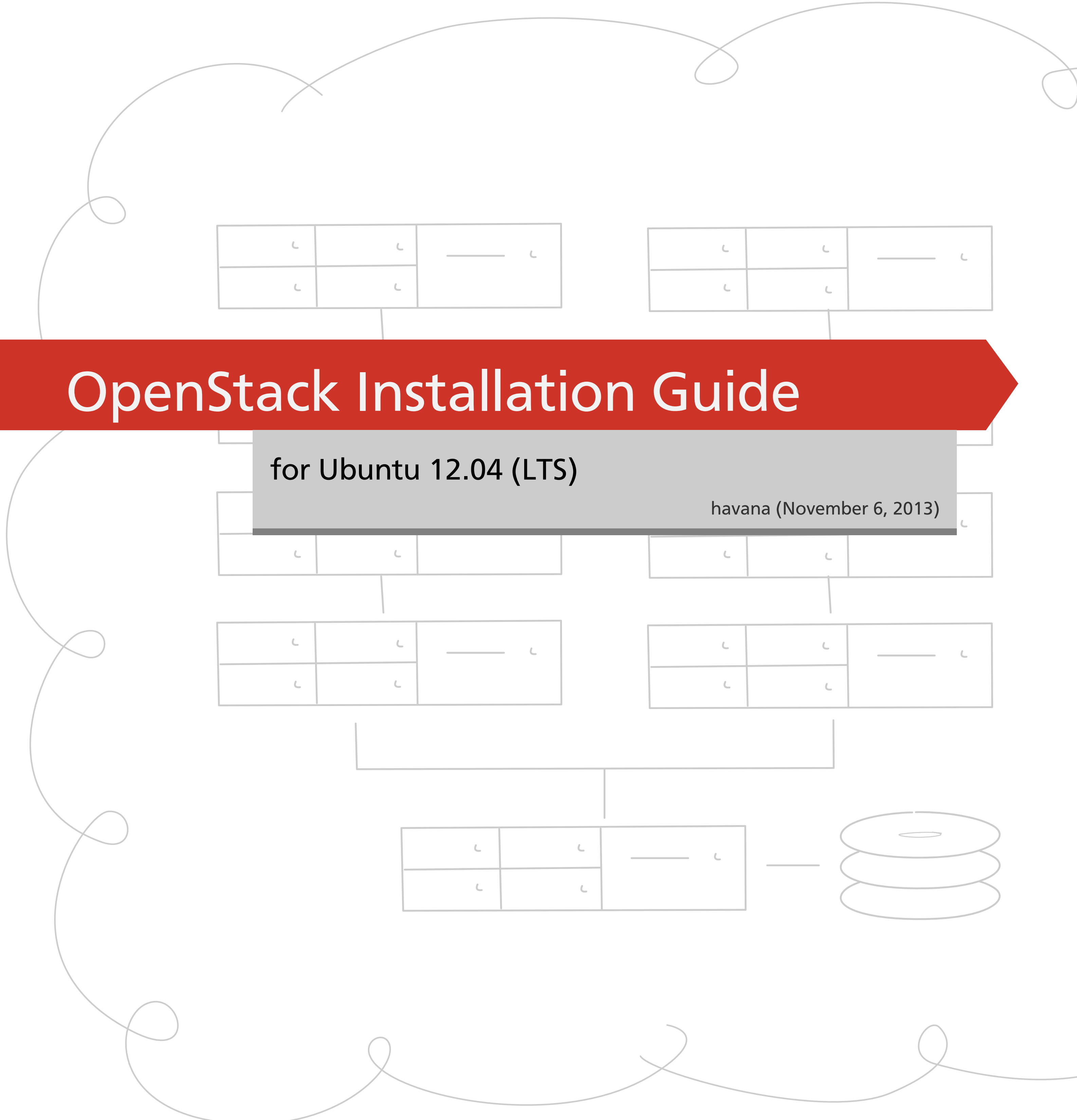
# OpenStack Installation Guide

## for Ubuntu 12.04 (LTS)

havana (November 6, 2013)



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# OpenStack Installation Guide for Ubuntu 12.04 (LTS)

havana (2013-11-06)


The OpenStack® system consists of several key projects that are separately installed but can work together depending on your cloud needs: these projects include OpenStack Compute, OpenStack Object Storage, OpenStack Block Storage, OpenStack Identity Service, OpenStack Networking, and the OpenStack Image Service. You can install any of these projects separately and then configure them either as standalone or connected entities. This guide walks through an installation using packages available through Ubuntu 12.04 (LTS). Additionally, explanations of configuration options and sample configuration files are included.

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# Preface

## Document change history

This version of the guide replaces and obsoletes all previous versions. The following table describes the most recent changes:

| Revision Date | Summary of Changes |
|---|---|
| October 25, 2013 | • Added initial Debian support. |
| October 17, 2013 | • Havana release. |
| October 16, 2013 | • Add support for SUSE Linux Enterprise. |
| October 8, 2013 | • Complete reorganization for Havana. |
| September 9, 2013 | • Build also for openSUSE. |
| August 1, 2013 | • Fixes to Object Storage verification steps. Fix bug 1207347. |
| July 25, 2013 | • Adds creation of cinder user and addition to the service tenant. Fix bug 1205057. |
| May 8, 2013 | • Updated the book title for consistency. |
| May 2, 2013 | • Updated cover and fixed small errors in appendix. |
| April 30, 2013 | • Grizzly release. |
| April 18, 2013 | • Updates and clean up on the Object Storage installation. |
| April 8, 2013 | • Adds a note about availability of Grizzly packages on Ubuntu and Debian. |
| April 3, 2013 | • Updates RHEL/CentOS/Fedora information for Grizzly release. |
| March 26, 2013 | • Updates Dashboard (Horizon) information for Grizzly release. |
| February 12, 2013 | • Adds chapter about Essex to Folsom upgrade for Compute and related services (excludes OpenStack Object Storage (Swift) and OpenStack Networking (Quantum)). |
| January 16, 2013 | • Fix file copy issue for figures in the /common/ directory. |
| November 9, 2012 | • Folsom release of this document. |
| October 10, 2012 | • Doc bug fixes: 10544591064745 |
| September 26, 2012 | • Adds an all-in-one install section. |
| July 23, 2012 | • Adds additional detail about installing and configuring nova-volumes.<br>• Doc bug fixes: 978510 1027230 |
| July 17, 2012 | • Update build process so two uniquely-named PDF files are output. |
| July 13, 2012 | • Doc bug fixes: 1025840 1025847 |
| June 19, 2012 | • Fix PDF links.<br>• Doc bug fixes: 967778 984959, 1002294, 1010163. |
| May 31, 2012 | • Revise install guide to encompass more Linux distros.<br>• Doc bug fixes: 996988, 998116, 999005. |
| May 3, 2012 | • Fixes problems with `glance-api-paste.ini` and `glance-registry-paste.ini` samples and instructions.<br>• Removes "DRAFT" designation. |
| May 2, 2012 | • Essex release. |
| May 1, 2012 | • Updates the Object Storage and Identity (Keystone) configuration. |
| April 25, 2012 | • Changes service_id copy/paste error for the EC2 service-create command.<br><br>Adds verification steps for Object Storage installation.<br><br>Fixes `proxy-server.conf` file so it points to keystone not tempauth. |
| April 23, 2012 | • Adds installation and configuration for multi-node Object Storage service. |
| April 17, 2012 | • Doc bug fixes: 983417, 984106, 984034 |

| Revision Date | Summary of Changes |
|---|---|
| April 13, 2012 | • Doc bug fixes: 977905, 980882, 977823, adds additional Glance database preparation steps |
| April 10, 2012 | • Doc bug fixes: 977831 |
| March 23, 2012 | • Updates for Xen hypervisor. |
| March 9, 2012 | • Updates for Essex release, includes new Glance config files, new Keystone configuration. |
| January 24, 2012 | • Initial draft for Essex.<br>• Assumes use of Ubuntu 12.04 repository. |
| January 24, 2011 | • Initial draft for Diablo. |

# 1. Architecture

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This install guide offers a few of the many ways to install OpenStack components and have them work together. It is meant as a "choose your own adventure" guide, not a comprehensive guide. The *OpenStack Configuration Reference* lists every option in all OpenStack services. Before you begin an installation adventure, here are some things you should know about OpenStack concepts.

The OpenStack project is an open source cloud computing platform for all types of clouds, which aims to be simple to implement, massively scalable, and feature rich. Developers and cloud computing technologists from around the world create the OpenStack project.

OpenStack provides an Infrastructure as a Service (IaaS) solution through a set of interrelated services. Each service offers an application programming interface (API) that facilitates this integration. Depending on your needs, you can install some or all services.

The following table describes the OpenStack services that make up the OpenStack architecture:

### Table 1.1. OpenStack services

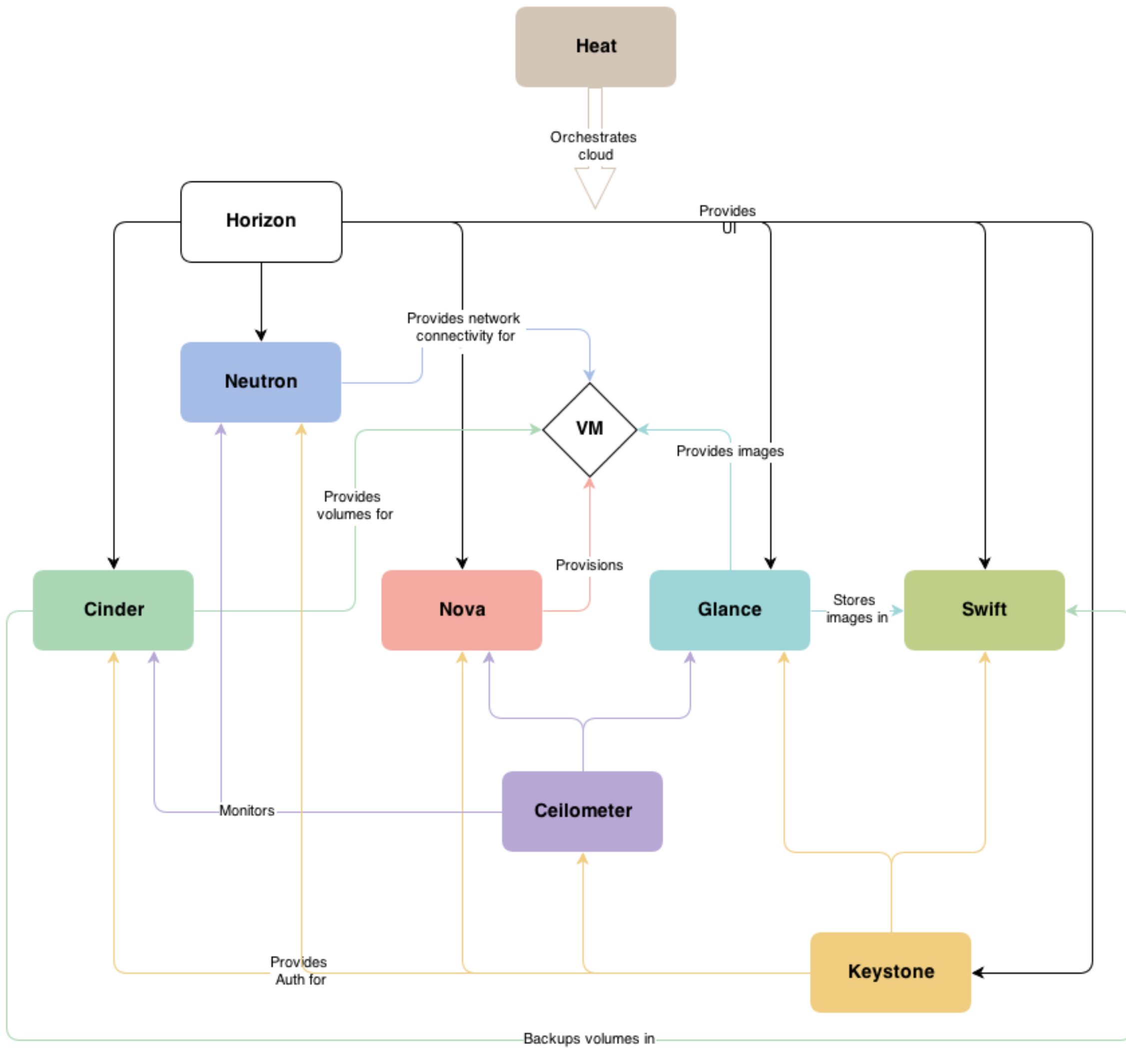
| Service | Project name | Description |
|---|---|---|
| Dashboard | Horizon | Enables users to interact with OpenStack services to launch an instance, assign IP addresses, set access controls, and so on. |
| Compute | Nova | Provisions and manages large networks of virtual machines on demand. |
| Networking | Neutron | Enables network connectivity as a service among interface devices managed by other OpenStack services, usually Compute. Enables users to create and attach interfaces to networks. Has a pluggable architecture that supports many popular networking vendors and technologies. |
| Storage | | |
| Object Storage | Swift | Stores and gets files. Does not mount directories like a file server. |
| Block Storage | Cinder | Provides persistent block storage to guest virtual machines. |
| Shared services | | |
| Identity Service | Keystone | Provides authentication and authorization for the OpenStack services. Also provides a service catalog within a particular OpenStack cloud. |
| Image Service | Glance | Provides a registry of virtual machine images. Compute uses it to provision instances. |
| Metering/ Monitoring Service | Ceilometer | Monitors and meters the OpenStack cloud for billing, benchmarking, scalability, and statistics purposes. |
| Higher-level services | | |

| Service | Project name | Description |
|---|---|---|
| Orchestration Service | Heat | Orchestrates multiple composite cloud applications by using either the native HOT template format or the AWS CloudFormation template format, through both an OpenStack-native REST API and a CloudFormation-compatible Query API. |

# Conceptual architecture

The following diagram shows the relationships among the OpenStack services:

**Figure 1.1. OpenStack conceptual architecture**




# Logical architecture

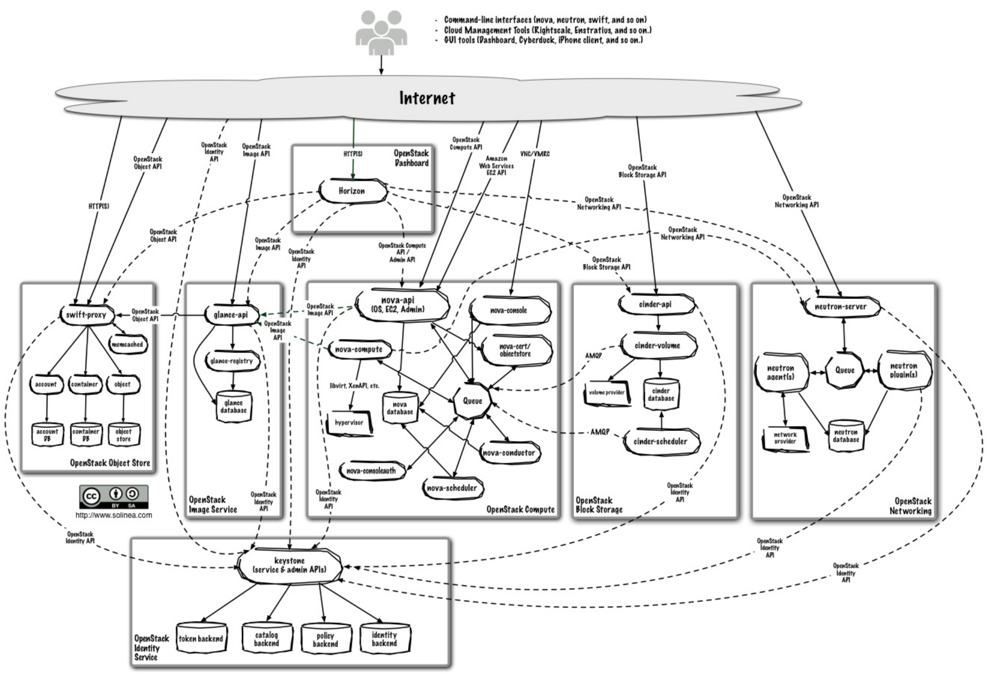
To design, install, and configure a cloud, cloud administrators must understand the logical architecture.

OpenStack modules are one of the following types:

- Daemon. Runs as a daemon. On Linux platforms, a daemon is usually installed as a service.
- Script. Installs and tests of a virtual environment. For example, the `run_tests.sh` script installs and optionally tests a virtual environment for a service.
- Command-line interface (CLI). Enables users to submit API calls to OpenStack services through easy-to-use commands.

The following diagram shows the most common, but not the only, architecture for an OpenStack cloud:

**Figure 1.2. OpenStack logical architecture**




As in Figure 1.1, “OpenStack conceptual architecture” [2], end users can interact through the dashboard, CLIs, and APIs. All services authenticate through a common Identity Service and individual services interact with each other through public APIs, except where privileged administrator commands are necessary.

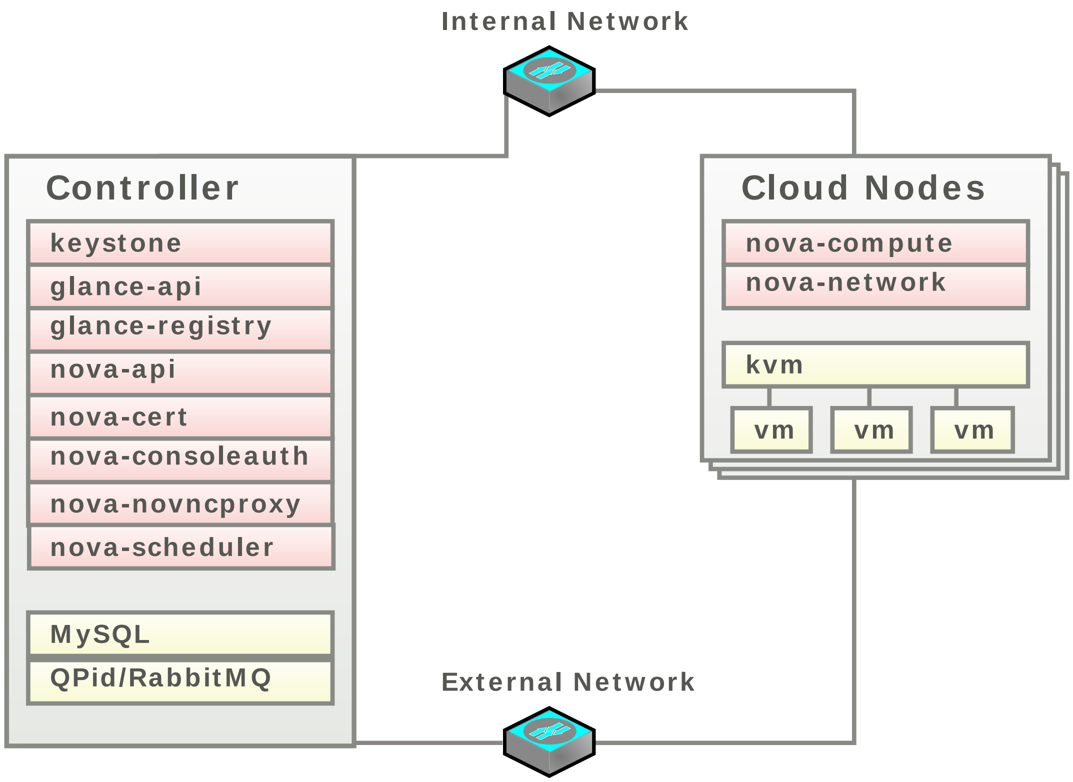
# Sample architectures

This guide enables you to choose your own OpenStack adventure. OpenStack is highly configurable to meet different needs with various storage and networking options.

This guide offers the following sample architecture examples:

- Example basic architecture. This architecture has two nodes. A cloud controller node runs the control services, such as database, message queue and API services for the Identity Service, Image Service and Compute. A compute node runs the hypervisor where virtual machines live.

**Figure 1.3. Basic architecture**




Technical details: Compute with KVM, local ephemeral storage, nova-network in multi-host flatDHCP mode, MySQL, nova-api, default scheduler, RabbitMQ for messaging, Identity with SQL back end, Image with local storage, Dashboard (optional extra). Uses as many default options as possible.

- Example architecture from the *OpenStack Operations Guide*. Same as the basic architecture but with Block Storage LVM/iSCSI back end, nova-network in multi-host with FlatDHCP, Live Migration back end shared storage with NFS, and Object Storage. One controller node and multiple compute nodes.

- Example architecture with Identity Service and Object Storage: Five node installation with Identity Service on the proxy node and three replications of object servers. Dashboard does not support this configuration so examples are with CLI.

- Example architecture with OpenStack Networking.

# 2. Basic Operating System Configuration

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This guide starts by creating two nodes: a controller node to host most services, and a compute node to run virtual machine instances. Later chapters create additional nodes to run more services. OpenStack offers a lot of flexibility in how and where you run each service, so this is not the only possible configuration. However, you do need to configure certain aspects of the operating system on each node.

This chapter details a sample configuration for both the controller node and any additional nodes. It's possible to configure the operating system in other ways, but the remainder of this guide assumes you have a configuration compatible with the one shown here.

All of the commands throughout this guide assume you have administrative privileges. Either run the commands as the root user, or prefix them with the **sudo** command.

# Networking

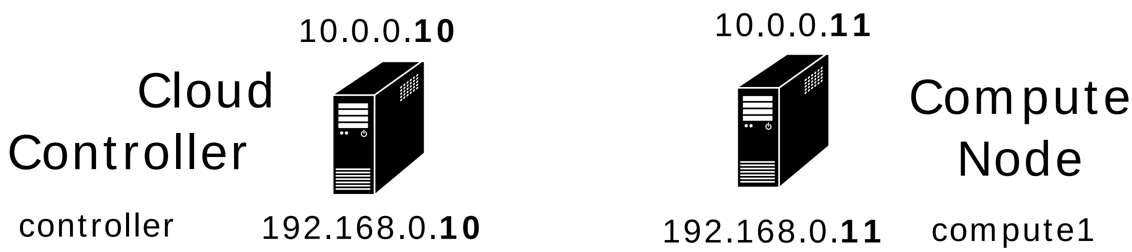
For a production deployment of OpenStack, most nodes should have two network interface cards: one for external network traffic, and one to communicate only with other OpenStack nodes. For simple test cases, you can use machines with only a single network interface card.

This section sets up networking on two networks with static IP addresses and manually manages a list of host names on each machine. If you manage a large network, you probably already have systems in place to manage this. If so, you may skip this section, but note that the rest of this guide assumes that each node can reach the other nodes on the internal network using host names like `controller` and `compute1`.

Next, create the configuration for both `eth0` and `eth1`. This guide uses the `192.168.0.x` address for the internal network and the `10.0.0.x` addresses for the external network. Make sure that the corresponding network devices are connected to the correct network.

In this guide, the controller node uses the IP addresses `192.168.0.10` and `10.0.0.10`. When creating the compute node, use `192.168.0.11` and `10.0.0.11` instead. Additional nodes added in later chapters will follow this pattern.

**Figure 2.1. Basic Architecture**




**Example 2.1. /etc/network/interfaces**

```
# Internal Network
auto eth0
iface eth0 inet static
    address 192.168.0.10
    netmask 255.255.255.0

# External Network
auto eth1
iface eth1 inet static
    address 10.0.0.10
    netmask 255.255.255.0
```

Once you've configured the network, restart the daemon for changes to take effect:

```
# service networking restart
```

Set the host name of each machine. Name the controller node `controller` and the first compute node `compute1`. These are the host names used in the examples throughout this guide.

Use the **hostname** command to set the host name:

```
# hostname controller
```

To have this host name set when the system reboots, you need to specify it in the file `/etc/hostname`. This file contains a single line with just the host name.

Finally, ensure that each node can reach the other nodes using host names. In this guide, we will manually edit the `/etc/hosts` file on each system. For large-scale deployments, you should use DNS or a configuration management system like Puppet.

```
127.0.0.1       localhost
192.168.0.10    controller
192.168.0.11    compute1
```

# Network Time Protocol (NTP)

To keep all the services in sync across multiple machines, you need to install NTP. In this guide, we will configure the controller node to be the reference server, and configure all additional nodes to set their time from the controller node.

Install the `ntp` package on each system running OpenStack services.

```
# apt-get install ntp
```

Set up all additional nodes to synchronize their time from the controller node. The simplest way to do this is to add a daily cron job. Add a file at `/etc/cron.daily/ntpdate` that contains the following:

```
# ntpdate controller
# hwclock -w
```

Make sure to mark this file as executable.

```
# chmod a+x /etc/cron.daily/ntpdate
```

# MySQL database

Most OpenStack services require a database to store information. In this guide, we use a MySQL database running on the controller node. The controller node needs to have the MySQL database installed. Any additional nodes that access MySQL need to have the MySQL client software installed:

- On the controller node, install the MySQL client, the MySQL database, and the MySQL Python library.

  ```
  # apt-get install python-mysqldb mysql-server
  ```

  ### Note

  When you install the server package, you will be asked to enter a root password for the database. Be sure to choose a strong password and remember it - it will be needed later.

  Edit `/etc/mysql/my.cnf` and set the `bind-address` to the internal IP address of the controller, to allow access from outside the controller node.

  ```
  # Instead of skip-networking the default is now to listen only on
  # localhost which is more compatible and is not less secure.
  bind-address            = 192.168.0.10
  ```

- On any nodes besides the controller node, just install the MySQL client and the MySQL Python library. This is all you need to do on any system not hosting the MySQL database.

  ```
  # apt-get install python-mysqldb
  ```

You need to delete the anonymous users that are created when the database is first started. Otherwise, you will get database connection problems when following the instructions in this guide. You can do this with the **mysql_secure_installation** command.

```
# mysql_secure_installation
```

This command will present a number of options for you to secure your database installation. Answer yes to all of them unless you have a good reason to do otherwise.

# OpenStack Packages

Distributions might release OpenStack packages as part of their distribution or through other methods because the OpenStack and distribution release times are independent of each other.

This section describes the additional configuration you must complete after you configure machines to install the latest OpenStack packages.

### To use the Ubuntu Cloud Archive for Havana

The Ubuntu Cloud Archive is a special repository that allows you to install newer releases of OpenStack on the stable supported version of Ubuntu.

1. Install the Ubuntu Cloud Archive for Havana:

```
# apt-get install python-software-properties
# add-apt-repository cloud-archive:havana
```

2. Upgrade the system (and reboot if you need):

```
# apt-get update && apt-get dist-upgrade
```

Numerous archive.gplhost.com mirrors are available around the world. All are available with both FTP and HTTP protocols (you should use the closest mirror). The list of mirrors is available at http://archive.gplhost.com/readme.mirrors.

# Messaging Server

On the controller node, install the messaging queue server. Typically this is RabbitMQ but Qpid and ZeroMQ (0MQ) are also available.

```
# apt-get install rabbitmq-server
```

### Important security consideration

The rabbitmq-server package configures the RabbitMQ service to start automatically and creates a `guest` user with a default `guest` password. The RabbitMQ examples in this guide use the `guest` account, though it is strongly advised to change its default password, especially if you have IPv6 available: by default the RabbitMQ server enables anyone to connect to it by using guest as login and password, and with IPv6, it is reachable from the outside.

To change the default guest password of RabbitMQ:

```
# rabbitmqctl change_password guest NEW_PASS
```

Congratulations, now you are ready to start installing OpenStack services!

# 3. Configure the Identity Service

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# Identity Service concepts

The Identity Service performs the following functions:

- User management. Tracks users and their permissions.
- Service catalog. Provides a catalog of available services with their API endpoints.

To understand the Identity Service, you must understand the following concepts:

**User**
Digital representation of a person, system, or service who uses OpenStack cloud services. The Identity Service validates that incoming requests are made by the user who claims to be making the call. Users have a login and may be assigned tokens to access resources. Users can be directly assigned to a particular tenant and behave as if they are contained in that tenant.

**Credentials**
Data that is known only by a user that proves who they are. In the Identity Service, examples are: User name and password, user name and API key, or an authentication token provided by the Identity Service.

**Authentication**
The act of confirming the identity of a user. The Identity Service confirms an incoming request by validating a set of credentials supplied by the user.

These credentials are initially a user name and password or a user name and API key. In response to these credentials, the Identity Service issues an authentication token to the user, which the user provides in subsequent requests.

**Token**
An arbitrary bit of text that is used to access resources. Each token has a scope which describes which resources are accessible with it. A token may be revoked at any time and is valid for a finite duration.

While the Identity Service supports token-based authentication in this release, the intention is for it to support additional protocols in the future. The intent is for it to be an integration service foremost, and not aspire to be a full-fledged identity store and management solution.

**Tenant** A container used to group or isolate resources and/or identity objects. Depending on the service operator, a tenant may map to a customer, account, organization, or project.

