoga) release, Nova policies implemented the scope concept and default roles provided by keystone (admin, member, and reader). Using common roles from keystone reduces the likelihood of similar, but different, roles implemented across projects or deployments (e.g., a role called `observer` versus `reader` versus `auditor`). With the help of the new defaults it is easier to understand who can do what across projects, reduces divergence, and increases interoperability.

The below sections explain how these new defaults in the Nova can solve the first two issues mentioned above and extend more functionality to end users in a safe and secure way.

More information is provided in the nova specification.

Scope

OpenStack Keystone supports different scopes in tokens. These are described here. Token scopes represent the layer of authorization. Policy `scope_types` represent the layer of authorization required to access an API.

Note

The `scope_type` of each policy is hardcoded to `project` scoped and is not overridable via the policy file.

Nova policies have implemented the scope concept by defining the `scope_type` for all the policies to `project` scoped. It means if user tries to access nova APIs with `system` scoped token they will get 403 permission denied error.

For example, consider the `POST /os-server-groups` API.

```
# Create a new server group
# POST  /os-server-groups
# Intended scope(s): project
#"os_compute_api:os-server-groups:create": "rule:project_member_api"
```

Policy scope is disabled by default to allow operators to migrate from the old policy enforcement system in a graceful way. This can be enabled by configuring the *oslo_policy.enforce_scope* option to `True`.

Note

[oslo_policy] enforce_scope=True

Roles

You can refer to this document to know about all available defaults from Keystone.

Along with the `scope_type` feature, Nova policy defines new defaults for each policy.

reader

This provides read-only access to the resources. Nova policies are defaulted to below rules:

```
policy.RuleDefault(
    name="project_reader",
    check_str="role:reader and project_id:%(project_id)s",
    description="Default rule for Project level read only APIs."
)
```

Using it in policy rule (with admin + reader access): (because we want to keep legacy admin behavior the same we need to give access of reader APIs to admin role too.)

```
policy.DocumentedRuleDefault(
    name='os_compute_api:servers:show',
```

(continues on next page)

(continued from previous page)

```
    check_str='role:admin or (' + 'role:reader and project_id:%(project_id)s)
↪',
    description="Show a server",
    operations=[
        {
            'method': 'GET',
            'path': '/servers/{server_id}'
        }
    ],
    scope_types=['project'],
)
```

OR

```
policy.RuleDefault(
    name="admin_api",
    check_str="role:admin",
    description="Default rule for administrative APIs."
)

policy.DocumentedRuleDefault(
    name='os_compute_api:servers:show',
    check_str='rule: admin or rule:project_reader',
    description='Show a server',
    operations=[
        {
            'method': 'GET',
            'path': '/servers/{server_id}'
        }
    ],
    scope_types=['project'],
)
```

member

project-member is denoted by someone with the member role on a project. It is intended to be used by end users who consume resources within a project which requires higher permission than reader role but less than admin role. It inherits all the permissions of a project-reader.

project-member persona in the policy check string:

```
policy.RuleDefault(
    name="project_member",
    check_str="role:member and project_id:%(project_id)s",
    description="Default rule for Project level non admin APIs."
)
```

Using it in policy rule (with admin + member access): (because we want to keep legacy admin behavior, admin role gets access to the project level member APIs.)

```
policy.DocumentedRuleDefault(
    name='os_compute_api:servers:create',
    check_str='role:admin or (' + 'role:member and project_id:%(project_id)s)
↪',
    description='Create a server',
    operations=[
        {
            'method': 'POST',
            'path': '/servers'
        }
    ],
    scope_types=['project'],
)
```

OR

```
policy.RuleDefault(
    name="admin_api",
    check_str="role:admin",
    description="Default rule for administrative APIs."
)

policy.DocumentedRuleDefault(
    name='os_compute_api:servers:create',
    check_str='rule_admin or rule:project_member',
    description='Create a server',
    operations=[
        {
            'method': 'POST',
            'path': '/servers'
        }
    ],
    scope_types=['project'],
)
```

project_id:%(project_id)s in the check_str is important to restrict the access within the requested project.

manager

`project_manager` is denoted by someone with the manager role on a project. It is intended to be used in project-level management APIs and perform more privileged operations on its project resources than `project_member`. It inherits all the permissions of a `project_member` and `project_reader`. For example, a `project_manager` can migrate (cold or live) their servers without specifying the host. Further, a `project_manager` will be able to list migrations related to their own project.

`project_manager` persona in Nova policy rule (it is defined as `project_manager_api` in policy yaml) looks like:

project_id:%(project_id)s in the check_str is important to restrict the access within the requested project.

```
# Default rule for Project level management APIs.
"project_manager_api": "role:manager and project_id:%(project_id)s"
```

To keep the legacy `admin` behavior unchanged, Nova allow `admin` also to access the project level management APIs:

```
# Default rule for Project level management APIs.
"project_manager_or_admin": "rule:project_manager_api or rule:context_is_admin
↪"
```

The above base rule are used for specific API access:

```
# Cold migrate a server without specifying a host
# POST  /servers/{server_id}/action (migrate)
# Intended scope(s): project
"os_compute_api:os-migrate-server:migrate": "rule:project_manager_or_admin"
```

admin

This role is to perform the admin level write operations. Nova policies are defaulted to below rules:

```
policy.DocumentedRuleDefault(
    name='os_compute_api:os-hypervisors:list',
    check_str='role:admin',
    scope_types=['project']
)
```

With these new defaults, you can solve the problem of:

1. Providing the read-only access to the user. Polices are made more granular and defaulted to reader rules. For example: If you need to let someone audit your deployment for security purposes.
2. Customize the policy in better way. For example, you will be able to provide access to project level user to perform operations within their project only.

service

The `service` role is a special role in Keystone, which is used for the internal service-to-service communication. It is assigned to service users i.e. nova or neutron which model the OpenStack services. Nova defaults its service-to-service APIs to require the `service` role so that they cannot be used by any non-service users. Allowing access to service-to-service APIs to non-service users can be destructive to resources and leave the deployment in an invalid state. Its advisable to audit the `policy.yaml` files and keystone users to make sure those APIs are not allowed to any non-service users and the service role is not granted to human admin accounts.

Note

Make sure the configured nova service user in other services has the `service` role otherwise communication from the other services to Nova will fail. For example, user configured as `username` option in `neutron.conf` file under `[nova]` section has the `service` role.

Nova supported scope & Roles

Nova supports the below combination of scopes and roles where roles can be overridden in the policy.yaml file but scope is not override-able.

1. ADMIN: `admin` role on `project` scope. This is an administrator to perform the admin level operations. Example: enable/disable compute service, Live migrate server etc.
2. PROJECT_MANAGER: `manager` role on `project` scope. This is used to perform project management operations within project. For example: migrate a server.
3. PROJECT_MEMBER: `member` role on `project` scope. This is used to perform resource owner level operation within project. For example: Pause a server.
4. PROJECT_READER: `reader` role on `project` scope. This is used to perform read-only operation within project. For example: Get server.
5. PROJECT_MANAGER_OR_ADMIN: `admin` or `manager` role on `project` scope. Such policy rules are default to project management level APIs and along with `manager` role, legacy admin can continue to access those APIs.
6. PROJECT_MEMBER_OR_ADMIN: `admin` or `member` role on `project` scope. Such policy rules are default to most of the owner level APIs and align with `member` role legacy admin can continue to access those APIs.
7. PROJECT_READER_OR_ADMIN: `admin` or `reader` role on `project` scope. Such policy rules are default to most of the read only APIs so that legacy admin can continue to access those APIs.
8. SERVICE_ROLE (Internal): `service` role on service users with `project` scope. Such policy rules are default to the service-to-service APIs (The APIs only meant to be called by the OpenStack services).

Backward Compatibility

Backward compatibility with versions prior to 21.0.0 (Ussuri) is maintained by supporting the old defaults and disabling the `scope_type` feature by default. This means the old defaults and deployments that use them will keep working as-is. However, we encourage every deployment to switch to the new policy. The new defaults will be enabled by default in OpenStack 2023.1 (Nova 27.0.0) release and old defaults will be removed starting in the OpenStack 2023.2 (Nova 28.0.0) release.

To implement the new default reader roles, some policies needed to become granular. They have been renamed, with the old names still supported for backwards compatibility.

Migration Plan

To have a graceful migration, Nova provides two flags to switch to the new policy completely. You do not need to overwrite the policy file to adopt the new policy defaults.

Here is step wise guide for migration:

1. Create scoped token:

   You need to create the new token with scope knowledge via below CLI:

   - Create Project Scoped Token.

2. Create new default roles in keystone if not done:

If you do not have new defaults in Keystone then you can create and re-run the Keystone Bootstrap. Keystone added this support in 14.0.0 (Rocky) release.

3. Enable Scope Checks

   The *oslo_policy.enforce_scope* flag is to enable the `scope_type` features. The scope of the token used in the request is always compared to the `scope_type` of the policy. If the scopes do not match, one of two things can happen. If *oslo_policy.enforce_scope* is True, the request will be rejected. If *oslo_policy.enforce_scope* is False, an warning will be logged, but the request will be accepted (assuming the rest of the policy passes). The default value of this flag is False.

4. Enable new defaults

   The *oslo_policy.enforce_new_defaults* flag switches the policy to new defaults-only. This flag controls whether or not to use old deprecated defaults when evaluating policies. If True, the old deprecated defaults are not evaluated. This means if any existing token is allowed for old defaults but is disallowed for new defaults, it will be rejected. The default value of this flag is False.

   Note

   Before you enable this flag, you need to educate users about the different roles they need to use to continue using Nova APIs.

5. Check for deprecated policies

   A few policies were made more granular to implement the reader roles. New policy names are available to use. If old policy names which are renamed are overwritten in policy file, then warning will be logged. Please migrate those policies to new policy names.

NOTE:

```
We recommend to enable the both scope as well new defaults together
otherwise you may experience some late failures with unclear error
messages. For example, if you enable new defaults and disable scope
check then it will allow system users to access the APIs but fail
later due to the project check which can be difficult to debug.
```

Below table show how legacy rules are mapped to new rules:

Legacy Rule	New Rule	Operation	Scope
RULE_ADMIN_API	ADMIN	Global resource Write & Read	project
RULE_ADMIN_API	PROJECT_MANAGER_OR_ADMIN	Project management level	project
RULE_ADMIN_OR_O\	PROJECT_MEMBER_OR_ADMIN	Project resource write	project
RULE_ADMIN_OR_O\	PROJECT_READER_OR_ADMIN	Project resource read	project

We expect all deployments to migrate to the new policy by OpenStack 2023.1 (Nova 27.0.0) release (`project_manager` role is available from Nova 32.0.0) so that we can remove the support of old policies.

Nova Policies

The following is an overview of all available policies in Nova.

Warning

JSON formatted policy file is deprecated since Nova 22.0.0(Victoria). Use YAML formatted file. Use oslopolicy-convert-json-to-yaml tool to convert the existing JSON to YAML formatted policy file in backward compatible way.

nova

`context_is_admin`

Default
`role:admin`

Decides what is required for the is_admin:True check to succeed.

`admin_or_owner`

Default
`is_admin:True or project_id:%(project_id)s`

Default rule for most non-Admin APIs.

`admin_api`

Default
`is_admin:True`

Default rule for most Admin APIs.

`project_manager_api`

Default
`role:manager and project_id:%(project_id)s`

Default rule for Project level management APIs.

`project_member_api`

Default
`role:member and project_id:%(project_id)s`

Default rule for Project level non admin APIs.

`project_reader_api`

Default
`role:reader and project_id:%(project_id)s`

Default rule for Project level read only APIs.

`service_api`

Default

```
role:service
```

Default rule for service-to-service APIs.

`project_manager_or_admin`

Default

```
rule:project_manager_api or rule:context_is_admin
```

Default rule for Project Manager or admin APIs.

`project_member_or_admin`

Default

```
rule:project_member_api or rule:context_is_admin
```

Default rule for Project Member or admin APIs.

`project_reader_or_admin`

Default

```
rule:project_reader_api or rule:context_is_admin
```

Default rule for Project reader or admin APIs.

`service_or_admin`

Default

```
rule:service_api or rule:context_is_admin
```

Default rule for service or admin APIs.

`os_compute_api:os-admin-actions:reset_state`

Default

```
rule:context_is_admin
```

Operations

- **POST** `/servers/{server_id}/action (os-resetState)`

Scope Types

- **project**

Reset the state of a given server

`os_compute_api:os-admin-actions:inject_network_info`

Default

```
rule:context_is_admin
```

Operations

- **POST** `/servers/{server_id}/action (injectNetworkInfo)`

Scope Types

- **project**

Inject network information into the server

`os_compute_api:os-admin-password`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (changePassword)`

Scope Types

- **project**

Change the administrative password for a server

`os_compute_api:os-aggregates:set_metadata`

Default
`rule:context_is_admin`

Operations

- **POST** `/os-aggregates/{aggregate_id}/action (set_metadata)`

Scope Types

- **project**

Create or replace metadata for an aggregate

`os_compute_api:os-aggregates:add_host`

Default
`rule:context_is_admin`

Operations

- **POST** `/os-aggregates/{aggregate_id}/action (add_host)`

Scope Types

- **project**

Add a host to an aggregate

`os_compute_api:os-aggregates:create`

Default
`rule:context_is_admin`

Operations

- **POST** `/os-aggregates`

Scope Types

- **project**

Create an aggregate

`os_compute_api:os-aggregates:remove_host`

Default
`rule:context_is_admin`

Operations

- **POST** `/os-aggregates/{aggregate_id}/action (remove_host)`

Scope Types

- **project**

Remove a host from an aggregate

`os_compute_api:os-aggregates:update`

Default
`rule:context_is_admin`

Operations

- **PUT** `/os-aggregates/{aggregate_id}`

Scope Types

- **project**

Update name and/or availability zone for an aggregate

`os_compute_api:os-aggregates:index`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-aggregates`

Scope Types

- **project**

List all aggregates

`os_compute_api:os-aggregates:delete`

Default
`rule:context_is_admin`

Operations

- **DELETE** `/os-aggregates/{aggregate_id}`

Scope Types

- **project**

Delete an aggregate

`os_compute_api:os-aggregates:show`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-aggregates/{aggregate_id}`

Scope Types

- **project**

Show details for an aggregate

`compute:aggregates:images`

Default
`rule:context_is_admin`

Operations

- **POST** `/os-aggregates/{aggregate_id}/images`

Scope Types

- **project**

Request image caching for an aggregate

`os_compute_api:os-assisted-volume-snapshots:create`

Default
`rule:service_or_admin`

Operations

- **POST** `/os-assisted-volume-snapshots`

Scope Types

- **project**

Create an assisted volume snapshot

`os_compute_api:os-assisted-volume-snapshots:delete`

Default
`rule:service_or_admin`

Operations

- **DELETE** `/os-assisted-volume-snapshots/{snapshot_id}`

Scope Types

- **project**

Delete an assisted volume snapshot

`os_compute_api:os-attach-interfaces:list`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/{server_id}/os-interface`

Scope Types

- **project**

List port interfaces attached to a server

`os_compute_api:os-attach-interfaces:show`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/{server_id}/os-interface/{port_id}`

Scope Types

- **project**

Show details of a port interface attached to a server

`os_compute_api:os-attach-interfaces:create`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/os-interface`

Scope Types

- **project**

Attach an interface to a server

`os_compute_api:os-attach-interfaces:delete`

Default
`rule:project_member_or_admin`

Operations

- **DELETE** `/servers/{server_id}/os-interface/{port_id}`

Scope Types

- **project**

Detach an interface from a server

`os_compute_api:os-availability-zone:list`

Default
`@`

Operations

- **GET** `/os-availability-zone`

Scope Types

- **project**

List availability zone information without host information

`os_compute_api:os-availability-zone:detail`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-availability-zone/detail`

Scope Types

- **project**

List detailed availability zone information with host information

`os_compute_api:os-baremetal-nodes:list`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-baremetal-nodes`

Scope Types

- **project**

List and show details of bare metal nodes.

These APIs are proxy calls to the Ironic service and are deprecated.

`os_compute_api:os-baremetal-nodes:show`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-baremetal-nodes/{node_id}`

Scope Types

- **project**

Show action details for a server.

`os_compute_api:os-console-auth-tokens`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-console-auth-tokens/{console_token}`

Scope Types

- **project**

Show console connection information for a given console authentication token

`os_compute_api:os-console-output`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (os-getConsoleOutput)`

Scope Types

- **project**

Show console output for a server

`os_compute_api:os-create-backup`

Default
`rule:project_member_or_admin`

Operations

- **POST** /servers/{server_id}/action (createBackup)

Scope Types

- **project**

Create a back up of a server

`os_compute_api:os-deferred-delete:restore`

Default
rule:project_member_or_admin

Operations

- **POST** /servers/{server_id}/action (restore)

Scope Types

- **project**

Restore a soft deleted server

`os_compute_api:os-deferred-delete:force`

Default
rule:project_member_or_admin

Operations

- **POST** /servers/{server_id}/action (forceDelete)

Scope Types

- **project**

Force delete a server before deferred cleanup

`os_compute_api:os-evacuate`

Default
rule:context_is_admin

Operations

- **POST** /servers/{server_id}/action (evacuate)

Scope Types

- **project**

Evacuate a server from a failed host to a new host

`os_compute_api:os-extended-server-attributes`

Default
rule:context_is_admin

Operations

- **GET** /servers/{id}
- **GET** /servers/detail
- **PUT** /servers/{server_id}
- **POST** /servers/{server_id}/action (rebuild)

Scope Types

- **project**

Return extended attributes for server.

This rule will control the visibility for a set of servers attributes:

- `OS-EXT-SRV-ATTR:host`
- `OS-EXT-SRV-ATTR:instance_name`
- `OS-EXT-SRV-ATTR:reservation_id` (since microversion 2.3)
- `OS-EXT-SRV-ATTR:launch_index` (since microversion 2.3)
- `OS-EXT-SRV-ATTR:hostname` (since microversion 2.3)
- `OS-EXT-SRV-ATTR:kernel_id` (since microversion 2.3)
- `OS-EXT-SRV-ATTR:ramdisk_id` (since microversion 2.3)
- `OS-EXT-SRV-ATTR:root_device_name` (since microversion 2.3)
- `OS-EXT-SRV-ATTR:user_data` (since microversion 2.3)

Microvision 2.75 added the above attributes in the `PUT /servers/{server_id}` and `POST /servers/{server_id}/action (rebuild)` API responses which are also controlled by this policy rule, like the `GET /servers*` APIs.

Microversion 2.90 made the `OS-EXT-SRV-ATTR:hostname` attribute available to all users, so this policy has no effect on that field for microversions 2.90 and greater. Controlling the visibility of this attribute for all microversions is therefore deprecated and will be removed in a future release.

`os_compute_api:extensions`

Default

`@`

Operations

- **GET** `/extensions`
- **GET** `/extensions/{alias}`

Scope Types

- **project**

List available extensions and show information for an extension by alias

`os_compute_api:os-flavor-access:add_tenant_access`

Default

`rule:context_is_admin`

Operations

- **POST** `/flavors/{flavor_id}/action (addTenantAccess)`

Scope Types

- **project**

Add flavor access to a tenant

`os_compute_api:os-flavor-access:remove_tenant_access`

Default
`rule:context_is_admin`

Operations

- **POST** `/flavors/{flavor_id}/action (removeTenantAccess)`

Scope Types

- **project**

Remove flavor access from a tenant

`os_compute_api:os-flavor-access`

Default
`rule:context_is_admin`

Operations

- **GET** `/flavors/{flavor_id}/os-flavor-access`

Scope Types

- **project**

List flavor access information

Allows access to the full list of tenants that have access to a flavor via an os-flavor-access API.

`os_compute_api:os-flavor-extra-specs:show`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/flavors/{flavor_id}/os-extra_specs/{flavor_extra_spec_key}`

Scope Types

- **project**

Show an extra spec for a flavor

`os_compute_api:os-flavor-extra-specs:create`

Default
`rule:context_is_admin`

Operations

- **POST** `/flavors/{flavor_id}/os-extra_specs/`

Scope Types

- **project**

Create extra specs for a flavor

`os_compute_api:os-flavor-extra-specs:update`

Default
`rule:context_is_admin`

Operations

- **PUT** `/flavors/{flavor_id}/os-extra_specs/{flavor_extra_spec_key}`

Scope Types

- **project**

Update an extra spec for a flavor

`os_compute_api:os-flavor-extra-specs:delete`

Default
`rule:context_is_admin`

Operations

- **DELETE** `/flavors/{flavor_id}/os-extra_specs/{flavor_extra_spec_key}`

Scope Types

- **project**

Delete an extra spec for a flavor

`os_compute_api:os-flavor-extra-specs:index`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/flavors/{flavor_id}/os-extra_specs/`
- **POST** `/flavors`
- **GET** `/flavors/detail`
- **GET** `/flavors/{flavor_id}`
- **PUT** `/flavors/{flavor_id}`

Scope Types

- **project**

List extra specs for a flavor. Starting with microversion 2.61, extra specs may be returned in responses for the flavor resource.

`os_compute_api:os-flavor-manage:create`

Default
`rule:context_is_admin`

Operations

- **POST** `/flavors`

Scope Types

- **project**

Create a flavor

`os_compute_api:os-flavor-manage:update`

Default
`rule:context_is_admin`

Operations

- **PUT** `/flavors/{flavor_id}`

Scope Types

- **project**

Update a flavor

`os_compute_api:os-flavor-manage:delete`

Default
`rule:context_is_admin`

Operations

- **DELETE** `/flavors/{flavor_id}`

Scope Types

- **project**

Delete a flavor

`os_compute_api:os-floating-ip-pools`

Default
`@`

Operations

- **GET** `/os-floating-ip-pools`

Scope Types

- **project**

List floating IP pools. This API is deprecated.

`os_compute_api:os-floating-ips:add`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (addFloatingIp)`

Scope Types

- **project**

Associate floating IPs to server. This API is deprecated.

`os_compute_api:os-floating-ips:remove`

Default
`rule:project_member_or_admin`

Operations

- **POST** /servers/{server_id}/action (removeFloatingIp)

Scope Types

- **project**

Disassociate floating IPs to server. This API is deprecated.

`os_compute_api:os-floating-ips:list`

Default
rule:project_reader_or_admin

Operations

- **GET** /os-floating-ips

Scope Types

- **project**

List floating IPs. This API is deprecated.

`os_compute_api:os-floating-ips:create`

Default
rule:project_member_or_admin

Operations

- **POST** /os-floating-ips

Scope Types

- **project**

Create floating IPs. This API is deprecated.

`os_compute_api:os-floating-ips:show`

Default
rule:project_reader_or_admin

Operations

- **GET** /os-floating-ips/{floating_ip_id}

Scope Types

- **project**

Show floating IPs. This API is deprecated.

`os_compute_api:os-floating-ips:delete`

Default
rule:project_member_or_admin

Operations

- **DELETE** /os-floating-ips/{floating_ip_id}

Scope Types

- **project**

Delete floating IPs. This API is deprecated.

`os_compute_api:os-hosts:list`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-hosts`

Scope Types

- **project**

List physical hosts.

This API is deprecated in favor of os-hypervisors and os-services.

`os_compute_api:os-hosts:show`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-hosts/{host_name}`

Scope Types

- **project**

Show physical host.

This API is deprecated in favor of os-hypervisors and os-services.

`os_compute_api:os-hosts:update`

Default
`rule:context_is_admin`

Operations

- **PUT** `/os-hosts/{host_name}`

Scope Types

- **project**

Update physical host.

This API is deprecated in favor of os-hypervisors and os-services.

`os_compute_api:os-hosts:reboot`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-hosts/{host_name}/reboot`

Scope Types

- **project**

Reboot physical host.

This API is deprecated in favor of os-hypervisors and os-services.

`os_compute_api:os-hosts:shutdown`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-hosts/{host_name}/shutdown`

Scope Types

- **project**

Shutdown physical host.

This API is deprecated in favor of os-hypervisors and os-services.

`os_compute_api:os-hosts:start`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-hosts/{host_name}/startup`

Scope Types

- **project**

Start physical host.

This API is deprecated in favor of os-hypervisors and os-services.

`os_compute_api:os-hypervisors:list`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-hypervisors`

Scope Types

- **project**

List all hypervisors.

`os_compute_api:os-hypervisors:list-detail`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-hypervisors/details`

Scope Types

- **project**

List all hypervisors with details

`os_compute_api:os-hypervisors:statistics`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-hypervisors/statistics`

Scope Types

- **project**

Show summary statistics for all hypervisors over all compute nodes.

`os_compute_api:os-hypervisors:show`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-hypervisors/{hypervisor_id}`

Scope Types

- **project**

Show details for a hypervisor.

`os_compute_api:os-hypervisors:uptime`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-hypervisors/{hypervisor_id}/uptime`

Scope Types

- **project**

Show the uptime of a hypervisor.

`os_compute_api:os-hypervisors:search`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-hypervisors/{hypervisor_hostname_pattern}/search`

Scope Types

- **project**

Search hypervisor by hypervisor_hostname pattern.

`os_compute_api:os-hypervisors:servers`

Default
`rule:context_is_admin`

Operations

- **GET** /os-hypervisors/{hypervisor_hostname_pattern}/servers

Scope Types

- **project**

List all servers on hypervisors that can match the provided hypervisor_hostname pattern.

`os_compute_api:os-instance-actions:events:details`

Default
rule:context_is_admin

Operations

- **GET** /servers/{server_id}/os-instance-actions/{request_id}

Scope Types

- **project**

Add details key in action events for a server.

This check is performed only after the check os_compute_api:os-instance-actions:show passes. Beginning with Microversion 2.84, new field details is exposed via API which can have more details about event failure. That field is controlled by this policy which is system reader by default. Making the details field visible to the non-admin user helps to understand the nature of the problem (i.e. if the action can be retried), but in the other hand it might leak information about the deployment (e.g. the type of the hypervisor).

`os_compute_api:os-instance-actions:events`

Default
rule:context_is_admin

Operations

- **GET** /servers/{server_id}/os-instance-actions/{request_id}

Scope Types

- **project**

Add events details in action details for a server. This check is performed only after the check os_compute_api:os-instance-actions:show passes. Beginning with Microversion 2.51, events details are always included; traceback information is provided per event if policy enforcement passes. Beginning with Microversion 2.62, each event includes a hashed host identifier and, if policy enforcement passes, the name of the host.

`os_compute_api:os-instance-actions:list`

Default
rule:project_reader_or_admin

Operations

- **GET** /servers/{server_id}/os-instance-actions

Scope Types

- **project**

List actions for a server.

`os_compute_api:os-instance-actions:show`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/{server_id}/os-instance-actions/{request_id}`

Scope Types

- **project**

Show action details for a server.

`os_compute_api:os-instance-usage-audit-log:list`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-instance_usage_audit_log`

Scope Types

- **project**

List all usage audits.

`os_compute_api:os-instance-usage-audit-log:show`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-instance_usage_audit_log/{before_timestamp}`

Scope Types

- **project**

List all usage audits occurred before a specified time for all servers on all compute hosts where usage auditing is configured

`os_compute_api:ips:show`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/{server_id}/ips/{network_label}`

Scope Types

- **project**

Show IP addresses details for a network label of a server

`os_compute_api:ips:index`

Default
`rule:project_reader_or_admin`

Operations

- **GET** /servers/{server_id}/ips

Scope Types

- **project**

List IP addresses that are assigned to a server

`os_compute_api:os-keypairs:index`

Default

```
(rule:context_is_admin) or user_id:%(user_id)s
```

Operations

- **GET** /os-keypairs

Scope Types

- **project**

List all keypairs

`os_compute_api:os-keypairs:create`

Default

```
(rule:context_is_admin) or user_id:%(user_id)s
```

Operations

- **POST** /os-keypairs

Scope Types

- **project**

Create a keypair

`os_compute_api:os-keypairs:delete`

Default

```
(rule:context_is_admin) or user_id:%(user_id)s
```

Operations

- **DELETE** /os-keypairs/{keypair_name}

Scope Types

- **project**

Delete a keypair

`os_compute_api:os-keypairs:show`

Default

```
(rule:context_is_admin) or user_id:%(user_id)s
```

Operations

- **GET** /os-keypairs/{keypair_name}

Scope Types

- **project**

Show details of a keypair

`os_compute_api:limits`

Default
`@`

Operations

- **GET** `/limits`

Scope Types

- **project**

Show rate and absolute limits for the current user project

`os_compute_api:limits:other_project`

Default
`rule:context_is_admin`

Operations

- **GET** `/limits`

Scope Types

- **project**

Show rate and absolute limits of other project.

This policy only checks if the user has access to the requested project limits. And this check is performed only after the check os_compute_api:limits passes

`os_compute_api:os-lock-server:lock`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (lock)`

Scope Types

- **project**

Lock a server

`os_compute_api:os-lock-server:unlock`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (unlock)`

Scope Types

- **project**

Unlock a server

`os_compute_api:os-lock-server:unlock:unlock_override`

Default
`rule:context_is_admin`

Operations

- **POST** `/servers/{server_id}/action (unlock)`

Scope Types

- **project**

Unlock a server, regardless who locked the server.

This check is performed only after the check os_compute_api:os-lock-server:unlock passes

`os_compute_api:os-migrate-server:migrate`

Default
`rule:project_manager_or_admin`

Operations

- **POST** `/servers/{server_id}/action (migrate)`

Scope Types

- **project**

Cold migrate a server without specifying a host

`os_compute_api:os-migrate-server:migrate:host`

Default
`rule:context_is_admin`

Operations

- **POST** `/servers/{server_id}/action (migrate)`

Scope Types

- **project**

Cold migrate a server to a specified host

`os_compute_api:os-migrate-server:migrate_live`

Default
`rule:project_manager_or_admin`

Operations

- **POST** `/servers/{server_id}/action (os-migrateLive)`

Scope Types

- **project**

Live migrate a server to a new host without a reboot without specifying a host.

`os_compute_api:os-migrate-server:migrate_live:host`

Default
`rule:context_is_admin`

Operations

- **POST** /servers/{server_id}/action (os-migrateLive)

Scope Types

- **project**

Live migrate a server to a specified host without a reboot.

`os_compute_api:os-migrations:index`

Default
rule:project_manager_or_admin

Operations

- **GET** /os-migrations

Scope Types

- **project**

List migrations without host info

`os_compute_api:os-migrations:index:all_projects`

Default
rule:context_is_admin

Operations

- **GET** /os-migrations

Scope Types

- **project**

List migrations for all or cross projects

`os_compute_api:os-migrations:index:host`

Default
rule:context_is_admin

Operations

- **GET** /os-migrations

Scope Types

- **project**

List migrations with host info

`os_compute_api:os-multinic:add`

Default
rule:project_member_or_admin

Operations

- **POST** /servers/{server_id}/action (addFixedIp)

Scope Types

- **project**

Add a fixed IP address to a server.

This API is proxy calls to the Network service. This is deprecated.

`os_compute_api:os-multinic:remove`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (removeFixedIp)`

Scope Types

- **project**

Remove a fixed IP address from a server.

This API is proxy calls to the Network service. This is deprecated.

`os_compute_api:os-networks:list`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/os-networks`

Scope Types

- **project**

List networks for the project.

This API is proxy calls to the Network service. This is deprecated.

`os_compute_api:os-networks:show`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/os-networks/{network_id}`

Scope Types

- **project**

Show network details.

This API is proxy calls to the Network service. This is deprecated.

`os_compute_api:os-pause-server:pause`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (pause)`

Scope Types

- **project**

Pause a server

`os_compute_api:os-pause-server:unpause`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (unpause)`

Scope Types

- **project**

Unpause a paused server

`os_compute_api:os-quota-class-sets:show`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-quota-class-sets/{quota_class}`

Scope Types

- **project**

List quotas for specific quota classes

`os_compute_api:os-quota-class-sets:update`

Default
`rule:context_is_admin`

Operations

- **PUT** `/os-quota-class-sets/{quota_class}`

Scope Types

- **project**

Update quotas for specific quota class

`os_compute_api:os-quota-sets:update`

Default
`rule:context_is_admin`

Operations

- **PUT** `/os-quota-sets/{tenant_id}`

Scope Types

- **project**

Update the quotas

`os_compute_api:os-quota-sets:defaults`

Default
`@`

Operations

- **GET** /os-quota-sets/{tenant_id}/defaults

Scope Types

- **project**

List default quotas

`os_compute_api:os-quota-sets:show`

Default
rule:project_reader_or_admin

Operations

- **GET** /os-quota-sets/{tenant_id}

Scope Types

- **project**

Show a quota

`os_compute_api:os-quota-sets:delete`

Default
rule:context_is_admin

Operations

- **DELETE** /os-quota-sets/{tenant_id}

Scope Types

- **project**

Revert quotas to defaults

`os_compute_api:os-quota-sets:detail`

Default
rule:project_reader_or_admin

Operations

- **GET** /os-quota-sets/{tenant_id}/detail

Scope Types

- **project**

Show the detail of quota

`os_compute_api:os-remote-consoles`

Default
rule:project_member_or_admin

Operations

- **POST** /servers/{server_id}/action (os-getSerialConsole)
- **POST** /servers/{server_id}/action (os-getSPICEConsole)
- **POST** /servers/{server_id}/action (os-getVNCConsole)

- **POST** /servers/{server_id}/remote-consoles

Scope Types

- **project**

Generate a URL to access remote server console.

This policy is for POST /remote-consoles API and below Server actions APIs are deprecated:

- os-getSerialConsole
- os-getSPICEConsole
- os-getVNCConsole.

`os_compute_api:os-rescue`

Default
rule:project_member_or_admin

Operations

- **POST** /servers/{server_id}/action (rescue)

Scope Types

- **project**

Rescue a server

`os_compute_api:os-unrescue`

Default
rule:project_member_or_admin

Operations

- **POST** /servers/{server_id}/action (unrescue)

Scope Types

- **project**

Unrescue a server

`os_compute_api:os-security-groups:get`

Default
rule:project_reader_or_admin

Operations

- **GET** /os-security-groups

Scope Types

- **project**

List security groups. This API is deprecated.

`os_compute_api:os-security-groups:show`

Default
rule:project_reader_or_admin

Operations

- **GET** /os-security-groups/{security_group_id}

Scope Types

- **project**

Show security group. This API is deprecated.

`os_compute_api:os-security-groups:create`

Default
rule:project_member_or_admin

Operations

- **POST** /os-security-groups

Scope Types

- **project**

Create security group. This API is deprecated.

`os_compute_api:os-security-groups:update`

Default
rule:project_member_or_admin

Operations

- **PUT** /os-security-groups/{security_group_id}

Scope Types

- **project**

Update security group. This API is deprecated.

`os_compute_api:os-security-groups:delete`

Default
rule:project_member_or_admin

Operations

- **DELETE** /os-security-groups/{security_group_id}

Scope Types

- **project**

Delete security group. This API is deprecated.

`os_compute_api:os-security-groups:rule:create`

Default
rule:project_member_or_admin

Operations

- **POST** /os-security-group-rules

Scope Types

- **project**

Create security group Rule. This API is deprecated.

`os_compute_api:os-security-groups:rule:delete`

Default
`rule:project_member_or_admin`

Operations

- **DELETE** `/os-security-group-rules/{security_group_id}`

Scope Types

- **project**

Delete security group Rule. This API is deprecated.

`os_compute_api:os-security-groups:list`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/{server_id}/os-security-groups`

Scope Types

- **project**

List security groups of server.

`os_compute_api:os-security-groups:add`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (addSecurityGroup)`

Scope Types

- **project**

Add security groups to server.

`os_compute_api:os-security-groups:remove`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (removeSecurityGroup)`

Scope Types

- **project**

Remove security groups from server.

`os_compute_api:os-server-diagnostics`

Default
`rule:context_is_admin`

Operations

- **GET** /servers/{server_id}/diagnostics

Scope Types

- **project**

Show the usage data for a server

`os_compute_api:os-server-external-events:create`

Default
rule:service_or_admin

Operations

- **POST** /os-server-external-events

Scope Types

- **project**

Create one or more external events

`os_compute_api:os-server-groups:create`

Default
rule:project_member_or_admin

Operations

- **POST** /os-server-groups

Scope Types

- **project**

Create a new server group

`os_compute_api:os-server-groups:delete`

Default
rule:project_member_or_admin

Operations

- **DELETE** /os-server-groups/{server_group_id}

Scope Types

- **project**

Delete a server group

`os_compute_api:os-server-groups:index`

Default
rule:project_reader_or_admin

Operations

- **GET** /os-server-groups

Scope Types

- **project**

List all server groups

`os_compute_api:os-server-groups:index:all_projects`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-server-groups`

Scope Types

- **project**

List all server groups for all projects

`os_compute_api:os-server-groups:show`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/os-server-groups/{server_group_id}`

Scope Types

- **project**

Show details of a server group

`os_compute_api:server-metadata:index`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/{server_id}/metadata`

Scope Types

- **project**

List all metadata of a server

`os_compute_api:server-metadata:show`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/{server_id}/metadata/{key}`

Scope Types

- **project**

Show metadata for a server

`os_compute_api:server-metadata:create`

Default
`rule:project_member_or_admin`

Operations

- **POST** /servers/{server_id}/metadata

Scope Types

- **project**

Create metadata for a server

`os_compute_api:server-metadata:update_all`

Default
rule:project_member_or_admin

Operations

- **PUT** /servers/{server_id}/metadata

Scope Types

- **project**

Replace metadata for a server

`os_compute_api:server-metadata:update`

Default
rule:project_member_or_admin

Operations

- **PUT** /servers/{server_id}/metadata/{key}

Scope Types

- **project**

Update metadata from a server

`os_compute_api:server-metadata:delete`

Default
rule:project_member_or_admin

Operations

- **DELETE** /servers/{server_id}/metadata/{key}

Scope Types

- **project**

Delete metadata from a server

`os_compute_api:os-server-password:show`

Default
rule:project_reader_or_admin

Operations

- **GET** /servers/{server_id}/os-server-password

Scope Types

- **project**

Show the encrypted administrative password of a server

`os_compute_api:os-server-password:clear`

Default
`rule:project_member_or_admin`

Operations

- **DELETE** `/servers/{server_id}/os-server-password`

Scope Types

- **project**

Clear the encrypted administrative password of a server

`os_compute_api:os-server-shares:index`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/{server_id}/shares`

Scope Types

- **project**

List all shares for given server

`os_compute_api:os-server-shares:create`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/shares`

Scope Types

- **project**

Attach a share to the specified server

`os_compute_api:os-server-shares:show`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/{server_id}/shares/{share_id}`

Scope Types

- **project**

Show a share configured for the specified server

`os_compute_api:os-server-shares:delete`

Default
`rule:project_member_or_admin`

Operations

- **DELETE** /servers/{server_id}/shares/{share_id}

Scope Types

- **project**

Detach a share to the specified server

`os_compute_api:os-server-tags:delete_all`

Default
rule:project_member_or_admin

Operations

- **DELETE** /servers/{server_id}/tags

Scope Types

- **project**

Delete all the server tags

`os_compute_api:os-server-tags:index`

Default
rule:project_reader_or_admin

Operations

- **GET** /servers/{server_id}/tags

Scope Types

- **project**

List all tags for given server

`os_compute_api:os-server-tags:update_all`

Default
rule:project_member_or_admin

Operations

- **PUT** /servers/{server_id}/tags

Scope Types

- **project**

Replace all tags on specified server with the new set of tags.

`os_compute_api:os-server-tags:delete`

Default
rule:project_member_or_admin

Operations

- **DELETE** /servers/{server_id}/tags/{tag}

Scope Types

- **project**

Delete a single tag from the specified server

`os_compute_api:os-server-tags:update`

Default
`rule:project_member_or_admin`

Operations

- **PUT** `/servers/{server_id}/tags/{tag}`

Scope Types

- **project**

Add a single tag to the server if server has no specified tag

`os_compute_api:os-server-tags:show`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/{server_id}/tags/{tag}`

Scope Types

- **project**

Check tag existence on the server.

`compute:server:topology:index`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/{server_id}/topology`

Scope Types

- **project**

Show the NUMA topology data for a server

`compute:server:topology:host:index`

Default
`rule:context_is_admin`

Operations

- **GET** `/servers/{server_id}/topology`

Scope Types

- **project**

Show the NUMA topology data for a server with host NUMA ID and CPU pinning information

`os_compute_api:servers:index`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers`

Scope Types

- **project**

List all servers

`os_compute_api:servers:detail`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/detail`

Scope Types

- **project**

List all servers with detailed information

`os_compute_api:servers:index:get_all_tenants`

Default
`rule:context_is_admin`

Operations

- **GET** `/servers`

Scope Types

- **project**

List all servers for all projects

`os_compute_api:servers:detail:get_all_tenants`

Default
`rule:context_is_admin`

Operations

- **GET** `/servers/detail`

Scope Types

- **project**

List all servers with detailed information for all projects

`os_compute_api:servers:allow_all_filters`

Default
`rule:context_is_admin`

Operations

- **GET** `/servers`
- **GET** `/servers/detail`

Scope Types

- **project**

Allow all filters when listing servers

`os_compute_api:servers:show`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/{server_id}`

Scope Types

- **project**

Show a server

`os_compute_api:servers:show:flavor-extra-specs`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/detail`
- **GET** `/servers/{server_id}`
- **PUT** `/servers/{server_id}`
- **POST** `/servers/{server_id}/action (rebuild)`

Scope Types

- **project**

Starting with microversion 2.47, the flavor and its extra specs used for a server is also returned in the response when showing server details, updating a server or rebuilding a server.

`os_compute_api:servers:show:host_status`

Default
`rule:context_is_admin`

Operations

- **GET** `/servers/{server_id}`
- **GET** `/servers/detail`
- **PUT** `/servers/{server_id}`
- **POST** `/servers/{server_id}/action (rebuild)`

Scope Types

- **project**

Show a server with additional host status information.

This means host_status will be shown irrespective of status value. If showing only host_status UNKNOWN is desired, use the `os_compute_api:servers:show:host_status:unknown-only` policy rule.

Microvision 2.75 added the `host_status` attribute in the `PUT /servers/{server_id}` and `POST /servers/{server_id}/action (rebuild)` API responses which are also controlled by this policy rule, like the `GET /servers*` APIs.

`os_compute_api:servers:show:host_status:unknown-only`

Default
`rule:context_is_admin`

Operations

- **GET** `/servers/{server_id}`
- **GET** `/servers/detail`
- **PUT** `/servers/{server_id}`
- **POST** `/servers/{server_id}/action (rebuild)`

Scope Types

- **project**

Show a server with additional host status information, only if host status is UNKNOWN.

This policy rule will only be enforced when the `os_compute_api:servers:show:host_status` policy rule does not pass for the request. An example policy configuration could be where the `os_compute_api:servers:show:host_status` rule is set to allow admin-only and the `os_compute_api:servers:show:host_status:unknown-only` rule is set to allow everyone.

`os_compute_api:servers:create`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers`

Scope Types

- **project**

Create a server

`os_compute_api:servers:create:forced_host`

Default
`rule:context_is_admin`

Operations

- **POST** `/servers`

Scope Types

- **project**

Create a server on the specified host and/or node.

In this case, the server is forced to launch on the specified host and/or node by bypassing the scheduler filters unlike the `compute:servers:create:requested_destination` rule.

`compute:servers:create:requested_destination`

Default
`rule:context_is_admin`

Operations

- **POST** `/servers`

Scope Types

- **project**

Create a server on the requested compute service host and/or hypervisor_hostname.

In this case, the requested host and/or hypervisor_hostname is validated by the scheduler filters unlike the `os_compute_api:servers:create:forced_host` rule.

`os_compute_api:servers:create:attach_volume`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers`

Scope Types

- **project**

Create a server with the requested volume attached to it

`os_compute_api:servers:create:attach_network`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers`

Scope Types

- **project**

Create a server with the requested network attached to it

`os_compute_api:servers:create:trusted_certs`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers`

Scope Types

- **project**

Create a server with trusted image certificate IDs

`os_compute_api:servers:create:zero_disk_flavor`

Default
`rule:context_is_admin`

Operations

- **POST** `/servers`

Scope Types

- **project**

This rule controls the compute API validation behavior of creating a server with a flavor that has 0 disk, indicating the server should be volume-backed.

For a flavor with disk=0, the root disk will be set to exactly the size of the image used to deploy the instance. However, in this case the filter_scheduler cannot select the compute host based on the virtual image size. Therefore, 0 should only be used for volume booted instances or for testing purposes.

WARNING: It is a potential security exposure to enable this policy rule if users can upload their own images since repeated attempts to create a disk=0 flavor instance with a large image can exhaust the local disk of the compute (or shared storage cluster). See bug https://bugs.launchpad.net/nova/+bug/1739646 for details.

`network:attach_external_network`

Default
`rule:context_is_admin`

Operations

- **POST** `/servers`
- **POST** `/servers/{server_id}/os-interface`

Scope Types

- **project**

Attach an unshared external network to a server

`os_compute_api:servers:delete`

Default
`rule:project_member_or_admin`

Operations

- **DELETE** `/servers/{server_id}`

Scope Types

- **project**

Delete a server

`os_compute_api:servers:update`

Default
`rule:project_member_or_admin`

Operations

- **PUT** `/servers/{server_id}`

Scope Types

- **project**

Update a server

`os_compute_api:servers:confirm_resize`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (confirmResize)`

Scope Types

- **project**

Confirm a server resize

`os_compute_api:servers:revert_resize`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (revertResize)`

Scope Types

- **project**

Revert a server resize

`os_compute_api:servers:reboot`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (reboot)`

Scope Types

- **project**

Reboot a server

`os_compute_api:servers:resize`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (resize)`

Scope Types

- **project**

Resize a server

`compute:servers:resize:cross_cell`

Default
`!`

Operations

- **POST** `/servers/{server_id}/action (resize)`

Scope Types

- **project**

Resize a server across cells. By default, this is disabled for all users and recommended to be tested in a deployment for admin users before opening it up to non-admin users. Resizing within a cell is the default preferred behavior even if this is enabled.

`os_compute_api:servers:rebuild`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (rebuild)`

Scope Types

- **project**

Rebuild a server

`os_compute_api:servers:rebuild:trusted_certs`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (rebuild)`

Scope Types

- **project**

Rebuild a server with trusted image certificate IDs

`os_compute_api:servers:create_image`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (createImage)`

Scope Types

- **project**

Create an image from a server

`os_compute_api:servers:create_image:allow_volume_backed`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (createImage)`

Scope Types

- **project**

Create an image from a volume backed server

`os_compute_api:servers:start`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (os-start)`

Scope Types

- **project**

Start a server

`os_compute_api:servers:stop`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (os-stop)`

Scope Types

- **project**

Stop a server

`os_compute_api:servers:trigger_crash_dump`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/action (trigger_crash_dump)`

Scope Types

- **project**

Trigger crash dump in a server

`os_compute_api:servers:migrations:show`

Default
`rule:context_is_admin`

Operations

- **GET** `/servers/{server_id}/migrations/{migration_id}`

Scope Types

- **project**

Show details for an in-progress live migration for a given server

`os_compute_api:servers:migrations:force_complete`

Default
`rule:project_manager_or_admin`

Operations

- **POST** `/servers/{server_id}/migrations/{migration_id}/action (force_complete)`

Scope Types

- **project**

Force an in-progress live migration for a given server to complete

`os_compute_api:servers:migrations:delete`

Default
`rule:project_manager_or_admin`

Operations

- **DELETE** `/servers/{server_id}/migrations/{migration_id}`

Scope Types

- **project**

Delete(Abort) an in-progress live migration

`os_compute_api:servers:migrations:index`

Default
`rule:project_manager_or_admin`

Operations

- **GET** `/servers/{server_id}/migrations`

Scope Types

- **project**

Lists in-progress live migrations for a given server without host info.

`os_compute_api:servers:migrations:index:host`

Default
`rule:context_is_admin`

Operations

- **GET** `/servers/{server_id}/migrations`

Scope Types

- **project**

Lists in-progress live migrations for a given server with host info.

`os_compute_api:os-services:list`

Default
`rule:context_is_admin`

Operations

- **GET** /os-services

Scope Types

- **project**

List all running Compute services in a region.

`os_compute_api:os-services:update`

Default
rule:context_is_admin

Operations

- **PUT** /os-services/{service_id}

Scope Types

- **project**

Update a Compute service.

`os_compute_api:os-services:delete`

Default
rule:context_is_admin

Operations

- **DELETE** /os-services/{service_id}

Scope Types

- **project**

Delete a Compute service.

`os_compute_api:os-shelve:shelve`

Default
rule:project_member_or_admin

Operations

- **POST** /servers/{server_id}/action (shelve)

Scope Types

- **project**

Shelve server

`os_compute_api:os-shelve:unshelve`

Default
rule:project_member_or_admin

Operations

- **POST** /servers/{server_id}/action (unshelve)

Scope Types

- **project**

Unshelve (restore) shelved server

`os_compute_api:os-shelve:unshelve_to_host`

Default
`rule:context_is_admin`

Operations

- **POST** `/servers/{server_id}/action (unshelve)`

Scope Types

- **project**

Unshelve (restore) shelve offloaded server to a specific host

`os_compute_api:os-shelve:shelve_offload`

Default
`rule:context_is_admin`

Operations

- **POST** `/servers/{server_id}/action (shelveOffload)`

Scope Types

- **project**

Shelf-offload (remove) server

`os_compute_api:os-simple-tenant-usage:show`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/os-simple-tenant-usage/{tenant_id}`

Scope Types

- **project**

Show usage statistics for a specific tenant

`os_compute_api:os-simple-tenant-usage:list`

Default
`rule:context_is_admin`

Operations

- **GET** `/os-simple-tenant-usage`

Scope Types

- **project**

List per tenant usage statistics for all tenants

`os_compute_api:os-suspend-server:resume`

Default
`rule:project_member_or_admin`

Operations

- **POST** /servers/{server_id}/action (resume)

Scope Types

- **project**

Resume suspended server

`os_compute_api:os-suspend-server:suspend`

Default
rule:project_member_or_admin

Operations

- **POST** /servers/{server_id}/action (suspend)

Scope Types

- **project**

Suspend server

`os_compute_api:os-tenant-networks:list`

Default
rule:project_reader_or_admin

Operations

- **GET** /os-tenant-networks

Scope Types

- **project**

List project networks.

This API is proxy calls to the Network service. This is deprecated.

`os_compute_api:os-tenant-networks:show`

Default
rule:project_reader_or_admin

Operations

- **GET** /os-tenant-networks/{network_id}

Scope Types

- **project**

Show project network details.

This API is proxy calls to the Network service. This is deprecated.

`os_compute_api:os-volumes:list`

Default
rule:project_reader_or_admin

Operations

- **GET** /os-volumes

Scope Types

- **project**

List volumes.

This API is a proxy call to the Volume service. It is deprecated.

`os_compute_api:os-volumes:create`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/os-volumes`

Scope Types

- **project**

Create volume.

This API is a proxy call to the Volume service. It is deprecated.

`os_compute_api:os-volumes:detail`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/os-volumes/detail`

Scope Types

- **project**

List volumes detail.

This API is a proxy call to the Volume service. It is deprecated.

`os_compute_api:os-volumes:show`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/os-volumes/{volume_id}`

Scope Types

- **project**

Show volume.

This API is a proxy call to the Volume service. It is deprecated.

`os_compute_api:os-volumes:delete`

Default
`rule:project_member_or_admin`

Operations

- **DELETE** `/os-volumes/{volume_id}`

Scope Types

- **project**

Delete volume.

This API is a proxy call to the Volume service. It is deprecated.

`os_compute_api:os-volumes:snapshots:list`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/os-snapshots`

Scope Types

- **project**

List snapshots.

This API is a proxy call to the Volume service. It is deprecated.

`os_compute_api:os-volumes:snapshots:create`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/os-snapshots`

Scope Types

- **project**

Create snapshots.

This API is a proxy call to the Volume service. It is deprecated.

`os_compute_api:os-volumes:snapshots:detail`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/os-snapshots/detail`

Scope Types

- **project**

List snapshots details.

This API is a proxy call to the Volume service. It is deprecated.

`os_compute_api:os-volumes:snapshots:show`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/os-snapshots/{snapshot_id}`

Scope Types

- **project**

Show snapshot.

This API is a proxy call to the Volume service. It is deprecated.

`os_compute_api:os-volumes:snapshots:delete`

Default
`rule:project_member_or_admin`

Operations

- **DELETE** `/os-snapshots/{snapshot_id}`

Scope Types

- **project**

Delete snapshot.

This API is a proxy call to the Volume service. It is deprecated.

`os_compute_api:os-volumes-attachments:index`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/{server_id}/os-volume_attachments`

Scope Types

- **project**

List volume attachments for an instance

`os_compute_api:os-volumes-attachments:create`

Default
`rule:project_member_or_admin`

Operations

- **POST** `/servers/{server_id}/os-volume_attachments`

Scope Types

- **project**

Attach a volume to an instance

`os_compute_api:os-volumes-attachments:show`

Default
`rule:project_reader_or_admin`

Operations

- **GET** `/servers/{server_id}/os-volume_attachments/{volume_id}`

Scope Types

- **project**

Show details of a volume attachment

`os_compute_api:os-volumes-attachments:update`

Default
`rule:project_member_or_admin`

Operations

- **PUT** `/servers/{server_id}/os-volume_attachments/{volume_id}`

Scope Types

- **project**

Update a volume attachment. New update policy about swap + update request (which is possible only >2.85) only <swap policy> is checked. We expect <swap policy> to be always superset of this policy permission.

`os_compute_api:os-volumes-attachments:swap`

Default
`rule:service_or_admin`

Operations

- **PUT** `/servers/{server_id}/os-volume_attachments/{volume_id}`

Scope Types

- **project**

Update a volume attachment with a different volumeId

`os_compute_api:os-volumes-attachments:delete`

Default
`rule:project_member_or_admin`

Operations

- **DELETE** `/servers/{server_id}/os-volume_attachments/{volume_id}`

Scope Types

- **project**

Detach a volume from an instance

3.5.2.3 Extra Specs

Nova uses *flavor extra specs* as a way to provide additional information to instances beyond basic information like amount of RAM or disk. This information can range from hints for the scheduler to hypervisor-specific configuration instructions for the instance.

- *Extra Spec Reference*: A complete reference for all extra specs currently recognized and supported by nova.

Extra Specs

The following is an overview of all extra specs recognized by nova in its default configuration.

Note

Other services and virt drivers may provide additional extra specs not listed here. In addition, it is possible to register your own extra specs. For more information on the latter, refer to *Compute schedulers*.

Placement

The following extra specs are used during scheduling to modify the request sent to placement.

`resources`

The following extra specs are used to request an amount of the specified resource from placement when scheduling. All extra specs expect an integer value.

