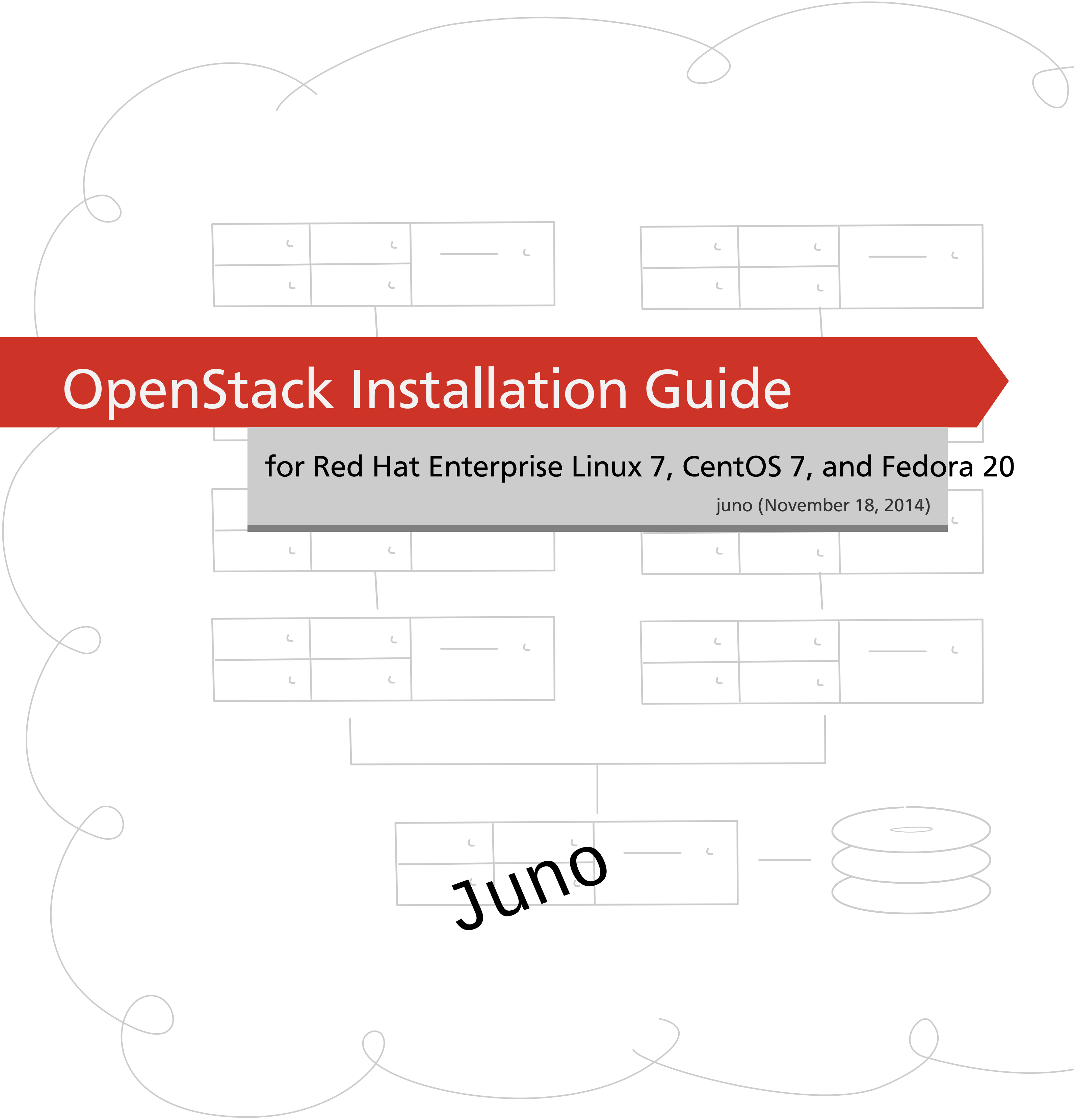
OpenStack Installation Guide

for Red Hat Enterprise Linux 7, CentOS 7, and Fedora 20

juno (November 18, 2014)



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OpenStack Installation Guide for Red Hat Enterprise Linux 7, CentOS 7, and Fedora 20

juno (2014-11-18)

The OpenStack® system consists of several key projects that you install separately but that work together depending on your cloud needs. These projects include Compute, Identity Service, Networking, Image Service, Block Storage, Object Storage, Telemetry, Orchestration, and Database. You can install any of these projects separately and configure them stand-alone or as connected entities. This guide shows you how to install OpenStack by using packages available through Fedora 20 as well as on Red Hat Enterprise Linux 7 and its derivatives through the EPEL repository. Explanations of configuration options and sample configuration files are included.

Table of Contents

List of Figures

List of Tables

Preface

Conventions

The OpenStack documentation uses several typesetting conventions.

Notices

Notices take these forms:

Note

A handy tip or reminder.

Important

Something you must be aware of before proceeding.

Warning

Critical information about the risk of data loss or security issues.

Command prompts

$ prompt Any user, including the `root` user, can run commands that are prefixed with the $ prompt.

# prompt The `root` user must run commands that are prefixed with the # prompt. You can also prefix these commands with the **sudo** command, if available, to run them.

Document change history

This version of the guide replaces and obsoletes all earlier versions.

The following table describes the most recent changes:

Revision Date	Summary of Changes
October 15, 2014	• For the Juno release, this guide contains these updates: Replace openstack-config commands with general configuration file editing. Standardize on a single message queue system (RabbitMQ). Reference generic SQL database, enabling MySQL or MariaDB where appropriate. Replace auth_port and auth_protocol with identity_uri, and auth_host with auth_uri. Multiple edits for consistency. It has been updated for Juno and new distribution versions.
June 3, 2014	• Start documentation for Juno.
April 16, 2014	• Update for Icehouse, rework Networking setup to use ML2 as plugin, add new chapter for Database Service setup, improved basic configuration.
October 25, 2013	• Added initial Debian support.
October 17, 2013	• Havana release.
October 16, 2013	• Add support for SUSE Linux Enterprise.

Revision Date	Summary of Changes
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.

1. Architecture

Table of Contents

Overview

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

OpenStack provides an Infrastructure-as-a-Service (*IaaS*) solution through a variety of complemental services. Each service offers an application programming interface (*API*) that facilitates this integration. The following table provides a list of OpenStack services:

Table 1.1. OpenStack services

Service	Project name	Description
Dashboard	*Horizon*	Provides a web-based self-service portal to interact with underlying OpenStack services, such as launching an instance, assigning IP addresses and configuring access controls.
Compute	*Nova*	Manages the lifecycle of compute instances in an OpenStack environment. Responsibilities include spawning, scheduling and decommissioning of virtual machines on demand.
Networking	*Neutron*	Enables Network-Connectivity-as-a-Service for other OpenStack services, such as OpenStack Compute. Provides an API for users to define networks and the attachments into them. Has a pluggable architecture that supports many popular networking vendors and technologies.
Storage		
Object Storage	*Swift*	Stores and retrieves arbitrary unstructured data objects via a *RESTful*, HTTP based API. It is highly fault tolerant with its data replication and scale out architecture. Its implementation is not like a file server with mountable directories.
Block Storage	*Cinder*	Provides persistent block storage to running instances. Its pluggable driver architecture facilitates the creation and management of block storage devices.
Shared services		
Identity service	*Keystone*	Provides an authentication and authorization service for other OpenStack services. Provides a catalog of endpoints for all OpenStack services.
Image Service	*Glance*	Stores and retrieves virtual machine disk images. OpenStack Compute makes use of this during instance provisioning.
Telemetry	*Ceilometer*	Monitors and meters the OpenStack cloud for billing, benchmarking, scalability, and statistical purposes.

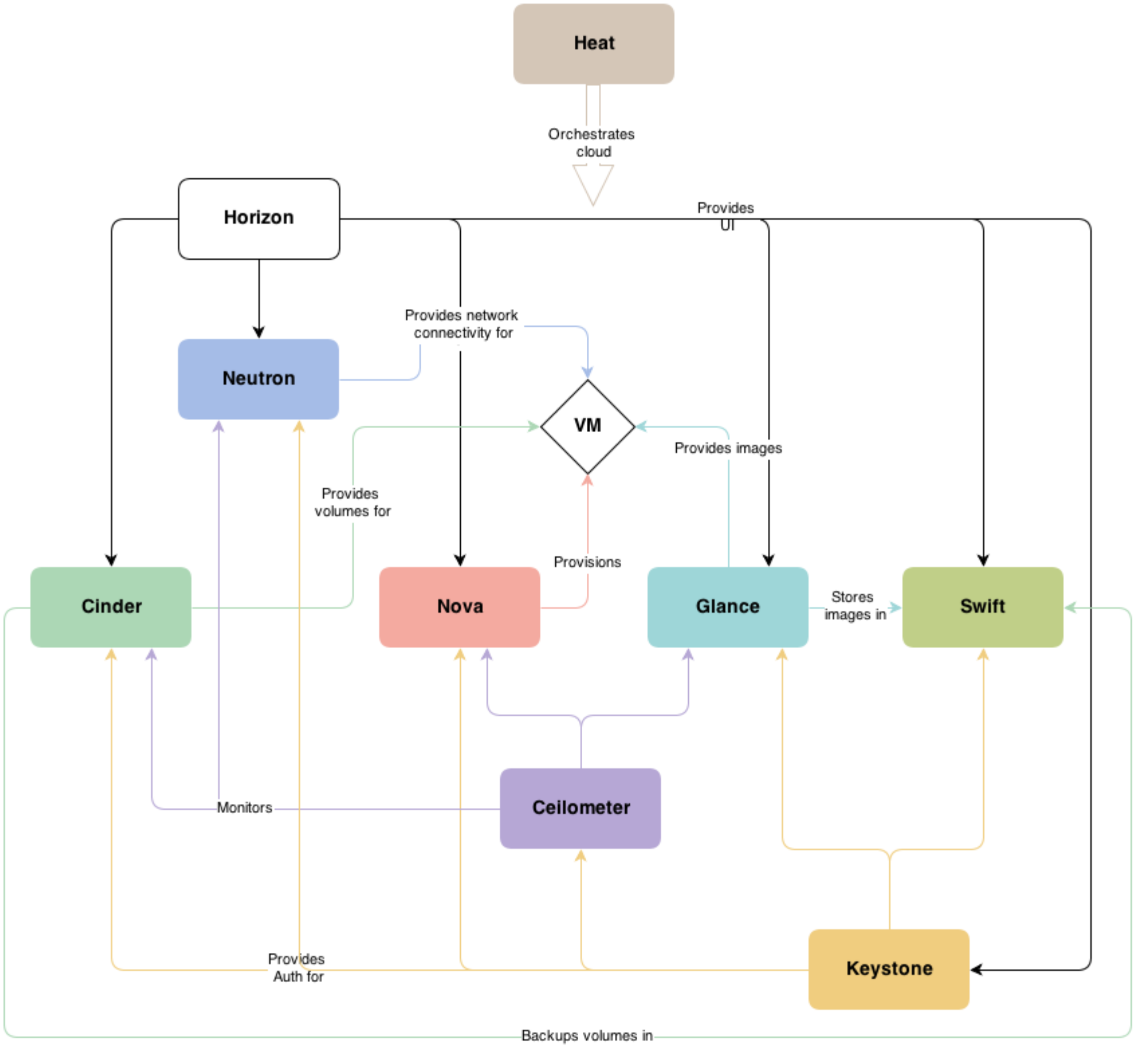
Service	Project name	Description
Higher-level services		
Orchestration	*Heat*	Orchestrates multiple composite cloud applications by using either the native *HOT* template format or the AWS CloudFormation template format, through both an OpenStack-native REST API and a CloudFormation-compatible Query API.
Database Service	*Trove*	Provides scalable and reliable Cloud Database-as-a-Service functionality for both relational and non-relational database engines.

This guide describes how to deploy these services in a functional test environment and, by example, teaches you how to build a production environment.

Conceptual architecture

Launching a virtual machine or instance involves many interactions among several services. The following diagram provides the conceptual architecture of a typical OpenStack environment.

Figure 1.1. Conceptual architecture



Example architectures

OpenStack is highly configurable to meet different needs with various compute, networking, and storage options. This guide enables you to choose your own OpenStack adventure using a combination of basic and optional services. This guide uses the following example architectures:

- Three-node architecture with OpenStack Networking (neutron). See Figure 1.2, “Three-node architecture with OpenStack Networking (neutron)” [4].
  - The basic controller node runs the Identity service, Image Service, management portions of Compute and Networking, Networking plug-in, and the dashboard. It also includes supporting services such as a database, *message broker*, and *Network Time Protocol (NTP)*.

    Optionally, the controller node also runs portions of Block Storage, Object Storage, Database Service, Orchestration, and Telemetry. These components provide additional features for your environment.
  - The network node runs the Networking plug-in, layer-2 agent, and several layer-3 agents that provision and operate tenant networks. Layer-2 services include provisioning of virtual networks and tunnels. Layer-3 services include routing, *NAT*, and *DHCP*. This node also handles external (Internet) connectivity for tenant virtual machines or instances.
  - The compute node runs the hypervisor portion of Compute, which operates tenant virtual machines or instances. By default Compute uses KVM as the hypervisor. The compute node also runs the Networking plug-in and layer-2 agent which operate tenant networks and implement security groups. You can run more than one compute node.

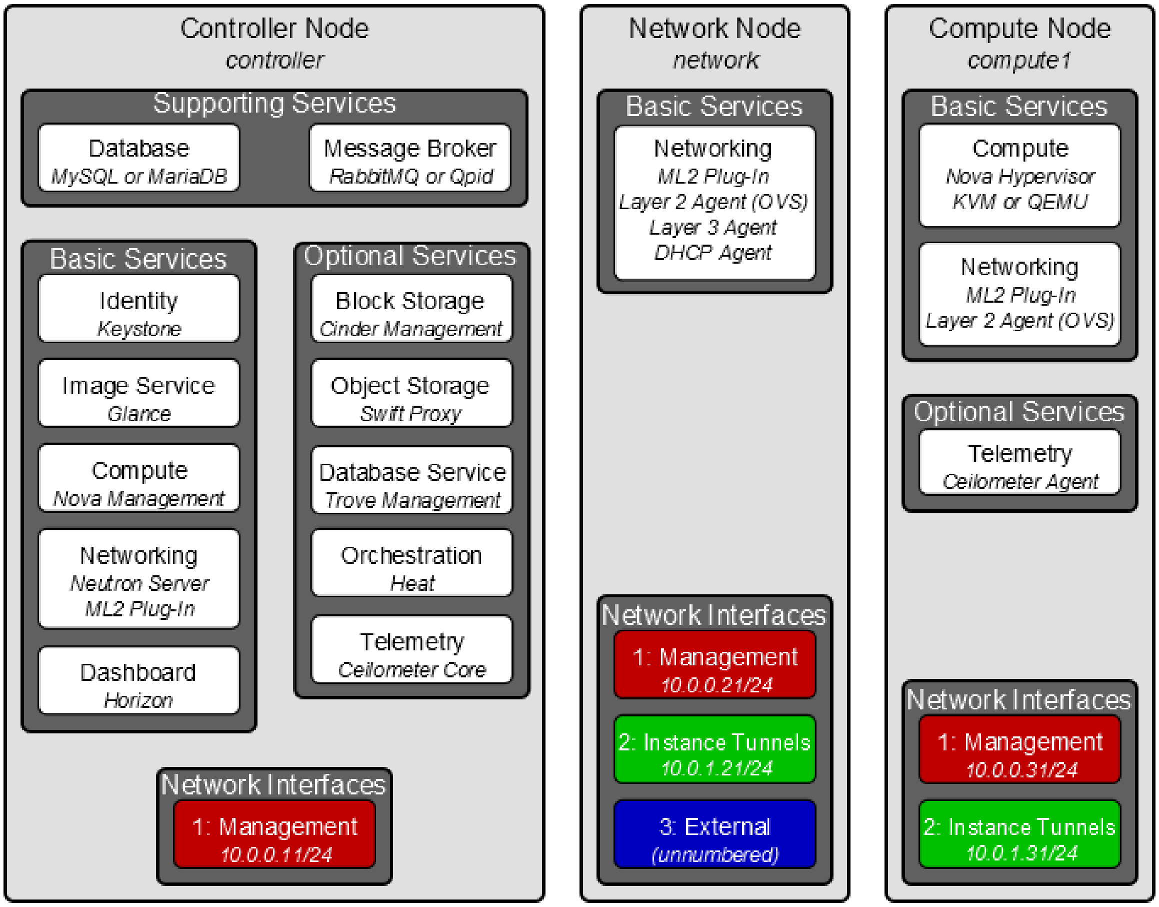
    Optionally, the compute node also runs the Telemetry agent. This component provides additional features for your environment.
  - The optional storage node contains the disks that the Block Storage service uses to serve volumes. You can run more than one storage node.

    Optionally, the storage node also runs the Telemetry agent. This component provides additional features for your environment.

Note

When you implement this architecture, skip the section called “Legacy networking (nova-network)” [76] in Chapter 6, “Add a networking component” [53]. To use optional services, you might need to install additional nodes, as described in subsequent chapters.

Figure 1.2. Three-node architecture with OpenStack Networking (neutron)



- Two-node architecture with legacy networking (nova-network). See Figure 1.3, “Two-node architecture with legacy networking (nova-network)” [5].

  - The basic *controller node* runs the Identity service, Image Service, management portion of Compute, and the dashboard necessary to launch a simple instance. It also includes supporting services such as a database, message broker, and NTP.

    Optionally, the controller node also runs portions of Block Storage, Object Storage, Database Service, Orchestration, and Telemetry. These components provide additional features for your environment.

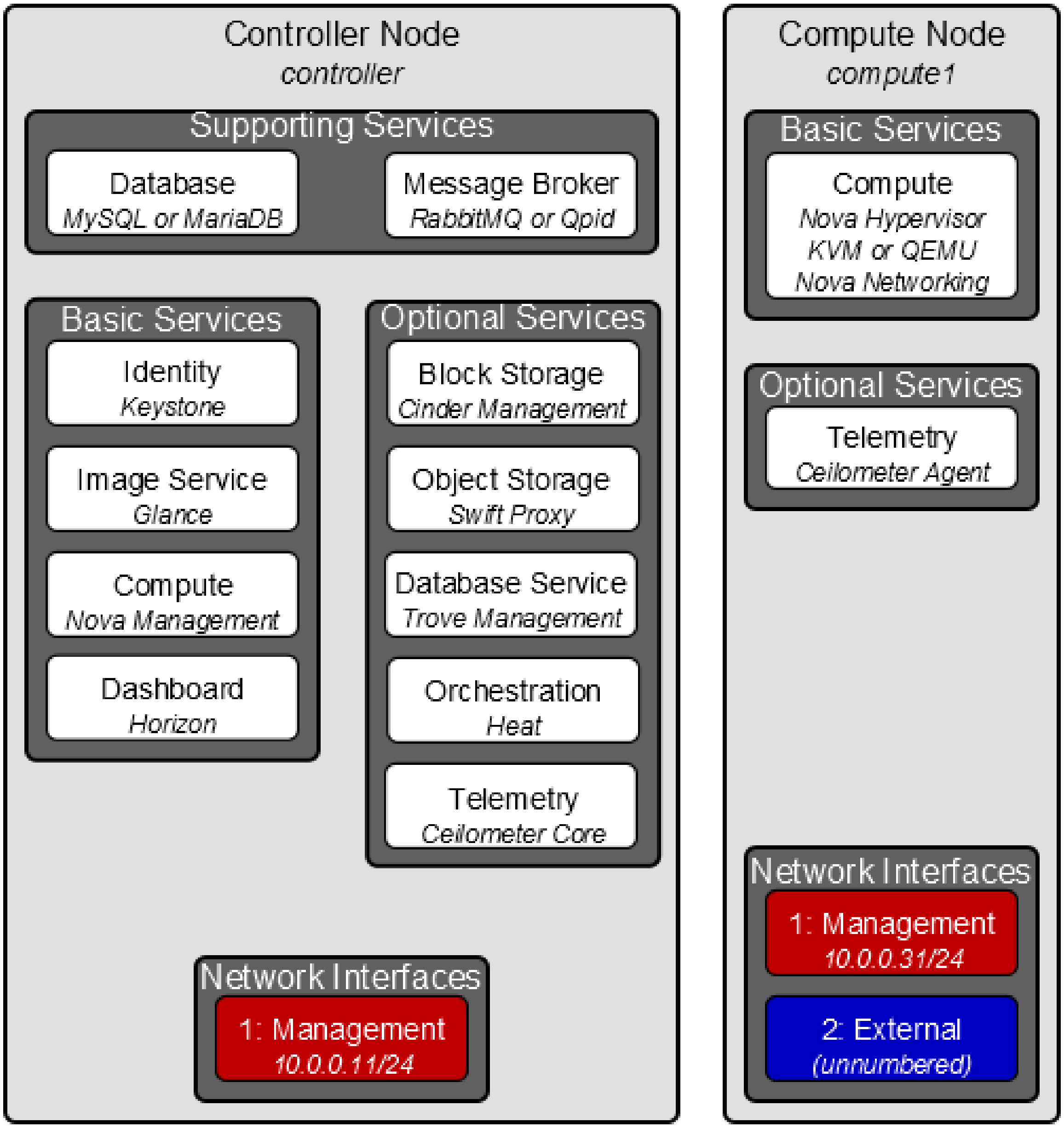
  - The basic *compute node* runs the *hypervisor* portion of Compute, which operates *tenant virtual machines* or instances. By default, Compute uses *KVM* as the *hypervisor*. Compute also provisions and operates tenant networks and implements *security groups*. You can run more than one compute node.

    Optionally, the compute node also runs the Telemetry agent. This component provides additional features for your environment.