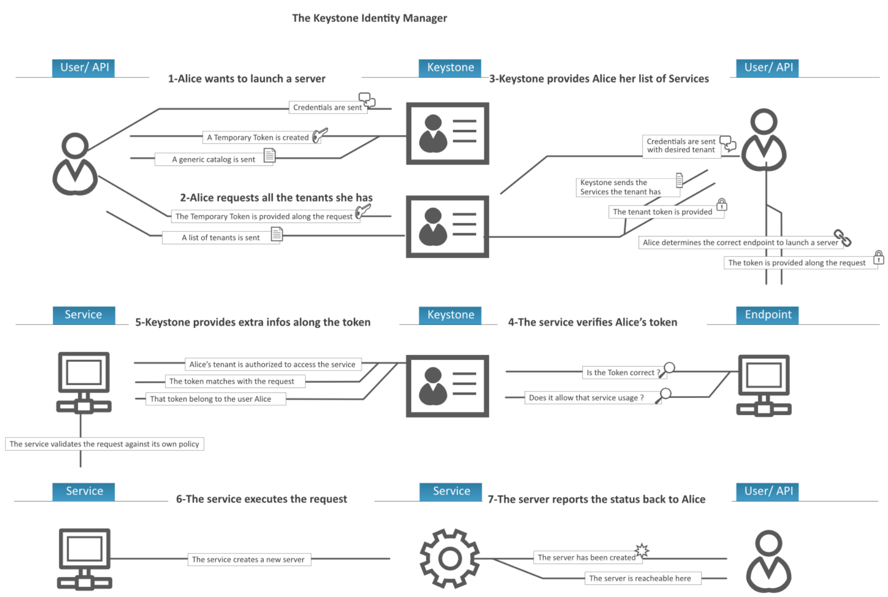
**Service** An OpenStack service, such as Compute (Nova), Object Storage (Swift), or Image Service (Glance). Provides one or more endpoints through which users can access resources and perform operations.

**Endpoint** An network-accessible address, usually described by URL, from where you access a service. If using an extension for templates, you can create an endpoint template, which represents the templates of all the consumable services that are available across the regions.

**Role** A personality that a user assumes that enables them to perform a specific set of operations. A role includes a set of rights and privileges. A user assuming that role inherits those rights and privileges.

In the Identity Service, a token that is issued to a user includes the list of roles that user has. Services that are being called by that user determine how they interpret the set of roles a user has and to which operations or resources each role grants access.

The following diagram shows the Identity Service process flow:




# Installing the Identity Service

1. Install the Identity Service on the controller node, together with python-keystoneclient (which is a dependency):

```
# apt-get install keystone
```

2. The Identity Service uses a database to store information. Specify the location of the database in the configuration file. In this guide, we use a MySQL database on the

controller node with the username `keystone`. Replace *KEYSTONE_DBPASS* with a suitable password for the database user.

Edit `/etc/keystone/keystone.conf` and change the `[sql]` section.

```
...
[sql]
# The SQLAlchemy connection string used to connect to the database
connection = mysql://keystone:KEYSTONE_DBPASS@controller/keystone
...
```

3. First, we need to create a database user called `keystone`, by logging in as root using the password we set earlier.

```
# mysql -u root -p
mysql> CREATE DATABASE keystone;
mysql> GRANT ALL PRIVILEGES ON keystone.* TO 'keystone'@'localhost' \
IDENTIFIED BY 'KEYSTONE_DBPASS';
mysql> GRANT ALL PRIVILEGES ON keystone.* TO 'keystone'@'%' \
IDENTIFIED BY 'KEYSTONE_DBPASS';
```

4. We now start the keystone service and create its tables.

```
# keystone-manage db_sync
# service keystone restart
```

5. You need to define an authorization token that is used as a shared secret between the Identity Service and other OpenStack services. Use **openssl** to generate a random token, then store it in the configuration file.

```
# openssl rand -hex 10
```

Edit `/etc/keystone/keystone.conf` and change the `[DEFAULT]` section, replacing ADMIN_TOKEN with the results of the command.

```
[DEFAULT]
# A "shared secret" between keystone and other openstack services
admin_token = ADMIN_TOKEN
...
```

6. Restart the Identity service.

```
# service keystone restart
```

# Defining Users, Tenants, and Roles

Once Keystone is installed and running, you set up users, tenants, and roles to authenticate against. These are used to allow access to services and endpoints, described in the next section.

Typically, you would use a username and password to authenticate with the Identity service. At this point, however, we have not created any users, so we have to use the authorization token created in the previous section. You can pass this with the `--token` option to the **keystone** command or set the `OS_SERVICE_TOKEN` environment variable. We'll set `OS_SERVICE_TOKEN`, as well as `OS_SERVICE_ENDPOINT` to specify where the Identity Service is running. Replace ***`FCAF3E...`*** with your authorization token.

```
# export OS_SERVICE_TOKEN=FCAF3E...
# export OS_SERVICE_ENDPOINT=http://controller:35357/v2.0
```

First, create a tenant for an administrative user and a tenant for other OpenStack services to use.

```
# keystone tenant-create --name=admin --description="Admin Tenant"
# keystone tenant-create --name=service --description="Service Tenant"
```

Next, create an administrative user called `admin`. Choose a password for the `admin` user and specify an email address for the account.

```
# keystone user-create --name=admin --pass=ADMIN_PASS \
   --email=admin@example.com
```

Create a role for administrative tasks called `admin`. Any roles you create should map to roles specified in the `policy.json` files of the various OpenStack services. The default policy files use the `admin` role to allow access to most services.

```
# keystone role-create --name=admin
```

Finally, you have to add roles to users. Users always log in with a tenant, and roles are assigned to users within roles. Add the `admin` role to the `admin` user when logging in with the `admin` tenant.

```
# keystone user-role-add --user=admin --tenant=admin --role=admin
```

# Defining Services and API Endpoints

The Identity Service also tracks what OpenStack services are installed and where to locate them on the network. For each service on your OpenStack installation, you must call **keystone service-create** to describe the service and **keystone endpoint-create** to specify the API endpoints associated with the service.

For now, create a service for the Identity Service itself. This will allow you to stop using the authorization token and instead use normal authentication when using the **keystone** command in the future.

First, create a service entry for the Identity Service.

```
# keystone service-create --name=keystone --type=identity \
  --description="Keystone Identity Service"
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
| description | Keystone Identity Service        |
| id          | 15c11a23667e427e91bc31335b45f4bd |
| name        | keystone                         |
| type        | identity                         |
+-------------+----------------------------------+
```

The service id is randomly generated, and will be different from the one shown above when you run the command. Next, specify an API endpoint for the Identity Service using the service id you received. When you specify an endpoint, you provide three URLs for the public API, the internal API, and the admin API. In this guide, we use the hostname `controller`. Note that the Identity Service uses a different port for the admin API.

```
# keystone endpoint-create \
  --service-id=the_service_id_above \
  --publicurl=http://controller:5000/v2.0 \
  --internalurl=http://controller:5000/v2.0 \
  --adminurl=http://controller:35357/v2.0
+-------------+-----------------------------------+
|   Property  |             Value                 |
+-------------+-----------------------------------+
| adminurl    | http://controller:35357/v2.0      |
| id          | 11f9c625a3b94a3f8e66bf4e5de2679f  |
| internalurl | http://controller:5000/v2.0       |
| publicurl   | http://controller:5000/v2.0       |
| region      | regionOne                         |
| service_id  | 15c11a23667e427e91bc31335b45f4bd  |
+-------------+-----------------------------------+
```

As you add other services to your OpenStack installation, you will call these commands again to register those services with the Identity Service.

# Verifying the Identity Service Installation

To verify the Identity Service is installed and configured correctly, first unset the `OS_SERVICE_TOKEN` and `OS_SERVICE_ENDPOINT` environment variables. These were only used to bootstrap the administrative user and register the Identity Service.

```
# unset OS_SERVICE_TOKEN OS_SERVICE_ENDPOINT
```

You can now use regular username-based authentication. Request a authentication token using the `admin` user and the password you chose for that user.

```
# keystone --os-username=admin --os-password=ADMIN_PASS \
  --os-auth-url=http://controller:35357/v2.0 token-get
```

You should receive a token in response, paired with your user ID. This verifies that keystone is running on the expected endpoint, and that your user account is established with the expected credentials.

Next, verify that authorization is behaving as expected by requesting authorization on a tenant.

```
# keystone --os-username=admin --os-password=ADMIN_PASS \
  --os-tenant-name=admin --os-auth-url=http://controller:35357/v2.0 token-get
```

You should receive a new token in response, this time including the ID of the tenant you specified. This verifies that your user account has an explicitly defined role on the specified tenant, and that the tenant exists as expected.

You can also set your `--os-*` variables in your environment to simplify command-line usage. Set up a `keystonerc` file with the admin credentials and admin endpoint.

```
export OS_USERNAME=admin
export OS_PASSWORD=ADMIN_PASS
export OS_TENANT_NAME=admin
export OS_AUTH_URL=http://controller:35357/v2.0
```

You can source this file to read in the environment variables.

```
# source keystonerc
```

Verify that your `keystonerc` is configured correctly by performing the same command as above, but without the `--os-*` arguments.

```
$ keystone token-get
```

The command returns a token and the ID of the specified tenant. This verifies that you have configured your environment variables correctly.

Finally, verify that your admin account has authorization to perform administrative commands.

```
# keystone user-list

+----------------------------------+---------+--------------------+--------+
|                id                | enabled | email              |  name  |
+----------------------------------+---------+--------------------+--------+
| a4c2d43f80a549a19864c89d759bb3fe | True    | admin@example.com  | admin  |
```

This verifies that your user account has the `admin` role, which matches the role used in the Identity Service's `policy.json` file.

# 4. Configuring the Image Service

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The OpenStack Image service provides users the ability to discover, register, and retrieve virtual machine images. Also known as the glance project, the Image service offers a REST API that allows querying of virtual machine image metadata as well as retrieval of the actual image. Virtual machine images made available through the Image service can be stored in a variety of locations from simple filesystems to object-storage systems like the OpenStack Object Storage service.

## Image Service Overview

The Image Service includes the following components:

- `glance-api`. Accepts Image API calls for image discovery, retrieval, and storage.
- `glance-registry`. Stores, processes, and retrieves metadata about images. Metadata includes size, type, and so on.
- Database. Stores image metadata. You can choose your database depending on your preference. Most deployments use MySQL or SQlite.
- Storage repository for image files. In Figure 1.2, "OpenStack logical architecture" [3], the Object Storage Service is the image repository. However, you can configure a different repository. The Image Service supports normal file systems, RADOS block devices, Amazon S3, and HTTP. Some of these choices are limited to read-only usage.

A number of periodic processes run on the Image Service to support caching. Replication services ensures consistency and availability through the cluster. Other periodic processes include auditors, updaters, and reapers.

As shown in the section called "Conceptual architecture" [2], the Image Service is central to the overall IaaS picture. It accepts API requests for images or image metadata from end users or Compute components and can store its disk files in the Object Storage Service.

## Installing the Image Service

The Image service acts as a registry for virtual disk images. Users can add new images or take a snapshot (copy) of an existing server for immediate storage. Snapshots can be used as back up or as templates for new servers. Registered images can be stored in the Object Storage service, as well as in other locations (for example, in simple file systems or external web servers).

### Note

Steps in this procedure assume you have the appropriate environment variables set to specify your credentials, as described in the section called “Verifying the Identity Service Installation” [13].

## Install the Image Service

1. Install the Image Service on the controller node.

```
# apt-get install glance
```

2. The Image Service stores information about images in a database. This guide uses the MySQL database that is used by other OpenStack services.

   Specify the location of the database in the configuration files. The Image Service provides two OpenStack services: `glance-api` and `glance-registry`. They each have separate configuration files, so you must configure both files throughout this section. Replace *GLANCE_DBPASS* with an Image Service database password of your choosing.

   Edit `/etc/glance/glance-api.conf` and `/etc/glance/glance-registry.conf` and change the `[DEFAULT]` section.

```
...
[DEFAULT]
...
# SQLAlchemy connection string for the reference implementation
# registry server. Any valid SQLAlchemy connection string is fine.
# See: http://www.sqlalchemy.org/docs/05/reference/sqlalchemy/connections.
html#sqlalchemy.create_engine
sql_connection = mysql://glance:GLANCE_DBPASS@localhost/glance
...
```

3. The Ubuntu packages create an sqlite database by default. Delete the `glance.sqlite` file created in the `/var/lib/glance/` directory so it is not used by mistake.

   First, we need to create a database user called `glance`, by logging in as root using the password we set earlier.

```
# mysql -u root -p
mysql> CREATE DATABASE glance;
mysql> GRANT ALL PRIVILEGES ON glance.* TO 'glance'@'localhost' \
IDENTIFIED BY 'GLANCE_DBPASS';
mysql> GRANT ALL PRIVILEGES ON glance.* TO 'glance'@'%' \
IDENTIFIED BY 'GLANCE_DBPASS';
```

4. We now create the database tables for the Image service.

```
# glance-manage db_sync
```

5. Create a user called `glance` that the Image Service can use to authenticate with the Identity Service. Choose a password for the `glance` user and specify an email address for the account. Use the `service` tenant and give the user the `admin` role.

```
# keystone user-create --name=glance --pass=GLANCE_PASS \
   --email=glance@example.com
# keystone user-role-add --user=glance --tenant=service --role=admin
```

6. Add the credentials to the Image Service's configuration files.

   Edit `/etc/glance/glance-api.conf` and `/etc/glance/glance-registry.conf` and change the `[keystone_authtoken]` section.

```
...
[keystone_authtoken]
auth_host = controller
auth_port = 35357
auth_protocol = http
admin_tenant_name = service
admin_user = glance
admin_password = GLANCE_PASS
...
```

   ### Note

   If you have troubles connecting to the database, try using the IP address instead of the host name in the credentials.

7. You also have to add the credentials to the files `/etc/glance/glance-api-paste.ini` and `/etc/glance/glance-registry-paste.ini`.

   Open each file in a text editor and locate the section `[filter:authtoken]`. Make sure the following options are set:

```
[filter:authtoken]
paste.filter_factory=keystoneclient.middleware.auth_token:filter_factory
auth_host=controller
admin_user=glance
admin_tenant_name=service
admin_password=GLANCE_PASS
```

8. Register the Image Service with the Identity Service so that other OpenStack services can locate it. Register the service and specify the endpoint using the **keystone** command.

```
# keystone service-create --name=glance --type=image \
  --description="Glance Image Service"
```

9. Note the service's `id` property returned in the previous step and use it when creating the endpoint.

```
# keystone endpoint-create \
  --service-id=the_service_id_above \
  --publicurl=http://controller:9292 \
  --internalurl=http://controller:9292 \
  --adminurl=http://controller:9292
```

10. We now restart the glance service with its new settings.

```
# service glance-registry restart
```

```
# service glance-api restart
```

# Verifying the Image Service Installation

To test the Image Service installation, download at least one virtual machine image that is known to work with OpenStack. For example, CirrOS is a small test image that is often used for testing OpenStack deployments (CirrOS downloads). The 64-bit CirrOS QCOW2 image is the image we'll use for this walkthrough.

For more information about:

- Downloading and building images, refer to the *OpenStack Virtual Machine Image Guide*.
- How to manage images, refer to the "Image Management" chapter in the *OpenStack User Guide*.

## Upload and View an Image in the Image Service

1. Download the image into a dedicated directory:

```
$ mkdir images
$ cd images/
$ curl -O http://cdn.download.cirros-cloud.net/0.3.1/cirros-0.3.1-x86_64-
disk.img
```

2. Use the **glance image-create** command to upload the image to the Image Service, as follows:

```
# glance image-create --name=imageLabel --disk-format=fileFormat \
  --container-format=containerFormat --is-public=accessValue < imageFile
```

Where:

*imageLabel* — Arbitrary label. This is the name by which users will refer to the image.

*fileFormat* — Specifies the format of the image file. Valid formats include `qcow2`, `raw`, `vhd`, `vmdk`, `vdi`, `iso`, `aki`, `ari`, and `ami`.

You can verify the format using the **file** command:

```
$ file cirros-0.3.1-x86_64-disk.img
cirros-0.3.1-x86_64-disk.img: QEMU QCOW Image (v2),
 41126400 bytes
```

*containerFormat* — Specifies the container format. Valid formats include: `bare`, `ovf`, `aki`, `ari` and `ami`.

Specify `bare` to indicate that the image file is not in a file format that contains metadata about the virtual machine. Although this field is currently required, it is not actually used by any of the OpenStack services and has no effect on system behavior. Because the value is not used anywhere, it safe to always specify `bare` as the container format.

*accessValue* Specifies image access:

- true - All users will be able to view and use the image.
- false - Only administrators will be able to view and use the image.

*imageFile* Specifies the name of your downloaded image file.

For example:

```
# glance image-create --name="CirrOS 0.3.1" --disk-format=qcow2 \
  --container-format=bare --is-public=true < cirros-0.3.1-x86_64-disk.img
+------------------+--------------------------------------+
| Property         | Value                                |
+------------------+--------------------------------------+
| checksum         | d972013792949d0d3ba628fbe8685bce     |
| container_format | bare                                 |
| created_at       | 2013-10-08T18:59:18                  |
| deleted          | False                                |
| deleted_at       | None                                 |
| disk_format      | qcow2                                |
| id               | acafc7c0-40aa-4026-9673-b879898e1fc2 |
| is_public        | True                                 |
| min_disk         | 0                                    |
| min_ram          | 0                                    |
| name             | CirrOS 0.3.1                         |
| owner            | efa984b0a914450e9a47788ad330699d     |
| protected        | False                                |
| size             | 13147648                             |
| status           | active                               |
| updated_at       | 2013-05-08T18:59:18                  |
+------------------+--------------------------------------+
```

## Note

The returned image ID is generated dynamically, and therefore will be different on your deployment than in this example.

3. Use the **glance image-list** command to confirm that the image has been uploaded and to display its attributes:

```
# glance image-list
+--------------------------------------+-----------------+-------------
+------------------+----------+--------+
| ID                                   | Name            | Disk Format |
 Container Format | Size     | Status |
+--------------------------------------+-----------------+-------------
+------------------+----------+--------+
| acafc7c0-40aa-4026-9673-b879898e1fc2 | CirrOS 0.3.1    | qcow2       |
 bare             | 13147648 | active |
+--------------------------------------+-----------------+-------------
+------------------+----------+--------+
```

# 5. Configuring the Compute Services

## Table of Contents



## Compute Service

The Compute Service is a cloud computing fabric controller, the main part of an IaaS system. It can be used for hosting and managing cloud computing systems. The main modules are implemented in Python.

Compute interacts with the Identity service for authentication, Image service for images, and the Dashboard service for the user and administrative interface. Access to images is limited by project and by user; quotas are limited per project (for example, the number of instances). The Compute service is designed to scale horizontally on standard hardware, and can download images to launch instances as required.

The Compute Service is made up of the following functional areas and their underlying components:

### API

- `nova-api` service. Accepts and responds to end user compute API calls. Supports the OpenStack Compute API, the Amazon EC2 API, and a special Admin API for privileged users to perform administrative actions. Also, initiates most orchestration activities, such as running an instance, and enforces some policies.
- `nova-api-metadata` service. Accepts metadata requests from instances. The `nova-api-metadata` service is generally only used when you run in multi-host mode with `nova-network` installations. For details, see Metadata service in the *Cloud Administrator Guide*.

  Note for Debian users: on Debian system, it is included in the `nova-api` package, and can be selected through `debconf`.

### Compute core

- `nova-compute` process. A worker daemon that creates and terminates virtual machine instances through hypervisor APIs. For example, XenAPI for XenServer/XCP, libvirt for KVM or QEMU, VMwareAPI for VMware, and so on. The process by which it does so is fairly complex but the basics are simple: Accept actions from the queue and perform a series of system commands, like launching a KVM instance, to carry them out while updating state in the database.

- `nova-scheduler` process. Conceptually the simplest piece of code in Compute. Takes a virtual machine instance request from the queue and determines on which compute server host it should run.
- `nova-conductor` module. Mediates interactions between `nova-compute` and the database. Aims to eliminate direct accesses to the cloud database made by `nova-compute`. The `nova-conductor` module scales horizontally. However, do not deploy it on any nodes where `nova-compute` runs. For more information, see A new Nova service: nova-conductor.

### Networking for VMs

- `nova-network` worker daemon. Similar to `nova-compute`, it accepts networking tasks from the queue and performs tasks to manipulate the network, such as setting up bridging interfaces or changing iptables rules. This functionality is being migrated to OpenStack Networking, which is a separate OpenStack service.
- `nova-dhcpbridge` script. Tracks IP address leases and records them in the database by using the dnsmasq `dhcp-script` facility. This functionality is being migrated to OpenStack Networking. OpenStack Networking provides a different script.

### Console interface

- `nova-consoleauth` daemon. Authorizes tokens for users that console proxies provide. See `nova-novncproxy` and `nova-xvpnvcproxy`. This service must be running for console proxies to work. Many proxies of either type can be run against a single `nova-consoleauth` service in a cluster configuration. For information, see About nova-consoleauth.

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

- `nova-console` daemon. Deprecated for use with Grizzly. Instead, the `nova-xvpnvncproxy` is used.

- `nova-xvpnvncproxy` daemon. A proxy for accessing running instances through a VNC connection. Supports a Java client specifically designed for OpenStack.

- `nova-cert` daemon. Manages x509 certificates.

### Image Management (EC2 scenario)

- `nova-objectstore` daemon. Provides an S3 interface for registering images with the Image Service. Mainly used for installations that must support euca2ools. The euca2ools tools talk to `nova-objectstore` in *S3 language*, and `nova-objectstore` translates S3 requests into Image Service requests.

- euca2ools client. A set of command-line interpreter commands for managing cloud resources. Though not an OpenStack module, you can configure `nova-api` to support this EC2 interface. For more information, see the Eucalyptus 2.0 Documentation.

### Command Line Interpreter/Interfaces

- nova client. Enables users to submit commands as a tenant administrator or end user.

- nova-manage client. Enables cloud administrators to submit commands.

### Other components

- The queue. A central hub for passing messages between daemons. Usually implemented with RabbitMQ, but could be any AMPQ message queue, such as Apache Qpid or Zero MQ.

- SQL database. Stores most build-time and runtime states for a cloud infrastructure. Includes instance types that are available for use, instances in use, available networks, and projects. Theoretically, OpenStack Compute can support any database that SQL-Alchemy supports, but the only databases widely used are sqlite3 databases (only appropriate for test and development work), MySQL, and PostgreSQL.

The Compute Service interacts with other OpenStack services: Identity Service for authentication, Image Service for images, and the OpenStack Dashboard for a web interface.

# Installing the Nova Controller Services

The OpenStack Compute Service is a collection of services that allow you to spin up virtual machine instances. These services can be configured to run on separate nodes or all on the same system. In this guide, we run most of the services on the controller node, and use a dedicated compute node to run the service that launches virtual machines. This section details the installation and configuration on the controller node.

## Install the Nova Controller Services

1. Install the following Nova packages. These packages provide the OpenStack Compute services that will be run on the controller node in this guide.

```
# apt-get install nova-novncproxy novnc nova-api \
  nova-ajax-console-proxy nova-cert nova-conductor \
  nova-consoleauth nova-doc nova-scheduler
```

2. The Compute Service stores information in a database. This guide uses the MySQL database used by other OpenStack services.

   Specify the location of the database in the configuration files. Replace *NOVA_DBPASS* with a Compute Service password of your choosing.

   Edit `/etc/nova/nova.conf` and add the `[database]` section.

```
...
[database]
# The SQLAlchemy connection string used to connect to the database
connection = mysql://nova:NOVA_DBPASS@controller/nova
```

3. Next, we need to create a database user called `nova`, by logging in as root using the password we set earlier.

```
# mysql -u root -p
mysql> CREATE DATABASE nova;
mysql> GRANT ALL PRIVILEGES ON nova.* TO 'nova'@'localhost' \
IDENTIFIED BY 'NOVA_DBPASS';
mysql> GRANT ALL PRIVILEGES ON nova.* TO 'nova'@'%' \
IDENTIFIED BY 'NOVA_DBPASS';
```

4. We now create the tables for the nova service.

```
# nova-manage db sync
```

5. Set the configuration keys `my_ip`, `vncserver_listen`, and `vncserver_proxyclient_address` to the internal IP address of the controller node.

   Edit `/etc/nova/nova.conf` and add to the `[DEFAULT]` section.

```
...
[DEFAULT]
...
my_ip=192.168.0.10
vncserver_listen=192.168.0.10
vncserver_proxyclient_address=192.168.0.10
```

6. Create a user called `nova` that the Compute Service can use to authenticate with the Identity Service. Use the `service` tenant and give the user the `admin` role.

```
# keystone user-create --name=nova --pass=NOVA_PASS --email=nova@example.
com
# keystone user-role-add --user=nova --tenant=service --role=admin
```

7. For the Compute Service to use these credentials, you must alter the `nova.conf` configuration file.

   Edit `/etc/nova/nova.conf` and add to the `[DEFAULT]` section.

```
...
[DEFAULT]
...
auth_strategy=keystone
```

8. Add the credentials to the file `/etc/nova/api-paste.ini`. Open the file in a text editor and locate the section `[filter:authtoken]`. Make sure the following options are set:

```
[filter:authtoken]
paste.filter_factory=keystoneclient.middleware.auth_token:filter_factory
auth_host=controller
auth_uri=http://controller:5000
admin_tenant_name=service
admin_user=nova
admin_password=NOVA_PASS
```

9. You have to register the Compute Service with the Identity Service so that other OpenStack services can locate it. Register the service and specify the endpoint using the **keystone** command.

```
# keystone service-create --name=nova --type=compute \
  --description="Nova Compute Service"
```

10. Note the `id` property returned and use it when creating the endpoint.

```
# keystone endpoint-create \
  --service-id=the_service_id_above \
  --publicurl=http://controller:8774/v2/%\(tenant_id\)s \
  --internalurl=http://controller:8774/v2/%\(tenant_id\)s \
  --adminurl=http://controller:8774/v2/%\(tenant_id\)s
```

11. Configure the Compute Service to use the RabbitMQ message broker by setting the following configuration keys. Add them in the `DEFAULT` configuration group of the `/etc/nova/nova.conf` file.

```
rpc_backend = nova.rpc.impl_kombu
rabbit_host = controller
```

12. Finally, restart the various Nova services.

```
# service nova-api restart
# service nova-cert restart
# service nova-consoleauth restart
# service nova-scheduler restart
# service nova-conductor restart
# service nova-novncproxy restart
```

13. To verify that everything is configured correctly, use the **nova image-list** to get a list of available images. The output is similar to the output of **glance image-list**.

```
# nova image-list
+--------------------------------------+-----------------+--------
+--------+
| ID                                   | Name            | Status | Server
 |
+--------------------------------------+-----------------+--------
+--------+
| acafc7c0-40aa-4026-9673-b879898e1fc2 | CirrOS 0.3.1    | ACTIVE |
 |
+--------------------------------------+-----------------+--------
+--------+
```

# Configuring a Compute Node

After configuring the Compute Services on the controller node, configure a second system to be a Compute node. The Compute node receives requests from the controller node and hosts virtual machine instances. You can run all services on a single node, but this guide uses separate systems. This makes it easy to scale horizontally by adding additional Compute nodes following the instructions in this section.

The Compute Service relies on a hypervisor to run virtual machine instances. OpenStack can use various hypervisors, but this guide uses KVM.

## Configure a Compute Node

1. Begin by configuring the system using the instructions in Chapter 2, “Basic Operating System Configuration” [5]. Note the following differences from the controller node:

   - Use different IP addresses when configuring `eth0`. This guide uses `192.168.0.11` for the internal network. Do not configure `eth1` with a static IP address. An IP address will be assigned and configured by the networking component of OpenStack.

   - Set the hostname to `compute1` (this can be checked using `uname -n`). Ensure that the IP addresses and hostnames for both nodes are listed in the `/etc/hosts` file on each system.

   - Follow the instructions in the section called “Network Time Protocol (NTP)” [6] to synchronize from the controller node.

- Install the MySQL client libraries. You do not need to install the MySQL database server or start the MySQL service.
- Enable the OpenStack packages for the distribution you are using, see the section called "OpenStack Packages" [7].

2. After configuring the operating system, install the appropriate packages for the compute service.

   Then do:

   ```
   # apt-get install nova-compute-kvm python-guestfs
   ```

   Select "Yes" when asked to create a supermin appliance during install.

3. Due to this bug that is marked "Won't Fix", guestfs is restricted. Run the following command to relax the restriction:

   ```
   # chmod 0644 /boot/vmlinuz*
   ```

4. Remove the SQLite Database created by the packages

   ```
   # rm /var/lib/nova/nova.sqlite
   ```

5. Set the configuration keys `my_ip`, `vncserver_listen`, and `vncserver_proxyclient_address` to the IP address of the compute node on the internal network.

   Edit `/etc/nova/nova.conf` and add to the `[DEFAULT]` section.