Note

Not all of the resource types listed below are supported by all virt drivers.

`resources{group}:VCPU`

Type
int

The amount of resource VCPU requested.

`resources{group}:MEMORY_MB`

Type
int

The amount of resource MEMORY_MB requested.

`resources{group}:DISK_GB`

Type
int

The amount of resource DISK_GB requested.

`resources{group}:PCI_DEVICE`

Type
int

The amount of resource PCI_DEVICE requested.

`resources{group}:SRIOV_NET_VF`

Type
int

The amount of resource SRIOV_NET_VF requested.

resources{group}:NUMA_SOCKET

Type
int

The amount of resource NUMA_SOCKET requested.

resources{group}:NUMA_CORE

Type
int

The amount of resource NUMA_CORE requested.

resources{group}:NUMA_THREAD

Type
int

The amount of resource NUMA_THREAD requested.

resources{group}:NUMA_MEMORY_MB

Type
int

The amount of resource NUMA_MEMORY_MB requested.

resources{group}:IPV4_ADDRESS

Type
int

The amount of resource IPV4_ADDRESS requested.

resources{group}:VGPU

Type
int

The amount of resource VGPU requested.

resources{group}:VGPU_DISPLAY_HEAD

Type
int

The amount of resource VGPU_DISPLAY_HEAD requested.

resources{group}:NET_BW_EGR_KILOBIT_PER_SEC

Type
int

The amount of resource NET_BW_EGR_KILOBIT_PER_SEC requested.

resources{group}:NET_BW_IGR_KILOBIT_PER_SEC

Type
int

The amount of resource NET_BW_IGR_KILOBIT_PER_SEC requested.

resources{group}:PCPU

Type
int

The amount of resource PCPU requested.

resources{group}:MEM_ENCRYPTION_CONTEXT

Type
int

The amount of resource MEM_ENCRYPTION_CONTEXT requested.

resources{group}:FPGA

Type
int

The amount of resource FPGA requested.

resources{group}:PGPU

Type
int

The amount of resource PGPU requested.

resources{group}:NET_PACKET_RATE_KILOPACKET_PER_SEC

Type
int

The amount of resource NET_PACKET_RATE_KILOPACKET_PER_SEC requested.

resources{group}:NET_PACKET_RATE_EGR_KILOPACKET_PER_SEC

Type
int

The amount of resource NET_PACKET_RATE_EGR_KILOPACKET_PER_SEC requested.

resources{group}:NET_PACKET_RATE_IGR_KILOPACKET_PER_SEC

Type
int

The amount of resource NET_PACKET_RATE_IGR_KILOPACKET_PER_SEC requested.

resources{group}:CUSTOM_{resource}

Type
int

The amount of resource CUSTOM_{resource} requested.

trait

The following extra specs are used to request a specified trait from placement when scheduling. All extra specs expect one of the following values:

- `required`
- `forbidden`

Note

Not all of the traits listed below are supported by all virt drivers.

trait{group}:COMPUTE_DEVICE_TAGGING

Type
str

Require or forbid trait COMPUTE_DEVICE_TAGGING.

trait{group}:COMPUTE_NODE

Type
str

Require or forbid trait COMPUTE_NODE.

trait{group}:COMPUTE_TRUSTED_CERTS

Type
str

Require or forbid trait COMPUTE_TRUSTED_CERTS.

trait{group}:COMPUTE_SAME_HOST_COLD_MIGRATE

Type
str

Require or forbid trait COMPUTE_SAME_HOST_COLD_MIGRATE.

trait{group}:COMPUTE_RESCUE_BFV

Type
str

Require or forbid trait COMPUTE_RESCUE_BFV.

trait{group}:COMPUTE_ACCELERATORS

Type
str

Require or forbid trait COMPUTE_ACCELERATORS.

trait{group}:COMPUTE_SOCKET_PCI_NUMA_AFFINITY

Type
str

Require or forbid trait COMPUTE_SOCKET_PCI_NUMA_AFFINITY.

trait{group}:COMPUTE_REMOTE_MANAGED_PORTS

Type
str

Require or forbid trait COMPUTE_REMOTE_MANAGED_PORTS.

trait{group}:COMPUTE_MEM_BACKING_FILE

Type
str

Require or forbid trait COMPUTE_MEM_BACKING_FILE.

trait{group}:COMPUTE_MANAGED_PCI_DEVICE

Type
str

Require or forbid trait COMPUTE_MANAGED_PCI_DEVICE.

trait{group}:COMPUTE_ADDRESS_SPACE_PASSTHROUGH

Type
str

Require or forbid trait COMPUTE_ADDRESS_SPACE_PASSTHROUGH.

trait{group}:COMPUTE_ADDRESS_SPACE_EMULATED

Type
str

Require or forbid trait COMPUTE_ADDRESS_SPACE_EMULATED.

trait{group}:COMPUTE_SHARE_LOCAL_FS

Type
str

Require or forbid trait COMPUTE_SHARE_LOCAL_FS.

trait{group}:COMPUTE_ARCH_AARCH64

Type
str

Require or forbid trait COMPUTE_ARCH_AARCH64.

trait{group}:COMPUTE_ARCH_PPC64LE

Type
str

Require or forbid trait COMPUTE_ARCH_PPC64LE.

trait{group}:COMPUTE_ARCH_MIPSEL

Type
str

Require or forbid trait COMPUTE_ARCH_MIPSEL.

trait{group}:COMPUTE_ARCH_S390X

Type
str

Require or forbid trait COMPUTE_ARCH_S390X.

trait{group}:COMPUTE_ARCH_RISCV64

Type
str

Require or forbid trait COMPUTE_ARCH_RISCV64.

trait{group}:COMPUTE_ARCH_X86_64

Type
str

Require or forbid trait COMPUTE_ARCH_X86_64.

trait{group}:COMPUTE_CONFIG_DRIVE_REGENERATION

Type
str

Require or forbid trait COMPUTE_CONFIG_DRIVE_REGENERATION.

trait{group}:COMPUTE_EPHEMERAL_ENCRYPTION

Type
str

Require or forbid trait COMPUTE_EPHEMERAL_ENCRYPTION.

trait{group}:COMPUTE_EPHEMERAL_ENCRYPTION_PLAIN

Type
str

Require or forbid trait COMPUTE_EPHEMERAL_ENCRYPTION_PLAIN.

trait{group}:COMPUTE_EPHEMERAL_ENCRYPTION_LUKS

Type
str

Require or forbid trait COMPUTE_EPHEMERAL_ENCRYPTION_LUKS.

trait{group}:COMPUTE_EPHEMERAL_ENCRYPTION_LUKSV2

Type
str

Require or forbid trait COMPUTE_EPHEMERAL_ENCRYPTION_LUKSV2.

trait{group}:COMPUTE_FIRMWARE_BIOS

Type
str

Require or forbid trait COMPUTE_FIRMWARE_BIOS.

trait{group}:COMPUTE_FIRMWARE_UEFI

Type
str

Require or forbid trait COMPUTE_FIRMWARE_UEFI.

trait{group}:COMPUTE_GRAPHICS_MODEL_BOCHS

Type
str

Require or forbid trait COMPUTE_GRAPHICS_MODEL_BOCHS.

trait{group}:COMPUTE_GRAPHICS_MODEL_CIRRUS

Type
str

Require or forbid trait COMPUTE_GRAPHICS_MODEL_CIRRUS.

trait{group}:COMPUTE_GRAPHICS_MODEL_GOP

Type
str

Require or forbid trait COMPUTE_GRAPHICS_MODEL_GOP.

trait{group}:COMPUTE_GRAPHICS_MODEL_NONE

Type
str

Require or forbid trait COMPUTE_GRAPHICS_MODEL_NONE.

trait{group}:COMPUTE_GRAPHICS_MODEL_QXL

Type
str

Require or forbid trait COMPUTE_GRAPHICS_MODEL_QXL.

trait{group}:COMPUTE_GRAPHICS_MODEL_VGA

Type
str

Require or forbid trait COMPUTE_GRAPHICS_MODEL_VGA.

trait{group}:COMPUTE_GRAPHICS_MODEL_VIRTIO

Type
str

Require or forbid trait COMPUTE_GRAPHICS_MODEL_VIRTIO.

trait{group}:COMPUTE_GRAPHICS_MODEL_VMVGA

Type
str

Require or forbid trait COMPUTE_GRAPHICS_MODEL_VMVGA.

trait{group}:COMPUTE_GRAPHICS_MODEL_XEN

Type
str

Require or forbid trait COMPUTE_GRAPHICS_MODEL_XEN.

trait{group}:COMPUTE_IMAGE_TYPE_AKI

Type
str

Require or forbid trait COMPUTE_IMAGE_TYPE_AKI.

trait{group}:COMPUTE_IMAGE_TYPE_AMI

Type
str

Require or forbid trait COMPUTE_IMAGE_TYPE_AMI.

trait{group}:COMPUTE_IMAGE_TYPE_ARI

Type
str

Require or forbid trait COMPUTE_IMAGE_TYPE_ARI.

trait{group}:COMPUTE_IMAGE_TYPE_ISO

Type
str

Require or forbid trait COMPUTE_IMAGE_TYPE_ISO.

trait{group}:COMPUTE_IMAGE_TYPE_QCOW2

Type
str

Require or forbid trait COMPUTE_IMAGE_TYPE_QCOW2.

trait{group}:COMPUTE_IMAGE_TYPE_RAW

Type
str

Require or forbid trait COMPUTE_IMAGE_TYPE_RAW.

trait{group}:COMPUTE_IMAGE_TYPE_VDI

Type
str

Require or forbid trait COMPUTE_IMAGE_TYPE_VDI.

trait{group}:COMPUTE_IMAGE_TYPE_VHD

Type
str

Require or forbid trait COMPUTE_IMAGE_TYPE_VHD.

trait{group}:COMPUTE_IMAGE_TYPE_VHDX

Type
str

Require or forbid trait COMPUTE_IMAGE_TYPE_VHDX.

trait{group}:COMPUTE_IMAGE_TYPE_VMDK

Type
str

Require or forbid trait COMPUTE_IMAGE_TYPE_VMDK.

trait{group}:COMPUTE_IMAGE_TYPE_PLOOP

Type
str

Require or forbid trait COMPUTE_IMAGE_TYPE_PLOOP.

trait{group}:COMPUTE_MIGRATE_AUTO_CONVERGE

Type
str

Require or forbid trait COMPUTE_MIGRATE_AUTO_CONVERGE.

trait{group}:COMPUTE_MIGRATE_POST_COPY

Type
str

Require or forbid trait COMPUTE_MIGRATE_POST_COPY.

trait{group}:COMPUTE_NET_ATTACH_INTERFACE

Type
str

Require or forbid trait COMPUTE_NET_ATTACH_INTERFACE.

trait{group}:COMPUTE_NET_ATTACH_INTERFACE_WITH_TAG

Type
str

Require or forbid trait COMPUTE_NET_ATTACH_INTERFACE_WITH_TAG.

trait{group}:COMPUTE_NET_VIRTIO_PACKED

Type
str

Require or forbid trait COMPUTE_NET_VIRTIO_PACKED.

trait{group}:COMPUTE_NET_VIF_MODEL_E1000

Type
str

Require or forbid trait COMPUTE_NET_VIF_MODEL_E1000.

trait{group}:COMPUTE_NET_VIF_MODEL_E1000E

Type
str

Require or forbid trait COMPUTE_NET_VIF_MODEL_E1000E.

trait{group}:COMPUTE_NET_VIF_MODEL_LAN9118

Type
str

Require or forbid trait COMPUTE_NET_VIF_MODEL_LAN9118.

trait{group}:COMPUTE_NET_VIF_MODEL_NETFRONT

Type
str

Require or forbid trait COMPUTE_NET_VIF_MODEL_NETFRONT.

trait{group}:COMPUTE_NET_VIF_MODEL_NE2K_PCI

Type
str

Require or forbid trait COMPUTE_NET_VIF_MODEL_NE2K_PCI.

trait{group}:COMPUTE_NET_VIF_MODEL_PCNET

Type
str

Require or forbid trait COMPUTE_NET_VIF_MODEL_PCNET.

trait{group}:COMPUTE_NET_VIF_MODEL_RTL8139

Type
str

Require or forbid trait COMPUTE_NET_VIF_MODEL_RTL8139.

trait{group}:COMPUTE_NET_VIF_MODEL_SPAPR_VLAN

Type
str

Require or forbid trait COMPUTE_NET_VIF_MODEL_SPAPR_VLAN.

trait{group}:COMPUTE_NET_VIF_MODEL_SRIOV

Type
str

Require or forbid trait COMPUTE_NET_VIF_MODEL_SRIOV.

trait{group}:COMPUTE_NET_VIF_MODEL_VIRTIO

Type
str

Require or forbid trait COMPUTE_NET_VIF_MODEL_VIRTIO.

trait{group}:COMPUTE_NET_VIF_MODEL_VMXNET

Type
str

Require or forbid trait COMPUTE_NET_VIF_MODEL_VMXNET.

trait{group}:COMPUTE_NET_VIF_MODEL_VMXNET3

Type
str

Require or forbid trait COMPUTE_NET_VIF_MODEL_VMXNET3.

trait{group}:COMPUTE_NET_VIF_MODEL_IGB

Type
str

Require or forbid trait COMPUTE_NET_VIF_MODEL_IGB.

trait{group}:COMPUTE_SECURITY_TPM_1_2

Type
str

Require or forbid trait COMPUTE_SECURITY_TPM_1_2.

trait{group}:COMPUTE_SECURITY_TPM_2_0

Type
str

Require or forbid trait COMPUTE_SECURITY_TPM_2_0.

trait{group}:COMPUTE_SECURITY_TPM_TIS

Type
str

Require or forbid trait COMPUTE_SECURITY_TPM_TIS.

trait{group}:COMPUTE_SECURITY_TPM_CRB

Type
str

Require or forbid trait COMPUTE_SECURITY_TPM_CRB.

trait{group}:COMPUTE_SECURITY_TPM_SECRET_SECURITY_USER

Type
str

Require or forbid trait COMPUTE_SECURITY_TPM_SECRET_SECURITY_USER.

trait{group}:COMPUTE_SECURITY_TPM_SECRET_SECURITY_HOST

Type
str

Require or forbid trait COMPUTE_SECURITY_TPM_SECRET_SECURITY_HOST.

trait{group}:COMPUTE_SECURITY_TPM_SECRET_SECURITY_DEPLOYMENT

Type
str

Require or forbid trait COMPUTE_SECURITY_TPM_SECRET_SECURITY_DEPLOYMENT.

trait{group}:COMPUTE_SECURITY_UEFI_SECURE_BOOT

Type
str

Require or forbid trait COMPUTE_SECURITY_UEFI_SECURE_BOOT.

trait{group}:COMPUTE_SECURITY_STATELESS_FIRMWARE

Type
str

Require or forbid trait COMPUTE_SECURITY_STATELESS_FIRMWARE.

trait{group}:COMPUTE_SOUND_MODEL_SB16

Type
str

Require or forbid trait COMPUTE_SOUND_MODEL_SB16.

trait{group}:COMPUTE_SOUND_MODEL_ES1370

Type
str

Require or forbid trait COMPUTE_SOUND_MODEL_ES1370.

trait{group}:COMPUTE_SOUND_MODEL_PCSPK

Type
str

Require or forbid trait COMPUTE_SOUND_MODEL_PCSPK.

trait{group}:COMPUTE_SOUND_MODEL_AC97

Type
str

Require or forbid trait COMPUTE_SOUND_MODEL_AC97.

trait{group}:COMPUTE_SOUND_MODEL_ICH6

Type
str

Require or forbid trait COMPUTE_SOUND_MODEL_ICH6.

trait{group}:COMPUTE_SOUND_MODEL_ICH9

Type
str

Require or forbid trait COMPUTE_SOUND_MODEL_ICH9.

trait{group}:COMPUTE_SOUND_MODEL_USB

Type
str

Require or forbid trait COMPUTE_SOUND_MODEL_USB.

trait{group}:COMPUTE_SOUND_MODEL_VIRTIO

Type
str

Require or forbid trait COMPUTE_SOUND_MODEL_VIRTIO.

trait{group}:COMPUTE_STATUS_DISABLED

Type
str

Require or forbid trait COMPUTE_STATUS_DISABLED.

trait{group}:COMPUTE_STORAGE_BUS_FDC

Type
str

Require or forbid trait COMPUTE_STORAGE_BUS_FDC.

trait{group}:COMPUTE_STORAGE_BUS_IDE

Type
str

Require or forbid trait COMPUTE_STORAGE_BUS_IDE.

trait{group}:COMPUTE_STORAGE_BUS_LXC

Type
str

Require or forbid trait COMPUTE_STORAGE_BUS_LXC.

trait{group}:COMPUTE_STORAGE_BUS_SATA

Type
str

Require or forbid trait COMPUTE_STORAGE_BUS_SATA.

trait{group}:COMPUTE_STORAGE_BUS_SCSI

Type
str

Require or forbid trait COMPUTE_STORAGE_BUS_SCSI.

trait{group}:COMPUTE_STORAGE_BUS_USB

Type
str

Require or forbid trait COMPUTE_STORAGE_BUS_USB.

trait{group}:COMPUTE_STORAGE_BUS_VIRTIO

Type
str

Require or forbid trait COMPUTE_STORAGE_BUS_VIRTIO.

trait{group}:COMPUTE_STORAGE_BUS_UML

Type
str

Require or forbid trait COMPUTE_STORAGE_BUS_UML.

trait{group}:COMPUTE_STORAGE_BUS_XEN

Type
str

Require or forbid trait COMPUTE_STORAGE_BUS_XEN.

trait{group}:COMPUTE_STORAGE_VIRTIO_FS

Type
str

Require or forbid trait COMPUTE_STORAGE_VIRTIO_FS.

trait{group}:COMPUTE_USB_MODEL_QEMU_XHCI

Type
str

Require or forbid trait COMPUTE_USB_MODEL_QEMU_XHCI.

trait{group}:COMPUTE_USB_MODEL_NEC_XHCI

Type
str

Require or forbid trait COMPUTE_USB_MODEL_NEC_XHCI.

trait{group}:COMPUTE_VIOMMU_MODEL_INTEL

Type
str

Require or forbid trait COMPUTE_VIOMMU_MODEL_INTEL.

trait{group}:COMPUTE_VIOMMU_MODEL_SMMUV3

Type
str

Require or forbid trait COMPUTE_VIOMMU_MODEL_SMMUV3.

trait{group}:COMPUTE_VIOMMU_MODEL_VIRTIO

Type
str

Require or forbid trait COMPUTE_VIOMMU_MODEL_VIRTIO.

trait{group}:COMPUTE_VIOMMU_MODEL_AUTO

Type
str

Require or forbid trait COMPUTE_VIOMMU_MODEL_AUTO.

trait{group}:COMPUTE_VOLUME_ATTACH

Type
str

Require or forbid trait COMPUTE_VOLUME_ATTACH.

trait{group}:COMPUTE_VOLUME_ATTACH_WITH_TAG

Type
str

Require or forbid trait COMPUTE_VOLUME_ATTACH_WITH_TAG.

trait{group}:COMPUTE_VOLUME_EXTEND

Type
str

Require or forbid trait COMPUTE_VOLUME_EXTEND.

trait{group}:COMPUTE_VOLUME_MULTI_ATTACH

Type
str

Require or forbid trait COMPUTE_VOLUME_MULTI_ATTACH.

trait{group}:HW_ARCH_ALPHA

Type
str

Require or forbid trait HW_ARCH_ALPHA.

trait{group}:HW_ARCH_ARMV6

Type
str

Require or forbid trait HW_ARCH_ARMV6.

trait{group}:HW_ARCH_ARMV7

Type
str

Require or forbid trait HW_ARCH_ARMV7.

trait{group}:HW_ARCH_ARMV7B

Type
str

Require or forbid trait HW_ARCH_ARMV7B.

trait{group}:HW_ARCH_AARCH64

Type
str

Require or forbid trait HW_ARCH_AARCH64.

trait{group}:HW_ARCH_CRIS

Type
str

Require or forbid trait HW_ARCH_CRIS.

trait{group}:HW_ARCH_I686

Type
str

Require or forbid trait HW_ARCH_I686.

trait{group}:HW_ARCH_IA64

Type
str

Require or forbid trait HW_ARCH_IA64.

trait{group}:HW_ARCH_LM32

Type
str

Require or forbid trait HW_ARCH_LM32.

trait{group}:HW_ARCH_M68K

Type
str

Require or forbid trait HW_ARCH_M68K.

trait{group}:HW_ARCH_MICROBLAZE

Type
str

Require or forbid trait HW_ARCH_MICROBLAZE.

trait{group}:HW_ARCH_MICROBLAZEEL

Type
str

Require or forbid trait HW_ARCH_MICROBLAZEEL.

trait{group}:HW_ARCH_MIPS

Type
str

Require or forbid trait HW_ARCH_MIPS.

trait{group}:HW_ARCH_MIPSEL

Type
str

Require or forbid trait HW_ARCH_MIPSEL.

trait{group}:HW_ARCH_MIPS64

Type
str

Require or forbid trait HW_ARCH_MIPS64.

trait{group}:HW_ARCH_MIPS64EL

Type
str

Require or forbid trait HW_ARCH_MIPS64EL.

trait{group}:HW_ARCH_OPENRISC

Type
str

Require or forbid trait HW_ARCH_OPENRISC.

trait{group}:HW_ARCH_PARISC

Type
str

Require or forbid trait HW_ARCH_PARISC.

trait{group}:HW_ARCH_PARISC64

Type
str

Require or forbid trait HW_ARCH_PARISC64.

trait{group}:HW_ARCH_PPC

Type
str

Require or forbid trait HW_ARCH_PPC.

trait{group}:HW_ARCH_PPCLE

Type
str

Require or forbid trait HW_ARCH_PPCLE.

trait{group}:HW_ARCH_PPC64

Type
str

Require or forbid trait HW_ARCH_PPC64.

trait{group}:HW_ARCH_PPC64LE

Type
str

Require or forbid trait HW_ARCH_PPC64LE.

trait{group}:HW_ARCH_PPCEMB

Type
str

Require or forbid trait HW_ARCH_PPCEMB.

trait{group}:HW_ARCH_S390

Type
str

Require or forbid trait HW_ARCH_S390.

trait{group}:HW_ARCH_S390X

Type
str

Require or forbid trait HW_ARCH_S390X.

trait{group}:HW_ARCH_SH4

Type
str

Require or forbid trait HW_ARCH_SH4.

trait{group}:HW_ARCH_SH4EB

Type
str

Require or forbid trait HW_ARCH_SH4EB.

trait{group}:HW_ARCH_SPARC

Type
str

Require or forbid trait HW_ARCH_SPARC.

trait{group}:HW_ARCH_SPARC64

Type
str

Require or forbid trait HW_ARCH_SPARC64.

trait{group}:HW_ARCH_UNICORE32

Type
str

Require or forbid trait HW_ARCH_UNICORE32.

trait{group}:HW_ARCH_X86_64

Type
str

Require or forbid trait HW_ARCH_X86_64.

trait{group}:HW_ARCH_XTENSA

Type
str

Require or forbid trait HW_ARCH_XTENSA.

trait{group}:HW_ARCH_XTENSAEB

Type
str

Require or forbid trait HW_ARCH_XTENSAEB.

trait{group}:HW_CPU_HYPERTHREADING

Type
str

Require or forbid trait HW_CPU_HYPERTHREADING.

trait{group}:HW_CPU_AARCH64_FP

Type
str

Require or forbid trait HW_CPU_AARCH64_FP.

trait{group}:HW_CPU_AARCH64_ASIMD

Type
str

Require or forbid trait HW_CPU_AARCH64_ASIMD.

trait{group}:HW_CPU_AARCH64_EVTSTRM

Type
str

Require or forbid trait HW_CPU_AARCH64_EVTSTRM.

trait{group}:HW_CPU_AARCH64_AES

Type
str

Require or forbid trait HW_CPU_AARCH64_AES.

trait{group}:HW_CPU_AARCH64_PMULL

Type
str

Require or forbid trait HW_CPU_AARCH64_PMULL.

trait{group}:HW_CPU_AARCH64_SHA1

Type
str

Require or forbid trait HW_CPU_AARCH64_SHA1.

trait{group}:HW_CPU_AARCH64_SHA2

Type
str

Require or forbid trait HW_CPU_AARCH64_SHA2.

trait{group}:HW_CPU_AARCH64_CRC32

Type
str

Require or forbid trait HW_CPU_AARCH64_CRC32.

trait{group}:HW_CPU_AARCH64_FPHP

Type
str

Require or forbid trait HW_CPU_AARCH64_FPHP.

trait{group}:HW_CPU_AARCH64_ASIMDHP

Type
str

Require or forbid trait HW_CPU_AARCH64_ASIMDHP.

trait{group}:HW_CPU_AARCH64_ASIMDRDM

Type
str

Require or forbid trait HW_CPU_AARCH64_ASIMDRDM.

trait{group}:HW_CPU_AARCH64_ATOMICS

Type
str

Require or forbid trait HW_CPU_AARCH64_ATOMICS.

trait{group}:HW_CPU_AARCH64_JSCVT

Type
str

Require or forbid trait HW_CPU_AARCH64_JSCVT.

trait{group}:HW_CPU_AARCH64_FCMA

Type
str

Require or forbid trait HW_CPU_AARCH64_FCMA.

trait{group}:HW_CPU_AARCH64_LRCPC

Type
str

Require or forbid trait HW_CPU_AARCH64_LRCPC.

trait{group}:HW_CPU_AARCH64_DCPOP

Type
str

Require or forbid trait HW_CPU_AARCH64_DCPOP.

trait{group}:HW_CPU_AARCH64_SHA3

Type
str

Require or forbid trait HW_CPU_AARCH64_SHA3.

trait{group}:HW_CPU_AARCH64_SM3

Type
str

Require or forbid trait HW_CPU_AARCH64_SM3.

trait{group}:HW_CPU_AARCH64_SM4

Type
str

Require or forbid trait HW_CPU_AARCH64_SM4.

trait{group}:HW_CPU_AARCH64_ASIMDDP

Type
str

Require or forbid trait HW_CPU_AARCH64_ASIMDDP.

trait{group}:HW_CPU_AARCH64_SHA512

Type
str

Require or forbid trait HW_CPU_AARCH64_SHA512.

trait{group}:HW_CPU_AARCH64_SVE

Type
str

Require or forbid trait HW_CPU_AARCH64_SVE.

trait{group}:HW_CPU_AARCH64_CPUID

Type
str

Require or forbid trait HW_CPU_AARCH64_CPUID.

trait{group}:HW_CPU_AMD_SEV

Type
str

Require or forbid trait HW_CPU_AMD_SEV.

trait{group}:HW_CPU_PPC64LE_POWER8

Type
str

Require or forbid trait HW_CPU_PPC64LE_POWER8.

trait{group}:HW_CPU_PPC64LE_POWER9

Type
str

Require or forbid trait HW_CPU_PPC64LE_POWER9.

trait{group}:HW_CPU_X86_AVX

Type
str

Require or forbid trait HW_CPU_X86_AVX.

trait{group}:HW_CPU_X86_AVX2

Type
str

Require or forbid trait HW_CPU_X86_AVX2.

trait{group}:HW_CPU_X86_CLMUL

Type
str

Require or forbid trait HW_CPU_X86_CLMUL.

trait{group}:HW_CPU_X86_FMA3

Type
str

Require or forbid trait HW_CPU_X86_FMA3.

trait{group}:HW_CPU_X86_FMA4

Type
str

Require or forbid trait HW_CPU_X86_FMA4.

trait{group}:HW_CPU_X86_F16C

Type
str

Require or forbid trait HW_CPU_X86_F16C.

trait{group}:HW_CPU_X86_MMX

Type
str

Require or forbid trait HW_CPU_X86_MMX.

trait{group}:HW_CPU_X86_SSE

Type
str

Require or forbid trait HW_CPU_X86_SSE.

trait{group}:HW_CPU_X86_SSE2

Type
str

Require or forbid trait HW_CPU_X86_SSE2.

trait{group}:HW_CPU_X86_SSE3

Type
str

Require or forbid trait HW_CPU_X86_SSE3.

trait{group}:HW_CPU_X86_SSSE3

Type
str

Require or forbid trait HW_CPU_X86_SSSE3.

trait{group}:HW_CPU_X86_SSE41

Type
str

Require or forbid trait HW_CPU_X86_SSE41.

trait{group}:HW_CPU_X86_SSE42

Type
str

Require or forbid trait HW_CPU_X86_SSE42.

trait{group}:HW_CPU_X86_SSE4A

Type
str

Require or forbid trait HW_CPU_X86_SSE4A.

trait{group}:HW_CPU_X86_XOP

Type
str

Require or forbid trait HW_CPU_X86_XOP.

trait{group}:HW_CPU_X86_3DNOW

Type
str

Require or forbid trait HW_CPU_X86_3DNOW.

trait{group}:HW_CPU_X86_AVX512F

Type
str

Require or forbid trait HW_CPU_X86_AVX512F.

trait{group}:HW_CPU_X86_AVX512CD

Type
str

Require or forbid trait HW_CPU_X86_AVX512CD.

trait{group}:HW_CPU_X86_AVX512PF

Type
str

Require or forbid trait HW_CPU_X86_AVX512PF.

trait{group}:HW_CPU_X86_AVX512ER

Type
str

Require or forbid trait HW_CPU_X86_AVX512ER.

trait{group}:HW_CPU_X86_AVX512VL

Type
str

Require or forbid trait HW_CPU_X86_AVX512VL.

trait{group}:HW_CPU_X86_AVX512BW

Type
str

Require or forbid trait HW_CPU_X86_AVX512BW.

trait{group}:HW_CPU_X86_AVX512DQ

Type
str

Require or forbid trait HW_CPU_X86_AVX512DQ.

trait{group}:HW_CPU_X86_AVX512VNNI

Type
str

Require or forbid trait HW_CPU_X86_AVX512VNNI.

trait{group}:HW_CPU_X86_AVX512VBMI

Type
str

Require or forbid trait HW_CPU_X86_AVX512VBMI.

trait{group}:HW_CPU_X86_AVX512IFMA

Type
str

Require or forbid trait HW_CPU_X86_AVX512IFMA.

trait{group}:HW_CPU_X86_AVX512VBMI2

Type
str

Require or forbid trait HW_CPU_X86_AVX512VBMI2.

trait{group}:HW_CPU_X86_AVX512BITALG

Type
str

Require or forbid trait HW_CPU_X86_AVX512BITALG.

trait{group}:HW_CPU_X86_AVX512VAES

Type
str

Require or forbid trait HW_CPU_X86_AVX512VAES.

trait{group}:HW_CPU_X86_AVX512GFNI

Type
str

Require or forbid trait HW_CPU_X86_AVX512GFNI.

trait{group}:HW_CPU_X86_AVX512VPCLMULQDQ

Type
str

Require or forbid trait HW_CPU_X86_AVX512VPCLMULQDQ.

trait{group}:HW_CPU_X86_AVX512VPOPCNTDQ

Type
str

Require or forbid trait HW_CPU_X86_AVX512VPOPCNTDQ.

trait{group}:HW_CPU_X86_ABM

Type
str

Require or forbid trait HW_CPU_X86_ABM.

`trait{group}:HW_CPU_X86_BMI`

Type
str

Require or forbid trait HW_CPU_X86_BMI.

`trait{group}:HW_CPU_X86_BMI2`

Type
str

Require or forbid trait HW_CPU_X86_BMI2.

`trait{group}:HW_CPU_X86_TBM`

Type
str

Require or forbid trait HW_CPU_X86_TBM.

`trait{group}:HW_CPU_X86_AESNI`

Type
str

Require or forbid trait HW_CPU_X86_AESNI.

`trait{group}:HW_CPU_X86_SHA`

Type
str

Require or forbid trait HW_CPU_X86_SHA.

`trait{group}:HW_CPU_X86_MPX`

Type
str

Require or forbid trait HW_CPU_X86_MPX.

`trait{group}:HW_CPU_X86_SGX`

Type
str

Require or forbid trait HW_CPU_X86_SGX.

`trait{group}:HW_CPU_X86_TSX`

Type
str

Require or forbid trait HW_CPU_X86_TSX.

`trait{group}:HW_CPU_X86_ASF`

Type
str

Require or forbid trait HW_CPU_X86_ASF.

trait{group}:HW_CPU_X86_VMX

Type
str

Require or forbid trait HW_CPU_X86_VMX.

trait{group}:HW_CPU_X86_SVM

Type
str

Require or forbid trait HW_CPU_X86_SVM.

trait{group}:HW_CPU_X86_PDPE1GB

Type
str

Require or forbid trait HW_CPU_X86_PDPE1GB.

trait{group}:HW_CPU_X86_STIBP

Type
str

Require or forbid trait HW_CPU_X86_STIBP.

trait{group}:HW_CPU_X86_AMD_SEV

Type
str

Require or forbid trait HW_CPU_X86_AMD_SEV.

trait{group}:HW_CPU_X86_AMD_SEV_ES

Type
str

Require or forbid trait HW_CPU_X86_AMD_SEV_ES.

trait{group}:HW_CPU_X86_AMD_SVM

Type
str

Require or forbid trait HW_CPU_X86_AMD_SVM.

trait{group}:HW_CPU_X86_AMD_IBPB

Type
str

Require or forbid trait HW_CPU_X86_AMD_IBPB.

trait{group}:HW_CPU_X86_AMD_NO_SSB

Type
str

Require or forbid trait HW_CPU_X86_AMD_NO_SSB.

trait{group}:HW_CPU_X86_AMD_SSBD

Type
str

Require or forbid trait HW_CPU_X86_AMD_SSBD.

trait{group}:HW_CPU_X86_AMD_VIRT_SSBD

Type
str

Require or forbid trait HW_CPU_X86_AMD_VIRT_SSBD.

trait{group}:HW_CPU_X86_INTEL_MD_CLEAR

Type
str

Require or forbid trait HW_CPU_X86_INTEL_MD_CLEAR.

trait{group}:HW_CPU_X86_INTEL_PCID

Type
str

Require or forbid trait HW_CPU_X86_INTEL_PCID.

trait{group}:HW_CPU_X86_INTEL_SPEC_CTRL

Type
str

Require or forbid trait HW_CPU_X86_INTEL_SPEC_CTRL.

trait{group}:HW_CPU_X86_INTEL_SSBD

Type
str

Require or forbid trait HW_CPU_X86_INTEL_SSBD.

trait{group}:HW_CPU_X86_INTEL_VMX

Type
str

Require or forbid trait HW_CPU_X86_INTEL_VMX.

trait{group}:HW_GPU_API_DIRECTX_V10

Type
str

Require or forbid trait HW_GPU_API_DIRECTX_V10.

trait{group}:HW_GPU_API_DIRECTX_V11

Type
str

Require or forbid trait HW_GPU_API_DIRECTX_V11.

trait{group}:HW_GPU_API_DIRECTX_V12

Type
str

Require or forbid trait HW_GPU_API_DIRECTX_V12.

trait{group}:HW_GPU_API_DIRECT2D

Type
str

Require or forbid trait HW_GPU_API_DIRECT2D.

trait{group}:HW_GPU_API_DIRECT3D_V6_0

Type
str

Require or forbid trait HW_GPU_API_DIRECT3D_V6_0.

trait{group}:HW_GPU_API_DIRECT3D_V7_0

Type
str

Require or forbid trait HW_GPU_API_DIRECT3D_V7_0.

trait{group}:HW_GPU_API_DIRECT3D_V8_0

Type
str

Require or forbid trait HW_GPU_API_DIRECT3D_V8_0.

trait{group}:HW_GPU_API_DIRECT3D_V8_1

Type
str

Require or forbid trait HW_GPU_API_DIRECT3D_V8_1.

trait{group}:HW_GPU_API_DIRECT3D_V9_0

Type
str

Require or forbid trait HW_GPU_API_DIRECT3D_V9_0.

trait{group}:HW_GPU_API_DIRECT3D_V9_0B

Type
str

Require or forbid trait HW_GPU_API_DIRECT3D_V9_0B.

trait{group}:HW_GPU_API_DIRECT3D_V9_0C

Type
str

Require or forbid trait HW_GPU_API_DIRECT3D_V9_0C.

trait{group}:HW_GPU_API_DIRECT3D_V9_0L

Type
str

Require or forbid trait HW_GPU_API_DIRECT3D_V9_0L.

trait{group}:HW_GPU_API_DIRECT3D_V10_0

Type
str

Require or forbid trait HW_GPU_API_DIRECT3D_V10_0.

trait{group}:HW_GPU_API_DIRECT3D_V10_1

Type
str

Require or forbid trait HW_GPU_API_DIRECT3D_V10_1.

trait{group}:HW_GPU_API_DIRECT3D_V11_0

Type
str

Require or forbid trait HW_GPU_API_DIRECT3D_V11_0.

trait{group}:HW_GPU_API_DIRECT3D_V11_1

Type
str

Require or forbid trait HW_GPU_API_DIRECT3D_V11_1.

trait{group}:HW_GPU_API_DIRECT3D_V11_2

Type
str

Require or forbid trait HW_GPU_API_DIRECT3D_V11_2.

trait{group}:HW_GPU_API_DIRECT3D_V11_3

Type
str

Require or forbid trait HW_GPU_API_DIRECT3D_V11_3.

trait{group}:HW_GPU_API_DIRECT3D_V12_0

Type
str

Require or forbid trait HW_GPU_API_DIRECT3D_V12_0.

trait{group}:HW_GPU_API_VULKAN

Type
str

Require or forbid trait HW_GPU_API_VULKAN.

trait{group}:HW_GPU_API_DXVA

Type
str

Require or forbid trait HW_GPU_API_DXVA.

trait{group}:HW_GPU_API_OPENCL_V1_0

Type
str

Require or forbid trait HW_GPU_API_OPENCL_V1_0.

trait{group}:HW_GPU_API_OPENCL_V1_1

Type
str

Require or forbid trait HW_GPU_API_OPENCL_V1_1.

trait{group}:HW_GPU_API_OPENCL_V1_2

Type
str

Require or forbid trait HW_GPU_API_OPENCL_V1_2.

trait{group}:HW_GPU_API_OPENCL_V2_0

Type
str

Require or forbid trait HW_GPU_API_OPENCL_V2_0.

trait{group}:HW_GPU_API_OPENCL_V2_1

Type
str

Require or forbid trait HW_GPU_API_OPENCL_V2_1.

trait{group}:HW_GPU_API_OPENCL_V2_2

Type
str

Require or forbid trait HW_GPU_API_OPENCL_V2_2.

trait{group}:HW_GPU_API_OPENGL_V1_1

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V1_1.

trait{group}:HW_GPU_API_OPENGL_V1_2

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V1_2.

trait{group}:HW_GPU_API_OPENGL_V1_3

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V1_3.

trait{group}:HW_GPU_API_OPENGL_V1_4

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V1_4.

trait{group}:HW_GPU_API_OPENGL_V1_5

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V1_5.

trait{group}:HW_GPU_API_OPENGL_V2_0

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V2_0.

trait{group}:HW_GPU_API_OPENGL_V2_1

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V2_1.

trait{group}:HW_GPU_API_OPENGL_V3_0

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V3_0.

trait{group}:HW_GPU_API_OPENGL_V3_1

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V3_1.

trait{group}:HW_GPU_API_OPENGL_V3_2

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V3_2.

trait{group}:HW_GPU_API_OPENGL_V3_3

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V3_3.

trait{group}:HW_GPU_API_OPENGL_V4_0

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V4_0.

trait{group}:HW_GPU_API_OPENGL_V4_1

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V4_1.

trait{group}:HW_GPU_API_OPENGL_V4_2

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V4_2.

trait{group}:HW_GPU_API_OPENGL_V4_3

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V4_3.

trait{group}:HW_GPU_API_OPENGL_V4_4

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V4_4.

trait{group}:HW_GPU_API_OPENGL_V4_5

Type
str

Require or forbid trait HW_GPU_API_OPENGL_V4_5.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V1_0

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V1_0.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V1_1

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V1_1.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V1_2

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V1_2.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V1_3

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V1_3.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V2_0

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V2_0.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V2_1

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V2_1.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V3_0

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V3_0.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V3_2

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V3_2.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V3_5

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V3_5.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V3_7

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V3_7.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V5_0

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V5_0.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V5_2

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V5_2.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V5_3

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V5_3.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V6_0

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V6_0.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V6_1

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V6_1.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V6_2

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V6_2.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V7_0

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V7_0.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V7_1

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V7_1.

trait{group}:HW_GPU_CUDA_COMPUTE_CAPABILITY_V7_2

Type
str

Require or forbid trait HW_GPU_CUDA_COMPUTE_CAPABILITY_V7_2.

trait{group}:HW_GPU_CUDA_SDK_V6_5

Type
str

Require or forbid trait HW_GPU_CUDA_SDK_V6_5.

trait{group}:HW_GPU_CUDA_SDK_V7_5

Type
str

Require or forbid trait HW_GPU_CUDA_SDK_V7_5.

trait{group}:HW_GPU_CUDA_SDK_V8_0

Type
str

Require or forbid trait HW_GPU_CUDA_SDK_V8_0.

trait{group}:HW_GPU_CUDA_SDK_V9_0

Type
str

Require or forbid trait HW_GPU_CUDA_SDK_V9_0.

trait{group}:HW_GPU_CUDA_SDK_V9_1

Type
str

Require or forbid trait HW_GPU_CUDA_SDK_V9_1.

trait{group}:HW_GPU_CUDA_SDK_V9_2

Type
str

Require or forbid trait HW_GPU_CUDA_SDK_V9_2.

trait{group}:HW_GPU_CUDA_SDK_V10_0

Type
str

Require or forbid trait HW_GPU_CUDA_SDK_V10_0.

trait{group}:HW_GPU_MAX_DISPLAY_HEADS_1

Type
str

Require or forbid trait HW_GPU_MAX_DISPLAY_HEADS_1.

trait{group}:HW_GPU_MAX_DISPLAY_HEADS_2

Type
str

Require or forbid trait HW_GPU_MAX_DISPLAY_HEADS_2.

trait{group}:HW_GPU_MAX_DISPLAY_HEADS_4

Type
str

Require or forbid trait HW_GPU_MAX_DISPLAY_HEADS_4.

trait{group}:HW_GPU_MAX_DISPLAY_HEADS_6

Type
str

Require or forbid trait HW_GPU_MAX_DISPLAY_HEADS_6.

trait{group}:HW_GPU_MAX_DISPLAY_HEADS_8

Type
str

Require or forbid trait HW_GPU_MAX_DISPLAY_HEADS_8.

trait{group}:HW_GPU_RESOLUTION_W320H240

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W320H240.

trait{group}:HW_GPU_RESOLUTION_W640H480

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W640H480.

trait{group}:HW_GPU_RESOLUTION_W800H600

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W800H600.

trait{group}:HW_GPU_RESOLUTION_W1024H600

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W1024H600.

trait{group}:HW_GPU_RESOLUTION_W1024H768

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W1024H768.

trait{group}:HW_GPU_RESOLUTION_W1152H864

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W1152H864.

trait{group}:HW_GPU_RESOLUTION_W1280H720

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W1280H720.

trait{group}:HW_GPU_RESOLUTION_W1280H768

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W1280H768.

trait{group}:HW_GPU_RESOLUTION_W1280H800

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W1280H800.

trait{group}:HW_GPU_RESOLUTION_W1280H1024

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W1280H1024.

trait{group}:HW_GPU_RESOLUTION_W1360H768

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W1360H768.

trait{group}:HW_GPU_RESOLUTION_W1366H768

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W1366H768.

trait{group}:HW_GPU_RESOLUTION_W1440H900

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W1440H900.

trait{group}:HW_GPU_RESOLUTION_W1600H900

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W1600H900.

trait{group}:HW_GPU_RESOLUTION_W1600H1200

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W1600H1200.

trait{group}:HW_GPU_RESOLUTION_W1680H1050

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W1680H1050.

trait{group}:HW_GPU_RESOLUTION_W1920H1080

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W1920H1080.

trait{group}:HW_GPU_RESOLUTION_W1920H1200

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W1920H1200.

trait{group}:HW_GPU_RESOLUTION_W2560H1440

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W2560H1440.

trait{group}:HW_GPU_RESOLUTION_W2560H1600

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W2560H1600.

trait{group}:HW_GPU_RESOLUTION_W3840H2160

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W3840H2160.

trait{group}:HW_GPU_RESOLUTION_W7680H4320

Type
str

Require or forbid trait HW_GPU_RESOLUTION_W7680H4320.

trait{group}:HW_NIC_SRIOV

Type
str

Require or forbid trait HW_NIC_SRIOV.

trait{group}:HW_NIC_MULTIQUEUE

Type
str

Require or forbid trait HW_NIC_MULTIQUEUE.

trait{group}:HW_NIC_VMDQ

Type
str

Require or forbid trait HW_NIC_VMDQ.

trait{group}:HW_NIC_PROGRAMMABLE_PIPELINE

Type
str

Require or forbid trait HW_NIC_PROGRAMMABLE_PIPELINE.

trait{group}:HW_NIC_ACCEL_SSL

Type
str

Require or forbid trait HW_NIC_ACCEL_SSL.

trait{group}:HW_NIC_ACCEL_IPSEC

Type
str

Require or forbid trait HW_NIC_ACCEL_IPSEC.

trait{group}:HW_NIC_ACCEL_TLS

Type
str

Require or forbid trait HW_NIC_ACCEL_TLS.

trait{group}:HW_NIC_ACCEL_DIFFIEH

Type
str

Require or forbid trait HW_NIC_ACCEL_DIFFIEH.

trait{group}:HW_NIC_ACCEL_RSA

Type
str

Require or forbid trait HW_NIC_ACCEL_RSA.

trait{group}:HW_NIC_ACCEL_ECC

Type
str

Require or forbid trait HW_NIC_ACCEL_ECC.

trait{group}:HW_NIC_ACCEL_LZS

Type
str

Require or forbid trait HW_NIC_ACCEL_LZS.

trait{group}:HW_NIC_ACCEL_DEFLATE

Type
str

Require or forbid trait HW_NIC_ACCEL_DEFLATE.

trait{group}:HW_NIC_DCB_PFC

Type
str

Require or forbid trait HW_NIC_DCB_PFC.

trait{group}:HW_NIC_DCB_ETS

Type
str

Require or forbid trait HW_NIC_DCB_ETS.

trait{group}:HW_NIC_DCB_QCN

Type
str

Require or forbid trait HW_NIC_DCB_QCN.

trait{group}:HW_NIC_OFFLOAD_TSO

Type
str

Require or forbid trait HW_NIC_OFFLOAD_TSO.

trait{group}:HW_NIC_OFFLOAD_GRO

Type
str

Require or forbid trait HW_NIC_OFFLOAD_GRO.

trait{group}:HW_NIC_OFFLOAD_GSO

Type
str

Require or forbid trait HW_NIC_OFFLOAD_GSO.

trait{group}:HW_NIC_OFFLOAD_UFO

Type
str

Require or forbid trait HW_NIC_OFFLOAD_UFO.

trait{group}:HW_NIC_OFFLOAD_LRO

Type
str

Require or forbid trait HW_NIC_OFFLOAD_LRO.

trait{group}:HW_NIC_OFFLOAD_LSO

Type
str

Require or forbid trait HW_NIC_OFFLOAD_LSO.

trait{group}:HW_NIC_OFFLOAD_TCS

Type
str

Require or forbid trait HW_NIC_OFFLOAD_TCS.

`trait{group}:HW_NIC_OFFLOAD_UCS`

Type
str

Require or forbid trait HW_NIC_OFFLOAD_UCS.

`trait{group}:HW_NIC_OFFLOAD_SCS`

Type
str

Require or forbid trait HW_NIC_OFFLOAD_SCS.

`trait{group}:HW_NIC_OFFLOAD_L2CRC`

Type
str

Require or forbid trait HW_NIC_OFFLOAD_L2CRC.

`trait{group}:HW_NIC_OFFLOAD_FDF`

Type
str

Require or forbid trait HW_NIC_OFFLOAD_FDF.

`trait{group}:HW_NIC_OFFLOAD_RXVLAN`

Type
str

Require or forbid trait HW_NIC_OFFLOAD_RXVLAN.

`trait{group}:HW_NIC_OFFLOAD_TXVLAN`

Type
str

Require or forbid trait HW_NIC_OFFLOAD_TXVLAN.

`trait{group}:HW_NIC_OFFLOAD_VXLAN`

Type
str

Require or forbid trait HW_NIC_OFFLOAD_VXLAN.

`trait{group}:HW_NIC_OFFLOAD_GRE`

Type
str

Require or forbid trait HW_NIC_OFFLOAD_GRE.

`trait{group}:HW_NIC_OFFLOAD_GENEVE`

Type
str

Require or forbid trait HW_NIC_OFFLOAD_GENEVE.

trait{group}:HW_NIC_OFFLOAD_TXUDP

Type
str

Require or forbid trait HW_NIC_OFFLOAD_TXUDP.

trait{group}:HW_NIC_OFFLOAD_QINQ

Type
str

Require or forbid trait HW_NIC_OFFLOAD_QINQ.

trait{group}:HW_NIC_OFFLOAD_RDMA

Type
str

Require or forbid trait HW_NIC_OFFLOAD_RDMA.

trait{group}:HW_NIC_OFFLOAD_RXHASH

Type
str

Require or forbid trait HW_NIC_OFFLOAD_RXHASH.

trait{group}:HW_NIC_OFFLOAD_RX

Type
str

Require or forbid trait HW_NIC_OFFLOAD_RX.

trait{group}:HW_NIC_OFFLOAD_TX

Type
str

Require or forbid trait HW_NIC_OFFLOAD_TX.

trait{group}:HW_NIC_OFFLOAD_SG

Type
str

Require or forbid trait HW_NIC_OFFLOAD_SG.

trait{group}:HW_NIC_OFFLOAD_SWITCHDEV

Type
str

Require or forbid trait HW_NIC_OFFLOAD_SWITCHDEV.

trait{group}:HW_NIC_SRIOV_QOS_TX

Type
str

Require or forbid trait HW_NIC_SRIOV_QOS_TX.

trait{group}:HW_NIC_SRIOV_QOS_RX

Type
str

Require or forbid trait HW_NIC_SRIOV_QOS_RX.

trait{group}:HW_NIC_SRIOV_MULTIQUEUE

Type
str

Require or forbid trait HW_NIC_SRIOV_MULTIQUEUE.

trait{group}:HW_NIC_SRIOV_TRUSTED

Type
str

Require or forbid trait HW_NIC_SRIOV_TRUSTED.

trait{group}:HW_NUMA_ROOT

Type
str

Require or forbid trait HW_NUMA_ROOT.

trait{group}:HW_PCI_LIVE_MIGRATABLE

Type
str

Require or forbid trait HW_PCI_LIVE_MIGRATABLE.

trait{group}:HW_PCI_ONE_TIME_USE

Type
str

Require or forbid trait HW_PCI_ONE_TIME_USE.

trait{group}:MISC_SHARES_VIA_AGGREGATE

Type
str

Require or forbid trait MISC_SHARES_VIA_AGGREGATE.

trait{group}:OWNER_CYBORG

Type
str

Require or forbid trait OWNER_CYBORG.

trait{group}:OWNER_NOVA

Type
str

Require or forbid trait OWNER_NOVA.

`trait{group}:STORAGE_DISK_HDD`

Type
str

Require or forbid trait STORAGE_DISK_HDD.

`trait{group}:STORAGE_DISK_SSD`

Type
str

Require or forbid trait STORAGE_DISK_SSD.

`trait{group}:CUSTOM_{trait}`

Type
str

Require or forbid trait CUSTOM_{trait}.

Scheduler Filters

The following extra specs are specific to various in-tree scheduler filters.

aggregate_instance_extra_specs

The following extra specs are used to specify metadata that must be present on the aggregate of a host. If this metadata is not present or does not match the expected value, the aggregate and all hosts within in will be rejected.

Requires the `AggregateInstanceExtraSpecsFilter` scheduler filter.

`aggregate_instance_extra_specs:{key}`

Type
str

Specify metadata that must be present on the aggregate of a host. If this metadata is not present, the host will be rejected. Requires the `AggregateInstanceExtraSpecsFilter` scheduler filter.

The value can be one of the following:

- = (equal to or greater than as a number; same as vcpus case)
- == (equal to as a number)
- != (not equal to as a number)
- >= (greater than or equal to as a number)
- <= (less than or equal to as a number)
- s== (equal to as a string)
- s!= (not equal to as a string)
- s>= (greater than or equal to as a string)
- s> (greater than as a string)

- s<= (less than or equal to as a string)
- s< (less than as a string)
- <in> (substring)
- <all-in> (all elements contained in collection)
- <or> (find one of these)
- A specific value, e.g. true, 123, testing

capabilities

The following extra specs are used to specify a host capability that must be provided by the host compute service. If this capability is not present or does not match the expected value, the host will be rejected.

Requires the ComputeCapabilitiesFilter scheduler filter.