Note

When you implement this architecture, skip the section called "OpenStack Networking (neutron)" [53] in Chapter 6, "Add a networking component" [53]. To use optional services, you might need to install additional nodes, as described in subsequent chapters.

Figure 1.3. Two-node architecture with legacy networking (nova-network)



2. Basic environment

Table of Contents

Note

The trunk version of this guide focuses on the future Juno release and will not work for the current Icehouse release. If you want to install Icehouse, you must use the Icehouse version of this guide instead.

This chapter explains how to configure each node in the example architectures including the two-node architecture with legacy networking and three-node architecture with OpenStack Networking (neutron).

Note

Although most environments include OpenStack Identity, Image Service, Compute, at least one networking service, and the dashboard, OpenStack Object Storage can operate independently of most other services. If your use case only involves Object Storage, you can skip to Chapter 9, “Add Object Storage” [92]. However, the dashboard will not run without at least OpenStack Image Service and Compute.

Note

You must use an account with administrative privileges to configure each node. Either run the commands as the `root` user or configure the `sudo` utility.

Note

The **systemctl enable** call on openSUSE outputs a warning message when the service uses SysV Init scripts instead of native systemd files. This warning can be ignored.

Before you begin

For a functional environment, OpenStack doesn't require a significant amount of resources. We recommend that your environment meets or exceeds the following minimum requirements which can support several minimal *CirrOS* instances:

- Controller Node: 1 processor, 2 GB memory, and 5 GB storage
- Network Node: 1 processor, 512 MB memory, and 5 GB storage
- Compute Node: 1 processor, 2 GB memory, and 10 GB storage

To minimize clutter and provide more resources for OpenStack, we recommend a minimal installation of your Linux distribution. Also, we strongly recommend that you install a 64-bit version of your distribution on at least the compute node. If you install a 32-bit version of your distribution on the compute node, attempting to start an instance using a 64-bit image will fail.

Note

A single disk partition on each node works for most basic installations. However, you should consider *Logical Volume Manager (LVM)* for installations with optional services such as Block Storage.

Many users build their test environments on *virtual machines (VMs)*. The primary benefits of VMs include the following:

- One physical server can support multiple nodes, each with almost any number of network interfaces.
- Ability to take periodic "snap shots" throughout the installation process and "roll back" to a working configuration in the event of a problem.

However, VMs will reduce performance of your instances, particularly if your hypervisor and/or processor lacks support for hardware acceleration of nested VMs.

Note

If you choose to install on VMs, make sure your hypervisor permits *promiscuous mode* on the *external network*.

For more information about system requirements, see the OpenStack Operations Guide.

Security

OpenStack services support various security methods including password, policy, and encryption. Additionally, supporting services including the database server and message broker support at least password security.

To ease the installation process, this guide only covers password security where applicable. You can create secure passwords manually, generate them using a tool such as pwgen, or by running the following command:

```
$ openssl rand -hex 10
```

For OpenStack services, this guide uses *SERVICE_PASS* to reference service account passwords and *SERVICE_DBPASS* to reference database passwords.

The following table provides a list of services that require passwords and their associated references in the guide:

Table 2.1. Passwords

Password name	Description
Database password (no variable used)	Root password for the database
RABBIT_PASS	Password of user guest of RabbitMQ
KEYSTONE_DBPASS	Database password of Identity service
DEMO_PASS	Password of user demo
ADMIN_PASS	Password of user admin
GLANCE_DBPASS	Database password for Image Service
GLANCE_PASS	Password of Image Service user glance
NOVA_DBPASS	Database password for Compute service
NOVA_PASS	Password of Compute service user nova
DASH_DBPASS	Database password for the dashboard
CINDER_DBPASS	Database password for the Block Storage service
CINDER_PASS	Password of Block Storage service user cinder
NEUTRON_DBPASS	Database password for the Networking service
NEUTRON_PASS	Password of Networking service user neutron
HEAT_DBPASS	Database password for the Orchestration service
HEAT_PASS	Password of Orchestration service user heat
CEILOMETER_DBPASS	Database password for the Telemetry service
CEILOMETER_PASS	Password of Telemetry service user ceilometer
TROVE_DBPASS	Database password of Database service
TROVE_PASS	Password of Database Service user trove

OpenStack and supporting services require administrative privileges during installation and operation. In some cases, services perform modifications to the host that can interfere with deployment automation tools such as Ansible, Chef, and Puppet. For example, some OpenStack services add a root wrapper to sudo that can interfere with security policies. See the Cloud Administrator Guide for more information. Also, the Networking service assumes default values for kernel network parameters and modifies firewall rules. To avoid most issues during your initial installation, we recommend using a stock deployment of a supported distribution on your hosts. However, if you choose to automate deployment of your hosts, review the configuration and policies applied to them before proceeding further.

Networking

After installing the operating system on each node for the architecture that you choose to deploy, you must configure the network interfaces. We recommend that you disable any automated network management tools and manually edit the appropriate configuration files for your distribution. For more information on how to configure networking on your distribution, see the documentation.

RHEL and CentOS enable a restrictive *firewall* by default. During the installation process, certain steps will fail unless you alter or disable the firewall. For more information about securing your environment, refer to the OpenStack Security Guide.

Proceed to network configuration for the example OpenStack Networking (neutron) or legacy networking (nova-network) architecture.

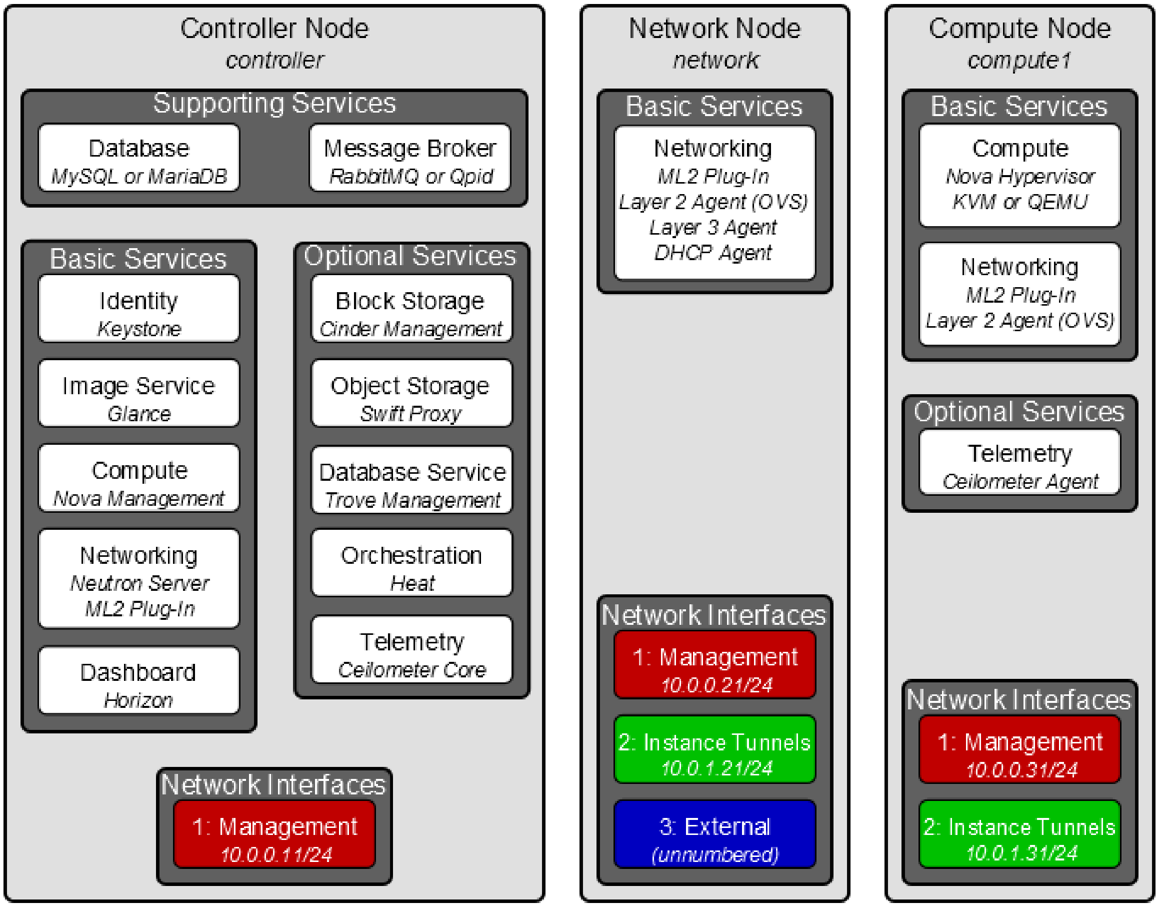
OpenStack Networking (neutron)

The example architecture with OpenStack Networking (neutron) requires one controller node, one network node, and at least one compute node. The controller node contains one network interface on the *management network*. The network node contains one network interface on the management network, one on the *instance tunnels network*, and one on the *external network*. The compute node contains one network interface on the management network and one on the instance tunnels network.

Note

Network interface names vary by distribution. Traditionally, interfaces use "eth" followed by a sequential number. To cover all variations, this guide simply refers to the first interface as the interface with the lowest number, the second interface as the interface with the middle number, and the third interface as the interface with the highest number.

Figure 2.1. Three-node architecture with OpenStack Networking (neutron)



Unless you intend to use the exact configuration provided in this example architecture, you must modify the networks in this procedure to match your environment. Also, each node must resolve the other nodes by name in addition to IP address. For example, the *`controller`* name must resolve to `10.0.0.11`, the IP address of the management interface on the controller node.

Warning

Reconfiguring network interfaces will interrupt network connectivity. We recommend using a local terminal session for these procedures.

Controller node

To configure networking:

1. Configure the first interface as the management interface:

   IP address: 10.0.0.11

   Network mask: 255.255.255.0 (or /24)

   Default gateway: 10.0.0.1

2. Reboot the system to activate the changes.

To configure name resolution:

1. Set the hostname of the node to *`controller`*.

2. Edit the `/etc/hosts` file to contain the following:

```
# controller
10.0.0.11       controller

# network
10.0.0.21       network

# compute1
10.0.0.31       compute1
```

Network node

To configure networking:

1. Configure the first interface as the management interface:

   IP address: 10.0.0.21

   Network mask: 255.255.255.0 (or /24)

   Default gateway: 10.0.0.1

2. Configure the second interface as the instance tunnels interface:

   IP address: 10.0.1.21

Network mask: 255.255.255.0 (or /24)

3. The external interface uses a special configuration without an IP address assigned to it. Configure the third interface as the external interface:

   Replace *INTERFACE_NAME* with the actual interface name. For example, *eth2* or *ens256*.

   - Edit the `/etc/sysconfig/network-scripts/ifcfg-INTERFACE_NAME` file to contain the following:

     Do not change the `HWADDR` and `UUID` keys.

     ```
     DEVICE=INTERFACE_NAME
     TYPE=Ethernet
     ONBOOT="yes"
     BOOTPROTO="none"
     ```

4. Reboot the system to activate the changes.

To configure name resolution:

1. Set the hostname of the node to `network`.

2. Edit the `/etc/hosts` file to contain the following:

```
# network
10.0.0.21       network

# controller
10.0.0.11       controller

# compute1
10.0.0.31       compute1
```

Compute node

To configure networking:

1. Configure the first interface as the management interface:

   IP address: 10.0.0.31

   Network mask: 255.255.255.0 (or /24)

   Default gateway: 10.0.0.1

   Note

   Additional compute nodes should use 10.0.0.32, 10.0.0.33, and so on.

2. Configure the second interface as the instance tunnels interface:

   IP address: 10.0.1.31

   Network mask: 255.255.255.0 (or /24)

Note

Additional compute nodes should use 10.0.1.32, 10.0.1.33, and so on.

3. Reboot the system to activate the changes.

To configure name resolution:

1. Set the hostname of the node to `compute1`.

2. Edit the `/etc/hosts` file to contain the following:

```
# compute1
10.0.0.31       compute1

# controller
10.0.0.11       controller

# network
10.0.0.21       network
```

Verify connectivity

We recommend that you verify network connectivity to the Internet and among the nodes before proceeding further.

1. From the *controller* node, **ping** a site on the Internet:

```
# ping -c 4 openstack.org
PING openstack.org (174.143.194.225) 56(84) bytes of data.
64 bytes from 174.143.194.225: icmp_seq=1 ttl=54 time=18.3 ms
64 bytes from 174.143.194.225: icmp_seq=2 ttl=54 time=17.5 ms
64 bytes from 174.143.194.225: icmp_seq=3 ttl=54 time=17.5 ms
64 bytes from 174.143.194.225: icmp_seq=4 ttl=54 time=17.4 ms

--- openstack.org ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3022ms
rtt min/avg/max/mdev = 17.489/17.715/18.346/0.364 ms
```

2. From the *controller* node, **ping** the management interface on the *network* node:

```
# ping -c 4 network
PING network (10.0.0.21) 56(84) bytes of data.
64 bytes from network (10.0.0.21): icmp_seq=1 ttl=64 time=0.263 ms
64 bytes from network (10.0.0.21): icmp_seq=2 ttl=64 time=0.202 ms
64 bytes from network (10.0.0.21): icmp_seq=3 ttl=64 time=0.203 ms
64 bytes from network (10.0.0.21): icmp_seq=4 ttl=64 time=0.202 ms

--- network ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.202/0.217/0.263/0.030 ms
```

3. From the *controller* node, **ping** the management interface on the *compute* node:

```
# ping -c 4 compute1
PING compute1 (10.0.0.31) 56(84) bytes of data.
64 bytes from compute1 (10.0.0.31): icmp_seq=1 ttl=64 time=0.263 ms
64 bytes from compute1 (10.0.0.31): icmp_seq=2 ttl=64 time=0.202 ms
```

```
64 bytes from compute1 (10.0.0.31): icmp_seq=3 ttl=64 time=0.203 ms
64 bytes from compute1 (10.0.0.31): icmp_seq=4 ttl=64 time=0.202 ms

--- network ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.202/0.217/0.263/0.030 ms
```

4. From the *network* node, **ping** a site on the Internet:

```
# ping -c 4 openstack.org
PING openstack.org (174.143.194.225) 56(84) bytes of data.
64 bytes from 174.143.194.225: icmp_seq=1 ttl=54 time=18.3 ms
64 bytes from 174.143.194.225: icmp_seq=2 ttl=54 time=17.5 ms
64 bytes from 174.143.194.225: icmp_seq=3 ttl=54 time=17.5 ms
64 bytes from 174.143.194.225: icmp_seq=4 ttl=54 time=17.4 ms

--- openstack.org ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3022ms
rtt min/avg/max/mdev = 17.489/17.715/18.346/0.364 ms
```

5. From the *network* node, **ping** the management interface on the *controller* node:

```
# ping -c 4 controller
PING controller (10.0.0.11) 56(84) bytes of data.
64 bytes from controller (10.0.0.11): icmp_seq=1 ttl=64 time=0.263 ms
64 bytes from controller (10.0.0.11): icmp_seq=2 ttl=64 time=0.202 ms
64 bytes from controller (10.0.0.11): icmp_seq=3 ttl=64 time=0.203 ms
64 bytes from controller (10.0.0.11): icmp_seq=4 ttl=64 time=0.202 ms

--- controller ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.202/0.217/0.263/0.030 ms
```

6. From the *network* node, **ping** the instance tunnels interface on the *compute* node:

```
# ping -c 4 10.0.1.31
PING 10.0.1.31 (10.0.1.31) 56(84) bytes of data.
64 bytes from 10.0.1.31 (10.0.1.31): icmp_seq=1 ttl=64 time=0.263 ms
64 bytes from 10.0.1.31 (10.0.1.31): icmp_seq=2 ttl=64 time=0.202 ms
64 bytes from 10.0.1.31 (10.0.1.31): icmp_seq=3 ttl=64 time=0.203 ms
64 bytes from 10.0.1.31 (10.0.1.31): icmp_seq=4 ttl=64 time=0.202 ms

--- 10.0.1.31 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.202/0.217/0.263/0.030 ms
```

7. From the *compute* node, **ping** a site on the Internet:

```
# ping -c 4 openstack.org
PING openstack.org (174.143.194.225) 56(84) bytes of data.
64 bytes from 174.143.194.225: icmp_seq=1 ttl=54 time=18.3 ms
64 bytes from 174.143.194.225: icmp_seq=2 ttl=54 time=17.5 ms
64 bytes from 174.143.194.225: icmp_seq=3 ttl=54 time=17.5 ms
64 bytes from 174.143.194.225: icmp_seq=4 ttl=54 time=17.4 ms

--- openstack.org ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3022ms
rtt min/avg/max/mdev = 17.489/17.715/18.346/0.364 ms
```

8. From the *compute* node, **ping** the management interface on the *controller* node:

```
# ping -c 4 controller
PING controller (10.0.0.11) 56(84) bytes of data.
64 bytes from controller (10.0.0.11): icmp_seq=1 ttl=64 time=0.263 ms
64 bytes from controller (10.0.0.11): icmp_seq=2 ttl=64 time=0.202 ms
64 bytes from controller (10.0.0.11): icmp_seq=3 ttl=64 time=0.203 ms
64 bytes from controller (10.0.0.11): icmp_seq=4 ttl=64 time=0.202 ms

--- controller ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.202/0.217/0.263/0.030 ms
```

9. From the *compute* node, **ping** the instance tunnels interface on the *network* node:

```
# ping -c 4 10.0.1.21
PING 10.0.1.21 (10.0.1.21) 56(84) bytes of data.
64 bytes from 10.0.1.21 (10.0.1.21): icmp_seq=1 ttl=64 time=0.263 ms
64 bytes from 10.0.1.21 (10.0.1.21): icmp_seq=2 ttl=64 time=0.202 ms
64 bytes from 10.0.1.21 (10.0.1.21): icmp_seq=3 ttl=64 time=0.203 ms
64 bytes from 10.0.1.21 (10.0.1.21): icmp_seq=4 ttl=64 time=0.202 ms

--- 10.0.1.21 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.202/0.217/0.263/0.030 ms
```

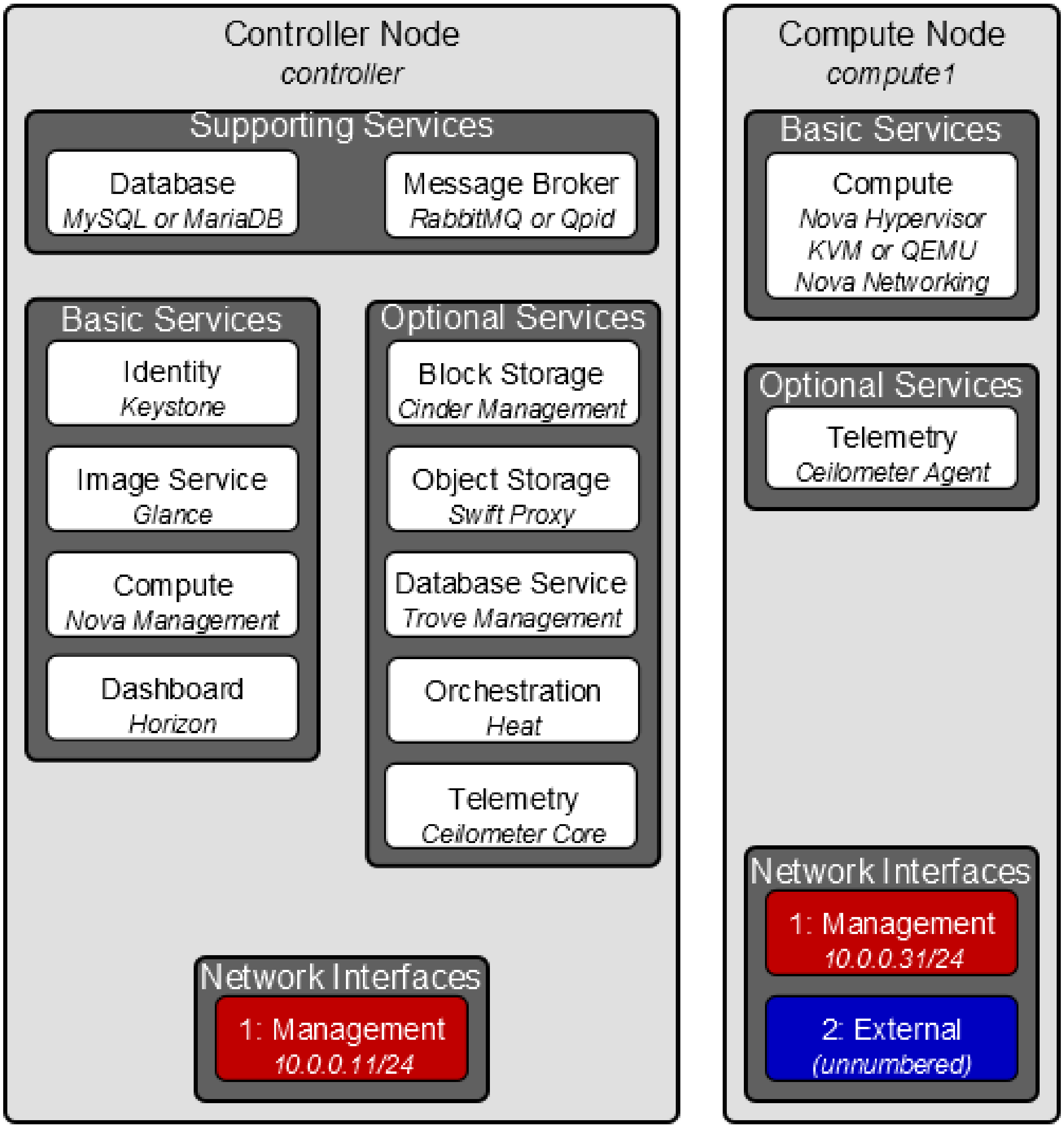
Legacy networking (nova-network)

The example architecture with legacy networking (nova-network) requires a controller node and at least one compute node. The controller node contains one network interface on the *management network*. The compute node contains one network interface on the management network and one on the *external network*.