   ```
   [DEFAULT]
   ...
   my_ip=192.168.0.11
   vncserver_listen=0.0.0.0
   vncserver_proxyclient_address=192.168.0.11
   ```

6. Specify the host running the Image Service. Edit `/etc/nova/nova.conf` and add to the `[DEFAULT]` section.

   ```
   [DEFAULT]
   ...
   glance_host=controller
   ```

7. Copy the file `/etc/nova/api-paste.ini` from the *`controller`* node, or edit the file to add the credentials in the `[filter:authtoken]` section.

   ```
   [filter:authtoken]
   paste.filter_factory=keystoneclient.middleware.auth_token:filter_factory
   auth_host=controller
   auth_port = 35357
   auth_protocol = http
   admin_user=nova
   admin_tenant_name=service
   admin_password=NOVA_PASS
   ```

8. Restart the Compute service.

   ```
   # service nova-compute restart
   ```

# Enabling Networking

Configuring Networking can be one of the most bewildering experiences you will encounter when working with OpenStack. To assist in this we have chosen the simplest production-ready configuration for this guide: the legacy networking in OpenStack Compute, with a flat network, that takes care of DHCP.

This setup uses "multi-host" functionality: the networking is configured to be highly available by splitting networking functionality across multiple hosts. As a result, there is no single network controller that acts as a single point of failure. Because each compute node is configured for networking in this setup, no additional networking configuration is required on the controller.

### Note

If you require the full software-defined networking stack, see Using Neutron Networking.

## Enable networking on a compute node

1. After performing initial configuration of the compute node, install the appropriate packages for compute networking.

```
# apt-get install nova-network
```

2. First, set the configuration options needed in `nova.conf` for the chosen networking mode.

Edit `/etc/nova/nova.conf` and add to the `[DEFAULT]` section.

```
[DEFAULT]
...

network_manager=nova.network.manager.FlatDHCPManager
firewall_driver=nova.virt.libvirt.firewall.IptablesFirewallDriver
network_size=254
allow_same_net_traffic=False
multi_host=True
send_arp_for_ha=True
share_dhcp_address=True
force_dhcp_release=True
flat_network_bridge=br100
flat_interface=eth1
public_interface=eth1
rabbit_host=controller
```

3. Restart the network service.

```
# service nova-network restart
```

Finally, you have to create a network that virtual machines can use. You only need to do this once for the entire installation, not for each compute node. Run the **nova network-create** command anywhere your admin user credentials are loaded.

```
# source keystonerc
```

```
# nova network-create vmnet --fixed-range-v4=10.0.0.0/24 \
  --bridge-interface=br100 --multi-host=T
```

# Booting an Image

After you've configured the Compute service, you can now launch an instance. An instance is a virtual machine provisioned by OpenStack on one of the Compute servers. Use the procedure below to launch a low-resource instance using an image you've already downloaded.

### Note

This procedure assumes you have:

- Appropriate environment variables set to specify your credentials (see the section called "Verifying the Identity Service Installation" [13]
- Downloaded an image (see the section called "Verifying the Image Service Installation" [18]).
- Configured networking (see the section called "Enabling Networking" [27]).

## Launch a Compute instance

1. Generate a keypair consisting of a private key and a public key to be able to launch instances on OpenStack. These keys are injected into the instances to make password-less SSH access to the instance. This depends on the way the necessary tools are bundled into the images. For more details, see "Manage instances" in the Administration User Guide.

   ```
   $ ssh-keygen
   $ cd .ssh
   $ nova keypair-add --pub_key id_rsa.pub mykey
   ```

   You have just created a new keypair called mykey. The private key id_rsa is saved locally in ~/.ssh which can be used to connect to an instance launched using mykey as the keypair. You can view available keypairs using the **nova keypair-list** command.

   ```
   $ nova keypair-list
   +--------+-------------------------------------------------+
   |  Name  |                   Fingerprint                   |
   +--------+-------------------------------------------------+
   | mykey  | b0:18:32:fa:4e:d4:3c:1b:c4:6c:dd:cb:53:29:13:82 |
   +--------+-------------------------------------------------+
   ```

2. To launch an instance using OpenStack, you must specify the ID for the flavor you want to use for the instance. A flavor is a resource allocation profile. For example, it specifies how many virtual CPUs and how much RAM your instance will get. To see a list of the available profiles, run the **nova flavor-list** command.

   ```
   $ nova flavor-list
   ```

```
+----+-----------+-----------+------+-----------+------+-------
+-------------+-----------+
| ID | Name      | Memory_MB | Disk | Ephemeral | Swap | VCPUs |
 RXTX_Factor | Is_Public |
+----+-----------+-----------+------+-----------+------+-------
+-------------+-----------+
| 1  | m1.tiny   | 512       | 1    | 0         |      | 1     | 1.0
   | True      |
| 2  | m1.small  | 2048      | 20   | 0         |      | 1     | 1.0
   | True      |
| 3  | m1.medium | 4096      | 40   | 0         |      | 2     | 1.0
   | True      |
| 4  | m1.large  | 8192      | 80   | 0         |      | 4     | 1.0
   | True      |
| 5  | m1.xlarge | 16384     | 160  | 0         |      | 8     | 1.0
   | True      |
+----+-----------+-----------+------+-----------+------+-------
+-------------+-----------+
```

3. Get the ID of the image you would like to use for the instance using the **nova image-list** command.

```
$ nova image-list
+--------------------------------------+--------------+--------+--------+
| ID                                   | Name         | Status | Server |
+--------------------------------------+--------------+--------+--------+
| 9e5c2bee-0373-414c-b4af-b91b0246ad3b | CirrOS 0.3.1 | ACTIVE |        |
+--------------------------------------+--------------+--------+--------+
```

4. Your instances need security group rules to be set for SSH and ping. Refer to the *OpenStack User Guide* for detailed information.

```
# nova secgroup-add-rule default tcp 22 22 0.0.0.0/0
```

```
# nova secgroup-add-rule default icmp -1 -1 0.0.0.0/0
```

5. Create the instance using the **nova boot**.

```
$ nova boot --flavor flavorType --key_name keypairName --
image ID newInstanceName
```

Create an instance using flavor 1 or 2, for example:

```
$ nova boot --flavor 1 --key_name mykey --image 9e5c2bee-0373-414c-b4af-
b91b0246ad3b --security_group default cirrOS
+-------------------------------------
+--------------------------------------+
| Property                             | Value
    |
+-------------------------------------
+--------------------------------------+
| OS-EXT-STS:task_state                | scheduling
    |
| image                                | CirrOS 0.3.1
    |
| OS-EXT-STS:vm_state                  | building
    |
| OS-EXT-SRV-ATTR:instance_name        | instance-00000001
    |
| OS-SRV-USG:launched_at               | None
    |
```

```
| flavor                               | m1.tiny
    |
| id                                   | 3bdf98a0-c767-4247-
bf41-2d147e4aa043 |
| security_groups                      | [{u'name': u'default'}]
    |
| user_id                              | 530166901fa24d1face95cda82cfae56
    |
| OS-DCF:diskConfig                    | MANUAL
    |
| accessIPv4                           |
    |
| accessIPv6                           |
    |
| progress                             | 0
    |
| OS-EXT-STS:power_state               | 0
    |
| OS-EXT-AZ:availability_zone          | nova
    |
| config_drive                         |
    |
| status                               | BUILD
    |
| updated                              | 2013-10-10T06:47:26Z
    |
| hostId                               |
    |
| OS-EXT-SRV-ATTR:host                 | None
    |
| OS-SRV-USG:terminated_at             | None
    |
| key_name                             | mykey
    |
| OS-EXT-SRV-ATTR:hypervisor_hostname  | None
    |
| name                                 | cirrOS
    |
| adminPass                            | DWCDW6FnsKNq
    |
| tenant_id                            | e66d97ac1b704897853412fc8450f7b9
    |
| created                              | 2013-10-10T06:47:23Z
    |
| os-extended-volumes:volumes_attached | []
    |
| metadata                             | {}
    |
+--------------------------------------
+--------------------------------------+
```

### Note

If there is not enough RAM available for the instance, Compute will create the instance, but will not start it (status 'Error').

6. After the instance has been created, it will show up in the output of **nova list** (as the instance is booted up, the status will change from 'BUILD' to 'ACTIVE').

```
$ nova list
+--------------------------------------+-----------+--------+------------
+-------------+----------------+
| ID                                   | Name      | Status | Task State |
 Power State | Networks       |
+--------------------------------------+-----------+--------+------------
+-------------+----------------+
| dcc4a894-869b-479a-a24a-659eef7a54bd | cirrOS    | BUILD  | spawning   |
 NOSTATE     | vmnet=10.0.0.3 |
+--------------------------------------+-----------+--------+------------
+-------------+----------------+
$ nova list
+--------------------------------------+-----------+--------+------------
+-------------+----------------+
| ID                                   | Name      | Status | Task State |
 Power State | Networks       |
+--------------------------------------+-----------+--------+------------
+-------------+----------------+
| dcc4a894-869b-479a-a24a-659eef7a54bd | cirrOS    | ACTIVE | None       |
 Running     | vmnet=10.0.0.3 |
+--------------------------------------+-----------+--------+------------
+-------------+----------------+
```

## Note

You can also retrieve additional details about the specific instance using the **nova show** command.

```
$ nova show dcc4a894-869b-479a-a24a-659eef7a54bd
             +--------------------------------------
+------------------------------------------------------------+
| Property                            | Value
                                   |
+---------------------------------------
+------------------------------------------------------------+
| status                              | ACTIVE
                                   |
| updated                             | 2013-10-16T21:55:24Z
                                   |
| OS-EXT-STS:task_state               | None
                                   |
| OS-EXT-SRV-ATTR:host                | compute-node
                                   |
| key_name                            | mykey
                                   |
| image                               | cirros
 (918a1017-8a1b-41ff-8809-6106ba45366e)          |
| vmnet network                       | 10.0.0.3
                                   |
| hostId                              |
 306d7c693911170ad4e5218f626f531cc68caa45f3a0f70f1aeba94d |
| OS-EXT-STS:vm_state                 | active
                                   |
| OS-EXT-SRV-ATTR:instance_name       | instance-0000000a
                                   |
| OS-SRV-USG:launched_at              | 2013-10-16T21:55:24.
000000                                |
```

```
| OS-EXT-SRV-ATTR:hypervisor_hostname  | compute-node
                                 |
| flavor                               | m1.tiny (1)
                                 |
| id                                   | dcc4a894-869b-479a-
a24a-659eef7a54bd                    |
| security_groups                      | [{u'name': u'default'}]
                                 |
| OS-SRV-USG:terminated_at             | None
                                 |
| user_id                              |
 887ac8736b5b473b9dc3c5430a88b15f                        |
| name                                 | cirrOS
                                 |
| created                              | 2013-10-16T21:54:52Z
                                 |
| tenant_id                            |
 43ab520b2b484578bb6924c0ea926190                        |
| OS-DCF:diskConfig                    | MANUAL
                                 |
| metadata                             | {}
                                 |
| os-extended-volumes:volumes_attached | []
                                 |
| accessIPv4                           |
                                 |
| accessIPv6                           |
                                 |
| progress                             | 0
                                 |
| OS-EXT-STS:power_state               | 1
                                 |
| OS-EXT-AZ:availability_zone          | nova
                                 |
| config_drive                         |
                                 |
+-------------------------------------
+------------------------------------------------------------+
```

7. Once enough time has passed so that the instance is fully booted and initialized and your security groups are set, you can **ssh** into the instance without a password, using the keypair given to **nova boot**. You can obtain the IP address of the instance from the output of **nova list**. You don't need to specify the private key to use, because the private key of the mykey keypair was stored in the default location for the **ssh** client (`~/.ssh/.id_rsa`).

   **Note**

   You must log in to a CirrOS instance as user cirros, not root.

   You can also log in to the cirros account without an ssh key using the password `cubswin:)`

   ```
   $ ssh cirros@10.0.0.3
   ```

# 6. Adding a Dashboard

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The OpenStack dashboard, also known as Horizon, is a Web interface that allows cloud administrators and users to manage various OpenStack resources and services.

The dashboard enables web-based interactions with the OpenStack Compute cloud controller through the OpenStack APIs.

The following instructions show an example deployment configured with an Apache web server.

After you install and configure the dashboard, you can complete the following tasks:

- Customize your dashboard. See section Customize the dashboard in the *Cloud Administrator Guide*.
- Set up session storage for the dashboard. See the section called “Set up session storage for the dashboard” [35].

## System requirements

Before you install the OpenStack dashboard, you must meet the following system requirements:

- OpenStack Compute installation. Enable the Identity Service for user and project management.

  Note the URLs of the Identity Service and Compute endpoints.

- Identity Service user with sudo privileges. Because Apache does not serve content from a root user, users must run the dashboard as an Identity Service user with sudo privileges.
- Python 2.6 or 2.7. The Python version must support Django. The Python version should run on any system, including Mac OS X. Installation prerequisites might differ by platform.

Then, install and configure the dashboard on a node that can contact the Identity Service.

Provide users with the following information so that they can access the dashboard through a web browser on their local machine:

- The public IP address from which they can access the dashboard

- The user name and password with which they can access the dashboard

Your web browser, and that of your users, must support HTML5 and have cookies and JavaScript enabled.

### Note

To use the VNC client with the dashboard, the browser must support HTML5 Canvas and HTML5 WebSockets.

For details about browsers that support noVNC, see https://github.com/kanaka/noVNC/blob/master/README.md, and https://github.com/kanaka/noVNC/wiki/Browser-support, respectively.

# Install the dashboard

Before you can install and configure the dashboard, meet the requirements in the section called "System requirements" [33].

### Note

When you install Object Storage and Identity only, even if you install the Dashboard, it does not pull up projects and is unusable.

For more information about how to deploy the dashboard, see Deploying Horizon.

1. Install the dashboard on the node that can contact the Identity Service as root:

   ```
   # apt-get install memcached libapache2-mod-wsgi openstack-dashboard
   ```

   ### Note for Ubuntu users

   Remove the `openstack-dashboard-ubuntu-theme` package. This theme prevents translations, several menus as well as the network map from rendering correctly:

   ```
   # apt-get remove --purge openstack-dashboard-ubuntu-theme
   ```

2. Modify the value of `CACHES['default']['LOCATION']` in `/etc/openstack-dashboard/local_settings.py` to match the ones set in `/etc/memcached.conf`.

   Open `/etc/openstack-dashboard/local_settings.py` and look for this line:

   ```
   CACHES = {
   'default': {
   'BACKEND' : 'django.core.cache.backends.memcached.MemcachedCache',
   'LOCATION' : '127.0.0.1:11211'
   }
   }
   ```

   ### Notes

   - The address and port must match the ones set in `/etc/memcached.conf`.

If you change the memcached settings, you must restart the Apache web server for the changes to take effect.

- You can use options other than memcached option for session storage. Set the session back-end through the *SESSION_ENGINE* option.
- To change the timezone, use the dashboard or edit the /etc/openstack-dashboard/local_settings.py file.

  Change the following parameter: TIME_ZONE = "UTC"

3. Update the ALLOWED_HOSTSin local_settings.py to include the addresses you wish to access the dashboard from.

   Edit /etc/openstack-dashboard/local_settings.py

```
ALLOWED_HOSTS = ['localhost', 'my-desktop']
```

4. This guide assumes that you are running the Dashboard on the controller node. You can easily run the dashboard on a separate server, by changing the appropriate settings in local_settings.py

   Edit /etc/openstack-dashboard/local_settings.py and change OPENSTACK_HOST to the hostname of your Identity Service.

```
OPENSTACK_HOST = "controller"
```

5. You can now access the dashboard at http://controller/horizon .

   Login with credentials for any user that you created with the OpenStack Identity Service.

# Set up session storage for the dashboard

The dashboard uses Django sessions framework to handle user session data. However, you can use any available session back end. You customize the session back end through the SESSION_ENGINE setting in your local_settings file (on Fedora/RHEL/CentOS: /etc/openstack-dashboard/local_settings, on Ubuntu and Debian: /etc/openstack-dashboard/local_settings.py and on openSUSE: /usr/share/openstack-dashboard/openstack_dashboard/local/local_settings.py).

The following sections describe the pros and cons of each option as it pertains to deploying the dashboard.

## Local memory cache

Local memory storage is the quickest and easiest session back end to set up, as it has no external dependencies whatsoever. It has the following significant drawbacks:

- No shared storage across processes or workers.
- No persistence after a process terminates.

The local memory back end is enabled as the default for Horizon solely because it has no dependencies. It is not recommended for production use, or even for serious development work. Enabled by:

```
SESSION_ENGINE = 'django.contrib.sessions.backends.cache'
CACHES = {
    'BACKEND': 'django.core.cache.backends.locmem.LocMemCache'
}
```

# Key-value stores

You can use applications such as Memcached or Redis for external caching. These applications offer persistence and shared storage and are useful for small-scale deployments and/or development.

## Memcached

Memcached is an high-performance and distributed memory object caching system providing in-memory key-value store for small chunks of arbitrary data.

Requirements:

- Memcached service running and accessible.
- Python module `python-memcached` installed.

Enabled by:

```
SESSION_ENGINE = 'django.contrib.sessions.backends.cache'
CACHES = {
    'BACKEND': 'django.core.cache.backends.memcached.MemcachedCache'
    'LOCATION': 'my_memcached_host:11211',
}
```

## Redis

Redis is an open source, BSD licensed, advanced key-value store. It is often referred to as a data structure server.

Requirements:

- Redis service running and accessible.
- Python modules `redis` and `django-redis` installed.

Enabled by:

```
SESSION_ENGINE = 'django.contrib.sessions.backends.cache'
CACHES = {
    "default": {
        "BACKEND": "redis_cache.cache.RedisCache",
        "LOCATION": "127.0.0.1:6379:1",
        "OPTIONS": {
            "CLIENT_CLASS": "redis_cache.client.DefaultClient",
        }
    }
}
```

## Database

Database-backed sessions are scalable, persistent, and can be made high-concurrency and highly-available.

However, database-backed sessions are one of the slower session storages and incur a high overhead under heavy usage. Proper configuration of your database deployment can also be a substantial undertaking and is far beyond the scope of this documentation.

### To initialize and configure the database:

1. Start the mysql command line client:

   ```
   $ mysql -u root -p
   ```

2. Enter the MySQL root user's password when prompted.

3. To configure the MySQL database, create the dash database:

   ```
   mysql> CREATE DATABASE dash;
   ```

4. Create a MySQL user for the newly-created dash database that has full control of the database:

   ```
   mysql> GRANT ALL ON dash.* TO 'dash'@'%' IDENTIFIED BY 'yourpassword';
   ```

5. Enter quit at the `mysql>` prompt to exit MySQL.

6. In the `local_settings` file (on Fedora/RHEL/CentOS: `/etc/openstack-dashboard/local_settings`, on Ubuntu: `local_settings.py` and on openSUSE: `/usr/share/openstack-dashboard/openstack_dashboard/local/local_settings.py`), change these options:

   ```
   SESSION_ENGINE = 'django.core.cache.backends.db.DatabaseCache'
   DATABASES = {
       'default': {
           # Database configuration here
           'ENGINE': 'django.db.backends.mysql',
           'NAME': 'dash',
           'USER': 'dash',
           'PASSWORD': 'yourpassword',
           'HOST': 'localhost',
           'default-character-set': 'utf8'
       }
   }
   ```

7. After configuring the `local_settings` as shown, you can run the **manage.py syncdb** command to populate this newly-created database.

   ```
   $ /usr/share/openstack-dashboard/manage.py syncdb
   ```

   As a result, the following output is returned:

   ```
   Installing custom SQL ...
   Installing indexes ...
   DEBUG:django.db.backends:(0.008) CREATE INDEX `django_session_c25c2c28` ON
    `django_session` (`expire_date`);; args=()
   No fixtures found.
   ```

8. On Ubuntu: If you want to avoid a warning when you restart apache2, create a blackhole directory in the dashboard directory, as follows:

   ```
   # sudo mkdir -p /var/lib/dash/.blackhole
   ```

9. Restart Apache to pick up the default site and symbolic link settings:

   On Ubuntu:

   ```
   # /etc/init.d/apache2 restart
   ```

   On Fedora/RHEL/CentOS:

   ```
   # service httpd restart
   ```

   ```
   # service apache2 restart
   ```

   On openSUSE:

   ```
   # systemctl restart apache2.service
   ```

10. On Ubuntu, restart the `nova-api` service to ensure that the API server can connect to the dashboard without error:

    ```
    # sudo restart nova-api
    ```

# Cached database

To mitigate the performance issues of database queries, you can use the Django cached_db session back end, which utilizes both your database and caching infrastructure to perform write-through caching and efficient retrieval.

Enable this hybrid setting by configuring both your database and cache, as discussed previously. Then, set the following value:

```
SESSION_ENGINE = "django.contrib.sessions.backends.cached_db"
```

# Cookies

If you use Django 1.4 or later, the signed_cookies back end avoids server load and scaling problems.

This back end stores session data in a cookie, which is stored by the user's browser. The back end uses a cryptographic signing technique to ensure session data is not tampered with during transport. This is not the same as encryption; session data is still readable by an attacker.

The pros of this engine are that it requires no additional dependencies or infrastructure overhead, and it scales indefinitely as long as the quantity of session data being stored fits into a normal cookie.

The biggest downside is that it places session data into storage on the user's machine and transports it over the wire. It also limits the quantity of session data that can be stored.

See the Django cookie-based sessions documentation.

# 7. Adding Block Storage

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The OpenStack Block Storage service works though the interaction of a series of daemon processes named cinder-* that reside persistently on the host machine or machines. The binaries can all be run from a single node, or spread across multiple nodes. They can also be run on the same node as other OpenStack services. The following sections explain the Block Storage components as well as how to configure and install Block Storage.

# Block Storage Service

The Block Storage Service enables management of volumes, volume snapshots, and volume types. It includes the following components:

- `cinder-api`. Accepts API requests and routes them to `cinder-volume` for action.
- `cinder-volume`. Responds to requests to read from and write to the Object Storage database to maintain state, interacting with other processes (like `cinder-scheduler`) through a message queue and directly upon block storage providing hardware or software. It can interact with a variety of storage providers through a driver architecture.
- `cinder-scheduler` daemon. Like the `nova-scheduler`, picks the optimal block storage provider node on which to create the volume.
- Messaging queue. Routes information between the Block Storage Service processes.

The Block Storage Service interacts with Compute to provide volumes for instances.

# Configure a Block Storage controller

To create the components that control the Block Storage Service, complete the following steps on the controller node.

You can configure OpenStack to use various storage systems. The examples in this guide show you how to configure LVM.

1. Install the appropriate packages for the Block Storage Service.

   ```
   # apt-get install cinder-api cinder-scheduler
   ```

2. The Block Storage Service stores volume information in a database. The examples in this section use the MySQL database that is used by other OpenStack services.

   Configure the Block Storage Service to use the database. Replace *`CINDER_DBPASS`* with a password of your choosing.

Edit `/etc/cinder/cinder.conf` and change the `[database]` section.

```
[database]
        ...
        # The SQLAlchemy connection string used to connect to the
        # database (string value)
        connection = mysql://cinder:CINDER_DBPASS@localhost/cinder
        ...
```

3. Use the password that you set in the previous example to log in as root to create a `cinder` database.

```
# mysql -u root -p
mysql> CREATE DATABASE cinder;
mysql> GRANT ALL PRIVILEGES ON cinder.* TO 'cinder'@'localhost' \
IDENTIFIED BY 'CINDER_DBPASS';
mysql> GRANT ALL PRIVILEGES ON cinder.* TO 'cinder'@'%' \
IDENTIFIED BY 'CINDER_DBPASS';
```

4. Create the database tables for the Block Storage Service.

```
# cinder-manage db sync
```

5. Create a `cinder` user. The Block Storage Service use this user to authenticate with the Identity Service. Use the `service` tenant and give the user the `admin` role.

```
# keystone user-create --name=cinder --pass=CINDER_PASS --
email=cinder@example.com
# keystone user-role-add --user=cinder --tenant=service --role=admin
```

6. Add the credentials to the file `/etc/cinder/api-paste.ini`. Open the file in a text editor and locate the section `[filter:authtoken]`. Set the following options:

```
[filter:authtoken]
paste.filter_factory=keystoneclient.middleware.auth_token:filter_factory
auth_host=controller
auth_port = 35357
auth_protocol = http
admin_tenant_name=service
admin_user=cinder
admin_password=CINDER_PASS
```

7. Register the Block Storage Service with the Identity Service so that other OpenStack services can locate it. Register the service and specify the endpoint using the **keystone** command.

```
# keystone service-create --name=cinder --type=volume \
  --description="Cinder Volume Service"
```

Note the `id` property returned and use it to create the endpoint.

```
# keystone endpoint-create \
  --service-id=the_service_id_above \
  --publicurl=http://controller:8776/v1/%\(tenant_id\)s \
  --internalurl=http://controller:8776/v1/%\(tenant_id\)s \
  --adminurl=http://controller:8776/v1/%\(tenant_id\)s
```

8. Also register a service and endpoint for version 2 of the Block Storage Service API.

```
# keystone service-create --name=cinder --type=volumev2 \
  --description="Cinder Volume Service V2"
```

Note the id property returned and use it to create the endpoint.

```
# keystone endpoint-create \
  --service-id=the_service_id_above \
  --publicurl=http://controller:8776/v2/%\(tenant_id\)s \
  --internalurl=http://controller:8776/v2/%\(tenant_id\)s \
  --adminurl=http://controller:8776/v2/%\(tenant_id\)s
```

9. Restart the cinder service with its new settings:

```
# service cinder-scheduler restart
        # service cinder-api restart
```

# Configure a Block Storage node

After you configure the services on the controller node, configure a second system to be a Block Storage node. This node contains the disk that serves volumes.

You can configure OpenStack to use various storage systems. The examples in this guide show how to configure LVM.

1. Use the instructions in Chapter 2, "Basic Operating System Configuration" [5] to configure the system. Note the following differences from the controller node:

   - Set the host name to `block1`. Ensure that the IP addresses and host names for both nodes are listed in the `/etc/hosts` file on each system.

   - Follow the instructions in the section called "Network Time Protocol (NTP)" [6] to synchronize from the controller node.

2. Create the LVM physical and logical volumes. This guide assumes a second disk `/dev/sdb` that is used for this purpose.

```
# pvcreate /dev/sdb
# vgcreate cinder-volumes /dev/sdb
```

3. Add a filter entry to the devices section `/etc/lvm/lvm.conf` to keep LVM from scanning devices used by virtual machines.

   ### Note

   You must add required physical volumes for LVM on the Cinder host. Run the **pvdisplay** command to get a list or required volumes.

   Each item in the filter array starts with either an "a" for accept, or an "r" for reject. Physical volumes that are needed on the Cinder host begin with "a". The array must end with "`r/.*/`" to reject any device not listed.

   In this example, `/dev/sda1` is the volume where the volumes for the operating system for the node reside, while `/dev/sdb` is the volume reserved for `cinder-volumes`.

```
devices {
...
filter = [ "a/sda1/", "a/sdb/", "r/.*/"]
...
}
```

4. After you configure the operating system, install the appropriate packages for the Block Storage service.

   ```
   # apt-get install cinder-volume lvm2
   ```

5. Copy the `/etc/cinder/api-paste.ini` file from the controller, or open the file in a text editor and locate the section `[filter:authtoken]`. Make sure the following options are set:

   ```
   [filter:authtoken]
   paste.filter_factory=keystoneclient.middleware.auth_token:filter_factory
   auth_host=controller
   auth_port = 35357
   auth_protocol = http
   admin_tenant_name=service
   admin_user=cinder
   admin_password=CINDER_PASS
   ```

6. Configure the Block Storage Service to use the RabbitMQ message broker by setting the following configuration keys. They are found in the DEFAULT configuration group of the `/etc/cinder/cinder.conf` file.

   ```
   rpc_backend = cinder.openstack.common.rpc.impl_kombu
   rabbit_host = controller
   rabbit_port = 5672
   # Change the following settings if you're not using the default RabbitMQ
    configuration
   #rabbit_userid = guest
   #rabbit_password = guest
   #rabbit_virtual_host = /nova
   ```

7. Configure the Block Storage Service on this Block Storage node to use the cinder database on the controller node.

   Edit `/etc/cinder/cinder.conf` and change the `[database]` section.

   ```
   [database]
   ...
   # The SQLAlchemy connection string used to connect to the
   # database (string value)
   connection = mysql://cinder:CINDER_DBPASS@controller/cinder
   ...
   ```

8. Restart the cinder service with its new settings.

   ```
   # service cinder-volume restart
   # service tgt restart
   ```

# 8. Adding Object Storage

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The OpenStack Object Storage services work together to provide object storage and retrieval through a REST API. For this example architecture, it's assumed you have the Identity Service (keystone) installed already.

# Object Storage Service

The Object Storage Service is a highly scalable and durable multi-tenant object storage system for large amounts of unstructured data at low cost through a RESTful http API.