All extra specs expect similar types of values:

- = (equal to or greater than as a number; same as vcpus case)
- == (equal to as a number)
- != (not equal to as a number)
- >= (greater than or equal to as a number)
- <= (less than or equal to as a number)
- s== (equal to as a string)
- s!= (not equal to as a string)
- s>= (greater than or equal to as a string)
- s> (greater than as a string)
- s<= (less than or equal to as a string)
- s< (less than as a string)
- <in> (substring)
- <all-in> (all elements contained in collection)
- <or> (find one of these)
- A specific value, e.g. true, 123, testing

Examples are: >= 5, s== 2.1.0, <in> gcc, <all-in> aes mmx, and <or> fpu <or> gpu

Note

Not all operators will apply to all types of values. For example, the == operator should not be used for a string value - use s== instead.

capabilities:id

Type
str

Specify that the id capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:uuid`

Type
str

Specify that the uuid capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:service_id`

Type
str

Specify that the service_id capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:host`

Type
str

Specify that the host capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:vcpus`

Type
str

Specify that the vcpus capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:memory_mb`

Type
str

Specify that the memory_mb capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:local_gb`

Type
str

Specify that the local_gb capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:vcpus_used`

Type
str

Specify that the vcpus_used capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:memory_mb_used`

Type
str

Specify that the memory_mb_used capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:local_gb_used`

Type
str

Specify that the local_gb_used capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:hypervisor_type`

Type
str

Specify that the hypervisor_type capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:hypervisor_version`

Type
str

Specify that the hypervisor_version capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:hypervisor_hostname`

Type
str

Specify that the hypervisor_hostname capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:free_ram_mb`

Type
str

Specify that the free_ram_mb capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:free_disk_gb`

Type
str

Specify that the free_disk_gb capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:current_workload`

Type
str

Specify that the current_workload capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:running_vms`

Type
str

Specify that the running_vms capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:disk_available_least`

Type
str

Specify that the disk_available_least capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:host_ip`

Type
str

Specify that the host_ip capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:mapped`

Type
str

Specify that the mapped capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:cpu_allocation_ratio`

Type
str

Specify that the cpu_allocation_ratio capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:ram_allocation_ratio`

Type
str

Specify that the ram_allocation_ratio capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:disk_allocation_ratio`

Type
str

Specify that the disk_allocation_ratio capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:total_usable_ram_mb`

Type
str

Specify that the total_usable_ram_mb capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:total_usable_disk_gb`

Type
str

Specify that the total_usable_disk_gb capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:disk_mb_used`

Type
str

Specify that the disk_mb_used capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:free_disk_mb`

Type
str

Specify that the free_disk_mb capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:vcpus_total`

Type
str

Specify that the vcpus_total capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:num_instances`

Type
str

Specify that the num_instances capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:num_io_ops`

Type
str

Specify that the num_io_ops capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:failed_builds`

Type
str

Specify that the failed_builds capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:aggregates`

Type
str

Specify that the aggregates capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:cell_uuid`

Type
str

Specify that the cell_uuid capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:updated`

Type
str

Specify that the updated capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:cpu_info{filter}`

Type
str

Specify that the cpu_info capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:metrics{filter}`

Type
str

Specify that the metrics capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:stats{filter}`

Type
str

Specify that the stats capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:numa_topology{filter}`

Type
str

Specify that the numa_topology capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:supported_hv_specs{filter}`

Type
str

Specify that the supported_hv_specs capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:pci_device_pools{filter}`

Type
str

Specify that the pci_device_pools capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:nodename{filter}`

Type
str

Specify that the nodename capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:pci_stats{filter}`

Type
str

Specify that the pci_stats capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:supported_instances{filter}`

Type
str

Specify that the supported_instances capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:limits{filter}`

Type
str

Specify that the limits capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

`capabilities:instances{filter}`

Type
str

Specify that the instances capability provided by the host compute service satisfy the provided filter value. Requires the `ComputeCapabilitiesFilter` scheduler filter.

Virt driver

The following extra specs are used as hints to configure internals of a instance, from the bus used for paravirtualized devices to the amount of a physical device to passthrough to the instance. Most of these are virt driver-specific.

quota

The following extra specs are used to configure quotas for various paravirtualized devices. Different quotas are supported by different virt drivers, as noted below.

quota:cpu_limit

Type
int

Min
0

The upper limit for CPU allocation in MHz. The utilization of an instance will not exceed this limit, even if there are available resources. This is typically used to ensure a consistent performance of instances independent of available resources. The value `0` indicates that CPU usage is not limited. Only supported by the VMWare virt driver.

quota:cpu_reservation

Type
int

The guaranteed minimum CPU reservation in MHz. This means the specified amount of CPU that will be guaranteed for the instance. Only supported by the VMWare virt driver.

quota:cpu_shares_level

Type
str

The allocation level for CPU. If you choose custom, set the number of CPU shares using quota:cpu_shares_share. Only supported by the VMWare virt driver.

quota:cpu_shares_share

Type
int

Min
0

The number of shares of CPU allocated in the event that quota:cpu_shares_level=custom is used. Ignored otherwise. There is no unit for this value: it is a relative measure based on the settings for other instances. Only supported by the VMWare virt driver.

quota:memory_limit

Type
int

Min
0

The upper limit for memory allocation in MB. The utilization of an instance will not exceed this limit, even if there are available resources. This is typically used to ensure a consistent performance of instances independent of available resources. The value `0` indicates that memory usage is not limited. Only supported by the VMWare virt driver.

`quota:memory_reservation`

Type
int

The guaranteed minimum memory reservation in MB. This means the specified amount of memory that will be guaranteed for the instance. Only supported by the VMWare virt driver.

`quota:memory_shares_level`

Type
str

The allocation level for memory. If you choose custom, set the number of memory shares using quota:memory_shares_share. Only supported by the VMWare virt driver.

`quota:memory_shares_share`

Type
int

Min
0

The number of shares of memory allocated in the event that quota:memory_shares_level=custom is used. Ignored otherwise. There is no unit for this value: it is a relative measure based on the settings for other instances. Only supported by the VMWare virt driver.

`quota:disk_io_limit`

Type
int

Min
0

The upper limit for disk IO allocation in I/O per second. The utilization of an instance will not exceed this limit, even if there are available resources. This is typically used to ensure a consistent performance of instances independent of available resources. The value `0` indicates that disk IO usage is not limited. Only supported by the VMWare virt driver.

`quota:disk_io_reservation`

Type
int

The guaranteed minimum disk IO reservation in I/O per second. This means the specified amount of disk IO that will be guaranteed for the instance. Only supported by the VMWare virt driver.

`quota:disk_io_shares_level`

Type
str

The allocation level for disk IO. If you choose custom, set the number of disk IO shares using quota:disk_io_shares_share. Only supported by the VMWare virt driver.

`quota:disk_io_shares_share`

Type
int

Min
0

The number of shares of disk IO allocated in the event that quota:disk_io_shares_level=custom is used. Ignored otherwise. There is no unit for this value: it is a relative measure based on the settings for other instances. Only supported by the VMWare virt driver.

`quota:vif_limit`

Type
int

Min
0

The upper limit for virtual interface allocation in Mbps. The utilization of an instance will not exceed this limit, even if there are available resources. This is typically used to ensure a consistent performance of instances independent of available resources. The value `0` indicates that virtual interface usage is not limited. Only supported by the VMWare virt driver.

`quota:vif_reservation`

Type
int

The guaranteed minimum virtual interface reservation in Mbps. This means the specified amount of virtual interface that will be guaranteed for the instance. Only supported by the VMWare virt driver.

`quota:vif_shares_level`

Type
str

The allocation level for virtual interface. If you choose custom, set the number of virtual interface shares using quota:vif_shares_share. Only supported by the VMWare virt driver.

`quota:vif_shares_share`

Type
int

Min
0

The number of shares of virtual interface allocated in the event that quota:vif_shares_level=custom is used. Ignored otherwise. There is no unit for this value: it is a relative measure based on the settings for other instances. Only supported by the VMWare virt driver.

`quota:cpu_shares`

Type
int

Min
0

The proportional weighted share for the domain. If this element is omitted, the service defaults to the OS provided defaults. There is no unit for the value; it is a relative measure based on the setting of other VMs. For example, a VM configured with a value of 2048 gets twice as much CPU time as a VM configured with value 1024. Only supported by the libvirt virt driver.

`quota:cpu_period`

Type
int

Min
0

Specifies the enforcement interval in microseconds. Within a period, each VCPU of the instance is not allowed to consume more than the quota worth of runtime. The value should be in range 1,000 - 1,000,000. A period with a value of 0 means no value. Only supported by the libvirt virt driver.

`quota:cpu_quota`

Type
int

The maximum allowed bandwidth in microseconds. Can be combined with quota:cpu_period to limit an instance to a percentage of capacity of a physical CPU. The value should be in range 1,000 - 2^64 or negative. A negative value indicates that the instance has infinite bandwidth. Only supported by the libvirt virt driver.

`quota:disk_read_bytes_sec`

Type
int

Min
0

The quota read bytes for disk. Only supported by the libvirt virt driver.

`quota:disk_read_iops_sec`

Type
int

Min
0

The quota read iops for disk. Only supported by the libvirt virt driver.

`quota:disk_write_bytes_sec`

Type
int

Min
0

The quota write bytes for disk. Only supported by the libvirt virt driver.

`quota:disk_write_iops_sec`

Type
int

Min
0

The quota write iops for disk. Only supported by the libvirt virt driver.

`quota:disk_total_bytes_sec`

Type
int

Min
0

The quota total bytes for disk. Only supported by the libvirt virt driver.

`quota:disk_total_iops_sec`

Type
int

Min
0

The quota total iops for disk. Only supported by the libvirt virt driver.

`quota:vif_inbound_average`

Type
int

Min
0

The quota inbound average for VIF. Only supported by the libvirt virt driver.

`quota:vif_inbound_peak`

Type
int

Min
0

The quota inbound peak for VIF. Only supported by the libvirt virt driver.

`quota:vif_inbound_burst`

Type
int

Min
0

The quota inbound burst for VIF. Only supported by the libvirt virt driver.

`quota:vif_outbound_average`

Type
int

Min
0

The quota outbound average for VIF. Only supported by the libvirt virt driver.

`quota:vif_outbound_peak`

Type
int

Min
0

The quota outbound peak for VIF. Only supported by the libvirt virt driver.

`quota:vif_outbound_burst`

Type
int

Min
0

The quota outbound burst for VIF. Only supported by the libvirt virt driver.

accel

The following extra specs are used to configure attachment of various accelerators to an instance. For more information, refer to the Cyborg documentation.

They are only supported by the libvirt virt driver.

`accel:device_profile`

Type
str

The name of a device profile to configure for the instance. A device profile may be viewed as a flavor for devices.

pci_passthrough

The following extra specs are used to configure passthrough of a host PCI device to an instance. This requires prior host configuration. For more information, refer to *Attaching physical PCI devices to guests*.

They are only supported by the libvirt virt driver.

`pci_passthrough:alias`

Type
str

Specify the number of `$alias` PCI device(s) to attach to the instance. Must be of format `$alias:$count`, where `$alias` corresponds to a particular PCI device class (as configured in `nova.conf`) and `$count` is the amount of PCI devices of type `$alias` to be assigned to the instance. Use commas to specify multiple values. Only supported by the libvirt virt driver.

hw

The following extra specs are used to configure various attributes of instances. Some of the extra specs act as feature flags, while others tweak for example the guest-visible CPU topology of the instance.

Except where otherwise stated, they are only supported by the libvirt virt driver.

hw:cpu_realtime

Type
bool

Determine whether realtime mode should be enabled for the instance or not. Only supported by the libvirt virt driver.

hw:cpu_realtime_mask

Type
str

A exclusion mask of CPUs that should not be enabled for realtime. Only supported by the libvirt virt driver.

hw:hide_hypervisor_id

Type
bool

Determine whether the hypervisor ID should be hidden from the guest. Only supported by the libvirt virt driver.

hw:cpu_policy

Type
str

The policy to apply when determining what host CPUs the guest CPUs can run on. If `shared` (default), guest CPUs can be overallocated but cannot float across host cores. If `dedicated`, guest CPUs cannot be overallocated but are individually pinned to their own host core. If `mixed`, the policy for each instance CPU can be specified using the `hw:cpu_dedicated_mask` or `hw:cpu_realtime_mask` extra specs. Only supported by the libvirt virt driver.

hw:cpu_thread_policy

Type
str

The policy to apply when determining whether the destination host can have hardware threads enabled or not. If `prefer` (default), hosts with hardware threads will be preferred. If `require`, hosts with hardware threads will be required. If `isolate`, hosts with hardware threads will be forbidden. Only supported by the libvirt virt driver.

`hw:emulator_threads_policy`

Type
str

The policy to apply when determining whether emulator threads should be offloaded to a separate isolated core or to a pool of shared cores. If `share`, emulator overhead threads will be offloaded to a pool of shared cores. If `isolate`, emulator overhead threads will be offloaded to their own core. Only supported by the libvirt virt driver.

`hw:cpu_dedicated_mask`

Type
str

A mapping of **guest** (instance) CPUs to be pinned to **host** CPUs for an instance with a `mixed` CPU policy. Any **guest** CPUs which are not in this mapping will float across host cores. Only supported by the libvirt virt driver.

`hw:mem_page_size`

Type
str

The size of memory pages to allocate to the guest with. Can be one of the three alias - `large`, `small` or `any`, - or an actual size. Only supported by the libvirt virt driver.

`hw:locked_memory`

Type
bool

Determine if **guest** (instance) memory should be locked preventing swapping. This is required in rare cases for device DMA transfers. Only supported by the libvirt virt driver.

`hw:numa_nodes`

Type
int

Min
1

The number of virtual NUMA nodes to allocate to configure the guest with. Each virtual NUMA node will be mapped to a unique host NUMA node. Only supported by the libvirt virt driver.

`hw:numa_cpus.{num}`

Type
str

A mapping of **guest** (instance) CPUs to the **guest** (not host!) NUMA node identified by `{num}`. This can be used to provide asymmetric CPU-NUMA allocation and is necessary where the number of guest NUMA nodes is not a factor of the number of guest CPUs. Only supported by the libvirt virt driver.

`hw:numa_mem.{num}`

Type
int

Min
1

A mapping of **guest** memory to the **guest** (not host!) NUMA node identified by `{num}`. This can be used to provide asymmetric memory-NUMA allocation and is necessary where the number of guest NUMA nodes is not a factor of the total guest memory. Only supported by the libvirt virt driver.

`hw:pci_numa_affinity_policy`

Type
str

The NUMA affinity policy of any PCI passthrough devices or SR-IOV network interfaces attached to the instance. If `required`, only PCI devices from one of the host NUMA nodes the instance VCPUs are allocated from can be used by said instance. If `preferred`, any PCI device can be used, though preference will be given to those from the same NUMA node as the instance VCPUs. If `legacy` (default), behavior is as with `required` unless the PCI device does not support provide NUMA affinity information, in which case affinity is ignored. Only supported by the libvirt virt driver.

`hw:cpu_sockets`

Type
int

Min
1

The number of virtual CPU sockets to emulate in the guest CPU topology. Defaults to the number of vCPUs requested. Only supported by the libvirt virt driver.

`hw:cpu_cores`

Type
int

Min
1

The number of virtual CPU cores to emulate per socket in the guest CPU topology. Defaults to 1. Only supported by the libvirt virt driver.

`hw:cpu_threads`

Type
int

Min
1

The number of virtual CPU threads to emulate per core in the guest CPU topology. Defaults to 1. Only supported by the libvirt virt driver.

`hw:cpu_max_sockets`

Type
int

Min
1

The max number of virtual CPU sockets to emulate in the guest CPU topology. This is used to limit the topologies that can be requested by an image and will be used to validate the `hw_cpu_sockets` image metadata property. Only supported by the libvirt virt driver.

`hw:cpu_max_cores`

Type
int

Min
1

The max number of virtual CPU cores to emulate per socket in the guest CPU topology. This is used to limit the topologies that can be requested by an image and will be used to validate the `hw_cpu_cores` image metadata property. Only supported by the libvirt virt driver.

`hw:cpu_max_threads`

Type
int

Min
1

The max number of virtual CPU threads to emulate per core in the guest CPU topology. This is used to limit the topologies that can be requested by an image and will be used to validate the `hw_cpu_threads` image metadata property. Only supported by the libvirt virt driver.

`hw:boot_menu`

Type
bool

Whether to show a boot menu when booting the guest. Only supported by the libvirt virt driver.

`hw:vif_multiqueue_enabled`

Type
bool

Whether to enable the virtio-net multiqueue feature. When set, the driver sets the number of queues equal to the number of guest vCPUs. This makes the network performance scale across a number of vCPUs. This requires guest support and is only supported by the libvirt driver.

`hw:mem_encryption`

Type
bool

Whether to enable memory encryption for the guest. Only supported by the libvirt virt driver on hosts with AMD SEV support.

`hw:mem_encryption_model`

Type
str

CPU feature used for memory encryption of the guest. This has no effect unless hw:mem_encryption (or equivalent image property) is set to True.

hw:pmem

Type
str

A comma-separated list of `$LABEL`s defined in config for vPMEM devices. Only supported by the libvirt virt driver on hosts with PMEM devices.

hw:pmu

Type
bool

Whether to enable the Performance Monitory Unit (PMU) for the guest. If this option is not specified, the presence of the vPMU is determined by the hypervisor. The vPMU is used by tools like `perf` in the guest to provide more accurate information for profiling application and monitoring guest performance. For realtime workloads, the emulation of a vPMU can introduce additional latency which may be undesirable. If the telemetry it provides is not required, such workloads should disable this feature. For most workloads, the default of unset will be correct. Only supported by the libvirt virt driver.

hw:serial_port_count

Type
int

Min
0

The number of serial ports to allocate to the guest. Only supported by the libvirt virt driver.

hw:tpm_model

Type
str

The model of the attached TPM device. Only supported by the libvirt virt driver.

hw:tpm_version

Type
str

The TPM version. Required if requesting a vTPM via the hw:tpm_model extra spec or equivalent image metadata property. Only supported by the libvirt virt driver.

hw:tpm_secret_security

Type
str

The TPM secret security. Only supported by the libvirt virt driver.

hw:watchdog_action

Type
str

The action to take when the watchdog timer is kicked. Watchdog devices keep an eye on the instance and carry out the specified action if the server hangs. The watchdog uses the `i6300esb` device, emulating a PCI Intel 6300ESB. Only supported by the libvirt virt driver.

`hw:viommu_model`

Type
str

This can be used to set model for virtual IOMMU device.

`hw:virtio_packed_ring`

Type
bool

Permit guests to negotiate the virtio packed ring format. This requires guest support and is only supported by the libvirt driver.

`hw:sound_model`

Type
str

The model of the attached sound device. Only supported by the libvirt virt driver. If unset, no sound device is attached.

`hw:usb_model`

Type
str

The model of the attached USB controller device. Only supported by the libvirt virt driver. If unset, no USB controller device is attached.

`hw:redirected_usb_ports`

Type
int

Min
0

Max
15

The number of redirected USB ports to add to the virtual machine. Only supported by the libvirt virt driver. If unset, no redirected USB ports are added. The maximum value is 15.

`hw:ephemeral_encryption`

Type
bool

Whether to enable ephemeral storage encryption.

`hw:ephemeral_encryption_format`

Type
str

The encryption format to be used if ephemeral storage encryption is enabled via hw:ephemeral_encryption.

hw_rng

The following extra specs are used to configure a random number generator for an instance.

They are only supported by the libvirt virt driver.

hw_rng:allowed

Type
bool

Whether to disable configuration of a random number generator in their image. Before 21.0.0 (Ussuri), random number generators were not enabled by default so this was used to determine whether to **enable** configuration.

hw_rng:rate_bytes

Type
int

Min
0

The allowed amount of bytes for the guest to read from the hosts entropy per period.

hw_rng:rate_period

Type
int

Min
0

The duration of a read period in milliseconds.

hw_video

The following extra specs are used to configure attributes of the default guest video device.

They are only supported by the libvirt virt driver.

hw_video:ram_max_mb

Type
int

Min
0

The maximum amount of memory the user can request using the `hw_video_ram` image metadata property, which represents the video memory that the guest OS will see. This has no effect for vGPUs.

os

The following extra specs are used to configure secure_boot.

They are only supported by the libvirt virt driver.

os:secure_boot

> **Type**
> str
>
> Determine whether secure boot is enabled or not. Only supported by the libvirt virt drivers.

vmware

The following extra specs are used to configure various attributes of instances when using the VMWare virt driver.

They are only supported by the VMWare virt driver.

vmware:hw_version

> **Type**
> str
>
> Specify the hardware version used to create images. In an environment with different host versions, you can use this parameter to place instances on the correct hosts.

vmware:storage_policy

> **Type**
> str
>
> Specify the storage policy used for new instances. If Storage Policy-Based Management (SPBM) is not enabled, this parameter is ignored.

Others (uncategorized)

The following extra specs are not part of a group.

hide_hypervisor_id

> **Type**
> bool
>
> Determine whether the hypervisor ID should be hidden from the guest. Only supported by the libvirt virt driver. This extra spec is not compatible with the AggregateInstanceExtraSpecsFilter scheduler filter. The `hw:hide_hypervisor_id` extra spec should be used instead.
>
> **Warning**
>
> This extra spec has been deprecated and should not be used.

group_policy

> **Type**
> str

The group policy to apply when using the granular resource request syntax.

CHAPTER

FOUR

FOR CONTRIBUTORS

- *So You Want to Contribute*: If you are a new contributor this should help you to start contributing to Nova.
- *Contributor Documentation*: If you are new to Nova, this should help you start to understand what Nova actually does, and why.
- *Technical Reference Deep Dives*: There are also a number of technical references on both current and future looking parts of our architecture. These are collected here.

4.1 Contributor Documentation

Contributing to nova gives you the power to help add features, fix bugs, enhance documentation, and increase testing. Contributions of any type are valuable, and part of what keeps the project going. Here are a list of resources to get your started.

4.1.1 Basic Information

4.1.1.1 So You Want to Contribute

For general information on contributing to OpenStack, please check out the contributor guide to get started. It covers all the basics that are common to all OpenStack projects: the accounts you need, the basics of interacting with our Gerrit review system, how we communicate as a community, etc.

Below will cover the more project specific information you need to get started with nova.

Communication

How to get (more) involved with Nova

Contacting the Core Team

The overall structure of the Nova team is documented on the wiki.

New Feature Planning

If you want to propose a new feature please read the *Blueprints, Specs and Priorities* page.

Task Tracking

We track our tasks in Launchpad.

If youre looking for some smaller, easier work item to pick up and get started on, search for the low-hanging-fruit tag.

Reporting a Bug

You found an issue and want to make sure we are aware of it? You can do so on Launchpad. More info about Launchpad usage can be found on OpenStack docs page.

Getting Your Patch Merged

All changes proposed to the Nova requires two `Code-Review +2` votes from Nova core reviewers before one of the core reviewers can approve patch by giving `Workflow +1` vote. More detailed guidelines for reviewers of Nova patches are available at *Code Review Guide for Nova*.

Project Team Lead Duties

All common PTL duties are enumerated in the PTL guide.

For the Nova specific duties you can read the Nova PTL guide *Chronological PTL guide*

4.1.2 Getting Started

- *How to get (more) involved with Nova*: Overview of engaging in the project
- *Development Quickstart*: Get your computer setup to contribute

4.1.2.1 How to get (more) involved with Nova

So you want to get more involved with Nova? Or you are new to Nova and wondering where to start?

We are working on building easy ways for you to get help and ideas on how to learn more about Nova and how the Nova community works.

Any questions, please ask! If you are unsure who to ask, then please contact the PTL.

How do I get started?

There are quite a few global docs on this:

- https://docs.openstack.org/contributors/
- https://www.openstack.org/community/
- https://www.openstack.org/assets/welcome-guide/OpenStackWelcomeGuide.pdf
- https://wiki.openstack.org/wiki/How_To_Contribute

There is more general info, non Nova specific info here:

- https://wiki.openstack.org/wiki/Mentoring
- https://docs.openstack.org/upstream-training/

What should I work on?

So you are starting out your Nova journey, where is a good place to start?

If youd like to learn how Nova works before changing anything (good idea!), we recommend looking for reviews with -1s and -2s and seeing why they got downvoted. There is also the *Code Review Guide for Nova*. Once you have some understanding, start reviewing patches. Its OK to ask people to explain things you dont understand. Its also OK to see some potential problems but put a +0.

Once youre ready to write code, take a look at some of the work already marked as low-hanging fruit:

- https://bugs.launchpad.net/nova/+bugs?field.tag=low-hanging-fruit

How do I get my feature in?

The best way of getting your feature in is well it depends.

First concentrate on solving your problem and/or use case, dont fixate on getting the code you have working merged. Its likely things will need significant re-work after you discuss how your needs match up with all the existing ways Nova is currently being used. The good news, is this process should leave you with a feature thats more flexible and doesnt lock you into your current way of thinking.

A key part of getting code merged, is helping with reviewing other peoples code. Great reviews of others code will help free up more core reviewer time to look at your own patches. In addition, you will understand how the review is thinking when they review your code.

Also, work out if any on going efforts are blocking your feature and helping out speeding those up. The spec review process should help with this effort.

For more details on our process, please see: *Nova team process*.

What is expected of a good contributor?

TODO - need more info on this

Top Tips for working with the Nova community

Here are some top tips around engaging with the Nova community:

- IRC
  - we talk a lot in #openstack-nova
  - do ask us questions in there, and we will try to help you
  - not sure about asking questions? feel free to listen in around other peoples questions
  - we recommend you setup an IRC bouncer: https://docs.openstack.org/contributors/common/irc.html
- Email
  - Use the [nova] tag in the mailing lists
  - Filtering on [nova] and [all] can help tame the list
- Be Open
  - i.e. dont review your teams code in private, do it publicly in gerrit
  - i.e. be ready to talk about openly about problems you are having, not theoretical issues

    - that way you can start to gain the trust of the wider community
- Got a problem? Please ask!
    - Please raise any problems and ask questions early
    - we want to help you before you are frustrated or annoyed
    - unsure who to ask? Just ask in IRC, or check out the list of Nova people.
- Talk about problems first, then solutions
    - Nova is a big project. At first, it can be hard to see the big picture
    - Dont think about merging your patch, instead think about solving your problem
    - conversations are more productive that way
- Its not the decision thats important, its the reason behind it thats important
    - Dont like the way the community is going?
    - Please ask why we were going that way, and please engage with the debate
    - If you dont, we are unable to learn from what you have to offer
- No one will decide, this is stuck, who can help me?
    - its rare, but it happens
    - its the Nova PTLs job to help you
    - but if you dont ask, its hard for them to help you

Process

It can feel like you are faced with a wall of process. We are a big community, to make sure the right communication happens, we do use a minimal amount of process.

If you find something that doesnt make sense, please:

- ask questions to find out *why* it happens
- if you know of a better way to do it, please speak up
- one better way might be to remove the process if it no longer helps

To learn more about Novas process, please read *Nova team process*.

Why bother with any process?

Why is it worth creating a bug or blueprint to track your code review? This may seem like silly process, but there is usually a good reason behind it.

We have lots of code to review, and we have tools to try and get to really important code reviews first. If yours is really important, but not picked up by our tools, its possible you just get lost in the bottom of a big queue.

If you have a bug fix, you have done loads of work to identify the issue, and test out your fix, and submit it. By adding a bug report, you are making it easier for other folks who hit the same problem to find your work, possibly saving them the hours of pain you went through. With any luck that gives all those people the time to fix different bugs, all that might have affected you, if you had not given them the time go fix it.

Its similar with blueprints. You have worked out how to scratch your itch, lets tell others about that great new feature you have added, so they can use that. Also, it stops someone with a similar idea going through all the pain of creating a feature only to find you already have that feature ready and up for review, or merged into the latest release.

Hopefully this gives you an idea why we have applied a small layer of process to what we are doing. Having said all this, we need to unlearn old habits to move forward, there may be better ways to do things, and we are open to trying them. Please help be part of the solution.

Why do code reviews if I am not in nova-core?

Code reviews are the life blood of the Nova developer community.

There is a good discussion on how you do good reviews, and how anyone can be a reviewer: http://docs.openstack.org/infra/manual/developers.html#peer-review

In the draft process guide, I discuss how doing reviews can help get your code merged faster: *Nova team process*.

Lets look at some of the top reasons why participating with code reviews really helps you:

- Doing more reviews, and seeing what other reviewers notice, will help you better understand what is expected of code that gets merged into master.
- Having more non-core people do great reviews, leaves less review work for the core reviewers to do, so we are able get more code merged.
- Empathy is one of the keys to a happy community. If you are used to doing code reviews, you will better understand the comments you get when people review your code. As you do more code reviews, and see what others notice, you will get a better idea of what people are looking for when then apply a +2 to your code.
- If you do quality reviews, youll be noticed and its more likely youll get reciprocal eyes on your reviews.

What are the most useful types of code review comments? Well here are a few to the top ones:

- Fundamental flaws are the biggest thing to spot. Does the patch break a whole set of existing users, or an existing feature?
- Consistency of behaviour is really important. Does this bit of code do things differently to where similar things happen else where in Nova?
- Is the code easy to maintain, well tested and easy to read? Code is read order of magnitude times more than it is written, so optimise for the reader of the code, not the writer.
- TODO - what others should go here?

Lets look at some problems people hit when starting out doing code reviews:

- My +1 doesnt mean anything, why should I bother?
  - So your +1 really does help. Some really useful -1 votes that lead to a +1 vote helps get code into a position
- When to use -1 vs 0 vs +1
  - Please see the guidelines here: http://docs.openstack.org/infra/manual/developers.html#peer-review
- I have already reviewed this code internally, no point in adding a +1 externally?

  - Please talk to your company about doing all code reviews in the public, that is a much better way to get involved. showing how the code has evolved upstream, is much better than trying to perfect code internally, before uploading for public review. You can use Draft mode, and mark things as WIP if you prefer, but please do the reviews upstream.

- Where do I start? What should I review?
  - There are various tools, but a good place to start is: https://review.opendev.org/q/project:openstack/nova+status:open+label:Review-Priority%253DANY
  - Depending on the time in the cycle, its worth looking at NeedsCodeReview blueprints: https://blueprints.launchpad.net/nova/
  - Custom Gerrit review dashboards often provide a more manageable view of the outstanding reviews, and help focus your efforts:
    * Nova Review Inbox: https://goo.gl/1vTS0Z
    * Small Bug Fixes: http://ow.ly/WAw1J
  - Maybe take a look at things you want to see merged, bug fixes and features, or little code fixes
  - Look for things that have been waiting a long time for a review: https://review.opendev.org/#/q/project:openstack/nova+status:open+age:2weeks
  - If you get through the above lists, try other tools, such as: http://status.openstack.org/reviews

How to do great code reviews?

http://docs.openstack.org/infra/manual/developers.html#peer-review

For more tips, please see: *Why do code reviews if I am not in nova-core?*

How do I become nova-core?

You dont have to be nova-core to be a valued member of the Nova community. There are many, many ways you can help. Every quality review that helps someone get their patch closer to being ready to merge helps everyone get their code merged faster.

The first step to becoming nova-core is learning how to be an active member of the Nova community, including learning how to do great code reviews. For more details see: https://wiki.openstack.org/wiki/Nova/CoreTeam#Membership_Expectations

If you feel like you have the time to commit to all the nova-core membership expectations, reach out to the Nova PTL who will be able to find you an existing member of nova-core to help mentor you. If all goes well, and you seem like a good candidate, your mentor will contact the rest of the nova-core team to ask them to start looking at your reviews, so they are able to vote for you, if you get nominated for join nova-core.

We encourage all mentoring, where possible, to occur on #openstack-nova so everyone can learn and benefit from your discussions.

The above mentoring is available to every one who wants to learn how to better code reviews, even if you dont ever want to commit to becoming nova-core. If you already have a mentor, thats great, the process is only there for folks who are still trying to find a mentor. Being admitted to the mentoring program no way guarantees you will become a member of nova-core eventually, its here to help you improve, and help you have the sort of involvement and conversations that can lead to becoming a member of nova-core.

How to do great nova-spec reviews?

https://specs.openstack.org/openstack/nova-specs/specs/2025.2/template.html

Blueprints, Specs and Priorities.

Spec reviews are always a step ahead of the normal code reviews. Follow the above links for some great information on specs/reviews.

The following could be some important tips:

1. The specs are published as html documents. Ensure that the author has a proper render of the same via the .rst file.

2. More often than not, its important to know that there are no overlaps across multiple specs.

3. Ensure that a proper dependency of the spec is identified. For example - a user desired feature that requires a proper base enablement should be a dependent spec.

4. Ask for clarity on changes that appear ambiguous to you.

5. Every release nova gets a huge set of spec proposals and thats a huge task for the limited set of nova cores to complete. Helping the cores with additional reviews is always a great thing.

How to do great bug triage?

https://wiki.openstack.org/wiki/Nova/BugTriage

Sylvain Bauza and Stephen Finucane gave a nice presentation on this topic at the Queens summit in Sydney.

How to step up into a project leadership role?

There are many ways to help lead the Nova project:

- Mentoring efforts, and getting started tips: https://wiki.openstack.org/wiki/Nova/Mentoring
- Info on process, with a focus on how you can go from an idea to getting code merged Nova: *Nova team process*
- Consider leading an existing Nova subteam or forming a new one.
- Consider becoming a Bug tag owner.
- Contact the PTL about becoming a Czar Nova People.

4.1.2.2 Development Quickstart

This page describes how to setup and use a working Python development environment that can be used in developing nova on Ubuntu, Fedora or Mac OS X. These instructions assume youre already familiar with git.

Following these instructions will allow you to build the documentation and run the nova unit tests. If you want to be able to run nova (i.e., launch VM instances), you will also need to either manually or by letting DevStack do it for you install libvirt and at least one of the supported hypervisors. Running nova is currently only supported on Linux, although you can run the unit tests on Mac OS X.

Note

For how to contribute to Nova, see HowToContribute. Nova uses the Gerrit code review system, GerritWorkflow.

Setup

There are two ways to create a development environment: using DevStack, or explicitly installing and cloning just what you need.

Using DevStack

See Devstack Documentation. If you would like to use Vagrant, there is a Vagrant for DevStack.

Explicit Install/Clone

DevStack installs a complete OpenStack environment. Alternatively, you can explicitly install and clone just what you need for Nova development.

Getting the code

Grab the code from git:

```
git clone https://opendev.org/openstack/nova
cd nova
```

Linux Systems

The first step of this process is to install the system (not Python) packages that are required. Following are instructions on how to do this on Linux and on the Mac.

Note

This section is tested for Nova on Ubuntu (14.04-64) and Fedora-based (RHEL 6.1) distributions. Feel free to add notes and change according to your experiences or operating system.

Install the prerequisite packages listed in the `bindep.txt` file.

On Debian-based distributions (e.g., Debian/Mint/Ubuntu):

```
sudo apt-get install python-pip
sudo pip install tox
tox -e bindep
sudo apt-get install <indicated missing package names>
```

On Fedora-based distributions (e.g., Fedora/RHEL/CentOS/Scientific Linux):

```
sudo dnf install python-pip
sudo pip install tox
```

(continues on next page)

(continued from previous page)

```
tox -e bindep
sudo dnf install <indicated missing package names>
```

On openSUSE-based distributions (SLES, openSUSE Leap / Tumbleweed):

```
sudo zypper in python-pip
sudo pip install tox
tox -e bindep
sudo zypper in <indicated missing package names>
```

Mac OS X Systems

Install virtualenv:

```
sudo easy_install virtualenv
```

Check the version of OpenSSL you have installed:

```
openssl version
```

The stock version of OpenSSL that ships with Mac OS X 10.6 (OpenSSL 0.9.8l) or Mac OS X 10.7 (OpenSSL 0.9.8r) or Mac OS X 10.10.3 (OpenSSL 0.9.8zc) works fine with nova. OpenSSL versions from brew like OpenSSL 1.0.1k work fine as well.

Brew is very useful for installing dependencies. As a minimum for running tests, install the following:

```
brew install python3 postgres
python3 -mpip install tox
```

Building the Documentation

Install the prerequisite packages: graphviz

To do a full documentation build, issue the following command while the nova directory is current.

```
tox -edocs
```

That will create a Python virtual environment, install the needed Python prerequisites in that environment, and build all the documentation in that environment.

Running unit tests

See Running Python Unit Tests.

Note that some unit and functional tests use a database. See the file `tools/test-setup.sh` on how the databases are set up in the OpenStack CI environment and replicate it in your test environment.

Using the pre-commit hook

Nova can make use of the pre-commit framework to allow running of some linters on each commit. This must be enabled locally to function:

```
$ pip install --user pre-commit
$ pre-commit install --allow-missing-config
```

As a reminder, the hooks are optional and you are not enforced to run them. You can either not install pre-commit or skip the hooks once by using the `--no-verify` flag on `git commit`.

Using fake computes for tests

The number of instances supported by fake computes is not limited by physical constraints. It allows you to perform stress tests on a deployment with few resources (typically a laptop). Take care to avoid using scheduler filters that will limit the number of instances per compute, such as `NumInstancesFilter`.

Fake computes can also be used in multi hypervisor-type deployments in order to take advantage of fake and real computes during tests:

- create many fake instances for stress tests
- create some real instances for functional tests

Fake computes can be used for testing Nova itself but also applications on top of it.

4.1.3 Nova Process

The nova community is a large community. We have lots of users, and they all have a lot of expectations around upgrade and backwards compatibility. For example, having a good stable API, with discoverable versions and capabilities is important for maintaining the strong ecosystem around nova.

Our process is always evolving, just as nova and the community around nova evolves over time. If there are things that seem strange, or you have ideas on how to improve things, please bring them forward on IRC or the openstack-discuss mailing list, so we continue to improve how the nova community operates.

This section looks at the processes and why. The main aim behind all the process is to aid communication between all members of the nova community, while keeping users happy and keeping developers productive.

- *Scope of the Nova project*: The focus is on features and bug fixes that make nova work better within this scope
- *Development policies*: General guidelines about whats supported
- *Nova team process*: The processes we follow around feature and bug submission, including how the release calendar works, and the freezes we go under
- *Blueprints, Specs and Priorities*: An overview of our tracking artifacts.
- *Chronological PTL guide*: A chronological PTL reference guide

4.1.3.1 Scope of the Nova project

Nova is focusing on doing an awesome job of its core mission. This document aims to clarify that core mission.

This is a living document to help record where we agree about what Nova should and should not be doing, and why. Please treat this as a discussion of interesting, and hopefully useful, examples. It is not intended to be an exhaustive policy statement.

Mission

Our mission statement starts with:

> To implement services and associated libraries to provide massively scalable, on demand, self service access to compute resources.

Our official mission statement also includes the following examples of compute resources: bare metal, virtual machines, and containers. For the full official mission statement see: https://governance.openstack.org/tc/reference/projects/nova.html#mission

This document aims to help clarify what the mission statement means.

Compute Resources

Nova is all about access to compute resources. This section looks at the types of compute resource Nova works with.

Virtual Servers

Nova was originally focused purely on providing access to virtual servers running on a variety of different hypervisors. The majority of users use Nova only to provide access to virtual servers from a single hypervisor, however, its possible to have a Nova deployment include multiple different types of hypervisors, while at the same time offering containers and bare metal servers.

Containers

The Nova API is not a good fit for a lot of container use cases. The Magnum project intends to deliver a good container experience built on top of Nova.

Nova allows you to use containers in a similar way to how you would use on demand virtual machines. We want to maintain this distinction, so we maintain the integrity and usefulness of the existing Nova API.

For example, Nova is not designed to spin up new containers for every apache request, nor do we plan to control what goes on inside containers. They get the same metadata provided to them as virtual machines, to do with as they see fit.

Bare Metal Servers

Ironic project has been pioneering the idea of treating physical machines in a similar way to on demand virtual machines.

Novas driver is able to allow a multi-tenant cloud style use of Ironic controlled resources.

While currently there are operations that are a fundamental part of our virtual machine abstraction that are not currently available in ironic, such as attaching iSCSI volumes, it does not fundamentally change the semantics of our API, and as such is a suitable Nova driver. Moreover, it is expected that gap with shrink over time.

Driver Parity

Our goal for the Nova API is to provide a consistent abstraction to access on demand compute resources. We are not aiming to expose all features of all hypervisors. Where the details of the underlying hypervisor leak through our APIs, we have failed in this goal, and we must work towards better abstractions that are

more interoperable. This is one reason why we put so much emphasis on the use of Tempest in third party CI systems.

The key tenet of driver parity is that if a feature is supported in a driver, it must feel the same to users, as if they where using any of the other drivers that also support that feature. The exception is that, if possible for widely different performance characteristics, but the effect of that API call must be identical.

Following on from that, should a feature only be added to one of the drivers, we must make every effort to ensure another driver could be implemented to match that behavior.

It is important that drivers support enough features, so the API actually provides a consistent abstraction. For example, being unable to create a server or delete a server would severely undermine that goal. In fact, Nova only ever manages resources it creates.

Upgrades

Nova is widely used in production. As such we need to respect the needs of our existing users. At the same time we need evolve the current code base, including both adding and removing features.

This section outlines how we expect people to upgrade, and what we do to help existing users that upgrade in the way we expect.

Upgrade expectations

Our upgrade plan is to concentrate on upgrades from N-1 to the Nth release. So for someone running juno, they would have to upgrade to kilo before upgrading to liberty. This is designed to balance the need for a smooth upgrade, against having to keep maintaining the compatibility code to make that upgrade possible. We talk about this approach as users consuming the stable branch.

In addition, we also support users upgrading from the master branch, technically, between any two commits within the same release cycle. In certain cases, when crossing release boundaries, you must upgrade to the stable branch, before upgrading to the tip of master. This is to support those that are doing some level of Continuous Deployment from the tip of master into production. Many of the public cloud provides running OpenStack use this approach so they are able to get access to bug fixes and features they work on into production sooner.

This becomes important when you consider reverting a commit that turns out to have been bad idea. We have to assume any public API change may have already been deployed into production, and as such cannot be reverted. In a similar way, a database migration may have been deployed.

Any commit that will affect an upgrade gets the UpgradeImpact tag added to the commit message, so there is no requirement to wait for release notes.

Dont break existing users

As a community we are aiming towards a smooth upgrade process, where users must be unaware you have just upgraded your deployment, except that there might be additional feature available and improved stability and performance of some existing features.

We dont ever want to remove features our users rely on. Sometimes we need to migrate users to a new implementation of that feature, which may require extra steps by the deployer, but the end users must be unaffected by such changes. However there are times when some features become a problem to maintain, and fall into disrepair. We aim to be honest with our users and highlight the issues we have, so we are in a position to find help to fix that situation. Ideally we are able to rework the feature so it can be maintained, but in some rare cases, the feature no longer works, is not tested, and no one is stepping forward to maintain that feature, the best option can be to remove that feature.

When we remove features, we need to warn users by first marking those features as deprecated, before we finally remove the feature. The idea is to get feedback on how important the feature is to our user base. Where a feature is important we work with the whole community to find a path forward for those users.

API Scope

Nova aims to provide a highly interoperable and stable REST API for our users to get self-service access to compute resources.

No more API Proxies

Nova API current has some APIs that are now (in kilo) mostly just a proxy to other OpenStack services. If it were possible to remove a public API, these are some we might start with. As such, we dont want to add any more.

The first example is the API that is a proxy to the Glance v1 API. As Glance moves to deprecate its v1 API, we need to translate calls from the old v1 API we expose, to Glances v2 API.

The next API to mention is the networking APIs, in particular the security groups API. Most of these APIs exist from when `nova-network` existed and the proxies were added during the transition. However, security groups has a much richer Neutron API, and if you use both Nova API and Neutron API, the mismatch can lead to some very unexpected results, in certain cases.

Our intention is to avoid adding to the problems we already have in this area.

No more Orchestration

Nova is a low level infrastructure API. It is plumbing upon which richer ideas can be built. Heat and Magnum being great examples of that.

While we have some APIs that could be considered orchestration, and we must continue to maintain those, we do not intend to add any more APIs that do orchestration.

Third Party APIs

Nova aims to focus on making a great API that is highly interoperable across all Nova deployments.

We have historically done a very poor job of implementing and maintaining compatibility with third party APIs inside the Nova tree.

As such, all new efforts should instead focus on external projects that provide third party compatibility on top of the Nova API. Where needed, we will work with those projects to extend the Nova API such that its possible to add that functionality on top of the Nova API. However, we do not intend to add API calls for those services to persist third party API specific information in the Nova database. Instead we want to focus on additions that enhance the existing Nova API.

Scalability

Our mission includes the text massively scalable. Lets discuss what that means.

Nova has three main axes of scale: Number of API requests, number of compute nodes and number of active instances. In many cases the number of compute nodes and active instances are so closely related, you rarely need to consider those separately. There are other items, such as the number of tenants, and the number of instances per tenant. But, again, these are very rarely the key scale issue. Its possible to have a small cloud with lots of requests for very short lived VMs, or a large cloud with lots of longer

lived VMs. These need to scale out different components of the Nova system to reach their required level of scale.

Ideally all Nova components are either scaled out to match the number of API requests and build requests, or scaled out to match the number of running servers. If we create components that have their load increased relative to both of these items, we can run into inefficiencies or resource contention. Although it is possible to make that work in some cases, this should always be considered.

We intend Nova to be usable for both small and massive deployments. Where small involves 1-10 hypervisors and massive deployments are single regions with greater than 10,000 hypervisors. That should be seen as our current goal, not an upper limit.

There are some features that would not scale well for either the small scale or the very large scale. Ideally we would not accept these features, but if there is a strong case to add such features, we must work hard to ensure you can run without that feature at the scale you are required to run.

IaaS not Batch Processing

Currently Nova focuses on providing on-demand compute resources in the style of classic Infrastructure-as-a-service clouds. A large pool of compute resources that people can consume in a self-service way.

Nova is not currently optimized for dealing with a larger number of requests for compute resources compared with the amount of compute resources currently available. We generally assume that a level of spare capacity is maintained for future requests. This is needed for users who want to quickly scale out, and extra capacity becomes available again as users scale in. While spare capacity is also not required, we are not optimizing for a system that aims to run at 100% capacity at all times. As such our quota system is more focused on limiting the current level of resource usage, rather than ensuring a fair balance of resources between all incoming requests. This doesnt exclude adding features to support making a better use of spare capacity, such as spot instances.

There have been discussions around how to change Nova to work better for batch job processing. But the current focus is on how to layer such an abstraction on top of the basic primitives Nova currently provides, possibly adding additional APIs where that makes good sense. Should this turn out to be impractical, we may have to revise our approach.

Deployment and Packaging

Nova does not plan on creating its own packaging or deployment systems.

Our CI infrastructure is powered by Devstack. This can also be used by developers to test their work on a full deployment of Nova.

We do not develop any deployment or packaging for production deployments. Being widely adopted by many distributions and commercial products, we instead choose to work with all those parties to ensure they are able to effectively package and deploy Nova.

4.1.3.2 Development policies

Out Of Tree Support

While nova has many entrypoints and other places in the code that allow for wiring in out of tree code, upstream doesnt actively make any guarantees about these extensibility points; we dont support them, make any guarantees about compatibility, stability, etc.

Furthermore, hooks and extension points in the code impede efforts in Nova to support interoperability between OpenStack clouds. Therefore an effort is being made to systematically deprecate and remove

hooks, extension points, and classloading of managers and other services.

Public Contractual APIs

Although nova has many internal APIs, they are not all public contractual APIs. Below is a link of our public contractual APIs:

- https://docs.openstack.org/api-ref/compute/

Anything not in this list is considered private, not to be used outside of nova, and should not be considered stable.

REST APIs

Follow the guidelines set in: https://wiki.openstack.org/wiki/APIChangeGuidelines

The canonical source for REST API behavior is the code *not* documentation. Documentation is manually generated after the code by folks looking at the code and writing up what they think it does, and it is very easy to get this wrong.

This policy is in place to prevent us from making backwards incompatible changes to REST APIs.

Patches and Reviews

Merging a patch requires a non-trivial amount of reviewer resources. As a patch author, you should try to offset the reviewer resources spent on your patch by reviewing other patches. If no one does this, the review team (cores and otherwise) become spread too thin.

For review guidelines see: *Code Review Guide for Nova*

Reverts for Retrospective Vetos

Sometimes our simple 2 +2s approval policy will result in errors. These errors might be a bug that was missed, or equally importantly, it might be that other cores feel that there is a need for more discussion on the implementation of a given piece of code.

Rather than an enforced time-based solution - for example, a patch couldnt be merged until it has been up for review for 3 days - we have chosen an honor-based system where core reviewers would not approve potentially contentious patches until the proposal had been sufficiently socialized and everyone had a chance to raise any concerns.

Recognising that mistakes can happen, we also have a policy where contentious patches which were quickly approved should be reverted so that the discussion around the proposal can continue as if the patch had never been merged in the first place. In such a situation, the procedure is:

0. The commit to be reverted must not have been released.
1. The core team member who has a -2 worthy objection should propose a revert, stating the specific concerns that they feel need addressing.
2. Any subsequent patches depending on the to-be-reverted patch may need to be reverted also.
3. Other core team members should quickly approve the revert. No detailed debate should be needed at this point. A -2 vote on a revert is strongly discouraged, because it effectively blocks the right of cores approving the revert from -2 voting on the original patch.
4. The original patch submitter should re-submit the change, with a reference to the original patch and the revert.

5. The original reviewers of the patch should restore their votes and attempt to summarize their previous reasons for their votes.
6. The patch should not be re-approved until the concerns of the people proposing the revert are worked through. A mailing list discussion or design spec might be the best way to achieve this.

Metrics Gathering

Nova currently has a monitor plugin to gather CPU metrics on compute nodes. This feeds into the MetricsFilter and MetricsWeigher in the scheduler. The CPU metrics monitor is only implemented for the libvirt compute driver. External projects like Ceilometer and Watcher consume these metrics.

Over time people have tried to add new monitor plugins for things like memory bandwidth. There have also been attempts to expose these monitors over CLI, the REST API, and notifications.

At the Newton midcycle it was decided that Nova does a poor job as a metrics gathering tool, especially as its incomplete, not tested, and there are numerous other tools available to get this information as their primary function.

Therefore, there is a freeze on adding new metrics monitoring plugins which also includes exposing existing monitored metrics outside of Nova, like with the nova-manage CLI, the REST API, or the notification bus. Long-term, metrics gathering will likely be deprecated within Nova. Since there is not yet a clear replacement, the deprecation is open-ended, but serves as a signal that new deployments should not rely on the metrics that Nova gathers and should instead focus their efforts on alternative solutions for placement.

Continuous Delivery Mentality

Nova generally tries to subscribe to a philosophy of anything we merge today can be in production today, and people can continuously deliver Nova.

In practice this means we should not merge code that will not work until some later change is merged, because that later change may never come, or not come in the same release cycle, or may be substantially different from what was originally intended. For example, if patch A uses code that is not available until patch D later in the series.

The strategy for dealing with this in particularly long and complicated series of changes is to start from the bottom with code that is no-op until it is turned on at the top of the stack, generally with some feature flag, policy rule, API microversion, etc. So in the example above, the code from patch D should come before patch A even if nothing is using it yet, but things will build on it. Realistically this means if you are working on a feature that touches most of the Nova stack, i.e. compute driver/service through to API, you will work on the compute driver/service code first, then conductor and/or scheduler, and finally the API. An extreme example of this can be found by reading the code review guide for the cross-cell resize feature.

Even if this philosophy is not the reality of how the vast majority of OpenStack deployments consume Nova, it is a development philosophy to try and avoid merging broken code.

4.1.3.3 Nova team process

Nova is always evolving its processes, but its important to explain why we have them: so we can all work to ensure that the interactions we need to happen do happen. The process exists to make productive communication between all members of our community easier.

OpenStack Wide Patterns

Nova follows most of the generally adopted norms for OpenStack projects. You can get more details here:

- https://docs.openstack.org/infra/manual/developers.html
- https://docs.openstack.org/project-team-guide/

If you are new to Nova, please read this first: *How to get (more) involved with Nova*.

Dates overview

For 2025.2 Flamingo, please see: https://wiki.openstack.org/wiki/Nova/2025.2_Release_Schedule

> **Note**
>
> Throughout this document any link which references the name of a release cycle in the link can usually be changed to the name of the current cycle to get up to date information.

Feature Freeze

Feature freeze primarily provides a window of time to help the horizontal teams prepare their items for release, while giving developers time to focus on stabilising what is currently in master, and encouraging users and packagers to perform tests (automated, and manual) on the release, to spot any major bugs.

The Nova release process is aligned with the development cycle schedule used by many OpenStack projects, including the following steps.

- Feature Proposal Freeze
  - make sure all code is up for review
  - so we can optimise for completed features, not lots of half completed features
- Feature Freeze
  - make sure all feature code is merged
- String Freeze
  - give translators time to translate all our strings

  > **Note**
  >
  > debug logs are no longer translated

- Dependency Freeze
  - time to coordinate the final list of dependencies, and give packagers time to package them
  - generally it is also quite destabilising to take upgrades (beyond bug fixes) this late

As with all processes here, there are exceptions. The exceptions at this stage need to be discussed with the horizontal teams that might be affected by changes beyond this point, and as such are discussed with one of the OpenStack release managers.

Spec and Blueprint Approval Freeze

This is a (mostly) Nova specific process.

Why we have a Spec Freeze:

- specs take a long time to review and reviewing specs throughout the cycle distracts from code reviews
- keeping specs open and being slow at reviewing them (or just ignoring them) annoys the spec submitters
- we generally have more code submitted that we can review, this time bounding is a useful way to limit the number of submissions

By the freeze date, we expect all blueprints that will be approved for the cycle to be listed on launchpad and all relevant specs to be merged. For 2025.2 Flamingo, blueprints can be found at https://blueprints.launchpad.net/nova/2025.2 and specs at https://specs.openstack.org/openstack/nova-specs/specs/2025.2/index.html

Starting with Liberty, we are keeping a backlog open for submission at all times.

Note

The focus is on accepting and agreeing problem statements as being in scope, rather than queueing up work items for the next release. We are still working on a new lightweight process to get out of the backlog and approved for a particular release. For more details on backlog specs, please see: http://specs.openstack.org/openstack/nova-specs/specs/backlog/index.html

There can be exceptions, usually its an urgent feature request that comes up after the initial deadline. These will generally be discussed at the weekly Nova meeting, by adding the spec or blueprint to discuss in the appropriate place in the meeting agenda here (ideally make yourself available to discuss the blueprint, or alternatively make your case on the ML before the meeting): https://wiki.openstack.org/wiki/Meetings/Nova#Agenda_for_next_meeting

String Freeze

String Freeze provides an opportunity for translators to translate user-visible messages to a variety of languages. By not changing strings after the date of the string freeze, the job of the translators is made a bit easier. For more information on string and other OpenStack-wide release processes see the release management docs.

How do I get my code merged?