Note

Network interface names vary by distribution. Traditionally, interfaces use "eth" followed by a sequential number. To cover all variations, this guide simply refers to the first interface as the interface with the lowest number and the second interface as the interface with the highest number.

Figure 2.2. Two-node architecture with legacy networking (nova-network)



Unless you intend to use the exact configuration provided in this example architecture, you must modify the networks in this procedure to match your environment. Also, each node must resolve the other nodes by name in addition to IP address. For example, the `controller` name must resolve to `10.0.0.11`, the IP address of the management interface on the controller node.

Warning

Reconfiguring network interfaces will interrupt network connectivity. We recommend using a local terminal session for these procedures.

Controller node

To configure networking:

1. Configure the first interface as the management interface:

   IP address: 10.0.0.11

   Network mask: 255.255.255.0 (or /24)

   Default gateway: 10.0.0.1

2. Reboot the system to activate the changes.

To configure name resolution:

1. Set the hostname of the node to `controller`.

2. Edit the `/etc/hosts` file to contain the following:

```
# controller
10.0.0.11       controller

# compute1
10.0.0.31       compute1
```

Compute node

To configure networking:

1. Configure the first interface as the management interface:

   IP address: 10.0.0.31

   Network mask: 255.255.255.0 (or /24)

   Default gateway: 10.0.0.1

   Note

   Additional compute nodes should use 10.0.0.32, 10.0.0.33, and so on.

2. The external interface uses a special configuration without an IP address assigned to it. Configure the second interface as the external interface:

   Replace *`INTERFACE_NAME`* with the actual interface name. For example, *eth1* or *ens224*.

   - Edit the `/etc/sysconfig/network-scripts/ifcfg-`*`INTERFACE_NAME`* file to contain the following:

     Do not change the `HWADDR` and `UUID` keys.

```
DEVICE=INTERFACE_NAME
TYPE=Ethernet
ONBOOT="yes"
BOOTPROTO="none"
```

3. Reboot the system to activate the changes.

To configure name resolution:

1. Set the hostname of the node to `compute1`.

2. Edit the `/etc/hosts` file to contain the following:

```
# compute1
10.0.0.31       compute1

# controller
10.0.0.11       controller
```

Verify connectivity

We recommend that you verify network connectivity to the Internet and among the nodes before proceeding further.

1. From the *controller* node, **ping** a site on the Internet:

```
# ping -c 4 openstack.org
PING openstack.org (174.143.194.225) 56(84) bytes of data.
64 bytes from 174.143.194.225: icmp_seq=1 ttl=54 time=18.3 ms
64 bytes from 174.143.194.225: icmp_seq=2 ttl=54 time=17.5 ms
64 bytes from 174.143.194.225: icmp_seq=3 ttl=54 time=17.5 ms
64 bytes from 174.143.194.225: icmp_seq=4 ttl=54 time=17.4 ms

--- openstack.org ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3022ms
rtt min/avg/max/mdev = 17.489/17.715/18.346/0.364 ms
```

2. From the *controller* node, **ping** the management interface on the *compute* node:

```
# ping -c 4 compute1
PING compute1 (10.0.0.31) 56(84) bytes of data.
64 bytes from compute1 (10.0.0.31): icmp_seq=1 ttl=64 time=0.263 ms
64 bytes from compute1 (10.0.0.31): icmp_seq=2 ttl=64 time=0.202 ms
64 bytes from compute1 (10.0.0.31): icmp_seq=3 ttl=64 time=0.203 ms
64 bytes from compute1 (10.0.0.31): icmp_seq=4 ttl=64 time=0.202 ms

--- compute1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.202/0.217/0.263/0.030 ms
```

3. From the *compute* node, **ping** a site on the Internet:

```
# ping -c 4 openstack.org
PING openstack.org (174.143.194.225) 56(84) bytes of data.
64 bytes from 174.143.194.225: icmp_seq=1 ttl=54 time=18.3 ms
64 bytes from 174.143.194.225: icmp_seq=2 ttl=54 time=17.5 ms
64 bytes from 174.143.194.225: icmp_seq=3 ttl=54 time=17.5 ms
64 bytes from 174.143.194.225: icmp_seq=4 ttl=54 time=17.4 ms
```

```
--- openstack.org ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3022ms
rtt min/avg/max/mdev = 17.489/17.715/18.346/0.364 ms
```

4. From the *compute* node, **ping** the management interface on the *controller* node:

```
# ping -c 4 controller
PING controller (10.0.0.11) 56(84) bytes of data.
64 bytes from controller (10.0.0.11): icmp_seq=1 ttl=64 time=0.263 ms
64 bytes from controller (10.0.0.11): icmp_seq=2 ttl=64 time=0.202 ms
64 bytes from controller (10.0.0.11): icmp_seq=3 ttl=64 time=0.203 ms
64 bytes from controller (10.0.0.11): icmp_seq=4 ttl=64 time=0.202 ms

--- controller ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.202/0.217/0.263/0.030 ms
```

Network Time Protocol (NTP)

You must install *NTP* to properly synchronize services among nodes. We recommend that you configure the controller node to reference more accurate (lower stratum) servers and other nodes to reference the controller node.

Controller node

To install the NTP service

-
  ```
  # yum install ntp
  ```

To configure the NTP service

By default, the controller node synchronizes the time via a pool of public servers. However, you can optionally edit the `/etc/ntp.conf` file to configure alternative servers such as those provided by your organization.

1. Edit the `/etc/ntp.conf` file and add, change, or remove the following keys as necessary for your environment:

   ```
   server NTP_SERVER iburst
   restrict -4 default kod notrap nomodify
   restrict -6 default kod notrap nomodify
   ```

   Replace *NTP_SERVER* with the hostname or IP address of a suitable more accurate (lower stratum) NTP server. The configuration supports multiple `server` keys.

   Note

   For the `restrict` keys, you essentially remove the `nopeer` and `noquery` options.

2. Start the NTP service and configure it to start when the system boots:

   ```
   # systemctl enable ntpd.service
   ```

```
# systemctl start ntpd.service
```

Other nodes

To install the NTP service

-
  ```
  # yum install ntp
  ```

To configure the NTP service

Configure the network and compute nodes to reference the controller node.

1. Edit the `/etc/ntp.conf` file:

   Comment out or remove all but one `server` key and change it to reference the controller node.

   ```
   server controller iburst
   ```

2. Start the NTP service and configure it to start when the system boots:

   ```
   # systemctl enable ntpd.service
   # systemctl start ntpd.service
   ```

Verify operation

We recommend that you verify NTP synchronization before proceeding further. Some nodes, particularly those that reference the controller node, can take several minutes to synchronize.

1. Run this command on the *controller* node:

   ```
   # ntpq -c peers
        remote           refid      st t when poll reach   delay   offset
    jitter
   ==========================================================================
   ====
   *ntp-server1     192.0.2.11       2 u  169 1024  377    1.901   -0.611
    5.483
   +ntp-server2     192.0.2.12       2 u  887 1024  377    0.922   -0.246
    2.864
   ```

   Contents in the *remote* column should indicate the hostname or IP address of one or more NTP servers.

   Note

   Contents in the *refid* column typically reference IP addresses of upstream servers.

2. Run this command on the *controller* node:

   ```
   # ntpq -c assoc
   ind assid status  conf reach auth condition  last_event cnt
   ===========================================================
     1 20487  961a   yes   yes  none  sys.peer    sys_peer  1
   ```

```
  2 20488  941a   yes   yes  none candidate    sys_peer  1
```

Contents in the *condition* column should indicate `sys.peer` for at least one server.

3. Run this command on *all other* nodes:

```
# ntpq -c peers
     remote           refid      st t when poll reach   delay   offset
 jitter
==========================================================================
====
*controller      192.0.2.21       3 u   47   64   37    0.308   -0.251
 0.079
```

Contents in the *remote* column should indicate the hostname of the controller node.

> **Note**
>
> Contents in the *refid* column typically reference IP addresses of upstream servers.

4. Run this command on *all other* nodes:

```
# ntpq -c assoc
ind assid status  conf reach auth condition  last_event cnt
===========================================================
  1 21181  963a   yes   yes  none  sys.peer    sys_peer  3
```

Contents in the *condition* column should indicate `sys.peer`.

OpenStack packages

Distributions release OpenStack packages as part of the distribution or using other methods because of differing release schedules. Perform these procedures on all nodes.

> **Note**
>
> Disable or remove any automatic update services because they can impact your OpenStack environment.

To configure prerequisites

1. Install the yum-plugin-priorities package to enable assignment of relative priorities within repositories:

```
# yum install yum-plugin-priorities
```

2. Install the epel-release package to enable the EPEL repository:

```
# yum install http://dl.fedoraproject.org/pub/epel/7/x86_64/e/epel-
release-7-2.noarch.rpm
```

> **Note**
>
> Fedora does not require this package.

To enable the OpenStack repository

- Install the rdo-release-juno package to enable the RDO repository:

  ```
  # yum install http://rdo.fedorapeople.org/openstack-juno/rdo-release-juno.
  rpm
  ```

To finalize installation

1. Upgrade the packages on your system:

   ```
   # yum upgrade
   ```

   Note

   If the upgrade process includes a new kernel, reboot your system to activate it.

2. RHEL and CentOS enable *SELinux* by default. Install the openstack-selinux package to automatically manage security policies for OpenStack services:

   ```
   # yum install openstack-selinux
   ```

   Note

   Fedora does not require this package.

   Note

   The installation process for this package can take a while.

Database

Most OpenStack services use an SQL database to store information. The database typically runs on the controller node. The procedures in this guide use MariaDB or MySQL depending on the distribution. OpenStack services also support other SQL databases including PostgreSQL.

To install and configure the database server

1. Install the packages:

   Note

   The Python MySQL library is compatible with MariaDB.

   ```
   # yum install mariadb mariadb-server MySQL-python
   ```

2. Edit the `/etc/my.cnf` file and complete the following actions:

   a. In the `[mysqld]` section, set the `bind-address` key to the management IP address of the controller node to enable access by other nodes via the management network:

```
[mysqld]
...
bind-address = 10.0.0.11
```

b. In the `[mysqld]` section, set the following keys to enable useful options and the UTF-8 character set:

```
[mysqld]
...
default-storage-engine = innodb
innodb_file_per_table
collation-server = utf8_general_ci
init-connect = 'SET NAMES utf8'
character-set-server = utf8
```

To finalize installation

1. Start the database service and configure it to start when the system boots:

```
# systemctl enable mariadb.service
# systemctl start mariadb.service
```

2. Secure the database service including choosing a suitable password for the root account:

```
# mysql_secure_installation
```

Messaging server

OpenStack uses a *message broker* to coordinate operations and status information among services. The message broker service typically runs on the controller node. OpenStack supports several message brokers including RabbitMQ, Qpid, and ZeroMQ. However, most distributions that package OpenStack support a particular message broker. This guide covers the RabbitMQ message broker which is supported by each distribution. If you prefer to implement a different message broker, consult the documentation associated with it.

- RabbitMQ
- Qpid
- ZeroMQ

To install the RabbitMQ message broker service

-
  ```
  # yum install rabbitmq-server
  ```

To configure the message broker service

1. Start the message broker service and configure it to start when the system boots:

```
# systemctl enable rabbitmq-server.service
# systemctl start rabbitmq-server.service
```

2. The message broker creates a default account that uses `guest` for the username and password. To simplify installation of your test environment, we recommend that you use this account, but change the password for it.

Run the following command:

Replace *RABBIT_PASS* with a suitable password.

```
# rabbitmqctl change_password guest RABBIT_PASS
Changing password for user "guest" ...
...done.
```

You must configure the `rabbit_password` key in the configuration file for each OpenStack service that uses the message broker.

Note

For production environments, you should create a unique account with suitable password. For more information on securing the message broker, see the documentation.

If you decide to create a unique account with suitable password for your test environment, you must configure the `rabbit_userid` and `rabbit_password` keys in the configuration file of each OpenStack service that uses the message broker.

Congratulations, now you are ready to install OpenStack services!

3. Add the Identity service

Table of Contents

OpenStack Identity concepts

The OpenStack*Identity Service* performs the following functions:

- Tracking users and their permissions.
- Providing a catalog of available services with their API endpoints.

When installing OpenStack Identity service, you must register each service in your OpenStack installation. Identity service can then track which OpenStack services are installed, and where they are located on the network.

To understand OpenStack Identity, 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 confirms the user's identity. For example: user name and password, user name and API key, or an authentication token provided by the Identity Service.

Authentication The process of confirming the identity of a user. OpenStack Identity 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. When user credentials are validated, OpenStack Identity issues an authentication token which the user provides in subsequent requests.

Token An alpha-numeric string of text used to access OpenStack APIs and resources. A token may be revoked at any time and is valid for a finite duration.

While OpenStack Identity supports token-based authentication in this release, the intention is to support additional protocols in the future. Its main purpose is to be an integration service, and not aspire to be a full-fledged identity store and management solution.

Tenant

A container used to group or isolate resources. Tenants also group or isolate 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). It provides one or more endpoints in which users can access resources and perform operations.

Endpoint

A network-accessible address where you access a service, usually a URL address. If you are using an extension for templates, an endpoint template can be created, which represents the templates of all the consumable services that are available across the regions.

Role

A personality with a defined set of user rights and privileges to perform a specific set of operations.

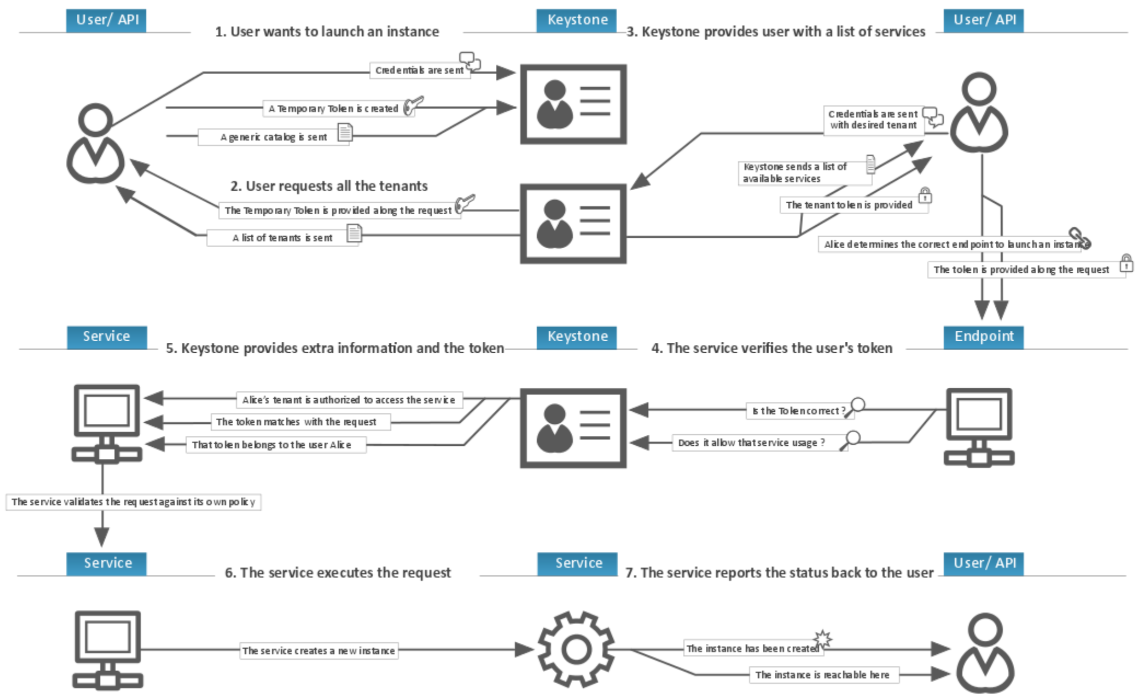
In the Identity service, a token that is issued to a user includes the list of roles. Services that are being called by that user determine how they interpret the set of roles a user has and to which operations or resources each role grants access.

Keystone Client

A command line interface for the OpenStack Identity API. For example, users can run the **keystone service-create** and **keystone endpoint-create** commands to register services in their OpenStack installations.

The following diagram shows the OpenStack Identity process flow:

The Keystone Identity Manager


User/ API
1. User wants to launch an instance
Keystone
Credentials are sent
A Temporary Token is created
A generic catalog is sent
2. User requests all the tenants
The Temporary Token is provided along the request
A list of tenants is sent
3. Keystone provides user with a list of services
User/ API
Credentials are sent with desired tenant
Keystone sends a list of available services
The tenant token is provided
Alice determines the correct end point to launch an instance
The token is provided along the request
Service
5. Keystone provides extra information and the token
Keystone
4. The service verifies the user's token
Endpoint
Alice's tenant is authorized to access the service
The token matches with the request
That token belongs to the user Alice
Is the Token correct ?
Does it allow that service usage ?
The service validates the request against its own policy
Service
6. The service executes the request
Service
7. The service reports the status back to the user
User/ API
The service creates a new instance
The instance has been created
The instance is reachable here

Install and configure

This section describes how to install and configure the OpenStack Identity service on the controller node.

To configure prerequisites

Before you configure the OpenStack Identity service, you must create a database and an administration token.

1. To create the database, complete these steps:

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

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

   b. Create the `keystone` database:

   ```
   CREATE DATABASE keystone;
   ```

   c. Grant proper access to the `keystone` database:

   ```
   GRANT ALL PRIVILEGES ON keystone.* TO 'keystone'@'localhost' \
     IDENTIFIED BY 'KEYSTONE_DBPASS';
   GRANT ALL PRIVILEGES ON keystone.* TO 'keystone'@'%' \
     IDENTIFIED BY 'KEYSTONE_DBPASS';
   ```

   Replace *KEYSTONE_DBPASS* with a suitable password.

   d. Exit the database access client.

2. Generate a random value to use as the administration token during initial configuration:

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

To install and configure the components

1. Run the following command to install the packages:

   ```
   # yum install openstack-keystone python-keystoneclient
   ```

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

   a. In the `[DEFAULT]` section, define the value of the initial administration token:

      ```
      [DEFAULT]
      ...
      admin_token = ADMIN_TOKEN
      ```

      Replace *`ADMIN_TOKEN`* with the random value that you generated in a previous step.

   b. In the `[database]` section, configure database access:

      ```
      [database]
      ...
      connection = mysql://keystone:KEYSTONE_DBPASS@controller/keystone
      ```

      Replace *KEYSTONE_DBPASS* with the password you chose for the database.

   c. In the `[token]` section, configure the UUID token provider and SQL driver:

      ```
      [token]
      ...
      provider = keystone.token.providers.uuid.Provider
      driver = keystone.token.persistence.backends.sql.Token
      ```

   d. (Optional) To assist with troubleshooting, enable verbose logging in the `[DEFAULT]` section:

      ```
      [DEFAULT]
      ...
      verbose = True
      ```

3. Create generic certificates and keys and restrict access to the associated files:

   ```
   # keystone-manage pki_setup --keystone-user keystone --keystone-group
    keystone
   # chown -R keystone:keystone /var/log/keystone
   # chown -R keystone:keystone /etc/keystone/ssl
   # chmod -R o-rwx /etc/keystone/ssl
   ```

4. Populate the Identity service database:

   ```
   # su -s /bin/sh -c "keystone-manage db_sync" keystone
   ```

To finalize installation

1. Start the Identity service and configure it to start when the system boots:

   ```
   # systemctl enable openstack-keystone.service
   # systemctl start openstack-keystone.service
   ```

2. By default, the Identity service stores expired tokens in the database indefinitely. The accumulation of expired tokens considerably increases the database size and might degrade service performance, particularly in environments with limited resources.

   We recommend that you use `cron` to configure a periodic task that purges expired tokens hourly:

   ```
   # (crontab -l -u keystone 2>&1 | grep -q token_flush) || \
     echo '@hourly /usr/bin/keystone-manage token_flush >/var/log/keystone/
   keystone-tokenflush.log 2>&1' \
     >> /var/spool/cron/keystone
   ```

Create tenants, users, and roles

After you install the Identity service, create *tenants* (projects), *users*, and *roles* for your environment. You must use the temporary administration token that you created in the section called “Install and configure” [26] and manually configure the location (endpoint) of the Identity service before you run **keystone** commands.

You can pass the value of the administration token to the **keystone** command with the *`--os-token`* option or set the temporary `OS_SERVICE_TOKEN` environment variable. Similarly, you can pass the location of the Identity service to the **keystone** command with the *`--os-endpoint`* option or set the temporary `OS_SERVICE_ENDPOINT` environment variable. This guide uses environment variables to reduce command length.

For more information, see the Operations Guide - Managing Project and Users.

To configure prerequisites

1. Configure the administration token:

   ```
   $ export OS_SERVICE_TOKEN=ADMIN_TOKEN
   ```

   Replace *`ADMIN_TOKEN`* with the administration token that you generated in the section called “Install and configure” [26]. For example:

   ```
   $ export OS_SERVICE_TOKEN=294a4c8a8a475f9b9836
   ```

2. Configure the endpoint:

   ```
   $ export OS_SERVICE_ENDPOINT=http://controller:35357/v2.0
   ```

To create tenants, users, and roles

1. Create an administrative tenant, user, and role for administrative operations in your environment:

   a. Create the `admin` tenant:

      ```
      $ keystone tenant-create --name admin --description "Admin Tenant"
      ```

```
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
| description |           Admin Tenant           |
|   enabled   |               True               |
|      id     | 6f4c1e4cbfef4d5a8a1345882fbca110 |
|     name    |              admin               |
+-------------+----------------------------------+
```

Note

Because OpenStack generates IDs dynamically, you will see different values from this example command output.

b. Create the `admin` user:

```
$ keystone user-create --name admin --pass ADMIN_PASS --
email EMAIL_ADDRESS
+----------+----------------------------------+
| Property |              Value               |
+----------+----------------------------------+
|  email   |        admin@example.com         |
| enabled  |               True               |
|    id    | ea8c352d253443118041c9c8b8416040 |
|   name   |              admin               |
| username |              admin               |
+----------+----------------------------------+
```

Replace *`ADMIN_PASS`* with a suitable password and *`EMAIL_ADDRESS`* with a suitable e-mail address.

c. Create the `admin` role:

```
$ keystone role-create --name admin
+----------+----------------------------------+
| Property |              Value               |
+----------+----------------------------------+
|    id    | bff3a6083b714fa29c9344bf8930d199 |
|   name   |              admin               |
+----------+----------------------------------+
```

d. Add the `admin` tenant and user to the `admin` role:

```
$ keystone user-role-add --tenant admin --user admin --role admin
```

Note

This command provides no output.

e. By default, the dashboard limits access to users with the `_member_` role.