It includes the following components:

- Proxy Servers (`swift-proxy-server`). Accepts Object Storage API and raw HTTP requests to upload files, modify metadata, and create containers. It also serves file or container listings to web browsers. To improve performance, the proxy server can use an optional cache usually deployed with memcache.
- Account servers (`swift-account-server`). Manage accounts defined with the Object Storage Service.
- Container servers (`swift-container-server`). Manage a mapping of containers, or folders, within the Object Storage Service.
- Object servers (`swift-object-server`). Manage actual objects, such as files, on the storage nodes.
- A number of periodic processes. Performs housekeeping tasks on the large data store. The replication services ensure consistency and availability through the cluster. Other periodic processes include auditors, updaters, and reapers.

Configurable WSGI middleware, which is usually the Identity Service, handles authentication.

# System Requirements

**Hardware**: OpenStack Object Storage is specifically designed to run on commodity hardware.

### Note

When you install Object Storage and Identity only, you cannot use the Dashboard unless you also install Compute and the Image service.

**Table 8.1. Hardware Recommendations**

| Server | Recommended Hardware | Notes |
|---|---|---|
| Object Storage object servers | Processor: dual quad core<br><br>Memory: 8 or 12 GB RAM<br><br>Disk space: optimized for cost per GB<br><br>Network: one 1 GB Network Interface Card (NIC) | The amount of disk space depends on how much you can fit into the rack efficiently. You want to optimize these for best cost per GB while still getting industry-standard failure rates. At Rackspace, our storage servers are currently running fairly generic 4U servers with 24 2T SATA drives and 8 cores of processing power. RAID on the storage drives is not required and not recommended. Swift's disk usage pattern is the worst case possible for RAID, and performance degrades very quickly using RAID 5 or 6.<br><br>As an example, Rackspace runs Cloud Files storage servers with 24 2T SATA drives and 8 cores of processing power. Most services support either a worker or concurrency value in the settings. This allows the services to make effective use of the cores available. |
| Object Storage container/account servers | Processor: dual quad core<br><br>Memory: 8 or 12 GB RAM<br><br>Network: one 1 GB Network Interface Card (NIC) | Optimized for IOPS due to tracking with SQLite databases. |
| Object Storage proxy server | Processor: dual quad core<br><br>Network: one 1 GB Network Interface Card (NIC) | Higher network throughput offers better performance for supporting many API requests.<br><br>Optimize your proxy servers for best CPU performance. The Proxy Services are more CPU and network I/O intensive. If you are using 10g networking to the proxy, or are terminating SSL traffic at the proxy, greater CPU power will be required. |

**Operating System**: OpenStack Object Storage currently runs on Ubuntu, RHEL, CentOS, Fedora, openSUSE, or SLES.

**Networking**: 1Gpbs or 10 Gbps is suggested internally. For OpenStack Object Storage, an external network should connect the outside world to the proxy servers, and the storage network is intended to be isolated on a private network or multiple private networks.

**Database**: For OpenStack Object Storage, a SQLite database is part of the OpenStack Object Storage container and account management process.

**Permissions**: You can install OpenStack Object Storage either as root or as a user with sudo permissions if you configure the sudoers file to enable all the permissions.

# Object Storage Network Planning

For both conserving network resources and ensuring that network administrators understand the needs for networks and public IP addresses for providing access to the APIs and storage network as necessary, this section offers recommendations and required minimum sizes. Throughput of at least 1000 Mbps is suggested.

This document refers to three networks. One is a public network for connecting to the Proxy server. The second is a storage network that is not accessible from outside the cluster, to which all of the nodes are connected. The third is a replication network that is also isolated from outside networks and dedicated to replication traffic between Storage nodes.

The public and storage networks are mandatory. The replication network is optional and must be configured in the Ring.

By default, all of the OpenStack Object Storage services, as well as the rsync daemon on the Storage nodes, are configured to listen on their `STORAGE_LOCAL_NET` IP addresses.

If a replication network is configured in the Ring, then Account, Container and Object servers listen on both the `STORAGE_LOCAL_NET` and `STORAGE_REPLICATION_NET` IP addresses. The rsync daemon will only listen on the `STORAGE_REPLICATION_NET` IP address in this case.

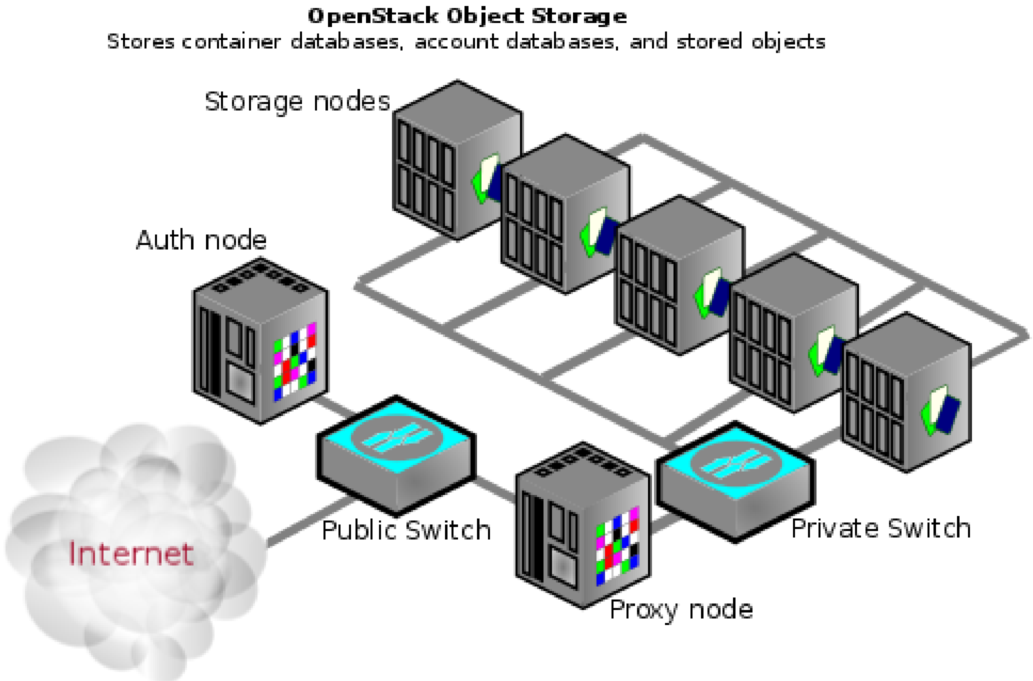
| | |
|---|---|
| Public Network (Publicly routable IP range) | This network provides public IP accessibility to the API endpoints within the cloud infrastructure.<br><br>Minimum size: one IP address per proxy server. |
| Storage Network (RFC1918 IP Range, not publicly routable) | This network is utilized for all inter-server communications within the Object Storage infrastructure.<br><br>Minimum size: one IP address per storage node, and proxy server.<br><br>Recommended size: as above, with room for expansion to the largest your cluster will be (For example, 255 or CIDR /24) |
| Replication Network (RFC1918 IP Range, not publicly routable) | This network is utilized for replication-related communications between storage servers within the Object Storage infrastructure.<br><br>Recommended size: as for `STORAGE_LOCAL_NET` |

# Example Object Storage Installation Architecture

- node - a host machine running one or more OpenStack Object Storage services
- Proxy node - node that runs Proxy services
- Storage node - node that runs Account, Container, and Object services
- Ring - a set of mappings of OpenStack Object Storage data to physical devices
- Replica - a copy of an object. The default is to keep 3 copies in the cluster.
- Zone - a logically separate section of the cluster, related to independent failure characteristics.

To increase reliability and performance, you may want to add additional proxy servers.

This document describes each storage node as a separate zone in the ring. It is recommended to have a minimum of 5 zones. A zone is a group of nodes that is as isolated as possible from other nodes (separate servers, network, power, even geography). The ring guarantees that every replica is stored in a separate zone. This diagram shows one possible configuration for a minimal installation.




# Installing OpenStack Object Storage

Though you can install OpenStack Object Storage for development or testing purposes on a single server, a multiple-server installation enables the high availability and redundancy you want in a production distributed object storage system.

If you would like to perform a single node installation for development purposes from source code, use the Swift All In One instructions (Ubuntu) or DevStack (multiple distros). See http://swift.openstack.org/development_saio.html for manual instructions or http://devstack.org for all-in-one including authentication with the OpenStack Identity service (keystone).

## Before You Begin

Have a copy of the operating system installation media on hand if you are installing on a new server.

These steps assume you have set up repositories for packages for your operating system as shown in OpenStack Packages.

This document demonstrates installing a cluster using the following types of nodes:

- One proxy node which runs the swift-proxy-server processes. The proxy server proxies requests to the appropriate storage nodes.

- Five storage nodes that run the swift-account-server, swift-container-server, and swift-object-server processes which control storage of the account databases, the container databases, as well as the actual stored objects.

### Note

Fewer storage nodes can be used initially, but a minimum of 5 is recommended for a production cluster.

## General Installation Steps

1. Install core Swift files and openSSH.

```
# apt-get install swift openssh-server rsync memcached python-netifaces \
  python-xattr python-memcache
```

2. Create and populate configuration directories on all nodes:

```
# mkdir -p /etc/swift
# chown -R swift:swift /etc/swift/
```

3. Create `/etc/swift/swift.conf` on all nodes:

```
[swift-hash]
# random unique string that can never change (DO NOT LOSE)
swift_hash_path_suffix = fLIbertYgibbitZ
```

### Note

The suffix value in `/etc/swift/swift.conf` should be set to some random string of text to be used as a salt when hashing to determine mappings in the ring. This file should be the same on every node in the cluster!

Next, set up your storage nodes and proxy node. In this example we'll use the OpenStack Identity Service, Keystone, for the common auth piece.

# Installing and Configuring the Storage Nodes

### Note

OpenStack Object Storage should work on any modern filesystem that supports Extended Attributes (XATTRS). We currently recommend XFS as it demonstrated the best overall performance for the swift use case after considerable testing and benchmarking at Rackspace. It is also the only filesystem that has been thoroughly tested. Consult the *OpenStack Configuration Reference* for additional recommendations.

1. Install Storage node packages:

```
# apt-get install swift-account swift-container swift-object xfsprogs
```

2. For every device on the node you wish to use for storage, set up the XFS volume (`/dev/sdb` is used as an example). Use a single partition per drive. For example, in a

server with 12 disks you may use one or two disks for the operating system which should not be touched in this step. The other 10 or 11 disks should be partitioned with a single partition, then formatted in XFS.

```
# fdisk /dev/sdb
# mkfs.xfs /dev/sdb1
# echo "/dev/sdb1 /srv/node/sdb1 xfs noatime,nodiratime,nobarrier,logbufs=
8 0 0" >> /etc/fstab
# mkdir -p /srv/node/sdb1
# mount /srv/node/sdb1
# chown -R swift:swift /srv/node
```

3. Create /etc/rsyncd.conf:

```
uid = swift
gid = swift
log file = /var/log/rsyncd.log
pid file = /var/run/rsyncd.pid
address = <STORAGE_LOCAL_NET_IP>

[account]
max connections = 2
path = /srv/node/
read only = false
lock file = /var/lock/account.lock

[container]
max connections = 2
path = /srv/node/
read only = false
lock file = /var/lock/container.lock

[object]
max connections = 2
path = /srv/node/
read only = false
lock file = /var/lock/object.lock
```

4. (Optional) If you want to separate rsync and replication traffic to replication network, set STORAGE_REPLICATION_NET_IP instead of STORAGE_LOCAL_NET_IP:

```
address = <STORAGE_REPLICATION_NET_IP>
```

5. Edit the following line in /etc/default/rsync:

```
RSYNC_ENABLE = true
```

6. Start rsync daemon:

```
# service rsync start
```

> **Note**
>
> The rsync daemon requires no authentication, so it should be run on a local, private network.

7. Create the swift recon cache directory and set its permissions.

```
# mkdir -p /var/swift/recon
```

```
# chown -R swift:swift /var/swift/recon
```

# Installing and Configuring the Proxy Node

The proxy server takes each request and looks up locations for the account, container, or object and routes the requests correctly. The proxy server also handles API requests. You enable account management by configuring it in the `proxy-server.conf` file.

### Note

Swift processes run under a separate user and group, set by configuration options, and referred to as swift:swift. The default user is swift, which may not exist on your system.

1. Install swift-proxy service:

   ```
   # apt-get install swift-proxy memcached python-keystoneclient python-swiftclient python-webob
   ```

2. Create self-signed cert for SSL:

   ```
   # cd /etc/swift
   # openssl req -new -x509 -nodes -out cert.crt -keyout cert.key
   ```

3. Modify memcached to listen on the default interfaces. Preferably this should be on a local, non-public network. Edit the following line in `/etc/memcached.conf`, changing:

   ```
   -l 127.0.0.1
   ```

   to

   ```
   -l <PROXY_LOCAL_NET_IP>
   ```

4. Restart the memcached server:

   ```
   # service memcached restart
   ```

5. Ubuntu only: Because the distribution packages do not include a copy of the keystoneauth middleware, here are steps to ensure the proxy server includes them:

   ```
   $ git clone https://github.com/openstack/swift.git
                   $ cd swift
                   $ python setup.py install
                   $ swift-init proxy start
   ```

6. Create `/etc/swift/proxy-server.conf`:

   ```
   [DEFAULT]
   bind_port = 8888
   user = swift

   [pipeline:main]
   pipeline = healthcheck cache authtoken keystoneauth proxy-server
   ```

```
[app:proxy-server]
use = egg:swift#proxy
allow_account_management = true
account_autocreate = true

[filter:keystoneauth]
use = egg:swift#keystoneauth
operator_roles = Member,admin,swiftoperator

[filter:authtoken]
paste.filter_factory = keystoneclient.middleware.auth_token:filter_factory

# Delaying the auth decision is required to support token-less
# usage for anonymous referrers ('.r:*').
delay_auth_decision = true

# cache directory for signing certificate
signing_dir = /home/swift/keystone-signing

# auth_* settings refer to the Keystone server
auth_protocol = http
auth_host = 192.168.56.3
auth_port = 35357

# the same admin_token as provided in keystone.conf
admin_token = 012345SECRET99TOKEN012345

# the service tenant and swift userid and password created in Keystone
admin_tenant_name = service
admin_user = swift
admin_password = swift

[filter:cache]
use = egg:swift#memcache

[filter:catch_errors]
use = egg:swift#catch_errors

[filter:healthcheck]
use = egg:swift#healthcheck
```

### Note

If you run multiple memcache servers, put the multiple IP:port listings in the [filter:cache] section of the `proxy-server.conf` file like:

```
10.1.2.3:11211,10.1.2.4:11211
```

Only the proxy server uses memcache.

7. Create the *`signing_dir`* and set its permissions accordingly.

```
# mkdir -p /home/swift/keystone-signing
# chown -R swift:swift /home/swift/keystone-signing
```

8. Create the account, container and object rings. The builder command is basically creating a builder file with a few parameters. The parameter with the value of 18 represents 2 ^ 18th, the value that the partition will be sized to. Set this “partition power” value based on the total amount of storage you expect your entire ring to use.

The value of 3 represents the number of replicas of each object, with the last value being the number of hours to restrict moving a partition more than once.

```
# cd /etc/swift
# swift-ring-builder account.builder create 18 3 1
# swift-ring-builder container.builder create 18 3 1
# swift-ring-builder object.builder create 18 3 1
```

9. For every storage device on each node add entries to each ring:

```
# swift-ring-builder account.builder add z<ZONE>-
<STORAGE_LOCAL_NET_IP>:6002[R<STORAGE_REPLICATION_NET_IP>:6005]/<DEVICE>
 100
# swift-ring-builder container.builder add z<ZONE>-
<STORAGE_LOCAL_NET_IP_1>:6001[R<STORAGE_REPLICATION_NET_IP>:6004]/<DEVICE>
 100
# swift-ring-builder object.builder add z<ZONE>-
<STORAGE_LOCAL_NET_IP_1>:6000[R<STORAGE_REPLICATION_NET_IP>:6003]/<DEVICE>
 100
```

### Note

`STORAGE_REPLICATION_NET_IP` is an optional parameter which must be omitted if you do not want to use dedicated network for replication

For example, if you were setting up a storage node with a partition in Zone 1 on IP 10.0.0.1. Storage node has address 10.0.1.1 from replication network. The mount point of this partition is /srv/node/sdb1, and the path in `rsyncd.conf` is /srv/node/, the DEVICE would be sdb1 and the commands would look like:

```
# swift-ring-builder account.builder add z1-10.0.0.1:6002R10.0.1.1:6005/
sdb1 100
# swift-ring-builder container.builder add z1-10.0.0.1:6001R10.0.1.1:6005/
sdb1 100
# swift-ring-builder object.builder add z1-10.0.0.1:6000R10.0.1.1:6005/
sdb1 100
```

### Note

Assuming there are 5 zones with 1 node per zone, ZONE should start at 1 and increment by one for each additional node.

10. Verify the ring contents for each ring:

```
# swift-ring-builder account.builder
# swift-ring-builder container.builder
# swift-ring-builder object.builder
```

11. Rebalance the rings:

```
# swift-ring-builder account.builder rebalance
# swift-ring-builder container.builder rebalance
# swift-ring-builder object.builder rebalance
```

### Note

Rebalancing rings can take some time.

12. Copy the `account.ring.gz`, `container.ring.gz`, and `object.ring.gz` files to each of the Proxy and Storage nodes in /etc/swift.

13. Make sure all the config files are owned by the swift user:

```
# chown -R swift:swift /etc/swift
```

14. Start Proxy services:

```
# service proxy-server start
```

# Start the Storage Nodes Services

Now that the ring files are on each storage node, the services can be started. On each storage node run the following:

```
# service swift-object start
# service swift-object-replicator start
# service swift-object-updater start
# service swift-object-auditor start
# service swift-container start
# service swift-container-replicator start
# service swift-container-updater start
# service swift-container-auditor start
# service swift-account start
# service swift-account-replicator start
# service swift-account-reaper start
# service swift-account-auditor start
# service rsyslog restart
# service memcached restart
```

# OpenStack Object Storage Post Installation

## Verify the Installation

You can run these commands from the proxy server or any server that has access to the Identity Service.

### To verify the installation

1. Export the swift admin password, which you set up as an Identity service admin, and added to the `proxy-server.conf` file, to a variable. You can also set up an openrc file as described in the OpenStack User Guide where the variable is `OS_USERNAME`.

```
$ export OS_PASSWORD=ADMIN_PASS
```

```
$ export OS_AUTH_URL=http://controller:5000/v2.0
```

#### Note

The sample `proxy-server.conf` file uses "swift" for *`ADMIN_PASS`*. If you do not wish to have the swift admin password stored in your shell's history, you can run the following command:

```
$ export SWIFT_PROXY_CONF=/etc/swift/proxy-server.conf export
 OS_PASSWORD=$( grep admin_password ${SWIFT_PROXY_CONF} | awk
 '{ print $NF }' )
```

2. Run the following swift command with the correct Identity Service URL:

```
$ swift -V 2.0 -A $OS_AUTH_URL -U demo:admin -K $ADMINPASS stat
Account: AUTH_11b9758b7049476d9b48f7a91ea11493
Containers: 0
   Objects: 0
     Bytes: 0
Content-Type: text/plain; charset=utf-8
X-Timestamp: 1381434243.83760
X-Trans-Id: txdcdd594565214fb4a2d33-0052570383
X-Put-Timestamp: 1381434243.83760
```

3. Run the following swift commands to upload files to a container (create a test text files if needed):

```
$ swift -V 2.0 -A $OS_AUTH_URL -U demo:admin -K $OS_PASSWORD upload
 myfiles test.txt
$ swift -V 2.0 -A $OS_AUTH_URL -U demo:admin -K $ADMINPASS upload myfiles
 test2.txt
```

4. Run the following swift command to download all files from the ‘myfiles’ container:

```
$ swift -V 2.0 -A $OS_AUTH_URL -U demo:admin -K $ADMINPASS download
 myfiles
```

```
test2.txt [headers 0.267s, total 0.267s, 0.000s MB/s]
test.txt [headers 0.271s, total 0.271s, 0.000s MB/s]
```

## Adding an Additional Proxy Server

For reliability’s sake you may want to have more than one proxy server. You can set up the additional proxy node in the same manner that you set up the first proxy node but with additional configuration steps.

Once you have more than two proxies, you also want to load balance between the two, which means your storage endpoint (what clients use to connect to your storage) also changes. You can select from different strategies for load balancing. For example, you could use round robin DNS, or a software or hardware load balancer (like pound) in front of the two proxies, and point your storage URL to the load balancer.

Configure an initial proxy node for the initial setup, and then follow these additional steps for more proxy servers.

1. Update the list of memcache servers in `/etc/swift/proxy-server.conf` for all the added proxy servers. If you run multiple memcache servers, use this pattern for the multiple IP:port listings:

   ```
   10.1.2.3:11211,10.1.2.4:11211
   ```

   in each proxy server’s conf file:

   ```

   [filter:cache]
   ```

```
use = egg:swift#memcache
memcache_servers = <PROXY_LOCAL_NET_IP>:11211
```

2. Next, copy all the ring information to all the nodes, including your new proxy nodes, and ensure the ring info gets to all the storage nodes as well.

3. After you sync all the nodes, make sure the admin has the keys in `/etc/swift` and the ownership for the ring file is correct.

# 9. Installing OpenStack Networking Service

## Table of Contents



### Warning

This chapter is a bit more adventurous than we would like. We are working on cleanup and improvements to it. Like for the rest of the Installation Guide, feedback via bug reports and patches to improve it are welcome.

## Considerations for OpenStack Networking

Drivers for OpenStack Networking range from software bridges to full control of certain switching hardware. This guide focuses on the Open vSwitch driver. However, the theories presented here should be mostly applicable to other mechanisms, and the *OpenStack Configuration Reference* offers additional information.

For specific OpenStack installation instructions to prepare for installation, see the section called “OpenStack Packages” [7].

### Warning

If you followed the previous chapter to set up networking for your compute node using `nova-network`, this configuration overrides those settings.

## Neutron Concepts

Like Nova Networking, Neutron manages software-defined networking for your OpenStack installation. However, unlike Nova Networking, you can configure Neutron for advanced virtual network topologies, such as per-tenant private networks and more.

Neutron has the following object abstractions: networks, subnets, and routers. Each has functionality that mimics its physical counterpart: networks contain subnets, and routers route traffic between different subnet and networks.

Any given Neutron set up has at least one external network. This network, unlike the other networks, is not merely a virtually defined network. Instead, it represents the view into a slice of the external network that is accessible outside the OpenStack installation. IP addresses on the Neutron external network are accessible by anybody physically on the outside network. Because this network merely represents a slice of the outside network, DHCP is disabled on this network.

In addition to external networks, any Neutron set up has one or more internal networks. These software-defined networks connect directly to the VMs. Only the VMs on any given internal network, or those on subnets connected through interfaces to a similar router, can access VMs connected to that network directly.

For the outside network to access VMs, and vice versa, routers between the networks are needed. Each router has one gateway that is connected to a network and many interfaces that are connected to subnets. Like a physical router, subnets can access machines on other subnets that are connected to the same router, and machines can access the outside network through the gateway for the router.

Additionally, you can allocate IP addresses on an external networks to ports on the internal network. Whenever something is connected to a subnet, that connection is called a port. You can associate external network IP addresses with ports to VMs. This way, entities on the outside network can access VMs.

Neutron also supports *security groups*. Security groups enable administrators to define firewall rules in groups. A VM can belong to one or more security groups, and Neutron applies the rules in those security groups to block or unblock ports, port ranges, or traffic types for that VM.

Each plug-in that Neutron uses has its own concepts. While not vital to operating Neutron, understanding these concepts can help you set up Neutron. All Neutron installations use a core plug-in and a security group plug-in (or just the No-Op security group plug-in). Additionally, Firewall-as-a-service (FWaaS) and Load-balancing-as-a-service (LBaaS) plug-ins are available.

## Open vSwitch Concepts

The Open vSwitch plug-in is one of the most popular core plug-ins. Open vSwitch configurations consists of bridges and ports. Ports represent connections to other things, such as physical interfaces and patch cables. Packets from any given port on a bridge are shared with all other ports on that bridge. Bridges can be connected through Open vSwitch virtual patch cables or through Linux virtual Ethernet cables (`veth`). Additionally, bridges appear as network interfaces to Linux, so you can assign IP addresses to them.

In Neutron, the integration bridge, called `br-int`, connects directly to the VMs and associated services. The external bridge, called `br-ex`, connects to the external network. Finally, the VLAN configuration of the Open vSwitch plug-in uses bridges associated with each physical network.

In addition to defining bridges, Open vSwitch has OpenFlow, which enables you to define networking flow rules. Certain configurations use these rules to transfer packets between VLANs.

Finally, some configurations of Open vSwitch use network namespaces that enable Linux to group adapters into unique namespaces that are not visible to other namespaces, which allows the same network node to manage multiple Neutron routers.

With Open vSwitch, you can use two different technologies to create the virtual networks: GRE or VLANs.

Generic Routing Encapsulation (GRE) is the technology used in many VPNs. It wraps IP packets to create entirely new packets with different routing information. When the new packet reaches its destination, it is unwrapped, and the underlying packet is routed. To use GRE with Open vSwitch, Neutron creates GRE tunnels. These tunnels are ports on a bridge and enable bridges on different systems to act as though they were one bridge, which allows the compute and network nodes to act as one for the purposes of routing.

Virtual LANs (VLANs), on the other hand, use a special modification to the Ethernet header. They add a 4-byte VLAN tag that ranges from 1 to 4094 (the 0 tag is special, and the 4095 tag, made of all ones, is equivalent to an untagged packet). Special NICs, switches, and routers know how to interpret the VLAN tags, as does Open vSwitch. Packets tagged for one VLAN are only shared with other devices configured to be on that VLAN, even through all devices are on the same physical network.

The most common security group driver used with Open vSwitch is the Hybrid IPTables/ Open vSwitch plug-in. It uses a combination for IPTables and OpenFlow rules. Use the IPTables tool to create firewalls and set up NATs on Linux. This tool uses a complex rule system and chains of rules to accommodate the complex rules required by Neutron security groups.

# Install Networking Services

Before you configure individual nodes for Neutron, you must create the required OpenStack components: user, service, database, and one or more endpoints. After you complete the following steps, follow the instructions in the subsections of this guide to set up OpenStack nodes for Neutron.

1. Create a `neutron` database by logging into as root using the password you set previously:

   ```
   # mysql -u root -p
   mysql> CREATE DATABASE neutron;
   mysql> GRANT ALL PRIVILEGES ON neutron.* TO 'neutron'@'localhost' \
   IDENTIFIED BY 'NEUTRON_DBPASS';
   mysql> GRANT ALL PRIVILEGES ON neutron.* TO 'neutron'@'%' \
   IDENTIFIED BY 'NEUTRON_DBPASS';
   ```

2. Create the required user, service, and endpoint so that Neutron can interface with the Identity Service.

   To list the tenant IDs:

   ```
   # keystone tenant-list
   ```

   To list role IDs:

   ```
   # keystone role-list
   ```

   Create a neutron user:

   ```
   # keystone user-create --name=neutron --pass=NEUTRON_PASS --
   email=neutron@example.com
   ```

   Add the user role to the neutron user:

```
# keystone user-role-add --user=neutron --tenant=service --role=admin
```

Create the neutron service:

```
# keystone service-create --name=neutron --type=network \
     --description="OpenStack Networking Service"
```

Create the neutron endpoint. Use the `id` property for the service that was returned in the previous step to create the endpoint:

```
# keystone endpoint-create --service-id the_service_id_above \
                               --publicurl http://controller:9696 \
                               --adminurl http://controller:9696 \
                               --internalurl http://controller:9696
```

# Install networking services on a dedicated network node

## Note

Before you start, set up a machine to be a dedicated network node. Dedicated network nodes should have the following NICs: the management NIC (called *MGMT_INTERFACE*), the data NIC (called *DATA_INTERFACE*), and the external NIC (called *EXTERNAL_INTERFACE*).

The management network handles communication between nodes. The data network handles communication coming to and from VMs. The external NIC connects the network node, and optionally to the controller node, so your VMs can have connectivity to the outside world.

All NICs must have static IPs. However, the data and external NICs have a special set up. For details about Neutron plug-ins, see the section called “Install and configure the Neutron plug-ins” [59].