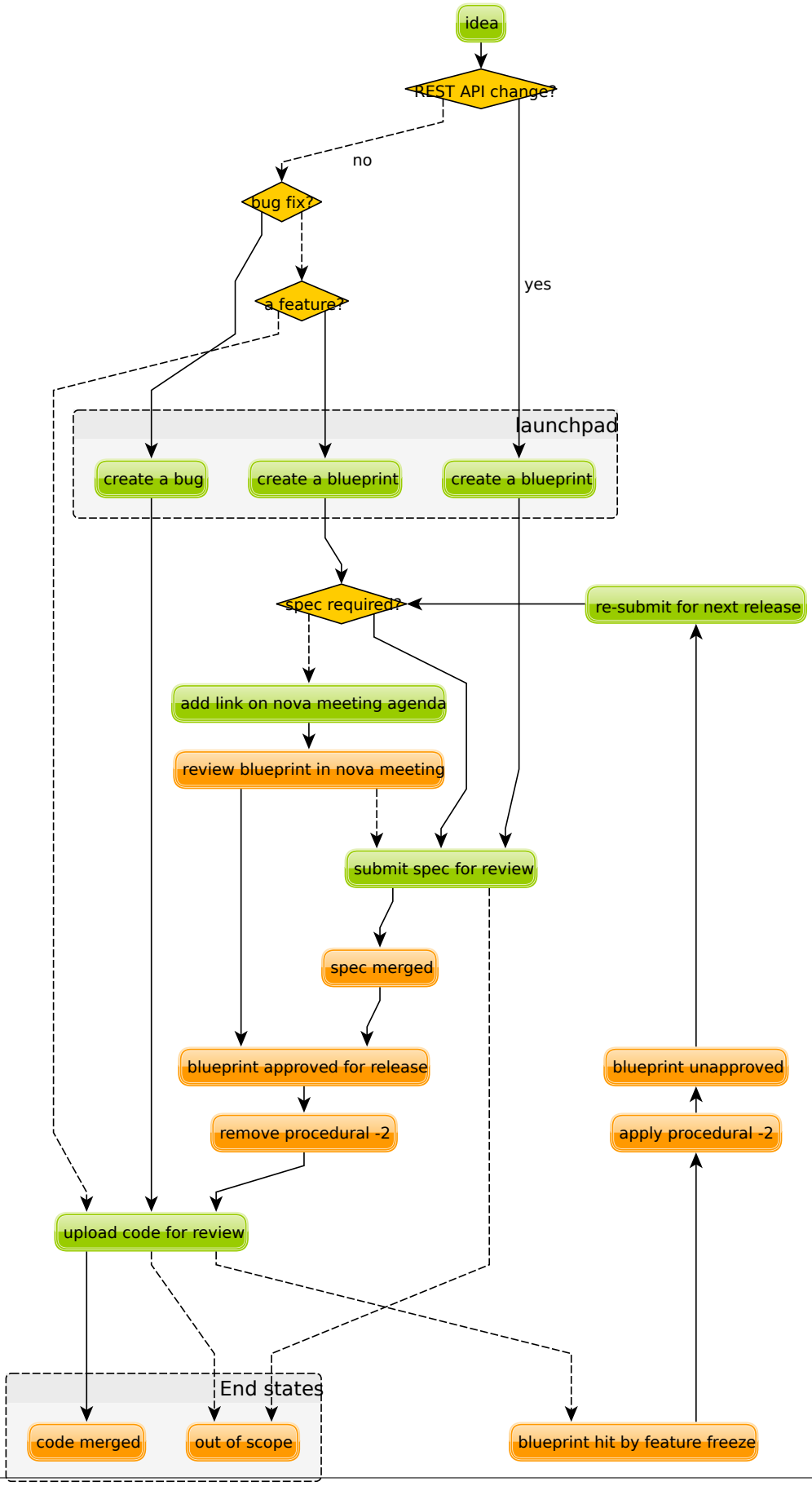
OK, so you are new to Nova, and you have been given a feature to implement. How do I make that happen?

You can get most of your questions answered here:

- https://docs.openstack.org/infra/manual/developers.html

But lets put a Nova specific twist on things

Overview


idea
REST API change?
no
yes
bug fix?
a feature?
launchpad
create a bug
create a blueprint
create a blueprint
spec required?
re-submit for next release
add link on nova meeting agenda
review blueprint in nova meeting
submit spec for review
spec merged
blueprint approved for release
blueprint unapproved
remove procedural -2
apply procedural -2
upload code for review
End states
code merged
out of scope
blueprint hit by feature freeze

Where do you track bugs?

We track bugs here:

- https://bugs.launchpad.net/nova

If you fix an issue, please raise a bug so others who spot that issue can find the fix you kindly created for them.

Also before submitting your patch its worth checking to see if someone has already fixed it for you (Launchpad helps you with that, at little, when you create the bug report).

When do I need a blueprint vs a spec?

For more details refer to *Blueprints, Specs and Priorities*.

To understand this question, we need to understand why blueprints and specs are useful.

But here is the rough idea:

- if it needs a spec, it will need a blueprint.
- if its an API change, it needs a spec.
- if its a single small patch that touches a small amount of code, with limited deployer and doc impact, it probably doesnt need a spec.

If you are unsure, please ask the PTL on IRC, or one of the other nova-drivers.

How do I get my blueprint approved?

So you need your blueprint approved? Here is how:

- if you dont need a spec, please add a link to your blueprint to the agenda for the next nova meeting: https://wiki.openstack.org/wiki/Meetings/Nova
  - be sure your blueprint description has enough context for the review in that meeting.
- if you need a spec, then please submit a nova-spec for review, see: https://docs.openstack.org/infra/manual/developers.html

Got any more questions? Contact the PTL or one of the other nova-specs-core who are awake at the same time as you. IRC is best as you will often get an immediate response, if they are too busy send him/her an email.

How do I get a procedural -2 removed from my patch?

When feature freeze hits, any patches for blueprints that are still in review get a procedural -2 to stop them merging. In Nova a blueprint is only approved for a single release. To have the -2 removed, you need to get the blueprint approved for the current release (see *How do I get my blueprint approved?*).

Why are the reviewers being mean to me?

Code reviews take intense concentration and a lot of time. This tends to lead to terse responses with very little preamble or nicety. That said, theres no excuse for being actively rude or mean. OpenStack has a Code of Conduct (https://www.openstack.org/legal/community-code-of-conduct/) and if you feel this has been breached please raise the matter privately. Either with the relevant parties, the PTL or failing those, the OpenStack Foundation.

That said, there are many objective reasons for applying a -1 or -2 to a patch:

- Firstly and simply, patches must address their intended purpose successfully.
- Patches must not have negative side-effects like wiping the database or causing a functional regression. Usually removing anything, however tiny, requires a deprecation warning be issued for a cycle.
- Code must be maintainable, that is it must adhere to coding standards and be as readable as possible for an average OpenStack developer (we acknowledge that this person is not easy to define).
- Patches must respect the direction of the project, for example they should not make approved specs substantially more difficult to implement.
- Release coordinators need the correct process to be followed so scope can be tracked accurately. Bug fixes require bugs, features require blueprints and all but the simplest features require specs. If there is a blueprint, it must be approved for the release/milestone the patch is attempting to merge into.

Please particularly bear in mind that a -2 does not mean never ever nor does it mean your idea is bad and you are dumb. It simply means do not merge today. You may need to wait some time, rethink your approach or even revisit the problem definition but there is almost always some way forward. The core who applied the -2 should tell you what you need to do.

My code review seems stuck, what can I do?

First and foremost - address any -1s and -2s! The review load on Nova is high enough that patches with negative reviews often get filtered out entirely. A few tips:

- Be precise. Ensure youre not talking at cross purposes.
- Try to understand where the reviewer is coming from. They may have a very different perspective and/or use-case to you.
- If you dont understand the problem, ask them to explain - this is common and helpful behaviour.
- Be positive. Everyones patches have issues, including core reviewers. No-one cares once the issues are fixed.
- Try not to flip-flop. When two reviewers are pulling you in different directions, stop pushing code and negotiate the best way forward.
- If the reviewer does not respond to replies left on the patchset, reach out to them on IRC or email. If they still dont respond, you can try to ask their colleagues if theyre on holiday (or simply wait). Finally, you can ask for mediation in the Nova meeting by adding it to the agenda (https://wiki.openstack.org/wiki/Meetings/Nova). This is also what you should do if you are unable to negotiate a resolution to an issue.

Secondly, Nova is a big project, look for things that have been waiting a long time for a review: https://review.opendev.org/#/q/project:openstack/nova+status:open+age:2weeks

Eventually you should get some +1s from people working through the review queue. Expect to get -1s as well. You can ask for reviews within your company, 1-2 are useful (not more), especially if those reviewers are known to give good reviews. You can spend some time while you wait reviewing other peoples code - they may reciprocate and you may learn something (*Why do code reviews when Im not core?*).

If youve waited an appropriate amount of time and you havent had any +1s, you can ask on IRC for reviews. Please dont ask for core review straight away, especially not directly (IRC or email). Core

reviewer time is very valuable and gaining some +1s is a good way to show your patch meets basic quality standards.

Once you have a few +1s, be patient. Remember the average wait times. You can ask for reviews each week in IRC, it helps to ask when cores are awake.

Bugs

It helps to apply correct tracking information.

- Put Closes-Bug, Partial-Bug or Related-Bug in the commit message tags as necessary.
- If you have to raise a bug in Launchpad first, do it - this helps someone else find your fix.
- Make sure the bug has the correct priority and tag set.

Features

Again, it helps to apply correct tracking information. For blueprint-only features:

- Put your blueprint in the commit message, EG blueprint simple-feature.
- Mark the blueprint as NeedsCodeReview if you are finished.
- Maintain the whiteboard on the blueprint so its easy to understand which patches need reviews.
- Use a single topic for all related patches. All patches for one blueprint should share a topic.

For blueprint and spec features, do everything for blueprint-only features and also:

- Ensure your spec is approved for the current release cycle.

If your code is a project or subteam priority, the cores interested in that priority might not mind a ping after it has sat with +1s for a week. If you abuse this privilege, youll lose respect.

If its not a priority, your blueprint/spec has been approved for the cycle and you have been patient, you can raise it during the Nova meeting. The outcome may be that your spec gets unapproved for the cycle, so that priority items can take focus. If this happens to you, sorry - it should not have been approved in the first place, Nova team bit off more than they could chew, it is their mistake not yours. You can re-propose it for the next cycle.

If its not a priority and your spec has not been approved, your code will not merge this cycle. Please re-propose your spec for the next cycle.

Nova Process Mission

This section takes a high level look at the guiding principles behind the Nova process.

Open

Our mission is to have:

- Open Source
- Open Design
- Open Development
- Open Community

We have to work out how to keep communication open in all areas. We need to be welcoming and mentor new people, and make it easy for them to pickup the knowledge they need to get involved with OpenStack. For more info on Open, please see: https://wiki.openstack.org/wiki/Open

Interoperable API, supporting a vibrant ecosystem

An interoperable API that gives users on-demand access to compute resources is at the heart of *novas mission*.

Nova has a vibrant ecosystem of tools built on top of the current Nova API. All features should be designed to work with all technology combinations, so the feature can be adopted by our ecosystem. If a new feature is not adopted by the ecosystem, it will make it hard for your users to make use of those features, defeating most of the reason to add the feature in the first place. The microversion system allows users to isolate themselves

This is a very different aim to being pluggable or wanting to expose all capabilities to end users. At the same time, it is not just a lowest common denominator set of APIs. It should be discoverable which features are available, and while no implementation details should leak to the end users, purely admin concepts may need to understand technology specific details that back the interoperable and more abstract concepts that are exposed to the end user. This is a hard goal, and one area we currently dont do well is isolating image creators from these technology specific details.

Smooth Upgrades

As part of our mission for a vibrant ecosystem around our APIs, we want to make it easy for those deploying Nova to upgrade with minimal impact to their users. Here is the scope of Novas upgrade support:

- upgrade from any commit, to any future commit, within the same major release
- only support upgrades between N and N+1 major versions, to reduce technical debt relating to upgrades

Here are some of the things we require developers to do, to help with upgrades:

- when replacing an existing feature or configuration option, make it clear how to transition to any replacement
- deprecate configuration options and features before removing them
  - i.e. continue to support and test features for at least one release before they are removed
  - this gives time for operator feedback on any removals
- End User API will always be kept backwards compatible

Interaction goals

When thinking about the importance of process, we should take a look at: http://agilemanifesto.org

With that in mind, lets look at how we want different members of the community to interact. Lets start with looking at issues we have tried to resolve in the past (currently in no particular order). We must:

- have a way for everyone to review blueprints and designs, including allowing for input from operators and all types of users (keep it open)
- take care to not expand Novas scope any more than absolutely necessary

- ensure we get sufficient focus on the core of Nova so that we can maintain or improve the stability and flexibility of the overall codebase
- support any API we release approximately forever. We currently release every commit, so were motivated to get the API right the first time
- avoid low priority blueprints that slow work on high priority work, without blocking those forever
- focus on a consistent experience for our users, rather than ease of development
- optimise for completed blueprints, rather than more half completed blueprints, so we get maximum value for our users out of our review bandwidth
- focus efforts on a subset of patches to allow our core reviewers to be more productive
- set realistic expectations on what can be reviewed in a particular cycle, to avoid sitting in an expensive rebase loop
- be aware of users that do not work on the project full time
- be aware of users that are only able to work on the project at certain times that may not align with the overall community cadence
- discuss designs for non-trivial work before implementing it, to avoid the expense of late-breaking design issues

FAQs

Why bother with all this process?

We are a large community, spread across multiple timezones, working with several horizontal teams. Good communication is a challenge and the processes we have are mostly there to try and help fix some communication challenges.

If you have a problem with a process, please engage with the community, discover the reasons behind our current process, and help fix the issues you are experiencing.

Why dont you remove old process?

We do! For example, in Liberty we stopped trying to predict the milestones when a feature will land.

As we evolve, it is important to unlearn new habits and explore if things get better if we choose to optimise for a different set of issues.

Why are specs useful?

Spec reviews allow anyone to step up and contribute to reviews, just like with code. Before we used gerrit, it was a very messy review process, that felt very closed to most people involved in that process.

As Nova has grown in size, it can be hard to work out how to modify Nova to meet your needs. Specs are a great way of having that discussion with the wider Nova community.

For Nova to be a success, we need to ensure we dont break our existing users. The spec template helps focus the mind on the impact your change might have on existing users and gives an opportunity to discuss the best way to deal with those issues.

However, there are some pitfalls with the process. Here are some top tips to avoid them:

- keep it simple. Shorter, simpler, more decomposed specs are quicker to review and merge much quicker (just like code patches).
- specs can help with documentation but they are only intended to document the design discussion rather than document the final code.
- dont add details that are best reviewed in code, its better to leave those things for the code review.

If we have specs, why still have blueprints?

We use specs to record the design agreement, we use blueprints to track progress on the implementation of the spec.

Currently, in Nova, specs are only approved for one release, and must be re-submitted for each release you want to merge the spec, although that is currently under review.

Why do we have priorities?

To be clear, there is no nova dev team manager, we are an open team of professional software developers, that all work for a variety of (mostly competing) companies that collaborate to ensure the Nova project is a success.

Over time, a lot of technical debt has accumulated, because there was a lack of collective ownership to solve those cross-cutting concerns. Before the Kilo release, it was noted that progress felt much slower, because we were unable to get appropriate attention on the architectural evolution of Nova. This was important, partly for major concerns like upgrades and stability. We agreed its something we all care about and it needs to be given priority to ensure that these things get fixed.

Since Kilo, priorities have been discussed at the summit. This turns in to a spec review which eventually means we get a list of priorities here: http://specs.openstack.org/openstack/nova-specs/#priorities

Allocating our finite review bandwidth to these efforts means we have to limit the reviews we do on non-priority items. This is mostly why we now have the non-priority Feature Freeze. For more on this, see below.

Blocking a priority effort is one of the few widely acceptable reasons to block someone adding a feature. One of the great advantages of being more explicit about that relationship is that people can step up to help review and/or implement the work that is needed to unblock the feature they want to get landed. This is a key part of being an Open community.

Why is there a Feature Freeze (and String Freeze) in Nova?

The main reason Nova has a feature freeze is that it allows people working on docs and translations to sync up with the latest code. Traditionally this happens at the same time across multiple projects, so the docs are synced between what used to be called the integrated release.

We also use this time period as an excuse to focus our development efforts on bug fixes, ideally lower risk bug fixes, and improving test coverage.

In theory, with a waterfall hat on, this would be a time for testing and stabilisation of the product. In Nova we have a much stronger focus on keeping every commit stable, by making use of extensive continuous testing. In reality, we frequently see the biggest influx of fixes in the few weeks after the release, as distributions do final testing of the released code.

It is hoped that the work on Feature Classification will lead us to better understand the levels of testing of different Nova features, so we will be able to reduce and dependency between Feature Freeze and

regression testing. It is also likely that the move away from integrated releases will help find a more developer friendly approach to keep the docs and translations in sync.

Why is there a non-priority Feature Freeze in Nova?

We have already discussed why we have priority features.

The rate at which code can be merged to Nova is primarily constrained by the amount of time able to be spent reviewing code. Given this, earmarking review time for priority items means depriving it from non-priority items.

The simplest way to make space for the priority features is to stop reviewing and merging non-priority features for a whole milestone. The idea being developers should focus on bug fixes and priority features during that milestone, rather than working on non-priority features.

A known limitation of this approach is developer frustration. Many developers are not being given permission to review code, work on bug fixes or work on priority features, and so feel very unproductive upstream. An alternative approach of slots or runways has been considered, that uses a kanban style approach to regulate the influx of work onto the review queue. We are yet to get agreement on a more balanced approach, so the existing system is being continued to ensure priority items are more likely to get the attention they require.

Why do you still use Launchpad?

We are actively looking for an alternative to Launchpads bugs and blueprints.

Originally the idea was to create Storyboard. However development stalled for a while so interest waned. The project has become more active recently so it may be worth looking again: https://storyboard.openstack.org/#!/page/about

When should I submit my spec?

Ideally we want to get all specs for a release merged before the summit. For things that we cant get agreement on, we can then discuss those at the summit. There will always be ideas that come up at the summit and need to be finalised after the summit. This causes a rush which is best avoided.

How can you get the current specs and bug fixes tracked?

As there are a lot of incoming changes, both feature implementation and bug fixes, that core reviewers need to keep up with, the Nova team is using a tracking process.

The team creates an etherpad for every new release cycle and tracks the status of blueprints, feature implementations and bug fixes. The purpose of this process is to help with managing the core reviewers load, while ensuring that things dont fall through the cracks.

If you have a blueprint or bug fix to track during the release cycle, please add it to the correct section in the etherpad. You can follow the format that is already applied in the different sections. Please check the below template to use as guidance for what information to include at the minimum:

- <lauchpad tracker link (bug or blueprint)> [<launchpad issue title> optional]
  - <gerrit review link or topic> repeat as needed
  - short note of summary of current status. i.e. needs second +2, needs spec approval.

How can I get my code merged faster?

So no-one is coming to review your code, how do you speed up that process?

Firstly, make sure you are following the above process. If its a feature, make sure you have an approved blueprint. If its a bug, make sure it is triaged, has its priority set correctly, it has the correct bug tag and is marked as in progress. If the blueprint has all the code up for review, change it from Started into NeedsCodeReview so people know only reviews are blocking you, make sure it hasnt accidentally got marked as implemented.

Secondly, if you have a negative review (-1 or -2) and you responded to that in a comment or uploading a new change with some updates, but that reviewer hasnt come back for over a week, its probably a good time to reach out to the reviewer on IRC (or via email) to see if they could look again now you have addressed their comments. If you cant get agreement, and your review gets stuck (i.e. requires mediation), you can raise your patch during the Nova meeting and we will try to resolve any disagreement.

Thirdly, is it in merge conflict with master or are any of the CI tests failing? Particularly any third-party CI tests that are relevant to the code you are changing. If youre fixing something that only occasionally failed before, maybe recheck a few times to prove the tests stay passing. Without green tests, reviewers tend to move on and look at the other patches that have the tests passing.

OK, so you have followed all the process (i.e. your patches are getting advertised via the projects tracking mechanisms), and your patches either have no reviews, or only positive reviews. Now what?

Have you considered reviewing other peoples patches? Firstly, participating in the review process is the best way for you to understand what reviewers are wanting to see in the code you are submitting. As you get more practiced at reviewing it will help you to write merge-ready code. Secondly, if you help review other peoples code and help get their patches ready for the core reviewers to add a +2, it will free up a lot of non-core and core reviewer time, so they are more likely to get time to review your code. For more details, please see: *Why do code reviews when Im not core?*

Please note, I am not recommending you go to ask people on IRC or via email for reviews. Please try to get your code reviewed using the above process first. In many cases multiple direct pings generate frustration on both sides and that tends to be counter productive.

Now you have got your code merged, lets make sure you dont need to fix this bug again. The fact the bug exists means there is a gap in our testing. Your patch should have included some good unit tests to stop the bug coming back. But dont stop there, maybe its time to add tempest tests, to make sure your use case keeps working? Maybe you need to set up a third party CI so your combination of drivers will keep working? Getting that extra testing in place should stop a whole heap of bugs, again giving reviewers more time to get to the issues or features you want to add in the future.

Process Evolution Ideas

We are always evolving our process as we try to improve and adapt to the changing shape of the community. Here we discuss some of the ideas, along with their pros and cons.

Splitting out the virt drivers (or other bits of code)

Currently, Nova doesnt have strong enough interfaces to split out the virt drivers, scheduler or REST API. This is seen as the key blocker. Lets look at both sides of the debate here.

Reasons for the split:

- can have separate core teams for each repo
  - this leads to quicker turn around times, largely due to focused teams

- splitting out things from core means less knowledge required to become core in a specific area

Reasons against the split:

- loss of interoperability between drivers
  - this is a core part of Novas mission, to have a single API across all deployments, and a strong ecosystem of tools and apps built on that
  - we can overcome some of this with stronger interfaces and functional tests
- new features often need changes in the API and virt driver anyway
  - the new depends-on can make these cross-repo dependencies easier
- loss of code style consistency across the code base
- fear of fragmenting the nova community, leaving few to work on the core of the project
- could work in subteams within the main tree

TODO - need to complete analysis

Subteam recommendation as a +2

There are groups of people with great knowledge of particular bits of the code base. It may be a good idea to give their recommendation of a merge greater strength. In addition, having the subteam focus review efforts on a subset of patches should help concentrate the nova-core reviews they get, and increase the velocity of getting code merged.

Ideally this would be done with gerrit user tags. There are some investigations by sdague in how feasible it would be to add tags to gerrit.

Stop having to submit a spec for each release

As mentioned above, we use blueprints for tracking, and specs to record design decisions. Targeting specs to a specific release is a heavyweight solution and blurs the lines between specs and blueprints. At the same time, we dont want to lose the opportunity to revise existing blueprints. Maybe there is a better balance?

What about this kind of process:

- backlog has these folders:
  - backlog/incomplete - merge a partial spec
  - backlog/complete - merge complete specs (remove tracking details, such as assignee part of the template)
  - ?? backlog/expired - specs are moved here from incomplete or complete when no longer seem to be given attention (after 1 year, by default)
  - /implemented - when a spec is complete it gets moved into the release directory and possibly updated to reflect what actually happened
  - there will no longer be a per-release approved spec list

To get your blueprint approved:

- add it to the next nova meeting
  - if a spec is required, update the URL to point to the spec merged in a spec to the blueprint

    - ensure there is an assignee in the blueprint
- a day before the meeting, a note is sent to the ML to review the list before the meeting
- discuss any final objections in the nova-meeting
    - this may result in a request to refine the spec, if things have changed since it was merged
- trivial cases can be approved in advance by a nova-driver, so not all folks need to go through the meeting

This still needs more thought, but should decouple the spec review from the release process. It is also more compatible with a runway style system, that might be less focused on milestones.

Replacing Milestones with SemVer Releases

You can deploy any commit of Nova and upgrade to a later commit in that same release. Making our milestones versioned more like an official release would help signal to our users that people can use the milestones in production, and get a level of upgrade support.

It could go something like this:

- 14.0.0 is milestone 1
- 14.0.1 is milestone 2 (maybe, because we add features, it should be 14.1.0?)
- 14.0.2 is milestone 3
- we might do other releases (once a critical bug is fixed?), as it makes sense, but we will always be the time bound ones
- 14.0.3 two weeks after milestone 3, adds only bug fixes (and updates to RPC versions?)
    - maybe a stable branch is created at this point?
- 14.1.0 adds updated translations and co-ordinated docs
    - this is released from the stable branch?
- 15.0.0 is the next milestone, in the following cycle
    - not the bump of the major version to signal an upgrade incompatibility with 13.x

We are currently watching Ironic to see how their use of semver goes, and see what lessons need to be learnt before we look to maybe apply this technique during M.

Feature Classification

This is a look at moving forward the *support matrix effort*.

The things we need to cover:

- note what is tested, and how often that test passes (via 3rd party CI, or otherwise)
    - link to current test results for stable and master (time since last pass, recent pass rate, etc)
    - TODO - sync with jogo on his third party CI audit and getting trends, ask infra
- include experimental features (untested feature)
- get better at the impact of volume drivers and network drivers on available features (not just hypervisor drivers)

Main benefits:

- users get a clear picture of what is known to work
- be clear about when experimental features are removed, if no tests are added
- allows a way to add experimental things into Nova, and track either their removal or maturation

4.1.3.4 Blueprints, Specs and Priorities

Like most OpenStack projects, Nova uses blueprints and specifications (specs) to track new features, but not all blueprints require a spec. This document covers when a spec is needed.

Note

Novas specs live at: specs.openstack.org

Specs

A spec is needed for any feature that requires a design discussion. All features need a blueprint but not all blueprints require a spec.

If a new feature is straightforward enough that it doesnt need any design discussion, then no spec is required. In order to provide the sort of documentation that would otherwise be provided via a spec, the commit message should include a `DocImpact` flag and a thorough description of the feature from a user/operator perspective.

Guidelines for when a feature doesnt need a spec.

- Is the feature a single self contained change?
  - If the feature touches code all over the place, it probably should have a design discussion.
  - If the feature is big enough that it needs more than one commit, it probably should have a design discussion.
- Not an API change.
  - API changes always require a design discussion.

When a blueprint does not require a spec it still needs to be approved before the code which implements the blueprint is merged. Specless blueprints are discussed and potentially approved during the `Open Discussion` portion of the weekly nova IRC meeting. See trivial specifications for more details.

Project Priorities

- Pick several project priority themes, in the form of use cases, to help us prioritize work
  - Generate list of improvement blueprints based on the themes
  - Produce rough draft of list going into summit and finalize the list at the summit
  - Publish list of project priorities and look for volunteers to work on them
- Update spec template to include
  - Specific use cases
  - State if the spec is project priority or not

- Keep an up to date list of project priority blueprints that need code review in an etherpad.
- Consumers of project priority and project priority blueprint lists:
  - Reviewers looking for direction of where to spend their blueprint review time. If a large subset of nova-core doesnt use the project priorities it means the core team is not aligned properly and should revisit the list of project priorities
  - The blueprint approval team, to help find the right balance of blueprints
  - Contributors looking for something to work on
  - People looking for what they can expect in the next release

4.1.3.5 Chronological PTL guide

This is just a reference guide that a PTL may use as an aid, if they choose.

New PTL

- Update the nova meeting chair
  - https://github.com/openstack-infra/irc-meetings/blob/master/meetings/nova-team-meeting.yaml
- Update the team wiki
  - https://wiki.openstack.org/wiki/Nova#People
- Get acquainted with the release schedule
  - Example: https://releases.openstack.org/antelope/schedule.html
  - Also, note that we usually create a specific wiki page for each cycle like https://wiki.openstack.org/wiki/Nova/2023.1_Release_Schedule but its preferred to use the main release schedule above.

Project Team Gathering

- Create PTG planning etherpad, retrospective etherpad and alert about it in nova meeting and dev mailing list
  - Example: https://etherpad.opendev.org/p/nova-antelope-ptg
- Run sessions at the PTG
- Do a retro of the previous cycle
- Make agreement on the agenda for this release, including but not exhaustively:
  - Number of review days, for either specs or implementation
  - Define the Spec approval and Feature freeze dates
  - Modify the release schedule if needed by adding the new dates. As an example : https://review.opendev.org/c/openstack/releases/+/877094
- Discuss the implications of the SLURP or non-SLURP current release
- Sign up for group photo at the PTG (if applicable)

After PTG

- Send PTG session summaries to the dev mailing list
- Add RFE bugs if you have action items that are simple to do but without a owner yet.
- Update IRC #openstack-nova channel topic to point to new development-planning etherpad.

A few weeks before milestone 1

- Plan a spec review day
- Periodically check the series goals others have proposed in the Set series goals link:
  - Example: https://blueprints.launchpad.net/nova/antelope/+setgoals

Milestone 1

- Do milestone release of nova and python-novaclient (in launchpad only, can be optional)
  - This is launchpad bookkeeping only. With the latest release team changes, projects no longer do milestone releases. See: https://releases.openstack.org/reference/release_models.html#cycle-with-milestones-legacy
  - For nova, set the launchpad milestone release as released with the date
- Release other libraries if there are significant enough changes since last release. When releasing the first version of a library for the cycle, bump the minor version to leave room for future stable branch releases
  - os-vif
  - placement
  - os-traits / os-resource-classes
- Release stable branches of nova
  - `git checkout <stable branch>`
  - `git log --no-merges <last tag>..`
    - Examine commits that will go into the release and use it to decide whether the release is a major, minor, or revision bump according to semver
  - Then, propose the release with version according to semver x.y.z
    - X - backward-incompatible changes
    - Y - features
    - Z - bug fixes
  - Use the new-release command to generate the release
    - https://releases.openstack.org/reference/using.html#using-new-release-command

Summit

- Prepare the project update presentation. Enlist help of others
- Prepare the on-boarding session materials. Enlist help of others
- Prepare the operator meet-and-greet session. Enlist help of others

A few weeks before milestone 2

- Plan a spec review day (optional)

Milestone 2

- Spec freeze (if agreed)
- Release nova and python-novaclient (if new features were merged)
- Release other libraries as needed
- Stable branch releases of nova
- For nova, set the launchpad milestone release as released with the date (can be optional)

Shortly after spec freeze

- Create a blueprint status etherpad to help track, especially non-priority blueprint work, to help things get done by Feature Freeze (FF). Example:
  - https://etherpad.opendev.org/p/nova-antelope-blueprint-status
- Create or review a patch to add the next releases specs directory so people can propose specs for next release after spec freeze for current release

Non-client library release freeze

- Final release for os-vif
- Final release for os-traits
- Final release for os-resource-classes

Milestone 3

- Feature freeze day
- Client library freeze, release python-novaclient and osc-placement
- Close out all blueprints, including catch all blueprints like mox, versioned notifications
- Stable branch releases of nova
- For nova, set the launchpad milestone release as released with the date
- Start writing the cycle highlights

Week following milestone 3

- Consider announcing the FFE (feature freeze exception process) to have people propose FFE requests to a special etherpad where they will be reviewed and possibly sponsored:
  - https://docs.openstack.org/nova/latest/contributor/process.html#non-priority-feature-freeze

> **Note**
>
> if there is only a short time between FF and RC1 (lately its been 2 weeks), then the only likely candidates will be low-risk things that are almost done

- Mark the max microversion for the release in the *REST API Version History*:
  - Example: https://review.opendev.org/c/openstack/nova/+/719313

A few weeks before RC

- Make a RC1 todos etherpad and tag bugs as `<release>-rc-potential` and keep track of them, example:
  - https://etherpad.opendev.org/p/nova-antelope-rc-potential
- Go through the bug list and identify any rc-potential bugs and tag them

RC

- Do steps described on the release checklist wiki:
  - https://wiki.openstack.org/wiki/Nova/ReleaseChecklist
- If we want to drop backward-compat RPC code, we have to do a major RPC version bump and coordinate it just before the major release:
  - https://wiki.openstack.org/wiki/RpcMajorVersionUpdates
  - Example: https://review.opendev.org/541035
- Merge latest translations means translation patches
  - Check for translations with:
    - https://review.opendev.org/#/q/status:open+project:openstack/nova+branch:master+topic:zanata/translations
- Should NOT plan to have more than one RC if possible. RC2 should only happen if there was a mistake and something was missed for RC, or a new regression was discovered
- Do the RPC version aliases just before RC1 if no further RCs are planned. Else do them at RC2. In the past, we used to update all service version aliases (example: https://review.opendev.org/230132) but since we really only support compute being backlevel/old during a rolling upgrade, we only need to update the compute service alias, see related IRC discussion: http://eavesdrop.openstack.org/irclogs/%23openstack-nova/%23openstack-nova.2018-08-08.log.html#t2018-08-08T17:13:45
  - Example: https://review.opendev.org/642599

  - More detail on how version aliases work: https://docs.openstack.org/nova/latest/configuration/config.html#upgrade-levels
- Write the reno prelude for the release GA
  - Example: https://review.opendev.org/644412
- Push the cycle-highlights in marketing-friendly sentences and propose to the openstack/releases repo. Usually based on reno prelude but made more readable and friendly
  - Example: https://review.opendev.org/644697

Immediately after RC

- Look for bot proposed changes to reno and stable/<cycle>
- Follow the post-release checklist
  - https://wiki.openstack.org/wiki/Nova/ReleaseChecklist
  - Drop old RPC compat code (if there was a RPC major version bump and if agreed on at the PTG)
    - Example: https://review.opendev.org/543580
  - Bump the oldest supported compute service version (if master branch is now on a non-SLURP version)
    - https://review.opendev.org/#/c/738482/
- Create the launchpad series for the next cycle
- Set the development focus of the project to the new cycle series
- Set the status of the new series to active development
- Set the last series status to current stable branch release
- Set the previous to last series status to supported
- Repeat launchpad steps ^ for python-novaclient (optional)
- Repeat launchpad steps ^ for placement
- Register milestones in launchpad for the new cycle based on the new cycle release schedule
- Make sure the specs directory for the next cycle gets created so people can start proposing new specs
- Make sure to move implemented specs from the previous release
  - Use `tox -e move-implemented-specs <release>`
  - Also remove template from `doc/source/specs/<release>/index.rst`
  - Also delete template file `doc/source/specs/<release>/template.rst`
- Create new release wiki:
  - Example: https://wiki.openstack.org/wiki/Nova/2023.1_Release_Schedule
- Update the contributor guide for the new cycle
  - Example: https://review.opendev.org/#/c/754427/

Miscellaneous Notes

How to approve a launchpad blueprint

- Set the approver as the person who +W the spec, or set to self if its specless
- Set the Direction => Approved and Definition => Approved and make sure the Series goal is set to the current release. If code is already proposed, set Implementation => Needs Code Review
- Add a comment to the Whiteboard explaining the approval, with a date (launchpad does not record approval dates). For example: We discussed this in the team meeting and agreed to approve this for <release>. <nick> <YYYYMMDD>

How to complete a launchpad blueprint

- Set Implementation => Implemented. The completion date will be recorded by launchpad

4.1.4 Reviewing

- *Release Notes*: When we need a release note for a contribution.
- *Code Review Guide for Nova*: Important cheat sheet for whats important when doing code review in Nova, especially some things that are hard to test for, but need human eyes.
- *Internationalization*: What we require for i18n in patches
- *Documentation Guidelines*: Guidelines for handling documentation contributions

4.1.4.1 Release Notes

What is reno ?

Nova uses reno for providing release notes in-tree. That means that a patch can include a *reno file* or a series can have a follow-on change containing that file explaining what the impact is.

A *reno file* is a YAML file written in the `releasenotes/notes` tree which is generated using the *reno* tool this way:

```
$ tox -e venv -- reno new <name-your-file>
```

where usually `<name-your-file>` can be `bp-<blueprint_name>` for a blueprint or `bug-XXXXXX` for a bugfix.

Refer to the reno documentation for more information.

When a release note is needed

A release note is required anytime a reno section is needed. Below are some examples for each section. Any sections that would be blank should be left out of the note file entirely. If no section is needed, then you know you dont need to provide a release note :-)

- **`upgrade`**
  - The patch has an UpgradeImpact tag
  - A DB change needs some deployer modification (like a migration)
  - A configuration option change (deprecation, removal or modified default)

  - some specific changes that have a DocImpact tag but require further action from an deployer perspective
  - any patch that requires an action from the deployer in general
- `security`
  - If the patch fixes a known vulnerability
- `features`
  - If the patch has an APIImpact tag
  - For nova-manage and python-novaclient changes, if it adds or changes a new command, including adding new options to existing commands
  - not all blueprints in general, just the ones impacting a *Development policies*
  - a new virt driver is provided or an existing driver impacts the *HypervisorSupportMatrix*
- `critical`
  - Bugfixes categorized as Critical in Launchpad *impacting users*
- `fixes`
  - No clear definition of such bugfixes. Hairy long-standing bugs with high importance that have been fixed are good candidates though.

Three sections are left intentionally unexplained (`prelude`, `issues` and `other`). Those are targeted to be filled in close to the release time for providing details about the soon-ish release. Dont use them unless you know exactly what you are doing.

4.1.4.2 Code Review Guide for Nova

OpenStack has a general set of code review guidelines: https://docs.openstack.org/infra/manual/developers.html#peer-review

What follows is a very terse set of points for reviewers to consider when looking at nova code. These are things that are important for the continued smooth operation of Nova, but that tend to be carried as tribal knowledge instead of being written down. It is an attempt to boil down some of those things into nearly checklist format. Further explanation about why some of these things are important belongs elsewhere and should be linked from here.

Upgrade-Related Concerns

RPC API Versions

- If an RPC method is modified, the following needs to happen:
  - The manager-side (example: compute/manager) needs a version bump
  - The manager-side method needs to tolerate older calls as well as newer calls
  - Arguments can be added as long as they are optional. Arguments cannot be removed or changed in an incompatible way.
  - The RPC client code (example: compute/rpcapi.py) needs to be able to honor a pin for the older version (see self.client.can_send_version() calls). If we are pinned at 1.5, but the version requirement for a method is 1.7, we need to be able to formulate the call at version 1.5.

  - Methods can drop compatibility with older versions when we bump a major version.

- RPC methods can be deprecated by removing the client (example: compute/rpcapi.py) implementation. However, the manager method must continue to exist until the major version of the API is bumped.

Object Versions

- If a tracked attribute (i.e. listed in fields) or remotable method is added, or a method is changed, the object version must be bumped. Changes for methods follow the same rules as above for regular RPC methods. We have tests to try to catch these changes, which remind you to bump the version and then correct the version-hash in the tests.
- Field types cannot be changed. If absolutely required, create a new attribute and deprecate the old one. Ideally, support converting the old attribute to the new one with an obj_load_attr() handler. There are some exceptional cases where changing the type can be allowed, but care must be taken to ensure it does not affect the wireline API.
- New attributes should be removed from the primitive in obj_make_compatible() if the attribute was added after the target version.
- Remotable methods should not return unversioned structures wherever possible. They should return objects or simple values as the return types are not (and cannot) be checked by the hash tests.
- Remotable methods should not take complex structures as arguments. These cannot be verified by the hash tests, and thus are subject to drift. Either construct an object and pass that, or pass all the simple values required to make the call.
- Changes to an object as described above will cause a hash to change in TestObjectVersions. This is a reminder to the developer and the reviewer that the version needs to be bumped. There are times when we need to make a change to an object without bumping its version, but those cases are only where the hash logic detects a change that is not actually a compatibility issue and must be handled carefully.

Database Schema

- Changes to the database schema must generally be additive-only. This means you can add columns, but you cant drop or alter a column. We have some hacky tests to try to catch these things, but they are fragile. Extreme reviewer attention to non-online alterations to the DB schema will help us avoid disaster.
- Dropping things from the schema is a thing we need to be extremely careful about, making sure that the column has not been used (even present in one of our models) for at least a release.
- Data migrations must not be present in schema migrations. If data needs to be converted to another format, or moved from one place to another, then that must be done while the database server remains online. Generally, this can and should be hidden within the object layer so that an object can load from either the old or new location, and save to the new one.
- Multiple Cells v2 cells are supported started in the Pike release. As such, any online data migrations that move data from a cell database to the API database must be multi-cell aware.

REST API

When making a change to the nova API, we should always follow the API WG guidelines rather than going for local consistency. Developers and reviewers should read all of the guidelines, but they are very long. So here are some key points:

- Terms
  - `project` should be used in the REST API instead of `tenant`.
  - `server` should be used in the REST API instead of `instance`.
  - `compute` should be used in the REST API instead of `nova`.
- Naming Conventions
  - URL should not include underscores; use hyphens (-) instead.
  - The field names contained in a request/response body should use snake_case style, not CamelCase or Mixed_Case style.
- HTTP Response Codes
  - Synchronous resource creation: `201 Created`
  - Asynchronous resource creation: `202 Accepted`
  - Synchronous resource deletion: `204 No Content`
  - For all other successful operations: `200 OK`

Config Options

Location

The central place where all config options should reside is the `/nova/conf/` package. Options that are in named sections of `nova.conf`, such as `[serial_console]`, should be in their own module. Options that are in the `[DEFAULT]` section should be placed in modules that represent a natural grouping. For example, all of the options that affect the scheduler would be in the `scheduler.py` file, and all the networking options would be moved to `network.py`.

Implementation

A config option should be checked for:

- A short description which explains what it does. If it is a unit (e.g. timeouts or so) describe the unit which is used (seconds, megabyte, mebibyte,).
- A long description which explains the impact and scope. The operators should know the expected change in the behavior of Nova if they tweak this.
- Descriptions/Validations for the possible values.
  - If this is an option with numeric values (int, float), describe the edge cases (like the min value, max value, 0, -1).
  - If this is a DictOpt, describe the allowed keys.
  - If this is a StrOpt, list any possible regex validations, or provide a list of acceptable and/or prohibited values.

Previously used sections which explained which services consume a specific config option and which options are related to each other got dropped because they are too hard to maintain: http://lists.openstack.org/pipermail/openstack-dev/2016-May/095538.html

Third Party Tests

Any change that is not tested well by the Jenkins check jobs must have a recent +1 vote from an appropriate third party test (or tests) on the latest patchset, before a core reviewer is allowed to make a +2 vote.

Virt drivers

At a minimum, we must ensure that any technology specific code has a +1 from the relevant third party test, on the latest patchset, before a +2 vote can be applied. Specifically, changes to nova/virt/driver/<NNNN> need a +1 vote from the respective third party CI. For example, if you change something in the VMware virt driver, you must wait for a +1 from the VMware CI on the latest patchset, before you can give that patch set a +2 vote.

This is important to ensure:

- We keep those drivers stable
- We dont break that third party CI

Notes

Please note:

- Long term, we should ensure that any patch a third party CI is allowed to vote on, can be blocked from merging by that third party CI. But we need a lot more work to make something like that feasible, hence the proposed compromise.
- While its possible to break a virt driver CI system by changing code that is outside the virt drivers, this policy is not focusing on fixing that. A third party test failure should always be investigated, but the failure of a third party test to report in a timely manner should not block others.
- We are only talking about the testing of in-tree code. Please note the only public API is our REST API, see: *Development policies*

Should I run the experimental queue jobs on this change?

Because we cant run all CI jobs in the check and gate pipelines, some jobs can be executed on demand, thanks to the experimental pipeline. To run the experimental jobs, you need to comment your Gerrit review with check experimental.

The experimental jobs aim to test specific features, such as LXC containers or DVR with multiple nodes. Also, it might be useful to run them when we want to test backward compatibility with tools that deploy OpenStack outside Devstack (e.g. TripleO, etc). They can produce a non-voting feedback of whether the system continues to work when we deprecate or remove some options or features in Nova.

The experimental queue can also be used to test that new CI jobs are correct before making them voting.

Database Schema

- Use the `utf8` charset only where necessary. Some string fields, such as hex-stringified UUID values, MD5 fingerprints, SHA1 hashes or base64-encoded data, are always interpreted using ASCII encoding. A hex-stringified UUID value in `latin1` is 1/3 the size of the same field in `utf8`, impacting performance without bringing any benefit. If there are no string type columns in the table, or the string type columns contain **only** the data described above, then stick with `latin1`.

Microversion API

If a new microversion API is added, the following needs to happen:

- A new patch for the microversion API change in both python-novaclient and in python-openstackclient should be submitted before the microversion change in Nova is merged. See Adding support for a new microversion in python-novaclient for more details. See also Add support for server group create rule parameter patch as example how to support a new microversion in the openstack client.
- If the microversion changes the response schema, a new schema and test for the microversion must be added to Tempest. The microversion change in Nova should not be merged until the Tempest test is submitted and at least passing; it does not need to be merged yet as long as it is testing the Nova change via Depends-On. The Nova microversion change commit message should reference the Change-Id of the Tempest test for reviewers to identify it.

Notifications

- Every new notification type shall use the new versioned notification infrastructure documented in *Available versioned notifications*

Release Notes

A release note is required on changes that have upgrade impact, security impact, introduce a new feature, fix Critical bugs, or fix long-standing bugs with high importance. See *Release Notes* for details on how to create a release note, each available section and the type of content required.

4.1.4.3 Internationalization

Nova uses the oslo.i18n library to support internationalization. The oslo.i18n library is built on top of gettext and provides functions that are used to enable user-facing strings such as log messages to appear in the appropriate language in different locales.

Nova exposes the oslo.i18n library support via the `nova/i18n.py` integration module. This module provides the functions needed to wrap translatable strings. It provides the `_()` wrapper for general user-facing messages (such as ones that end up in command line responses, or responses over the network).

One upon a time there was an effort to translate log messages in OpenStack projects. But starting with the Ocata release these are no longer being supported. Log messages **should not** be translated.

You should use the basic wrapper `_()` for strings which are not log messages that are expected to get to an end user:

```
raise nova.SomeException(_('Invalid service catalogue'))
```

Do not use `locals()` for formatting messages because:

1. It is not as clear as using explicit dicts.
2. It could produce hidden errors during refactoring.
3. Changing the name of a variable causes a change in the message.
4. It creates a lot of otherwise unused variables.

If you do not follow the project conventions, your code may cause hacking checks to fail.

The `_()` function can be imported with

```
from nova.i18n import _
```

4.1.4.4 Documentation Guidelines

These are some basic guidelines for contributing to documentation in nova.

Review Guidelines

Documentation-only patches differ from code patches in a few ways.

- They are often written by users / operators that arent plugged into daily cycles of nova or on IRC
- Outstanding patches are far more likely to trigger merge conflict in Git than code patches
- There may be wide variation on points of view of what the best or clearest way is to say a thing

This all can lead to a large number of practical documentation improvements stalling out because the author submitted the fix, and does not have the time to merge conflict chase or is used to the Gerrit follow up model.

As such, documentation patches should be evaluated in the basic context of does this make things better than the current tree. Patches are cheap, it can always be further enhanced in future patches.

Typo / trivial documentation only fixes should get approved with a single +2.

How users consume docs

The current primary target for all documentation in nova is the web. While it is theoretically possible to generate PDF versions of the content, the tree is not currently well structured for that, and its not clear there is an audience for that.

The main nova docs tree `doc/source` is published per release, so there will be copies of all of this as both the `latest` URL (which is master), and for every stable release (e.g. `pike`).

Note

This raises an interesting and unexplored question about whether we want all of `doc/source` published with stable branches that will be stale and unimproved as we address content in `latest`.

The `api-ref` and `api-guide` publish only from master to a single site on `docs.openstack.org`. As such, they are effectively branchless.

Guidelines for consumable docs

- Give users context before following a link

  Most users exploring our documentation will be trying to learn about our software. Entry and sub-pages that provide links to in depth topics need to provide some basic context about why someone would need to know about a `filter scheduler` before following the link named filter scheduler.

  Providing these summaries helps the new consumer come up to speed more quickly.

- Doc moves require `.htaccess` redirects

  If a file is moved in a documentation source tree, we should be aware that it might be linked from external sources, and is now a `404 Not Found` error for real users.

  All doc moves should include an entry in `doc/source/_extra/.htaccess` to redirect from the old page to the new page.

- Images are good, please provide source

  An image is worth a 1000 words, but can go stale pretty quickly. We ideally want `png` files for display on the web, but thats a non modifiable format. For any new diagram contributions we should also get some kind of source format (`svg` is ideal as it can be modified with open tools) along with `png` formats.

Long Term TODOs

- Sort out our toctree / sidebar navigation

  During the bulk import of the install, admin, config guides we started with a unified toctree, which was a ton of entries, and made the navigation sidebar in Nova incredibly confusing. The short term fix was to just make that almost entirely hidden and rely on structured landing and sub pages.

  Long term it would be good to reconcile the toctree / sidebar into something that feels coherent.

4.1.5 Testing

Because Python is a dynamic language, code that is not tested might not even be Python code. All new code needs to be validated somehow.

- *Test Strategy*: An overview of our test taxonomy and the kinds of testing we do and expect.
- **Testing Guides**: There are also specific testing guides for features that are hard to test in our gate.
  - *Testing NUMA related hardware setup with libvirt*
  - *Testing Serial Console*
  - *Testing Zero Downtime Upgrade Process*
  - *Testing Down Cells*
  - *Testing PCI passthrough and SR-IOV with emulated PCI NIC*
- **Profiling Guides**: These are guides to profiling nova.
  - *Profiling With Eventlet*

4.1.5.1 Test Strategy

A key part of the four opens is ensuring the OpenStack delivers well-tested and usable software. For more details see: http://docs.openstack.org/project-team-guide/introduction.html#the-four-opens

Experience has shown that untested features are frequently broken, in part due to the velocity of upstream changes. As we aim to ensure we keep all features working across upgrades, we must aim to test all features.

Reporting Test Coverage

For details on plans to report the current test coverage, refer to *Feature Classification*.

Running tests and reporting results

Running tests locally

Please see https://opendev.org/openstack/nova/src/branch/master/HACKING.rst#running-tests

Voting in Gerrit

On every review in gerrit, check tests are run on very patch set, and are able to report a +1 or -1 vote. For more details, please see: http://docs.openstack.org/infra/manual/developers.html#automated-testing

Before merging any code, there is an integrate gate test queue, to ensure master is always passing all tests. For more details, please see: http://docs.openstack.org/infra/zuul/user/gating.html

Infra vs Third-Party

Tests that use fully open source components are generally run by the OpenStack Infra teams. Test setups that use non-open technology must be run outside of that infrastructure, but should still report their results upstream.

For more details, please see: http://docs.openstack.org/infra/system-config/third_party.html

Ad-hoc testing

It is particularly common for people to run ad-hoc tests on each released milestone, such as RC1, to stop regressions. While these efforts can help stabilize the release, as a community we have a much stronger preference for continuous integration testing. Partly this is because we encourage users to deploy master, and we generally have to assume that any upstream commit may already been deployed in production.

Types of tests

Unit tests

Unit tests help document and enforce the contract for each component. Without good unit test coverage it is hard to continue to quickly evolve the codebase. The correct level of unit test coverage is very subjective, and as such we are not aiming for a particular percentage of coverage, rather we are aiming for good coverage. Generally, every code change should have a related unit test: https://opendev.org/openstack/nova/src/branch/master/HACKING.rst#creating-unit-tests

Integration tests

Today, our integration tests involve running the Tempest test suite on a variety of Nova deployment scenarios. The integration job setup is defined in the `.zuul.yaml` file in the root of the nova repository. Jobs are restricted by queue:

- `check`: jobs in this queue automatically run on all proposed changes even with non-voting jobs
- `gate`: jobs in this queue automatically run on all approved changes (voting jobs only)
- `experimental`: jobs in this queue are non-voting and run on-demand by leaving a review comment on the change of check experimental

In addition, we have third parties running the tests on their preferred Nova deployment scenario.

Functional tests

Nova has a set of in-tree functional tests that focus on things that are out of scope for tempest testing and unit testing. Tempest tests run against a full live OpenStack deployment, generally deployed using devstack. At the other extreme, unit tests typically use mock to test a unit of code in isolation. Functional tests dont run an entire stack, they are isolated to nova code, and have no reliance on external services. They do have a WSGI app, nova services and a database, with minimal stubbing of nova internals.

Interoperability tests

The Interop Working Group maintains a list that contains a subset of Tempest tests. These are used to verify if a particular Nova deployments API responds as expected. For more details, see: https://docs.opendev.org/openinfra/interop/latest/

4.1.5.2 Testing NUMA related hardware setup with libvirt

This page describes how to test the libvirt drivers handling of the NUMA placement, large page allocation and CPU pinning features. It relies on setting up a virtual machine as the test environment and requires support for nested virtualization since plain QEMU is not sufficiently functional. The virtual machine will itself be given NUMA topology, so it can then act as a virtual host for testing purposes.

Provisioning a virtual machine for testing

The entire test process will take place inside a large virtual machine running Fedora 24. The instructions should work for any other Linux distribution which includes libvirt >= 1.2.9 and QEMU >= 2.1.2

The tests will require support for nested KVM, which is not enabled by default on hypervisor hosts. It must be explicitly turned on in the host when loading the kvm-intel/kvm-amd kernel modules.

On Intel hosts verify it with

```
# cat /sys/module/kvm_intel/parameters/nested
N

# rmmod kvm-intel
# echo "options kvm-intel nested=y" > /etc/modprobe.d/dist.conf
# modprobe kvm-intel

# cat /sys/module/kvm_intel/parameters/nested
Y
```

While on AMD hosts verify it with

```
# cat /sys/module/kvm_amd/parameters/nested
0

# rmmod kvm-amd
# echo "options kvm-amd nested=1" > /etc/modprobe.d/dist.conf
# modprobe kvm-amd

# cat /sys/module/kvm_amd/parameters/nested
1
```

The virt-install command below shows how to provision a basic Fedora 24 x86_64 guest with 8 virtual CPUs, 8 GB of RAM and 20 GB of disk space:

```
# cd /var/lib/libvirt/images
# wget https://download.fedoraproject.org/pub/fedora/linux/releases/29/Server/
↪x86_64/iso/Fedora-Server-netinst-x86_64-29-1.2.iso

# virt-install \
   --name f29x86_64 \
   --ram 8000 \
   --vcpus 8 \
   --file /var/lib/libvirt/images/f29x86_64.img \
   --file-size 20
   --cdrom /var/lib/libvirt/images/Fedora-Server-netinst-x86_64-24-1.2.iso \
   --os-variant fedora23
```

When the virt-viewer application displays the installer, follow the defaults for the installation with a couple of exceptions:

- The automatic disk partition setup can be optionally tweaked to reduce the swap space allocated. No more than 500MB is required, freeing up an extra 1.5 GB for the root disk
- Select Minimal install when asked for the installation type since a desktop environment is not required
- When creating a user account be sure to select the option Make this user administrator so it gets sudo rights

Once the installation process has completed, the virtual machine will reboot into the final operating system. It is now ready to deploy an OpenStack development environment.