Create the `_member_` role:

```
$ keystone role-create --name _member_
+----------+----------------------------------+
| Property |              Value               |
+----------+----------------------------------+
|    id    | 0f198e94ffce416cbcbe344e1843eac8 |
|   name   |             _member_             |
+----------+----------------------------------+
```

f. Add the `admin` tenant and user to the `_member_` role:

```
$ keystone user-role-add --tenant admin --user admin --role _member_
```

Note

This command provides no output.

Note

Any roles that you create must map to roles specified in the `policy.json` file included with each OpenStack service. The default policy for most services grants administrative access to the `admin` role. For more information, see the Operations Guide - Managing Projects and Users.

2. Create a demo tenant and user for typical operations in your environment:

a. Create the `demo` tenant:

```
$ keystone tenant-create --name demo --description "Demo Tenant"
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
| description |           Demo Tenant            |
|   enabled   |               True               |
|      id     | 4aa51bb942be4dd0ac0555d7591f80a6 |
|     name    |               demo               |
+-------------+----------------------------------+
```

Note

Do not repeat this step when creating additional users for this tenant.

b. Create the `demo` user:

```
$ keystone user-create --name demo --pass DEMO_PASS --
email EMAIL_ADDRESS
+----------+----------------------------------+
| Property |              Value               |
+----------+----------------------------------+
|  email   |         demo@example.com         |
| enabled  |               True               |
|    id    | 7004dfa0dda84d63aef81cf7f100af01 |
|   name   |               demo               |
| username |               demo               |
+----------+----------------------------------+
```

Replace *`DEMO_PASS`* with a suitable password and *`EMAIL_ADDRESS`* with a suitable e-mail address.

c. Add the `demo` tenant and user to the `_member_` role:

```
$ keystone user-role-add --tenant demo --user demo --role _member_
```

Note

This command provides no output.

Note

You can repeat this procedure to create additional tenants and users.

3. OpenStack services also require a tenant, user, and role to interact with other services. You will create a user in the `service` tenant for each service that you install.

    - Create the `service` tenant:

```
$ keystone tenant-create --name service --description "Service Tenant"
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
| description |          Service Tenant          |
|   enabled   |               True               |
|      id     | 6b69202e1bf846a4ae50d65bc4789122 |
|     name    |             service              |
+-------------+----------------------------------+
```

Create the service entity and API endpoint

After you create tenants, users, and roles, you must create the *service* entity and *API endpoint* for the Identity service.

To configure prerequisites

- Set the `OS_SERVICE_TOKEN` and `OS_SERVICE_ENDPOINT` environment variables, as described in the section called “Create tenants, users, and roles” [28].

To create the service entity and API endpoint

1. The Identity service manages a catalog of services in your OpenStack environment. Services use this catalog to locate other services in your environment.

   Create the service entity for the Identity service:

```
$ keystone service-create --name keystone --type identity \
  --description "OpenStack Identity"
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
| description |        OpenStack Identity        |
|   enabled   |               True               |
|      id     | 15c11a23667e427e91bc31335b45f4bd |
|     name    |             keystone             |
|     type    |             identity             |
+-------------+----------------------------------+
```

Note

Because OpenStack generates IDs dynamically, you will see different values from this example command output.

2. The Identity service manages a catalog of API endpoints associated with the services in your OpenStack environment. Services use this catalog to determine how to communicate with other services in your environment.

   OpenStack provides three API endpoint variations for each service: admin, internal, and public. In a production environment, the variants might reside on separate networks that service different types of users for security reasons. Also, OpenStack supports multiple regions for scalability. For simplicity, this configuration uses the management network for all endpoint variations and the `regionOne` region.

   Create the API endpoint for the Identity service:

```
$ keystone endpoint-create \
  --service-id $(keystone service-list | awk '/ identity / {print $2}') \
  --publicurl http://controller:5000/v2.0 \
  --internalurl http://controller:5000/v2.0 \
  --adminurl http://controller:35357/v2.0 \
  --region regionOne
+-------------+----------------------------------+
|   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 |
+-------------+----------------------------------+
```

   Note

   This command references the ID of the service that you created in the previous step.

Note

Each service that you add to your OpenStack environment requires adding information such as API endpoints to the Identity service. The sections of this guide that cover service installation include steps to add the appropriate information to the Identity service.

Verify operation

This section describes how to verify operation of the Identity service.

1. Unset the temporary `OS_SERVICE_TOKEN` and `OS_SERVICE_ENDPOINT` environment variables:

```
$ unset OS_SERVICE_TOKEN OS_SERVICE_ENDPOINT
```

2. As the `admin` tenant and user, request an authentication token:

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

   Replace *`ADMIN_PASS`* with the password you chose for the `admin` user in the Identity service. You might need to use single quotes (') around your password if it includes special characters.

   Lengthy output that includes a token value verifies operation for the `admin` tenant and user.

3. As the `admin` tenant and user, list tenants to verify that the `admin` tenant and user can execute admin-only CLI commands and that the Identity service contains the tenants that you created in the section called “Create tenants, users, and roles” [28]:

   ```
   $ keystone --os-tenant-name admin --os-username admin --os-
   password ADMIN_PASS \
     --os-auth-url http://controller:35357/v2.0 tenant-list
   +----------------------------------+----------+---------+
   |                id                |   name   | enabled |
   +----------------------------------+----------+---------+
   | 6f4c1e4cbfef4d5a8a1345882fbca110 |  admin   |   True  |
   | 4aa51bb942be4dd0ac0555d7591f80a6 |   demo   |   True  |
   | 6b69202e1bf846a4ae50d65bc4789122 | service  |   True  |
   +----------------------------------+----------+---------+
   ```

   ### Note

   Because OpenStack generates IDs dynamically, you will see different values from this example command output.

4. As the `admin` tenant and user, list users to verify that the Identity service contains the users that you created in the section called “Create tenants, users, and roles” [28]:

   ```
   $ keystone --os-tenant-name admin --os-username admin --os-
   password ADMIN_PASS \
     --os-auth-url http://controller:35357/v2.0 user-list
   +----------------------------------+---------+---------
   +---------------------+
   |                id                |   name  | enabled |        email
      |
   +----------------------------------+---------+---------
   +---------------------+
   | ea8c352d253443118041c9c8b8416040 |  admin  |   True  |  admin@example.
   com   |
   | 7004dfa0dda84d63aef81cf7f100af01 |   demo  |   True  |  demo@example.com
      |
   +----------------------------------+---------+---------
   +---------------------+
   ```

5. As the `admin` tenant and user, list roles to verify that the Identity service contains the role that you created in the section called “Create tenants, users, and roles” [28]:

   ```
   $ keystone --os-tenant-name admin --os-username admin --os-
   password ADMIN_PASS \
     --os-auth-url http://controller:35357/v2.0 role-list
   ```

```
+----------------------------------+----------+
|                id                |   name   |
+----------------------------------+----------+
| 9fe2ff9ee4384b1894a90878d3e92bab | _member_ |
| bff3a6083b714fa29c9344bf8930d199 |  admin   |
+----------------------------------+----------+
```

6. As the demo tenant and user, request an authentication token:

```
$ keystone --os-tenant-name demo --os-username demo --os-
password DEMO_PASS \
  --os-auth-url http://controller:35357/v2.0 token-get
+-----------+----------------------------------+
|  Property |              Value               |
+-----------+----------------------------------+
|  expires  |       2014-10-10T12:51:33Z       |
|     id    | 1b87ceae9e08411ba4a16e4dada04802 |
| tenant_id | 4aa51bb942be4dd0ac0555d7591f80a6 |
|  user_id  | 7004dfa0dda84d63aef81cf7f100af01 |
+-----------+----------------------------------+
```

Replace *DEMO_PASS* with the password you chose for the demo user in the Identity service.

7. As the demo tenant and user, attempt to list users to verify that you cannot execute admin-only CLI commands:

```
$ keystone --os-tenant-name demo --os-username demo --os-
password DEMO_PASS \
  --os-auth-url http://controller:35357/v2.0 user-list
You are not authorized to perform the requested action, admin_required.
 (HTTP 403)
```

Note

Each OpenStack service references a `policy.json` file to determine the operations available to a particular tenant, user, or role. For more information, see the Operations Guide - Managing Projects and Users.

Create OpenStack client environment scripts

The previous section used a combination of environment variables and command options to interact with the Identity service via the **keystone** client. To increase efficiency of client operations, OpenStack supports simple client environment scripts also known as OpenRC files. These scripts typically contain common options for all clients, but also support unique options. For more information, see the OpenStack User Guide.

To create the scripts

Create client environment scripts for the `admin` and `demo` tenants and users. Future portions of this guide reference these scripts to load appropriate credentials for client operations.

1. Edit the `admin-openrc.sh` file and add the following content:

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

Replace `ADMIN_PASS` with the password you chose for the `admin` user in the Identity service.

2. Edit the `demo-openrc.sh` file and add the following content:

```
export OS_TENANT_NAME=demo
export OS_USERNAME=demo
export OS_PASSWORD=DEMO_PASS
export OS_AUTH_URL=http://controller:5000/v2.0
```

Replace `DEMO_PASS` with the password you chose for the `demo` user in the Identity service.

To load client environment scripts

- To run clients as a certain tenant and user, you can simply load the associated client environment script prior to running them. For example, to load the location of the Identity service and `admin` tenant and user credentials:

```
$ source admin-openrc.sh
```

4. Add the Image Service

Table of Contents

The OpenStack Image Service (glance) enables users to discover, register, and retrieve virtual machine images. It offers a *REST* API that enables you to query virtual machine image metadata and retrieve an actual image. You can store virtual machine images made available through the Image Service in a variety of locations, from simple file systems to object-storage systems like OpenStack Object Storage.

Important

For simplicity, this guide describes configuring the Image Service to use the `file` back end, which uploads and stores in a directory on the controller node hosting the Image Service. By default, this directory is `/var/lib/glance/images/`.

Before you proceed, ensure that the controller node has at least several gigabytes of space available in this directory.

For information on requirements for other back ends, see *Configuration Reference*.

OpenStack Image Service

The OpenStack Image Service is central to Infrastructure-as-a-Service (IaaS) as shown in Figure 1.1, "Conceptual architecture" [2]. It accepts API requests for disk or server images, and image metadata from end users or OpenStack Compute components. It also supports the storage of disk or server images on various repository types, including OpenStack Object Storage.

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

The OpenStack 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 items such as size and type.

Security note

The registry is a private internal service meant for use by OpenStack Image Service. Do not disclose it to users.

Database

Stores image metadata and you can choose your database depending on your preference. Most deployments use MySQL or SQLite.

Storage repository for image files

Various repository types are supported including normal file systems, Object Storage, RADOS block devices, HTTP, and Amazon S3. Note that some repositories will only support read-only usage.

Install and configure

This section describes how to install and configure the Image Service, code-named glance, on the controller node. For simplicity, this configuration stores images on the local file system.

Note

This section assumes proper installation, configuration, and operation of the Identity service as described in the section called “Install and configure” [26] and the section called “Verify operation” [32].

To configure prerequisites

Before you install and configure the Image Service, you must create a database and Identity service credentials including endpoints.

1. To create the database, complete these steps:

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

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

   b. Create the `glance` database:

   ```
   CREATE DATABASE glance;
   ```

   c. Grant proper access to the `glance` database:

   ```
   GRANT ALL PRIVILEGES ON glance.* TO 'glance'@'localhost' \
     IDENTIFIED BY 'GLANCE_DBPASS';
   GRANT ALL PRIVILEGES ON glance.* TO 'glance'@'%' \
     IDENTIFIED BY 'GLANCE_DBPASS';
   ```

   Replace *GLANCE_DBPASS* with a suitable password.

   d. Exit the database access client.

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

```
$ source admin-openrc.sh
```

3. To create the Identity service credentials, complete these steps:

   a. Create the `glance` user:

```
$ keystone user-create --name glance --pass GLANCE_PASS
+----------+----------------------------------+
| Property |              Value               |
+----------+----------------------------------+
|  email   |                                  |
| enabled  |               True               |
|    id    | f89cca5865dc42b18e2421fa5f5cce66 |
|   name   |              glance              |
| username |              glance              |
+----------+----------------------------------+
```

   Replace *GLANCE_PASS* with a suitable password.

   b. Link the `glance` user to the `service` tenant and `admin` role:

```
$ keystone user-role-add --user glance --tenant service --role admin
```

   Note

   This command provides no output.

   c. Create the `glance` service:

```
$ keystone service-create --name glance --type image \
  --description "OpenStack Image Service"
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
| description |     OpenStack Image Service      |
|   enabled   |               True               |
|      id     | 23f409c4e79f4c9e9d23d809c50fbacf |
|     name    |              glance              |
|     type    |              image               |
+-------------+----------------------------------+
```

4. Create the Identity service endpoints:

```
$ keystone endpoint-create \
  --service-id $(keystone service-list | awk '/ image / {print $2}') \
  --publicurl http://controller:9292 \
  --internalurl http://controller:9292 \
  --adminurl http://controller:9292 \
  --region regionOne
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
|   adminurl  |   http://controller:9292         |
|      id     | a2ee818c69cb475199a1ca108332eb35 |
| internalurl |   http://controller:9292         |
|  publicurl  |   http://controller:9292         |
|    region   |            regionOne             |
|  service_id | 23f409c4e79f4c9e9d23d809c50fbacf |
+-------------+----------------------------------+
```

To install and configure the Image Service components

1. Install the packages:

   ```
   # yum install openstack-glance python-glanceclient
   ```

2. Edit the `/etc/glance/glance-api.conf` file and complete the following actions:

   a. In the `[database]` section, configure database access:

   ```
   [database]
   ...
   connection = mysql://glance:GLANCE_DBPASS@controller/glance
   ```

   Replace *GLANCE_DBPASS* with the password you chose for the Image Service database.

   b. In the `[keystone_authtoken]` and `[paste_deploy]` sections, configure Identity service access:

   ```
   [keystone_authtoken]
   ...
   auth_uri = http://controller:5000/v2.0
   identity_uri = http://controller:35357
   admin_tenant_name = service
   admin_user = glance
   admin_password = GLANCE_PASS

   [paste_deploy]
   ...
   flavor = keystone
   ```

   Replace *GLANCE_PASS* with the password you chose for the `glance` user in the Identity service.

   Note

   Comment out any `auth_host`, `auth_port`, and `auth_protocol` options because the `identity_uri` option replaces them.

   c. In the `[glance_store]` section, configure the local file system store and location of image files:

   ```
   [glance_store]
   ...
   default_store = file
   filesystem_store_datadir = /var/lib/glance/images/
   ```

   d. (Optional) To assist with troubleshooting, enable verbose logging in the `[DEFAULT]` section:

   ```
   [DEFAULT]
   ...
   verbose = True
   ```

3. Edit the `/etc/glance/glance-registry.conf` file and complete the following actions:

a. In the `[database]` section, configure database access:

```
[database]
...
connection = mysql://glance:GLANCE_DBPASS@controller/glance
```

Replace *GLANCE_DBPASS* with the password you chose for the Image Service database.

b. In the `[keystone_authtoken]` and `[paste_deploy]` sections, configure Identity service access:

```
[keystone_authtoken]
...
auth_uri = http://controller:5000/v2.0
identity_uri = http://controller:35357
admin_tenant_name = service
admin_user = glance
admin_password = GLANCE_PASS

[paste_deploy]
...
flavor = keystone
```

Replace *GLANCE_PASS* with the password you chose for the `glance` user in the Identity service.

Note

Comment out any `auth_host`, `auth_port`, and `auth_protocol` options because the `identity_uri` option replaces them.

c. (Optional) To assist with troubleshooting, enable verbose logging in the `[DEFAULT]` section:

```
[DEFAULT]
...
verbose = True
```

4. Populate the Image Service database:

```
# su -s /bin/sh -c "glance-manage db_sync" glance
```

To finalize installation

- Start the Image Service services and configure them to start when the system boots:

```
# systemctl enable openstack-glance-api.service openstack-glance-registry.
service
# systemctl start openstack-glance-api.service openstack-glance-registry.
service
```

Verify operation

This section describes how to verify operation of the Image Service using CirrOS, a small Linux image that helps you test your OpenStack deployment.

For more information about how to download and build images, see *OpenStack Virtual Machine Image Guide*. For information about how to manage images, see the *OpenStack User Guide*.

1. Create and change into a temporary local directory:

```
$ mkdir /tmp/images
$ cd /tmp/images
```

2. Download the image to the temporary local directory:

```
$ wget http://cdn.download.cirros-cloud.net/0.3.3/cirros-0.3.3-x86_64-
disk.img
```

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

```
$ source admin-openrc.sh
```

4. Upload the image to the Image Service:

```
$ glance image-create --name "cirros-0.3.3-x86_64" --file cirros-0.3.3-
x86_64-disk.img \
  --disk-format qcow2 --container-format bare --is-public True --progress
[=============================>] 100%
+------------------+--------------------------------------+
| Property         | Value                                |
+------------------+--------------------------------------+
| checksum         | 133eae9fb1c98f45894a4e60d8736619     |
| container_format | bare                                 |
| created_at       | 2014-10-10T13:14:42                  |
| 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-0.3.3-x86_64                  |
| owner            | ea8c352d253443118041c9c8b8416040     |
| protected        | False                                |
| size             | 13200896                             |
| status           | active                               |
| updated_at       | 2014-10-10T13:14:43                  |
| virtual_size     | None                                 |
+------------------+--------------------------------------+
```

For information about the parameters for the **glance image-create** command, see Image Service command-line client in the *OpenStack Command-Line Interface Reference*.

For information about disk and container formats for images, see Disk and container formats for images in the *OpenStack Virtual Machine Image Guide*.

Note

Because the returned image ID is generated dynamically, your deployment generates a different ID than the one shown in this example.

5. Confirm upload of the image and validate attributes:

```
$ glance image-list
+--------------------------------------+---------------------
+-------------+------------------+----------+--------+
| ID                                   | Name                | Disk Format
 | Container Format | Size     | Status |
+--------------------------------------+---------------------
+-------------+------------------+----------+--------+
| acafc7c0-40aa-4026-9673-b879898e1fc2 | cirros-0.3.3-x86_64 | qcow2
 | bare             | 13200896 | active |
+--------------------------------------+---------------------
+-------------+------------------+----------+--------+
```

6. Remove the temporary local directory:

```
$ rm -r /tmp/images
```

5. Add the Compute service

Table of Contents

OpenStack Compute

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

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

OpenStack Compute consists of the following areas and their components:

API

`nova-api` service

Accepts and responds to end user compute API calls. The service supports the OpenStack Compute API, the Amazon EC2 API, and a special Admin API for privileged users to perform administrative actions. It enforces some policies and initiates most orchestration activities, such as running an instance.

`nova-api-metadata` service

Accepts metadata requests from instances. The `nova-api-metadata` service is generally used when you run in multi-host mode with `nova-network` installations. For details, see Metadata service in the *OpenStack Cloud Administrator Guide*.

On Debian systems, it is included in the `nova-api` package, and can be selected through debconf.

Compute core

`nova-compute` service

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

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

`nova-scheduler` service

Takes a virtual machine instance request from the queue and determines on which compute server host it runs.

`nova-conductor` module

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

Networking for VMs

`nova-network` worker daemon

Similar to the `nova-compute` service, accepts networking tasks from the queue and manipulates the network. Performs tasks such as setting up bridging interfaces or changing IPtables rules.

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. You can run proxies of either type 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-spicehtml5proxy` daemon

Provides a proxy for accessing running instances through a SPICE connection. Supports browser-based HTML5 client.

`nova-xvpnvncproxy` daemon

Provides a proxy for accessing running instances through a VNC connection. Supports an OpenStack-specific Java client.

`nova-cert` daemon

x509 certificates.

Image management (EC2 scenario)

`nova-objectstore` daemon

An S3 interface for registering images with the OpenStack Image Service. Used primarily 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. Although it is not an OpenStack module, you can configure `nova-api` to support this EC2 interface. For more information, see the Eucalyptus 3.4 Documentation.

Command-line clients and other interfaces

nova client

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

Other components

The queue

A central hub for passing messages between daemons. Usually implemented with RabbitMQ, but can be implemented with an AMQP message queue, such as Apache Qpid or Zero MQ.

SQL database

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

- Available instance types
- Instances in use

- Available networks

- Projects

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

Install and configure controller node

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

To configure prerequisites

Before you install and configure Compute, you must create a database and Identity service credentials including endpoints.

1. To create the database, complete these steps:

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

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

   b. Create the `nova` database:

   ```
   CREATE DATABASE nova;
   ```

   c. Grant proper access to the `nova` database:

   ```
   GRANT ALL PRIVILEGES ON nova.* TO 'nova'@'localhost' \
     IDENTIFIED BY 'NOVA_DBPASS';
   GRANT ALL PRIVILEGES ON nova.* TO 'nova'@'%' \
     IDENTIFIED BY 'NOVA_DBPASS';
   ```

   Replace *NOVA_DBPASS* with a suitable password.

   d. Exit the database access client.