1. Install the OpenStack Networking service on the network node:

   ```
   # apt-get install neutron-server neutron-dhcp-agent neutron-plugin-openvswitch-agent neutron-l3-agent
   ```

2. Enable packet forwarding and disable packet destination filtering so that the network node can coordinate traffic for the VMs. Edit the `/etc/sysctl.conf` file, as follows:

   ```
   net.ipv4.ip_forward=1
   net.ipv4.conf.all.rp_filter=0
   net.ipv4.conf.default.rp_filter=0
   ```

   ## Note

   With system network-related configurations, you might need to restart the network service to get the configurations to take effect, as follows:

   ```
   # service networking restart
   ```

3. Configure the core networking components. Edit the `/etc/neutron/neutron.conf` file and copying the following under the `keystone_authtoken` section:

```
[keystone_authtoken]
auth_host = controller
auth_port = 35357
auth_protocol = http
admin_tenant_name = service
admin_user = neutron
admin_password = NEUTRON_PASS
```

4. Tell Neutron how to connect to the database. Edit the `[database]` section in the same file, as follows:

   ```
   [database]
   connection = mysql://neutron:NEUTRON_DBPASS@controller/neutron
   ```

5. Edit the `/etc/neutron/api-paste.ini` file by copying the following statements under `[filter:authtoken]` section:

   ```
   [filter:authtoken]
   paste.filter_factory = keystoneclient.middleware.auth_token:filter_factory
   auth_host=controller
   auth_uri=http://controller:5000
   admin_user=neutron
   admin_tenant_name=service
   admin_password=NEUTRON_PASS
   ```

6. Install and configure a networking plug-in. Neutron uses the networking plug-in to perform software-defined networking. For instructions, see instructions. Then, return here.

Now that you've installed and configured a plug-in (you did do that, right?), it is time to configure the remaining parts of Neutron.

1. To perform DHCP on the software-defined networks, Neutron supports several different plug-ins. However, in general, you use the Dnsmasq plug-in. Edit the `/etc/neutron/dhcp_agent.ini` file:

   ```
   dhcp_driver = neutron.agent.linux.dhcp.Dnsmasq
   ```

2. Restart the rest of Neutron:

   ```
   # service neutron-dhcp-agent restart
   # service neutron-l3-agent restart
   ```

3. After you have configured your compute and controller nodes, configure the base networks.

# Install and configure the Neutron plug-ins

## Install the Open vSwitch (OVS) plug-in

1. Install the Open vSwitch plug-in and its dependencies:

   ```
   # apt-get install neutron-plugin-openvswitch-agent openvswitch-switch
   ```

2. Start Open vSwitch and configure it to start when the system boots:

   ```
   # service openvswitch-switch start
   # chkconfig openvswitch-switch on
   ```

3. Regardless of which networking technology you decide to use with Open vSwitch, Neutron, there is some common setup that must be done. You must add the `br-int` integration bridge (this connects to the VMs) and the `br-ex` external bridge (this connects to the outside world).

   ```
   # ovs-vsctl add-br br-int
   # ovs-vsctl add-br br-ex
   ```

4. Add a *port* (connection) from the interface *EXTERNAL_INTERFACE* to br-ex.

   ```
   # ovs-vsctl add-port br-ex EXTERNAL_INTERFACE
   ```

5. Configure the *EXTERNAL_INTERFACE* to not have an IP address and to be in promiscuous mode. Additionally, you must set the newly created `br-ex` interface to have the IP address that formerly belonged to *EXTERNAL_INTERFACE*.

6. There are also some common configuration options which must be set, regardless of the networking technology that you decide to use with Open vSwitch. You must tell L3 agent and DHCP agent you are using OVS. Edit the `/etc/neutron/l3_agent.ini` and `/etc/neutron/dhcp_agent.ini` files (respectively):

   ```
   interface_driver = neutron.agent.linux.interface.OVSInterfaceDriver
   ```

7. Similarly, you must also tell Neutron core to use OVS. Edit the `/etc/neutron/neutron.conf`:

   ```
   core_plugin = neutron.plugins.openvswitch.ovs_neutron_plugin.
   OVSNeutronPluginV2
   ```

8. Tell the L3 and DHCP agents that you want to use namespaces. To do so, edit the `/etc/neutron/l3_agent.ini` and `/etc/neutron/dhcp_agent.ini` files, respectively:

   ```
   use_namespaces = True
   ```

9. Tell the OVS plug-in how to connect to the database. Edit the `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini` file:

   ```
   [database]
   connection = mysql://neutron:NEUTRON_DBPASS@controller/neutron
   ```

10. Choose a networking technology to create the virtual networks. Neutron supports GRE tunneling, VLANs, and VXLANs. This guide shows how to configure GRE tunneling and VLANs.

    GRE tunneling is simpler to set up because it does not require any special configuration from any physical network hardware. However, its protocol makes it difficult to filter traffic on the physical network. Additionally, the following configuration does not use namespaces. You can have only one router for each network node. However, you can enable namespacing, and potentially veth, as described in the section detailing how to use VLANs with OVS).

    On the other hand, VLAN tagging modifies the ethernet header of packets. You can filter packets on the physical network through normal methods. However, not all NICs handle the increased packet size of VLAN-tagged packets well, and you might need to complete additional configuration on physical network hardware to ensure that your

Neutron VLANs do not interfere with any other VLANs on your network, and to ensure that any physical network hardware between nodes does not strip VLAN tags.

> **Note**
>
> While this guide currently enables network namespaces by default, you can disable them if you have issues or your kernel does not support them. Edit the `/etc/neutron/l3_agent.ini` and `/etc/neutron/dhcp_agent.ini` files (respectively):
>
> ```
> use_namespaces = False
> ```
>
> Edit the `/etc/neutron/neutron.conf` file to disable overlapping IP addresses:
>
> ```
> allow_overlapping_ips = False
> ```
>
> > **Note**
> >
> > With network namespaces disabled, you can have only one router for each network node, and overlapping IP addresses are not supported.
>
> You must complete additional steps after you create the initial Neutron virtual networks and router.

11. You should now configure a firewall plug-in. If you do not wish to enforce firewall rules (called *security groups* by Neutron), you can use the `neutron.agent.firewall.NoopFirewall`. Otherwise, you can choose one of the Neutron firewall plug-ins. The most common choice is the Hybrid OVS-IPTables driver, but you can also use the Firewall-as-a-Service driver. Edit the `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini` file:

    ```
    [securitygroup]
    # Firewall driver for realizing neutron security group function.
    firewall_driver = neutron.agent.linux.iptables_firewall.
    OVSHybridIptablesFirewallDriver
    ```

    > **Warning**
    >
    > You must use at least the No-Op firewall. Otherwise, Horizon and other OpenStack services cannot get and set required VM boot options.

12. Restart the OVS plug-in and make sure it starts on boot:

    ```
    # service neutron-plugin-openvswitch-agent restart
    # chkconfig neutron-plugin-openvswitch-agent on
    ```

13. Now, return whence you came!

### Configure the Neutron OVS plug-in for GRE tunneling

1. Tell the OVS plug-in to use GRE tunneling, the `br-int` integration bridge, the `br-tun` tunneling bridge, and a local IP for the *`DATA_INTERFACE`* tunnel IP. Edit the `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini` file:

```
[ovs]
tenant_network_type = gre
tunnel_id_ranges = 1:1000
enable_tunneling = True
integration_bridge = br-int
tunnel_bridge = br-tun
local_ip = DATA_INTERFACE_IP
```

2. Return to the general OVS instructions.

### Configure the Neutron OVS plug-in for VLANs

1. Tell OVS to use VLANS. Edit the `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini` file:

   ```
   [ovs]
   tenant_network_type = vlan
   network_vlan_ranges = physnet1:1:4094
   bridge_mappings = physnet1:br-DATA_INTERFACE
   ```

2. Create the bridge for *DATA_INTERFACE* and add *DATA_INTERFACE* to it:

   ```
   # ovs-vsctl add-br br-DATA_INTERFACE
   # ovs-vsctl add-port br-DATA_INTERFACE DATA_INTERFACE
   ```

3. Transfer the IP address for *DATA_INTERFACE* to the bridge. Do this in the same way that you transferred the *EXTERNAL_INTERFACE* IP address to `br-ex`. However, you do not need to turn on promiscuous mode.

4. Return to the OVS general instruction.

## Create the base Neutron networks

### Note

In the following sections, replace *SPECIAL_OPTIONS* with any options specific to your networking plug-in choices. See here to check if your plug-in requires any special options.

1. Create the external network, called `ext-net` (or something else, your choice). This network represents a slice of the outside world. VMs are not directly linked to this network; instead, they are connected to internal networks. Then, outgoing traffic is routed by Neutron to the external network. Additionally, floating IP addresses from `ext-net`'s subnet may be assigned to VMs so that they may be contacted from the external network. Neutron routes the traffic appropriately.

   ```
   # neutron net-create ext-net -- --router:external=True SPECIAL_OPTIONS
   ```

2. Create the associated subnet with the same gateway and CIDR as *EXTERNAL_INTERFACE*. It does not have DHCP, because it represents a slice of the external world:

   ```
   # neutron subnet-create ext-net \
     --allocation-pool start=FLOATING_IP_START,end=FLOATING_IP_END \
   ```

```
  --gateway=EXTERNAL_INTERFACE_GATEWAY --enable_dhcp=False \
  EXTERNAL_INTERFACE_CIDR
```

3. Create one or more initial tenants. Choose one (call it *DEMO_TENANT*) to use for the following steps.

   Create the router attached to the external network. This router routes traffic to the internal subnets as appropriate (you can create it under the a given tenant: Append `--tenant-id` option with a value of *DEMO_TENANT_ID* to the command).

   ```
   # neutron router-create ext-to-int
   ```

4. Connect the router to `ext-net` by setting the router's gateway as `ext-net`:

   ```
   # neutron router-gateway-set EXT_TO_INT_ID EXT_NET_ID
   ```

5. Create an internal network for *DEMO_TENANT* (and associated subnet over an arbitrary internal IP range, such as, `10.5.5.0/24`), and connect it to the router by setting it as a port:

   ```
   # neutron net-create --tenant-id DEMO_TENANT_ID demo-net SPECIAL_OPTIONS
   # neutron subnet-create --tenant-id DEMO_TENANT_ID demo-net 10.5.5.0/24 --
   gateway 10.5.5.1
   # neutron router-interface-add EXT_TO_INT_ID DEMO_NET_SUBNET_ID
   ```

6. Check your plug-ins special options page for remaining steps. Then, return whence you came.

## Plug-in-specific Neutron Network Options

### Open vSwitch Network configuration options

#### GRE Tunneling Network Options

> **Note**
>
> While this guide currently enables network namespaces by default, you can disable them if you have issues or your kernel does not support them. If you disabled namespaces, you must perform some additional configuration for the L3 agent.
>
> After you create all the networks, tell the L3 agent what the external network ID is, as well as the ID of the router associated with this machine (because you are not using namespaces, there can be only one router for each machine). To do this, edit the `/etc/neutron/l3_agent.ini` file:
>
> ```
> gateway_external_network_id = EXT_NET_ID
> router_id = EXT_TO_INT_ID
> ```
>
> Then, restart the L3 agent
>
> ```
> # service neutron-l3-agent restart
> ```

When creating networks, you should use the options:

```
--provider:network_type gre --provider:segmentation_id SEG_ID
```

*SEG_ID* should be 2 for the external network, and just any unique number inside the tunnel range specified before for any other network.

### Note

These options are not needed beyond the first network, as Neutron automatically increments the segmentation id and copy the network type option for any additional networks.

Return whence you came.

#### VLAN Network Options

When creating networks, use the following options:

```
--provider:network_type vlan --provider:physical_network physnet1 --
provider:segmentation_id SEG_ID
```

*SEG_ID* should be 2 for the external network, and just any unique number inside the vlan range specified above for any other network.

### Note

These options are not needed beyond the first network, as Neutron automatically increments the segmentation ID and copies the network type and physical network options for any additional networks. They are only needed if you wish to modify those values in any way.

### Warning

Some NICs have Linux drivers that do not handle VLANs properly. See the `ovs-vlan-bug-workaround` and `ovs-vlan-test` man pages for more information. Additionally, you might try turning off `rx-vlan-offload` and `tx-vlan-offload` by using `ethtool` on the *DATA_INTERFACE*. Another potential caveat to VLAN functionality is that VLAN tags add an additional 4 bytes to the packet size. If your NICs cannot handle large packets, make sure to set the MTU to a value that is 4 bytes less than the normal value on the *DATA_INTERFACE*.

If you run OpenStack inside a virtualized environment (for testing purposes), switching to the `virtio` NIC type (or a similar technology if you are not using KVM/QEMU to run your host VMs) might solve the issue.

## Install networking support on a dedicated compute node

### Note

This section details set up for any node that runs the `nova-compute` component but does not run the full network stack.

1. Disable packet destination filtering (route verification) to let the networking services route traffic to the VMs. Edit the `/etc/sysctl.conf` file and then restart networking:

```
net.ipv4.conf.all.rp_filter=0
net.ipv4.conf.default.rp_filter=0
```

2. Install and configure your networking plug-in components. To install and configure the network plug-in that you chose when you set up your network node, see the section called “Install and configure the Neutron plug-ins on a dedicated compute node” [65].

3. Configure the core components of Neutron. Edit the `/etc/neutron/neutron.conf` file:

```
auth_host = controller
admin_tenant_name = service
admin_user = neutron
admin_password = NEUTRON_PASS
auth_url = http://controller:35357/v2.0
auth_strategy = keystone
rpc_backend = YOUR_RPC_BACKEND
PUT_YOUR_RPC_BACKEND_SETTINGS_HERE_TOO
```

4. Edit the database URL under the `[database]` section in the above file, to tell Neutron how to connect to the database:

```
[database]
connection = mysql://neutron:NEUTRON_DBPASS@controller/neutron
```

5. Edit the `/etc/neutron/api-paste.ini` file and copying the following statements under `[filter:authtoken]` section:

```
[filter:authtoken]
paste.filter_factory = keystoneclient.middleware.auth_token:filter_factory
auth_host=controller
admin_user=neutron
admin_tenant_name=service
admin_password=NEUTRON_PASS
```

6. You must configure the networking plug-in.

## Install and configure the Neutron plug-ins on a dedicated compute node

### Install the Open vSwitch (OVS) plug-in on a dedicated compute node

1. Install the Open vSwitch plug-in and its dependencies.

2. Start Open vSwitch and configure it to start when the system boots:

```
# service openvswitch-switch start
# chkconfig openvswitch-switch on
```

3. Regardless of which networking technology you chose to use with Open vSwitch, there is some common setup. You must add the `br-int` integration bridge, which connects to the VMs.

```
# ovs-vsctl add-br br-int
```

4. Similarly, there are some common configuration options to be set. You must tell Neutron core to use OVS. Edit the `/etc/neutron/neutron.conf` file:

```
core_plugin = neutron.plugins.openvswitch.ovs_neutron_plugin.
OVSNeutronPluginV2
```

5. Tell the OVS plug-in how to connect to the database. Edit the `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini` file:

```
[database]
connection = mysql://neutron:NEUTRON_DBPASS@controller/neutron
```

6. Configure the networking type that you chose when you set up the network node: either GRE tunneling or VLANs.

7. You must configure a firewall as well. You should use the same firewall plug-in that you chose to use when you set up the network node. To do this, edit `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini` file and set the `firewall_driver` value under the `securitygroup` to the same value used on the network node. For instance, if you chose to use the Hybrid OVS-IPTables plug-in, your configuration looks like this:

```
[securitygroup]
# Firewall driver for realizing neutron security group function.
firewall_driver = neutron.agent.linux.iptables_firewall.
OVSHybridIptablesFirewallDriver
```

**Warning**

You must use at least the No-Op firewall. Otherwise, Horizon and other OpenStack services cannot get and set required VM boot options.

8. After you complete OVS configuration *and the core Neutron configuration after this section*, restart the Neutron Open vSwitch agent, and set it to start at boot:

```
# service neutron-plugin-openvswitch-agent restart
# chkconfig neutron-plugin-openvswitch-agent on
```

9. Now, return to the general OVS instructions.

### Configure the Neutron OVS plug-in for GRE tunneling on a dedicated compute node

1. Tell the OVS plug-in to use GRE tunneling with a `br-int` integration bridge, a `br-tun` tunneling bridge, and a local IP for the tunnel of *DATA_INTERFACE*'s IP Edit the `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini` file:

```
[ovs]
tenant_network_type = gre
tunnel_id_ranges = 1:1000
enable_tunneling = True
integration_bridge = br-int
tunnel_bridge = br-tun
local_ip = DATA_INTERFACE_IP
```

2. Now, return to the general OVS instructions.

### Configure the Neutron OVS plug-in for VLANs on a dedicated compute node

1. Tell OVS to use VLANs. Edit the `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini` file:

```
[ovs]
tenant_network_type = vlan
network_vlan_ranges = physnet1:1:4094
bridge_mappings = physnet1:br-DATA_INTERFACE
```

2. Create the bridge for the *DATA_INTERFACE* and add *DATA_INTERFACE* to it, the same way you did on the network node:

```
# ovs-vsctl add-br br-DATA_INTERFACE
# ovs-vsctl add-port br-DATA_INTERFACE DATA_INTERFACE
```

3. Return to the general OVS instructions.

# Install networking support on a dedicated controller node

## Note

This is for a node which runs the control components of Neutron, but does not run any of the components that provide the underlying functionality (such as the plug-in agent or the L3 agent). If you wish to have a combined controller/compute node follow these instructions, and then those for the compute node.

1. Install the main Neutron server, Neutron libraries for Python, and the Neutron command-line interface (CLI):

2. Configure the core components of Neutron. Edit the `/etc/neutron/neutron.conf` file:

```
auth_host = controller
admin_tenant_name = service
admin_user = neutron
admin_password = NEUTRON_PASS
auth_url = http://controller:35357/v2.0
auth_strategy = keystone
rpc_backend = YOUR_RPC_BACKEND
PUT_YOUR_RPC_BACKEND_SETTINGS_HERE_TOO
```

3. Edit the database URL under the `[database]` section in the above file, to tell Neutron how to connect to the database:

```
[database]
connection = mysql://neutron:NEUTRON_DBPASS@controller/neutron
```

4. Configure the Neutron copy of the `api-paste.ini` at `/etc/neutron/api-paste.ini` file:

```
[filter:authtoken]
EXISTING_STUFF_HERE
admin_tenant_name = service
admin_user = neutron
admin_password = NEUTRON_PASS
```

5. Configure the plug-in you chose when you set up the network node. Follow the instructions and return here.

6. Tell Nova about Neutron. Specifically, you must tell Nova that Neutron will be handling networking and the firewall. Edit the `/etc/nova/nova.conf` file:

```
network_api_class=nova.network.neutronv2.api.API
neutron_url=http://controller:9696
neutron_auth_strategy=keystone
neutron_admin_tenant_name=service
neutron_admin_username=neutron
neutron_admin_password=NEUTRON_PASS
neutron_admin_auth_url=http://controller:35357/v2.0
firewall_driver=nova.virt.firewall.NoopFirewallDriver
security_group_api=neutron
```

### Note

Regardless of which firewall driver you chose when you configure the network and compute nodes, set this driver as the No-Op firewall. The difference is that this is a *Nova* firewall, and because Neutron handles the Firewall, you must tell Nova not to use one.

7. Start neutron-server and set it to start at boot:

```
# service neutron-server start
# chkconfig neutron-server on
```

### Note

Make sure that the plug-in restarted successfully. If you get errors about a missing `plugin.ini` file, make a symlink that points to `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini` with the name `/etc/neutron/plugins.ini`.

# Install and configure the Neutron plug-ins on a dedicated controller node

## Install the Open vSwitch (OVS) plug-in on a dedicated controller node

1. Install the Open vSwitch plug-in:

2. Regardless of which networking technology you chose to use with Open vSwitch, there are some common configuration options which must be set. You must tell Neutron core to use OVS. Edit the `/etc/neutron/neutron.conf` file:

```
core_plugin = neutron.plugins.openvswitch.ovs_neutron_plugin.
OVSNeutronPluginV2
```

3. Tell the OVS plug-in how to connect to the database. Edit the `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini` file:

```
[database]
              connection = mysql://neutron:NEUTRON_DBPASS@controller/
neutron
```

4. Configure the OVS plug-in for the networking type that you chose when you configured the network node: GRE tunneling or VLANs.

### Note

Notice that the dedicated controller node does not actually need to run the Open vSwitch agent or run Open vSwitch itself.

5. Now, return whence you came.

#### Configure the Neutron OVS plug-in for GRE tunneling on a dedicated controller node

1. Tell the OVS plug-in to use GRE tunneling. Edit the `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini` file:

```
[ovs]
tenant_network_type = gre
tunnel_id_ranges = 1:1000
enable_tunneling = True
```

2. Return to the general OVS instructions.

#### Configure the Neutron OVS plug-in for VLANs on a dedicated controller node

1. Tell OVS to use VLANS. Edit the `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini` file, as follows:

```
[ovs]
tenant_network_type = vlan
network_vlan_ranges = physnet1:1:4094
```

2. Return to the general OVS instructions.

# Neutron deployment use cases

This section describes how to configure the Networking service and its components for some typical use cases.

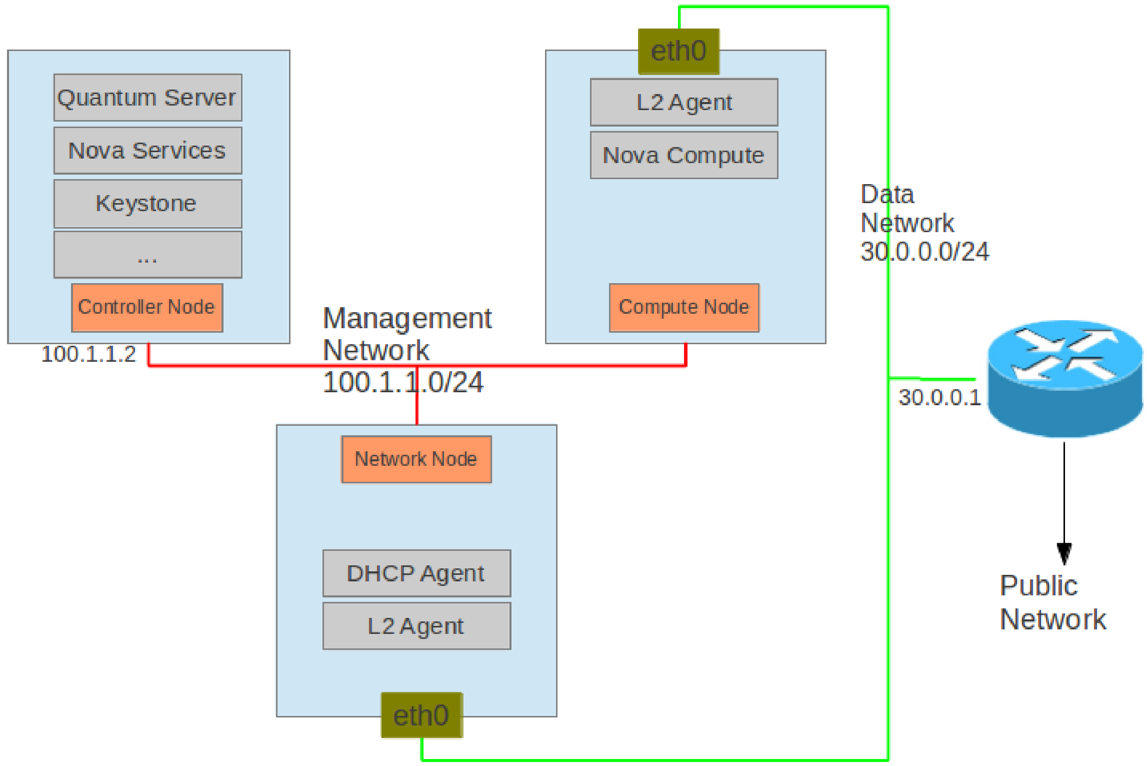
## Single flat network

This section describes how to install the OpenStack Networking service and its components for a single flat network use case.

The following diagram shows the set up. For simplicity, all nodes should have one interface for management traffic and one or more interfaces for traffic to and from VMs. The management network is 100.1.1.0/24 with controller node at 100.1.1.2. The example uses the Open vSwitch plug-in and agent.

### Note

You can modify this set up to make use of another supported plug-in and its agent.




The following table describes some nodes in the set up:

| Node | Description |
|---|---|
| Controller Node | Runs the Networking service, Identity Service, and Compute services that are required to deploy VMs (`nova-api`, `nova-scheduler`, for example). The node must have at least one network interface, which is connected to the Management Network. The host name is `controller`, which every other node resolves to the IP of the controller node. **Note** The nova-network service should not be running. This is replaced by Networking. |
| Compute Node | Runs the OpenStack Networking L2 agent and the Compute services that run VMs (`nova-compute` specifically, and optionally other nova-* services depending on configuration). The node must have at least two network interfaces. The first communicates with the controller node through the management network. The second interface handles the VM traffic on the data network. The VM can receive its IP address from the DHCP agent on this network. |
| Network Node | Runs Networking L2 agent and the DHCP agent. The DHCP agent allocates IP addresses to the VMs on the network. The node must have at least two network interfaces. The first communicates with the controller node through the management network. The second interface handles the VM traffic on the data network. |
| Router | Router has IP 30.0.0.1, which is the default gateway for all VMs. The router must be able to access public networks. |

The demo assumes the following prerequisites:

### Controller node

1. Relevant Compute services are installed, configured, and running.

2. Glance is installed, configured, and running. Additionally, an image must be available.
3. OpenStack Identity is installed, configured, and running. A Networking user **neutron** is in place on tenant **service** with password *NEUTRON_PASS*.
4. Additional services:
   - RabbitMQ is running with default guest and its password.
   - MySQL server (user is **root** and password is **root**).

**Compute node**

1. Compute is installed and configured.

## Install

- **Controller node - Networking server**
  1. Install the Networking server.
  2. Create database **ovs_neutron**.
  3. Update the Networking `/etc/neutron/neutron.conf` configuration file to choose a plug-in and Identity Service user as necessary:

```
[DEFAULT]
core_plugin = neutron.plugins.openvswitch.ovs_neutron_plugin.
OVSNeutronPluginV2
control_exchange = neutron
rabbit_host = controller
notification_driver = neutron.openstack.common.notifier.rabbit_notifier

[keystone_authtoken]
admin_tenant_name=service
admin_user=neutron
admin_password=NEUTRON_PASS
```

  4. Update the plug-in `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini` configuration file:

```
[database]
connection = mysql://root:root@controller:3306/ovs_neutron?charset=utf8
[ovs]
network_vlan_ranges = physnet1
bridge_mappings = physnet1:br-eth0
```

  5. Start the Networking service
- **Compute node - Compute**
  1. Install the `nova-compute` service.
  2. Update the Compute `/etc/nova/nova.conf` configuration file. Make sure the following line is at the end of the file:

```
network_api_class=nova.network.neutronv2.api.API

neutron_admin_username=neutron
neutron_admin_password=NEUTRON_PASS
neutron_admin_auth_url=http://controller:35357/v2.0/
neutron_auth_strategy=keystone
neutron_admin_tenant_name=service
neutron_url=http://controller:9696/

libvirt_vif_driver=nova.virt.libvirt.vif.LibvirtHybridOVSBridgeDriver
```

3. Restart the Compute service

- **Compute and Network node#L2 agent**

1. Install and start Open vSwitch.

2. Install the L2 agent (Neutron Open vSwitch agent).

3. Add the integration bridge to Open vSwitch:

```
# ovs-vsctl add-br br-int
```

4. Update the Networking `/etc/neutron/neutron.conf` configuration file:

```
[DEFAULT]
core_plugin = neutron.plugins.openvswitch.ovs_neutron_plugin.
OVSNeutronPluginV2
control_exchange = neutron
rabbit_host = controller
notification_driver = neutron.openstack.common.notifier.rabbit_notifier
```

5. Update the plug-in `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini` configuration file:

```
[database]
connection = mysql://root:root@controller:3306/ovs_neutron?charset=utf8
[ovs]
network_vlan_ranges = physnet1
bridge_mappings = physnet1:br-eth0
```

6. Create the **br-eth0** network bridge to handle communication between nodes using eth0:

```
# ovs-vsctl add-br br-eth0
# ovs-vsctl add-port br-eth0 eth0
```

7. Start the OpenStack Networking L2 agent.

- **Network node#DHCP agent**

1. Install the DHCP agent.

2. Update the Networking `/etc/neutron/neutron.conf` configuration file:

```
[DEFAULT]
core_plugin = neutron.plugins.openvswitch.ovs_neutron_plugin.
OVSNeutronPluginV2
control_exchange = neutron
rabbit_host = controller
notification_driver = neutron.openstack.common.notifier.rabbit_notifier
```

3. Update the DHCP `/etc/neutron/dhcp_agent.ini` configuration file:

```
interface_driver = neutron.agent.linux.interface.OVSInterfaceDriver
```

4. Start the DHCP agent.

## Configure logical network

Use the following commands on the network node.