Setting up a devstack environment

For later ease of use, copy your SSH public key into the virtual machine:

```
# ssh-copy-id  <IP of VM>
```

Now login to the virtual machine:

```
# ssh <IP of VM>
```

The Fedora minimal install does not contain git. Install git and clone the devstack repo:

```
$ sudo dnf install git
$ git clone https://opendev.org/openstack/devstack
$ cd devstack
```

At this point a fairly standard devstack setup can be done with one exception: we should enable the `NUMATopologyFilter` filter, which we will use later. For example:

```
$ cat >>local.conf <<EOF
[[local|localrc]]
DATA_DIR=$DEST/data
SERVICE_DIR=$DEST/status

LOGFILE=$DATA_DIR/logs/stack.log
VERBOSE=True

disable_service n-net
enable_service neutron q-svc q-dhcp q-l3 q-meta q-agt

MYSQL_PASSWORD=123456
DATABASE_PASSWORD=123456
SERVICE_TOKEN=123456
SERVICE_PASSWORD=123456
ADMIN_PASSWORD=123456
RABBIT_PASSWORD=123456

[[post-config|$NOVA_CONF]]
[filter_scheduler]
enabled_filters=ComputeFilter,ComputeCapabilitiesFilter,ImagePropertiesFilter,
↪PciPassthroughFilter,NUMATopologyFilter
EOF
$ FORCE=yes ./stack.sh
```

Unfortunately while devstack starts various system services and changes various system settings it doesnt make the changes persistent. Fix that now to avoid later surprises after reboots:

```
$ sudo systemctl enable mariadb.service
$ sudo systemctl enable rabbitmq-server.service
$ sudo systemctl enable httpd.service

$ sudo vi /etc/sysconfig/selinux
SELINUX=permissive
```

Testing basis non-NUMA usage

First to confirm weve not done anything unusual to the traditional operation of nova libvirt guests boot a tiny instance:

```
$ . openrc admin
$ openstack server create --image cirros-0.4.0-x86_64-disk --flavor m1.tiny \
    cirros1
```

The host will be reporting NUMA topology, but there should only be a single NUMA cell this point. We can validate this by querying the nova database. For example (with object versioning fields removed):

```
$ mysql -u root -p123456 nova_cell1
MariaDB [nova]> select numa_topology from compute_nodes;
+--------------------------------------------------------------------------------+
| numa_topology                                                                  |
+--------------------------------------------------------------------------------+
| {
|     "nova_object.name": "NUMATopology",
|     "nova_object.namespace": "nova",
|     "nova_object.version": "1.2",
|     "nova_object.data": {
|         "cells": [{
|             "nova_object.name": "NUMACell",
|             "nova_object.namespace": "nova",
|             "nova_object.version": "1.4",
|             "nova_object.data": {
|                 "id": 0,
|                 "cpuset": [0, 1, 2, 3, 4, 5, 6, 7],
|                 "pcpuset": [0, 1, 2, 3, 4, 5, 6, 7],
|                 "memory": 7975,
|                 "cpu_usage": 0,
|                 "memory_usage": 0,
|                 "pinned_cpus": [],
|                 "siblings": [
|                     [0],
|                     [1],
|                     [2],
|                     [3],
|                     [4],
|                     [5],
|                     [6],
|                     [7]
|                 ],
|                 "mempages": [{
|                     "nova_object.name": "NUMAPagesTopology",
|                     "nova_object.namespace": "nova",
|                     "nova_object.version": "1.1",
|                     "nova_object.data": {
|                         "size_kb": 4,
|                         "total": 2041795,
|                         "used": 0,
|                         "reserved": 0
|                     },
|                     "nova_object.changes": ["size_kb", "total", "reserved",
↪"used"]
|                 }, {
|                     "nova_object.name": "NUMAPagesTopology",
|                     "nova_object.namespace": "nova",
|                     "nova_object.version": "1.1",
```

(continues on next page)

(continued from previous page)

```
|                     "nova_object.data": {
|                         "size_kb": 2048,
|                         "total": 0,
|                         "used": 0,
|                         "reserved": 0
|                     },
|                     "nova_object.changes": ["size_kb", "total", "reserved",
↪"used"]
|                 }, {
|                     "nova_object.name": "NUMAPagesTopology",
|                     "nova_object.namespace": "nova",
|                     "nova_object.version": "1.1",
|                     "nova_object.data": {
|                         "size_kb": 1048576,
|                         "total": 0,
|                         "used": 0,
|                         "reserved": 0
|                     },
|                     "nova_object.changes": ["size_kb", "total", "reserved",
↪"used"]
|                 }],
|                 "network_metadata": {
|                     "nova_object.name": "NetworkMetadata",
|                     "nova_object.namespace": "nova",
|                     "nova_object.version": "1.0",
|                     "nova_object.data": {
|                         "physnets": [],
|                         "tunneled": false
|                     },
|                     "nova_object.changes": ["tunneled", "physnets"]
|                 }
|             },
|             "nova_object.changes": ["pinned_cpus", "memory_usage", "siblings
↪", "mempages", "memory", "id", "network_metadata", "cpuset", "cpu_usage",
↪"pcpuset"]
|         }]
|     },
|     "nova_object.changes": ["cells"]
| }
+--------------------------------------------------------------------------------+
```

Meanwhile, the guest instance should not have any NUMA configuration recorded:

```
MariaDB [nova]> select numa_topology from instance_extra;
+---------------+
| numa_topology |
+---------------+
| NULL          |
+---------------+
```

Reconfiguring the test instance to have NUMA topology

Now that devstack is proved operational, it is time to configure some NUMA topology for the test VM, so that it can be used to verify the OpenStack NUMA support. To do the changes, the VM instance that is running devstack must be shut down:

```
$ sudo shutdown -h now
```

And now back on the physical host edit the guest config as root:

```
$ sudo virsh edit f29x86_64
```

The first thing is to change the <cpu> block to do passthrough of the host CPU. In particular this exposes the SVM or VMX feature bits to the guest so that Nested KVM can work. At the same time we want to define the NUMA topology of the guest. To make things interesting were going to give the guest an asymmetric topology with 4 CPUS and 4 GBs of RAM in the first NUMA node and 2 CPUs and 2 GB of RAM in the second and third NUMA nodes. So modify the guest XML to include the following CPU XML:

```
<cpu mode='host-passthrough'>
  <numa>
    <cell id='0' cpus='0-3' memory='4096000'/>
    <cell id='1' cpus='4-5' memory='2048000'/>
    <cell id='2' cpus='6-7' memory='2048000'/>
  </numa>
</cpu>
```

Now start the guest again:

```
# virsh start f29x86_64
```

and login back in:

```
# ssh <IP of VM>
```

Before starting OpenStack services again, it is necessary to explicitly set the libvirt virtualization type to KVM, so that guests can take advantage of nested KVM:

```
$ sudo sed -i 's/virt_type = qemu/virt_type = kvm/g' /etc/nova/nova.conf
```

With that done, OpenStack can be started again:

```
$ cd devstack
$ ./stack.sh
```

The first thing is to check that the compute node picked up the new NUMA topology setup for the guest:

```
$ mysql -u root -p123456 nova_cell1
MariaDB [nova]> select numa_topology from compute_nodes;
+--------------------------------------------------------------------------+
| numa_topology                                                            |
+--------------------------------------------------------------------------+
| {
```

(continues on next page)

(continued from previous page)

```
    "nova_object.name": "NUMATopology",
    "nova_object.namespace": "nova",
    "nova_object.version": "1.2",
    "nova_object.data": {
        "cells": [{
            "nova_object.name": "NUMACell",
            "nova_object.namespace": "nova",
            "nova_object.version": "1.4",
            "nova_object.data": {
                "id": 0,
                "cpuset": [0, 1, 2, 3],
                "pcpuset": [0, 1, 2, 3],
                "memory": 3966,
                "cpu_usage": 0,
                "memory_usage": 0,
                "pinned_cpus": [],
                "siblings": [
                    [2],
                    [0],
                    [3],
                    [1]
                ],
                "mempages": [{
                    "nova_object.name": "NUMAPagesTopology",
                    "nova_object.namespace": "nova",
                    "nova_object.version": "1.1",
                    "nova_object.data": {
                        "size_kb": 4,
                        "total": 1015418,
                        "used": 0,
                        "reserved": 0
                    },
                    "nova_object.changes": ["total", "size_kb", "used",
↪"reserved"]
                }, {
                    "nova_object.name": "NUMAPagesTopology",
                    "nova_object.namespace": "nova",
                    "nova_object.version": "1.1",
                    "nova_object.data": {
                        "size_kb": 2048,
                        "total": 0,
                        "used": 0,
                        "reserved": 0
                    },
                    "nova_object.changes": ["total", "size_kb", "used",
↪"reserved"]
                }, {
                    "nova_object.name": "NUMAPagesTopology",
                    "nova_object.namespace": "nova",
```

(continues on next page)

(continued from previous page)

```
                    "nova_object.version": "1.1",
                    "nova_object.data": {
                        "size_kb": 1048576,
                        "total": 0,
                        "used": 0,
                        "reserved": 0
                    },
                    "nova_object.changes": ["total", "size_kb", "used",
↪"reserved"]
                }],
                "network_metadata": {
                    "nova_object.name": "NetworkMetadata",
                    "nova_object.namespace": "nova",
                    "nova_object.version": "1.0",
                    "nova_object.data": {
                        "physnets": [],
                        "tunneled": false
                    },
                    "nova_object.changes": ["physnets", "tunneled"]
                }
            },
            "nova_object.changes": ["pinned_cpus", "siblings", "memory", "id
↪", "cpuset", "network_metadata", "pcpuset", "mempages", "cpu_usage",
↪"memory_usage"]
        }, {
            "nova_object.name": "NUMACell",
            "nova_object.namespace": "nova",
            "nova_object.version": "1.4",
            "nova_object.data": {
                "id": 1,
                "cpuset": [4, 5],
                "pcpuset": [4, 5],
                "memory": 1994,
                "cpu_usage": 0,
                "memory_usage": 0,
                "pinned_cpus": [],
                "siblings": [
                    [5],
                    [4]
                ],
                "mempages": [{
                    "nova_object.name": "NUMAPagesTopology",
                    "nova_object.namespace": "nova",
                    "nova_object.version": "1.1",
                    "nova_object.data": {
                        "size_kb": 4,
                        "total": 510562,
                        "used": 0,
                        "reserved": 0
```

(continues on next page)

(continued from previous page)

```
                    },
                    "nova_object.changes": ["total", "size_kb", "used",
↪"reserved"]
                }, {
                    "nova_object.name": "NUMAPagesTopology",
                    "nova_object.namespace": "nova",
                    "nova_object.version": "1.1",
                    "nova_object.data": {
                        "size_kb": 2048,
                        "total": 0,
                        "used": 0,
                        "reserved": 0
                    },
                    "nova_object.changes": ["total", "size_kb", "used",
↪"reserved"]
                }, {
                    "nova_object.name": "NUMAPagesTopology",
                    "nova_object.namespace": "nova",
                    "nova_object.version": "1.1",
                    "nova_object.data": {
                        "size_kb": 1048576,
                        "total": 0,
                        "used": 0,
                        "reserved": 0
                    },
                    "nova_object.changes": ["total", "size_kb", "used",
↪"reserved"]
                }],
                "network_metadata": {
                    "nova_object.name": "NetworkMetadata",
                    "nova_object.namespace": "nova",
                    "nova_object.version": "1.0",
                    "nova_object.data": {
                        "physnets": [],
                        "tunneled": false
                    },
                    "nova_object.changes": ["physnets", "tunneled"]
                }
            },
            "nova_object.changes": ["pinned_cpus", "siblings", "memory", "id
↪", "cpuset", "network_metadata", "pcpuset", "mempages", "cpu_usage",
↪"memory_usage"]
        }, {
            "nova_object.name": "NUMACell",
            "nova_object.namespace": "nova",
            "nova_object.version": "1.4",
            "nova_object.data": {
                "id": 2,
                "cpuset": [6, 7],
```

(continues on next page)

(continued from previous page)

```
                "pcpuset": [6, 7],
                "memory": 2014,
                "cpu_usage": 0,
                "memory_usage": 0,
                "pinned_cpus": [],
                "siblings": [
                    [7],
                    [6]
                ],
                "mempages": [{
                    "nova_object.name": "NUMAPagesTopology",
                    "nova_object.namespace": "nova",
                    "nova_object.version": "1.1",
                    "nova_object.data": {
                        "size_kb": 4,
                        "total": 515727,
                        "used": 0,
                        "reserved": 0
                    },
                    "nova_object.changes": ["total", "size_kb", "used",
↪"reserved"]
                }, {
                    "nova_object.name": "NUMAPagesTopology",
                    "nova_object.namespace": "nova",
                    "nova_object.version": "1.1",
                    "nova_object.data": {
                        "size_kb": 2048,
                        "total": 0,
                        "used": 0,
                        "reserved": 0
                    },
                    "nova_object.changes": ["total", "size_kb", "used",
↪"reserved"]
                }, {
                    "nova_object.name": "NUMAPagesTopology",
                    "nova_object.namespace": "nova",
                    "nova_object.version": "1.1",
                    "nova_object.data": {
                        "size_kb": 1048576,
                        "total": 0,
                        "used": 0,
                        "reserved": 0
                    },
                    "nova_object.changes": ["total", "size_kb", "used",
↪"reserved"]
                }],
                "network_metadata": {
                    "nova_object.name": "NetworkMetadata",
                    "nova_object.namespace": "nova",
```

(continues on next page)

(continued from previous page)

```
|                    "nova_object.version": "1.0",
|                    "nova_object.data": {
|                        "physnets": [],
|                        "tunneled": false
|                    },
|                    "nova_object.changes": ["physnets", "tunneled"]
|                }
|            },
|            "nova_object.changes": ["pinned_cpus", "siblings", "memory", "id
↪", "cpuset", "network_metadata", "pcpuset", "mempages", "cpu_usage",
↪"memory_usage"]
|         }]
|     },
|     "nova_object.changes": ["cells"]
+--------------------------------------------------------------------------------+
```

This indeed shows that there are now 3 NUMA nodes for the host machine, the first with 4 GB of RAM and 4 CPUs, and others with 2 GB of RAM and 2 CPUs each.

Testing instance boot with no NUMA topology requested

For the sake of backwards compatibility, if the NUMA filter is enabled, but the flavor/image does not have any NUMA settings requested, it should be assumed that the guest will have a single NUMA node. The guest should be locked to a single host NUMA node too. Boot a guest with the `m1.tiny` flavor to test this condition:

```
$ . openrc admin admin
$ openstack server create --image cirros-0.4.0-x86_64-disk --flavor m1.tiny \
    cirros1
```

Now look at the libvirt guest XML:

```
$ sudo virsh list
 Id    Name                           State
----------------------------------------------------
 1     instance-00000001              running
$ sudo virsh dumpxml instance-00000001
...
<vcpu placement='static'>1</vcpu>
...
```

This example shows that there is no explicit NUMA topology listed in the guest XML.

Testing instance boot with 1 NUMA cell requested

Moving forward a little, explicitly tell nova that the NUMA topology for the guest should have a single NUMA node. This should operate in an identical manner to the default behavior where no NUMA policy is set. To define the topology we will create a new flavor:

```
$ openstack flavor create --ram 1024 --disk 1 --vcpus 4 m1.numa
$ openstack flavor set --property hw:numa_nodes=1 m1.numa
$ openstack flavor show m1.numa
```

Now boot the guest using this new flavor:

```
$ openstack server create --image cirros-0.4.0-x86_64-disk --flavor m1.numa \
    cirros2
```

Looking at the resulting guest XML from libvirt:

```
$ sudo virsh list
 Id    Name                           State
----------------------------------------------------
 1     instance-00000001              running
 2     instance-00000002              running
$ sudo virsh dumpxml instance-00000002
...
<vcpu placement='static'>4</vcpu>
<cputune>
  <vcpupin vcpu='0' cpuset='0-3'/>
  <vcpupin vcpu='1' cpuset='0-3'/>
  <vcpupin vcpu='2' cpuset='0-3'/>
  <vcpupin vcpu='3' cpuset='0-3'/>
  <emulatorpin cpuset='0-3'/>
</cputune>
...
<cpu>
  <topology sockets='4' cores='1' threads='1'/>
  <numa>
    <cell id='0' cpus='0-3' memory='1048576'/>
  </numa>
</cpu>
...
<numatune>
  <memory mode='strict' nodeset='0'/>
  <memnode cellid='0' mode='strict' nodeset='0'/>
</numatune>
```

The XML shows:

- Each guest CPU has been pinned to the physical CPUs associated with a particular NUMA node
- The emulator threads have been pinned to the union of all physical CPUs in the host NUMA node that the guest is placed on
- The guest has been given a virtual NUMA topology with a single node holding all RAM and CPUs
- The guest NUMA node has been strictly pinned to a host NUMA node.

As a further sanity test, check what nova recorded for the instance in the database. This should match the <numatune> information:

```
$ mysql -u root -p123456 nova_cell1
MariaDB [nova]> select numa_topology from instance_extra;
+--------------------------------------------------------------------------------+
| numa_topology                                                                  |
+--------------------------------------------------------------------------------+
| {
|     "nova_object.name": "InstanceNUMATopology",
|     "nova_object.namespace": "nova",
|     "nova_object.version": "1.3",
|     "nova_object.data": {
|         "cells": [{
|             "nova_object.name": "InstanceNUMACell",
|             "nova_object.namespace": "nova",
|             "nova_object.version": "1.4",
|             "nova_object.data": {
|                 "id": 0,
|                 "cpuset": [0, 1, 2, 3],
|                 "memory": 1024,
|                 "pagesize": null,
|                 "cpu_pinning_raw": null,
|                 "cpu_policy": null,
|                 "cpu_thread_policy": null,
|                 "cpuset_reserved": null
|             },
|             "nova_object.changes": ["id"]
|         }],
|         "emulator_threads_policy": null
|     },
|     "nova_object.changes": ["cells", "emulator_threads_policy"]
| }
+--------------------------------------------------------------------------------+
```

Delete this instance:

```
$ openstack server delete cirros2
```

Testing instance boot with 2 NUMA cells requested

Now getting more advanced we tell nova that the guest will have two NUMA nodes. To define the topology we will change the previously defined flavor:

```
$ openstack flavor set --property hw:numa_nodes=2 m1.numa
$ openstack flavor show m1.numa
```

Now boot the guest using this changed flavor:

```
$ openstack server create --image cirros-0.4.0-x86_64-disk --flavor m1.numa \
    cirros2
```

Looking at the resulting guest XML from libvirt:

```
$ sudo virsh list
 Id    Name                           State
----------------------------------------------------
 1     instance-00000001              running
 3     instance-00000003              running
$ sudo virsh dumpxml instance-00000003
...
<vcpu placement='static'>4</vcpu>
<cputune>
  <vcpupin vcpu='0' cpuset='0-3'/>
  <vcpupin vcpu='1' cpuset='0-3'/>
  <vcpupin vcpu='2' cpuset='4-5'/>
  <vcpupin vcpu='3' cpuset='4-5'/>
  <emulatorpin cpuset='0-5'/>
</cputune>
...
<cpu>
  <topology sockets='4' cores='1' threads='1'/>
  <numa>
    <cell id='0' cpus='0-1' memory='524288'/>
    <cell id='1' cpus='2-3' memory='524288'/>
  </numa>
</cpu>
...
<numatune>
  <memory mode='strict' nodeset='0-1'/>
  <memnode cellid='0' mode='strict' nodeset='0'/>
  <memnode cellid='1' mode='strict' nodeset='1'/>
</numatune>
```

The XML shows:

- Each guest CPU has been pinned to the physical CPUs associated with particular NUMA nodes
- The emulator threads have been pinned to the union of all physical CPUs in the host NUMA nodes that the guest is placed on
- The guest has been given a virtual NUMA topology with two nodes, each holding half the RAM and CPUs
- The guest NUMA nodes have been strictly pinned to different host NUMA node

As a further sanity test, check what nova recorded for the instance in the database. This should match the <numatune> information:

```
MariaDB [nova]> select numa_topology from instance_extra;
+--------------------------------------------------------------------------+
| numa_topology                                                            |
+--------------------------------------------------------------------------+
| {
|     "nova_object.name": "InstanceNUMATopology",
|     "nova_object.namespace": "nova",
|     "nova_object.version": "1.3",
```

(continues on next page)

(continued from previous page)

```
    "nova_object.data": {
        "cells": [{
            "nova_object.name": "InstanceNUMACell",
            "nova_object.namespace": "nova",
            "nova_object.version": "1.4",
            "nova_object.data": {
                "id": 0,
                "cpuset": [0, 1],
                "memory": 512,
                "pagesize": null,
                "cpu_pinning_raw": null,
                "cpu_policy": null,
                "cpu_thread_policy": null,
                "cpuset_reserved": null
            },
            "nova_object.changes": ["id"]
        }, {
            "nova_object.name": "InstanceNUMACell",
            "nova_object.namespace": "nova",
            "nova_object.version": "1.4",
            "nova_object.data": {
                "id": 1,
                "cpuset": [2, 3],
                "memory": 512,
                "pagesize": null,
                "cpu_pinning_raw": null,
                "cpu_policy": null,
                "cpu_thread_policy": null,
                "cpuset_reserved": null
            },
            "nova_object.changes": ["id"]
        }],
        "emulator_threads_policy": null
    },
    "nova_object.changes": ["cells", "emulator_threads_policy"]
}
+--------------------------------------------------------------------------+
```

4.1.5.3 Testing Serial Console

The main aim of this feature is exposing an interactive web-based serial consoles through a web-socket proxy. This page describes how to test it from a devstack environment.

Setting up a devstack environment

For instructions on how to setup devstack with serial console support enabled see this guide.

Testing the API

Starting a new instance.

```
# cd devstack && . openrc
# nova boot --flavor 1 --image cirros-0.3.2-x86_64-uec cirros1
```

Nova provides a command `nova get-serial-console` which will returns a URL with a valid token to connect to the serial console of VMs.

```
# nova get-serial-console cirros1
+--------+-----------------------------------------------------------------+
| Type   | Url                                                             |
+--------+-----------------------------------------------------------------+
| serial | ws://127.0.0.1:6083/?token=5f7854b7-bf3a-41eb-857a-43fc33f0b1ec |
+--------+-----------------------------------------------------------------+
```

Currently nova does not provide any client able to connect from an interactive console through a web-socket. A simple client for *test purpose* can be written with few lines of Python.

```
# sudo easy_install ws4py || sudo pip install ws4py
# cat >> client.py <<EOF
import sys
from ws4py.client.threadedclient import WebSocketClient
class LazyClient(WebSocketClient):
    def run(self):
        try:
            while not self.terminated:
                try:
                    b = self.sock.recv(4096)
                    while len(b) > 0:
                        # websocket data: opcode + length + data
                        word = b[2:b[1]+2]
                        b = b[b[1]+2:]
                        sys.stdout.buffer.write(word)
                        sys.stdout.flush()
                except: # socket error expected
                    pass
        finally:
            self.terminate()
if __name__ == '__main__':
    if len(sys.argv) != 2 or not sys.argv[1].startswith("ws"):
        print("Usage %s: Please use websocket url")
        print("Example: ws://127.0.0.1:6083/?token=xxx")
        exit(1)
    try:
        ws = LazyClient(sys.argv[1], protocols=['binary'])
        ws.connect()
```

(continues on next page)

(continued from previous page)

```
        while True:
            # keyboard event...
            c = sys.stdin.read(1)
            if c:
                ws.send(c.encode('utf-8'), binary=True)
        ws.run_forever()
    except KeyboardInterrupt:
        ws.close()
EOF
```

```
# python client.py ws://127.0.0.1:6083/?token=5f7854b7-bf3a-41eb-857a-
↪43fc33f0b1ec
<enter>
cirros1 login
```

4.1.5.4 Testing Zero Downtime Upgrade Process

Zero Downtime upgrade eliminates any disruption to nova API service during upgrade.

Nova API services are upgraded at the end. The basic idea of the zero downtime upgrade process is to have the connections drain from the old API before being upgraded. In this process, new connections go to the new API nodes while old connections slowly drain from the old nodes. This ensures that the user sees the max_supported API version as a monotonically increasing number. There might be some performance degradation during the process due to slow HTTP responses and delayed request handling, but there is no API downtime.

This page describes how to test the zero downtime upgrade process.

Environment

- **Multinode devstack environment with 2 nodes:**
  - controller - All services (N release)
  - compute-api - Only n-cpu and n-api services (N release)
- Highly available load balancer (HAProxy) on top of the n-api services. This is required for zero downtime upgrade as it allows one n-api service to run while we upgrade the other. See instructions to setup HAProxy below.

Instructions to setup HAProxy

Install HAProxy and Keepalived on both nodes.

```
# apt-get install haproxy keepalived
```

Let the kernel know that we intend to bind additional IP addresses that wont be defined in the interfaces file. To do this, edit `/etc/sysctl.conf` and add the following line:

```
net.ipv4.ip_nonlocal_bind=1
```

Make this take effect without rebooting.

```
# sysctl -p
```

Configure HAProxy to add backend servers and assign virtual IP to the frontend. On both nodes add the below HAProxy config:

```
# cd /etc/haproxy
# cat >> haproxy.cfg <<EOF

   global
      chroot /var/lib/haproxy
      user haproxy
      group haproxy
      daemon
      log 192.168.0.88 local0
      pidfile  /var/run/haproxy.pid
      stats socket /var/run/haproxy.sock mode 600 level admin
      stats timeout 2m
      maxconn 4000

   defaults
      log  global
      maxconn  8000
      mode  http
      option  redispatch
      retries  3
      stats  enable
      timeout  http-request 10s
      timeout  queue 1m
      timeout  connect 10s
      timeout  client 1m
      timeout  server 1m
      timeout  check 10s

   frontend nova-api-vip
      bind 192.168.0.95:8282              <<ha proxy virtual ip>>
      default_backend nova-api

   backend nova-api
      balance  roundrobin
      option  tcplog
      server  controller 192.168.0.88:8774  check
      server  apicomp  192.168.0.89:8774  check

  EOF
```

Note

Just change the IP for log in the global section on each node.

On both nodes add `keepalived.conf`:

```
# cd /etc/keepalived
# cat >> keepalived.conf <<EOF

   global_defs {
      router_id controller
   }
   vrrp_script haproxy {
      script "killall -0 haproxy"
      interval 2
      weight 2
   }
   vrrp_instance 50 {
      virtual_router_id 50
      advert_int 1
      priority 101
      state MASTER
      interface eth0
      virtual_ipaddress {
         192.168.0.95 dev eth0
      }
      track_script {
         haproxy
      }
   }

EOF
```

Note

Change priority on node2 to 100 (or vice-versa). Add HAProxy virtual IP.

Restart keepalived service.

```
# service keepalived restart
```

Add `ENABLED=1` in `/etc/default/haproxy` and then restart HAProxy service.

```
# service haproxy restart
```

When both the services have restarted, node with the highest priority for keepalived claims the virtual IP. You can check which node claimed the virtual IP using:

```
# ip a
```

Zero Downtime upgrade process

General rolling upgrade process: *Minimal Downtime Upgrade Process*.

Before Upgrade

- Change nova-api endpoint in keystone to point to the HAProxy virtual IP.
- Run tempest tests
- Check if n-api services on both nodes are serving the requests.

Before maintenance window

- Start the upgrade process with controller node.
- Follow the steps from the general rolling upgrade process to install new code and sync the db for schema changes.

During maintenance window

- Set compute option in upgrade_levels to auto in `nova.conf`.

```
[upgrade_levels]
compute = auto
```

- Starting with n-cond restart all services except n-api and n-cpu.
- In small batches gracefully shutdown nova-cpu, then start n-cpu service with new version of the code.
- Run tempest tests.
- Drain connections on n-api while the tempest tests are running. HAProxy allows you to drain the connections by setting weight to zero:

```
# echo "set weight nova-api/<<server>> 0" | sudo socat /var/run/haproxy.
↪sock stdio
```

- OR disable service using:

```
# echo "disable server nova-api/<<server>>" | sudo socat /var/run/haproxy.
↪sock stdio
```

- This allows the current node to complete all the pending requests. When this is being upgraded, other api node serves the requests. This way we can achieve zero downtime.
- Restart n-api service and enable n-api using the command:

```
# echo "enable server nova-api/<<server>>" | sudo socat /var/run/haproxy.
↪sock stdio
```

- Drain connections from other old api node in the same way and upgrade.
- No tempest tests should fail since there is no API downtime.

After maintenance window

- Follow the steps from general rolling upgrade process to clear any cached service version data and complete all online data migrations.

4.1.5.5 Testing Down Cells

This document describes how to recreate a down-cell scenario in a single-node devstack environment. This can be useful for testing the reliability of the controller services when a cell in the deployment is down.

Setup

DevStack config

This guide is based on a devstack install from the Train release using an Ubuntu Bionic 18.04 VM with 8 VCPU, 8 GB RAM and 200 GB of disk following the All-In-One Single Machine guide.

The following minimal local.conf was used:

```
[[local|localrc]]
# Define passwords
OS_PASSWORD=openstack1
SERVICE_TOKEN=$OS_PASSWORD
ADMIN_PASSWORD=$OS_PASSWORD
MYSQL_PASSWORD=$OS_PASSWORD
RABBIT_PASSWORD=$OS_PASSWORD
SERVICE_PASSWORD=$OS_PASSWORD
# Logging config
LOGFILE=$DEST/logs/stack.sh.log
LOGDAYS=2
# Disable non-essential services
disable_service horizon tempest
```

Populate cell1

Create a test server first so there is something in cell1:

```
$ source openrc admin admin
$ IMAGE=$(openstack image list -f value -c ID)
$ openstack server create --wait --flavor m1.tiny --image $IMAGE cell1-server
```

Take down cell1

Break the connection to the cell1 database by changing the `database_connection` URL, in this case with an invalid host IP:

```
mysql> select database_connection from cell_mappings where name='cell1';
+----------------------------------------------------------------+
| database_connection                                            |
+----------------------------------------------------------------+
| mysql+pymysql://root:openstack1@127.0.0.1/nova_cell1?charset=utf8 |
```

(continues on next page)

(continued from previous page)

```
+--------------------------------------------------------------------+
1 row in set (0.00 sec)

mysql> update cell_mappings set database_connection='mysql+pymysql://
↪root:openstack1@192.0.0.1/nova_cell1?charset=utf8' where name='cell1';
Query OK, 1 row affected (0.01 sec)
Rows matched: 1  Changed: 1  Warnings: 0
```

Update controller services

Prepare the controller services for the down cell. See *Handling cell failures* for details.

Modify nova.conf

Configure the API to avoid long timeouts and slow start times due to bug 1815697 by modifying `/etc/nova/nova.conf`:

```
[database]
...
max_retries = 1
retry_interval = 1

[upgrade_levels]
...
compute = stein  # N-1 from train release, just something other than "auto"
```

Restart services

Note

It is useful to tail the n-api service logs in another screen to watch for errors / warnings in the logs due to down cells:

```
$ sudo journalctl -f -a -u devstack@n-api.service
```

Restart controller services to flush the cell cache:

```
$ sudo systemctl restart devstack@n-api.service devstack@n-super-cond.service␣
↪devstack@n-sch.service
```

Test cases

1. Try to create a server which should fail and go to cell0.

   ```
   $ openstack server create --wait --flavor m1.tiny --image $IMAGE cell0-
   ↪server
   ```

   You can expect to see errors like this in the n-api logs:

```
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context␣
↪[None req-fdaff415-48b9-44a7-b4c3-015214e80b90 None None] Error␣
↪gathering result from cell 4f495a21-294a-4051-9a3d-8b34a250bbb4:␣
↪DBConnectionError: (pymysql.err.OperationalError) (2003, "Can't connect␣
↪to MySQL server on u'192.0.0.1' ([Errno 101] ENETUNREACH)") (Background␣
↪on this error at: http://sqlalche.me/e/e3q8)
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context␣
↪Traceback (most recent call last):
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪File "/opt/stack/nova/nova/context.py", line 441, in gather_result
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪  result = fn(cctxt, *args, **kwargs)
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪File "/opt/stack/nova/nova/db/sqlalchemy/api.py", line 211, in wrapper
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪  with reader_mode.using(context):
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪File "/usr/lib/python2.7/contextlib.py", line 17, in __enter__
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪  return self.gen.next()
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪File "/usr/local/lib/python2.7/dist-packages/oslo_db/sqlalchemy/
↪enginefacade.py", line 1061, in _transaction_scope
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪  context=context) as resource:
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪File "/usr/lib/python2.7/contextlib.py", line 17, in __enter__
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪  return self.gen.next()
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪File "/usr/local/lib/python2.7/dist-packages/oslo_db/sqlalchemy/
↪enginefacade.py", line 659, in _session
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪  bind=self.connection, mode=self.mode)
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪File "/usr/local/lib/python2.7/dist-packages/oslo_db/sqlalchemy/
↪enginefacade.py", line 418, in _create_session
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪  self._start()
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪File "/usr/local/lib/python2.7/dist-packages/oslo_db/sqlalchemy/
↪enginefacade.py", line 510, in _start
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪  engine_args, maker_args)
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪File "/usr/local/lib/python2.7/dist-packages/oslo_db/sqlalchemy/
↪enginefacade.py", line 534, in _setup_for_connection
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪  sql_connection=sql_connection, **engine_kwargs)
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
```

(continues on next page)

(continued from previous page)

```
↪File "/usr/local/lib/python2.7/dist-packages/debtcollector/renames.py",␣
↪line 43, in decorator
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪  return wrapped(*args, **kwargs)
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪File "/usr/local/lib/python2.7/dist-packages/oslo_db/sqlalchemy/engines.
↪py", line 201, in create_engine
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪  test_conn = _test_connection(engine, max_retries, retry_interval)
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪File "/usr/local/lib/python2.7/dist-packages/oslo_db/sqlalchemy/engines.
↪py", line 387, in _test_connection
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪  six.reraise(type(de_ref), de_ref)
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context  ␣
↪File "<string>", line 3, in reraise
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context␣
↪DBConnectionError: (pymysql.err.OperationalError) (2003, "Can't connect␣
↪to MySQL server on u'192.0.0.1' ([Errno 101] ENETUNREACH)") (Background␣
↪on this error at: http://sqlalche.me/e/e3q8)
Apr 04 20:48:22 train devstack@n-api.service[10884]: ERROR nova.context
Apr 04 20:48:22 train devstack@n-api.service[10884]: WARNING nova.objects.
↪service [None req-1cf4bf5c-2f74-4be0-a18d-51ff81df57dd admin admin]␣
↪Failed to get minimum service version for cell 4f495a21-294a-4051-9a3d-
↪8b34a250bbb4
```

2. List servers with the 2.69 microversion for down cells.

> **Note**
>
> Requires python-openstackclient >= 3.18.0 for v2.69 support.

The server in cell1 (which is down) will show up with status UNKNOWN:

```
$ openstack --os-compute-api-version 2.69 server list
+--------------------------------------+--------------+---------+---------
↪-+--------------------------+--------+
| ID                                   | Name         | Status  |␣
↪Networks | Image                    | Flavor |
+--------------------------------------+--------------+---------+---------
↪-+--------------------------+--------+
| 8e90f1f0-e8dd-4783-8bb3-ec8d594e60f1 |              | UNKNOWN |       ␣
↪ |                          |        |
| afd45d84-2bd7-4e49-9dff-93359f742bc1 | cell0-server | ERROR   |       ␣
↪ | cirros-0.4.0-x86_64-disk |        |
+--------------------------------------+--------------+---------+---------
↪-+--------------------------+--------+
```

3. Using v2.1 the UNKNOWN server is filtered out by default due to *api.list_records_by_skipping_down_cells*:

```
$ openstack --os-compute-api-version 2.1 server list
+--------------------------------------+-------------+--------+----------
↪+--------------------------+---------+
| ID                                   | Name        | Status | Networks␣
↪| Image                    | Flavor  |
+--------------------------------------+-------------+--------+----------
↪+--------------------------+---------+
| afd45d84-2bd7-4e49-9dff-93359f742bc1 | cell0-server | ERROR  |          ␣
↪| cirros-0.4.0-x86_64-disk | m1.tiny |
+--------------------------------------+-------------+--------+----------
↪+--------------------------+---------+
```

4. Configure nova-api with `list_records_by_skipping_down_cells=False`

```
[api]
list_records_by_skipping_down_cells = False
```

5. Restart nova-api and then listing servers should fail:

```
$ sudo systemctl restart devstack@n-api.service
$ openstack --os-compute-api-version 2.1 server list
Unexpected API Error. Please report this at http://bugs.launchpad.net/
↪nova/ and attach the Nova API log if possible.
<class 'nova.exception.NovaException'> (HTTP 500) (Request-ID: req-
↪e2264d67-5b6c-4f17-ae3d-16c7562f1b69)
```

6. Try listing compute services with a down cell.

   The services from the down cell are skipped:

```
$ openstack --os-compute-api-version 2.1 compute service list
+----+----------------+-------+----------+---------+-------+------------
↪----------------+
| ID | Binary         | Host  | Zone     | Status  | State | Updated At␣
↪               |
+----+----------------+-------+----------+---------+-------+------------
↪----------------+
|  2 | nova-scheduler | train | internal | enabled | up    | 2019-04-
↪04T21:12:47.000000 |
|  6 | nova-consoleauth | train | internal | enabled | up    | 2019-04-
↪04T21:12:38.000000 |
|  7 | nova-conductor | train | internal | enabled | up    | 2019-04-
↪04T21:12:47.000000 |
+----+----------------+-------+----------+---------+-------+------------
↪----------------+
```

   With 2.69 the nova-compute service from cell1 is shown with status UNKNOWN:

```
$ openstack --os-compute-api-version 2.69 compute service list
+--------------------------------------+----------------+-------+--------
↪---+---------+-------+----------------------------+
```

(continues on next page)

(continued from previous page)

```
| ID                                   | Binary           | Host   | Zone
↪    | Status  | State | Updated At                 |
+--------------------------------------+------------------+-------+-------
↪---+---------+-------+----------------------------+
| f68a96d9-d994-4122-a8f9-1b0f68ed69c2 | nova-scheduler   | train |
↪internal | enabled | up    | 2019-04-04T21:13:47.000000 |
| 70cd668a-6d60-4a9a-ad83-f863920d4c44 | nova-consoleauth | train |
↪internal | enabled | up    | 2019-04-04T21:13:38.000000 |
| ca88f023-1de4-49e0-90b0-581e16bebaed | nova-conductor   | train |
↪internal | enabled | up    | 2019-04-04T21:13:47.000000 |
|                                      | nova-compute     | train |
↪    | UNKNOWN |       |                            |
+--------------------------------------+------------------+-------+-------
↪---+---------+-------+----------------------------+
```

Future

This guide could be expanded for having multiple non-cell0 cells where one cell is down while the other is available and go through scenarios where the down cell is marked as disabled to take it out of scheduling consideration.

4.1.5.6 Profiling With Eventlet

When performance of one of the Nova services is worse than expected, and other sorts of analysis do not lead to candidate fixes, profiling is an excellent tool for producing detailed analysis of what methods in the code are called the most and which consume the most time.

Because most Nova services use eventlet, the standard profiling tool provided with Python, cProfile, will not work. Something is required to keep track of changing tasks. Thankfully eventlet comes with `eventlet.green.profile.Profile`, a mostly undocumented class that provides a similar (but not identical) API to the one provided by Pythons `Profile` while outputting the same format.

Note

The eventlet Profile outputs the `prof` format produced by `profile`, which is not the same as that output by `cProfile`. Some analysis tools (for example, SnakeViz) only read the latter so the options for analyzing eventlet profiling are not always deluxe (see below).

Setup

This guide assumes the Nova service being profiled is running devstack, but that is not necessary. What is necessary is that the code associated with the service can be changed and the service restarted, in place.

Profiling the entire service will produce mostly noise and the output will be confusing because different tasks will operate during the profile run. It is better to begin the process with a candidate task or method *within* the service that can be associated with an identifier. For example, `select_destinations` in the `SchedulerManager` can be associated with the list of `instance_uuids` passed to it and it runs only once for that set of instance UUIDs.

The process for profiling is:

1. Identify the method to be profiled.
2. Populate the environment with sufficient resources to exercise the code. For example you may wish to use the FakeVirtDriver to have nova aware of multiple `nova-compute` processes. Or you may wish to launch many instances if you are evaluating a method that loops over instances.
3. At the start of that method, change the code to instantiate a `Profile` object and `start()` it.
4. At the end of that method, change the code to `stop()` profiling and write the data (with `dump_stats()`) to a reasonable location.
5. Restart the service.
6. Cause the method being evaluated to run.
7. Analyze the profile data with the pstats module.

Note

`stop()` and `start()` are two of the ways in which the eventlet `Profile` API differs from the stdlib. There the methods are `enable()` and `disable()`.

Example

For this example we will analyze `select_destinations` in the `FilterScheduler`. A known problem is that it does excessive work when presented with too many candidate results from the Placement service. Wed like to know why.

Well configure and run devstack with FakeVirtDriver so there are several candidate hypervisors (the following `local.conf` is also useful for other profiling and benchmarking scenarios so not all changes are relevant here):

```
[[local|localrc]]
ADMIN_PASSWORD=secret
DATABASE_PASSWORD=$ADMIN_PASSWORD
RABBIT_PASSWORD=$ADMIN_PASSWORD
SERVICE_PASSWORD=$ADMIN_PASSWORD
VIRT_DRIVER=fake
# You may use different numbers of fake computes, but be careful: 100 will
# completely overwhelm a 16GB, 16VPCU server. In the test profiles below a
# value of 50 was used, on a 16GB, 16VCPU server.
NUMBER_FAKE_NOVA_COMPUTE=25
disable_service cinder
disable_service horizon
disable_service dstat
disable_service tempest

[[post-config|$NOVA_CONF]]
rpc_response_timeout = 300

# Disable filtering entirely. For some profiling this will not be what you
# want.
[filter_scheduler]
enabled_filters = """
```

(continues on next page)

(continued from previous page)

```
# Send only one type of notifications to avoid notification overhead.
[notifications]
notification_format = unversioned
```

Change the code in `nova/scheduler/manager.py` as follows to start the profiler at the start of the `_select_destinations` call and to dump the statistics at the end. For example:

```
diff --git nova/scheduler/manager.py nova/scheduler/manager.py
index 9cee6b3bfc..4859b21fb1 100644
--- nova/scheduler/manager.py
+++ nova/scheduler/manager.py
@@ -237,6 +237,10 @@ class SchedulerManager(manager.Manager):
         alloc_reqs_by_rp_uuid, provider_summaries,
         allocation_request_version=None, return_alternates=False,
     ):
+        from eventlet.green import profile
+        pr = profile.Profile()
+        pr.start()
+
         self.notifier.info(
             context, 'scheduler.select_destinations.start',
             {'request_spec': spec_obj.to_legacy_request_spec_dict()})
@@ -260,6 +264,9 @@ class SchedulerManager(manager.Manager):
             action=fields_obj.NotificationAction.SELECT_DESTINATIONS,
             phase=fields_obj.NotificationPhase.END)

+        pr.stop()
+        pr.dump_stats('/tmp/select_destinations/%s.prof' % ':'.join(instance_
↪uuids))
+
         return selections

     def _schedule(
```

Make a `/tmp/select_destinations` directory that is writable by the user nova-scheduler will run as. This is where the profile output will go.

Restart the scheduler service. Note that `systemctl restart` may not kill things sufficiently dead, so:

```
sudo systemctl stop devstack@n-sch
sleep 5
sudo systemctl start devstack@n-sch
```

Create a server (which will call `select_destinations`):

```
openstack server create --image cirros-0.4.0-x86_64-disk --flavor c1 x1
```

In `/tmp/select_destinations` there should be a file with a name using the UUID of the created server with a `.prof` extension.

Change to that directory and view the profile using the pstats interactive mode:

```
python3 -m pstats ef044142-f3b8-409d-9af6-c60cea39b273.prof
```

Note

The major version of python used to analyze the profile data must be the same as the version used to run the process being profiled.

Sort stats by their cumulative time:

```
ef044142-f3b8-409d-9af6-c60cea39b273.prof% sort cumtime
ef044142-f3b8-409d-9af6-c60cea39b273.prof% stats 10
Tue Aug  6 17:17:56 2019    ef044142-f3b8-409d-9af6-c60cea39b273.prof

         603477 function calls (587772 primitive calls) in 2.294 seconds

   Ordered by: cumulative time
   List reduced from 2484 to 10 due to restriction <10>

   ncalls  tottime  percall  cumtime  percall filename:lineno(function)
        1    0.000    0.000    1.957    1.957 profile:0(start)
        1    0.000    0.000    1.911    1.911 /mnt/share/opt/stack/nova/nova/
↪scheduler/filter_scheduler.py:113(_schedule)
        1    0.000    0.000    1.834    1.834 /mnt/share/opt/stack/nova/nova/
↪scheduler/filter_scheduler.py:485(_get_all_host_states)
        1    0.000    0.000    1.834    1.834 /mnt/share/opt/stack/nova/nova/
↪scheduler/host_manager.py:757(get_host_states_by_uuids)
        1    0.004    0.004    1.818    1.818 /mnt/share/opt/stack/nova/nova/
↪scheduler/host_manager.py:777(_get_host_states)
  104/103    0.001    0.000    1.409    0.014 /usr/local/lib/python3.6/dist-
↪packages/oslo_versionedobjects/base.py:170(wrapper)
       50    0.001    0.000    1.290    0.026 /mnt/share/opt/stack/nova/nova/
↪scheduler/host_manager.py:836(_get_instance_info)
       50    0.001    0.000    1.289    0.026 /mnt/share/opt/stack/nova/nova/
↪scheduler/host_manager.py:820(_get_instances_by_host)
      103    0.001    0.000    0.890    0.009 /usr/local/lib/python3.6/dist-
↪packages/sqlalchemy/orm/query.py:3325(__iter__)
       50    0.001    0.000    0.776    0.016 /mnt/share/opt/stack/nova/nova/
↪objects/host_mapping.py:99(get_by_host)
```

From this we can make a couple of useful inferences about `get_by_host`:

- It is called once for each of the 50 `FakeVirtDriver` hypervisors configured for these tests.
- It (and the methods it calls internally) consumes about 40% of the entire time spent running (`0.776 / 1.957`) the `select_destinations` method (indicated by `profile:0(start)`, above).

Several other sort modes can be used. List those that are available by entering `sort` without arguments.

Caveats

Real world use indicates that the eventlet profiler is not perfect. There are situations where it will not always track switches between greenlets as well as it could. This can result in profile data that does not make sense or random slowdowns in the system being profiled. There is no one size fits all solution to these issues; profiling eventlet services is more an art than science. However, this section tries to provide a (hopefully) growing body of advice on what to do to work around problems.

General Advice

- Try to profile chunks of code that operate mostly within one module or class and do not have many collaborators. The more convoluted the path through the code, the more confused the profiler gets.
- Similarly, where possible avoid profiling code that will trigger many greenlet context switches; either specific spawns, or multiple types of I/O. Instead, narrow the focus of the profiler.
- If possible, avoid RPC.

In nova-compute

The creation of this caveat section was inspired by issues experienced while profiling `nova-compute`. The `nova-compute` process is not allowed to speak with a database server directly. Instead communication is mediated through the conductor, communication happening via `oslo.versionedobjects` and remote calls. Profiling methods such as `update_available_resource` in the ResourceTracker, which needs information from the database, results in profile data that can be analyzed but is incorrect and misleading.

This can be worked around by temporarily changing `nova-compute` to allow it to speak to the database directly:

```
diff --git a/nova/cmd/compute.py b/nova/cmd/compute.py
index 01fd20de2e..655d503158 100644
--- a/nova/cmd/compute.py
+++ b/nova/cmd/compute.py
@@ -50,8 +50,10 @@ def main():

     gmr.TextGuruMeditation.setup_autorun(version, conf=CONF)

-    cmd_common.block_db_access('nova-compute')
-    objects_base.NovaObject.indirection_api = conductor_rpcapi.ConductorAPI()
+    # Temporarily allow access to the database. You must update the config␣
↪file
+    # used by this process to set [database]/connection to the cell1␣
↪database.
+    # cmd_common.block_db_access('nova-compute')
+    # objects_base.NovaObject.indirection_api = conductor_rpcapi.
↪ConductorAPI()
     objects.Service.enable_min_version_cache()
     server = service.Service.create(binary='nova-compute',
                                     topic=compute_rpcapi.RPC_TOPIC)
```

The configuration file used by the `nova-compute` process must also be updated to ensure that it contains a setting for the relevant database:

```
[database]
connection = mysql+pymysql://root:secret@127.0.0.1/nova_cell1?charset=utf8
```

In a single node devstack setup `nova_cell1` is the right choice. The connection string will vary in other setups.

Once these changes are made, along with the profiler changes indicated in the example above, `nova-compute` can be restarted and with luck some useful profiling data will emerge.

4.1.5.7 Testing PCI passthrough and SR-IOV with emulated PCI NIC

Testing nova PCI and SR-IOV device handling in devstack in general requires special hardware available in the devstack machine or VM.

Since libvirt 9.3.0 and qemu 8.0.0 the situation is a lot simpler as qemu is now capable of emulating and intel igb NIC that supports SR-IOV. So devstack can be run in a VM that has one or more SR-IOV capable NIC while the host running the devstack VM does not require any special hardware just recent libvirt and qemu installed.

Note

The emulated igb device used in this doc only useful for testing purposes. While network connectivity will work through both the PF and the VF interfaces the networking performance will be limited by the qemu emulation.

Add SR-IOV capable igb NIC to a devstack VM

You can add an igb NIC to the devstack VM definition:

```
virsh attach-interface --type network --source <libvirt network name> --model␣
↪igb --config <devstack-domain>
```

The SR-IOV capability also requires an IOMMU device and split APIC defined in the domain as well as the q35 machine type. So make sure you have the following sections:

```
<devices>
    ...
    <iommu model='intel'>
        <driver intremap='on' iotlb='on'/>
    </iommu>
</devices>
```

```
<features>
    ..
    <ioapic driver='qemu'/>
</features>
```

```
<os>
    ...
    <type arch='x86_64' machine='pc-q35'>hvm</type>
</os>
```

Then enable IOMMU in the devstack VM by adding `intel_iommu=on` to the kernel command line.

Using nova to get a VM with SR-IOV capable igb NICs

If you are using nova 2025.1 (Epoxy) or newer then you can use the `hw_machine_type=q35`, `hw_vif_model=igb`, and `hw_iommu_model=intel` image properties to request a VM with igb NICs.

Configuring your devstack VM for SR-IOV

Follow the guide;

4.1.6 The Nova API

Because we have many consumers of our API, were extremely careful about changes done to the API, as the impact can be very wide.

- *Extending the API*: How the code is structured inside the API layer
- *API Microversions*: How the API is (micro)versioned and what you need to do when adding an API exposed feature that needs a new microversion.
- *API reference guideline*: The guideline to write the API reference.

Nova also provides notifications over the RPC API, which you may wish to extend.

- *Notifications*: How to add your own notifications

4.1.6.1 Extending the API

Note

This document provides general background information on how one can extend the REST API in nova. For information on the microversion support including how to add new microversions, see *API Microversions*. For information on how to use the API, refer to the API guide and API reference guide.

Novas API is a mostly RESTful API. REST stands for *Representational State Transfer* and provides an architecture style for distributed systems using HTTP for transport. Figure out a way to express your request and response in terms of resources that are being created, modified, read, or destroyed.

Nova has v2.1 API frameworks which supports microversions. This document covers how to add API for the v2.1 API framework. A *microversions-specific document* covers the details around what is required for the microversions part.

The v2.1 API framework is under `nova/api` and each API is implemented in `nova/api/openstack/compute`.

Note

Any change to the Nova API to be merged will first require a spec be approved first. See here for the appropriate repository. For guidance on the design of the API please refer to the OpenStack API WG

Basic API Controller

API controller includes the implementation of API methods for a resource.

A very basic controller of a v2.1 API:

```
"""Basic Controller"""

from nova.api.openstack.compute.schemas import xyz
from nova.api.openstack import extensions
from nova.api.openstack import wsgi
from nova.api import validation

class BasicController(wsgi.Controller):

    # Define support for GET on a collection
    def index(self, req):
        data = {'param': 'val'}
        return data

    # Define support for POST on a collection
    @extensions.expected_errors((400, 409))
    @validation.schema(xyz.create)
    @wsgi.response(201)
    def create(self, req, body):
        write_body_here = ok
        return response_body

    # Defining support for other RESTful methods based on resource.

    # ...
```

See servers.py for ref.

All of the controller modules should live in the `nova/api/openstack/compute` directory.

URL Mapping to API

The URL mapping is based on the plain list which routes the API request to appropriate controller and method. Each API needs to add its route information in `nova/api/openstack/compute/routes.py`.

A basic skeleton of URL mapping in `routers.py`:

```
"""URL Mapping Router List"""

import functools

import nova.api.openstack
from nova.api.openstack.compute import basic_api

# Create a controller object
basic_controller = functools.partial(
    _create_controller, basic_api.BasicController, [], [],
```

(continues on next page)

(continued from previous page)

```
)

# Routing list structure:
# (
#     ('Route path': {
#         'HTTP method: [
#             'Controller',
#             'The method of controller is used to handle this route'
#         ],
#         ...
#     }),
#     ...
# )
ROUTE_LIST = (
    # ...
    ('/basic', {
        'GET': [basic_controller, 'index'],
        'POST': [basic_controller, 'create']
    }),
    # ...
)
```

Complete routing list can be found in routes.py.

Policy

For more info about policy, see *policies*, Also look at the `context.can(...)` call in existing API controllers.

Modularity

The Nova REST API is separated into different controllers in the directory `nova/api/openstack/compute/`.

Because microversions are supported in the Nova REST API, the API can be extended without any new controller. But for code readability, the Nova REST API code still needs modularity. Here are rules for how to separate modules:

- You are adding a new resource The new resource should be in standalone module. There isnt any reason to put different resources in a single module.
- Add sub-resource for existing resource To prevent an existing resource module becoming over-inflated, the sub-resource should be implemented in a separate module.
- Add extended attributes for existing resource In normally, the extended attributes is part of existing resources data model too. So this can be added into existing resource module directly and lightly. To avoid namespace complexity, we should avoid to add extended attributes in existing extended models. New extended attributes neednt any namespace prefix anymore.

Validation

Changed in version 2024.2: (Dalmatian)

Added response body schema validation, to complement request body and request query string validation.

The v2.1 API uses JSON Schema for validation. Before 2024.2 (Dalmatian), this was used for request body and request query string validation. Since then, it is also used for response body validation. The request body and query string validation is used at runtime and is non-optional, while the response body validation is only used for test and documentation purposes and should not be enabled at runtime.

Validation is added for a given resource and method using decorators provided in `nova.api.validation` while the schemas themselves can be found in `nova.api.openstack.compute.schemas`. We use unit tests to ensure all method are decorated correctly and schemas are defined. The decorators accept optional `min_version` and `max_version` arguments, allowing you to define different schemas for different microversions. For example:

```
@validation.schema(schema.update, '2.1', '2.77')
@validation.schema(schema.update_v278, '2.78')
@validation.query_schema(schema.update_query)
@validation.response_body_schema(schema.update_response, '2.1', '2.6')
@validation.response_body_schema(schema.update_response_v27, '2.7', '2.77')
@validation.response_body_schema(schema.update_response_v278, '2.78')
def update(self, req, id, body):
    ...
```

In addition to the JSON Schema validation decorator, we provide decorators for indicating expected response and error codes, indicating removed APIs, and indicating action APIs. These can be found in `nova.api.openstack.wsgi`. For example, to indicate that an API can return `400 (Bad Request)`, `404 (Not Found)`, or `409 (Conflict)` error codes but returns `200 (OK)` in the success case:

```
@wsgi.expected_errors((400, 404, 409))
@wsgi.response(201)
def update(self, req, id, body):
    ...
```

To define a new action, `foo`, for a given resource:

```
@wsgi.action('foo')
def update(self, req, id, body):
    ...
```

To indicate that an API has been removed and will now return `410 (Gone)` for all requests:

```
@wsgi.removed('30.0.0', 'This API was removed because...')
def update(self, req, id, body):
    ...
```

Unit Tests

Unit tests for the API can be found under path `nova/tests/unit/api/openstack/compute/`. Unit tests for the API are generally negative scenario tests, because the positive scenarios are tested with functional API samples tests.