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

   ```
   $ source admin-openrc.sh
   ```

3. To create the Identity service credentials, complete these steps:

   a. Create the `nova` user:

   ```
   $ keystone user-create --name nova --pass NOVA_PASS
   +----------+----------------------------------+
   | Property |              Value               |
   +----------+----------------------------------+
   |  email   |                                  |
   | enabled  |               True               |
   |    id    | 387dd4f7e46d4f72965ee99c76ae748c |
   |   name   |               nova               |
   | username |               nova               |
   ```

```
+----------+----------------------------------+
```

Replace *NOVA_PASS* with a suitable password.

b. Link the nova user to the `service` tenant and `admin` role:

```
$ keystone user-role-add --user nova --tenant service --role admin
```

Note

This command provides no output.

c. Create the nova service:

```
$ keystone service-create --name nova --type compute \
  --description "OpenStack Compute"
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
| description |        OpenStack Compute         |
|   enabled   |               True               |
|      id     | 6c7854f52ce84db795557ebc0373f6b9 |
|     name    |               nova               |
|     type    |             compute              |
+-------------+----------------------------------+
```

4. Create the Compute service endpoints:

```
$ keystone endpoint-create \
  --service-id $(keystone service-list | awk '/ compute / {print $2}') \
  --publicurl http://controller:8774/v2/%\(tenant_id\)s \
  --internalurl http://controller:8774/v2/%\(tenant_id\)s \
  --adminurl http://controller:8774/v2/%\(tenant_id\)s \
  --region regionOne
+-------------+-----------------------------------------+
|   Property  |                  Value                  |
+-------------+-----------------------------------------+
|   adminurl  | http://controller:8774/v2/%(tenant_id)s |
|      id     |    c397438bd82c41198ec1a9d85cb7cc74     |
| internalurl | http://controller:8774/v2/%(tenant_id)s |
|  publicurl  | http://controller:8774/v2/%(tenant_id)s |
|    region   |                regionOne                |
|  service_id |    6c7854f52ce84db795557ebc0373f6b9     |
+-------------+-----------------------------------------+
```

To install and configure Compute controller components

1. Install the packages:

```
# yum install openstack-nova-api openstack-nova-cert openstack-nova-
conductor \
  openstack-nova-console openstack-nova-novncproxy openstack-nova-
scheduler \
  python-novaclient
```

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

a. In the `[database]` section, configure database access:

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

Replace *NOVA_DBPASS* with the password you chose for the Compute database.

b. In the `[DEFAULT]` section, configure RabbitMQ message broker access:

```
[DEFAULT]
...
rpc_backend = rabbit
rabbit_host = controller
rabbit_password = RABBIT_PASS
```

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

c. In the `[DEFAULT]` and `[keystone_authtoken]` sections, configure Identity service access:

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

[keystone_authtoken]
...
auth_uri = http://controller:5000/v2.0
identity_uri = http://controller:35357
admin_tenant_name = service
admin_user = nova
admin_password = NOVA_PASS
```

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

Note

Comment out any `auth_host`, `auth_port`, and `auth_protocol` options because the `identity_uri` option replaces them.

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

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

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

```
[DEFAULT]
...
vncserver_listen = 10.0.0.11
vncserver_proxyclient_address = 10.0.0.11
```

f. In the `[glance]` section, configure the location of the Image Service:

```
[glance]
...
host = controller
```

g. (Optional) To assist with troubleshooting, enable verbose logging in the [DEFAULT] section:

```
[DEFAULT]
...
verbose = True
```

3. Populate the Compute database:

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

To finalize installation

- Start the Compute services and configure them to start when the system boots:

```
# systemctl enable openstack-nova-api.service openstack-nova-cert.service
 \
  openstack-nova-consoleauth.service openstack-nova-scheduler.service \
  openstack-nova-conductor.service openstack-nova-novncproxy.service
# systemctl start openstack-nova-api.service openstack-nova-cert.service \
  openstack-nova-consoleauth.service openstack-nova-scheduler.service \
  openstack-nova-conductor.service openstack-nova-novncproxy.service
```

Install and configure a compute node

This section describes how to install and configure the Compute service on a compute node. The service supports several *hypervisors* to deploy *instances* or *VMs*. For simplicity, this configuration uses the *QEMU* hypervisor with the *KVM* extension on compute nodes that support hardware acceleration for virtual machines. On legacy hardware, this configuration uses the generic QEMU hypervisor. You can follow these instructions with minor modifications to horizontally scale your environment with additional compute nodes.

To install and configure the Compute hypervisor components

1. Install the packages:

```
# yum install openstack-nova-compute sysfsutils
```

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

a. In the [DEFAULT] section, configure RabbitMQ message broker access:

```
[DEFAULT]
...
rpc_backend = rabbit
rabbit_host = controller
rabbit_password = RABBIT_PASS
```

Replace *RABBIT_PASS* with the password you chose for the guest account in RabbitMQ.

b. In the [DEFAULT] and [keystone_authtoken] sections, configure Identity service access:

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

[keystone_authtoken]
...
auth_uri = http://controller:5000/v2.0
identity_uri = http://controller:35357
admin_tenant_name = service
admin_user = nova
admin_password = NOVA_PASS
```

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

Note

Comment out any `auth_host`, `auth_port`, and `auth_protocol` options because the `identity_uri` option replaces them.

c. In the `[DEFAULT]` section, configure the `my_ip` option:

```
[DEFAULT]
...
my_ip = MANAGEMENT_INTERFACE_IP_ADDRESS
```

Replace *MANAGEMENT_INTERFACE_IP_ADDRESS* with the IP address of the management network interface on your compute node, typically 10.0.0.31 for the first node in the example architecture.

d. In the `[DEFAULT]` section, enable and configure remote console access:

```
[DEFAULT]
...
vnc_enabled = True
vncserver_listen = 0.0.0.0
vncserver_proxyclient_address = MANAGEMENT_INTERFACE_IP_ADDRESS
novncproxy_base_url = http://controller:6080/vnc_auto.html
```

The server component listens on all IP addresses and the proxy component only listens on the management interface IP address of the compute node. The base URL indicates the location where you can use a web browser to access remote consoles of instances on this compute node.

Replace *MANAGEMENT_INTERFACE_IP_ADDRESS* with the IP address of the management network interface on your compute node, typically 10.0.0.31 for the first node in the example architecture.

Note

If the web browser to access remote consoles resides on a host that cannot resolve the *`controller`* hostname, you must replace *`controller`* with the management interface IP address of the controller node.

e. In the `[glance]` section, configure the location of the Image Service:

```
[glance]
...
host = controller
```

f. (Optional) To assist with troubleshooting, enable verbose logging in the `[DEFAULT]` section:

```
[DEFAULT]
...
verbose = True
```

To finalize installation

1. Determine whether your compute node supports hardware acceleration for virtual machines:

   ```
   $ egrep -c '(vmx|svm)' /proc/cpuinfo
   ```

   If this command returns a value of *one or greater*, your compute node supports hardware acceleration which typically requires no additional configuration.

   If this command returns a value of *zero*, your compute node does not support hardware acceleration and you must configure `libvirt` to use QEMU instead of KVM.

   - Edit the `[libvirt]` section in the `/etc/nova/nova.conf` file as follows:

     ```
     [libvirt]
     ...
     virt_type = qemu
     ```

2. Start the Compute service including its dependencies and configure them to start automatically when the system boots:

   ```
   # systemctl enable libvirtd.service openstack-nova-compute.service
   # systemctl start libvirtd.service
   # systemctl start openstack-nova-compute.service
   ```

Verify operation

This section describes how to verify operation of the Compute service.

Note

Perform these commands on the controller node.

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

   ```
   $ source admin-openrc.sh
   ```

2. List service components to verify successful launch of each process:

   ```
   $ nova service-list
   +----+------------------+------------+----------+---------+-------
   +----------------------------+-----------------+
   ```

```
| Id | Binary           | Host       | Zone     | Status  | State |
 Updated_at                 | Disabled Reason |
+----+------------------+------------+----------+---------+-------
+----------------------------+-----------------+
| 1  | nova-conductor   | controller | internal | enabled | up    |
 2014-09-16T23:54:02.000000 | -               |
| 2  | nova-consoleauth | controller | internal | enabled | up    |
 2014-09-16T23:54:04.000000 | -               |
| 3  | nova-scheduler   | controller | internal | enabled | up    |
 2014-09-16T23:54:07.000000 | -               |
| 4  | nova-cert        | controller | internal | enabled | up    |
 2014-09-16T23:54:00.000000 | -               |
| 5  | nova-compute     | compute1   | nova     | enabled | up    |
 2014-09-16T23:54:06.000000 | -               |
+----+------------------+------------+----------+---------+-------
+----------------------------+-----------------+
```

Note

This output should indicate four components enabled on the controller node one component enabled on the compute node.

3. List images in the Image Service catalog to verify connectivity with the Identity service and Image Service:

```
$ nova image-list
+--------------------------------------+---------------------+--------
+--------+
| ID                                   | Name                | Status |
 Server |
+--------------------------------------+---------------------+--------
+--------+
| acafc7c0-40aa-4026-9673-b879898e1fc2 | cirros-0.3.3-x86_64 | ACTIVE |
     |
+--------------------------------------+---------------------+--------
+--------+
```

6. Add a networking component

Table of Contents

This chapter explains how to install and configure either OpenStack Networking (neutron) or the legacy `nova-network` networking service. The `nova-network` service enables you to deploy one network type per instance and is suitable for basic network functionality. OpenStack Networking enables you to deploy multiple network types per instance and includes *plug-ins* for a variety of products that support *virtual networking*.

For more information, see the Networking chapter of the *OpenStack Cloud Administrator Guide*.

OpenStack Networking (neutron)

Networking concepts

OpenStack Networking (neutron) manages all networking facets for the Virtual Networking Infrastructure (VNI) and the access layer aspects of the Physical Networking Infrastructure (PNI) in your OpenStack environment. OpenStack Networking enables tenants to create advanced virtual network topologies including services such as *firewalls*, *load balancers*, and *virtual private networks (VPNs)*.

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

Each router has one gateway that connects to a network, and many interfaces connected to subnets. Subnets can access machines on other subnets connected to the same router.

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

In addition to external networks, any Networking 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 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.

Networking 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 Networking applies the rules in those security groups to block or unblock ports, port ranges, or traffic types for that VM.

Each plug-in that Networking uses has its own concepts. While not vital to operating the VNI and OpenStack environment, understanding these concepts can help you set up Networking. All Networking 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-Balancer-as-a-Service (LBaaS) plug-ins are available.

Install and configure controller node

To configure prerequisites

Before you configure OpenStack Networking (neutron), you must create a database and Identity service credentials including endpoints.

1. To create the database, complete these steps:

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

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

   b. Create the `neutron` database:

   ```
   CREATE DATABASE neutron;
   ```

   c. Grant proper access to the `neutron` database:

   ```
   GRANT ALL PRIVILEGES ON neutron.* TO 'neutron'@'localhost' \
     IDENTIFIED BY 'NEUTRON_DBPASS';
   GRANT ALL PRIVILEGES ON neutron.* TO 'neutron'@'%' \
     IDENTIFIED BY 'NEUTRON_DBPASS';
   ```

   Replace *NEUTRON_DBPASS* with a suitable password.

   d. Exit the database access client.

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

   ```
   $ source admin-openrc.sh
   ```

3. To create the Identity service credentials, complete these steps:

   a. Create the `neutron` user:

   ```
   $ keystone user-create --name neutron --pass NEUTRON_PASS
   ```

```
+----------+----------------------------------+
| Property |              Value               |
+----------+----------------------------------+
|  email   |                                  |
| enabled  |               True               |
|    id    | 7fd67878dcd04d0393469ef825a7e005 |
|   name   |             neutron              |
| username |             neutron              |
+----------+----------------------------------+
```

Replace *NEUTRON_PASS* with a suitable password.

b. Link the `neutron` user to the `service` tenant and `admin` role:

```
$ keystone user-role-add --user neutron --tenant service --role admin
```

Note

This command provides no output.

c. Create the `neutron` service:

```
$ keystone service-create --name neutron --type network \
  --description "OpenStack Networking"
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
| description |       OpenStack Networking       |
|   enabled   |               True               |
|      id     | 6369ddaf99a447f3a0d41dac5e342161 |
|     name    |             neutron              |
|     type    |             network              |
+-------------+----------------------------------+
```

d. Create the Identity service endpoints:

```
$ keystone endpoint-create \
  --service-id $(keystone service-list | awk '/ network / {print $2}')
 \
  --publicurl http://controller:9696 \
  --adminurl http://controller:9696 \
  --internalurl http://controller:9696 \
  --region regionOne
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
|   adminurl  |   http://controller:9696         |
|      id     | fa18b41938a94bf6b35e2c152063ee21 |
| internalurl |   http://controller:9696         |
|  publicurl  |   http://controller:9696         |
|    region   |            regionOne             |
|  service_id | 6369ddaf99a447f3a0d41dac5e342161 |
+-------------+----------------------------------+
```

To install the Networking components

-
```
# yum install openstack-neutron openstack-neutron-ml2 python-neutronclient
 which
```

To configure the Networking server component

The Networking server component configuration includes the database, authentication mechanism, message broker, topology change notifications, and plug-in.

- Edit the `/etc/neutron/neutron.conf` file and complete the following actions:

  a. In the `[database]` section, configure database access:

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

  Replace *NEUTRON_DBPASS* with the password you chose for the database.

  b. In the `[DEFAULT]` section, configure RabbitMQ message broker access:

  ```
  [DEFAULT]
  ...
  rpc_backend = rabbit
  rabbit_host = controller
  rabbit_password = RABBIT_PASS
  ```

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

  c. In the `[DEFAULT]` and `[keystone_authtoken]` sections, configure Identity service access:

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

  [keystone_authtoken]
  ...
  auth_uri = http://controller:5000/v2.0
  identity_uri = http://controller:35357
  admin_tenant_name = service
  admin_user = neutron
  admin_password = NEUTRON_PASS
  ```

  Replace *NEUTRON_PASS* with the password you chose or the `neutron` user in the Identity service.

  #### Note

  Comment out any `auth_host`, `auth_port`, and `auth_protocol` options because the `identity_uri` option replaces them.

  d. In the `[DEFAULT]` section, enable the Modular Layer 2 (ML2) plug-in, router service, and overlapping IP addresses:

  ```
  [DEFAULT]
  ...
  core_plugin = ml2
  service_plugins = router
  allow_overlapping_ips = True
  ```

e. In the [DEFAULT] section, configure Networking to notify Compute of network topology changes:

```
[DEFAULT]
...
notify_nova_on_port_status_changes = True
notify_nova_on_port_data_changes = True
nova_url = http://controller:8774/v2
nova_admin_auth_url = http://controller:35357/v2.0
nova_region_name = regionOne
nova_admin_username = nova
nova_admin_tenant_id = SERVICE_TENANT_ID
nova_admin_password = NOVA_PASS
```

Replace *SERVICE_TENANT_ID* with the service tenant identifier (id) in the Identity service and *NOVA_PASS* with the password you chose for the nova user in the Identity service.

Note

To obtain the service tenant identifier (id):

```
$ source admin-openrc.sh
$ keystone tenant-get service
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
| description |          Service Tenant          |
|   enabled   |               True               |
|      id     | f727b5ec2ceb4d71bad86dfc414449bf |
|     name    |             service              |
+-------------+----------------------------------+
```

f. (Optional) To assist with troubleshooting, enable verbose logging in the [DEFAULT] section:

```
[DEFAULT]
...
verbose = True
```

To configure the Modular Layer 2 (ML2) plug-in

The ML2 plug-in uses the *Open vSwitch (OVS)* mechanism (agent) to build the virtual networking framework for instances. However, the controller node does not need the OVS components because it does not handle instance network traffic.

- Edit the /etc/neutron/plugins/ml2/ml2_conf.ini file and complete the following actions:

  a. In the [ml2] section, enable the *flat* and *generic routing encapsulation (GRE)* network type drivers, GRE tenant networks, and the OVS mechanism driver:

```
[ml2]
...
type_drivers = flat,gre
tenant_network_types = gre
mechanism_drivers = openvswitch
```

Warning

Once you configure the ML2 plug-in, be aware that disabling a network type driver and re-enabling it later can lead to database inconsistency.

b. In the `[ml2_type_gre]` section, configure the tunnel identifier (id) range:

```
[ml2_type_gre]
...
tunnel_id_ranges = 1:1000
```

c. In the `[securitygroup]` section, enable security groups, enable *ipset*, and configure the OVS *iptables* firewall driver:

```
[securitygroup]
...
enable_security_group = True
enable_ipset = True
firewall_driver = neutron.agent.linux.iptables_firewall.
OVSHybridIptablesFirewallDriver
```

To configure Compute to use Networking

By default, distribution packages configure Compute to use legacy networking. You must reconfigure Compute to manage networks through Networking.

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

a. In the `[DEFAULT]` section, configure the *APIs* and drivers:

```
[DEFAULT]
...
network_api_class = nova.network.neutronv2.api.API
security_group_api = neutron
linuxnet_interface_driver = nova.network.linux_net.
LinuxOVSInterfaceDriver
firewall_driver = nova.virt.firewall.NoopFirewallDriver
```

Note

By default, Compute uses an internal firewall service. Since Networking includes a firewall service, you must disable the Compute firewall service by using the `nova.virt.firewall.NoopFirewallDriver` firewall driver.

b. In the `[neutron]` section, configure access parameters:

```
[neutron]
...
url = http://controller:9696
auth_strategy = keystone
admin_auth_url = http://controller:35357/v2.0
admin_tenant_name = service
admin_username = neutron
admin_password = NEUTRON_PASS
```

Replace *NEUTRON_PASS* with the password you chose for the `neutron` user in the Identity service.

To finalize installation

1. The Networking service initialization scripts expect a symbolic link `/etc/neutron/plugin.ini` pointing to the ML2 plug-in configuration file, `/etc/neutron/plugins/ml2/ml2_conf.ini`. If this symbolic link does not exist, create it using the following command:

   ```
   # ln -s /etc/neutron/plugins/ml2/ml2_conf.ini /etc/neutron/plugin.ini
   ```

2. Populate the database:

   ```
   # su -s /bin/sh -c "neutron-db-manage --config-file /etc/neutron/neutron.
   conf \
     --config-file /etc/neutron/plugins/ml2/ml2_conf.ini upgrade juno"
    neutron
   ```

   ### Note

   Database population occurs later for Networking because the script requires complete server and plug-in configuration files.

3. Restart the Compute services:

   ```
   # systemctl restart openstack-nova-api.service openstack-nova-scheduler.
   service \
     openstack-nova-conductor.service
   ```

4. Start the Networking service and configure it to start when the system boots:

   ```
   # systemctl enable neutron-server.service
   # systemctl start neutron-server.service
   ```

Verify operation

Note

Perform these commands on the controller node.

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

   ```
   $ source admin-openrc.sh
   ```

2. List loaded extensions to verify successful launch of the `neutron-server` process:

   ```
   $ neutron ext-list
   +-----------------------+-----------------------------------------------+
   | alias                 | name                                          |
   +-----------------------+-----------------------------------------------+
   | security-group        | security-group                                |
   | l3_agent_scheduler    | L3 Agent Scheduler                            |
   | ext-gw-mode           | Neutron L3 Configurable external gateway mode |
   | binding               | Port Binding                                  |
   | provider              | Provider Network                              |
   | agent                 | agent                                         |
   ```

```
| quotas                | Quota management support                        |
| dhcp_agent_scheduler  | DHCP Agent Scheduler                            |
| l3-ha                 | HA Router extension                             |
| multi-provider        | Multi Provider Network                          |
| external-net          | Neutron external network                        |
| router                | Neutron L3 Router                               |
| allowed-address-pairs | Allowed Address Pairs                           |
| extraroute            | Neutron Extra Route                             |
| extra_dhcp_opt        | Neutron Extra DHCP opts                         |
| dvr                   | Distributed Virtual Router                      |
+-----------------------+-------------------------------------------------+
```

Install and configure network node

The network node primarily handles internal and external routing and *DHCP* services for virtual networks.

To configure prerequisites

Before you install and configure OpenStack Networking, you must configure certain kernel networking parameters.

1. Edit the `/etc/sysctl.conf` file to contain the following parameters:

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

2. Implement the changes:

```
# sysctl -p
```

To install the Networking components

-
```
# yum install openstack-neutron openstack-neutron-ml2 openstack-neutron-openvswitch
```

To configure the Networking common components

The Networking common component configuration includes the authentication mechanism, message broker, and plug-in.

- Edit the `/etc/neutron/neutron.conf` file and complete the following actions:

  a. In the `[database]` section, comment out any `connection` options because network nodes do not directly access the database.

  b. In the `[DEFAULT]` section, configure RabbitMQ message broker access:

```
[DEFAULT]
...
rpc_backend = rabbit
rabbit_host = controller
rabbit_password = RABBIT_PASS
```

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

c. In the [DEFAULT] and [keystone_authtoken] sections, configure Identity service access:

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

[keystone_authtoken]
...
auth_uri = http://controller:5000/v2.0
identity_uri = http://controller:35357
admin_tenant_name = service
admin_user = neutron
admin_password = NEUTRON_PASS
```

Replace *NEUTRON_PASS* with the password you chose or the neutron user in the Identity service.

Note

Comment out any auth_host, auth_port, and auth_protocol options because the identity_uri option replaces them.

d. In the [DEFAULT] section, enable the Modular Layer 2 (ML2) plug-in, router service, and overlapping IP addresses:

```
[DEFAULT]
...
core_plugin = ml2
service_plugins = router
allow_overlapping_ips = True
```

e. (Optional) To assist with troubleshooting, enable verbose logging in the [DEFAULT] section:

```
[DEFAULT]
...
verbose = True
```

To configure the Modular Layer 2 (ML2) plug-in

The ML2 plug-in uses the *Open vSwitch (OVS)* mechanism (agent) to build the virtual networking framework for instances.