### Note

Ensure that the following environment variables are set. Various clients use these variables to access the Identity Service.

```
export OS_USERNAME=admin
export OS_PASSWORD=adminpassword
export OS_TENANT_NAME=admin
export OS_AUTH_URL=http://127.0.0.1:5000/v2.0/
```

1. Get the tenant ID (Used as $TENANT_ID later):

```
# keystone tenant-list
+----------------------------------+---------+---------+
|                id                |   name  | enabled |
+----------------------------------+---------+---------+
| 247e478c599f45b5bd297e8ddbbc9b6a | TenantA |   True  |
| 2b4fec24e62e4ff28a8445ad83150f9d | TenantC |   True  |
| 3719a4940bf24b5a8124b58c9b0a6ee6 | TenantB |   True  |
| 5fcfbc3283a142a5bb6978b549a511ac |   demo  |   True  |
| b7445f221cda4f4a8ac7db6b218b1339 |  admin  |   True  |
+----------------------------------+---------+---------+
```

2. Get the user information:

```
# keystone user-list
+----------------------------------+-------+---------+-------------------+
|                id                |  name | enabled |       email       |
+----------------------------------+-------+---------+-------------------+
| 5a9149ed991744fa85f71e4aa92eb7ec |  demo |   True  |                   |
| 5b419c74980d46a1ab184e7571a8154e | admin |   True  | admin@example.com |
| 8e37cb8193cb4873a35802d257348431 | UserC |   True  |                   |
| c11f6b09ed3c45c09c21cbbc23e93066 | UserB |   True  |                   |
| ca567c4f6c0942bdac0e011e97bddbe3 | UserA |   True  |                   |
+----------------------------------+-------+---------+-------------------+
```

3. Create a internal shared network on the demo tenant ($TENANT_ID is b7445f221cda4f4a8ac7db6b218b1339):

```
$ neutron net-create --tenant-id $TENANT_ID sharednet1 --shared --
provider:network_type flat \
```

```
  --provider:physical_network physnet1
Created a new network:
+---------------------------+--------------------------------------+
| Field                     | Value                                |
+---------------------------+--------------------------------------+
| admin_state_up            | True                                 |
| id                        | 04457b44-e22a-4a5c-be54-a53a9b2818e7 |
| name                      | sharednet1                           |
| provider:network_type     | flat                                 |
| provider:physical_network | physnet1                             |
| provider:segmentation_id  |                                      |
| router:external           | False                                |
| shared                    | True                                 |
| status                    | ACTIVE                               |
| subnets                   |                                      |
| tenant_id                 | b7445f221cda4f4a8ac7db6b218b1339     |
+---------------------------+--------------------------------------+
```

4. Create a subnet on the network:

```
# neutron subnet-create --tenant-id $TENANT_ID sharednet1 30.0.0.0/24
Created a new subnet:
+------------------+--------------------------------------------+
| Field            | Value                                      |
+------------------+--------------------------------------------+
| allocation_pools | {"start": "30.0.0.2", "end": "30.0.0.254"} |
| cidr             | 30.0.0.0/24                                |
| dns_nameservers  |                                            |
| enable_dhcp      | True                                       |
| gateway_ip       | 30.0.0.1                                   |
| host_routes      |                                            |
| id               | b8e9a88e-ded0-4e57-9474-e25fa87c5937       |
| ip_version       | 4                                          |
| name             |                                            |
| network_id       | 04457b44-e22a-4a5c-be54-a53a9b2818e7       |
| tenant_id        | 5fcfbc3283a142a5bb6978b549a511ac           |
+------------------+--------------------------------------------+
```

5. Create a server for tenant A:

```
# nova --os-tenant-name TenantA --os-username UserA --os-password password \
  --os-auth-url=http://localhost:5000/v2.0 boot --image tty --flavor 1 \
  --nic net-id=04457b44-e22a-4a5c-be54-a53a9b2818e7 TenantA_VM1
```

```
# nova --os-tenant-name TenantA --os-username UserA --os-password password \
--os-auth-url=http://localhost:5000/v2.0  list
+--------------------------------------+-------------+--------
+---------------------+
| ID                                   | Name        | Status | Networks
         |
+--------------------------------------+-------------+--------
+---------------------+
| 09923b39-050d-4400-99c7-e4b021cdc7c4 | TenantA_VM1 | ACTIVE | sharednet1=
30.0.0.3 |
+--------------------------------------+-------------+--------
+---------------------+
```

6. Ping the server of tenant A:

```
# ip addr flush eth0
# ip addr add 30.0.0.201/24 dev br-eth0
```

```
$ ping 30.0.0.3
```

7. Ping the public network within the server of tenant A:

```
# ping 192.168.1.1
PING 192.168.1.1 (192.168.1.1) 56(84) bytes of data.
64 bytes from 192.168.1.1: icmp_req=1 ttl=64 time=1.74 ms
64 bytes from 192.168.1.1: icmp_req=2 ttl=64 time=1.50 ms
64 bytes from 192.168.1.1: icmp_req=3 ttl=64 time=1.23 ms
^C
--- 192.168.1.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003ms
rtt min/avg/max/mdev = 1.234/1.495/1.745/0.211 ms
```

**Note**

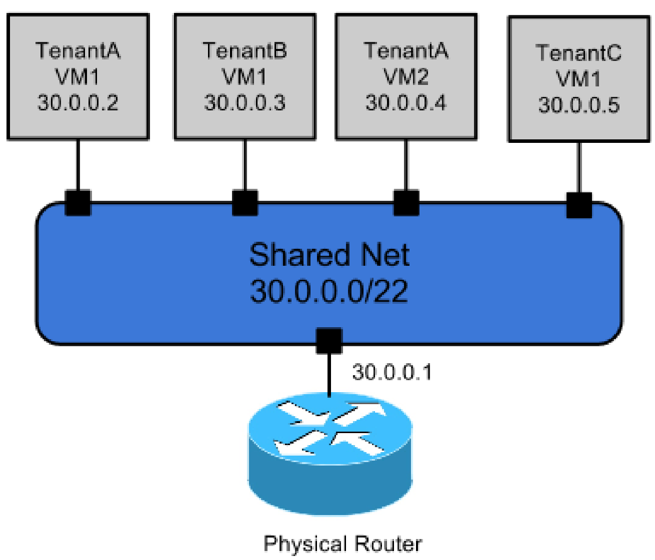
The 192.168.1.1 is an IP on public network to which the router connects.

8. Create servers for other tenants with similar commands. Because all VMs share the same subnet, they can access each other.

## Use case: single flat network

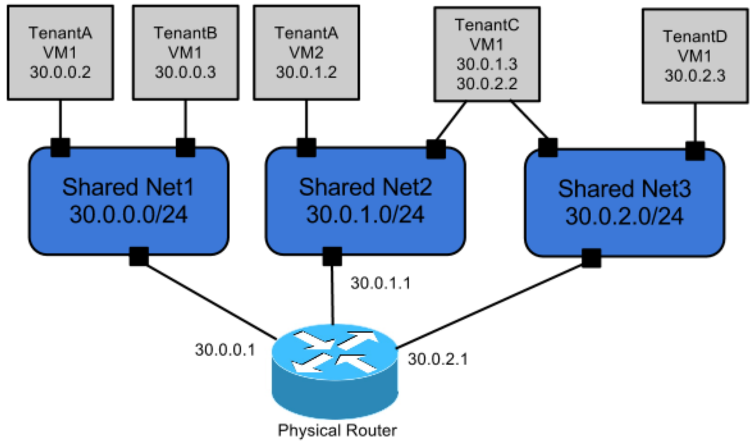
The simplest use case is a single network. This is a "shared" network, meaning it is visible to all tenants via the Networking API. Tenant VMs have a single NIC, and receive a fixed IP address from the subnet(s) associated with that network. This use case essentially maps to the FlatManager and FlatDHCPManager models provided by Compute. Floating IPs are not supported.

This network type is often created by the OpenStack administrator to map directly to an existing physical network in the data center (called a "provider network"). This allows the provider to use a physical router on that data center network as the gateway for VMs to reach the outside world. For each subnet on an external network, the gateway configuration on the physical router must be manually configured outside of OpenStack.



## Use case: multiple flat network

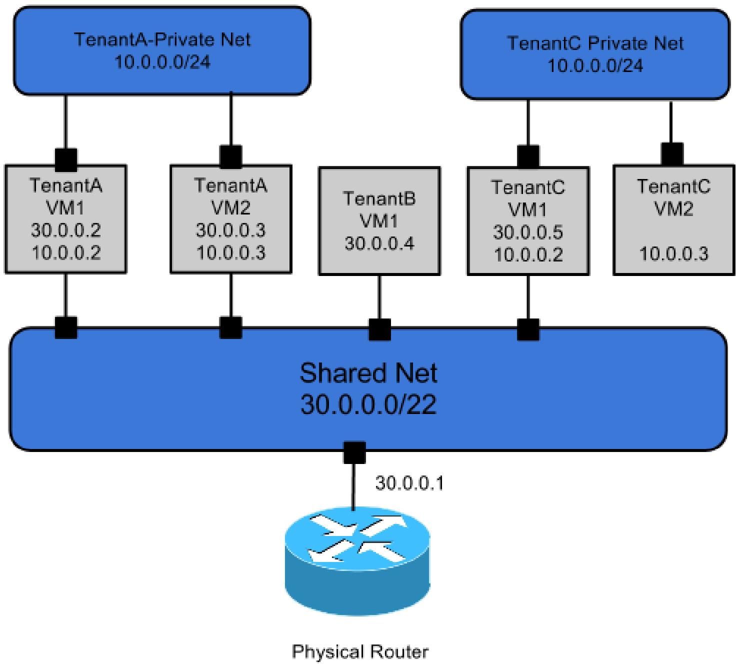
This use case is similar to the above single flat network use case, except that tenants can see multiple shared networks via the Networking API and can choose which network (or networks) to plug into.




## Use case: mixed flat and private network

This use case is an extension of the above Flat Network use cases. In addition to being able to see one or more shared networks via the OpenStack Networking API, tenants can also have access to private per-tenant networks (only visible to tenant users).

Created VMs can have NICs on any of the shared or private networks that the tenant owns. This enables the creation of multi-tier topologies that use VMs with multiple NICs. It also enables a VM to act as a gateway so that it can provide services such as routing, NAT, and load balancing.



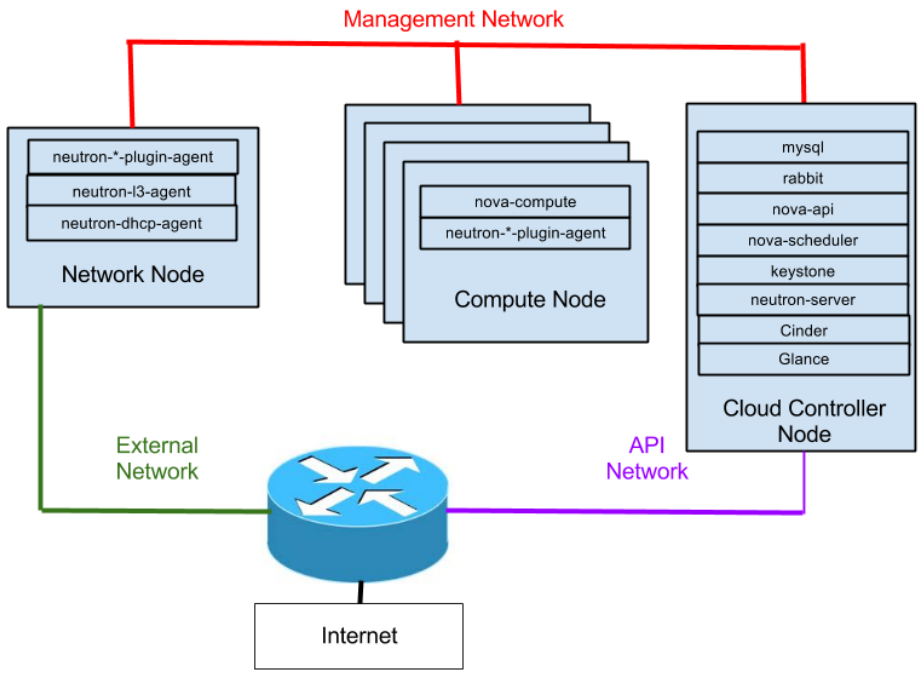

# Provider router with private networks

This section describes how to install the OpenStack Networking service and its components for a single router use case: a provider router with private networks.

The following figure shows the setup:

## Note

Because you run the DHCP agent and L3 agent on one node, you must set `use_namespaces` to `True` (which is the default) in both agents' configuration files.




The following nodes are in the setup:

## Table 9.1. Nodes for use case

| Node | Description |
|---|---|
| Controller | Runs the OpenStack Networking service, OpenStack Identity and all of the OpenStack Compute services that are required to deploy a VM.<br><br>The service must have at least two network interfaces. The first should be connected to the "Management Network" to communicate with the compute and network nodes. The second interface should be connected to the API/ public network. |
| Compute | Runs OpenStack Compute and the OpenStack Networking L2 agent.<br><br>This node will not have access the public network.<br><br>The node must have at least two network interfaces. The first is used to communicate with the controller node, through the management network. The VM will receive its IP address from the DHCP agent on this network. |
| Network | Runs OpenStack Networking L2 agent, DHCP agent, and L3 agent.<br><br>This node will have access to the public network. The DHCP agent will allocate IP addresses to the VMs on the network. The L3 agent will perform NAT and enable the VMs to access the public network.<br><br>The node must have at least three network interfaces. The first communicates with the controller node through the management network. The second interface is |

| Node | Description |
|---|---|
| | used for the VM traffic and is on the data network. The third interface connects to the external gateway on the network. |

# Install

## Controller

### To install and configure the controller node

1. Run the following command:

```
# apt-get install neutron-server
```

2. Configure Neutron services:

   - Edit file /etc/neutron/neutron.conf and modify:

```
core_plugin = neutron.plugins.openvswitch.ovs_neutron_plugin.
OVSNeutronPluginV2
auth_strategy = keystone
fake_rabbit = False
rabbit_password = guest
```

   - Edit file /etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini and modify:

```
[database]
connection = mysql://neutron:NEUTRON_DBPASS@localhost:3306/neutron
[ovs]
tenant_network_type = vlan
network_vlan_ranges = physnet1:100:2999
```

   - Edit file /etc/neutron/api-paste.ini and modify:

```
admin_tenant_name = service
admin_user = neutron
admin_password = NEUTRON_PASS
```

3. Start the services:

```
# service neutron-server restart
```

## Network node

### To install and configure the network node

1. Install the packages:

```
# apt-get install neutron-plugin-openvswitch-agent \
neutron-dhcp-agent neutron-l3-agent
```

2. Start Open vSwitch:

```
# service openvswitch-switch start
```

```
# service openvswitch-switch start
```

```
# chkconfig openvswitch-switch on
```

3. Add the integration bridge to the Open vSwitch:

   ```
   # ovs-vsctl add-br br-int
   ```

4. Update the OpenStack Networking configuration file, `/etc/neutron/neutron.conf`:

   ```
   rabbit_password = guest
   rabbit_host = controller
   ```

5. Update the plug-in configuration file, `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini` :

   ```
   [database]
   connection = mysql://neutron:NEUTRON_DBPASS@controller:3306/neutron
   [ovs]
   tenant_network_type=vlan
   network_vlan_ranges = physnet1:1:4094
   bridge_mappings = physnet1:br-eth1
   ```

6. Create the network bridge **br-eth1** (All VM communication between the nodes occurs through eth1):

   ```
   # ovs-vsctl add-br br-eth1
   # ovs-vsctl add-port br-eth1 eth1
   ```

7. Create the external network bridge to the Open vSwitch:

   ```
   # ovs-vsctl add-br br-ex
   # ovs-vsctl add-port br-ex eth2
   ```

8. Edit the file `/etc/neutron/l3_agent.ini` and modify:

   ```
   [DEFAULT]
   auth_url = http://controller:35357/v2.0
   admin_tenant_name = service
   admin_user = neutron
   admin_password = NEUTRON_PASS
   metadata_ip = controller
   use_namespaces = True
   ```

9. Edit the file `/etc/neutron/api-paste.ini` and modify:

   ```
   [DEFAULT]
   auth_host = controller
   admin_tenant_name = service
   admin_user = neutron
   admin_password = NEUTRON_PASS
   ```

10. Edit the file `/etc/neutron/dhcp_agent.ini` and modify:

    ```
    use_namespaces = True
    ```

11. Restart networking services:

    ```
    # service neutron-plugin-openvswitch-agent start
    # service neutron-dhcp-agent restart
    ```

```
# service neutron-l3-agent restart
```

## Compute Node

### To install and configure the compute node

1. Install the packages:

```
# apt-get install openvswitch-switch neutron-plugin-openvswitch-agent
```

2. Start the OpenvSwitch service:

```
# service openvswitch-switch start
```

```
# service openvswitch-switch start
# chkconfig openvswitch-switch on
```

3. Create the integration bridge:

```
# ovs-vsctl add-br br-int
```

4. Create the network bridge **br-eth1** (All VM communication between the nodes occurs through eth1):

```
# ovs-vsctl add-br br-eth1
# ovs-vsctl add-port br-eth1 eth1
```

5. Update the OpenStack Networking configuration file `/etc/neutron/neutron.conf`:

```
rabbit_password = guest
rabbit_host = controller
```

6. Update the file `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini`:

```
[database]
connection = mysql://neutron:NEUTRON_DBPASS@controller:3306/neutron
[ovs]
tenant_network_type = vlan
network_vlan_ranges = physnet1:1:4094
bridge_mappings = physnet1:br-eth1
```

7. Restart the OpenvSwitch Neutron plug-in agent:

```
# service neutron-plugin-openvswitch-agent restart
```

## Logical Network Configuration

You can run the commands in the following procedures on the network node.

### Note

Ensure that the following environment variables are set. Various clients use these variables to access OpenStack Identity.

- Create a `novarc` file:

```
export OS_TENANT_NAME=provider_tenant
export OS_USERNAME=admin
export OS_PASSWORD=password
export OS_AUTH_URL="http://controller:5000/v2.0/"
export SERVICE_ENDPOINT="http://controller:35357/v2.0"
export SERVICE_TOKEN=password
```

- Export the variables:

```
# source novarc echo "source novarc">>.bashrc
```

The admin user creates a network and subnet on behalf of tenant_A. A user from tenant_A can also complete these steps.

### To configure internal networking

1. Get the tenant ID (Used as $TENANT_ID later).

```
# keystone tenant-list
+----------------------------------+--------------------+---------+
|                id                |        name        | enabled |
+----------------------------------+--------------------+---------+
| 48fb81ab2f6b409bafac8961a594980f |  provider_tenant   |   True  |
| cbb574ac1e654a0a992bfc0554237abf |      service       |   True  |
| e371436fe2854ed89cca6c33ae7a83cd | invisible_to_admin |   True  |
| e40fa60181524f9f9ee7aa1038748f08 |      tenant_A      |   True  |
+----------------------------------+--------------------+---------+
```

2. Create an internal network named **net1** for tenant_A ($TENANT_ID will be e40fa60181524f9f9ee7aa1038748f08):

```
# neutron net-create --tenant-id $TENANT_ID net1
+---------------------------+--------------------------------------+
| Field                     | Value                                |
+---------------------------+--------------------------------------+
| admin_state_up            | True                                 |
| id                        | e99a361c-0af8-4163-9feb-8554d4c37e4f |
| name                      | net1                                 |
| provider:network_type     | vlan                                 |
| provider:physical_network | physnet1                             |
| provider:segmentation_id  | 1024                                 |
| router:external           | False                                |
| shared                    | False                                |
| status                    | ACTIVE                               |
| subnets                   |                                      |
| tenant_id                 | e40fa60181524f9f9ee7aa1038748f08     |
+---------------------------+--------------------------------------+
```

3. Create a subnet on the network **net1** (ID field below is used as $SUBNET_ID later):

```
# neutron subnet-create --tenant-id $TENANT_ID net1 10.5.5.0/24
+------------------+--------------------------------------------+
| Field            | Value                                      |
+------------------+--------------------------------------------+
| allocation_pools | {"start": "10.5.5.2", "end": "10.5.5.254"} |
| cidr             | 10.5.5.0/24                                |
| dns_nameservers  |                                            |
| enable_dhcp      | True                                       |
```

```
| gateway_ip       | 10.5.5.1                                     |
| host_routes      |                                              |
| id               | c395cb5d-ba03-41ee-8a12-7e792d51a167         |
| ip_version       | 4                                            |
| name             |                                              |
| network_id       | e99a361c-0af8-4163-9feb-8554d4c37e4f         |
| tenant_id        | e40fa60181524f9f9ee7aa1038748f08             |
+------------------+----------------------------------------------+
```

A user with the admin role must complete the following steps. In this procedure, the user is admin from provider_tenant.

### To configure the router and external networking

1. Create a router named **router1** (ID is used as $ROUTER_ID later):

```
# neutron router-create router1
+-----------------------+--------------------------------------+
| Field                 | Value                                |
+-----------------------+--------------------------------------+
| admin_state_up        | True                                 |
| external_gateway_info |                                      |
| id                    | 685f64e7-a020-4fdf-a8ad-e41194ae124b |
| name                  | router1                              |
| status                | ACTIVE                               |
| tenant_id             | 48fb81ab2f6b409bafac8961a594980f     |
+-----------------------+--------------------------------------+
```

> **Note**
>
> The `--tenant-id` parameter is not specified, so this router is assigned to the provider_tenant tenant.

2. Add an interface to **router1** and attach it to the subnet from **net1**:

```
# neutron router-interface-add $ROUTER_ID $SUBNET_ID
Added interface to router 685f64e7-a020-4fdf-a8ad-e41194ae124b
```

> **Note**
>
> You can repeat this step to add more interfaces for other networks that belong to other tenants.

3. Create the external network named **ext_net**:

```
# neutron net-create ext_net --router:external=True
+---------------------------+--------------------------------------+
| Field                     | Value                                |
+---------------------------+--------------------------------------+
| admin_state_up            | True                                 |
| id                        | 8858732b-0400-41f6-8e5c-25590e67ffeb |
| name                      | ext_net                              |
| provider:network_type     | vlan                                 |
| provider:physical_network | physnet1                             |
| provider:segmentation_id  | 1                                    |
| router:external           | True                                 |
| shared                    | False                                |
| status                    | ACTIVE                               |
```

```
| subnets                    |                                      |
| tenant_id                  | 48fb81ab2f6b409bafac8961a594980f     |
+----------------------------+--------------------------------------+
```

4. Create the subnet for floating IPs.

**Note**

The DHCP service is disabled for this subnet.

```
# neutron subnet-create ext_net \
--allocation-pool start=7.7.7.130,end=7.7.7.150 \
--gateway 7.7.7.1 7.7.7.0/24 --disable-dhcp
+-------------------+--------------------------------------------------+
| Field             | Value                                            |
+-------------------+--------------------------------------------------+
| allocation_pools  | {"start": "7.7.7.130", "end": "7.7.7.150"}       |
| cidr              | 7.7.7.0/24                                       |
| dns_nameservers   |                                                  |
| enable_dhcp       | False                                            |
| gateway_ip        | 7.7.7.1                                          |
| host_routes       |                                                  |
| id                | aef60b55-cbff-405d-a81d-406283ac6cff             |
| ip_version        | 4                                                |
| name              |                                                  |
| network_id        | 8858732b-0400-41f6-8e5c-25590e67ffeb             |
| tenant_id         | 48fb81ab2f6b409bafac8961a594980f                 |
+-------------------+--------------------------------------------------+
```

5. Set the router's gateway to be the external network:

```
# neutron router-gateway-set $ROUTER_ID $EXTERNAL_NETWORK_ID
Set gateway for router 685f64e7-a020-4fdf-a8ad-e41194ae124b
```

A user from tenant_A completes the following steps, so the credentials in the environment variables are different than those in the previous procedure.

## To allocate floating IP addresses

1. A floating IP address can be associated with a VM after it starts. The ID of the port ($PORT_ID) that was allocated for the VM is required and can be found as follows:

```
# nova list
+--------------------------------------+--------+--------+---------------+
|                  ID                  |  Name  | Status |    Networks   |
+--------------------------------------+--------+--------+---------------+
| 1cdc671d-a296-4476-9a75-f9ca1d92fd26 | testvm | ACTIVE | net1=10.5.5.3 |
+--------------------------------------+--------+--------+---------------+

neutron port-list -- --device_id 1cdc671d-a296-4476-9a75-f9ca1d92fd26
+--------------------------------------+------+-------------------
+---------------------------------------------------------------------------
+
| id                                   | name | mac_address       |
 fixed_ips
       |
+--------------------------------------+------+-------------------
+---------------------------------------------------------------------------
+
```

```
| 9aa47099-b87b-488c-8c1d-32f993626a30 |      | fa:16:3e:b4:d6:6c |
 {"subnet_id": "c395cb5d-ba03-41ee-8a12-7e792d51a167", "ip_address": "10.
5.5.3"} |
+--------------------------------------+------+-------------------
+---------------------------------------------------------------------------------
+
```

2. Allocate a floating IP (Used as $FLOATING_ID):

```
# neutron floatingip-create ext_net
+---------------------+--------------------------------------+
| Field               | Value                                |
+---------------------+--------------------------------------+
| fixed_ip_address    |                                      |
| floating_ip_address | 7.7.7.131                            |
| floating_network_id | 8858732b-0400-41f6-8e5c-25590e67ffeb |
| id                  | 40952c83-2541-4d0c-b58e-812c835079a5 |
| port_id             |                                      |
| router_id           |                                      |
| tenant_id           | e40fa60181524f9f9ee7aa1038748f08     |
+---------------------+--------------------------------------+
```

3. Associate the floating IP with the VM's port:

```
# neutron floatingip-associate $FLOATING_ID $PORT_ID
Associated floatingip 40952c83-2541-4d0c-b58e-812c835079a5
```

4. Show the floating IP:

```
# neutron floatingip-show $FLOATING_ID
+---------------------+--------------------------------------+
| Field               | Value                                |
+---------------------+--------------------------------------+
| fixed_ip_address    | 10.5.5.3                             |
| floating_ip_address | 7.7.7.131                            |
| floating_network_id | 8858732b-0400-41f6-8e5c-25590e67ffeb |
| id                  | 40952c83-2541-4d0c-b58e-812c835079a5 |
| port_id             | 9aa47099-b87b-488c-8c1d-32f993626a30 |
| router_id           | 685f64e7-a020-4fdf-a8ad-e41194ae124b |
| tenant_id           | e40fa60181524f9f9ee7aa1038748f08     |
+---------------------+--------------------------------------+
```

5. Test the floating IP:

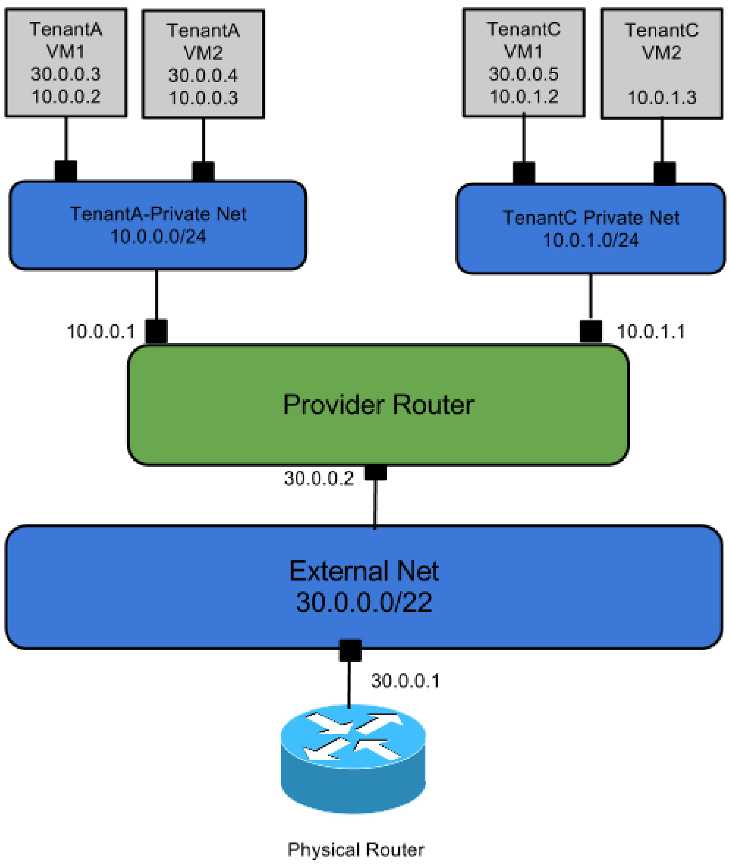
```
# ping 7.7.7.131
PING 7.7.7.131 (7.7.7.131) 56(84) bytes of data.
64 bytes from 7.7.7.131: icmp_req=2 ttl=64 time=0.152 ms
64 bytes from 7.7.7.131: icmp_req=3 ttl=64 time=0.049 ms
```

## Use case: provider router with private networks

This use case provides each tenant with one or more private networks, which connect to the outside world via an OpenStack Networking router. When each tenant gets exactly one network, this architecture maps to the same logical topology as the VlanManager in OpenStack Compute (although of course, OpenStack Networking doesn't require VLANs). Using the OpenStack Networking API, the tenant can only see a network for each private network assigned to that tenant. The router object in the API is created and owned by the cloud administrator.