Negative tests would include such things as:

- Request schema validation failures, for both the request body and query parameters
- `HTTPNotFound` or other >=400 response code failures

Functional tests and API Samples

All functional API changes, including new microversions - especially if there are new request or response parameters, should have new functional API samples tests.

The API samples tests are made of two parts:

- The API sample for the reference docs. These are found under path `doc/api_samples/`. There is typically one directory per API controller with subdirectories per microversion for that API controller. The unversioned samples are used for the base v2.0 / v2.1 APIs.
- Corresponding API sample templates found under path `nova/tests/functional/api_sample_tests/api_samples`. These have a similar structure to the API reference docs samples, except the format of the sample can include substitution variables filled in by the tests where necessary, for example, to substitute things that change per test run, like a server UUID.

The actual functional tests are found under path `nova/tests/functional/api_sample_tests/`. Most, if not all, API samples tests extend the `ApiSampleTestBaseV21` class which extends `ApiSampleTestBase`. These base classes provide the framework for making a request using an API reference doc sample and validating the response using the corresponding template file, along with any variable substitutions that need to be made.

Note that it is possible to automatically generate the API reference doc samples using the templates by simply running the tests using `tox -e api-samples`. This relies, of course, upon the test and templates being correct for the test to pass, which may take some iteration.

In general, if you are adding a new microversion to an existing API controller, it is easiest to simply copy an existing test and modify it for the new microversion and the new samples/templates.

The functional API samples tests are not the simplest thing in the world to get used to and it can be very frustrating at times when they fail in not obvious ways. If you need help debugging a functional API sample test failure, feel free to post your work-in-progress change for review and ask for help in the `openstack-nova` OFTC IRC channel.

Documentation

All API changes must also include updates to the compute API reference, which can be found under path `api-ref/source/`.

Things to consider here include:

- Adding new request and/or response parameters with a new microversion
- Marking existing parameters as deprecated in a new microversion

More information on the compute API reference format and conventions can be found in the *API reference guideline*.

For more detailed documentation of certain aspects of the API, consider writing something into the compute API guide found under path `api-guide/source/`.

Deprecating APIs

Compute REST API routes may be deprecated by capping a method or functionality using microversions. For example, the *2.36 microversion* deprecated several compute REST API routes which only worked when using the since-removed `nova-network` service or are proxies to other external services like cinder, neutron, etc.

The point of deprecating with microversions is users can still get the same functionality at a lower microversion but there is at least some way to signal to users that they should stop using the REST API.

The general steps for deprecating a REST API are:

- Set a maximum allowed microversion for the route. Requests beyond that microversion on that route will result in a `404 (Not Found)` error.
- Update the Compute API reference documentation to indicate the route is deprecated and move it to the bottom of the list with the other deprecated APIs.
- Deprecate, and eventually remove, related CLI / SDK functionality in other projects like *python-novaclient*.

Removing deprecated APIs

Nova tries to maintain backward compatibility with all REST APIs as much as possible, but when enough time has lapsed, there are few (if any) users or there are supported alternatives, the underlying service code that supports a deprecated REST API, like in the case of `nova-network`, is removed and the REST API must also be effectively removed.

The general steps for removing support for a deprecated REST API are:

- The route mapping will remain but all methods will return a `410 (Gone)` error response. This is slightly different to the `404 (Not Found)` error response a user will get for trying to use a microversion that does not support a deprecated API. 410 means the resource is gone and not coming back, which is more appropriate when the API is fully removed and will not work at any microversion.
- Related configuration options, policy rules, and schema validation are removed.
- The API reference documentation should be updated to move the documentation for the removed API to the Obsolete APIs section and mention in which release the API was removed.
- Unit tests can be removed.
- API sample functional tests can be changed to assert the 410 response behavior, but can otherwise be mostly gutted. Related *.tpl files for the API sample functional tests can be deleted since they will not be used.
- An upgrade *release note* should be added to mention the REST API routes that were removed along with any related configuration options that were also removed.

Here is an example of the above steps: https://review.opendev.org/567682/

4.1.6.2 API Microversions

Background

Nova uses a framework we call API Microversions for allowing changes to the API while preserving backward compatibility. The basic idea is that a user has to explicitly ask for their request to be treated with a particular version of the API. So breaking changes can be added to the API without breaking users

who dont specifically ask for it. This is done with an HTTP header `OpenStack-API-Version` which has as its value a string containing the name of the service, `compute`, and a monotonically increasing semantic version number starting from `2.1`. The full form of the header takes the form:

```
OpenStack-API-Version: compute 2.1
```

If a user makes a request without specifying a version, they will get the `DEFAULT_API_VERSION` as defined in `nova/api/openstack/wsgi.py`. This value is currently `2.1` and is expected to remain so for quite a long time.

There is a special value `latest` which can be specified, which will allow a client to always receive the most recent version of API responses from the server.

Warning

The `latest` value is mostly meant for integration testing and would be dangerous to rely on in client code since Nova microversions are not following semver and therefore backward compatibility is not guaranteed. Clients, like python-novaclient, should always require a specific microversion but limit what is acceptable to the version range that it understands at the time.

Warning

To maintain compatibility, an earlier form of the microversion header is acceptable. It takes the form:

```
X-OpenStack-Nova-API-Version: 2.1
```

This form will continue to be supported until the `DEFAULT_API_VERSION` is raised to version `2.27` or higher.

Clients accessing deployments of the Nova API which are not yet providing microversion `2.27` must use the older form.

For full details please read the Kilo spec for microversions and Microversion Specification.

When do I need a new Microversion?

A microversion is needed when the contract to the user is changed. The user contract covers many kinds of information such as:

- the Request
  - the list of resource urls which exist on the server

    Example: adding a new servers/{ID}/foo which didnt exist in a previous version of the code
  - the list of query parameters that are valid on urls

    Example: adding a new parameter `is_yellow` servers/{ID}?is_yellow=True
  - the list of query parameter values for non free form fields

    Example: parameter filter_by takes a small set of constants/enums A, B, C. Adding support for new enum D.
  - new headers accepted on a request

  - the list of attributes and data structures accepted.

    Example: adding a new attribute locked: True/False to the request body

    However, the attribute `os.scheduler_hints` of the create a server API is an exception to this. A new scheduler which adds a new attribute to `os:scheduler_hints` doesnt require a new microversion, because available schedulers depend on cloud environments, and we accept customized schedulers as a rule.

- the Response
  - the list of attributes and data structures returned

    Example: adding a new attribute locked: True/False to the output of servers/{ID}

  - the allowed values of non free form fields

    Example: adding a new allowed `status` to servers/{ID}

  - the list of status codes allowed for a particular request

    Example: an API previously could return 200, 400, 403, 404 and the change would make the API now also be allowed to return 409.

    See[2] for the 400, 403, 404 and 415 cases.

  - changing a status code on a particular response

    Example: changing the return code of an API from 501 to 400.

    > **Note**
    >
    > Fixing a bug so that a 400+ code is returned rather than a 500 or 503 does not require a microversion change. Its assumed that clients are not expected to handle a 500 or 503 response and therefore should not need to opt-in to microversion changes that fixes a 500 or 503 response from happening. According to the OpenStack API Working Group, a **500 Internal Server Error** should **not** be returned to the user for failures due to user error that can be fixed by changing the request on the client side. See[1].

  - new headers returned on a response

[2] The exception to not needing a microversion when returning a previously unspecified error code is the 400, 403, 404 and 415 cases. This is considered OK to return even if previously unspecified in the code since its implied given keystone authentication can fail with a 403 and API validation can fail with a 400 for invalid json request body. Request to url/resource that does not exist always fails with 404. Invalid content types are handled before API methods are called which results in a 415.

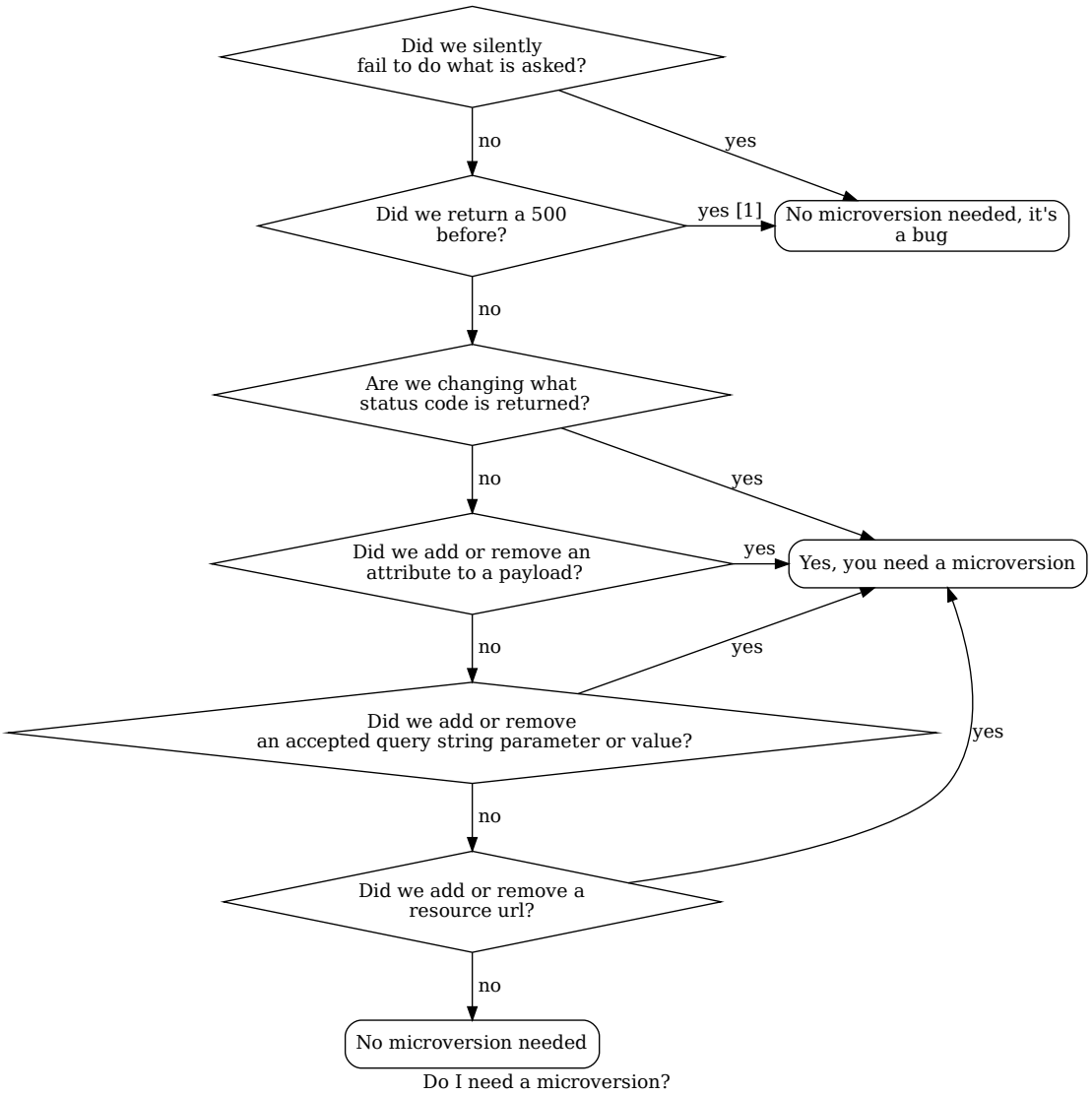
> **Note**
>
> When in doubt about whether or not a microversion is required for changing an error response code, consult the Nova API subteam.

[1] When fixing 500 errors that previously caused stack traces, try to map the new error into the existing set of errors that API call could previously return (400 if nothing else is appropriate). Changing the set of allowed status codes from a request is changing the contract, and should be part of a microversion (except in[2]).

The reason why we are so strict on contract is that wed like application writers to be able to know, for sure, what the contract is at every microversion in Nova. If they do not, they will need to write conditional code in their application to handle ambiguities.

When in doubt, consider application authors. If it would work with no client side changes on both Nova versions, you probably dont need a microversion. If, on the other hand, there is any ambiguity, a microversion is probably needed.

The following flow chart attempts to walk through the process of do we need a microversion.



Do I need a microversion?

Footnotes

When a microversion is not needed

A microversion is not needed in the following situation:

- the response
  - Changing the error message without changing the response code does not require a new microversion.
  - Removing an inapplicable HTTP header, for example, suppose the Retry-After HTTP header is being returned with a 4xx code. This header should only be returned with a 503 or 3xx response, so it may be removed without bumping the microversion.
  - An obvious regression bug in an admin-only API where the bug can still be fixed upstream on active stable branches. Admin-only APIs are less of a concern for interoperability and

generally a regression in behavior can be dealt with as a bug fix when the documentation clearly shows the API behavior was unexpectedly regressed. See[3] for an example. Intentional behavior changes to an admin-only API *do* require a microversion, like the *2.53 microversion* for example.

Footnotes

In Code

In `nova/api/openstack/wsgi.py` we define an `@api_version` decorator which is intended to be used on top-level Controller methods. It is not appropriate for lower-level methods. Some examples:

Adding a new API method

In the controller class:

```
@wsgi.api_version("2.4")
def my_api_method(self, req, id):
    ...
```

This method would only be available if the caller had specified an `OpenStack-API-Version` of `>= 2.4`. If they had specified a lower version (or not specified it and received the default of `2.1`) the server would respond with `HTTP/404`.

Removing an API method

In the controller class:

```
@wsgi.api_version("2.1", "2.4")
def my_api_method(self, req, id):
    ...
```

This method would only be available if the caller had specified an `OpenStack-API-Version` of `<= 2.4`. If `2.5` or later is specified the server will respond with `HTTP/404`.

A change in schema only

If there is no change to the method, only to the schema that is used for validation, you can add a version range to the `validation.schema` decorator:

```
@wsgi.api_version("2.1")
@validation.schema(dummy_schema.dummy, "2.3", "2.8")
@validation.schema(dummy_schema.dummy2, "2.9")
def update(self, req, id, body):
    ...
```

This method will be available from version `2.1`, validated according to `dummy_schema.dummy` from `2.3` to `2.8`, and validated according to `dummy_schema.dummy2` from `2.9` onward.

[3] https://review.opendev.org/#/c/523194/

Other API method changes

When you want to change more than the API request or response schema, you can directly test for the requested version with a method as long as you have access to the api request object (commonly called `req`). Every API method has an api_version_request object attached to the req object and that can be used to modify behavior based on its value:

```
def index(self, req):
    <common code>

    req_version = req.api_version_request
    req1_min = api_version_request.APIVersionRequest("2.1")
    req1_max = api_version_request.APIVersionRequest("2.5")
    req2_min = api_version_request.APIVersionRequest("2.6")
    req2_max = api_version_request.APIVersionRequest("2.10")

    if req_version.matches(req1_min, req1_max):
        ....stuff....
    elif req_version.matches(req2min, req2_max):
        ....other stuff....
    elif req_version > api_version_request.APIVersionRequest("2.10"):
        ....more stuff.....

    <common code>
```

The first argument to the matches method is the minimum acceptable version and the second is maximum acceptable version. A specified version can be null:

```
null_version = APIVersionRequest()
```

If the minimum version specified is null then there is no restriction on the minimum version, and likewise if the maximum version is null there is no restriction the maximum version. Alternatively a one sided comparison can be used as in the example above.

Other necessary changes

If you are adding a patch which adds a new microversion, it is necessary to add changes to other places which describe your change:

- Update `REST_API_VERSION_HISTORY` in `nova/api/openstack/api_version_request.py`
- Update `_MAX_API_VERSION` in `nova/api/openstack/api_version_request.py`
- Add a verbose description to `nova/api/openstack/compute/rest_api_version_history.rst`.
- Add a *release note* with a `features` section announcing the new or changed feature and the microversion.
- Update the expected versions in affected tests, for example in `nova/tests/unit/api/openstack/compute/test_versions.py`.
- Update the get versions api sample file: `doc/api_samples/versions/versions-get-resp.json` and `doc/api_samples/versions/v21-version-get-resp.json`.

- Make a new commit to python-novaclient and update corresponding files to enable the newly added microversion API. See Adding support for a new microversion in python-novaclient for more details.
- If the microversion changes the response schema, a new schema and test for the microversion must be added to Tempest.
- If applicable, add Functional sample tests under `nova/tests/functional/api_sample_tests`. Also, add JSON examples to `doc/api_samples` directory which can be generated automatically via tox env `api-samples` or run test with env var `GENERATE_SAMPLES` True.
- Update the API Reference documentation as appropriate. The source is located under `api-ref/source/`.
- If the microversion changes servers related APIs, update the `api-guide/source/server_concepts.rst` accordingly.

Allocating a microversion

If you are adding a patch which adds a new microversion, it is necessary to allocate the next microversion number. Except under extremely unusual circumstances and this would have been mentioned in the nova spec for the change, the minor number of `_MAX_API_VERSION` will be incremented. This will also be the new microversion number for the API change.

It is possible that multiple microversion patches would be proposed in parallel and the microversions would conflict between patches. This will cause a merge conflict. We dont reserve a microversion for each patch in advance as we dont know the final merge order. Developers may need over time to rebase their patch calculating a new version number as above based on the updated value of `_MAX_API_VERSION`.

Testing Microversioned API Methods

Testing a microversioned API method is very similar to a normal controller method test, you just need to add the `OpenStack-API-Version` header, for example:

```
req = fakes.HTTPRequest.blank('/testable/url/endpoint')
req.headers = {'OpenStack-API-Version': 'compute 2.28'}
req.api_version_request = api_version.APIVersionRequest('2.6')

controller = controller.TestableController()

res = controller.index(req)
... assertions about the response ...
```

For many examples of testing, the canonical examples are in `nova/tests/unit/api/openstack/compute/test_microversions.py`.

4.1.6.3 API reference guideline

The API reference should be updated when compute APIs are modified (microversion is bumped, etc.). This page describes the guideline for updating the API reference.

API reference

- Compute API reference

The guideline to write the API reference

The API reference consists of the following files.

Compute API reference

- API reference text: `api-ref/source/*.inc`
- Parameter definition: `api-ref/source/parameters.yaml`
- JSON request/response samples: `doc/api_samples/*`

Structure of inc file

Each REST API is described in the text file (*.inc). The structure of inc file is as follows:

- Title (Resource name)
  - Introductory text and context

    The introductory text and the context for the resource in question should be added. This might include links to the API Concept guide, or building other supporting documents to explain a concept (like versioning).
  - API Name
    - REST Method
      - URL
      - Description

        See the *Description* section for more details.
      - Response codes
      - Request
        - Parameters
        - JSON request body example (if exists)
      - Response
        - Parameters
        - JSON response body example (if exists)
  - API Name (Next)
    -

REST Method

The guideline for describing HTTP methods is described in this section. All supported methods by resource should be listed in the API reference.

The order of methods

Methods have to be sorted by each URI in the following order:

1. GET
2. POST
3. PUT
4. PATCH (unused by Nova)
5. DELETE

And sorted from broadest to narrowest. So for /severs it would be:

1. GET /servers
2. POST /servers
3. GET /servers/details
4. GET /servers/{server_id}
5. PUT /servers/{server_id}
6. DELETE /servers/{server_id}

Method titles spelling and case

The spelling and the case of method names in the title have to match what is in the code. For instance, the title for the section on method Get VNC Console should be Get VNC Console (os-getVNCConsole Action) NOT Get VNC Console (Os-Getvncconsole Action)

Description

The following items should be described in each API. Or links to the pages describing them should be added.

- The purpose of the API(s)
  - e.g. Lists, creates, shows details for, updates, and deletes servers.
  - e.g. Creates a server.
- Microversion
  - Deprecated
    - Warning
    - Microversion to start deprecation
    - Alternatives (superseded ways) and their links (if document is available)
  - Added
    - Microversion in which the API has been added
  - Changed behavior
    - Microversion to change behavior
    - Explanation of the behavior

    - Changed HTTP response codes
        * Microversion to change the response code
        * Explanation of the response code
- Warning if direct use is not recommended
    - e.g. This is an admin level service API only designed to be used by other OpenStack services. The point of this API is to coordinate between Nova and Neutron, Nova and Cinder (and potentially future services) on activities they both need to be involved in, such as network hotplugging. Unless you are writing Neutron or Cinder code you should not be using this API.
- Explanation about statuses of resource in question
    - e.g. The server status.
        * `ACTIVE`. The server is active.
- Supplementary explanation for parameters
    - Examples of query parameters
    - Parameters that are not specified at the same time
    - Values that cannot be specified.
        * e.g. A destination host is the same host.
- Behavior
    - Config options to change the behavior and the effect
    - Effect to resource status
        * Ephemeral disks, attached volumes, attached network ports and others
        * Data loss or preserve contents
    - Scheduler
        * Whether the scheduler choose a destination host or not
- Sort order of response results
    - Describe sorting order of response results if the API implements the order (e.g. The response is sorted by `created_at` and `id` in descending order by default)
- Policy
    - Default policy (the admin only, the admin or the owner)
    - How to change the policy
- Preconditions
    - Server status
    - Task state
    - Policy for locked servers
    - Quota
    - Limited support

        * e.g. Only qcow2 is supported
    - Compute driver support
        * If very few compute drivers support the operation, add a warning and a link to the support matrix of virt driver.
    - Cases that are not supported
        * e.g. A volume-backed server
- Postconditions
    - If the operation is asynchronous, it should be Asynchronous postconditions.
    - Describe what status/state resource in question becomes by the operation
        * Server status
        * Task state
        * Path of output file
- Troubleshooting
    - e.g. If the server status remains `BUILDING` or shows another error status, the request failed. Ensure you meet the preconditions then investigate the compute node.
- Related operations
    - Operations to be paired
        * e.g. Start and stop
    - Subsequent operation
        * e.g. Confirm resize after Resize operation
- Performance
    - e.g. The progress of this operation depends on the location of the requested image, network I/O, host load, selected flavor, and other factors.
- Progress
    - How to get progress of the operation if the operation is asynchronous.
- Restrictions
    - Range that ID is unique
        * e.g. HostId is unique per account and is not globally unique.
- How to avoid errors
    - e.g. The server to get console log from should set `export LC_ALL=en_US.UTF-8` in order to avoid incorrect unicode error.
- Reference
    - Links to the API Concept guide, or building other supporting documents to explain a concept (like versioning).
- Other notices

Response codes

The normal response codes (20x) and error response codes have to be listed. The order of response codes should be in ascending order. The description of typical error response codes are as follows:

Table 1: Error response codes

Response codes	Description
400	badRequest(400)
401	unauthorized(401)
403	forbidden(403)
404	itemNotFound(404)
409	conflict(409)
410	gone(410)
501	notImplemented(501)
503	serviceUnavailable(503)

In addition, the following explanations should be described.

- Conditions under which each normal response code is returned (If there are multiple normal response codes.)
- Conditions under which each error response code is returned

Parameters

Parameters need to be defined by 2 subsections. The one is in the Request subsection, the other is in the Response subsection. The queries, request headers and attributes go in the Request subsection and response headers and attributes go in the Response subsection.

The order of parameters in each API

The request and response parameters have to be listed in the following order in each API in the text file.

1. Header
2. Path
3. Query
4. Body
    a. Top level object (i.e. server)
    b. Required fields
    c. Optional fields
    d. Parameters added in microversions (by the microversion they were added)

Parameter type

The parameters are defined in the parameter file (`parameters.yaml`). The type of parameters have to be one of following:

- `array`

It is a list.

- `boolean`
- `float`
- `integer`
- `none`

  The value is always `null` in a response or should be `null` in a request.

- `object`

  The value is dict.

- `string`

  If the value can be specified by multiple types, specify one type in the file and mention the other types in the description.

Required or optional

In the parameter file, define the `required` field in each parameter.

`true`	The parameter must be specified in the request, or the parameter always appears in the response.
`false`	It is not always necessary to specify the parameter in the request, or the parameter does not appear in the response in some cases. e.g. A config option defines whether the parameter appears in the response or not. A parameter appears when administrators call but does not appear when non-admin users call.

If a parameter must be specified in the request or always appears in the response in the microversion added or later, the parameter must be defined as required (`true`).

Microversion

If a parameter is available starting from a microversion, the microversion must be described by `min_version` in the parameter file. However, if the minimum microversion is the same as a microversion that the API itself is added, it is not necessary to describe the microversion.

For example:

```
aggregate_uuid:
  description: |
    The UUID of the host aggregate.
  in: body
  required: true
  type: string
  min_version: 2.41
```

This example describes that `aggregate_uuid` is available starting from microversion 2.41.

If a parameter is available up to a microversion, the microversion must be described by `max_version` in the parameter file.

For example:

```
security_group_rules:
  description: |
    The number of allowed rules for each security group.
  in: body
  required: false
  type: integer
  max_version: 2.35
```

This example describes that `security_group_rules` is available up to microversion 2.35 (and has been removed since microversion 2.36).

The order of parameters in the parameter file

The order of parameters in the parameter file has to be kept as follows:

1. By in type
    a. Header
    b. Path
    c. Query
    d. Body
2. Then alphabetical by name

Example

One or more examples should be provided for operations whose request and/or response contains a payload. The example should describe what the operation is attempting to do and provide a sample payload for the request and/or response as appropriate. Sample files should be created in the `doc/api_samples` directory and inlined by inclusion.

When an operation has no payload in the response, a suitable message should be included. For example:

```
There is no body content for the response of a successful DELETE query.
```

Examples for multiple microversions should be included in ascending microversion order.

Reference

- Verifying the Nova API Ref
- The description for Parameters whose values are null
- The definition of Optional parameter
- How to document your OpenStack API service

4.1.6.4 Notifications

As discussed in *Notifications*, nova emits notifications to the message bus. There are two types of notifications provided in nova: legacy (unversioned) notifications and versioned notifications. As a developer, you may choose to add additional notifications or extend existing notifications.

Note

This section provides information on adding your own notifications in nova. For background information on notifications including usage information, refer to *Notifications*. For a list of available versioned notifications, refer to *Available versioned notifications*.

How to add a new versioned notification

To provide the versioning for versioned notifications, each notification is modeled with oslo.versionedobjects. Every versioned notification class shall inherit from the `nova.notifications.objects.base.NotificationBase` which already defines three mandatory fields of the notification `event_type`, `publisher` and `priority`. The new notification class shall add a new field `payload` with an appropriate payload type. The payload object of the notifications shall inherit from the `nova.notifications.objects.base.NotificationPayloadBase` class and shall define the fields of the payload as versionedobject fields. The base classes are described in the following section.

The `nova.notifications.objects.base` module

class nova.notifications.objects.base.**EventType**(*object*, *action*, *phase=None*)

Bases: `NotificationObject`

to_notification_event_type_field()

Serialize the object to the wire format.

class nova.notifications.objects.base.**NotificationBase**(***kwargs*)

Bases: `NotificationObject`

Base class for versioned notifications.

Every subclass shall define a payload field.

emit(*context*)

Send the notification.

class nova.notifications.objects.base.**NotificationObject**(***kwargs*)

Bases: `NovaObject`

Base class for every notification related versioned object.

class nova.notifications.objects.base.**NotificationPayloadBase**

Bases: `NotificationObject`

Base class for the payload of versioned notifications.

populate_schema(*set_none=True*, ***kwargs*)

Populate the object based on the SCHEMA and the source objects

Parameters

kwargs A dict contains the source object at the key defined in the SCHEMA

class nova.notifications.objects.base.**NotificationPublisher**(*host*, *source*)

Bases: `NotificationObject`

nova.notifications.objects.base.**notification_sample**(*sample*)

Class decorator to attach the notification sample information to the notification object for documentation generation purposes.

Parameters

sample the path of the sample json file relative to the doc/notification_samples/ directory in the nova repository root.

Note that the notification objects must not be registered to the `NovaObjectRegistry` to avoid mixing nova-internal objects with the notification objects. Instead, use the `register_notification` decorator on every concrete notification object.

The following code example defines the necessary model classes for a new notification `myobject.update`.

```
@notification.notification_sample('myobject-update.json')
@object_base.NovaObjectRegistry.register.register_notification
class MyObjectNotification(notification.NotificationBase):
    # Version 1.0: Initial version
    VERSION = '1.0'

    fields = {
        'payload': fields.ObjectField('MyObjectUpdatePayload')
    }


@object_base.NovaObjectRegistry.register.register_notification
class MyObjectUpdatePayload(notification.NotificationPayloadBase):
    # Version 1.0: Initial version
    VERSION = '1.0'
    fields = {
        'some_data': fields.StringField(),
        'another_data': fields.StringField(),
    }
```

After that the notification can be populated and emitted with the following code.

```
payload = MyObjectUpdatePayload(some_data="foo", another_data="bar")
MyObjectNotification(
    publisher=notification.NotificationPublisher.from_service_obj(
        <nova.objects.service.Service instance that emits the notification>),
    event_type=notification.EventType(
        object='myobject',
        action=fields.NotificationAction.UPDATE),
    priority=fields.NotificationPriority.INFO,
    payload=payload).emit(context)
```

The above code will generate the following notification on the wire.

```
{
    "priority":"INFO",
    "payload":{
        "nova_object.namespace":"nova",
        "nova_object.name":"MyObjectUpdatePayload",
        "nova_object.version":"1.0",
        "nova_object.data":{
```

(continues on next page)

(continued from previous page)

```
            "some_data":"foo",
            "another_data":"bar",
        }
    },
    "event_type":"myobject.update",
    "publisher_id":"<the name of the service>:<the host where the service␣
↪runs>"
}
```

There is a possibility to reuse an existing versionedobject as notification payload by adding a `SCHEMA` field for the payload class that defines a mapping between the fields of existing objects and the fields of the new payload object. For example the service.status notification reuses the existing `nova.objects.service.Service` object when defines the notifications payload.

```
@notification.notification_sample('service-update.json')
@object_base.NovaObjectRegistry.register.register_notification
class ServiceStatusNotification(notification.NotificationBase):
    # Version 1.0: Initial version
    VERSION = '1.0'

    fields = {
        'payload': fields.ObjectField('ServiceStatusPayload')
    }

@object_base.NovaObjectRegistry.register.register_notification
class ServiceStatusPayload(notification.NotificationPayloadBase):
    SCHEMA = {
        'host': ('service', 'host'),
        'binary': ('service', 'binary'),
        'topic': ('service', 'topic'),
        'report_count': ('service', 'report_count'),
        'disabled': ('service', 'disabled'),
        'disabled_reason': ('service', 'disabled_reason'),
        'availability_zone': ('service', 'availability_zone'),
        'last_seen_up': ('service', 'last_seen_up'),
        'forced_down': ('service', 'forced_down'),
        'version': ('service', 'version')
    }
    # Version 1.0: Initial version
    VERSION = '1.0'
    fields = {
        'host': fields.StringField(nullable=True),
        'binary': fields.StringField(nullable=True),
        'topic': fields.StringField(nullable=True),
        'report_count': fields.IntegerField(),
        'disabled': fields.BooleanField(),
        'disabled_reason': fields.StringField(nullable=True),
        'availability_zone': fields.StringField(nullable=True),
        'last_seen_up': fields.DateTimeField(nullable=True),
        'forced_down': fields.BooleanField(),
```

(continues on next page)

(continued from previous page)

```
        'version': fields.IntegerField(),
    }

    def populate_schema(self, service):
        super(ServiceStatusPayload, self).populate_schema(service=service)
```

If the SCHEMA field is defined then the payload object needs to be populated with the `populate_schema` call before it can be emitted.

```
payload = ServiceStatusPayload()
payload.populate_schema(service=<nova.object.service.Service object>)
ServiceStatusNotification(
    publisher=notification.NotificationPublisher.from_service_obj(
        <nova.object.service.Service object>),
    event_type=notification.EventType(
        object='service',
        action=fields.NotificationAction.UPDATE),
    priority=fields.NotificationPriority.INFO,
    payload=payload).emit(context)
```

The above code will emit the *already shown notification* on the wire.

Every item in the SCHEMA has the syntax of:

```
<payload field name which needs to be filled>:
    (<name of the parameter of the populate_schema call>,
     <the name of a field of the parameter object>)
```

The mapping defined in the SCHEMA field has the following semantics. When the `populate_schema` function is called the content of the SCHEMA field is enumerated and the value of the field of the pointed parameter object is copied to the requested payload field. So in the above example the `host` field of the payload object is populated from the value of the `host` field of the `service` object that is passed as a parameter to the `populate_schema` call.

A notification payload object can reuse fields from multiple existing objects. Also a notification can have both new and reused fields in its payload.

Note that the notifications publisher instance can be created two different ways. It can be created by instantiating the `NotificationPublisher` object with a `host` and a `source` string parameter or it can be generated from a `Service` object by calling `NotificationPublisher.from_service_obj` function.

Versioned notifications shall have a sample file stored under `doc/sample_notifications` directory and the notification object shall be decorated with the `notification_sample` decorator. For example the `service.update` notification has a sample file stored in `doc/sample_notifications/service-update.json` and the `ServiceUpdateNotification` class is decorated accordingly.

Notification payload classes can use inheritance to avoid duplicating common payload fragments in nova code. However the leaf classes used directly in a notification should be created with care to avoid future needs of adding extra level of inheritance that changes the name of the leaf class as that name is present in the payload class. If this cannot be avoided and the only change is the renaming then the version of the new payload shall be the same as the old payload was before the rename. See[1] as an example. If the

[1] https://review.opendev.org/#/c/463001/

renaming involves any other changes on the payload (e.g. adding new fields) then the version of the new payload shall be higher than the old payload was. See[2] as an example.

What should be in the notification payload?

This is just a guideline. You should always consider the actual use case that requires the notification.

- Always include the identifier (e.g. uuid) of the entity that can be used to query the whole entity over the REST API so that the consumer can get more information about the entity.
- You should consider including those fields that are related to the event you are sending the notification about. For example if a change of a field of the entity triggers an update notification then you should include the field to the payload.
- An update notification should contain information about what part of the entity is changed. Either by filling the nova_object.changes part of the payload (note that it is not supported by the notification framework currently) or sending both the old state and the new state of the entity in the payload.
- You should never include a nova internal object in the payload. Create a new object and use the SCHEMA field to map the internal object to the notification payload. This way the evolution of the internal object model can be decoupled from the evolution of the notification payload.

  Important

  This does not mean that every field from internal objects should be mirrored in the notification payload objects. Think about what is actually needed by a consumer before adding it to a payload. When in doubt, if no one is requesting specific information in notifications, then leave it out until someone asks for it.

- The delete notification should contain the same information as the create or update notifications. This makes it possible for the consumer to listen only to the delete notifications but still filter on some fields of the entity (e.g. project_id).

What should NOT be in the notification payload

- Generally anything that contains sensitive information about the internals of the nova deployment, for example fields that contain access credentials to a cell database or message queue (see bug 1823104).

4.1.7 Nova Major Subsystems

Major subsystems in nova have different needs. If you are contributing to one of these please read the *reference guide* before diving in.

- Move operations
  - *Evacuate vs Rebuild*: Describes the differences between the often-confused evacuate and rebuild operations.
  - *Resize and cold migrate*: Describes the differences and similarities between resize and cold migrate operations.

[2] https://review.opendev.org/#/c/453077/

4.1.7.1 Evacuate vs Rebuild

The evacuate API and rebuild API are commonly confused in nova because the internal conductor code and compute code use the same methods called `rebuild_instance`. This document explains some of the differences in what happens between an evacuate and rebuild operation.

High level

Evacuate is an operation performed by an administrator when a compute service or host is encountering some problem, goes down and needs to be fenced from the network. The servers that were running on that compute host can be rebuilt on a **different** host using the **same** image. If the source and destination hosts are running on shared storage then the root disk image of the servers can be retained otherwise the root disk image (if not using a volume-backed server) will be lost. This is one example of why it is important to attach data volumes to a server to store application data and leave the root disk for the operating system since data volumes will be re-attached to the server as part of the evacuate process.

Rebuild is an operation which can be performed by a non-administrative owner of the server (the user) performed on the **same** compute host to change certain aspects of the server, most notably using a **different** image. Note that the image does not *have* to change and in the case of volume-backed servers the image can be changed with microversion 2.93. Other attributes of the server can be changed as well such as `key_name` and `user_data`. See the rebuild API reference for full usage details. When a user rebuilds a server they want to change it which requires re-spawning the guest in the hypervisor but retain the UUID, volumes and ports attached to the server.

Scheduling

Evacuate always schedules the server to another host and rebuild always occurs on the same host.

Note that when rebuilding with a different image, the request is run through the scheduler to ensure the new image is still valid for the current compute host.

Image

As noted above, the image that the server uses during an evacuate operation does not change. The image used to rebuild a server *may* change but does not have to.

Resource claims

The compute service `ResourceTracker` has a claims operation which is used to ensure resources are available before building a server on the host. The scheduler performs the initial filtering of hosts to ensure a server can be built on a given host and the compute claim is essentially meant as a secondary check to prevent races when the scheduler has out of date information or when there are concurrent build requests going to the same host.

During an evacuate operation there is a rebuild claim since the server is being re-built on a different host.

During a rebuild operation, since the flavor does not change, there is no claim made since the host does not change.

Allocations

Since the 16.0.0 (Pike) release, the scheduler uses the placement service to filter compute nodes (resource providers) based on information in the flavor and image used to build the server. Once the scheduler runs

through its filters and weighers and picks a host, resource class allocations are atomically consumed in placement with the server as the consumer.

During an evacuate operation, the allocations held by the server consumer against the source compute node resource provider are left intact since the source compute service is down. Note that migration-based allocations, which were introduced in the 17.0.0 (Queens) release, do not apply to evacuate operations but only resize, cold migrate and live migrate. So once a server is successfully evacuated to a different host, the placement service will track allocations for that server against both the source and destination compute node resource providers. If the source compute service is restarted after being evacuated and fixed, the compute service will delete the old allocations held by the evacuated servers.

During a rebuild operation, since neither the host nor flavor changes, the server allocations remain intact.

4.1.7.2 Resize and cold migrate

The resize API and cold migrate API are commonly confused in nova because the internal API code, conductor code and compute code use the same methods. This document explains some of the differences in what happens between a resize and cold migrate operation.

For the most part this document describes *same-cell resize*. For details on *cross-cell resize*, refer to *Cross-cell resize*.

High level

Cold migrate is an operation performed by an administrator to power off and move a server from one host to a **different** host using the **same** flavor. Volumes and network interfaces are disconnected from the source host and connected on the destination host. The type of file system between the hosts and image backend determine if the server files and disks have to be copied. If copy is necessary then root and ephemeral disks are copied and swap disks are re-created.

Resize is an operation which can be performed by a non-administrative owner of the server (the user) with a **different** flavor. The new flavor can change certain aspects of the server such as the number of CPUS, RAM and disk size. Otherwise for the most part the internal details are the same as a cold migration.

Scheduling

Depending on how the API is configured for `allow_resize_to_same_host`, the server may be able to be resized on the current host. *All* compute drivers support *resizing* to the same host but *only* the vCenter driver supports *cold migrating* to the same host. Enabling resize to the same host is necessary for features such as strict affinity server groups where there are more than one server in the same affinity group.

Starting with microversion 2.56 an administrator can specify a destination host for the cold migrate operation. Resize does not allow specifying a destination host.

Flavor

As noted above, with resize the flavor *must* change and with cold migrate the flavor *will not* change.

Resource claims

Both resize and cold migration perform a resize claim on the destination node. Historically the resize claim was meant as a safety check on the selected node to work around race conditions in the scheduler. Since the scheduler started atomically claiming VCPU, MEMORY_MB and DISK_GB allocations using Placement the role of the resize claim has been reduced to detecting the same conditions but for resources

like PCI devices and NUMA topology which, at least as of the 20.0.0 (Train) release, are not modeled in Placement and as such are not atomic.

If this claim fails, the operation can be rescheduled to an alternative host, if there are any. The number of possible alternative hosts is determined by the `scheduler.max_attempts` configuration option.

Allocations

Since the 16.0.0 (Pike) release, the scheduler uses the placement service to filter compute nodes (resource providers) based on information in the flavor and image used to build the server. Once the scheduler runs through its filters and weighers and picks a host, resource class allocations are atomically consumed in placement with the server as the consumer.

During both resize and cold migrate operations, the allocations held by the server consumer against the source compute node resource provider are moved to a migration record and the scheduler will create allocations, held by the instance consumer, on the selected destination compute node resource provider. This is commonly referred to as migration-based allocations which were introduced in the 17.0.0 (Queens) release.

If the operation is successful and confirmed, the source node allocations held by the migration record are dropped. If the operation fails or is reverted, the source compute node resource provider allocations held by the migration record are reverted back to the instance consumer and the allocations against the destination compute node resource provider are dropped.

Summary of differences

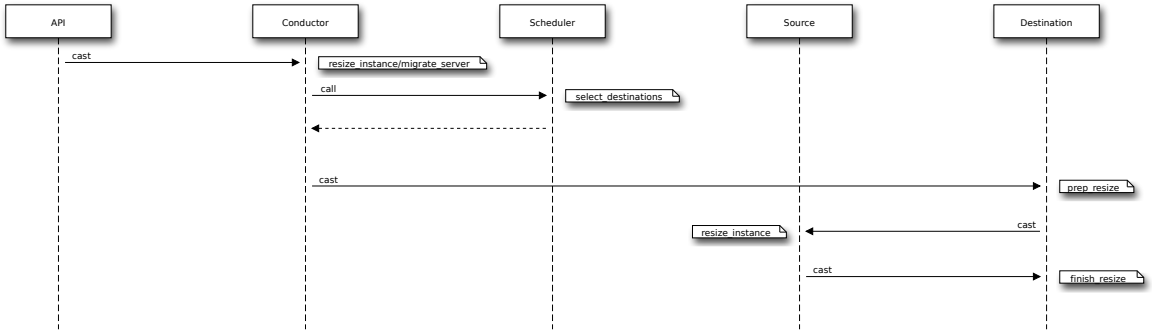
	Resize	Cold migrate
New flavor	Yes	No
Authorization (default)	Admin or owner (user) Policy rule: `os_compute_api:servers:resize`	Admin only Policy rule: `os_compute_api:os-migrate-server:migrate`
Same host	Maybe	Only vCenter
Can specify target host	No	Yes (microversion >= 2.56)

Sequence Diagrams

The following diagrams are current as of the 21.0.0 (Ussuri) release.

Resize

This is the sequence of calls to get the server to `VERIFY_RESIZE` status.



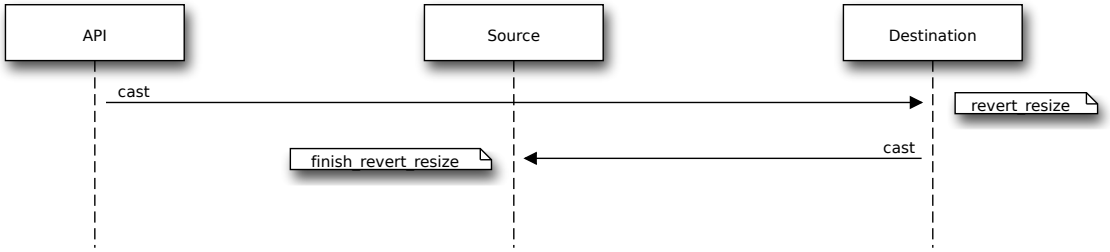
Confirm resize

This is the sequence of calls when confirming or deleting a server in `VERIFY_RESIZE` status.

Note that in the below diagram, if confirming a resize while deleting a server the API synchronously calls the source compute service.

Revert resize

This is the sequence of calls when reverting a server in `VERIFY_RESIZE` status.



4.2 Technical Reference Deep Dives

The nova project is large, and there are lots of complicated parts in it where it helps to have an overview to understand how the internals of a particular part work.

4.2.1 Internals

The following is a dive into some of the internals in nova.

- *AMQP and Nova*: How nova uses AMQP as an RPC transport
- *Scheduling*: The workflow through the scheduling process

- *Scheduler hints versus flavor extra specs*: The similarities and differences between flavor extra specs and scheduler hints.
- *Live Migration*: The live migration flow
- *Services, Managers and Drivers*: Module descriptions for some of the key modules used in starting / running services
- *Virtual Machine States and Transitions*: Cheat sheet for understanding the life cycle of compute instances
- *Threading model*: The concurrency model used in nova, which is based on eventlet, and may not be familiar to everyone.
- *Available versioned notifications*: The notifications available in nova.
- *ComputeDriver.update_provider_tree*: A detailed explanation of the `ComputeDriver.update_provider_tree` method.
- *Upgrade checks*: A guide to writing automated upgrade checks.
- *Database migrations*: A guide to writing database migrations, be they online or offline.
- *Conductor as a place for orchestrating tasks*

Todo

Need something about versioned objects and how they fit in with conductor as an object backporter during upgrades.

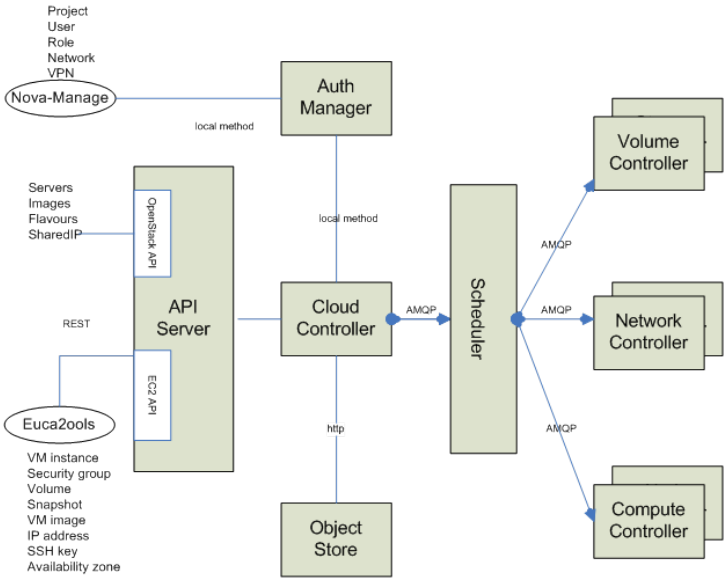
- *Filtering hosts by isolating aggregates*: Describes how the placement filter works in nova to isolate groups of hosts.
- *Attaching Volumes*: Describes the attach volume flow, using the libvirt virt driver as an example.
- *Driver BDM Data Structures*: Block Device Data Structures
- *Libvirt virt driver OS distribution support matrix*: Libvirt virt driver OS distribution support matrix

4.2.1.1 AMQP and Nova

AMQP is the messaging technology chosen by the OpenStack cloud. The AMQP broker, default to Rabbitmq, sits between any two Nova components and allows them to communicate in a loosely coupled fashion. More precisely, Nova components (the compute fabric of OpenStack) use Remote Procedure Calls (RPC hereinafter) to communicate to one another; however such a paradigm is built atop the publish/subscribe paradigm so that the following benefits can be achieved:

- Decoupling between client and servant (such as the client does not need to know where the servants reference is).
- Full a-synchronism between client and servant (such as the client does not need the servant to run at the same time of the remote call).
- Random balancing of remote calls (such as if more servants are up and running, one-way calls are transparently dispatched to the first available servant).

Nova uses direct, fanout, and topic-based exchanges. The architecture looks like the one depicted in the figure below:



Nova implements RPC (both request+response, and one-way, respectively nicknamed `rpc.call` and `rpc.cast`) over AMQP by providing an adapter class which take cares of marshaling and unmarshaling of messages into function calls. Each Nova service (for example Compute, Scheduler, etc.) create two queues at the initialization time, one which accepts messages with routing keys `NODE-TYPE.NODE-ID` (for example `compute.hostname`) and another, which accepts messages with routing keys as generic `NODE-TYPE` (for example `compute`). The former is used specifically when Nova-API needs to redirect commands to a specific node like `openstack server delete $instance`. In this case, only the compute node whose hosts hypervisor is running the virtual machine can kill the instance. The API acts as a consumer when RPC calls are request/response, otherwise it acts as a publisher only.

Nova RPC Mappings

The figure below shows the internals of a message broker node (referred to as a RabbitMQ node in the diagrams) when a single instance is deployed and shared in an OpenStack cloud. Every Nova component connects to the message broker and, depending on its personality (for example a compute node or a network node), may use the queue either as an Invoker (such as API or Scheduler) or a Worker (such as Compute or Network). Invokers and Workers do not actually exist in the Nova object model, but we are going to use them as an abstraction for sake of clarity. An Invoker is a component that sends messages in the queuing system via two operations: 1) `rpc.call` and ii) `rpc.cast`; a Worker is a component that receives messages from the queuing system and reply accordingly to `rpc.call` operations.

Figure 2 shows the following internal elements:

Topic Publisher
: A Topic Publisher comes to life when an `rpc.call` or an `rpc.cast` operation is executed; this object is instantiated and used to push a message to the queuing system. Every publisher connects always to the same topic-based exchange; its life-cycle is limited to the message delivery.

Direct Consumer
: A Direct Consumer comes to life if (and only if) an `rpc.call` operation is executed; this object is instantiated and used to receive a response message from the queuing system. Every consumer connects to a unique direct-based exchange via a unique exclusive queue; its life-cycle is limited to the message delivery; the exchange and queue identifiers are determined by a UUID generator, and are marshaled in the message sent by the Topic Publisher (only `rpc.call` operations).

Topic Consumer
: A Topic Consumer comes to life as soon as a Worker is instantiated and exists throughout its life-

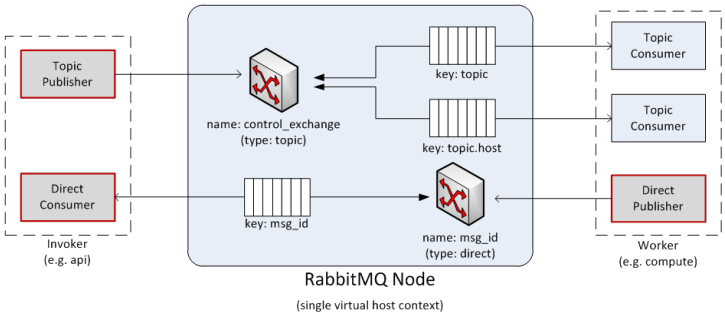
cycle; this object is used to receive messages from the queue and it invokes the appropriate action as defined by the Worker role. A Topic Consumer connects to the same topic-based exchange either via a shared queue or via a unique exclusive queue. Every Worker has two topic consumers, one that is addressed only during `rpc.cast` operations (and it connects to a shared queue whose exchange key is `topic`) and the other that is addressed only during `rpc.call` operations (and it connects to a unique queue whose exchange key is `topic.host`).

Direct Publisher
A Direct Publisher comes to life only during `rpc.call` operations and it is instantiated to return the message required by the request/response operation. The object connects to a direct-based exchange whose identity is dictated by the incoming message.

Topic Exchange
The Exchange is a routing table that exists in the context of a virtual host (the multi-tenancy mechanism provided by RabbitMQ etc); its type (such as topic vs. direct) determines the routing policy; a message broker node will have only one topic-based exchange for every topic in Nova.

Direct Exchange
This is a routing table that is created during `rpc.call` operations; there are many instances of this kind of exchange throughout the life-cycle of a message broker node, one for each `rpc.call` invoked.

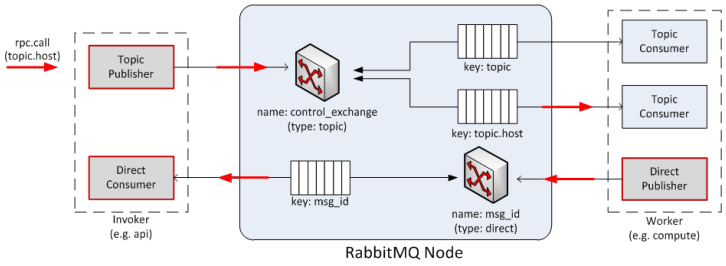
Queue Element
A Queue is a message bucket. Messages are kept in the queue until a Consumer (either Topic or Direct Consumer) connects to the queue and fetch it. Queues can be shared or can be exclusive. Queues whose routing key is `topic` are shared amongst Workers of the same personality.



RPC Calls

The diagram below shows the message flow during an `rpc.call` operation:

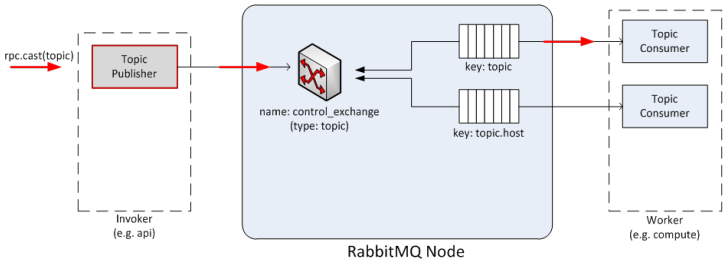
1. A Topic Publisher is instantiated to send the message request to the queuing system; immediately before the publishing operation, a Direct Consumer is instantiated to wait for the response message.
2. Once the message is dispatched by the exchange, it is fetched by the Topic Consumer dictated by the routing key (such as topic.host) and passed to the Worker in charge of the task.
3. Once the task is completed, a Direct Publisher is allocated to send the response message to the queuing system.
4. Once the message is dispatched by the exchange, it is fetched by the Direct Consumer dictated by the routing key (such as `msg_id`) and passed to the Invoker.



RPC Casts

The diagram below shows the message flow during an `rpc.cast` operation:

1. A Topic Publisher is instantiated to send the message request to the queuing system.
2. Once the message is dispatched by the exchange, it is fetched by the Topic Consumer dictated by the routing key (such as topic) and passed to the Worker in charge of the task.