- Edit the /etc/neutron/plugins/ml2/ml2_conf.ini file and complete the following actions:

a. In the [ml2] section, enable the *flat* and *generic routing encapsulation (GRE)* network type drivers, GRE tenant networks, and the OVS mechanism driver:

```
[ml2]
...
type_drivers = flat,gre
tenant_network_types = gre
mechanism_drivers = openvswitch
```

b. In the `[ml2_type_flat]` section, configure the external network:

```
[ml2_type_flat]
...
flat_networks = external
```

c. In the `[ml2_type_gre]` section, configure the tunnel identifier (id) range:

```
[ml2_type_gre]
...
tunnel_id_ranges = 1:1000
```

d. In the `[securitygroup]` section, enable security groups, enable *ipset*, and configure the OVS *iptables* firewall driver:

```
[securitygroup]
...
enable_security_group = True
enable_ipset = True
firewall_driver = neutron.agent.linux.iptables_firewall.
OVSHybridIptablesFirewallDriver
```

e. In the `[ovs]` section, configure the *Open vSwitch (OVS) agent*:

```
[ovs]
...
local_ip = INSTANCE_TUNNELS_INTERFACE_IP_ADDRESS
tunnel_type = gre
enable_tunneling = True
bridge_mappings = external:br-ex
```

Replace *`INSTANCE_TUNNELS_INTERFACE_IP_ADDRESS`* with the IP address of the instance tunnels network interface on your network node.

To configure the Layer-3 (L3) agent

The *Layer-3 (L3) agent* provides routing services for virtual networks.

- Edit the `/etc/neutron/l3_agent.ini` file and complete the following actions:

  a. In the `[DEFAULT]` section, configure the driver, enable *network namespaces*, and configure the external network bridge:

  ```
  [DEFAULT]
  ...
  interface_driver = neutron.agent.linux.interface.OVSInterfaceDriver
  use_namespaces = True
  external_network_bridge = br-ex
  ```

  b. (Optional) To assist with troubleshooting, enable verbose logging in the `[DEFAULT]` section:

  ```
  [DEFAULT]
  ...
  verbose = True
  ```

To configure the DHCP agent

The *DHCP agent* provides DHCP services for virtual networks.

1. Edit the `/etc/neutron/dhcp_agent.ini` file and complete the following actions:

   a. In the `[DEFAULT]` section, configure the drivers and enable namespaces:

   ```
   [DEFAULT]
   ...
   interface_driver = neutron.agent.linux.interface.OVSInterfaceDriver
   dhcp_driver = neutron.agent.linux.dhcp.Dnsmasq
   use_namespaces = True
   ```

   b. (Optional) To assist with troubleshooting, enable verbose logging in the `[DEFAULT]` section:

   ```
   [DEFAULT]
   ...
   verbose = True
   ```

2. (Optional)

   Tunneling protocols such as GRE include additional packet headers that increase overhead and decrease space available for the payload or user data. Without knowledge of the virtual network infrastructure, instances attempt to send packets using the default Ethernet *maximum transmission unit (MTU)* of 1500 bytes. *Internet protocol (IP)* networks contain the *path MTU discovery (PMTUD)* mechanism to detect end-to-end MTU and adjust packet size accordingly. However, some operating systems and networks block or otherwise lack support for PMTUD causing performance degradation or connectivity failure.

   Ideally, you can prevent these problems by enabling *jumbo frames* on the physical network that contains your tenant virtual networks. Jumbo frames support MTUs up to approximately 9000 bytes which negates the impact of GRE overhead on virtual networks. However, many network devices lack support for jumbo frames and OpenStack administrators often lack control over network infrastructure. Given the latter complications, you can also prevent MTU problems by reducing the instance MTU to account for GRE overhead. Determining the proper MTU value often takes experimentation, but 1454 bytes works in most environments. You can configure the DHCP server that assigns IP addresses to your instances to also adjust the MTU.

   #### Note

   Some cloud images ignore the DHCP MTU option in which case you should configure it using metadata, script, or other suitable method.

   a. Edit the `/etc/neutron/dhcp_agent.ini` file and complete the following action:

   - In the `[DEFAULT]` section, enable the *dnsmasq* configuration file:

     ```
     [DEFAULT]
     ...
     dnsmasq_config_file = /etc/neutron/dnsmasq-neutron.conf
     ```

b. Create and edit the `/etc/neutron/dnsmasq-neutron.conf` file and complete the following action:

- Enable the DHCP MTU option (26) and configure it to 1454 bytes:

```
dhcp-option-force=26,1454
```

c. Kill any existing `dnsmasq` processes:

```
# pkill dnsmasq
```

To configure the metadata agent

The *metadata agent* provides configuration information such as credentials to instances.

1. Edit the `/etc/neutron/metadata_agent.ini` file and complete the following actions:

   a. In the `[DEFAULT]` section, configure access parameters:

   ```
   [DEFAULT]
   ...
   auth_url = http://controller:5000/v2.0
   auth_region = regionOne
   admin_tenant_name = service
   admin_user = neutron
   admin_password = NEUTRON_PASS
   ```

   Replace *NEUTRON_PASS* with the password you chose for the `neutron` user in the Identity service.

   b. In the `[DEFAULT]` section, configure the metadata host:

   ```
   [DEFAULT]
   ...
   nova_metadata_ip = controller
   ```

   c. In the `[DEFAULT]` section, configure the metadata proxy shared secret:

   ```
   [DEFAULT]
   ...
   metadata_proxy_shared_secret = METADATA_SECRET
   ```

   Replace *METADATA_SECRET* with a suitable secret for the metadata proxy.

   d. (Optional) To assist with troubleshooting, enable verbose logging in the `[DEFAULT]` section:

   ```
   [DEFAULT]
   ...
   verbose = True
   ```

2. On the *controller* node, edit the `/etc/nova/nova.conf` file and complete the following action:

   - In the `[neutron]` section, enable the metadata proxy and configure the secret:

```
[neutron]
...
service_metadata_proxy = True
metadata_proxy_shared_secret = METADATA_SECRET
```

Replace *METADATA_SECRET* with the secret you chose for the metadata proxy.

3. On the *controller* node, restart the Compute *API* service:

```
# systemctl restart openstack-nova-api.service
```

To configure the Open vSwitch (OVS) service

The OVS service provides the underlying virtual networking framework for instances. The integration bridge `br-int` handles internal instance network traffic within OVS. The external bridge `br-ex` handles external instance network traffic within OVS. The external bridge requires a port on the physical external network interface to provide instances with external network access. In essence, this port connects the virtual and physical external networks in your environment.

1. Start the OVS service and configure it to start when the system boots:

```
# systemctl enable openvswitch.service
# systemctl start openvswitch.service
```

2. Add the external bridge:

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

3. Add a port to the external bridge that connects to the physical external network interface:

   Replace *INTERFACE_NAME* with the actual interface name. For example, *eth2* or *ens256*.

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

Note

Depending on your network interface driver, you may need to disable *generic receive offload (GRO)* to achieve suitable throughput between your instances and the external network.

To temporarily disable GRO on the external network interface while testing your environment:

```
# ethtool -K INTERFACE_NAME gro off
```

To finalize the installation

1. The Networking service initialization scripts expect a symbolic link `/etc/neutron/plugin.ini` pointing to the ML2 plug-in configuration file, `/etc/neutron/plugins/ml2/ml2_conf.ini`. If this symbolic link does not exist, create it using the following command:

```
# ln -s /etc/neutron/plugins/ml2/ml2_conf.ini /etc/neutron/plugin.ini
```

Due to a packaging bug, the Open vSwitch agent initialization script explicitly looks for the Open vSwitch plug-in configuration file rather than a symbolic link /etc/neutron/plugin.ini pointing to the ML2 plug-in configuration file. Run the following commands to resolve this issue:

```
# cp /usr/lib/systemd/system/neutron-openvswitch-agent.service \
  /usr/lib/systemd/system/neutron-openvswitch-agent.service.orig
# sed -i 's,plugins/openvswitch/ovs_neutron_plugin.ini,plugin.ini,g' \
  /usr/lib/systemd/system/neutron-openvswitch-agent.service
```

2. Start the Networking services and configure them to start when the system boots:

```
# systemctl enable neutron-openvswitch-agent.service neutron-l3-agent.
service \
  neutron-dhcp-agent.service neutron-metadata-agent.service \
  neutron-ovs-cleanup.service
# systemctl start neutron-openvswitch-agent.service neutron-l3-agent.
service \
  neutron-dhcp-agent.service neutron-metadata-agent.service
```

Note

Do not explictly start the neutron-ovs-cleanup service.

Verify operation

Note

Perform these commands on the controller node.

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

```
$ source admin-openrc.sh
```

2. List agents to verify successful launch of the neutron agents:

```
$ neutron agent-list
+--------------------------------------+--------------------+---------
+-------+----------------+---------------------------+
| id                                   | agent_type         | host    |
 alive | admin_state_up | binary                    |
+--------------------------------------+--------------------+---------
+-------+----------------+---------------------------+
| 30275801-e17a-41e4-8f53-9db63544f689 | Metadata agent     | network
 | :-)   | True           | neutron-metadata-agent    |
| 4bd8c50e-7bad-4f3b-955d-67658a491a15 | Open vSwitch agent | network
 | :-)   | True           | neutron-openvswitch-agent |
| 756e5bba-b70f-4715-b80e-e37f59803d20 | L3 agent           | network
 | :-)   | True           | neutron-l3-agent          |
| 9c45473c-6d6d-4f94-8df1-ebd0b6838d5f | DHCP agent         | network
 | :-)   | True           | neutron-dhcp-agent        |
+--------------------------------------+--------------------+---------
+-------+----------------+---------------------------+
```

Install and configure compute node

The compute node handles connectivity and *security groups* for instances.

To configure prerequisites

Before you install and configure OpenStack Networking, you must configure certain kernel networking parameters.

1. Edit the `/etc/sysctl.conf` file to contain the following parameters:

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

2. Implement the changes:

   ```
   # sysctl -p
   ```

To install the Networking components

-
  ```
  # yum install openstack-neutron-ml2 openstack-neutron-openvswitch
  ```

To configure the Networking common components

The Networking common component configuration includes the authentication mechanism, message broker, and plug-in.

- Edit the `/etc/neutron/neutron.conf` file and complete the following actions:

  a. In the `[database]` section, comment out any `connection` options because compute nodes do not directly access the database.

  b. In the `[DEFAULT]` section, configure RabbitMQ message broker access:

     ```
     [DEFAULT]
     ...
     rpc_backend = rabbit
     rabbit_host = controller
     rabbit_password = RABBIT_PASS
     ```

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

  c. In the `[DEFAULT]` and `[keystone_authtoken]` sections, configure Identity service access:

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

     [keystone_authtoken]
     ...
     auth_uri = http://controller:5000/v2.0
     identity_uri = http://controller:35357
     admin_tenant_name = service
     admin_user = neutron
     admin_password = NEUTRON_PASS
     ```

     Replace *NEUTRON_PASS* with the password you chose or the `neutron` user in the Identity service.

Note

Comment out any `auth_host`, `auth_port`, and `auth_protocol` options because the `identity_uri` option replaces them.

d. In the `[DEFAULT]` section, enable the Modular Layer 2 (ML2) plug-in, router service, and overlapping IP addresses:

```
[DEFAULT]
...
core_plugin = ml2
service_plugins = router
allow_overlapping_ips = True
```

e. (Optional) To assist with troubleshooting, enable verbose logging in the `[DEFAULT]` section:

```
[DEFAULT]
...
verbose = True
```

To configure the Modular Layer 2 (ML2) plug-in

The ML2 plug-in uses the Open vSwitch (OVS) mechanism (agent) to build the virtual networking framework for instances.

- Edit the `/etc/neutron/plugins/ml2/ml2_conf.ini` file and complete the following actions:

  a. In the `[ml2]` section, enable the *flat* and *generic routing encapsulation (GRE)* network type drivers, GRE tenant networks, and the OVS mechanism driver:

  ```
  [ml2]
  ...
  type_drivers = flat,gre
  tenant_network_types = gre
  mechanism_drivers = openvswitch
  ```

  b. In the `[ml2_type_gre]` section, configure the tunnel identifier (id) range:

  ```
  [ml2_type_gre]
  ...
  tunnel_id_ranges = 1:1000
  ```

  c. In the `[securitygroup]` section, enable security groups, enable *ipset*, and configure the OVS *iptables* firewall driver:

  ```
  [securitygroup]
  ...
  enable_security_group = True
  enable_ipset = True
  firewall_driver = neutron.agent.linux.iptables_firewall.
  OVSHybridIptablesFirewallDriver
  ```

  d. In the `[ovs]` section, configure the *Open vSwitch (OVS) agent*:

```
[ovs]
...
local_ip = INSTANCE_TUNNELS_INTERFACE_IP_ADDRESS
tunnel_type = gre
enable_tunneling = True
```

Replace *INSTANCE_TUNNELS_INTERFACE_IP_ADDRESS* with the IP address of the instance tunnels network interface on your compute node.

To configure the Open vSwitch (OVS) service

The OVS service provides the underlying virtual networking framework for instances.

- Start the OVS service and configure it to start when the system boots:

  ```
  # systemctl enable openvswitch.service
  # systemctl start openvswitch.service
  ```

To configure Compute to use Networking

By default, distribution packages configure Compute to use legacy networking. You must reconfigure Compute to manage networks through Networking.

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

  a. In the `[DEFAULT]` section, configure the *APIs* and drivers:

  ```
  [DEFAULT]
  ...
  network_api_class = nova.network.neutronv2.api.API
  security_group_api = neutron
  linuxnet_interface_driver = nova.network.linux_net.
  LinuxOVSInterfaceDriver
  firewall_driver = nova.virt.firewall.NoopFirewallDriver
  ```

  ### Note

  By default, Compute uses an internal firewall service. Since Networking includes a firewall service, you must disable the Compute firewall service by using the `nova.virt.firewall.NoopFirewallDriver` firewall driver.

  b. In the `[neutron]` section, configure access parameters:

  ```
  [neutron]
  ...
  url = http://controller:9696
  auth_strategy = keystone
  admin_auth_url = http://controller:35357/v2.0
  admin_tenant_name = service
  admin_username = neutron
  admin_password = NEUTRON_PASS
  ```

  Replace *NEUTRON_PASS* with the password you chose for the `neutron` user in the Identity service.

To finalize the installation

1. The Networking service initialization scripts expect a symbolic link `/etc/neutron/plugin.ini` pointing to the ML2 plug-in configuration file, `/etc/neutron/plugins/ml2/ml2_conf.ini`. If this symbolic link does not exist, create it using the following command:

   ```
   # ln -s /etc/neutron/plugins/ml2/ml2_conf.ini /etc/neutron/plugin.ini
   ```

   Due to a packaging bug, the Open vSwitch agent initialization script explicitly looks for the Open vSwitch plug-in configuration file rather than a symbolic link `/etc/neutron/plugin.ini` pointing to the ML2 plug-in configuration file. Run the following commands to resolve this issue:

   ```
   # cp /usr/lib/systemd/system/neutron-openvswitch-agent.service \
     /usr/lib/systemd/system/neutron-openvswitch-agent.service.orig
   # sed -i 's,plugins/openvswitch/ovs_neutron_plugin.ini,plugin.ini,g' \
     /usr/lib/systemd/system/neutron-openvswitch-agent.service
   ```

2. Restart the Compute service:

   ```
   # systemctl restart openstack-nova-compute.service
   ```

3. Start the Open vSwitch (OVS) agent and configure it to start when the system boots:

   ```
   # systemctl enable neutron-openvswitch-agent.service
   # systemctl start neutron-openvswitch-agent.service
   ```

Verify operation

Note

Perform these commands on the controller node.

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

   ```
   $ source admin-openrc.sh
   ```

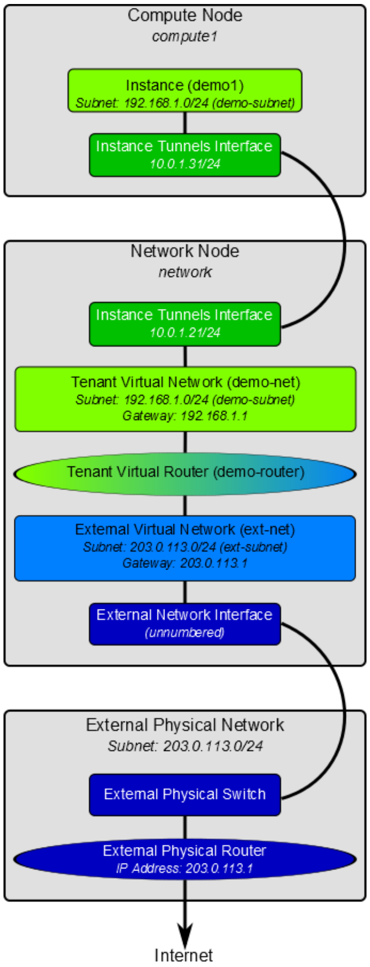
2. List agents to verify successful launch of the neutron agents:

   ```
   $ neutron agent-list
   +--------------------------------------+--------------------+---------
   +-------+----------------+---------------------------+
   | id                                   | agent_type         | host    |
    alive | admin_state_up | binary                    |
   +--------------------------------------+--------------------+---------
   +-------+----------------+---------------------------+
   ...
   | a5a49051-05eb-4b4f-bfc7-d36235fe9131 | Open vSwitch agent | compute1
    | :-)   | True           | neutron-openvswitch-agent |
   +--------------------------------------+--------------------+---------
   +-------+----------------+---------------------------+
   ```

Create initial networks

Before launching your first instance, you must create the necessary virtual network infrastructure to which the instance will connect, including the external network and tenant network. See Figure 6.1, “Initial networks” [71]. After creating this infrastructure, we recommend that you verify connectivity and resolve any issues before proceeding further.

Figure 6.1. Initial networks


Compute Node
compute1
Instance (demo1)
Subnet: 192.168.1.0/24 (demo-subnet)
Instance Tunnels Interface
10.0.1.31/24
Network Node
network
Instance Tunnels Interface
10.0.1.21/24
Tenant Virtual Network (demo-net)
Subnet: 192.168.1.0/24 (demo-subnet)
Gateway: 192.168.1.1
Tenant Virtual Router (demo-router)
External Virtual Network (ext-net)
Subnet: 203.0.113.0/24 (ext-subnet)
Gateway: 203.0.113.1
External Network Interface
(unnumbered)
External Physical Network
Subnet: 203.0.113.0/24
External Physical Switch
External Physical Router
IP Address: 203.0.113.1
Internet

External network

The external network typically provides Internet access for your instances. By default, this network only allows Internet access *from* instances using *Network Address Translation (NAT)*. You can enable Internet access *to* individual instances using a *floating IP address* and suitable *security group* rules. The `admin` tenant owns this network because it provides external network access for multiple tenants. You must also enable sharing to allow access by those tenants.

Note

Perform these commands on the controller node.

To create the external network

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

```
$ source admin-openrc.sh
```

2. Create the network:

```
$ neutron net-create ext-net --shared --router:external True \
  --provider:physical_network external --provider:network_type flat
Created a new network:
+---------------------------+--------------------------------------+
| Field                     | Value                                |
+---------------------------+--------------------------------------+
| admin_state_up            | True                                 |
| id                        | 893aebb9-1c1e-48be-8908-6b947f3237b3 |
| name                      | ext-net                              |
| provider:network_type     | flat                                 |
| provider:physical_network | external                             |
| provider:segmentation_id  |                                      |
| router:external           | True                                 |
| shared                    | True                                 |
| status                    | ACTIVE                               |
| subnets                   |                                      |
| tenant_id                 | 54cd044c64d5408b83f843d63624e0d8     |
+---------------------------+--------------------------------------+
```

Like a physical network, a virtual network requires a *subnet* assigned to it. The external network shares the same subnet and *gateway* associated with the physical network connected to the external interface on the network node. You should specify an exclusive slice of this subnet for *router* and floating IP addresses to prevent interference with other devices on the external network.

To create a subnet on the external network

- Create the subnet:

```
$ neutron subnet-create ext-net --name ext-subnet \
  --allocation-pool start=FLOATING_IP_START,end=FLOATING_IP_END \
  --disable-dhcp --gateway EXTERNAL_NETWORK_GATEWAY EXTERNAL_NETWORK_CIDR
```

Replace *`FLOATING_IP_START`* and *`FLOATING_IP_END`* with the first and last IP addresses of the range that you want to allocate for floating IP addresses. Replace *`EXTERNAL_NETWORK_CIDR`* with the subnet associated with the physical network. Replace *`EXTERNAL_NETWORK_GATEWAY`* with the gateway associated with the physical network, typically the ".1" IP address. You should disable *DHCP* on this subnet because instances do not connect directly to the external network and floating IP addresses require manual assignment.

For example, using `203.0.113.0/24` with floating IP address range `203.0.113.101` to `203.0.113.200`:

```
$ neutron subnet-create ext-net --name ext-subnet \
  --allocation-pool start=203.0.113.101,end=203.0.113.200 \
  --disable-dhcp --gateway 203.0.113.1 203.0.113.0/24
Created a new subnet:
+-------------------
+----------------------------------------------------+
| Field             | Value
 |
+-------------------
+----------------------------------------------------+
| allocation_pools  | {"start": "203.0.113.101", "end": "203.0.113.200"}
 |
| cidr              | 203.0.113.0/24
 |
| dns_nameservers   |
 |
| enable_dhcp       | False
 |
| gateway_ip        | 203.0.113.1
 |
| host_routes       |
 |
| id                | 9159f0dc-2b63-41cf-bd7a-289309da1391
 |
| ip_version        | 4
 |
| ipv6_address_mode |
 |
| ipv6_ra_mode      |
 |
| name              | ext-subnet
 |
| network_id        | 893aebb9-1c1e-48be-8908-6b947f3237b3
 |
| tenant_id         | 54cd044c64d5408b83f843d63624e0d8
 |
+-------------------
+-------------------------------------------------------+
```

Tenant network

The tenant network provides internal network access for instances. The architecture isolates this type of network from other tenants. The demo tenant owns this network because it only provides network access for instances within it.