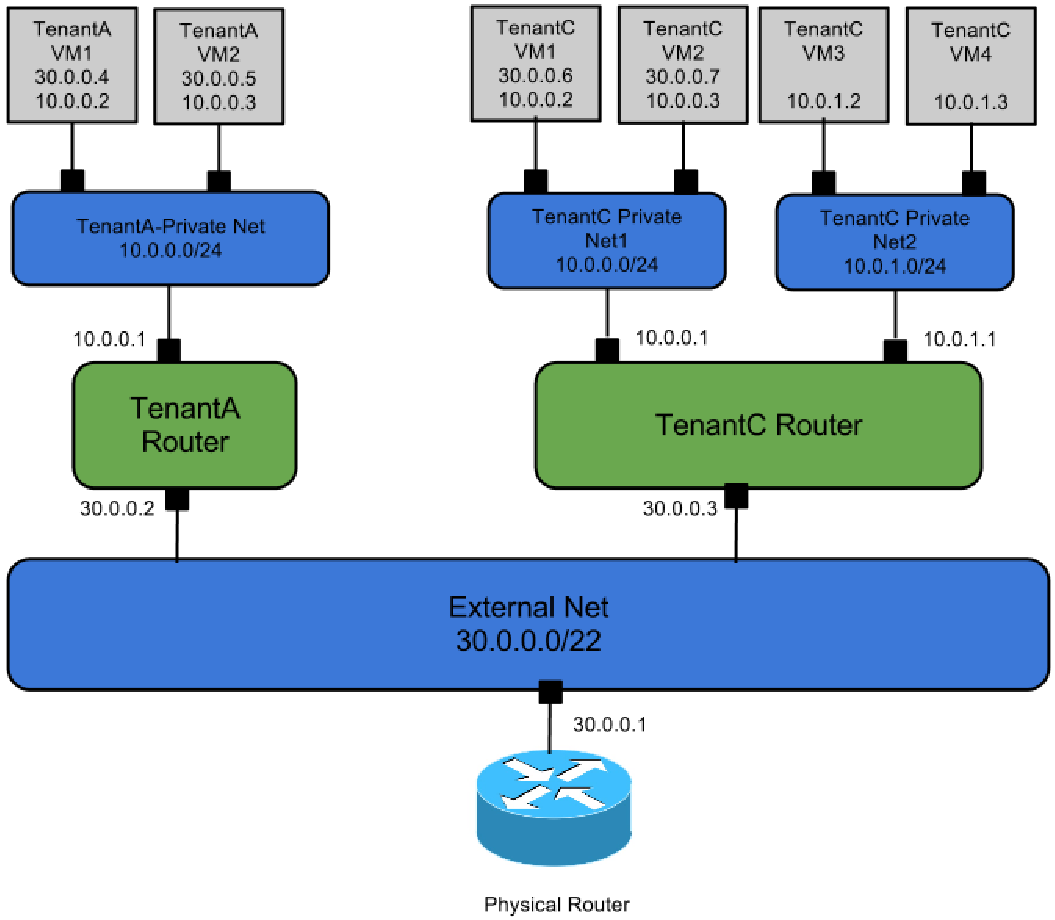
This model supports giving VMs public addresses using "floating IPs", in which the router maps public addresses from the external network to fixed IPs on private networks. Hosts without floating IPs can still create outbound connections to the external network, because the provider router performs SNAT to the router's external IP. The IP address of the physical router is used as the `gateway_ip` of the external network subnet, so the provider has a default router for Internet traffic.

The router provides L3 connectivity between private networks, meaning that different tenants can reach each other's instances unless additional filtering is used (for example, security groups). Because there is only a single router, tenant networks cannot use overlapping IPs. Thus, it is likely that the administrator would create the private networks on behalf of the tenants.

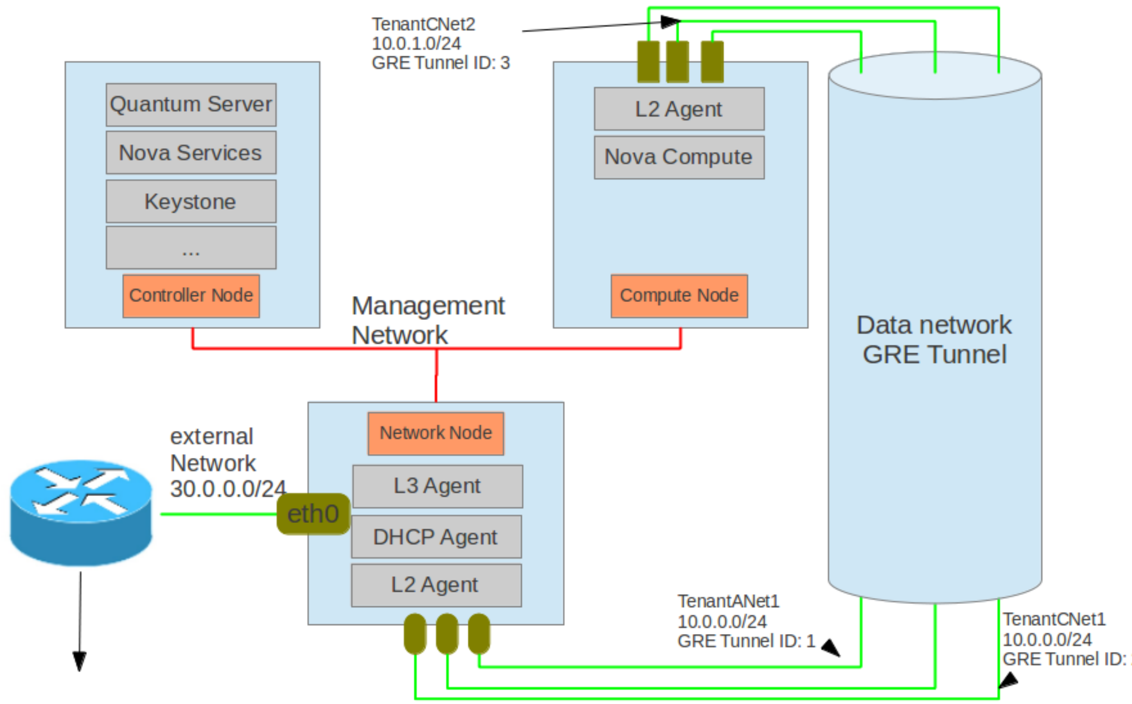



## Per-tenant routers with private networks

This section describes how to install the Networking service and its components for a per-tenant routers with private networks use case.




The following figure shows the setup:




As shown in the figure, the setup includes:

- An interface for management traffic on each node.
- Use of the Open vSwitch plug-in.
- GRE tunnels for data transport on all agents.
- Floating IPs and router gateway ports that are configured in an external network, and a physical router that connects the floating IPs and router gateway ports to the outside world.

## Note

Because this example runs a DHCP agent and L3 agent on one node, you must set the `use_namespace` option to `True` in the configuration file for each agent. The default is `True`.

The following table describes the nodes:

| Node | Description |
|---|---|
| Controller Node | Runs the Networking service, Identity, and all of the Compute services that are required to deploy VMs (`nova-api`, `nova-scheduler`, for example). The node must have at least one network interface, which is connected to the Management Network. The host name is controlnode, which every other node resolves to the IP of the controller node.<br>**Note**<br>The `nova-network` service should not be running. This is replaced by Networking. |
| Compute Node | Runs the Networking L2 agent and the Compute services that run VMs (`nova-compute` specifically, and optionally other `nova-*` services depending on configuration). The node must |

| Node | Description |
|---|---|
| | have at least two network interfaces. One interface communicates with the controller node through the management network. The other node is used for the VM traffic on the data network. The VM receives its IP address from the DHCP agent on this network. |
| Network Node | Runs Networking L2 agent, DHCP agent and L3 agent. This node has access to the external network. The DHCP agent allocates IP addresses to the VMs on data network. (Technically, the addresses are allocated by the Networking server, and distributed by the dhcp agent.) The node must have at least two network interfaces. One interface communicates with the controller node through the management network. The other interface is used as external network. GRE tunnels are set up as data networks. |
| Router | Router has IP 30.0.0.1, which is the default gateway for all VMs. The router must be able to access public networks. |

The use case assumes the following:

**Controller node**

1. Relevant Compute services are installed, configured, and running.
2. Glance is installed, configured, and running. In addition, an image named tty must be present.
3. Identity is installed, configured, and running. A Networking user named **neutron** should be created on tenant **service** with password **NEUTRON_PASS**.
4. Additional services:
    - RabbitMQ is running with default guest and its password
    - MySQL server (user is **root** and password is **root**)

**Compute node**

Compute is installed and configured.

## Install

- **Controller node#Networking server**
    1. Install the Networking server.
    2. Create database **ovs_neutron**.
    3. Update the Networking configuration file, `/etc/neutron/neutron.conf`, with plug-in choice and Identity Service user as necessary:

```
[DEFAULT]
core_plugin = neutron.plugins.openvswitch.ovs_neutron_plugin.
OVSNeutronPluginV2
control_exchange = neutron
rabbit_host = controller
notification_driver = neutron.openstack.common.notifier.rabbit_notifier

[keystone_authtoken]
admin_tenant_name=service
admin_user=neutron
admin_password=NEUTRON_PASS
```

4. Update the plug-in configuration file, `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini`:

   ```
   [database]
   connection = mysql://root:root@controlnode:3306/ovs_neutron?charset=utf8

   [ovs]
   tenant_network_type = gre
   tunnel_id_ranges = 1:1000
   enable_tunneling = True
   ```

5. Start the Networking server

   The Networking server can be a service of the operating system. The command to start the service depends on your operating system. The following command runs the Networking server directly:

   ```
   # neutron-server --config-file /etc/neutron/plugins/openvswitch/
   ovs_neutron_plugin.ini \
     --config-file /etc/neutron/neutron.conf
   ```

- **Compute node#Compute**

1. Install Compute services.

2. Update the Compute configuration file, `/etc/nova/nova.conf`. Make sure the following line appears at the end of this file:

   ```
   network_api_class=nova.network.neutronv2.api.API

   neutron_admin_username=neutron
   neutron_admin_password=NEUTRON_PASS
   neutron_admin_auth_url=http://controlnode:35357/v2.0/
   neutron_auth_strategy=keystone
   neutron_admin_tenant_name=service
   neutron_url=http://controlnode:9696/

   libvirt_vif_driver=nova.virt.libvirt.vif.LibvirtHybridOVSBridgeDriver
   ```

3. Restart relevant Compute services.

- **Compute and Network node#L2 agent**

1. Install and start Open vSwitch.

2. Install the L2 agent (Neutron Open vSwitch agent).

3. Add the integration bridge to the Open vSwitch:

   ```
   # ovs-vsctl add-br br-int
   ```

4. Update the Networking configuration file, `/etc/neutron/neutron.conf`:

```
[DEFAULT]
core_plugin = neutron.plugins.openvswitch.ovs_neutron_plugin.
OVSNeutronPluginV2
control_exchange = neutron
rabbit_host = controller
notification_driver = neutron.openstack.common.notifier.rabbit_notifier
```

5. Update the plug-in configuration file, `/etc/neutron/plugins/openvswitch/ovs_neutron_plugin.ini`.

   Compute node:

```
[database]
connection = mysql://root:root@controlnode:3306/ovs_neutron?charset=utf8
[ovs]
tenant_network_type = gre
tunnel_id_ranges = 1:1000
enable_tunneling = True
local_ip = 9.181.89.202
```

   Network node:

```
[database]
connection = mysql://root:root@controlnode:3306/ovs_neutron?charset=utf8
[ovs]
tenant_network_type = gre
tunnel_id_ranges = 1:1000
enable_tunneling = True
local_ip = 9.181.89.203
```

6. Create the integration bridge **br-int**:

```
# ovs-vsctl --may-exist add-br br-int
```

7. Start the Networking L2 agent

   The Networking Open vSwitch L2 agent can be a service of operating system. The command to start depends on your operating systems. The following command runs the service directly:

```
# neutron-openvswitch-agent --config-file /etc/neutron/plugins/
openvswitch/ovs_neutron_plugin.ini \
  --config-file /etc/neutron/neutron.conf
```

- **Network node#DHCP agent**

1. Install the DHCP agent.

2. Update the Networking configuration file, `/etc/neutron/neutron.conf`

```
[DEFAULT]
core_plugin = neutron.plugins.openvswitch.ovs_neutron_plugin.
OVSNeutronPluginV2
control_exchange = neutron
rabbit_host = controller
notification_driver = neutron.openstack.common.notifier.rabbit_notifier
allow_overlapping_ips = True
```

**Set `allow_overlapping_ips` because TenantA and TenantC use overlapping subnets.**

3. Update the DHCP configuration file `/etc/neutron/dhcp_agent.ini`

```
interface_driver = neutron.agent.linux.interface.OVSInterfaceDriver
```

4. Start the DHCP agent.

   The Networking DHCP agent can be a service of operating system. The command to start the service depends on your operating system. The following command runs the service directly:

```
# neutron-dhcp-agent --config-file /etc/neutron/neutron.conf \
  --config-file /etc/neutron/dhcp_agent.ini
```

- **Network node#L3 agent**

1. Install the L3 agent.

2. Add the external network bridge

```
# ovs-vsctl add-br br-ex
```

3. Add the physical interface, for example eth0, that is connected to the outside network to this bridge:

```
# ovs-vsctl add-port br-ex eth0
```

4. Update the L3 configuration file `/etc/neutron/l3_agent.ini`:

```
[DEFAULT]
interface_driver=neutron.agent.linux.interface.OVSInterfaceDriver
use_namespaces=True
```

   **Set the `use_namespaces` option (it is True by default) because TenantA and TenantC have overlapping subnets, and the routers are hosted on one l3 agent network node.**

5. Start the L3 agent

   The Networking L3 agent can be a service of operating system. The command to start the service depends on your operating system. The following command starts the agent directly:

```
# neutron-l3-agent --config-file /etc/neutron/neutron.conf \
--config-file /etc/neutron/l3_agent.ini
```

## Configure logical network

All of the commands below can be executed on the network node.

### Note

Ensure that the following environment variables are set. These are used by the various clients to access the Identity service.

```
export OS_USERNAME=admin
                export OS_PASSWORD=adminpassword
                export OS_TENANT_NAME=admin
                export OS_AUTH_URL=http://127.0.0.1:5000/v2.0/
```

1. Get the tenant ID (Used as $TENANT_ID later):

```
# keystone tenant-list
+----------------------------------+---------+---------+
|                id                |   name  | enabled |
+----------------------------------+---------+---------+
| 247e478c599f45b5bd297e8ddbbc9b6a | TenantA |   True  |
| 2b4fec24e62e4ff28a8445ad83150f9d | TenantC |   True  |
| 3719a4940bf24b5a8124b58c9b0a6ee6 | TenantB |   True  |
| 5fcfbc3283a142a5bb6978b549a511ac |   demo  |   True  |
| b7445f221cda4f4a8ac7db6b218b1339 |  admin  |   True  |
+----------------------------------+---------+---------+
```

2. Get the user information:

```
# keystone user-list
+----------------------------------+-------+---------+-------------------+
|                id                |  name | enabled |       email       |
+----------------------------------+-------+---------+-------------------+
| 5a9149ed991744fa85f71e4aa92eb7ec |  demo |   True  |                   |
| 5b419c74980d46a1ab184e7571a8154e | admin |   True  | admin@example.com |
| 8e37cb8193cb4873a35802d257348431 | UserC |   True  |                   |
| c11f6b09ed3c45c09c21cbbc23e93066 | UserB |   True  |                   |
| ca567c4f6c0942bdac0e011e97bddbe3 | UserA |   True  |                   |
+----------------------------------+-------+---------+-------------------+
```

3. Create the external network and its subnet by admin user:

```
# neutron net-create Ext-Net --provider:network_type local --router:external
 true
Created a new network:
+---------------------------+--------------------------------------+
| Field                     | Value                                |
+---------------------------+--------------------------------------+
| admin_state_up            | True                                 |
| id                        | 2c757c9e-d3d6-4154-9a77-336eb99bd573 |
| name                      | Ext-Net                              |
| provider:network_type     | local                                |
| provider:physical_network |                                      |
| provider:segmentation_id  |                                      |
| router:external           | True                                 |
| shared                    | False                                |
| status                    | ACTIVE                               |
| subnets                   |                                      |
| tenant_id                 | b7445f221cda4f4a8ac7db6b218b1339     |
+---------------------------+--------------------------------------+
```

```
# neutron subnet-create Ext-Net 30.0.0.0/24 --disable-dhcp
Created a new subnet:
+------------------+--------------------------------------------+
| Field            | Value                                      |
+------------------+--------------------------------------------+
| allocation_pools | {"start": "30.0.0.2", "end": "30.0.0.254"} |
| cidr             | 30.0.0.0/24                                |
```

```
| dns_nameservers  |                                              |
| enable_dhcp      | False                                        |
| gateway_ip       | 30.0.0.1                                     |
| host_routes      |                                              |
| id               | ba754a55-7ce8-46bb-8d97-aa83f4ffa5f9         |
| ip_version       | 4                                            |
| name             |                                              |
| network_id       | 2c757c9e-d3d6-4154-9a77-336eb99bd573         |
| tenant_id        | b7445f221cda4f4a8ac7db6b218b1339             |
+------------------+----------------------------------------------+
```

**`provider:network_type local` means that Networking does not have to realize this network through provider network. `router:external true` means that an external network is created where you can create floating IP and router gateway port.**

4. Add an IP on external network to br-ex.

   Because br-ex is the external network bridge, add an IP 30.0.0.100/24 to br-ex and ping the floating IP of the VM from our network node.

   ```
   # ip addr add 30.0.0.100/24 dev br-ex
   # ip link set br-ex up
   ```

5. Serve TenantA.

   For TenantA, create a private network, subnet, server, router, and floating IP.

   a. Create a network for TenantA:

      ```
      # neutron --os-tenant-name TenantA --os-username UserA --os-password
       password \
       --os-auth-url=http://localhost:5000/v2.0 net-create TenantA-Net
      Created a new network:
      +-----------------+--------------------------------------+
      | Field           | Value                                |
      +-----------------+--------------------------------------+
      | admin_state_up  | True                                 |
      | id              | 7d0e8d5d-c63c-4f13-a117-4dc4e33e7d68 |
      | name            | TenantA-Net                          |
      | router:external | False                                |
      | shared          | False                                |
      | status          | ACTIVE                               |
      | subnets         |                                      |
      | tenant_id       | 247e478c599f45b5bd297e8ddbbc9b6a     |
      +-----------------+--------------------------------------+
      ```

      After that, you can use admin user to query the provider network information:

      ```
      # neutron net-show TenantA-Net
      +---------------------------+--------------------------------------+
      | Field                     | Value                                |
      +---------------------------+--------------------------------------+
      | admin_state_up            | True                                 |
      | id                        | 7d0e8d5d-c63c-4f13-a117-4dc4e33e7d68 |
      | name                      | TenantA-Net                          |
      | provider:network_type     | gre                                  |
      | provider:physical_network |                                      |
      | provider:segmentation_id  | 1                                    |
      ```

```
| router:external           | False                                |
| shared                    | False                                |
| status                    | ACTIVE                               |
| subnets                   |                                      |
| tenant_id                 | 247e478c599f45b5bd297e8ddbbc9b6a     |
+---------------------------+--------------------------------------+
```

The network has GRE tunnel ID (for example, provider:segmentation_id) 1.

b. Create a subnet on the network TenantA-Net:

```
#
neutron --os-tenant-name TenantA --os-username UserA --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 subnet-create TenantA-Net 10.
0.0.0/24
Created a new subnet:
+------------------+--------------------------------------------+
| Field            | Value                                      |
+------------------+--------------------------------------------+
| allocation_pools | {"start": "10.0.0.2", "end": "10.0.0.254"} |
| cidr             | 10.0.0.0/24                                |
| dns_nameservers  |                                            |
| enable_dhcp      | True                                       |
| gateway_ip       | 10.0.0.1                                   |
| host_routes      |                                            |
| id               | 51e2c223-0492-4385-b6e9-83d4e6d10657       |
| ip_version       | 4                                          |
| name             |                                            |
| network_id       | 7d0e8d5d-c63c-4f13-a117-4dc4e33e7d68       |
| tenant_id        | 247e478c599f45b5bd297e8ddbbc9b6a           |
+------------------+--------------------------------------------+
```

c. Create a server for TenantA:

```
$ nova --os-tenant-name TenantA --os-username UserA --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 boot --image tty --flavor 1 \
  --nic net-id=7d0e8d5d-c63c-4f13-a117-4dc4e33e7d68 TenantA_VM1
```

```
$ nova --os-tenant-name TenantA --os-username UserA --os-password
 password \
   --os-auth-url=http://localhost:5000/v2.0 list

+--------------------------------------+-------------+--------
+----------------------+
| ID                                   | Name        | Status | Networks
            |
+--------------------------------------+-------------+--------
+----------------------+
| 7c5e6499-7ef7-4e36-8216-62c2941d21ff | TenantA_VM1 | ACTIVE | TenantA-
Net=10.0.0.3 |
+--------------------------------------+-------------+--------
+----------------------+
```

### Note

It is important to understand that you should not attach the instance to Ext-Net directly. Instead, you must use a floating IP to make it accessible from the external network.

d. Create and configure a router for TenantA:

```
# neutron --os-tenant-name TenantA --os-username UserA --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 router-create TenantA-R1
Created a new router:
+-----------------------+--------------------------------------+
| Field                 | Value                                |
+-----------------------+--------------------------------------+
| admin_state_up        | True                                 |
| external_gateway_info |                                      |
| id                    | 59cd02cb-6ee6-41e1-9165-d251214594fd |
| name                  | TenantA-R1                           |
| status                | ACTIVE                               |
| tenant_id             | 247e478c599f45b5bd297e8ddbbc9b6a     |
+-----------------------+--------------------------------------+
```

```
# neutron --os-tenant-name TenantA --os-username UserA --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 router-interface-add \
  TenantA-R1 51e2c223-0492-4385-b6e9-83d4e6d10657
```

Added interface to router TenantA-R1

```
# neutron --os-tenant-name TenantA --os-username UserA --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 \
  router-gateway-set TenantA-R1 Ext-Net
```

e. Associate a floating IP for TenantA_VM1.

1. Create a floating IP:

```
# neutron --os-tenant-name TenantA --os-username UserA --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 floatingip-create Ext-Net
Created a new floatingip:
+---------------------+--------------------------------------+
| Field               | Value                                |
+---------------------+--------------------------------------+
| fixed_ip_address    |                                      |
| floating_ip_address | 30.0.0.2                             |
| floating_network_id | 2c757c9e-d3d6-4154-9a77-336eb99bd573 |
| id                  | 5a1f90ed-aa3c-4df3-82cb-116556e96bf1 |
| port_id             |                                      |
| router_id           |                                      |
| tenant_id           | 247e478c599f45b5bd297e8ddbbc9b6a     |
+---------------------+--------------------------------------+
```

2. Get the port ID of the VM with ID 7c5e6499-7ef7-4e36-8216-62c2941d21ff:

```
$ neutron --os-tenant-name TenantA --os-username UserA --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 port-list -- \
  --device_id 7c5e6499-7ef7-4e36-8216-62c2941d21ff
+--------------------------------------+------+-------------------
+----------------------------------------------------------------------------------
+
| id                                   | name | mac_address       |
 fixed_ips
        |
+--------------------------------------+------+-------------------
+----------------------------------------------------------------------------------
+
| 6071d430-c66e-4125-b972-9a937c427520 |      | fa:16:3e:a0:73:0d |
 {"subnet_id": "51e2c223-0492-4385-b6e9-83d4e6d10657", "ip_address": "10.
0.0.3"} |
+--------------------------------------+------+-------------------
+----------------------------------------------------------------------------------
+
```

3. Associate the floating IP with the VM port:

```
$ neutron --os-tenant-name TenantA --os-username UserA --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 floatingip-associate \
  5a1f90ed-aa3c-4df3-82cb-116556e96bf1 6071d430-c66e-4125-
b972-9a937c427520
Associated floatingip 5a1f90ed-aa3c-4df3-82cb-116556e96bf1
```

```
$ neutron floatingip-list
+--------------------------------------+------------------
+---------------------+--------------------------------------+
| id                                   | fixed_ip_address |
 floating_ip_address | port_id                              |
+--------------------------------------+------------------
+---------------------+--------------------------------------+
| 5a1f90ed-aa3c-4df3-82cb-116556e96bf1 | 10.0.0.3         | 30.0.0.2
       | 6071d430-c66e-4125-b972-9a937c427520 |
+--------------------------------------+------------------
+---------------------+--------------------------------------+
```

f. Ping the public network from the server of TenantA.

In my environment, 192.168.1.0/24 is my public network connected with my physical router, which also connects to the external network 30.0.0.0/24. With the floating IP and virtual router, we can ping the public network within the server of tenant A:

```
$ ping 192.168.1.1
PING 192.168.1.1 (192.168.1.1) 56(84) bytes of data.
64 bytes from 192.168.1.1: icmp_req=1 ttl=64 time=1.74 ms
64 bytes from 192.168.1.1: icmp_req=2 ttl=64 time=1.50 ms
64 bytes from 192.168.1.1: icmp_req=3 ttl=64 time=1.23 ms
^C
--- 192.168.1.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003ms
rtt min/avg/max/mdev = 1.234/1.495/1.745/0.211 ms
```

g. Ping floating IP of the TenantA's server:

```
$ ping 30.0.0.2
PING 30.0.0.2 (30.0.0.2) 56(84) bytes of data.
64 bytes from 30.0.0.2: icmp_req=1 ttl=63 time=45.0 ms
64 bytes from 30.0.0.2: icmp_req=2 ttl=63 time=0.898 ms
64 bytes from 30.0.0.2: icmp_req=3 ttl=63 time=0.940 ms
^C
--- 30.0.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2002ms
rtt min/avg/max/mdev = 0.898/15.621/45.027/20.793 ms
```

h. Create other servers for TenantA.

   We can create more servers for TenantA and add floating IPs for them.

6. Serve TenantC.

   For TenantC, we will create two private networks with subnet 10.0.0.0/24 and subnet 10.0.1.0/24, some servers, one router to connect to these two subnets and some floating IPs.

   a. Create networks and subnets for TenantC:

```
# neutron --os-tenant-name TenantC --os-username UserC --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 net-create TenantC-Net1
# neutron --os-tenant-name TenantC --os-username UserC --os-password
 password \
   --os-auth-url=http://localhost:5000/v2.0 subnet-create TenantC-Net1 \
    10.0.0.0/24 --name TenantC-Subnet1
# neutron --os-tenant-name TenantC --os-username UserC --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 net-create TenantC-Net2
# neutron --os-tenant-name TenantC --os-username UserC --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 subnet-create TenantC-Net2 \
  10.0.1.0/24 --name TenantC-Subnet2
```

   After that we can use admin user to query the network's provider network information:

```
# neutron net-show TenantC-Net1
+---------------------------+--------------------------------------+
| Field                     | Value                                |
+---------------------------+--------------------------------------+
| admin_state_up            | True                                 |
| id                        | 91309738-c317-40a3-81bb-bed7a3917a85 |
| name                      | TenantC-Net1                         |
| provider:network_type     | gre                                  |
| provider:physical_network |                                      |
| provider:segmentation_id  | 2                                    |
| router:external           | False                                |
| shared                    | False                                |
| status                    | ACTIVE                               |
| subnets                   | cf03fd1e-164b-4527-bc87-2b2631634b83 |
| tenant_id                 | 2b4fec24e62e4ff28a8445ad83150f9d     |
+---------------------------+--------------------------------------+
```

```
# neutron net-show TenantC-Net2
```

```
+---------------------------+--------------------------------------+
| Field                     | Value                                |
+---------------------------+--------------------------------------+
| admin_state_up            | True                                 |
| id                        | 5b373ad2-7866-44f4-8087-f87148abd623 |
| name                      | TenantC-Net2                         |
| provider:network_type     | gre                                  |
| provider:physical_network |                                      |
| provider:segmentation_id  | 3                                    |
| router:external           | False                                |
| shared                    | False                                |
| status                    | ACTIVE                               |
| subnets                   | 38f0b2f0-9f98-4bf6-9520-f4abede03300 |
| tenant_id                 | 2b4fec24e62e4ff28a8445ad83150f9d     |
+---------------------------+--------------------------------------+
```

We can see that we have GRE tunnel IDs (I.E. provider:segmentation_id) 2 and 3. And also note down the network IDs and subnet IDs because we will use them to create VMs and router.

b. Create a server TenantC-VM1 for TenantC on TenantC-Net1.

```
# nova --os-tenant-name TenantC --os-username UserC --os-password
 password  \
  --os-auth-url=http://localhost:5000/v2.0 boot --image tty --flavor 1 \
  --nic net-id=91309738-c317-40a3-81bb-bed7a3917a85 TenantC_VM1
```

c. Create a server TenantC-VM3 for TenantC on TenantC-Net2.

```
# nova --os-tenant-name TenantC --os-username UserC --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 boot --image tty --flavor 1 \
  --nic net-id=5b373ad2-7866-44f4-8087-f87148abd623 TenantC_VM3
```

d. List servers of TenantC.

```
# nova --os-tenant-name TenantC --os-username UserC --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 list

+--------------------------------------+-------------+--------
+-----------------------+
| ID                                   | Name        | Status | Networks
             |
+--------------------------------------+-------------+--------
+-----------------------+
| b739fa09-902f-4b37-bcb4-06e8a2506823 | TenantC_VM1 | ACTIVE | TenantC-
Net1=10.0.0.3 |
| 17e255b2-b14f-48b3-ab32-5df36566d2e8 | TenantC_VM3 | ACTIVE | TenantC-
Net2=10.0.1.3 |
+--------------------------------------+-------------+--------
+-----------------------+
```

Note down the server IDs since we will use them later.

e. Make sure servers get their IPs.