AMQP Broker Load

At any given time the load of a message broker node running RabbitMQ etc is function of the following parameters:

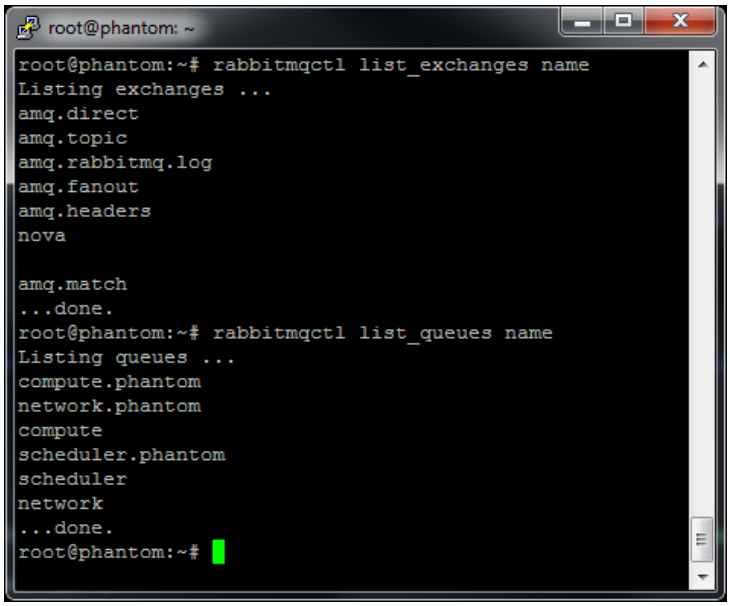
Throughput of API calls
: The number of API calls (more precisely `rpc.call` ops) being served by the OpenStack cloud dictates the number of direct-based exchanges, related queues and direct consumers connected to them.

Number of Workers
: There is one queue shared amongst workers with the same personality; however there are as many exclusive queues as the number of workers; the number of workers dictates also the number of routing keys within the topic-based exchange, which is shared amongst all workers.

The figure below shows the status of a RabbitMQ node after Nova components bootstrap in a test environment. Exchanges and queues being created by Nova components are:

- Exchanges
  1. nova (topic exchange)
- Queues
  1. `compute.phantom` (`phantom` is hostname)
  2. `compute`
  3. `network.phantom` (`phantom` is hostname)
  4. `network`

5. `scheduler.phantom` (`phantom` is hostname)
6. `scheduler`



RabbitMQ Gotchas

Nova uses Kombu to connect to the RabbitMQ environment. Kombu is a Python library that in turn uses AMQPLib, a library that implements the standard AMQP 0.8 at the time of writing. When using Kombu, Invokers and Workers need the following parameters in order to instantiate a Connection object that connects to the RabbitMQ server (please note that most of the following material can be also found in the Kombu documentation; it has been summarized and revised here for sake of clarity):

`hostname`
: The hostname to the AMQP server.

`userid`
: A valid username used to authenticate to the server.

`password`
: The password used to authenticate to the server.

`virtual_host`
: The name of the virtual host to work with. This virtual host must exist on the server, and the user must have access to it. Default is /.

`port`
: The port of the AMQP server. Default is `5672` (amqp).

The following parameters are default:

`insist`
: Insist on connecting to a server. In a configuration with multiple load-sharing servers, the Insist option tells the server that the client is insisting on a connection to the specified server. Default is False.

`connect_timeout`
: The timeout in seconds before the client gives up connecting to the server. The default is no timeout.

`ssl`
: Use SSL to connect to the server. The default is False.

More precisely Consumers need the following parameters:

`connection`
: The above mentioned Connection object.

`queue`
: Name of the queue.

`exchange`
: Name of the exchange the queue binds to.

`routing_key`
: The interpretation of the routing key depends on the value of the `exchange_type` attribute.

  Direct exchange
  : If the routing key property of the message and the `routing_key` attribute of the queue are identical, then the message is forwarded to the queue.

  Fanout exchange
  : Messages are forwarded to the queues bound the exchange, even if the binding does not have a key.

  Topic exchange
  : If the routing key property of the message matches the routing key of the key according to a primitive pattern matching scheme, then the message is forwarded to the queue. The message routing key then consists of words separated by dots (`.`, like domain names), and two special characters are available; star (`*`) and hash (`#`). The star matches any word, and the hash matches zero or more words. For example `.stock.#` matches the routing keys `usd.stock` and `eur.stock.db` but not `stock.nasdaq`.

`durable`
: This flag determines the durability of both exchanges and queues; durable exchanges and queues remain active when a RabbitMQ server restarts. Non-durable exchanges/queues (transient exchanges/queues) are purged when a server restarts. It is worth noting that AMQP specifies that durable queues cannot bind to transient exchanges. Default is True.

`auto_delete`
: If set, the exchange is deleted when all queues have finished using it. Default is False.

`exclusive`
: Exclusive queues (such as non-shared) may only be consumed from by the current connection. When exclusive is on, this also implies `auto_delete`. Default is False.

`exchange_type`
: AMQP defines several default exchange types (routing algorithms) that covers most of the common messaging use cases.

`auto_ack`
: Acknowledgment is handled automatically once messages are received. By default `auto_ack` is set to False, and the receiver is required to manually handle acknowledgment.

`no_ack`
: It disable acknowledgment on the server-side. This is different from `auto_ack` in that acknowledgment is turned off altogether. This functionality increases performance but at the cost of reliability. Messages can get lost if a client dies before it can deliver them to the application.

`auto_declare`
: If this is True and the exchange name is set, the exchange will be automatically declared at instantiation. Auto declare is on by default.

Publishers specify most the parameters of Consumers (such as they do not specify a queue name), but they can also specify the following:

`delivery_mode`
: The default delivery mode used for messages. The value is an integer. The following delivery modes are supported by RabbitMQ:

  1 (transient)
  : The message is transient. Which means it is stored in memory only, and is lost if the server dies or restarts.

  2 (persistent)
  : The message is persistent. Which means the message is stored both in-memory, and on disk, and therefore preserved if the server dies or restarts.

The default value is 2 (persistent). During a send operation, Publishers can override the delivery mode of messages so that, for example, transient messages can be sent over a durable queue.

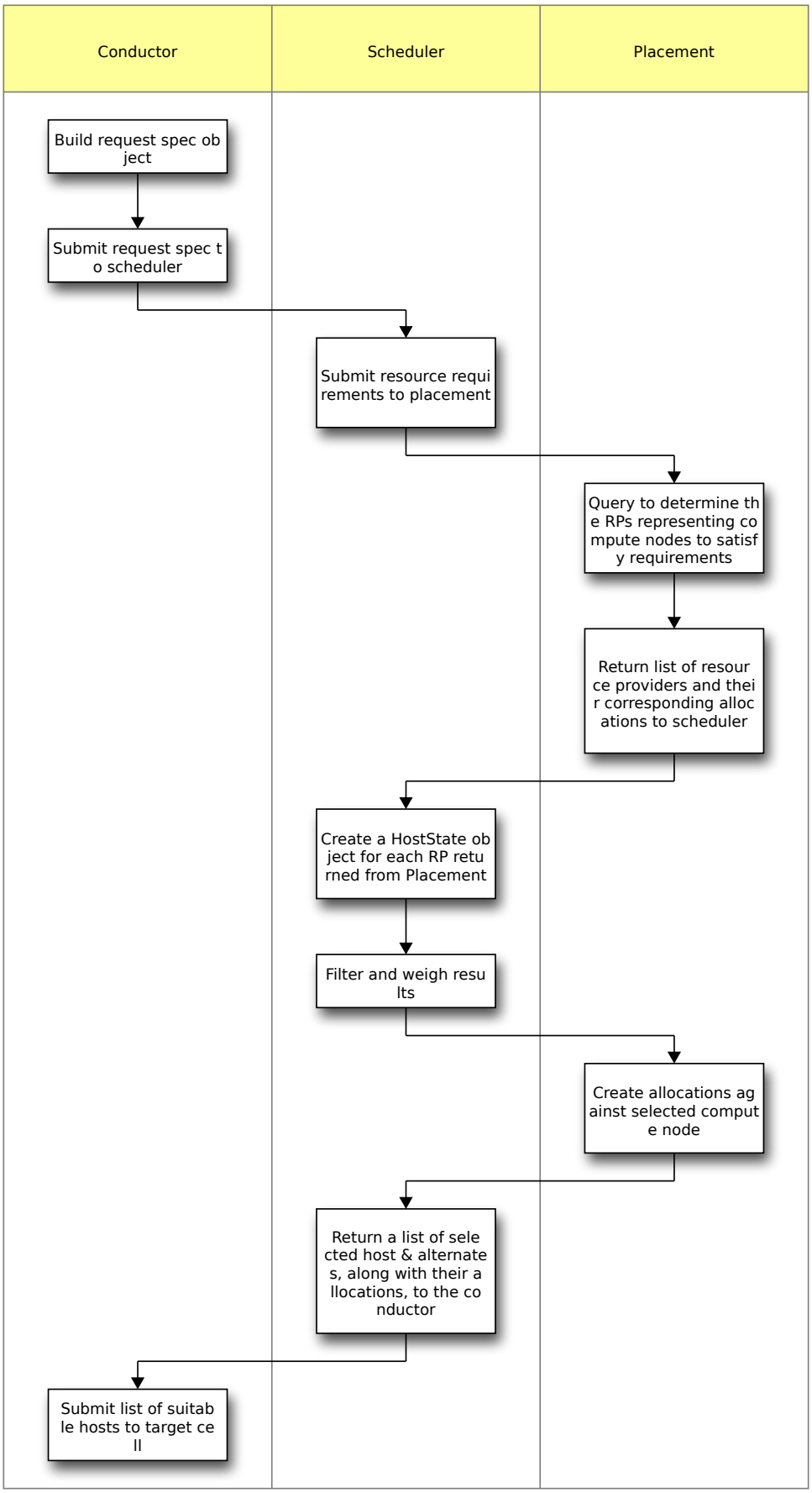
4.2.1.2 Scheduling

This is an overview of how scheduling works in nova from Pike onwards. For information on the scheduler itself, refer to *Compute schedulers*. For an overview of why weve changed how the scheduler works, refer to *Scheduler Evolution*.

Overview

The scheduling process is described below.

> **Note**
>
> This is current as of the 16.0.0 Pike release. Any mention of alternative hosts passed between the scheduler and conductor(s) is future work.


Conductor
Scheduler
Placement
Build request spec ob ject
Submit request spec t o scheduler
Submit resource requi rements to placement
Query to determine th e RPs representing co mpute nodes to satisf y requirements
Return list of resour ce providers and thei r corresponding alloc ations to scheduler
Create a HostState ob ject for each RP retu rned from Placement
Filter and weigh resu lts
Create allocations ag ainst selected comput e node
Return a list of sele cted host & alternate s, along with their a llocations, to the co nductor
Submit list of suitab le hosts to target ce ll

As the above diagram illustrates, scheduling works like so:

1. Scheduler gets a request spec from the super conductor, containing resource requirements. The super conductor operates at the top level of a deployment, as contrasted with the cell conductor, which operates within a particular cell.
2. Scheduler sends those requirements to placement.
3. Placement runs a query to determine the resource providers (in this case, compute nodes) that can satisfy those requirements.
4. Placement then constructs a data structure for each compute node as documented in the spec. The data structure contains summaries of the matching resource provider information for each compute node, along with the AllocationRequest that will be used to claim the requested resources if that compute node is selected.
5. Placement returns this data structure to the Scheduler.
6. The Scheduler creates HostState objects for each compute node contained in the provider summaries. These HostState objects contain the information about the host that will be used for subsequent filtering and weighing.
7. Since the request spec can specify one or more instances to be scheduled. The Scheduler repeats the next several steps for each requested instance.
8. Scheduler runs these HostState objects through the filters and weighers to further refine and rank the hosts to match the request.
9. Scheduler then selects the HostState at the top of the ranked list, and determines its matching AllocationRequest from the data returned by Placement. It uses that AllocationRequest as the body of the request sent to Placement to claim the resources.
10. If the claim is not successful, that indicates that another process has consumed those resources, and the host is no longer able to satisfy the request. In that event, the Scheduler moves on to the next host in the list, repeating the process until it is able to successfully claim the resources.
11. Once the Scheduler has found a host for which a successful claim has been made, it needs to select a number of alternate hosts. These are hosts from the ranked list that are in the same cell as the selected host, which can be used by the cell conductor in the event that the build on the selected host fails for some reason. The number of alternates is determined by the configuration option `scheduler.max_attempts`.
12. Scheduler creates two list structures for each requested instance: one for the hosts (selected + alternates), and the other for their matching AllocationRequests.
13. To create the alternates, Scheduler determines the cell of the selected host. It then iterates through the ranked list of HostState objects to find a number of additional hosts in that same cell. It adds those hosts to the host list, and their AllocationRequest to the allocation list.
14. Once those lists are created, the Scheduler has completed what it needs to do for a requested instance.
15. Scheduler repeats this process for any additional requested instances. When all instances have been scheduled, it creates a 2-tuple to return to the super conductor, with the first element of the tuple being a list of lists of hosts, and the second being a list of lists of the AllocationRequests.
16. Scheduler returns that 2-tuple to the super conductor.
17. For each requested instance, the super conductor determines the cell of the selected host. It then sends a 2-tuple of ([hosts], [AllocationRequests]) for that instance to the target cell conductor.

18. Target cell conductor tries to build the instance on the selected host. If it fails, it uses the AllocationRequest data for that host to unclaim the resources for the selected host. It then iterates through the list of alternates by first attempting to claim the resources, and if successful, building the instance on that host. Only when all alternates fail does the build request fail.

4.2.1.3 Scheduler hints versus flavor extra specs

People deploying and working on Nova often have questions about flavor extra specs and scheduler hints and what role they play in scheduling decisions, and which is a better choice for exposing capability to an end user of the cloud. There are several things to consider and it can get complicated. This document attempts to explain at a high level some of the major differences and drawbacks with both flavor extra specs and scheduler hints.

Extra Specs

In general flavor extra specs are specific to the cloud and how it is organized for capabilities, and should be abstracted from the end user. Extra specs are tied to *host aggregates* and a lot of them also define how a guest is created in the hypervisor, for example what the watchdog action is for a VM. Extra specs are also generally interchangeable with image properties when it comes to VM behavior, like the watchdog example. How that is presented to the user is via the name of the flavor, or documentation specifically for that deployment, e.g. instructions telling a user how to setup a baremetal instance.

Scheduler Hints

Scheduler hints, also known simply as hints, can be specified during server creation to influence the placement of the server by the scheduler depending on which scheduler filters are enabled. Hints are mapped to specific filters. For example, the `ServerGroupAntiAffinityFilter` scheduler filter is used with the `group` scheduler hint to indicate that the server being created should be a member of the specified anti-affinity group and the filter should place that server on a compute host which is different from all other current members of the group.

Hints are not more dynamic than flavor extra specs. The end user specifies a flavor and optionally a hint when creating a server, but ultimately what they can specify is static and defined by the deployment.

Similarities

- Both scheduler hints and flavor extra specs can be used by *scheduler filters*.
- Both are totally customizable, meaning there is no whitelist within Nova of acceptable hints or extra specs, unlike image properties[1].
- An end user cannot achieve a new behavior without deployer consent, i.e. even if the end user specifies the `group` hint, if the deployer did not configure the `ServerGroupAntiAffinityFilter` the end user cannot have the `anti-affinity` behavior.

Differences

- A servers host location and/or behavior can change when resized with a flavor that has different extra specs from those used to create the server. Scheduler hints can only be specified during server creation, not during resize or any other move operation, but the original hints are still applied during the move operation.

[1] https://opendev.org/openstack/nova/src/commit/fbe6f77bc1cb41f5d6cfc24ece54d3413f997aab/nova/objects/image_meta.py#L225

- The flavor extra specs used to create (or resize) a server can be retrieved from the compute API using the 2.47 microversion. As of the 19.0.0 Stein release, there is currently no way from the compute API to retrieve the scheduler hints used to create a server.

  Note

  Exposing the hints used to create a server has been proposed[2]. Without this, it is possible to workaround the limitation by doing things such as including the scheduler hint in the server metadata so it can be retrieved via server metadata later.

- In the case of hints the end user can decide not to include a hint. On the other hand the end user cannot create a new flavor (by default policy) to avoid passing a flavor with an extra spec - the deployer controls the flavors.

Discoverability

When it comes to discoverability, by the default `os_compute_api:os-flavor-extra-specs:index` policy rule, flavor extra specs are more discoverable by the end user since they can list them for a flavor. However, one should not expect an average end user to understand what different extra specs mean as they are just a key/value pair. There is some documentation for some standard extra specs though[3]. However, that is not an exhaustive list and it does not include anything that different deployments would define for things like linking a flavor to a set of *host aggregates*, for example, when creating flavors for baremetal instances, or what the chosen *hypervisor driver* might support for flavor extra specs.

Scheduler hints are less discoverable from an end user perspective than extra specs. There are some standard hints defined in the API request schema[4]. However:

1. Those hints are tied to scheduler filters and the scheduler filters are configurable per deployment, so for example the `JsonFilter` might not be enabled (it is not enabled by default), so the `query` hint would not do anything.
2. Scheduler hints are not restricted to just what is in that schema in the upstream nova code because of the `additionalProperties: True` entry in the schema. This allows deployments to define their own hints outside of that API request schema for their own *custom scheduler filters* which are not part of the upstream nova code.

Interoperability

The only way an end user can really use scheduler hints is based on documentation (or GUIs/SDKs) that a specific cloud deployment provides for their setup. So if **CloudA** defines a custom scheduler filter X and a hint for that filter in their documentation, an end user application can only run with that hint on that cloud and expect it to work as documented. If the user moves their application to **CloudB** which does not have that scheduler filter or hint, they will get different behavior.

So obviously both flavor extra specs and scheduler hints are not interoperable.

[2] https://review.opendev.org/#/c/440580/

[3] https://docs.openstack.org/nova/latest/user/flavors.html#extra-specs

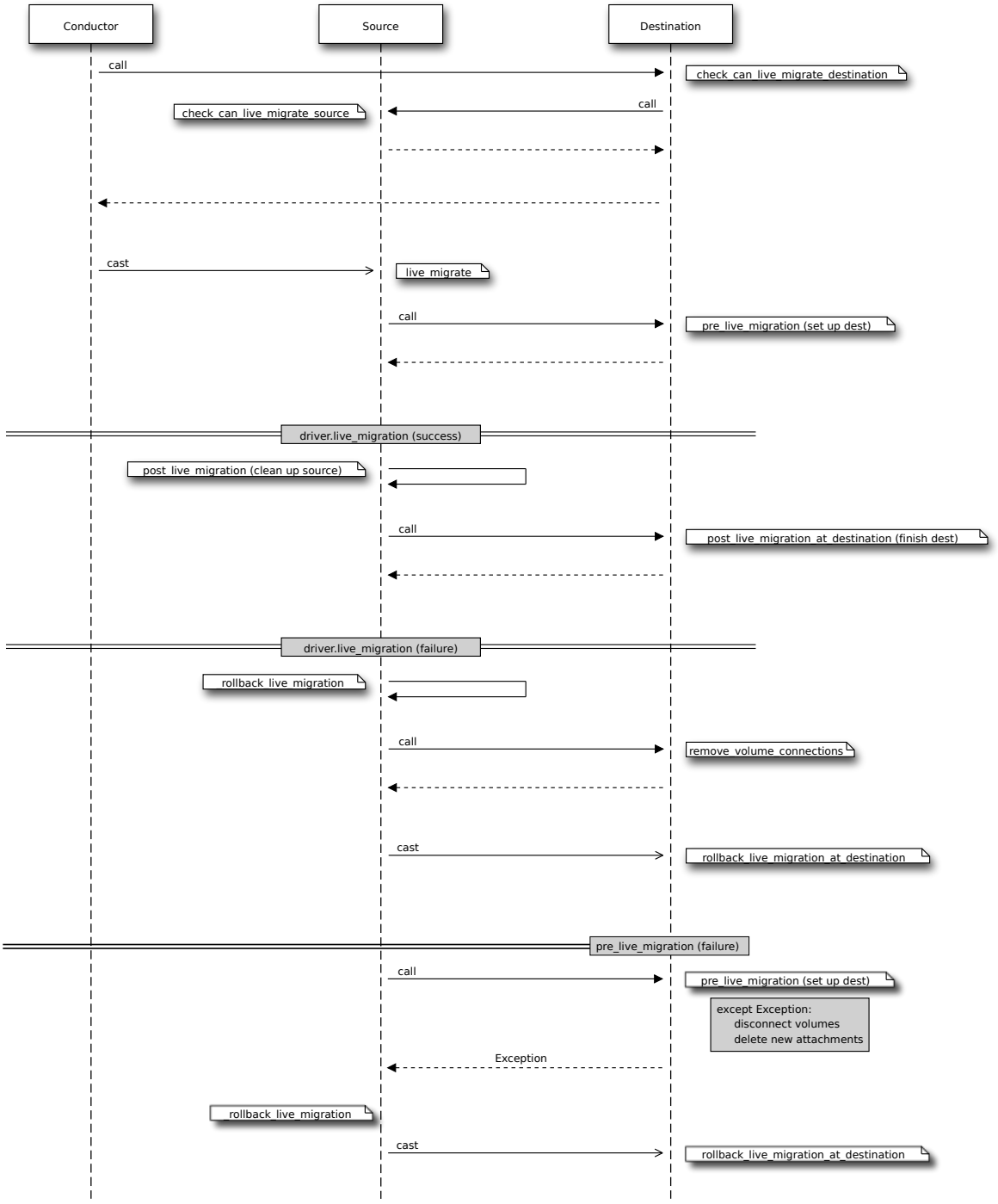
[4] https://opendev.org/openstack/nova/src/commit/fbe6f77bc1cb41f5d6cfc24ece54d3413f997aab/nova/api/openstack/compute/schemas/scheduler_hints.py

Which to use?

When it comes to defining a custom scheduler filter, you could use a hint or an extra spec. If you need a flavor extra spec anyway for some behavior in the hypervisor when creating the guest, or to be able to retrieve the original flavor extra specs used to create a guest later, then you might as well just use the extra spec. If you do not need that, then a scheduler hint may be an obvious choice, from an end user perspective, for exposing a certain scheduling behavior but it must be well documented and the end user should realize that hint might not be available in other clouds, and they do not have a good way of finding that out either. Long-term, flavor extra specs are likely to be more standardized than hints so ultimately extra specs are the recommended choice.

Footnotes

4.2.1.4 Live Migration



4.2.1.5 Services, Managers and Drivers

The responsibilities of Services, Managers, and Drivers, can be a bit confusing to people that are new to nova. This document attempts to outline the division of responsibilities to make understanding the system a little bit easier.

Currently, Managers and Drivers are specified by flags and loaded using utils.load_object(). This method allows for them to be implemented as singletons, classes, modules or objects. As long as the path specified by the flag leads to an object (or a callable that returns an object) that responds to getattr, it should work

as a manager or driver.

The nova.service Module

Generic Node base class for all workers that run on hosts.

class nova.service.**Service**(*host*, *binary*, *topic*, *manager*, *report_interval=None*, *periodic_enable=None*, *periodic_fuzzy_delay=None*, *periodic_interval_max=None*, **args*, ***kwargs*)

Bases: Service

Service object for binaries running on hosts.

A service takes a manager and enables rpc by listening to queues based on topic. It also periodically runs tasks on the manager and reports its state to the database services table.

basic_config_check()

Perform basic config checks before starting processing.

classmethod **create**(*host=None*, *binary=None*, *topic=None*, *manager=None*, *report_interval=None*, *periodic_enable=None*, *periodic_fuzzy_delay=None*, *periodic_interval_max=None*)

Instantiates class and passes back application object.

Parameters

- **host** defaults to CONF.host
- **binary** defaults to basename of executable
- **topic** defaults to bin_name - nova- part
- **manager** defaults to CONF.<topic>_manager
- **report_interval** defaults to CONF.report_interval
- **periodic_enable** defaults to CONF.periodic_enable
- **periodic_fuzzy_delay** defaults to CONF.periodic_fuzzy_delay
- **periodic_interval_max** if set, the max time to wait between runs

kill()

Destroy the service object in the datastore.

NOTE: Although this method is not used anywhere else than tests, it is convenient to have it here, so the tests might easily and in clean way stop and remove the service_ref.

periodic_tasks(*raise_on_error=False*)

Tasks to be run at a periodic interval.

reset()

reset the service.

start()

Start the service.

This includes starting an RPC service, initializing periodic tasks, etc.

stop()

stop the service and clean up.

nova.service.**serve**(*server*, *workers=None*, *no_fork=False*)

nova.service.**setup_profiler**(*binary*, *host*)

nova.service.**wait**()

The nova.manager Module

Base Manager class.

Managers are responsible for a certain aspect of the system. It is a logical grouping of code relating to a portion of the system. In general other components should be using the manager to make changes to the components that it is responsible for.

For example, other components that need to deal with volumes in some way, should do so by calling methods on the VolumeManager instead of directly changing fields in the database. This allows us to keep all of the code relating to volumes in the same place.

We have adopted a basic strategy of Smart managers and dumb data, which means rather than attaching methods to data objects, components should call manager methods that act on the data.

Methods on managers that can be executed locally should be called directly. If a particular method must execute on a remote host, this should be done via rpc to the service that wraps the manager

Managers should be responsible for most of the db access, and non-implementation specific data. Anything implementation specific that cant be generalized should be done by the Driver.

In general, we prefer to have one manager with multiple drivers for different implementations, but sometimes it makes sense to have multiple managers. You can think of it this way: Abstract different overall strategies at the manager level(FlatNetwork vs VlanNetwork), and different implementations at the driver level(LinuxNetDriver vs CiscoNetDriver).

Managers will often provide methods for initial setup of a host or periodic tasks to a wrapping service.

This module provides Manager, a base class for managers.

class nova.manager.**Manager**(*host=None*, *service_name='undefined'*)

Bases: PeriodicTasks

cleanup_host()

Hook to do cleanup work when the service shuts down.

Child classes should override this method.

init_host(*service_ref*)

Hook to do additional manager initialization when one requests the service be started. This is called before any service record is created, but if one already exists for this service, it is provided.

Child classes should override this method.

Parameters

service_ref An objects.Service if one exists, else None.

periodic_tasks(*context*, *raise_on_error=False*)

Tasks to be run at a periodic interval.

post_start_hook()

Hook to provide the manager the ability to do additional start-up work immediately after a service creates RPC consumers and starts running.

Child classes should override this method.

pre_start_hook(*service_ref*)

Hook to provide the manager the ability to do additional start-up work before any RPC queues/consumers are created. This is called after other initialization has succeeded and a service record is created.

Child classes should override this method.

Parameters

service_ref The nova.objects.Service for this

reset()

Hook called on SIGHUP to signal the manager to re-read any dynamic configuration or do any reconfiguration tasks.

class nova.manager.**ManagerMeta**(*names*, *bases*, *dict_*)

Bases: NoopMeta, _PeriodicTasksMeta

Metaclass to trace all children of a specific class.

This metaclass wraps every public method (not starting with _ or __) of the class using it. All children classes of the class using ManagerMeta will be profiled as well.

Adding this metaclass requires that the __trace_args__ attribute be added to the class we want to modify. That attribute is a dictionary with one mandatory key: name. name defines the name of the action to be traced (for example, wsgi, rpc, db).

The OSprofiler-based tracing, although, will only happen if profiler instance was initiated somewhere before in the thread, that can only happen if profiling is enabled in nova.conf and the API call to Nova API contained specific headers.

class nova.manager.**PeriodicTasks**

Bases: PeriodicTasks

Implementation-Specific Drivers

A manager will generally load a driver for some of its tasks. The driver is responsible for specific implementation details. Anything running shell commands on a host, or dealing with other non-python code should probably be happening in a driver.

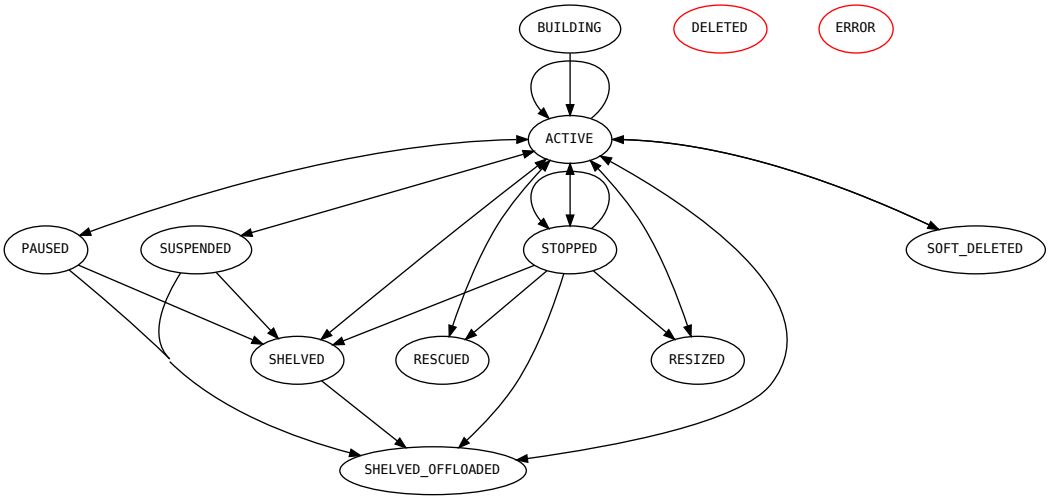
Drivers should not touch the database as the database management is done inside `nova-conductor`.

It usually makes sense to define an Abstract Base Class for the specific driver (i.e. VolumeDriver), to define the methods that a different driver would need to implement.

4.2.1.6 Virtual Machine States and Transitions

The following diagrams and tables show the required virtual machine (VM) states and task states for various commands issued by the user.

Allowed State Transitions



All states are allowed to transition to DELETED and ERROR.

Requirements for Commands

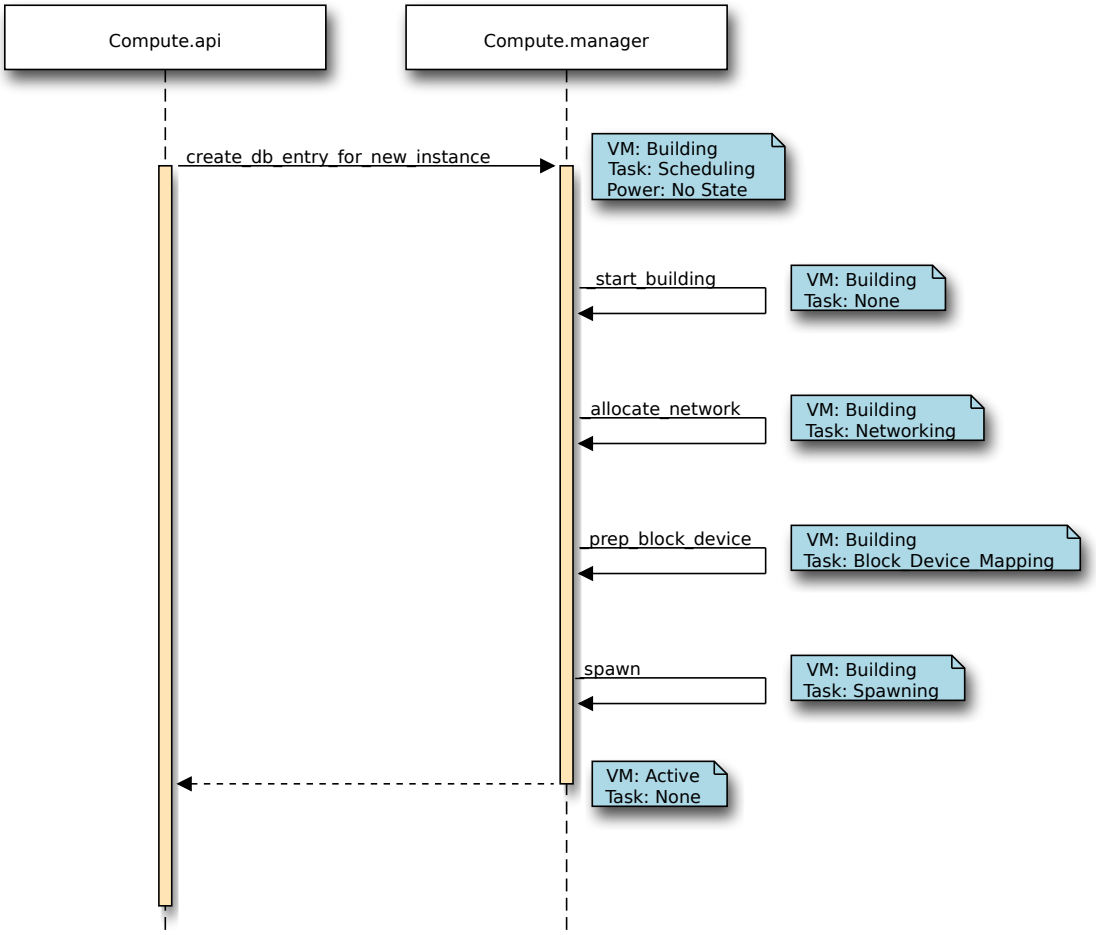
Command	Reqd VM States	Reqd Task States	Target State
pause	Active, Shutoff, Rescued	Resize Verify, unset	Paused
unpause	Paused	N/A	Active
suspend	Active, Shutoff	N/A	Suspended
resume	Suspended	N/A	Active
rescue	Active, Shutoff	Resize Verify, unset	Rescued
unrescue	Rescued	N/A	Active
set admin password	Active	N/A	Active
rebuild	Active, Shutoff	Resize Verify, unset	Active, Shutoff
force delete	Soft Deleted	N/A	Deleted
restore	Soft Deleted	N/A	Active
soft delete	Active, Shutoff, Error	N/A	Soft Deleted
delete	Active, Shutoff, Building, Rescued, Error	N/A	Deleted
backup	Active, Shutoff	N/A	Active, Shutoff
snapshot	Active, Shutoff	N/A	Active, Shutoff
start	Shutoff, Stopped	N/A	Active
stop	Active, Shutoff, Rescued	Resize Verify, unset	Stopped
reboot	Active, Shutoff, Rescued	Resize Verify, unset	Active
resize	Active, Shutoff	Resize Verify, unset	Resized
revert resize	Active, Shutoff	Resize Verify, unset	Active
confirm resize	Active, Shutoff	Resize Verify, unset	Active

VM states and Possible Commands

VM State	Commands
Paused	unpause
Suspended	resume
Active	set admin password, suspend, pause, rescue, rebuild, soft delete, delete, backup, snapshot, stop, reboot, resize, revert resize, confirm resize
Shutoff	suspend, pause, rescue, rebuild, soft delete, delete, backup, start, snapshot, stop, reboot, resize, revert resize, confirm resize
Rescued	unrescue, pause
Stopped	rescue, delete, start
Soft Deleted	force delete, restore
Error	soft delete, delete
Building	delete
Rescued	delete, stop, reboot

Create Instance States

The following diagram shows the sequence of VM states, task states, and power states when a new VM instance is created.



4.2.1.7 Threading model

Eventlet

Before the Flamingo release all OpenStack services used the *green thread* model of threading, implemented through using the Python eventlet and greenlet libraries.

Green threads use a cooperative model of threading: thread context switches can only occur when specific eventlet or greenlet library calls are made (e.g., sleep, certain I/O calls). From the operating systems point of view, each OpenStack service runs in a single thread.

The use of green threads reduces the likelihood of race conditions, but does not completely eliminate them. In some cases, you may need to use the `@lockutils.synchronized(...)` decorator to avoid races.

In addition, since there is only one operating system thread, a call that blocks that main thread will block the entire process.

Yielding the thread in long-running tasks

If a code path takes a long time to execute and does not contain any methods that trigger an eventlet context switch, the long-running thread will block any pending threads.

This scenario can be avoided by adding calls to the eventlet sleep method in the long-running code path. The sleep call will trigger a context switch if there are pending threads, and using an argument of 0 will

avoid introducing delays in the case that there is only a single green thread:

```
from eventlet import greenthread
...
greenthread.sleep(0)
```

In current code, time.sleep(0) does the same thing as greenthread.sleep(0) if time module is patched through eventlet.monkey_patch(). To be explicit, we recommend contributors use `greenthread.sleep()` instead of `time.sleep()`.

MySQL access and eventlet

There are some MySQL DB API drivers for oslo.db, like PyMySQL, MySQL-python etc. PyMySQL is the default MySQL DB API driver for oslo.db, and it works well with eventlet. MySQL-python uses an external C library for accessing the MySQL database. Since eventlet cannot use monkey-patching to intercept blocking calls in a C library, so queries to the MySQL database will block the main thread of a service.

The Diablo release contained a thread-pooling implementation that did not block, but this implementation resulted in a bug and was removed.

See this mailing list thread for a discussion of this issue, including a discussion of the impact on performance.

Native threading

Since the Flamingo release OpenStack started to transition away form `eventlet`. During this transition Nova maintains support for running services with `eventlet` while working to add support for running services with `native threading`.

To support both modes with the same codebase Nova started using the futurist library. In native threading mode `futurist.ThreadPoolsExecutors` are used to run concurrent tasks and both the oslo.service and the oslo.messaging libraries are configured to use native threads to execute tasks like periodics and RPC message handlers.

To see how to configure and tune the native threading mode read the *Nova service concurrency* guide.

4.2.1.8 Available versioned notifications

Note

Versioned notifications are added in each release, so the samples represented below may not necessarily be in an older version of nova. Ensure you are looking at the correct version of the documentation for the release you are using.

Event type	Notification class	Payload
`aggregate.cache_images.progress`	`AggregateCacheNotification`	`Aggreg`
`aggregate.add_host.end`	`AggregateNotification`	`Aggreg`
`aggregate.add_host.start`	`AggregateNotification`	`Aggreg`
`aggregate.cache_images.end`	`AggregateNotification`	`Aggreg`
`aggregate.cache_images.start`	`AggregateNotification`	`Aggreg`

Table 2 – continued from previous page

aggregate.create.end	AggregateNotification	Aggreg
aggregate.create.start	AggregateNotification	Aggreg
aggregate.delete.end	AggregateNotification	Aggreg
aggregate.delete.start	AggregateNotification	Aggreg
aggregate.remove_host.end	AggregateNotification	Aggreg
aggregate.remove_host.start	AggregateNotification	Aggreg
aggregate.update_metadata.end	AggregateNotification	Aggreg
aggregate.update_metadata.start	AggregateNotification	Aggreg
aggregate.update_prop.end	AggregateNotification	Aggreg
aggregate.update_prop.start	AggregateNotification	Aggreg
compute_task.build_instances.error	ComputeTaskNotification	Comput
compute_task.migrate_server.error	ComputeTaskNotification	Comput
compute_task.rebuild_server.error	ComputeTaskNotification	Comput
compute.exception	ExceptionNotification	Except
flavor.create	FlavorNotification	Flavor
flavor.delete	FlavorNotification	Flavor
flavor.update	FlavorNotification	Flavor
instance.delete.end	InstanceActionNotification	Instan
instance.delete.start	InstanceActionNotification	Instan
instance.evacuate	InstanceActionNotification	Instan
instance.interface_attach.end	InstanceActionNotification	Instan
instance.interface_attach.error	InstanceActionNotification	Instan
instance.interface_attach.start	InstanceActionNotification	Instan
instance.interface_detach.end	InstanceActionNotification	Instan
instance.interface_detach.start	InstanceActionNotification	Instan
instance.live_migration_abort.end	InstanceActionNotification	Instan
instance.live_migration_abort.start	InstanceActionNotification	Instan
instance.live_migration_force_complete.end	InstanceActionNotification	Instan
instance.live_migration_force_complete.start	InstanceActionNotification	Instan
instance.live_migration_post.end	InstanceActionNotification	Instan
instance.live_migration_post.start	InstanceActionNotification	Instan
instance.live_migration_post_dest.end	InstanceActionNotification	Instan
instance.live_migration_post_dest.start	InstanceActionNotification	Instan
instance.live_migration_pre.end	InstanceActionNotification	Instan
instance.live_migration_pre.start	InstanceActionNotification	Instan
instance.live_migration_rollback.end	InstanceActionNotification	Instan
instance.live_migration_rollback.start	InstanceActionNotification	Instan
instance.live_migration_rollback_dest.end	InstanceActionNotification	Instan
instance.live_migration_rollback_dest.start	InstanceActionNotification	Instan
instance.lock	InstanceActionNotification	Instan
instance.pause.end	InstanceActionNotification	Instan
instance.pause.start	InstanceActionNotification	Instan
instance.power_off.end	InstanceActionNotification	Instan
instance.power_off.start	InstanceActionNotification	Instan
instance.power_on.end	InstanceActionNotification	Instan
instance.power_on.start	InstanceActionNotification	Instan
instance.power_on_share.end	InstanceActionNotification	Instan
instance.power_on_share.start	InstanceActionNotification	Instan
instance.reboot.end	InstanceActionNotification	Instan

Table 2 – continued from previous page

instance.reboot.error	InstanceActionNotification	Instan
instance.reboot.start	InstanceActionNotification	Instan
instance.resize.end	InstanceActionNotification	Instan
instance.resize.error	InstanceActionNotification	Instan
instance.resize.start	InstanceActionNotification	Instan
instance.resize_confirm.end	InstanceActionNotification	Instan
instance.resize_confirm.start	InstanceActionNotification	Instan
instance.resize_finish.end	InstanceActionNotification	Instan
instance.resize_finish.start	InstanceActionNotification	Instan
instance.resize_revert.end	InstanceActionNotification	Instan
instance.resize_revert.start	InstanceActionNotification	Instan
instance.restore.end	InstanceActionNotification	Instan
instance.restore.start	InstanceActionNotification	Instan
instance.resume.end	InstanceActionNotification	Instan
instance.resume.start	InstanceActionNotification	Instan
instance.shelve.end	InstanceActionNotification	Instan
instance.shelve.start	InstanceActionNotification	Instan
instance.shelve_offload.end	InstanceActionNotification	Instan
instance.shelve_offload.start	InstanceActionNotification	Instan
instance.shutdown.end	InstanceActionNotification	Instan
instance.shutdown.start	InstanceActionNotification	Instan
instance.soft_delete.end	InstanceActionNotification	Instan
instance.soft_delete.start	InstanceActionNotification	Instan
instance.suspend.end	InstanceActionNotification	Instan
instance.suspend.start	InstanceActionNotification	Instan
instance.trigger_crash_dump.end	InstanceActionNotification	Instan
instance.trigger_crash_dump.start	InstanceActionNotification	Instan
instance.unlock	InstanceActionNotification	Instan
instance.unpause.end	InstanceActionNotification	Instan
instance.unpause.start	InstanceActionNotification	Instan
instance.unrescue.end	InstanceActionNotification	Instan
instance.unrescue.start	InstanceActionNotification	Instan
instance.unshelve.end	InstanceActionNotification	Instan
instance.unshelve.start	InstanceActionNotification	Instan
instance.rebuild.end	InstanceActionRebuildNotification	Instan
instance.rebuild.error	InstanceActionRebuildNotification	Instan
instance.rebuild.start	InstanceActionRebuildNotification	Instan
instance.rebuild_scheduled	InstanceActionRebuildNotification	Instan
instance.rescue.end	InstanceActionRescueNotification	Instan
instance.rescue.start	InstanceActionRescueNotification	Instan
instance.resize_prep.end	InstanceActionResizePrepNotification	Instan
instance.resize_prep.start	InstanceActionResizePrepNotification	Instan
instance.share_attach.end	InstanceActionShareNotification	Instan
instance.share_attach.error	InstanceActionShareNotification	Instan
instance.share_attach.start	InstanceActionShareNotification	Instan
instance.share_detach.end	InstanceActionShareNotification	Instan
instance.share_detach.error	InstanceActionShareNotification	Instan
instance.share_detach.start	InstanceActionShareNotification	Instan
instance.snapshot.end	InstanceActionSnapshotNotification	Instan

Table 2 – continued from previous page

instance.snapshot.start	InstanceActionSnapshotNotification	Instan
instance.volume_attach.end	InstanceActionVolumeNotification	Instan
instance.volume_attach.error	InstanceActionVolumeNotification	Instan
instance.volume_attach.start	InstanceActionVolumeNotification	Instan
instance.volume_detach.end	InstanceActionVolumeNotification	Instan
instance.volume_detach.start	InstanceActionVolumeNotification	Instan
instance.volume_swap.end	InstanceActionVolumeSwapNotification	Instan
instance.volume_swap.error	InstanceActionVolumeSwapNotification	Instan
instance.volume_swap.start	InstanceActionVolumeSwapNotification	Instan
instance.create.end	InstanceCreateNotification	Instan
instance.create.error	InstanceCreateNotification	Instan
instance.create.start	InstanceCreateNotification	Instan
instance.exists	InstanceExistsNotification	Instan
instance.update	InstanceUpdateNotification	Instan
keypair.create.end	KeypairNotification	Keypai
keypair.create.start	KeypairNotification	Keypai
keypair.delete.end	KeypairNotification	Keypai
keypair.delete.start	KeypairNotification	Keypai
keypair.import.end	KeypairNotification	Keypai
keypair.import.start	KeypairNotification	Keypai
libvirt.connect.error	LibvirtErrorNotification	Libvir
metrics.update	MetricsNotification	Metric
scheduler.select_destinations.end	SelectDestinationsNotification	Reques
scheduler.select_destinations.start	SelectDestinationsNotification	Reques
server_group.add_member	ServerGroupNotification	Server
server_group.create	ServerGroupNotification	Server
server_group.delete	ServerGroupNotification	Server
service.create	ServiceStatusNotification	Servic
service.delete	ServiceStatusNotification	Servic
service.update	ServiceStatusNotification	Servic
volume.usage	VolumeUsageNotification	Volume

4.2.1.9 Database migrations

Note

This document details how to generate database migrations as part of a new feature or bugfix. For info on how to apply existing database migrations, refer to the documentation for the **nova-manage db sync** and **nova-manage api_db sync** commands in *nova-manage*. For info on the general upgrade process for a nova deployment, refer to *Upgrades*.

A typical nova deployments consists of an API database and one or more cell-specific main databases. Occasionally these databases will require schema or data migrations.

Schema migrations

Changed in version 24.0.0: (Xena)

The database migration engine was changed from `sqlalchemy-migrate` to `alembic`.

Changed in version 28.0.0: (Bobcat)

The legacy `sqlalchemy-migrate`-based database migrations were removed.

The alembic database migration tool is used to manage schema migrations in nova. The migration files and related metadata can be found in `nova/db/api/migrations` (for the API database) and `nova/db/main/migrations` (for the main database(s)). As discussed in *Upgrades*, these can be run by end users using the **`nova-manage api_db sync`** and **`nova-manage db sync`** commands, respectively.

Note

There were also legacy migrations provided in the `legacy_migrations` subdirectory for both the API and main databases. These were provided to facilitate upgrades from pre-Xena (24.0.0) deployments. They were removed in the 28.0.0 (Bobcat) release.

The best reference for alembic is the alembic documentation, but a small example is provided here. You can create the migration either manually or automatically. Manual generation might be necessary for some corner cases such as renamed tables but auto-generation will typically handle your issues. Examples of both are provided below. In both examples, were going to demonstrate how you could add a new model, `Foo`, to the main database.

```
diff --git nova/db/main/models.py nova/db/main/models.py
index 7eab643e14..8f70bcdaca 100644
--- nova/db/main/models.py
+++ nova/db/main/models.py
@@ -73,6 +73,16 @@ def MediumText():
         sqlalchemy.dialects.mysql.MEDIUMTEXT(), 'mysql')


+class Foo(BASE, models.SoftDeleteMixin):
+    """A test-only model."""
+
+    __tablename__ = 'foo'
+
+    id = sa.Column(sa.Integer, primary_key=True)
+    uuid = sa.Column(sa.String(36), nullable=True)
+    bar = sa.Column(sa.String(255))
+
+
 class Service(BASE, models.SoftDeleteMixin):
     """Represents a running service on a host."""
```

(you might not be able to apply the diff above cleanly - this is just a demo).

Auto-generating migration scripts

In order for alembic to compare the migrations with the underlying models, it require a database that it can inspect and compare the models against. As such, we first need to create a working database. Well bypass `nova-manage` for this and go straight to the **`alembic`** CLI. The `alembic.ini` file provided in the `migrations` directories for both databases is helpfully configured to use an SQLite database by default (`nova.db` for the main database and `nova_api.db` for the API database). Create this database and apply the current schema, as dictated by the current migration scripts:

```
$ tox -e venv -- alembic -c nova/db/main/alembic.ini \
    upgrade head
```

Once done, you should notice the new `nova.db` file in the root of the repo. Now, lets generate the new revision:

```
$ tox -e venv -- alembic -c nova/db/main/alembic.ini \
    revision -m "Add foo model" --autogenerate
```

This will create a new file in `nova/db/main/migrations` with `add_foo_model` in the name including (hopefully!) the necessary changes to add the new `Foo` model. You **must** inspect this file once created, since theres a chance youll be missing imports or something else which will need to be manually corrected. Once youve inspected this file and made any required changes, you can apply the migration and make sure it works:

```
$ tox -e venv -- alembic -c nova/db/main/alembic.ini \
    upgrade head
```

Manually generating migration scripts

For trickier migrations or things that alembic doesnt understand, you may need to manually create a migration script. This is very similar to the auto-generation step, with the exception being that you dont need to have a database in place beforehand. As such, you can simply run:

```
$ tox -e venv -- alembic -c nova/db/main/alembic.ini \
    revision -m "Add foo model"
```

As before, this will create a new file in `nova/db/main/migrations` with `add_foo_model` in the name. You can simply modify this to make whatever changes are necessary. Once done, you can apply the migration and make sure it works:

```
$ tox -e venv -- alembic -c nova/db/main/alembic.ini \
    upgrade head
```

Data migrations

As discussed in *Upgrades*, online data migrations occur in two places:

- Inline migrations that occur as part of normal run-time activity as data is read in the old format and written in the new format.
- Background online migrations that are performed using `nova-manage` to complete transformations that will not occur incidentally due to normal runtime activity.

Inline data migrations

Inline data migrations are arguably the easier of the two to implement. Almost all of novas database models correspond to an oslo.versionedobject (o.vo) or part of one. These o.vos load their data from the underlying database by implementing the `obj_load_attr` method. By modifying this method, its possible to detect missing changes to the data - for example, a missing field - modify the data, save it back to the database, and finally return an object with the newly updated data. Change I6cd206542fdd28f3ef551dcc727f4cb35a53f6a3 provides a fully worked example of this approach.

The main advantage of these is that they are completely transparent to the operator who does not have to take any additional steps to upgrade their deployment: the database updates should happen at runtime as data is pulled from the database. The main disadvantage of this approach is that some records may not be frequently pulled from the database, meaning they never have a chance to get updated. This can prevent the eventual removal of the inline migration in a future release. To avoid this issue, you should inspect the object to see if its something that will be loaded as part of a standard runtime operation - for example, on startup or as part of a background task - and if necessary add a blocking online migration in a later release to catch and migrate the laggards.

Online data migrations

Unlike inline data migrations, online data migrations require operator involvement. They are run using the `nova-manage db online_data_migrations` command which, as noted in *nova-manage*, this should be run straight after upgrading to a new release once the database schema migrations have been applied and the code updated. Online migrations can be blocking, in that it will be necessary to apply given migrations while running N code before upgrading to N+1. Change I44919422c48570f2647f2325ff895255fc2adf27 provides a fully worked example of this approach.

The advantages and disadvantages of this approach are the inverse of those of the inline data migrations approach. While they can be used to ensure an data migration is actually applied, they require operator involvement and can prevent upgrades until fully applied.

4.2.1.10 ComputeDriver.update_provider_tree

This provides details on the `ComputeDriver` abstract method `update_provider_tree` for developers implementing this method in their own virt drivers.

Background

In the movement towards using placement for scheduling and resource management, the virt driver method `get_available_resource` was initially superseded by `get_inventory` (now gone), whereby the driver could specify its inventory in terms understood by placement. In Queens, a `get_traits` driver method was added. But `get_inventory` was limited to expressing only inventory (not traits or aggregates). And both of these methods were limited to the resource provider corresponding to the compute node.

Developments such as Nested Resource Providers necessitate the ability for the virt driver to have deeper control over what the resource tracker configures in placement on behalf of the compute node. This need is filled by the virt driver method `update_provider_tree` and its consumption by the resource tracker, allowing full control over the placement representation of the compute node and its associated providers.

The Method

`update_provider_tree` accepts the following parameters:

- A `nova.compute.provider_tree.ProviderTree` object representing all the providers in the tree associated with the compute node, and any sharing providers (those with the `MISC_SHARES_VIA_AGGREGATE` trait) associated via aggregate with any of those providers (but not *their* tree- or aggregate-associated providers), as currently known by placement. This object is fully owned by the `update_provider_tree` method, and can therefore be modified without locking/concurrency considerations. In other words, the parameter is passed *by reference* with the expectation that the virt driver will modify the object. Note, however, that it may contain providers not directly owned/controlled by the compute host. Care must be taken not to remove or modify such providers inadvertently. In addition, providers may be associated with traits and/or aggregates maintained by outside agents. The `update_provider_tree` method must therefore also be careful only to add/remove traits/aggregates it explicitly controls.
- String name of the compute node (i.e. `ComputeNode.hypervisor_hostname`) for which the caller is requesting updated provider information. Drivers may use this to help identify the compute node provider in the ProviderTree. Drivers managing more than one node (e.g. ironic) may also use it as a cue to indicate which node is being processed by the caller.
- Dictionary of `allocations` data of the form:

```
{ $CONSUMER_UUID: {
      # The shape of each "allocations" dict below is identical
      # to the return from GET /allocations/{consumer_uuid}
      "allocations": {
          $RP_UUID: {
              "generation": $RP_GEN,
              "resources": {
                  $RESOURCE_CLASS: $AMOUNT,
                  ...
              },
          },
          ...
      },
      "project_id": $PROJ_ID,
      "user_id": $USER_ID,
      "consumer_generation": $CONSUMER_GEN,
  },
  ...
}
```

  If `None`, and the method determines that any inventory needs to be moved (from one provider to another and/or to a different resource class), the `ReshapeNeeded` exception must be raised. Otherwise, this dict must be edited in place to indicate the desired final state of allocations. Drivers should *only* edit allocation records for providers whose inventories are being affected by the reshape operation. For more information about the reshape operation, refer to the spec.

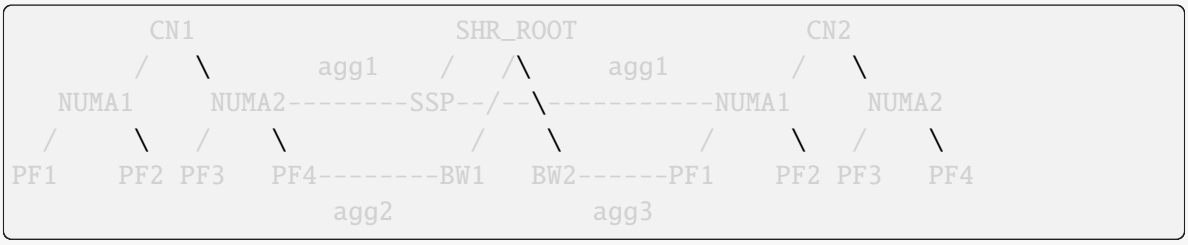
The virt driver is expected to update the ProviderTree object with current resource provider and inventory information. When the method returns, the ProviderTree should represent the correct hierarchy of nested resource providers associated with this compute node, as well as the inventory, aggregates, and traits associated with those resource providers.