Note

Perform these commands on the controller node.

To create the tenant network

1. Source the demo credentials to gain access to user-only CLI commands:

   ```
   $ source demo-openrc.sh
   ```

2. Create the network:

   ```
   $ neutron net-create demo-net
   Created a new network:
   +-----------------+--------------------------------------+
   | Field           | Value                                |
   +-----------------+--------------------------------------+
   | admin_state_up  | True                                 |
   | id              | ac108952-6096-4243-adf4-bb6615b3de28 |
   | name            | demo-net                             |
   | router:external | False                                |
   | shared          | False                                |
   | status          | ACTIVE                               |
   | subnets         |                                      |
   | tenant_id       | cdef0071a0194d19ac6bb63802dc9bae     |
   +-----------------+--------------------------------------+
   ```

Like the external network, your tenant network also requires a subnet attached to it. You can specify any valid subnet because the architecture isolates tenant networks. By default, this subnet will use DHCP so your instances can obtain IP addresses.

To create a subnet on the tenant network

- Create the subnet:

```
$ neutron subnet-create demo-net --name demo-subnet \
  --gateway TENANT_NETWORK_GATEWAY TENANT_NETWORK_CIDR
```

Replace *TENANT_NETWORK_CIDR* with the subnet you want to associate with the tenant network and *TENANT_NETWORK_GATEWAY* with the gateway you want to associate with it, typically the ".1" IP address.

Example using 192.168.1.0/24:

```
$ neutron subnet-create demo-net --name demo-subnet \
  --gateway 192.168.1.1 192.168.1.0/24
Created a new subnet:
+-------------------
+------------------------------------------------------+
| Field             | Value
 |
+-------------------
+------------------------------------------------------+
| allocation_pools  | {"start": "192.168.1.2", "end": "192.168.1.254"}
 |
| cidr              | 192.168.1.0/24
 |
| dns_nameservers   |
 |
| enable_dhcp       | True
 |
| gateway_ip        | 192.168.1.1
 |
| host_routes       |
 |
| id                | 69d38773-794a-4e49-b887-6de6734e792d
 |
| ip_version        | 4
 |
| ipv6_address_mode |
 |
| ipv6_ra_mode      |
 |
| name              | demo-subnet
 |
| network_id        | ac108952-6096-4243-adf4-bb6615b3de28
 |
| tenant_id         | cdef0071a0194d19ac6bb63802dc9bae
 |
+-------------------
+------------------------------------------------------+
```

A virtual router passes network traffic between two or more virtual networks. Each router requires one or more *interfaces* and/or gateways that provide access to specific networks. In this case, you will create a router and attach your tenant and external networks to it.

To create a router on the tenant network and attach the external and tenant networks to it

1. Create the router:

```
$ neutron router-create demo-router
Created a new router:
+-----------------------+--------------------------------------+
| Field                 | Value                                |
+-----------------------+--------------------------------------+
| admin_state_up        | True                                 |
| external_gateway_info |                                      |
| id                    | 635660ae-a254-4feb-8993-295aa9ec6418 |
| name                  | demo-router                          |
| routes                |                                      |
| status                | ACTIVE                               |
| tenant_id             | cdef0071a0194d19ac6bb63802dc9bae     |
+-----------------------+--------------------------------------+
```

2. Attach the router to the `demo` tenant subnet:

```
$ neutron router-interface-add demo-router demo-subnet
Added interface b1a894fd-aee8-475c-9262-4342afdc1b58 to router demo-
router.
```

3. Attach the router to the external network by setting it as the gateway:

```
$ neutron router-gateway-set demo-router ext-net
Set gateway for router demo-router
```

Verify connectivity

We recommend that you verify network connectivity and resolve any issues before proceeding further. Following the external network subnet example using `203.0.113.0/24`, the tenant router gateway should occupy the lowest IP address in the floating IP address range, `203.0.113.101`. If you configured your external physical network and virtual networks correctly, you should be able to **ping** this IP address from any host on your external physical network.

Note

If you are building your OpenStack nodes as virtual machines, you must configure the hypervisor to permit promiscuous mode on the external network.

To verify network connectivity

- Ping the tenant router gateway:

```
$ ping -c 4 203.0.113.101
PING 203.0.113.101 (203.0.113.101) 56(84) bytes of data.
64 bytes from 203.0.113.101: icmp_req=1 ttl=64 time=0.619 ms
64 bytes from 203.0.113.101: icmp_req=2 ttl=64 time=0.189 ms
64 bytes from 203.0.113.101: icmp_req=3 ttl=64 time=0.165 ms
64 bytes from 203.0.113.101: icmp_req=4 ttl=64 time=0.216 ms

--- 203.0.113.101 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 2999ms
```

```
rtt min/avg/max/mdev = 0.165/0.297/0.619/0.187 ms
```

Legacy networking (nova-network)

Configure controller node

Legacy networking primarily involves compute nodes. However, you must configure the controller node to use legacy networking.

To configure legacy networking

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

    - In the `[DEFAULT]` section, configure the network and security group APIs:

      ```
      [DEFAULT]
      ...
      network_api_class = nova.network.api.API
      security_group_api = nova
      ```

2. Restart the Compute services:

   ```
   # systemctl restart openstack-nova-api.service openstack-nova-scheduler.
   service \
     openstack-nova-conductor.service
   ```

Configure compute node

This section covers deployment of a simple *flat network* that provides IP addresses to your instances via *DHCP*. If your environment includes multiple compute nodes, the *multi-host* feature provides redundancy by spreading network functions across compute nodes.

To install legacy networking components

-
  ```
  # yum install openstack-nova-network openstack-nova-api
  ```

To configure legacy networking

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

    - In the `[DEFAULT]` section, configure the network parameters:

      ```
      [DEFAULT]
      ...
      network_api_class = nova.network.api.API
      security_group_api = nova
      firewall_driver = nova.virt.libvirt.firewall.IptablesFirewallDriver
      network_manager = nova.network.manager.FlatDHCPManager
      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 = INTERFACE_NAME
public_interface = INTERFACE_NAME
```

Replace *INTERFACE_NAME* with the actual interface name for the external network. For example, *eth1* or *ens224*.

2. Start the services and configure them to start when the system boots:

```
# systemctl enable openstack-nova-network.service openstack-nova-metadata-
api.service
# systemctl start openstack-nova-network.service openstack-nova-metadata-
api.service
```

Create initial network

Before launching your first instance, you must create the necessary virtual network infrastructure to which the instance will connect. This network typically provides Internet access *from* instances. You can enable Internet access *to* individual instances using a *floating IP address* and suitable *security group* rules. The `admin` tenant owns this network because it provides external network access for multiple tenants.

This network shares the same *subnet* associated with the physical network connected to the external *interface* on the compute node. You should specify an exclusive slice of this subnet to prevent interference with other devices on the external network.

Note

Perform these commands on the controller node.

To create the network

1. Source the `admin` tenant credentials:

```
$ source admin-openrc.sh
```

2. Create the network:

Replace *NETWORK_CIDR* with the subnet associated with the physical network.

```
$ nova network-create demo-net --bridge br100 --multi-host T \
  --fixed-range-v4 NETWORK_CIDR
```

For example, using an exclusive slice of `203.0.113.0/24` with IP address range `203.0.113.24` to `203.0.113.32`:

```
$ nova network-create demo-net --bridge br100 --multi-host T \
  --fixed-range-v4 203.0.113.24/29
```

Note

This command provides no output.

3. Verify creation of the network:

```
$ nova net-list
+--------------------------------------+----------+------------------+
| ID                                   | Label    | CIDR             |
+--------------------------------------+----------+------------------+
| 84b34a65-a762-44d6-8b5e-3b461a53f513 | demo-net | 203.0.113.24/29  |
+--------------------------------------+----------+------------------+
```

Next steps

Your OpenStack environment now includes the core components necessary to launch a basic instance. You can launch an instance or add more OpenStack services to your environment.

7. Add the dashboard

Table of Contents

The OpenStack dashboard, also known as Horizon, is a Web interface that enables 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.

Horizon enables you to customize the brand of the dashboard.

Horizon provides a set of core classes and reusable templates and tools.

This example deployment uses an Apache web server.

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 and configure

This section describes how to install and configure the dashboard on the controller node.

Before you proceed, verify that your system meets the requirements in the section called "System requirements" [79]. Also, the dashboard relies on functional core services including Identity, Image Service, Compute, and either Networking (neutron) or legacy networking (nova-network). Environments with stand-alone services such as Object Storage cannot use the dashboard. For more information, see the developer documentation.

To install the dashboard components

- Install the packages:

```
# yum install openstack-dashboard httpd mod_wsgi memcached python-
memcached
```

To configure the dashboard

- Edit the `/etc/openstack-dashboard/local_settings` file and complete the following actions:

  a. Configure the dashboard to use OpenStack services on the `controller` node:

  ```
  OPENSTACK_HOST = "controller"
  ```

  b. Allow all hosts to access the dashboard:

  ```
  ALLOWED_HOSTS = ['*']
  ```

  c. Configure the memcached session storage service:

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

  ### Note

  Comment out any other session storage configuration.

  d. Optionally, configure the time zone:

```
TIME_ZONE = "TIME_ZONE"
```

Replace *TIME_ZONE* with an appropriate time zone identifier. For more information, see the list of time zones.

To finalize installation

1. On RHEL and CentOS, configure SELinux to permit the web server to connect to OpenStack services:

   ```
   # setsebool -P httpd_can_network_connect on
   ```

2. Due to a packaging bug, the dashboard CSS fails to load properly. Run the following command to resolve this issue:

   ```
   # chown -R apache:apache /usr/share/openstack-dashboard/static
   ```

   For more information, see the bug report.

3. Start the web server and session storage service and configure them to start when the system boots:

   ```
   # systemctl enable httpd.service memcached.service
   # systemctl start httpd.service memcached.service
   ```

Verify operation

This section describes how to verify operation of the dashboard.

1. Access the dashboard using a web browser: `http://controller/dashboard` .

2. Authenticate using `admin` or `demo` user credentials.

Next steps

Your OpenStack environment now includes the dashboard. You can launch an instance or add more services to your environment in the following chapters.

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

- Customize your dashboard. See section Customize the dashboard in the *OpenStack Cloud Administrator Guide* for information on setting up colors, logos, and site titles.

- Set up session storage. See section Set up session storage for the dashboard in the *OpenStack Cloud Administrator Guide* for information on user session data.

8. Add the Block Storage service

Table of Contents

The OpenStack Block Storage service provides block storage devices to instances using various backends. The Block Storage API and scheduler services run on the controller node and the volume service runs on one or more storage nodes. Storage nodes provide volumes to instances using local block storage devices or SAN/NAS backends with the appropriate drivers. For more information, see the *Configuration Reference*.

Note

This chapter omits the backup manager because it depends on the Object Storage service.

OpenStack Block Storage

The OpenStack Block Storage service (cinder) adds persistent storage to a virtual machine. Block Storage provides an infrastructure for managing volumes, and interacts with OpenStack Compute to provide volumes for instances. The service also enables management of volume snapshots, and volume types.

The Block Storage service consists of the following components:

`cinder-api`

Accepts API requests, and routes them to the `cinder-volume` for action.

`cinder-volume`

Interacts directly with the Block Storage service, and processes such as the `cinder-scheduler`. It also interacts with these processes through a message queue. The `cinder-volume service` responds to read and write requests sent to the Block Storage service to maintain state. It can interact with a variety of storage providers through a driver architecture.

`cinder-scheduler` daemon

Selects the optimal storage provider node on which to create the volume. A similar component to the `nova-scheduler`.

Messaging queue

Routes information between the Block Storage processes.

Install and configure controller node

This section describes how to install and configure the Block Storage service, code-named cinder, on the controller node. This service requires at least one additional storage node that provides volumes to instances.

To configure prerequisites

Before you install and configure the Block Storage service, you must create a database and Identity service credentials including endpoints.

1. To create the database, complete these steps:

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

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

   b. Create the `cinder` database:

   ```
   CREATE DATABASE cinder;
   ```

   c. Grant proper access to the `cinder` database:

   ```
   GRANT ALL PRIVILEGES ON cinder.* TO 'cinder'@'localhost' \
     IDENTIFIED BY 'CINDER_DBPASS';
   GRANT ALL PRIVILEGES ON cinder.* TO 'cinder'@'%' \
     IDENTIFIED BY 'CINDER_DBPASS';
   ```

   Replace *CINDER_DBPASS* with a suitable password.

   d. Exit the database access client.

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

   ```
   $ source admin-openrc.sh
   ```

3. To create the Identity service credentials, complete these steps:

   a. Create a `cinder` user:

   ```
   $ keystone user-create --name cinder --pass CINDER_PASS
   +----------+----------------------------------+
   | Property |              Value               |
   +----------+----------------------------------+
   |  email   |                                  |
   | enabled  |               True               |
   |    id    | 881ab2de4f7941e79504a759a83308be |
   |   name   |              cinder              |
   | username |              cinder              |
   +----------+----------------------------------+
   ```

   Replace *CINDER_PASS* with a suitable password.

   b. Link the `cinder` user to the `service` tenant and `admin` role:

   ```
   $ keystone user-role-add --user cinder --tenant service --role admin
   ```

Note

This command provides no output.

c. Create the `cinder` services:

```
$ keystone service-create --name cinder --type volume \
  --description "OpenStack Block Storage"
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
| description |     OpenStack Block Storage      |
|   enabled   |               True               |
|      id     | 1e494c3e22a24baaafcaf777d4d467eb |
|     name    |              cinder              |
|     type    |              volume              |
+-------------+----------------------------------+
$ keystone service-create --name cinderv2 --type volumev2 \
  --description "OpenStack Block Storage"
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
| description |     OpenStack Block Storage      |
|   enabled   |               True               |
|      id     | 16e038e449c94b40868277f1d801edb5 |
|     name    |             cinderv2             |
|     type    |             volumev2             |
+-------------+----------------------------------+
```

Note

The Block Storage service requires two different services to support API versions 1 and 2.

d. Create the Block Storage service endpoints:

```
$ keystone endpoint-create \
  --service-id $(keystone service-list | awk '/ volume / {print $2}')
 \
  --publicurl http://controller:8776/v1/%\(tenant_id\)s \
  --internalurl http://controller:8776/v1/%\(tenant_id\)s \
  --adminurl http://controller:8776/v1/%\(tenant_id\)s \
  --region regionOne
+-------------+-----------------------------------------+
|   Property  |                  Value                  |
+-------------+-----------------------------------------+
|   adminurl  | http://controller:8776/v1/%(tenant_id)s |
|      id     |     d1b7291a2d794e26963b322c7f2a55a4    |
| internalurl | http://controller:8776/v1/%(tenant_id)s |
|  publicurl  | http://controller:8776/v1/%(tenant_id)s |
|    region   |                regionOne                |
|  service_id |     1e494c3e22a24baaafcaf777d4d467eb    |
+-------------+-----------------------------------------+
$ keystone endpoint-create \
  --service-id $(keystone service-list | awk '/ volumev2 / {print
 $2}') \
  --publicurl http://controller:8776/v2/%\(tenant_id\)s \
  --internalurl http://controller:8776/v2/%\(tenant_id\)s \
  --adminurl http://controller:8776/v2/%\(tenant_id\)s \
  --region regionOne
+-------------+-----------------------------------------+
|   Property  |                  Value                  |
+-------------+-----------------------------------------+
|   adminurl  | http://controller:8776/v2/%(tenant_id)s |
|      id     |    097b4a6fc8ba44b4b10d4822d2d9e076     |
| internalurl | http://controller:8776/v2/%(tenant_id)s |
|  publicurl  | http://controller:8776/v2/%(tenant_id)s |
|    region   |                regionOne                |
|  service_id |    16e038e449c94b40868277f1d801edb5     |
+-------------+-----------------------------------------+
```

Note

The Block Storage service requires two different endpoints to support API versions 1 and 2.

To install and configure Block Storage controller components

1. Install the packages:

   ```
   # yum install openstack-cinder python-cinderclient python-oslo-db
   ```

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

   a. In the `[database]` section, configure database access:

      ```
      [database]
      ...
      connection = mysql://cinder:CINDER_DBPASS@controller/cinder
      ```

      Replace *CINDER_DBPASS* with the password you chose for the Block Storage database.

   b. In the `[DEFAULT]` section, configure RabbitMQ message broker access:

      ```
      [DEFAULT]
      ...
      rpc_backend = rabbit
      rabbit_host = controller
      rabbit_password = RABBIT_PASS
      ```

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

   c. In the `[DEFAULT]` and `[keystone_authtoken]` sections, configure Identity service access:

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

[keystone_authtoken]
...
auth_uri = http://controller:5000/v2.0
identity_uri = http://controller:35357
admin_tenant_name = service
admin_user = cinder
admin_password = CINDER_PASS
```

Replace *`CINDER_PASS`* with the password you chose for the `cinder` user in the Identity service.

Note

Comment out any `auth_host`, `auth_port`, and `auth_protocol` options because the `identity_uri` option replaces them.

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

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

e. (Optional) To assist with troubleshooting, enable verbose logging in the `[DEFAULT]` section:

```
[DEFAULT]
...
verbose = True
```

3. Populate the Block Storage database:

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

To finalize installation

- Start the Block Storage services and configure them to start when the system boots:

```
# systemctl enable openstack-cinder-api.service openstack-cinder-
scheduler.service
# systemctl start openstack-cinder-api.service openstack-cinder-scheduler.
service
```

Install and configure a storage node

This section describes how to install and configure storage nodes for the Block Storage service. For simplicity, this configuration references one storage node with an empty local block storage device `/dev/sdb` that contains a suitable partition table with one partition `/dev/sdb1` occupying the entire device. The service provisions logical volumes on this device using the *LVM* driver and provides them to instances via *iSCSI* transport. You can follow these instructions with minor modifications to horizontally scale your environment with additional storage nodes.

To configure prerequisites

You must configure the storage node before you install and configure the volume service on it. Similar to the controller node, the storage node contains one network interface on the *management network*. The storage node also needs an empty block storage device of suitable size for your environment. For more information, see Chapter 2, "Basic environment" [6].

1. Configure the management interface:

   IP address: 10.0.0.41

   Network mask: 255.255.255.0 (or /24)

   Default gateway: 10.0.0.1

2. Set the hostname of the node to *block1*.

3. Copy the contents of the /etc/hosts file from the controller node to the storage node and add the following to it:

   ```
   # block1
   10.0.0.41       block1
   ```

   Also add this content to the /etc/hosts file on all other nodes in your environment.

4. Install and configure *NTP* using the instructions in the section called "Other nodes" [19].

5. Install the LVM packages:

   ```
   # yum install lvm2
   ```

   Note

   Some distributions include LVM by default.

6. Start the LVM metadata service and configure it to start when the system boots:

   ```
   # systemctl enable lvm2-lvmetad.service
   # systemctl start lvm2-lvmetad.service
   ```

7. Create the LVM physical volume /dev/sdb1:

   ```
   # pvcreate /dev/sdb1
     Physical volume "/dev/sdb1" successfully created
   ```

   Note

   If your system uses a different device name, adjust these steps accordingly.

8. Create the LVM volume group cinder-volumes:

   ```
   # vgcreate cinder-volumes /dev/sdb1
     Volume group "cinder-volumes" successfully created
   ```

   The Block Storage service creates logical volumes in this volume group.

9. Only instances can access Block Storage volumes. However, the underlying operating system manages the devices associated with the volumes. By default, the LVM volume scanning tool scans the `/dev` directory for block storage devices that contain volumes. If tenants use LVM on their volumes, the scanning tool detects these volumes and attempts to cache them which can cause a variety of problems with both the underlying operating system and tenant volumes. You must reconfigure LVM to scan only the devices that contain the `cinder-volume` volume group. Edit the `/etc/lvm/lvm.conf` file and complete the following actions:

   - In the `devices` section, add a filter that accepts the `/dev/sdb` device and rejects all other devices:

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

     Each item in the filter array begins with `a` for *accept* or `r` for *reject* and includes a regular expression for the device name. The array must end with `r/.*/` to reject any remaining devices. You can use the **vgs -vvvv** command to test filters.