We can use VNC to log on the VMs to check if they get IPs. If not, we have to make sure the Networking components are running right and the GRE tunnels work.

f. Create and configure a router for TenantC:

```
# neutron --os-tenant-name TenantC --os-username UserC --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 router-create TenantC-R1
```

```
# neutron --os-tenant-name TenantC --os-username UserC --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 router-interface-add \
  TenantC-R1 cf03fd1e-164b-4527-bc87-2b2631634b83
# neutron --os-tenant-name TenantC --os-username UserC --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 router-interface-add \
  TenantC-R1 38f0b2f0-9f98-4bf6-9520-f4abede03300
```

```
# neutron --os-tenant-name TenantC --os-username UserC --os-password
 password \
  --os-auth-url=http://localhost:5000/v2.0 \
  router-gateway-set TenantC-R1 Ext-Net
```

g. Checkpoint: ping from within TenantC's servers.

Since we have a router connecting to two subnets, the VMs on these subnets are able to ping each other. And since we have set the router's gateway interface, TenantC's servers are able to ping external network IPs, such as 192.168.1.1, 30.0.0.1 etc.

h. Associate floating IPs for TenantC's servers.

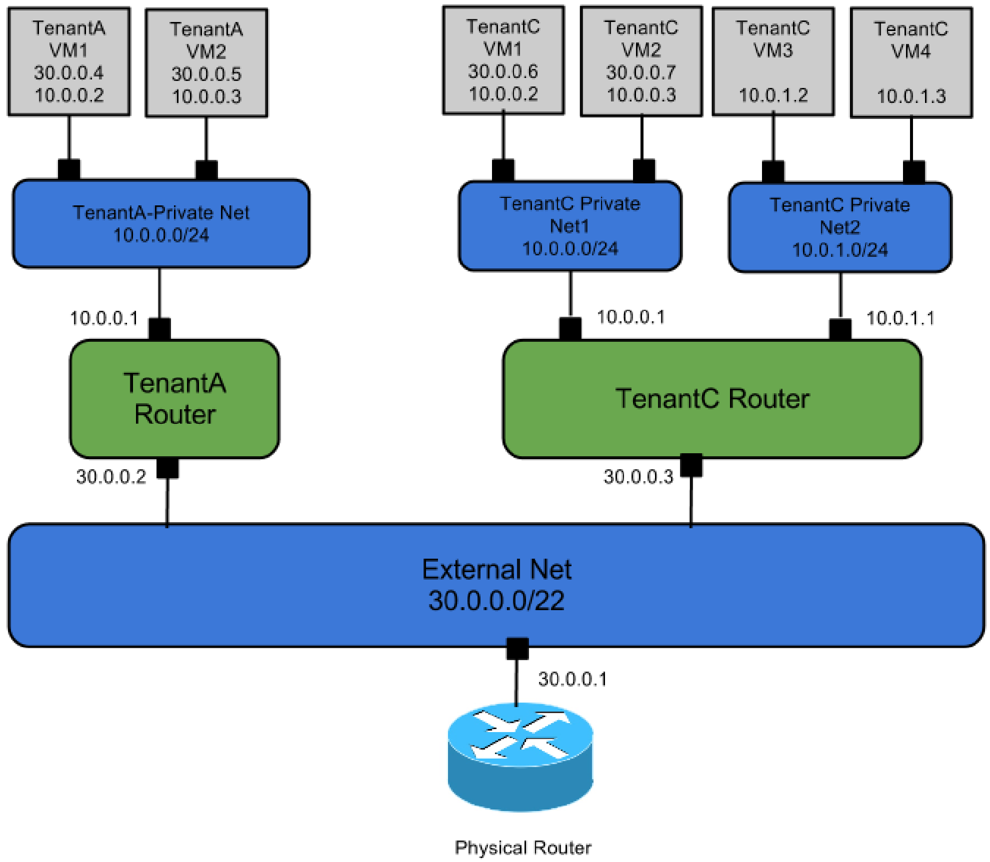
Since we have a router connecting to two subnets, the VMs on these subnets are able to ping each other. And since we have set the router's gateway interface, TenantC's servers are able to ping external network IPs, such as 192.168.1.1, 30.0.0.1 etc.

i. Associate floating IPs for TenantC's servers.

We can use the similar commands as we used in TenantA's section to finish this task.

## Use case: per-tenant routers with private networks

This use case represents a more advanced router scenario in which each tenant gets at least one router, and potentially has access to the Networking API to create additional routers. The tenant can create their own networks, potentially uplinking those networks to a router. This model enables tenant-defined, multi-tier applications, with each tier being a separate network behind the router. Since there are multiple routers, tenant subnets can overlap without conflicting, since access to external networks all happens via SNAT or Floating IPs. Each router uplink and floating IP is allocated from the external network subnet.


TenantA
VM1
30.0.0.4
10.0.0.2
TenantA
VM2
30.0.0.5
10.0.0.3
TenantC
VM1
30.0.0.6
10.0.0.2
TenantC
VM2
30.0.0.7
10.0.0.3
TenantC
VM3
10.0.1.2
TenantC
VM4
10.0.1.3
TenantA-Private Net
10.0.0.0/24
TenantC Private
Net1
10.0.0.0/24
TenantC Private
Net2
10.0.1.0/24
10.0.0.1
10.0.0.1
10.0.1.1
TenantA
Router
TenantC Router
30.0.0.2
30.0.0.3
External Net
30.0.0.0/22
30.0.0.1
Physical Router

# 10. Adding Orchestration

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Use the OpenStack Orchestration service to create cloud resources using a template language called HOT. The integrated project name is Heat.

# Orchestration Service Overview

The Orchestration service provides a template-based orchestration for describing a cloud application by running OpenStack API calls to generate running cloud applications. The software integrates other core components of OpenStack into a one-file template system. The templates enable you to create most OpenStack resource types, such as instances, floating IPs, volumes, security groups, users, and so on. Also, provides some more advanced functionality, such as instance high availability, instance auto-scaling, and nested stacks. By providing very tight integration with other OpenStack core projects, all OpenStack core projects could receive a larger user base.

The service enables deployers to integrate with the Orchestration service directly or through custom plug-ins.

The Orchestration service consists of the following components:

- `heat` tool. A CLI that communicates with the heat-api to run AWS CloudFormation APIs. End developers could also use the Orchestration REST API directly.
- `heat-api` component. Provides an OpenStack-native REST API that processes API requests by sending them to the heat-engine over RPC.
- `heat-api-cfn` component. Provides an AWS Query API that is compatible with AWS CloudFormation and processes API requests by sending them to the heat-engine over RPC.
- `heat-engine`. Orchestrates the launching of templates and provides events back to the API consumer.

# Install the Orchestration Service

1. Install the Orchestration Service on the controller node:

```
# apt-get install heat-api heat-api-cfn heat-engine
```

2. In the configuration file, specify the location of the database where the Orchestration Service stores data. The examples in this guide use a MySQL database on the controller node with the `heat` user name. Replace *HEAT_DBPASS* with the password for the database user:

Edit /etc/heat/heat.conf and change the [DEFAULT] section.

```
[database]
# The SQLAlchemy connection string used to connect to the database
connection = mysql://heat:HEAT_DBPASS@controller/heat
...
```

3. Create a heat database user by logging in as root using the password you set previously:

```
# mysql -u root -p
mysql> CREATE DATABASE heat;
mysql> GRANT ALL PRIVILEGES ON heat.* TO 'heat'@'localhost' \
IDENTIFIED BY 'HEAT_DBPASS';
mysql> GRANT ALL PRIVILEGES ON heat.* TO 'heat'@'%' \
IDENTIFIED BY 'HEAT_DBPASS';
```

4. Create the heat service tables:

```
# heat-manage db_sync
```

### Note

You can ignore any DeprecationWarning errors.

5. The Ubuntu packages do not correctly set up logging. Edit the /etc/heat/heat.conf file and change the [DEFAULT] section:

```
[DEFAULT]
...
# Print more verbose output (set logging level to INFO instead
# of default WARNING level). (boolean value)
verbose = True
...
# (Optional) The base directory used for relative --log-file
# paths (string value)
log_dir=/var/log/heat
```

6. Create a heat user that the Orchestration Service can use to authenticate with the Identity Service. Use the service tenant and give the user the admin role.

```
# keystone user-create --name=heat --pass=HEAT_PASS --email=heat@example.
com
# keystone user-role-add --user=heat --tenant=service --role=admin
```

7. Add the credentials to the configuration files for the Orchestration Service.

   Edit /etc/heat/api-paste.ini and change the [filter:authtoken] section.

```
...
[filter:authtoken]
paste.filter_factory = heat.common.auth_token:filter_factory
auth_host = controller
auth_port = 35357
auth_protocol = http
admin_tenant_name = service
admin_user = heat
admin_password = HEAT_PASS
...
```

8. Register the Orchestration Service (both Heat and CloudFormation APIs) with the Identity Service so that other OpenStack services can locate it. Use the **keystone** command to register the service and specify the endpoint:

```
# keystone service-create --name=heat --type=orchestration \
  --description="Heat Orchestration API"
```

9. Note the `id` property for the service that was returned in the previous step. Use it to create the endpoint.

```
# keystone endpoint-create \
  --service-id=the_service_id_above \
  --publicurl=http://controller:8004/v1/\$(tenant_id)s \
  --internalurl=http://controller:8004/v1/\$(tenant_id)s \
  --adminurl=http://controller:8004/v1/\$(tenant_id)s
```

```
# keystone service-create --name=heat-cfn --type=cloudformation \
  --description="Heat CloudFormation API"
```

10. Note the `id` property for the service that was returned in the previous step. Use it to create the endpoint.

```
# keystone endpoint-create \
  --service-id=the_service_id_above \
  --publicurl=http://controller:8000/v1 \
  --internalurl=http://controller:8000/v1 \
  --adminurl=http://controller:8000/v1
```

11. Restart the service with its new settings:

```
# service heat-api restart
# service heat-api-cfn restart
# service heat-engine restart
```

# Verifying the Orchestration Service Installation

To verify the Identity Service is installed and configured correctly, first ensure you have your credentials setup correctly in an `openrc` file, then source it so your environment has the username and password.

```
# source openrc
```

Next you can try creating some stacks, using the samples.

## Create and manage stacks

### Create a stack from an example template file

1. To create a stack, or template, from an example template file, run the following command:

```
$ heat stack-create mystack --template-file=/PATH_TO_HEAT_TEMPLATES/
WordPress_Single_Instance.template
     --parameters="InstanceType=m1.
large;DBUsername=USERNAME;DBPassword=PASSWORD;KeyName=HEAT_KEY;LinuxDistribution=
F17"
```

The `--parameters` values that you specify depend on the parameters that are defined in the template. If a website hosts the template file, you can specify the URL with the `--template-url` parameter instead of the `--template-file` parameter.

The command returns the following output:

```
+--------------------------------------+---------------
+--------------------+----------------------+
| id                 | stack_name      | stack_status        | creation_time
 |
+--------------------------------------+---------------
+--------------------+----------------------+
| 4c712026-dcd5-4664-90b8-0915494c1332 | mystack       |
 CREATE_IN_PROGRESS | 2013-04-03T23:22:08Z |
+--------------------------------------+---------------
+--------------------+----------------------+
```

2. You can also use the **stack-create** command to validate a template file without creating a stack from it.

   To do so, run the following command:

```
$ heat stack-create mystack --template-file=/PATH_TO_HEAT_TEMPLATES/
WordPress_Single_Instance.template
```

   If validation fails, the response returns an error message.

## Get information about stacks

To explore the state and history of a particular stack, you can run a number of commands.

- To see which stacks are visible to the current user, run the following command:

```
$ heat stack-list
+--------------------------------------+---------------+-----------------
+----------------------+
| id                 | stack_name      | stack_status     | creation_time        |
+--------------------------------------+---------------+-----------------
+----------------------+
| 4c712026-dcd5-4664-90b8-0915494c1332 | mystack       | CREATE_COMPLETE |
 2013-04-03T23:22:08Z |
| 7edc7480-bda5-4e1c-9d5d-f567d3b6a050 | my-otherstack | CREATE_FAILED   |
 2013-04-03T23:28:20Z |
+--------------------------------------+---------------+-----------------
+----------------------+
```

- To show the details of a stack, run the following command:

```
$ heat stack-show mystack
```

- A stack consists of a collection of resources.

  To list the resources and their status, run the following command:

```
$ heat resource-list mystack
+---------------------+---------------------+-----------------
+----------------------+
```

```
| logical_resource_id | resource_type       | resource_status | updated_time
        |
+---------------------+--------------------+-----------------
+----------------------+
| WikiDatabase        | AWS::EC2::Instance | CREATE_COMPLETE |
 2013-04-03T23:25:56Z |
+---------------------+--------------------+-----------------
+----------------------+
```

- To show the details for the specified resource in a stack, run the following command:

```
$ heat resource-show mystack WikiDatabase
```

Some resources have associated metadata which can change throughout the life-cycle of a resource:

```
$ heat resource-metadata mystack WikiDatabase
```

- A series of events is generated during the life-cycle of a stack.

To display life-cycle events, run::

```
$ heat event-list mystack
+---------------------+----+------------------------+-----------------
+----------------------+
| logical_resource_id | id | resource_status_reason | resource_status |
 event_time           |
+---------------------+----+------------------------+-----------------
+----------------------+
| WikiDatabase        | 1  | state changed          | IN_PROGRESS     |
 2013-04-03T23:22:09Z |
| WikiDatabase        | 2  | state changed          | CREATE_COMPLETE |
 2013-04-03T23:25:56Z |
+---------------------+----+------------------------+-----------------
+----------------------+
```

- To show the details for a particular event, run the following command:

```
$ heat event-show WikiDatabase 1
```

## Update a stack

- To update an existing stack from a modified template file, run a command like the following command:

```
$ heat stack-update mystack --template-file=/path/to/heat/templates/
WordPress_Single_Instance_v2.template
     --parameters="InstanceType=m1.large;DBUsername=wp;DBPassword=
verybadpassword;KeyName=heat_key;LinuxDistribution=F17"
+--------------------------------------+---------------+-----------------
+----------------------+
| id               | stack_name     | stack_status    | creation_time        |
+--------------------------------------+---------------+-----------------
+----------------------+
| 4c712026-dcd5-4664-90b8-0915494c1332 | mystack       | UPDATE_COMPLETE |
 2013-04-03T23:22:08Z |
| 7edc7480-bda5-4e1c-9d5d-f567d3b6a050 | my-otherstack | CREATE_FAILED   |
 2013-04-03T23:28:20Z |
+--------------------------------------+---------------+-----------------
+----------------------+
```

Some resources are updated in-place, while others are replaced with new resources.

# 11. Adding Metering

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The OpenStack Metering service provides a framework for monitoring and metering the OpenStack cloud. It is also known as the Ceilometer project.

# Metering/Monitoring Service

The Metering Service is designed to:

- Efficiently collect the metering data about the CPU and network costs.
- Collect data by monitoring notifications sent from services or by polling the infrastructure.
- Configure the type of collected data to meet various operating requirements. Accessing and inserting the metering data through the REST API.
- Expand the framework to collect custom usage data by additional plug-ins.
- Produce signed metering messages that cannot be repudiated.

The system consists of the following basic components:

- A compute agent (`ceilometer-agent-compute`). Runs on each compute node and polls for resource utilization statistics. There may be other types of agents in the future, but for now we will focus on creating the compute agent.
- A central agent (`ceilometer-agent-central`). Runs on a central management server to poll for resource utilization statistics for resources not tied to instances or compute nodes.
- A collector (`ceilometer-collector`). Runs on one or more central management servers to monitor the message queues (for notifications and for metering data coming from the agent). Notification messages are processed and turned into metering messages and sent back out onto the message bus using the appropriate topic. Metering messages are written to the data store without modification.
- An alarm notifier (`ceilometer-alarm-notifier`). runs on one or more central management servers to allow settting alarms based on threshold evaluation for a collection of samples.
- A data store. A database capable of handling concurrent writes (from one or more collector instances) and reads (from the API server).

- An API server (`ceilometer-api`). Runs on one or more central management servers to provide access to the data from the data store. These services communicate using the standard OpenStack messaging bus. Only the collector and API server have access to the data store.

These services communicate by using the standard OpenStack messaging bus. Only the collector and API server have access to the data store.

# Install the Metering Service

## Install the central Metering Service components

The Metering service consists of an API service, collector, and a range of disparate agents. This procedure details how to install the core components before you install the agents elsewhere, such as on the compute node.

1. Install the Metering Service on the controller node:

```
# apt-get install ceilometer-api ceilometer-collector ceilometer-agent-central python-ceilometerclient
```

2. The Metering Service uses a database to store information. Specify the location of the database in the configuration file. The examples in this guide use a MongoDB database on the controller node.

```
# apt-get install mongodb
```

3. Create the database and a `ceilometer` user for it:

```
# mongo
> use ceilometer
> db.addUser( { user: "ceilometer",
              pwd: "CEILOMETER_DBPASS",
              roles: [ "readWrite", "dbAdmin" ]
            } )
```

4. Tell the Metering Service to use the created database.

   Edit `/etc/ceilometer/ceilometer.conf` and change the `[database]` section.

```
...
[database]
...
# The SQLAlchemy connection string used to connect to the
# database (string value)
connection = mongodb://ceilometer:CEILOMETER_DBPASS@controller:27017/
ceilometer
...
```

5. You must define an secret key that is used as a shared secret between the Metering Service nodes. Use **openssl** to generate a random token and store it in the configuration file.

```
# openssl rand -hex 10
```

   Edit `/etc/ceilometer/ceilometer.conf` and change the `[DEFAULT]` section, replacing ADMIN_TOKEN with the results of the command.

```
...
[publisher_rpc]
...
# Secret value for signing metering messages (string value)
metering_secret = ADMIN_TOKEN
...
```

6. Create a user called `ceilometer` so that the Metering Service can use to authenticate with the Identity Service. Use the `service` tenant and give the user the `admin` role.

   ```
   # keystone user-create --name=ceilometer --pass=CEILOMETER_PASS --
   email=ceilometer@example.com
   # keystone user-role-add --user=ceilometer --tenant=service --role=admin
   ```

7. Add the credentials to the configuration files for the Metering Service.

   Edit `/etc/ceilometer/ceilometer.conf` and change the `[keystone_authtoken]` section.

   ```
   ...
   [keystone_authtoken]
   auth_host = controller
   auth_port = 35357
   auth_protocol = http
   admin_tenant_name = service
   admin_user = ceilometer
   admin_password = CEILOMETER_PASS
   ...
   ```

8. Register the Metering Service with the Identity Service so that other OpenStack services can locate it. Register the service and specify the endpoint using the **keystone** command.

   ```
   # keystone service-create --name=ceilometer --type=metering \
     --description="Ceilometer Metering Service"
   ```

9. Note the `id` property for the service that was returned in the previous step. Use it when you create the endpoint.

   ```
   # keystone endpoint-create \
     --service-id=the_service_id_above \
     --publicurl=http://controller:8777/ \
     --internalurl=http://controller:8777/ \
     --adminurl=http://controller:8777/
   ```

10. Restart the service with its new settings.

    ```
    # service ceilometer-agent-central restart
    # service ceilometer-api restart
    # service ceilometer-collector restart
    ```

# Adding the Agent: Compute

## Installing the Compute Agent for Metering

The Metering service consists of an API service, collector and a range of disparate agents. This procedure details the installation of the agent that runs on compute nodes.

1. Install the Metering service on the compute node:

   ```
   # apt-get install ceilometer-agent-compute
   ```

2. Set the following options in `/etc/nova/nova.conf`.

   Edit `/etc/nova/nova.conf` and add to the `[DEFAULT]` section.

   ```
   ...
   [DEFAULT]
   ...
   instance_usage_audit=True
   instance_usage_audit_period=hour
   notify_on_state_change=vm_and_task_state
   notification_driver=nova.openstack.common.notifier.rpc_notifier
   notification_driver=ceilometer.compute.nova_notifier
   ```

3. You need to set the secret key defined earlier that is used as a shared secret between the Metering service nodes.

   Edit `/etc/ceilometer/ceilometer.conf` and change the `[DEFAULT]` section, replacing ADMIN_TOKEN with the one created earlier.

   ```

   ...
   [publisher_rpc]
   # Secret value for signing metering messages (string value)
   metering_secret = ADMIN_TOKEN
   ...
   ```

4. Next, restart the service with its new settings.

   ```
   # service ceilometer-agent-compute restart
   ```

# Adding the Agent: Image Service

1. If you want to be able to retrieve image samples, you need to instruct the Image Service to send notifications to the bus by editing the `glance-api.conf` file changing `notifier_strategy` to `rabbit` or `qpid` and restarting the `glance-api` and `glance-registry` services.

2. We now restart the Image service with its new settings.

   ```
   # service glance-registry restart
   # service glance-api restart
   ```

# Adding the Agent: Block Storage

1. If you want to be able to retrieve volume samples, you need to instruct Block Storage to send notifications to the bus by editing the `cinder.conf` file and changing `notification_driver` to `cinder.openstack.common.notifier.rabbit_notifier` and `control_exchange` to `cinder`, before restarting the service.

2. We now restart the Block Storage service with its new settings.

```
# service cinder-volume restart
# service cinder-api restart
```

# Adding the Agent: Object Storage

1. In order to retrieve object store statistics, the Metering Service needs access to Object Storage with `ResellerAdmin` role. You should give this role to your `os_username` user for tenant `os_tenant_name`:

```
$ keystone role-create --name=ResellerAdmin
+----------+----------------------------------+
| Property |              Value               |
+----------+----------------------------------+
|    id    | 462fa46c13fd4798a95a3bfbe27b5e54 |
|   name   |          ResellerAdmin           |
+----------+----------------------------------+

$ keystone user-role-add --tenant_id $SERVICE_TENANT \
      --user_id $CEILOMETER_USER \
      --role_id 462fa46c13fd4798a95a3bfbe27b5e54
```

2. You'll also need to add the Metering middleware to Object Storage to account for incoming and outgoing traffic, by adding these lines to `/etc/swift/proxy-server.conf`:

```
[filter:ceilometer]
use = egg:ceilometer#swift
```

   Next, add `ceilometer` to the `pipeline` parameter of that same file, right before the entry `proxy-server`.

3. We now restart the service with its new settings.

```
# service swift-proxy-server restart
```

# Appendix A. Community support

## Table of Contents



To help you run and use OpenStack, many resources are available. Many OpenStack community members can answer questions and help with bug suspicions. We are constantly improving and adding to the main features of OpenStack, but if you have any problems, do not hesitate to ask. Use the following resources to get OpenStack support and troubleshoot your existing installations.

# Documentation

For the available OpenStack documentation, see docs.openstack.org.

To provide feedback on documentation, join and use the `<openstack-docs@lists.openstack.org>` mailing list at OpenStack Documentation Mailing List, or report a bug.

The following books explain how to install an OpenStack cloud and its components:

- *Installation Guide for Debian 7.0*
- *Installation Guide for openSUSE and SUSE Linux Enterprise Server*
- *Installation Guide for Red Hat Enterprise Linux, CentOS, and Fedora*
- *Installation Guide for Ubuntu 12.04 (LTS)*

The following books explain how to configure and run an OpenStack cloud:

- *Cloud Administrator Guide*
- *Configuration Reference*
- *Operations Guide*
- *High Availability Guide*
- *Security Guide*
- *Virtual Machine Image Guide*

The following books explain how to use the OpenStack dashboard and command-line clients:

- *API Quick Start*
- *End User Guide*
- *Admin User Guide*

The following documentation provides reference and guidance information for the OpenStack APIs:

- OpenStack API Reference
- *OpenStack Block Storage Service API v2 Reference*
- *OpenStack Compute API v2 and Extensions Reference*
- *OpenStack Identity Service API v2.0 Reference*
- *OpenStack Image Service API v2 Reference*
- *OpenStack Networking API v2.0 Reference*
- *OpenStack Object Storage API v1 Reference*

# ask.openstack.org

During set up or testing, you might have questions about how to do something or be in a situation where a feature does not work correctly. Use the ask.openstack.org site to ask questions and get answers. When you visit the http://ask.openstack.org site, scan the recently asked questions to see whether your question was already answered. If not, ask a new question. Be sure to give a clear, concise summary in the title and provide as much detail as possible in the description. Paste in your command output or stack traces, link to screen shots, and so on.

# OpenStack mailing lists

A great way to get answers and insights is to post your question or scenario to the OpenStack mailing list. You can learn from and help others who might have the same scenario as you. To subscribe or view the archives, go to http://lists.openstack.org/cgi-bin/mailman/listinfo/openstack. You might be interested in the other mailing lists for specific projects or development, which you can find on the wiki. A description of all mailing lists is available at http://wiki.openstack.org/MailingLists.

# The OpenStack wiki

The OpenStack wiki contains content on a broad range of topics but some of it sits a bit below the surface. Fortunately, the wiki search feature enables you to search by title or content. If you search for specific information, such as about networking or nova, you can find lots of content. More is being added all the time, so be sure to check back often. You can find the search box in the upper right corner of any OpenStack wiki page.

# The Launchpad Bugs area

So you think you've found a bug. That's great! Seriously, it is. The OpenStack community values your set up and testing efforts and wants your feedback. To log a bug, you must sign up for a Launchpad account at https://launchpad.net/+login. You can view existing bugs and report bugs in the Launchpad Bugs area. Use the search feature to determine whether the bug was already reported (or even better, already fixed). If it still seems like your bug is unreported, fill out a bug report.

Some tips:

- Give a clear, concise summary!
- Provide as much detail as possible in the description. Paste in your command output or stack traces, link to screen shots, and so on.
- Be sure to include the software version that you are using, especially if you are using a development branch, such as, `"Grizzly release" vs git commit bc79c3ecc55929bac585d04a03475b72e06a3208`.
- Any deployment specific information is helpful, such as Ubuntu 12.04 or multi-node install.

The Launchpad Bugs areas are available here:

- Bugs: OpenStack Compute (nova)
- Bugs : OpenStack Object Storage (swift)
- Bugs : OpenStack Image Service (glance)
- Bugs : OpenStack Identity (keystone)
- Bugs : OpenStack Dashboard (horizon)
- Bugs : OpenStack Networking (neutron)
- Bugs : OpenStack Orchestration (heat)
- Bugs : OpenStack Metering (ceilometer)

# The OpenStack IRC channel

The OpenStack community lives and breathes in the #openstack IRC channel on the Freenode network. You can hang out, ask questions, or get immediate feedback for urgent and pressing issues. To install an IRC client or use a browser-based client, go to http://webchat.freenode.net/. You can also use Colloquy (Mac OS X, http://colloquy.info/), mIRC (Windows, http://www.mirc.com/), or XChat (Linux). When you are in the IRC channel and want to share code or command output, the generally accepted method is to use a Paste Bin. The OpenStack project has one at http://paste.openstack.org. Just paste your longer amounts of text or logs in the web form and you get a URL you can paste into the channel. The OpenStack IRC channel is: `#openstack` on `irc.freenode.net`. You can find a list of all OpenStack-related IRC channels at https://wiki.openstack.org/wiki/IRC.

# Documentation feedback

To provide feedback on documentation, join and use the <openstack-docs@lists.openstack.org> mailing list at OpenStack Documentation Mailing List, or report a bug.

# OpenStack distribution packages

The following Linux distributions provide community-supported packages for OpenStack:

- **Debian:** http://wiki.debian.org/OpenStack
- **CentOS, Fedora, and Red Hat Enterprise Linux:** http://openstack.redhat.com/
- **openSUSE and SUSE Linux Enterprise Server:** http://en.opensuse.org/Portal:OpenStack
- **Ubuntu:** https://wiki.ubuntu.com/ServerTeam/CloudArchive