Note

Despite the name, a ProviderTree instance may in fact contain more than one tree. For purposes of this specification, the ProviderTree passed to `update_provider_tree` will contain:

- the entire tree associated with the compute node; and
- any sharing providers (those with the `MISC_SHARES_VIA_AGGREGATE` trait) which are associated via aggregate with any of the providers in the compute nodes tree. The sharing providers will be presented as lone roots in the ProviderTree, even if they happen to be part of a tree themselves.

Consider the example below. `SSP` is a shared storage provider and `BW1` and `BW2` are shared bandwidth providers; all three have the `MISC_SHARES_VIA_AGGREGATE` trait:



When `update_provider_tree` is invoked for `CN1`, it is passed a ProviderTree containing:

Driver implementations of `update_provider_tree` are expected to use public `ProviderTree` methods to effect changes to the provider tree passed in. Some of the methods which may be useful are as follows:

- `new_root`: Add a new root provider to the tree.
- `new_child`: Add a new child under an existing provider.
- `data`: Access information (name, UUID, parent, inventory, traits, aggregates) about a provider in the tree.
- `remove`: Remove a provider **and its descendants** from the tree. Use caution in multiple-ownership scenarios.
- `update_inventory`: Set the inventory for a provider.
- `add_traits`, `remove_traits`: Set/unset virt-owned traits for a provider.
- `add_aggregates`, `remove_aggregates`: Set/unset virt-owned aggregate associations for a provider.

Note

There is no supported mechanism for `update_provider_tree` to effect changes to allocations. This is intentional: in Nova, allocations are managed exclusively outside of virt. (Usually by the scheduler;

sometimes - e.g. for migrations - by the conductor.)

Porting from get_inventory

Virt driver developers wishing to move from `get_inventory` to `update_provider_tree` should use the `ProviderTree.update_inventory` method, specifying the compute node as the provider and the same inventory as returned by `get_inventory`. For example:

```
def get_inventory(self, nodename):
    inv_data = {
        'VCPU': { ... },
        'MEMORY_MB': { ... },
        'DISK_GB': { ... },
    }
    return inv_data
```

would become:

```
def update_provider_tree(self, provider_tree, nodename, allocations=None):
    inv_data = {
        'VCPU': { ... },
        'MEMORY_MB': { ... },
        'DISK_GB': { ... },
    }
    provider_tree.update_inventory(nodename, inv_data)
```

When reporting inventory for the standard resource classes `VCPU`, `MEMORY_MB` and `DISK_GB`, implementers of `update_provider_tree` may need to set the `allocation_ratio` and `reserved` values in the `inv_data` dict based on configuration to reflect changes on the compute for allocation ratios and reserved resource amounts back to the placement service.

Porting from get_traits

To replace `get_traits`, developers should use the `ProviderTree.add_traits` method, specifying the compute node as the provider and the same traits as returned by `get_traits`. For example:

```
def get_traits(self, nodename):
    traits = ['HW_CPU_X86_AVX', 'HW_CPU_X86_AVX2', 'CUSTOM_GOLD']
    return traits
```

would become:

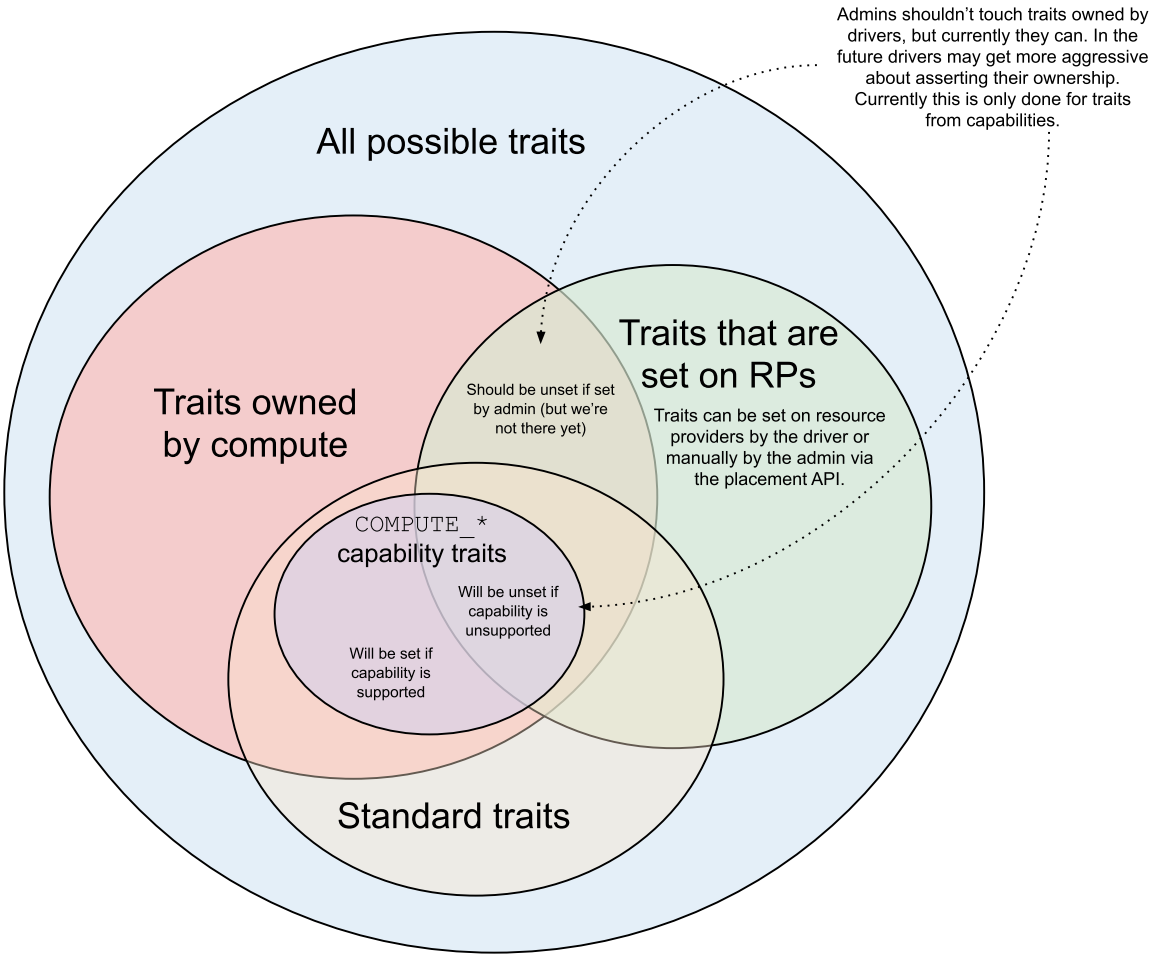
```
def update_provider_tree(self, provider_tree, nodename, allocations=None):
    provider_tree.add_traits(
        nodename, 'HW_CPU_X86_AVX', 'HW_CPU_X86_AVX2', 'CUSTOM_GOLD')
```

Taxonomy of traits and capabilities

There are various types of traits:

- Some are standard (registered in os-traits); others are custom.
- Some are owned by the compute service; others can be managed by operators.
- Some come from driver-supported capabilities, via a mechanism which was introduced to convert them to standard traits on the compute node resource provider. This mechanism is *documented in the configuration guide*.

This diagram may shed further light on how these traits relate to each other and how they are managed.



4.2.1.11 Upgrade checks

Note

This document details how to generate upgrade checks as part of a new feature or bugfix. For info on how to apply existing upgrade checks, refer to the documentation for the **`nova-status`** command in *nova-status*. For info on the general upgrade process for a nova deployment, refer to *Upgrades*.

Nova provides automated *upgrade check tooling* to assist deployment tools in verifying critical parts of the deployment, especially when it comes to major changes during upgrades that require operator

intervention.

This guide covers the background on novas upgrade check tooling, how it is used, and what to look for in writing new checks.

Background

Nova has historically supported offline database schema migrations (**nova-manage db sync** and **nova-manage api_db sync**) and online data migrations (**nova-manage db online_data_migrations**) during upgrades, as discussed in *Database migrations*. The **nova-status upgrade check** command was introduced in the 15.0.0 (Ocata) release to aid in the verification of two major required changes in that release, namely Placement and Cells v2.

Integration with the Placement service and deploying Cells v2 was optional starting in the 14.0.0 Newton release and made required in the Ocata release. The nova team working on these changes knew that there were required deployment changes to successfully upgrade to Ocata. In addition, the required deployment changes were not things that could simply be verified in a database migration script, e.g. a migration script should not make REST API calls to Placement.

So `nova-status upgrade check` was written to provide an automated pre-flight check to verify that required deployment steps were performed prior to upgrading to Ocata.

Reference the Ocata changes for implementation details.

Guidelines

- The checks should be able to run within a virtual environment or container. All that is required is a full configuration file, similar to running other `nova-manage` type administration commands. In the case of nova, this means having `api_database`, `placement`, etc sections configured.
- Candidates for automated upgrade checks are things in a projects upgrade release notes which can be verified via the database. For example, when upgrading to Cells v2 in Ocata, one required step was creating cell mappings for `cell0` and `cell1`. This can easily be verified by checking the contents of the `cell_mappings` table in the `nova_api` database.
- Checks will query the database(s) and potentially REST APIs (depending on the check) but should not expect to run RPC calls. For example, a check should not require that the `nova-compute` service is running on a particular host.
- Checks are typically meant to be run before re-starting and upgrading to new service code, which is how grenade uses them, but they can also be run as a *post-install verify step* which is how openstack-ansible also uses them. The high-level set of upgrade steps for upgrading nova in grenade is:
  - Install new code
  - Sync the database schema for new models (`nova-manage api_db sync`; `nova-manage db sync`)
  - Run the online data migrations (`nova-manage db online_data_migrations`)
  - Run the upgrade check (`nova-status upgrade check`)
  - Restart services with new code
- Checks must be idempotent so they can be run repeatedly and the results are always based on the latest data. This allows an operator to run the checks, fix any issues reported, and then iterate until the status check no longer reports any issues.

- Checks which cannot easily, or should not, be run within offline database migrations are a good candidate for these CLI-driven checks. For example, `instances` records are in the cell database and for each instance there should be a corresponding `request_specs` table entry in the `nova_api` database. A `nova-manage db online_data_migrations` routine was added in the Newton release to back-fill request specs for existing instances, and in Rocky an upgrade check was added to make sure all non-deleted instances have a request spec so compatibility code can be removed in Stein. In older releases of nova we would have added a blocker migration as part of the database schema migrations to make sure the online data migrations had been completed before the upgrade could proceed.

  Note

  Usage of `nova-status upgrade check` does not preclude the need for blocker migrations within a given database, but in the case of request specs the check spans multiple databases and was a better fit for the `nova-status` tooling.

- All checks should have an accompanying upgrade release note.

Structure

There is no graph logic for checks, meaning each check is meant to be run independently of other checks in the same set. For example, a project could have five checks which run serially but that does not mean the second check in the set depends on the results of the first check in the set, or the third check depends on the second, and so on.

The base framework is fairly simple as can be seen from the initial change. Each check is registered in the `_upgrade_checks` variable and the `check` method executes each check and records the result. The most severe result is recorded for the final return code.

There are one of three possible results per check:

- `Success`: All upgrade readiness checks passed successfully and there is nothing to do.
- `Warning`: At least one check encountered an issue and requires further investigation. This is considered a warning but the upgrade may be OK.
- `Failure`: There was an upgrade status check failure that needs to be investigated. This should be considered something that stops an upgrade.

The `UpgradeCheckResult` object provides for adding details when there is a warning or failure result which generally should refer to how to resolve the failure, e.g. maybe `nova-manage db online_data_migrations` is incomplete and needs to be run again.

Using the cells v2 check as an example, there are really two checks involved:

1. Do the cell0 and cell1 mappings exist?
2. Do host mappings exist in the API database if there are compute node records in the cell database?

Failing either check results in a `Failure` status for that check and return code of `2` for the overall run.

The initial placement check provides an example of a warning response. In that check, if there are fewer resource providers in Placement than there are compute nodes in the cell database(s), the deployment may be underutilized because the `nova-scheduler` is using the Placement service to determine candidate hosts for scheduling.

Warning results are good for cases where scenarios are known to run through a rolling upgrade process, e.g. `nova-compute` being configured to report resource provider information into the Placement service. These are things that should be investigated and completed at some point, but might not cause any immediate failures.

The results feed into a standard output for the checks:

```
$ nova-status upgrade check
+-----------------------------------------------------+
| Upgrade Check Results                               |
+-----------------------------------------------------+
| Check: Cells v2                                     |
| Result: Success                                     |
| Details: None                                       |
+-----------------------------------------------------+
| Check: Placement API                                |
| Result: Failure                                     |
| Details: There is no placement-api endpoint in the |
|          service catalog.                           |
+-----------------------------------------------------+
```

FAQs

- How is the `nova-status` upgrade script packaged and deployed?

  There is a `console_scripts` entry for `nova-status` in the `setup.cfg` file.

- Why are there multiple parts to the command structure, i.e. upgrade and check?

  This is an artifact of how the `nova-manage` command is structured which has categories of sub-commands, like `nova-manage db` is a sub-category made up of other sub-commands like `nova-manage db sync`. The `nova-status upgrade check` command was written in the same way for consistency and extensibility if other sub-commands need to be added later.

- Why is the upgrade check command not part of the standard python-*client CLIs?

  The `nova-status` command was modeled after the `nova-manage` command which is meant to be admin-only and has direct access to the database, unlike other CLI packages like python-novaclient which requires a token and communicates with nova over the REST API. Because of this, it is also possible to write commands in `nova-manage` and `nova-status` that can work while the API service is down for maintenance.

- How should the checks be documented?

  Each check should be documented in the *history section* of the CLI guide and have a release note. This is important since the checks can be run in an isolated environment apart from the actual deployed version of the code and since the checks should be idempotent, the history / change log is good for knowing what is being validated.

- Do other projects support upgrade checks?

  A community-wide goal for the Stein release is adding the same type of `$PROJECT-status upgrade check` tooling to other projects to ease in upgrading OpenStack across the board. So while the guidelines in this document are primarily specific to nova, they should apply generically to other projects wishing to incorporate the same tooling.

- Where should the documentation live for projects other than nova?

  As part of the standard OpenStack project documentation guidelines the command should be documented under `doc/source/cli` in each project repo.

- Can upgrade checks be backported?

  Sometimes upgrade checks can be backported to aid in preempting bugs on stable branches. For example, a check was added for bug 1759316 in Rocky which was also backported to stable/queens in case anyone upgrading from Pike to Queens would hit the same issue. Backportable checks are generally only made for latent bugs since someone who has already passed checks and upgraded to a given stable branch should not start failing after a patch release on that same branch. For this reason, any check being backported should have a release note with it.

- Can upgrade checks only be for N-1 to N version upgrades?

  No, not necessarily. The upgrade checks are also an essential part of fast-forward upgrades to make sure that as you roll through each release performing schema (data model) updates and data migrations that you are also completing all of the necessary changes. For example, if you are fast forward upgrading from Ocata to Rocky, something could have been added, deprecated or removed in Pike or Queens and a pre-upgrade check is a way to make sure the necessary steps were taking while upgrading through those releases before restarting the Rocky code at the end.

4.2.1.12 Conductor as a place for orchestrating tasks

In addition to its roles as a database proxy and object backporter the conductor service also serves as a centralized place to manage the execution of workflows which involve the scheduler. Rebuild, resize/migrate, and building an instance are managed here. This was done in order to have a better separation of responsibilities between what compute nodes should handle and what the scheduler should handle, and to clean up the path of execution. Conductor was chosen because in order to query the scheduler in a synchronous manner it needed to happen after the API had returned a response otherwise API response times would increase. And changing the scheduler call from asynchronous to synchronous helped to clean up the code.

To illustrate this the old process for building an instance was:

- API receives request to build an instance.
- API sends an RPC cast to the scheduler to pick a compute.
- Scheduler sends an RPC cast to the compute to build the instance, which means the scheduler needs to be able to communicate with all computes.
  - If the build succeeds it stops here.
  - If the build fails then the compute decides if the max number of scheduler retries has been hit. If so the build stops there.
    - If the build should be rescheduled the compute sends an RPC cast to the scheduler in order to pick another compute.

This was overly complicated and meant that the logic for scheduling/rescheduling was distributed throughout the code. The answer to this was to change to process to be the following:

- API receives request to build an instance.
- API sends an RPC cast to the conductor to build an instance. (or runs locally if conductor is configured to use local_mode)

- Conductor sends an RPC call to the scheduler to pick a compute and waits for the response. If there is a scheduler fail it stops the build at the conductor.
- Conductor sends an RPC cast to the compute to build the instance.
  - If the build succeeds it stops here.
  - If the build fails then compute sends an RPC cast to conductor to build an instance. This is the same RPC message that was sent by the API.

This new process means the scheduler only deals with scheduling, the compute only deals with building an instance, and the conductor manages the workflow. The code is now cleaner in the scheduler and computes.

4.2.1.13 Filtering hosts by isolating aggregates

Background

I want to set up an aggregate `ABC` with hosts that allow you to run only certain licensed images. I could tag the aggregate with metadata such as `<LICENSED=WINDOWS>`. Then if I boot an instance with an image containing the property `<LICENSED=WINDOWS>`, it will land on one of the hosts in aggregate `ABC`. But if the user creates a new image which does not include `<LICENSED=WINDOWS>` metadata, an instance booted with that image could still land on a host in aggregate `ABC` as reported in launchpad bug 1677217. The *AggregateImagePropertiesIsolation* scheduler filter passes even though the aggregate metadata `<LICENSED=WINDOWS>` is not present in the image properties.

Solution

The above problem is addressed by blueprint placement-req-filter-forbidden-aggregates which was implemented in the 20.0.0 Train release.

The following example assumes you have configured aggregate `ABC` and added hosts `HOST1` and `HOST2` to it in Nova, and that you want to isolate those hosts to run only instances requiring Windows licensing.

1. Set the *scheduler.enable_isolated_aggregate_filtering* config option to `true` in nova.conf and restart the nova-scheduler service.
2. Add trait `CUSTOM_LICENSED_WINDOWS` to the resource providers for `HOST1` and `HOST2` in the Placement service.

   First create the `CUSTOM_LICENSED_WINDOWS` trait

   ```
   # openstack --os-placement-api-version 1.6 trait create CUSTOM_LICENSED_
   ↪WINDOWS
   ```

   Assume `<HOST1_UUID>` is the UUID of `HOST1`, which is the same as its resource provider UUID.

   Start to build the command line by first collecting existing traits for `HOST1`

   ```
   # traits=$(openstack --os-placement-api-version 1.6 resource provider␣
   ↪trait list -f value <HOST1_UUID> | sed 's/^/--trait /')
   ```

   Replace `HOST1`s traits, adding `CUSTOM_LICENSED_WINDOWS`

   ```
   # openstack --os-placement-api-version 1.6 resource provider trait set
   ↪$traits --trait CUSTOM_LICENSED_WINDOWS <HOST1_UUID>
   ```

Repeat the above steps for HOST2.

3. Add the trait:CUSTOM_LICENSED_WINDOWS=required metadata property to aggregate ABC.

```
# openstack --os-compute-api-version 2.53 aggregate set --property␣
↪trait:CUSTOM_LICENSED_WINDOWS=required ABC
```

As before, any instance spawned with a flavor or image containing trait:CUSTOM_LICENSED_WINDOWS=required will land on HOST1 or HOST2 because those hosts expose that trait.

However, now that the isolate_aggregates request filter is configured, any instance whose flavor or image **does not** contain trait:CUSTOM_LICENSED_WINDOWS=required will **not** land on HOST1 or HOST2 because aggregate ABC requires that trait.

The above example uses a CUSTOM_LICENSED_WINDOWS trait, but you can use any custom or standard trait in a similar fashion.

The filter supports the use of multiple traits across multiple aggregates. The combination of flavor and image metadata must require **all** of the traits configured on the aggregate in order to pass.

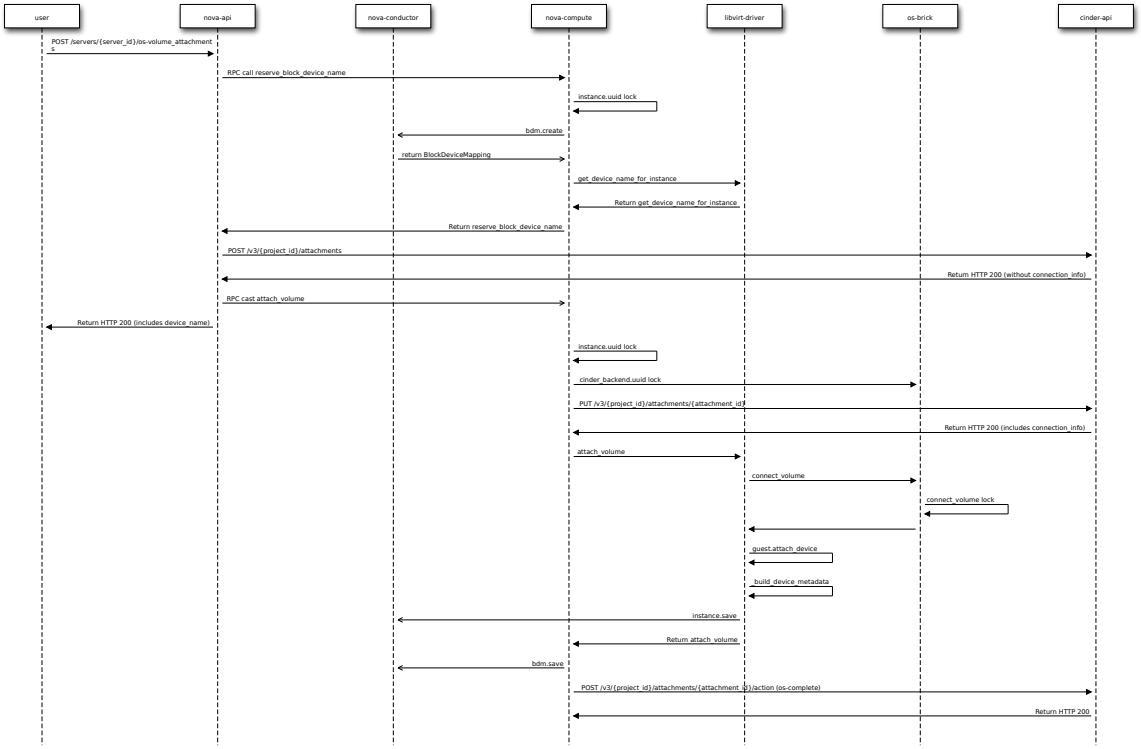
4.2.1.14 Attaching Volumes

The following sequence diagram outlines the current flow when attaching a volume to an instance using the os-volume_attachments API. This diagram uses the libvirt driver as an example virt driver to additionally document the optional interactions with the os-brick library on the compute hosts during the request.

Note

os-brick is not always used to connect volumes to the host, most notably when connecting an instance natively to ceph rbd volumes

The diagram also outlines the various locks taken on the compute during the attach volume flow. In this example these include locks against the instance.uuid, cinder_backend.uuid orchestrated for nova-compute by os-brick and the generic connect_volume lock taken within os-brick itself. This final connect_volume lock also being held when detaching and disconnecting a volume from the host by os-brick.



4.2.1.15 Driver BDM Data Structures

In addition to the *API BDM data format* there are also several internal data structures within Nova that map out how block devices are attached to instances. This document aims to outline the two general data structures and two additional specific data structures used by the libvirt virt driver.

Note

This document is based on an email to the openstack-dev mailing list by Matthew Booth below provided as a primer for developers working on virt drivers and interacting with these data structures.

http://lists.openstack.org/pipermail/openstack-dev/2016-June/097529.html

Note

References to local disks in the following document refer to any disk directly managed by nova compute. If nova is configured to use RBD or NFS for instance disks then these disks wont actually be local, but they are still managed locally and referred to as local disks. As opposed to RBD volumes provided by Cinder that are not considered local.

Generic BDM data structures

`BlockDeviceMapping`

The top level data structure is the `BlockDeviceMapping` (BDM) object. It is a `NovaObject`, persisted in the DB. Current code creates a BDM object for every disk associated with an instance, whether it is a volume or not.

The BDM object describes properties of each disk as specified by the user. It is initially from a user

request, for more details on the format of these requests please see the *Block Device Mapping in Nova* document.

The Compute API transforms and consolidates all BDMs to ensure that all disks, explicit or implicit, have a BDM, and then persists them. Look in `nova.objects.block_device` for all BDM fields, but in essence they contain information like (source_type=image, destination_type=local, image_id=<image uuid>), or equivalents describing ephemeral disks, swap disks or volumes, and some associated data.

Note

BDM objects are typically stored in variables called `bdm` with lists in `bdms`, although this is obviously not guaranteed (and unfortunately not always true: `bdm` in `libvirt.block_device` is usually a `DriverBlockDevice` object). This is a useful reading aid (except when its proactively confounding), as there is also something else typically called `block_device_mapping` which is not a `BlockDeviceMapping` object.

block_device_info

Changed in version 24.0.0: (Xena)

The legacy block_device_info format is no longer supported.

Drivers do not directly use BDM objects. Instead, they are transformed into a different driver-specific representation. This representation is normally called `block_device_info`, and is generated by `virt.driver.get_block_device_info()`. Its output is based on data in BDMs. `block_device_info` is a dict containing:

root_device_name
: Hypervisors notion of the root devices name

image
: An image backed disk if used

ephemerals
: A list of all ephemeral disks

block_device_mapping
: A list of all cinder volumes

swap
: A swap disk, or None if there is no swap disk

Note

The disks were previously represented in one of two ways, depending on the specific driver in use. A legacy plain dict format or the currently used DriverBlockDevice format discussed below. Support for the legacy format was removed in Xena.

Disks are represented by subclasses of `nova.block_device.DriverBlockDevice`. These subclasses retain a reference to the underlying BDM object. This means that by manipulating the `DriverBlockDevice` object, the driver is able to persist data to the BDM object in the DB.

Note

Common usage is to pull `block_device_mapping` out of this dict into a variable called `block_device_mapping`. This is not a `BlockDeviceMapping` object, or a list of them.

Note

If `block_device_info` was passed to the driver by compute manager, it was probably generated by `_get_instance_block_device_info()`. By default, this function filters out all cinder volumes from `block_device_mapping` which dont currently have `connection_info`. In other contexts this filtering will not have happened, and `block_device_mapping` will contain all volumes.

libvirt driver specific BDM data structures

`instance_disk_info`

The virt driver API defines a method `get_instance_disk_info`, which returns a JSON blob. The compute manager calls this and passes the data over RPC between calls without ever looking at it. This is driver-specific opaque data. It is also only used by the libvirt driver, despite being part of the API for all drivers. Other drivers do not return any data. The most interesting aspect of `instance_disk_info` is that it is generated from the libvirt XML, not from novas state.

Note

`instance_disk_info` is often named `disk_info` in code, which is unfortunate as this clashes with the normal naming of the next structure. Occasionally the two are used in the same block of code.

Note

RBD disks (including non-volume disks) and cinder volumes are not included in `instance_disk_info`.

`instance_disk_info` is a list of dicts for some of an instances disks. Each dict contains the following:

`type`
: libvirts notion of the disks type

`path`
: libvirts notion of the disks path

`virt_disk_size`
: The disks virtual size in bytes (the size the guest OS sees)

`backing_file`
: libvirts notion of the backing file path

`disk_size`
: The file size of path, in bytes.

`over_committed_disk_size`
: As-yet-unallocated disk size, in bytes.

disk_info

Note

As opposed to `instance_disk_info`, which is frequently called `disk_info`.

This data structure is actually described pretty well in the comment block at the top of `nova.virt.libvirt.blockinfo`. It is internal to the libvirt driver. It contains:

disk_bus
: The default bus used by disks

cdrom_bus
: The default bus used by cdrom drives

mapping
: Defined below

`mapping` is a dict which maps disk names to a dict describing how that disk should be passed to libvirt. This mapping contains every disk connected to the instance, both local and volumes.

First, a note on disk naming. Local disk names used by the libvirt driver are well defined. They are:

disk
: The root disk

disk.local
: The flavor-defined ephemeral disk

disk.ephX
: Where X is a zero-based index for BDM defined ephemeral disks

disk.swap
: The swap disk

disk.config
: The config disk

These names are hardcoded, reliable, and used in lots of places.

In `disk_info`, volumes are keyed by device name, eg vda, vdb. Different buses will be named differently, approximately according to legacy Linux device naming.

Additionally, `disk_info` will contain a mapping for root, which is the root disk. This will duplicate one of the other entries, either disk or a volume mapping.

Each dict within the `mapping` dict contains the following 3 required fields of bus, dev and type with two optional fields of format and `boot_index`:

bus:
: The guest bus type (ide, virtio, scsi, etc)

dev:
: The device name vda, hdc, sdf, xvde etc

type:
: Type of device eg disk, cdrom, floppy

format
Which format to apply to the device if applicable

boot_index
Number designating the boot order of the device

Note

`BlockDeviceMapping` and `DriverBlockDevice` store boot index zero-based. However, libvirts boot index is 1-based, so the value stored here is 1-based.

Todo

Add a section for the per disk `disk.info` file within instance directory when using the libvirt driver.

4.2.1.16 Libvirt virt driver OS distribution support matrix

This page documents the libvirt versions present in the various distro versions that OpenStack Nova aims to be deployable with.

Note

This document was previously hosted on the OpenStack wiki:

https://wiki.openstack.org/wiki/LibvirtDistroSupportMatrix

Libvirt minimum version change policy

At the start of each Nova development cycle this matrix will be consulted to determine if it is viable to drop support for any end-of-life or otherwise undesired distro versions. Based on this distro evaluation, it may be possible to increase the minimum required version of libvirt in Nova, and thus drop some compatibility code for older versions.

When a decision to update the minimum required libvirt version is made, there must be a warning issued for one cycle. This is achieved by editing `nova/virt/libvirt/driver.py` to set `NEXT_MIN_LIBVIRT_VERSION`. For example:

```
NEXT_MIN_LIBVIRT_VERSION = (X, Y, Z)
```

This causes a deprecation warning to be emitted when Nova starts up warning the admin that the version of libvirt in use on the host will no longer be supported in the subsequent release.

After a version has been listed in `NEXT_MIN_LIBVIRT_VERSION` for one release cycle, the corresponding actual minimum required libvirt can be updated by setting

```
MIN_LIBVIRT_VERSION = (X, Y, Z)
```

At this point of course, an even newer version might be set in `NEXT_MIN_LIBVIRT_VERSION` to repeat the process.

An email should also be sent at this point to the `openstack-discuss@lists.openstack.org` mailing list as a courtesy raising awareness of the change in minimum version requirements in the upcoming

release, for example:

http://lists.openstack.org/pipermail/openstack-discuss/2021-January/019849.html

There is more background on the rationale used for picking minimum versions in the operators mailing list thread here:

http://lists.openstack.org/pipermail/openstack-operators/2015-May/007012.html

QEMU minimum version change policy

After choosing a minimum libvirt version, the minimum QEMU version is determined by looking for the lowest QEMU version from all the distros that support the decided libvirt version.

`MIN_{LIBVIRT,QEMU}_VERSION` and `NEXT_MIN_{LIBVIRT,QEMU}_VERSION` table

Table 3: OpenStack Nova libvirt/QEMU Support Matrix

OpenStack Release	Nova Release	MIN_LIBVIRT_V	NEXT_MIN_LIBVIRT	MIN_QEMU_VE	NEXT_MIN_QEMU_VERSION
Havana	2013.2.0	0.9.6	0.9.6		
Icehouse	2014.1	0.9.6	0.9.11		
Juno	2014.2.0	0.9.11	0.9.11		
Kilo	2015.1.0	0.9.11	0.9.11		
Liberty	12.0.0	0.9.11	0.10.2		
Mitaka	13.0.0	0.10.2	1.2.1		
Newton	14.0.0	1.2.1	1.2.1	1.5.3	1.5.3
Ocata	15.0.0	1.2.1	1.2.9	1.5.3	2.1.0
Pike	16.0.0	1.2.9	1.3.1	2.1.0	2.5.0
Queens	17.0.0	1.2.9	1.3.1	2.1.0	2.5.0
Rocky	18.0.0	1.3.1	3.0.0	2.5.0	2.8.0
Stein	19.0.0	3.0.0	4.0.0	2.8.0	2.11.0
Train	20.0.0	3.0.0	4.0.0	2.8.0	2.11.0
Ussuri	21.0.0	4.0.0	5.0.0	2.11.0	4.0.0
Victoria	22.0.0	5.0.0	6.0.0	4.0.0	4.2.0
Wallaby	23.0.0	6.0.0	7.0.0	4.2.0	5.2.0
Xena	24.0.0	6.0.0	7.0.0	4.2.0	5.2.0
Yoga	25.0.0	6.0.0	7.0.0	4.2.0	5.2.0
Zed	26.0.0	6.0.0	7.0.0	4.2.0	5.2.0
2023.1 Antelope	27.0.0	6.0.0	7.0.0	4.2.0	5.2.0
2023.2 Bobcat	28.0.0	7.0.0	8.0.0	5.2.0	6.2.0
2024.1 Caracal	29.0.0	7.0.0	8.0.0	5.2.0	6.2.0
2024.2 Dalmatian	30.0.0	7.0.0	8.0.0	5.2.0	6.2.0
2025.1 Epoxy	31.0.0	8.0.0	10.0.0	6.2.0	8.2.2
2025.2 Flamingo	31.0.0	8.0.0	10.0.0	6.2.0	8.2.2

OS distribution versions

Warning

This section may become a bit outdated.

This table provides information on a representative sample of OS distros and the version of libvirt/QEMU/libguestfs that they ship. This is **NOT** intended to be an exhaustive list of distros where OpenStack Nova can run - it is intended to run on any Linux distro that can satisfy the minimum required software versions. This table merely aims to help identify when minimum required versions can be reasonably updated without losing support for important OS distros.

Table 4: Distro libvirt/QEMU Support Table

OS Distro	GA date	Libvirt	QEMU/KVM	libguestfs
CentOS Stream				
9	As of 2025-02-27.	10.10.0	9.1.0	1.50.1
Debian				
12.x (Bookworm) (oldstable)	2023-06-10	9.0.0	7.2	1.48.
13.x (Trixie) (stable)	2025-08-09	10.7.0	9.1.0	1.52.2
RHEL				
8.2	2020-04-28	6.0.0-17.2	4.2.0-19	1.40.2-22
8.3	2020-10-29	6.0.0-25.5	4.2.0-29	1.40.2-24
8.4	2021-05-18	7.0.0-8	5.2.0-10	1.44.0-2
8.5	2021-11-09	7.6.0-6	6.0.0-33	1.44.0-3
SLES				
15 (SP2)	2020	6.0.0	4.2.1	1.38.0
15 (SP3)	2021	7.1.0	5.2.0	1.38.0
Ubuntu				
20.04 (Focal Fossa LTS)	2020-04-23	6.0.0	4.2	1.40.2
21.04 (Hirsute Hippo)	2021-04-22	7.0.0	5.2	1.44.1
22.04 (Jammy Jellyfish)	2022-04-21	8.0.0	6.2	1.44.2
24.04 (Noble Numbat)	2024-04-25	10.0.0	8.2.2	1.52.0

4.2.2 Debugging

- *Guru Meditation Reports*: Inspired by Amiga, a way to trigger a very comprehensive dump of a running service for deep debugging.

4.2.2.1 Guru Meditation Reports

Nova contains a mechanism whereby developers and system administrators can generate a report about the state of a running Nova executable. This report is called a *Guru Meditation Report* (*GMR* for short).

Generating a GMR

A *GMR* can be generated by sending the *USR2* signal to any Nova process with support (see below). The *GMR* will then be outputted standard error for that particular process.

For example, suppose that `nova-compute` has process id `8675`, and was run with `2>/var/log/nova/nova-compute-err.log`. Then, `kill -USR2 8675` will trigger the Guru Meditation report to be

printed to `/var/log/nova/nova-compute-err.log`.

Nova API is commonly run under uWSGI, which intercepts `SIGUSR2` signals. In this case, a file trigger may be used instead:

```
[oslo_reports]
log_dir = /var/log/nova
file_event_handler = /var/log/nova/gmr_trigger
```

Whenever the trigger file is modified, a *GMR* will be generated. To get a report, one may use `touch /var/log/nova/gmr_trigger`. Note that the configured file trigger must exist when Nova starts.

If a log dir is specified, the report will be written to a file within that directory instead of `stderr`. The report file will be named `${serviceName}_gurumeditation_${timestamp}`.

Structure of a GMR

The *GMR* is designed to be extensible; any particular executable may add its own sections. However, the base *GMR* consists of several sections:

Package
: Shows information about the package to which this process belongs, including version information

Threads
: Shows stack traces and thread ids for each of the threads within this process

Green Threads
: Shows stack traces for each of the green threads within this process (green threads dont have thread ids)

Configuration
: Lists all the configuration options currently accessible via the CONF object for the current process

Adding Support for GMRs to New Executables

Adding support for a *GMR* to a given executable is fairly easy.

First import the module, as well as the Nova version module:

```
from oslo_reports import guru_meditation_report as gmr
from oslo_reports import opts as gmr_opts
from nova import version
```

Then, register any additional sections (optional):

```
gmr.TextGuruMeditation.register_section('Some Special Section',
                                        some_section_generator)
```

Finally (under main), before running the main loop of the executable (usually `service.server(server)` or something similar), register the *GMR* hook:

```
gmr_opts.set_defaults(CONF)
gmr.TextGuruMeditation.setup_autorun(
  version, conf=CONF, service_name=service_name)
```

The service name is used when generating report files. If unspecified, *GMR* tries to automatically detect the binary name using the stack trace but usually ends up with `thread.py`.

Extending the GMR

As mentioned above, additional sections can be added to the GMR for a particular executable. For more information, see the inline documentation under `oslo.reports`

4.2.3 Forward Looking Plans

The following section includes documents that describe the overall plan behind groups of nova-specs. Most of these cover items relating to the evolution of various parts of novas architecture. Once the work is complete, these documents will move into the Internals section.

If you want to get involved in shaping the future of novas architecture, these are a great place to start reading up on the current plans.

- *REST API Policy Enforcement*: How we want policy checks on API actions to work in the future
- *Nova Stable REST API*: What stable API means to nova
- *Scheduler Evolution*: Motivation behind the scheduler / placement evolution

4.2.3.1 REST API Policy Enforcement

The following describes some of the shortcomings in how policy is used and enforced in nova, along with some benefits of fixing those issues. Each issue has a section dedicated to describing the underlying cause and historical context in greater detail.

Problems with current system

The following is a list of issues with the existing policy enforcement system:

- *Testing default policies*
- *Mismatched authorization*
- *Inconsistent naming*
- *Incorporating default roles*
- *Compartmentalized policy enforcement*
- *Refactoring hard-coded permission checks*
- *Granular policy checks*

Addressing the list above helps operators by:

1. Providing them with flexible and useful defaults
2. Reducing the likelihood of writing and maintaining custom policies
3. Improving interoperability between deployments
4. Increasing RBAC confidence through first-class testing and verification
5. Reducing complexity by using consistent policy naming conventions
6. Exposing more functionality to end-users, safely, making the entire nova API more self-serviceable resulting in less operational overhead for operators to do things on behalf of users

Additionally, the following is a list of benefits to contributors:

1. Reduce developer maintenance and cost by isolating policy enforcement into a single layer
2. Reduce complexity by using consistent policy naming conventions
3. Increased confidence in RBAC refactoring through exhaustive testing that prevents regressions before they merge

Testing default policies

Testing default policies is important in protecting against authoritative regression. Authoritative regression is when a change accidentally allows someone to do something or see something they shouldnt. It can also be when a change accidentally restricts a user from doing something they used to have the authorization to perform. This testing is especially useful prior to refactoring large parts of the policy system. For example, this level of testing would be invaluable prior to pulling policy enforcement logic from the database layer up to the API layer.

Testing documentation exists that describes the process for developing these types of tests.

Mismatched authorization

The compute API is rich in functionality and has grown to manage both physical and virtual hardware. Some APIs were meant to assist operators while others were specific to end users. Historically, nova used project-scoped tokens to protect almost every API, regardless of the intended user. Using project-scoped tokens to authorize requests for system-level APIs makes for undesirable user-experience and is prone to overloading roles. For example, to prevent every user from accessing hardware level APIs that would otherwise violate tenancy requires operators to create a `system-admin` or `super-admin` role, then rewrite those system-level policies to incorporate that role. This means users with that special role on a project could access system-level resources that arent even tracked against projects (hypervisor information is an example of system-specific information.)

As of the Queens release, keystone supports a scope type dedicated to easing this problem, called system scope. Consuming system scope across the compute API results in fewer overloaded roles, less specialized authorization logic in code, and simpler policies that expose more functionality to users without violating tenancy. Please refer to keystones authorization scopes documentation to learn more about scopes and how to use them effectively.

Inconsistent naming

Inconsistent conventions for policy names are scattered across most OpenStack services, nova included. Recently, there was an effort that introduced a convention that factored in service names, resources, and use cases. This new convention is applicable to nova policy names. The convention is formally documented in oslo.policy and we can use policy deprecation tooling to gracefully rename policies.

Incorporating default roles

Up until the Rocky release, keystone only ensured a single role called `admin` was available to the deployment upon installation. In Rocky, this support was expanded to include `member` and `reader` roles as first-class citizens during keystones installation. This allows service developers to rely on these roles and include them in their default policy definitions. Standardizing on a set of role names for default policies increases interoperability between deployments and decreases operator overhead.

You can find more information on default roles in the keystone specification or developer documentation.

Compartmentalized policy enforcement

Policy logic and processing is inherently sensitive and often complicated. It is sensitive in that coding mistakes can lead to security vulnerabilities. It is complicated in the resources and APIs it needs to protect and the vast number of use cases it needs to support. These reasons make a case for isolating policy enforcement and processing into a compartmentalized space, as opposed to policy logic bleeding through to different layers of nova. Not having all policy logic in a single place makes evolving the policy enforcement system arduous and makes the policy system itself fragile.

Currently, the database and API components of nova contain policy logic. At some point, we should refactor these systems into a single component that is easier to maintain. Before we do this, we should consider approaches for bolstering testing coverage, which ensures we are aware of or prevent policy regressions. There are examples and documentation in API protection testing guides.

Refactoring hard-coded permission checks

The policy system in nova is designed to be configurable. Despite this design, there are some APIs that have hard-coded checks for specific roles. This makes configuration impossible, misleading, and frustrating for operators. Instead, we can remove hard-coded policies and ensure a configuration-driven approach, which reduces technical debt, increases consistency, and provides better user-experience for operators. Additionally, moving hard-coded checks into first-class policy rules let us use existing policy tooling to deprecate, document, and evolve policies.

Granular policy checks

Policies should be as granular as possible to ensure consistency and reasonable defaults. Using a single policy to protect CRUD for an entire API is restrictive because it prevents us from using default roles to make delegation to that API flexible. For example, a policy for `compute:foobar` could be broken into `compute:foobar:create`, `compute:foobar:update`, `compute:foobar:list`, `compute:foobar:get`, and `compute:foobar:delete`. Breaking policies down this way allows us to set read-only policies for readable operations or use another default role for creation and management of `foobar` resources. The oslo.policy library has examples that show how to do this using deprecated policy rules.

4.2.3.2 Nova Stable REST API

This document describes both the current state of the Nova REST API as of the Pike release and also attempts to describe how the Nova team evolved the REST APIs implementation over time and removed some of the cruft that has crept in over the years.

Background

Nova used to include two distinct frameworks for exposing REST API functionality. Older code is called the v2 API and existed in the /nova/api/openstack/compute/legacy_v2/ directory. This code tree was totally removed during Newton release time frame (14.0.0 and later). Newer code is called the v2.1 API and exists in the /nova/api/openstack/compute directory.

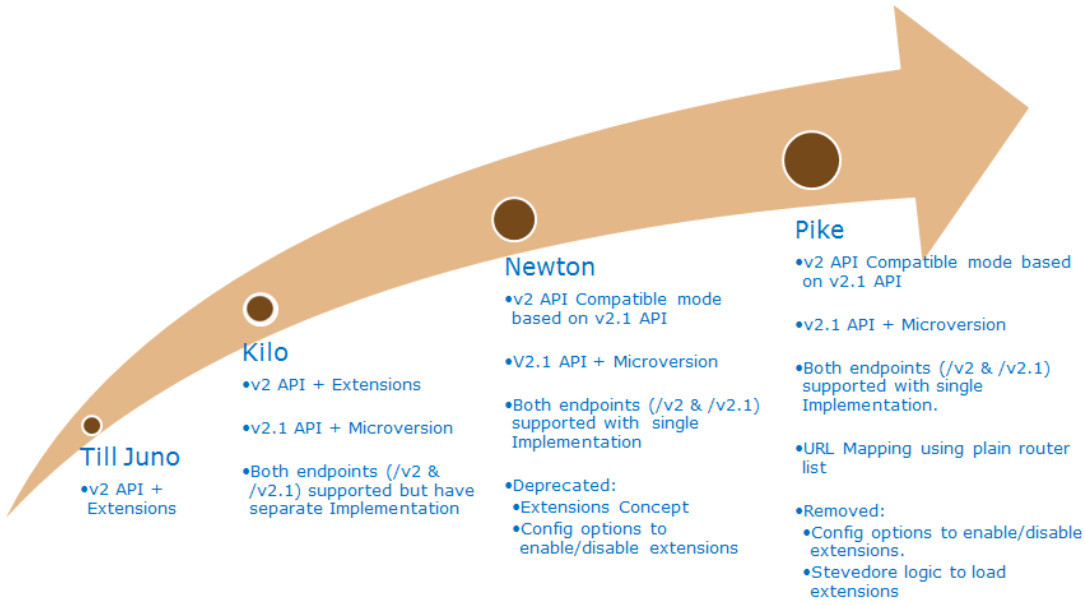
The v2 API is the old Nova REST API. It is mostly replaced by v2.1 API.

The v2.1 API is the new Nova REST API with a set of improvements which includes Microversion and standardized validation of inputs using JSON-Schema. Also the v2.1 API is totally backwards compatible with the v2 API (That is the reason we call it as v2.1 API).

Current Stable API

- Nova v2.1 API + Microversion (v2.1 APIs are backward-compatible with v2 API, but more strict validation)
- /v2 & /v2.1 endpoint supported
- v2 compatible mode for old v2 users

Evolution of Nova REST API



Nova v2 API + Extensions

Nova used to have v2 API. In v2 API, there was a concept called extension. An operator can use it to enable/disable part of Nova REST API based on requirements. An end user may query the /extensions API to discover what *API functionality* is supported by the Nova deployment.

Unfortunately, because v2 API extensions could be enabled or disabled from one deployment to another as well as custom API extensions added to one deployment and not another it was impossible for an end user to know what the OpenStack Compute API actually included. No two OpenStack deployments were consistent, which made cloud interoperability impossible.

In the Newton release, stevedore loading of API extension plugins was deprecated and marked for removal.

In the Newton release, v2 API code base has been removed and /v2 endpoints were directed to v2.1 code base.

v2 API compatibility mode based on v2.1 API

v2.1 API is exactly same as v2 API except strong input validation with no additional request parameter allowed and Microversion feature. Since Newton, /v2 endpoint also started using v2.1 API implementation. But to keep the backward compatibility of v2 API, /v2 endpoint should not return error on additional request parameter or any new headers for Microversion. v2 API must be same as it has been since starting.

To achieve that behavior legacy v2 compatibility mode has been introduced. v2 compatibility mode is based on v2.1 implementation with below difference:

- Skip additionalProperties checks in request body
- Ignore Microversion headers in request
- No Microversion headers in response

Nova v2.1 API + Microversion

In the Kilo release, nova v2.1 API has been released. v2.1 API is supposed to be backward compatible with v2 API with strong input validation using JSON Schema.

v2.1 API comes up with microversion concept which is a way to version the API changes. Each new feature or modification in API has to done via microversion bump.

API extensions concept was deprecated from the v2.1 API, are no longer needed to evolve the REST API, and no new API functionality should use the API extension classes to implement new functionality. Instead, new API functionality should be added via microversion concept and use the microversioning decorators to add or change the REST API.

v2.1 API had plugin framework which was using stevedore to load Nova REST API extensions instead of old V2 handcrafted extension load mechanism. There was an argument that the plugin framework supported extensibility in the Nova API to allow deployers to publish custom API resources.

In the Newton release, config options of blacklist and whitelist extensions and stevedore things were deprecated and marked for removal.

In Pike, stevedore based plugin framework has been removed and url mapping is done with plain router list. There is no more dynamic magic of detecting API implementation for url. See *Extending the API* for more information.

The /extensions API exposed the list of enabled API functions to users by GET method. However as the above, new API extensions should not be added to the list of this API. The /extensions API is frozen in Nova V2.1 API and is deprecated.

Things which are History now

As of the Pike release, many deprecated things have been removed and became history in Nova API world:

- v2 legacy framework
- API extensions concept
- stevedore magic to load the extension/plugin dynamically
- Configurable way to enable/disable APIs extensions

4.2.3.3 Scheduler Evolution

Evolving the scheduler has been a priority item over several releases: http://specs.openstack.org/openstack/nova-specs/#priorities

The scheduler has become tightly coupled with the rest of nova, limiting its capabilities, accuracy, flexibility and maintainability. The goal of scheduler evolution is to bring about a better separation of concerns between scheduling functionality and the rest of nova.

Once this effort has completed, its conceivable that the nova-scheduler could become a separate git repo, outside of nova but within the compute project. This is not the current focus.

Problem Use Cases

Many users are wanting to do more advanced things with the scheduler, but the current architecture is not ready to support those use cases in a maintainable way. A few examples will help to illustrate where the scheduler falls short:

Cross Project Affinity

It can be desirable, when booting from a volume, to use a compute node that is close to the shared storage where that volume is. Similarly, for the sake of performance, it can be desirable to use a compute node that is in a particular location in relation to a pre-created port.

Filter Scheduler Alternatives

For certain use cases, radically different schedulers may perform much better than the filter scheduler. We should not block this innovation. It is unreasonable to assume a single scheduler will work for all use cases.

However, to enable this kind of innovation in a maintainable way, a single strong scheduler interface is required.

Project Scale issues

There are many interesting ideas for new schedulers, like the solver scheduler, and frequent requests to add new filters and weights to the scheduling system. The current nova team does not have the bandwidth to deal with all these requests. A dedicated scheduler team could work on these items independently of the rest of nova.

The tight coupling that currently exists makes it impossible to work on the scheduler in isolation. A stable interface is required before the code can be split out.

Key areas we are evolving

Here we discuss, at a high level, areas that are being addressed as part of the scheduler evolution work.

Versioning Scheduler Placement Interfaces

At the start of kilo, the scheduler is passed a set of dictionaries across a versioned RPC interface. The dictionaries can create problems with the backwards compatibility needed for live-upgrades.

Luckily we already have the oslo.versionedobjects infrastructure we can use to model this data in a way that can be versioned across releases.

This effort is mostly focusing around the request_spec. See, for example, this spec.

Sending host and node stats to the scheduler

Periodically nova-compute updates the scheduler state stored in the database.

We need a good way to model the data that is being sent from the compute nodes into the scheduler, so over time, the scheduler can move to having its own database.

This is linked to the work on the resource tracker.

Updating the Scheduler about other data

Over time, its possible that we need to send cinder and neutron data, so the scheduler can use that data to help pick a nova-compute host.

Resource Tracker

The recent work to add support for NUMA and PCI pass through have shown we have no good pattern to extend the resource tracker. Ideally we want to keep the innovation inside the nova tree, but we also need it to be easier.

This is very related to the effort to re-think how we model resources, as covered by discussion about resource providers.

Parallelism and Concurrency

The current design of the nova-scheduler is very racy, and can lead to excessive numbers of build retries before the correct host is found. The recent NUMA features are particularly impacted by how the scheduler works. All this has lead to many people running only a single nova-scheduler process configured to use a very small greenthread pool.

The work on cells v2 will mean that we soon need the scheduler to scale for much larger problems. The current scheduler works best with less than 1k nodes but we will need the scheduler to work with at least 10k nodes.

Various ideas have been discussed to reduce races when running multiple nova-scheduler processes. One idea is to use two-phase commit style resource tracker claims. Another idea involves using incremental updates so it is more efficient to keep the schedulers state up to date, potentially using Kafka.

For more details, see the backlog spec that describes more of the details around this problem.

4.2.4 Additional Information

- *Glossary*: A quick reference guide to some of the terms you might encounter working on or using nova.

4.2.4.1 Glossary

Availability Zone
: Availability zones are a logical subdivision of cloud block storage, compute and network services. They provide a way for cloud operators to logically segment their compute based on arbitrary factors like location (country, datacenter, rack), network layout and/or power source.

  For more information, refer to *Host aggregates*.

Boot From Volume
: A server that is created with a *Block Device Mapping* with `boot_index=0` and `destination_type=volume`. The root volume can already exist when the server is created or be created by the compute service as part of the server creation. Note that a server can have volumes attached and not be boot-from-volume. A boot from volume server has an empty () `image` parameter in `GET /servers/{server_id}` responses.

Cell
: A cell is a shard or horizontal partition in a nova deployment. A cell mostly consists of a database, queue, and set of compute nodes. All deployments will have at least one cell (and one fake cell). Larger deployments can have many.

For more information, refer to *Cells (v2)*.

Cross-Cell Resize
A resize (or cold migrate) operation where the source and destination compute hosts are mapped to different cells. By default, resize and cold migrate operations occur within the same cell.

For more information, refer to *Cross-cell resize*.

Host Aggregate
Host aggregates can be regarded as a mechanism to further partition an *Availability Zone*; while availability zones are visible to users, host aggregates are only visible to administrators. Host aggregates provide a mechanism to allow administrators to assign key-value pairs to groups of machines. Each node can have multiple aggregates, each aggregate can have multiple key-value pairs, and the same key-value pair can be assigned to multiple aggregates.

For more information, refer to *Host aggregates*.

Same-Cell Resize
A resize (or cold migrate) operation where the source and destination compute hosts are mapped to the same cell. Also commonly referred to as standard resize or simply resize. By default, resize and cold migrate operations occur within the same cell.

For more information, refer to *Resize and cold migrate*.

INDEX

Symbols

A

B

C

H

N

S