     #### Warning

     If your storage nodes use LVM on the operating system disk, you must also add the associated device to the filter. For example, if the `/dev/sda` device contains the operating system:

     ```
     filter = [ "a/sda", "a/sdb/", "r/.*/"]
     ```

     Similarly, if your compute nodes use LVM on the operating system disk, you must also modify the filter in the `/etc/lvm/lvm.conf` file on those nodes to include only the operating system disk. For example, if the `/dev/sda` device contains the operating system:

     ```
     filter = [ "a/sda", "r/.*/"]
     ```

Install and configure Block Storage volume components

1. Install the packages:

   ```
   # yum install openstack-cinder targetcli python-oslo-db MySQL-python
   ```

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

   a. In the `[database]` section, configure database access:

   ```
   [database]
   ...
   connection = mysql://cinder:CINDER_DBPASS@controller/cinder
   ```

   Replace *`CINDER_DBPASS`* with the password you chose for the Block Storage database.

   b. In the `[DEFAULT]` section, configure RabbitMQ message broker access:

```
[DEFAULT]
...
rpc_backend = rabbit
rabbit_host = controller
rabbit_password = RABBIT_PASS
```

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

c. In the `[DEFAULT]` and `[keystone_authtoken]` sections, configure Identity service access:

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

[keystone_authtoken]
...
auth_uri = http://controller:5000/v2.0
identity_uri = http://controller:35357
admin_tenant_name = service
admin_user = cinder
admin_password = CINDER_PASS
```

Replace *`CINDER_PASS`* with the password you chose for the `cinder` user in the Identity service.

Note

Comment out any `auth_host`, `auth_port`, and `auth_protocol` options because the `identity_uri` option replaces them.

d. In the `[DEFAULT]` section, configure the `my_ip` option:

```
[DEFAULT]
...
my_ip = MANAGEMENT_INTERFACE_IP_ADDRESS
```

Replace *`MANAGEMENT_INTERFACE_IP_ADDRESS`* with the IP address of the management network interface on your storage node, typically 10.0.0.41 for the first node in the example architecture.

e. In the `[DEFAULT]` section, configure the location of the Image Service:

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

f. In the `[DEFAULT]` section, configure Block Storage to use the **lioadm** iSCSI service:

```
[DEFAULT]
...
iscsi_helper = lioadm
```

g. (Optional) To assist with troubleshooting, enable verbose logging in the [DEFAULT] section:

```
[DEFAULT]
...
verbose = True
```

To finalize installation

- Start the Block Storage volume service including its dependencies and configure them to start when the system boots:

```
# systemctl enable openstack-cinder-volume.service target.service
# systemctl start openstack-cinder-volume.service target.service
```

Verify operation

This section describes how to verify operation of the Block Storage service by creating a volume.

For more information about how to manage volumes, see the *OpenStack User Guide*.

Note

Perform these commands on the controller node.

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

```
$ source admin-openrc.sh
```

2. List service components to verify successful launch of each process:

```
$ cinder service-list
+------------------+------------+------+---------+-------
+----------------------------+-----------------+
|      Binary      |    Host    | Zone |  Status | State |
 Updated_at          | Disabled Reason |
+------------------+------------+------+---------+-------
+----------------------------+-----------------+
| cinder-scheduler | controller | nova | enabled |   up  |
 2014-10-18T01:30:54.000000 |       None      |
|  cinder-volume   |   block1   | nova | enabled |   up  |
 2014-10-18T01:30:57.000000 |       None      |
+------------------+------------+------+---------+-------
+----------------------------+-----------------+
```

3. Source the demo tenant credentials to perform the following steps as a non-administrative tenant:

```
$ source demo-openrc.sh
```

4. Create a 1 GB volume:

```
$ cinder create --display-name demo-volume1 1
+---------------------+--------------------------------------+
|       Property      |                Value                 |
+---------------------+--------------------------------------+
|     attachments     |                  []                  |
|  availability_zone  |                 nova                 |
|       bootable      |                false                 |
|      created_at     |      2014-10-14T23:11:50.870239      |
| display_description |                 None                 |
|     display_name    |             demo-volume1             |
|      encrypted      |                False                 |
|          id         | 158bea89-07db-4ac2-8115-66c0d6a4bb48 |
|       metadata      |                  {}                  |
|         size        |                  1                   |
|     snapshot_id     |                 None                 |
|     source_volid    |                 None                 |
|        status       |               creating               |
|     volume_type     |                 None                 |
+---------------------+--------------------------------------+
```

5. Verify creation and availability of the volume:

```
$ cinder list
--------------------------------------+-----------+--------------+------
+-------------+----------+-------------+
|                  ID                  |   Status  | Display Name | Size |
 Volume Type | Bootable | Attached to |
+--------------------------------------+-----------+--------------+------
+-------------+----------+-------------+
| 158bea89-07db-4ac2-8115-66c0d6a4bb48 | available | demo-volume1 |  1   |
    None     |  false   |             |
+--------------------------------------+-----------+--------------+------
+-------------+----------+-------------+
```

If the status does not indicate `available`, check the logs in the `/var/log/cinder` directory on the controller and volume nodes for more information.

Note

The launch an instance chapter includes instructions for attaching this volume to an instance.

Next steps

Your OpenStack environment now includes Block Storage. You can launch an instance or add more services to your environment in the following chapters.

9. Add Object Storage

Table of Contents

The OpenStack Object Storage services work together to provide object storage and retrieval through a REST API. For this example architecture, you must have already installed the Identity Service, also known as Keystone.

OpenStack Object Storage

The OpenStack Object Storage is a multi-tenant object storage system. It is highly scalable and can manage large amounts of unstructured data at low cost through a RESTful HTTP API.

It includes the following components:

Proxy servers (`swift-proxy-server`) Accepts OpenStack 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 that is usually deployed with memcache.

Account servers (`swift-account-server`) Manages accounts defined with Object Storage.

Container servers (`swift-container-server`) Manages the mapping of containers or folders, within Object Storage.

Object servers (`swift-object-server`) Manages actual objects,such as files, on the storage nodes.

Various 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.

WSGI middleware Handles authentication and is usually OpenStack Identity.

System requirements

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

Note

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

Table 9.1. Hardware recommendations

Server	Recommended Hardware	Notes
Object Storage object servers	Processor: dual quad core Memory: 8 or 12 GB RAM Disk space: optimized for cost per GB 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. 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 Memory: 8 or 12 GB RAM 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 Network: one 1 GB Network Interface Card (NIC)	Higher network throughput offers better performance for supporting many API requests. Optimize your proxy servers for best CPU performance. The Proxy Services are more CPU and network I/O intensive. If you are using 10 GB networking to the proxy, or are terminating SSL traffic at the proxy, greater CPU power is required.

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

Networking: 1 Gbps 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.

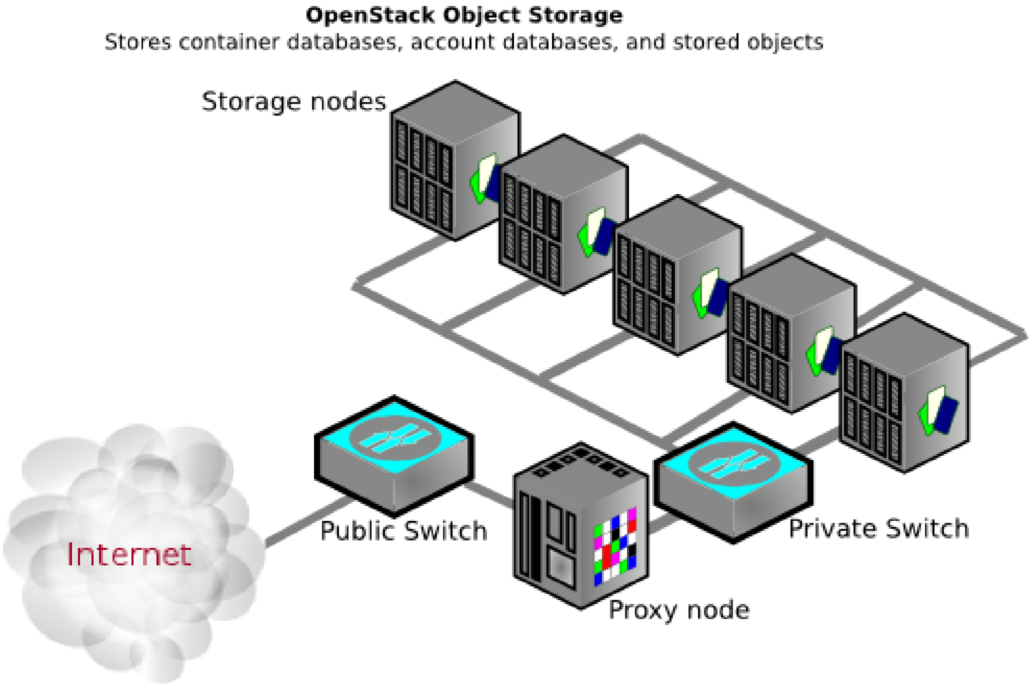
Example architecture

In a production environment, the Object Storage service requires at least two proxy nodes and five storage nodes. For simplicity, this guide uses a minimal architecture with the proxy service running on the existing OpenStack controller node and two storage nodes. However, these concepts still apply.

- Node: A host machine that runs one or more OpenStack Object Storage services.
- Proxy node: Runs proxy services.
- Storage node: Runs account, container, and object services. Contains the SQLite databases.
- Ring: A set of mappings between OpenStack Object Storage data to physical devices.
- Replica: A copy of an object. By default, three copies are maintained in the cluster.
- Zone (optional): A logically separate section of the cluster, related to independent failure characteristics.
- Region (optional): A logically separate section of the cluster, representing distinct physical locations such as cities or countries. Similar to zones, but representing physical locations of portions of the cluster rather than logical segments.

To increase reliability and performance, you can add additional proxy servers.

The following diagram shows one possible architecture for a minimal production environment:



Install and configure the controller node

This section describes how to install and configure the proxy service that handles requests for the account, container, and object services operating on the storage nodes. For simplicity, this guide installs and configures the proxy service on the controller node. However, you can run the proxy service on any node with network connectivity to the storage nodes. Additionally, you can install and configure the proxy service on multiple nodes to increase performance and redundancy. For more information, see the Deployment Guide.

To configure prerequisites

The proxy service relies on an authentication and authorization mechanism such as the Identity service. However, unlike other services, it also offers an internal mechanism that allows it to operate without any other OpenStack services. However, for simplicity, this guide references the Identity service in Chapter 3, "Add the Identity service" [24]. Before you configure the Object Storage service, you must create Identity service credentials including endpoints.

Note

The Object Storage service does not use a SQL database on the controller node.

1. To create the Identity service credentials, complete these steps:

   a. Create a `swift` user:

   ```
   $ keystone user-create --name swift --pass SWIFT_PASS
   +----------+----------------------------------+
   | Property |              Value               |
   +----------+----------------------------------+
   |  email   |                                  |
   | enabled  |               True               |
   |    id    | d535e5cbd2b74ac7bfb97db9cced3ed6 |
   |   name   |              swift               |
   | username |              swift               |
   +----------+----------------------------------+
   ```

   Replace *SWIFT_PASS* with a suitable password.

   b. Link the `swift` user to the `service` tenant and `admin` role:

   ```
   $ keystone user-role-add --user swift --tenant service --role admin
   ```

   #### Note

   This command provides no output.

   c. Create the `swift` service:

   ```
   $ keystone service-create --name swift --type object-store \
     --description "OpenStack Object Storage"
   +-------------+----------------------------------+
   |   Property  |              Value               |
   +-------------+----------------------------------+
   | description |     OpenStack Object Storage     |
   |   enabled   |               True               |
   |      id     | 75ef509da2c340499d454ae96a2c5c34 |
   |     name    |              swift               |
   |     type    |           object-store           |
   +-------------+----------------------------------+
   ```

2. Create the Identity service endpoints:

```
$ keystone endpoint-create \
  --service-id $(keystone service-list | awk '/ object-store / {print
 $2}') \
  --publicurl 'http://controller:8080/v1/AUTH_%(tenant_id)s' \
  --internalurl 'http://controller:8080/v1/AUTH_%(tenant_id)s' \
  --adminurl http://controller:8080 \
  --region regionOne
+-------------+---------------------------------------------------+
|   Property  |                       Value                       |
+-------------+---------------------------------------------------+
|   adminurl  |            http://controller:8080/                |
|      id     |          af534fb8b7ff40a6acf725437c586ebe         |
| internalurl | http://controller:8080/v1/AUTH_%(tenant_id)s      |
|  publicurl  | http://controller:8080/v1/AUTH_%(tenant_id)s      |
|    region   |                     regionOne                     |
|  service_id |          75ef509da2c340499d454ae96a2c5c34         |
+-------------+---------------------------------------------------+
```

To install and configure the controller node components

1. Install the packages:

   ## Note

   Complete OpenStack environments already include some of these packages.

   ```
   # yum install openstack-swift-proxy python-swiftclient python-keystone-
   auth-token memcached
   ```

2. Obtain the proxy service configuration file from the Object Storage source repository:

   ```
   # curl -o /etc/swift/proxy-server.conf \
     https://raw.githubusercontent.com/openstack/swift/stable/juno/etc/proxy-
   server.conf-sample
   ```

3. Edit the /etc/swift/proxy-server.conf file and complete the following actions:

   a. In the [DEFAULT] section, configure the bind port, user, and configuration directory:

      ```
      [DEFAULT]
      ...
      bind_port = 8080
      user = swift
      swift_dir = /etc/swift
      ```

   b. In the [pipeline:main] section, enable the appropriate modules:

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

      ## Note

      For more information on other modules that enable additional features, see the Deployment Guide.

c. In the `[app:proxy-server]` section, enable account management:

```
[app:proxy-server]
...
allow_account_management = true
account_autocreate = true
```

d. In the `[filter:keystoneauth]` section, configure the operator roles:

```
[filter:keystoneauth]
use = egg:swift#keystoneauth
...
operator_roles = admin,_member_
```

Note

You might need to uncomment this section.

e. In the `[filter:authtoken]` section, configure Identity service access:

```
[filter:authtoken]
paste.filter_factory = keystonemiddleware.auth_token:filter_factory
...
auth_uri = http://controller:5000/v2.0
identity_uri = http://controller:35357
admin_tenant_name = service
admin_user = swift
admin_password = SWIFT_PASS
delay_auth_decision = true
```

Replace *SWIFT_PASS* with the password you chose for the `swift` user in the Identity service.

Note

You might need to uncomment this section.

Note

Comment out any `auth_host`, `auth_port`, and `auth_protocol` options because the `identity_uri` option replaces them.

f. In the `[filter:cache]` section, configure the memcached location:

```
[filter:cache]
...
memcache_servers = 127.0.0.1:11211
```

Install and configure the storage nodes

This section describes how to install and configure storage nodes that operate the account, container, and object services. For simplicity, this configuration references two storage nodes, each containing two empty local block storage devices. Each of the devices, `/dev/sdb` and `/dev/sdc`, must contain a suitable partition table with one partition occupying the entire device. Although the Object Storage service supports any file system with *extend-*

ed attributes (xattr), testing and benchmarking indicate the best performance and reliability on *XFS*. For more information on horizontally scaling your environment, see the Deployment Guide.

To configure prerequisites

You must configure each storage node before you install and configure the Object Storage service on it. Similar to the controller node, each storage node contains one network interface on the *management network*. Optionally, each storage node can contain a second network interface on a separate network for replication. For more information, see Chapter 2, "Basic environment" [6].

1. Configure unique items on the first storage node:

   a. Configure the management interface:

      IP address: 10.0.0.51

      Network mask: 255.255.255.0 (or /24)

      Default gateway: 10.0.0.1

   b. Set the hostname of the node to `object1`.

2. Configure unique items on the second storage node:

   a. Configure the management interface:

      IP address: 10.0.0.52

      Network mask: 255.255.255.0 (or /24)

      Default gateway: 10.0.0.1

   b. Set the hostname of the node to `object2`.

3. Configure shared items on both storage nodes:

   a. Copy the contents of the `/etc/hosts` file from the controller node and add the following to it:

      ```
      # object1
      10.0.0.51        object1

      # object2
      10.0.0.52        object2
      ```

      Also add this content to the `/etc/hosts` file on all other nodes in your environment.

   b. Install and configure *NTP* using the instructions in the section called "Other nodes" [19].

   c. Install the supporting utility packages:

      ```
      # yum install xfsprogs rsync
      ```

d. Format the `/dev/sdb1` and `/dev/sdc1` partitions as XFS:

```
# mkfs.xfs /dev/sdb1
# mkfs.xfs /dev/sdc1
```

e. Create the mount point directory structure:

```
# mkdir -p /srv/node/sdb1
# mkdir -p /srv/node/sdc1
```

f. Edit the `/etc/fstab` file and add the following to it:

```
/dev/sdb1 /srv/node/sdb1 xfs noatime,nodiratime,nobarrier,logbufs=8 0
 2
/dev/sdc1 /srv/node/sdc1 xfs noatime,nodiratime,nobarrier,logbufs=8 0
 2
```

g. Mount the devices:

```
# mount /srv/node/sdb1
# mount /srv/node/sdc1
```

4. Edit the `/etc/rsyncd.conf` file and add the following to it:

```
uid = swift
gid = swift
log file = /var/log/rsyncd.log
pid file = /var/run/rsyncd.pid
address = MANAGEMENT_INTERFACE_IP_ADDRESS

[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
```

Replace *`MANAGEMENT_INTERFACE_IP_ADDRESS`* with the IP address of the management network on the storage node.

Note

The `rsync` service requires no authentication, so consider running it on a private network.

5. Start the `rsyncd` service and configure it to start when the system boots:

```
# systemctl enable rsyncd.service
# systemctl start rsyncd.service
```

Install and configure storage node components

Note

Perform these steps on each storage node.

1. Install the packages:

   ```
   # yum install openstack-swift-account openstack-swift-container \
     openstack-swift-object
   ```

2. Obtain the accounting, container, and object service configuration files from the Object Storage source repository:

   ```
   # curl -o /etc/swift/account-server.conf \
     https://raw.githubusercontent.com/openstack/swift/stable/juno/etc/
   account-server.conf-sample
   ```

   ```
   # curl -o /etc/swift/container-server.conf \
     https://raw.githubusercontent.com/openstack/swift/stable/juno/etc/
   container-server.conf-sample
   ```

   ```
   # curl -o /etc/swift/object-server.conf \
     https://raw.githubusercontent.com/openstack/swift/stable/juno/etc/
   object-server.conf-sample
   ```

3. Edit the `/etc/swift/account-server.conf`, `/etc/swift/container-server.conf`, and `/etc/swift/object-server.conf` files and complete the following actions:

   a. In the `[DEFAULT]` section, configure the bind IP address, bind port, user, configuration directory, and mount point directory:

      ```
      [DEFAULT]
      ...
      bind_ip = MANAGEMENT_INTERFACE_IP_ADDRESS
      bind_port = 6002
      user = swift
      swift_dir = /etc/swift
      devices = /srv/node
      ```

      Replace *MANAGEMENT_INTERFACE_IP_ADDRESS* with the IP address of the management network on the storage node.

   b. In the `[pipeline:main]` section, enable the appropriate modules:

      ```
      [pipeline:main]
      pipeline = healthcheck recon account-server
      ```

      ### Note

      For more information on other modules that enable additional features, see the Deployment Guide.

c. In the `[filter:recon]` section, configure the recon (metrics) cache directory:

```
[filter:recon]
...
recon_cache_path = /var/cache/swift
```

4. Ensure proper ownership of the mount point directory structure:

```
# chown -R swift:swift /srv/node
```

5. Create the `recon` directory and ensure proper ownership of it:

```
# mkdir -p /var/cache/swift
# chown -R swift:swift /var/cache/swift
```

Create initial rings

Before starting the Object Storage services, you must create the initial account, container, and object rings. The ring builder creates configuration files that each node uses to determine and deploy the storage architecture. For simplicity, this guide uses one region and zone with 2^10 (1024) maximum partitions, 3 replicas of each object, and 1 hour minimum time between moving a partition more than once. For Object Storage, a partition indicates a directory on a storage device rather than a conventional partition table. For more information, see the Deployment Guide.

Account ring

The account server uses the account ring to maintain lists of containers.

To create the ring

Note

Perform these steps on the controller node.

1. Change to the `/etc/swift` directory.

2. Create the base `account.builder` file:

```
# swift-ring-builder account.builder create 10 3 1
```

3. Add each storage node to the ring:

```
# swift-ring-builder account.builder \
  add
 r1z1-STORAGE_NODE_MANAGEMENT_INTERFACE_IP_ADDRESS:6002/DEVICE_NAME DEVICE_WEIGHT
```

Replace *STORAGE_NODE_MANAGEMENT_INTERFACE_IP_ADDRESS* with the IP address of the management network on the storage node. Replace *DEVICE_NAME* with a storage device name on the same storage node. For example, using the first storage node in the section called “Install and configure the storage nodes” [97] with the `/dev/sdb1` storage device and weight of 100:

```
# swift-ring-builder account.builder add r1z1-10.0.0.51:6002/sdb1 100
```

Repeat this command for each storage device on each storage node. The example architecture requires four variations of this command.

4. Verify the ring contents:

```
# swift-ring-builder account.builder
account.builder, build version 4
1024 partitions, 3.000000 replicas, 1 regions, 1 zones, 4 devices, 0.00
 balance
The minimum number of hours before a partition can be reassigned is 1
Devices:    id  region  zone      ip address  port  replication ip
 replication port      name weight partitions balance meta
             0       1     1       10.0.0.51  6002       10.0.0.51
       6002      sdb1 100.00        768    0.00
             1       1     1       10.0.0.51  6002       10.0.0.51
       6002      sdc1 100.00        768    0.00
             2       1     1       10.0.0.52  6002       10.0.0.52
       6002      sdb1 100.00        768    0.00
             3       1     1       10.0.0.52  6002       10.0.0.52
       6002      sdc1 100.00        768    0.00
```

5. Rebalance the ring:

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

Note

This process can take a while.

Container ring

The container server uses the container ring to maintain lists of objects. However, it does not track object locations.

To create the ring

Note

Perform these steps on the controller node.

1. Change to the `/etc/swift` directory.

2. Create the base `container.builder` file:

```
# swift-ring-builder container.builder create 10 3 1
```

3. Add each storage node to the ring:

```
# swift-ring-builder container.builder \
  add
 r1z1-STORAGE_NODE_MANAGEMENT_INTERFACE_IP_ADDRESS:6001/DEVICE_NAME DEVICE_WEIGHT
```

Replace *`STORAGE_NODE_MANAGEMENT_INTERFACE_IP_ADDRESS`* with the IP address of the management network on the storage node. Replace *`DEVICE_NAME`* with a storage device name on the same storage node. For example, using the first storage node in the section called "Install and configure the storage nodes" [97] with the /dev/sdb1 storage device and weight of 100:

```
# swift-ring-builder container.builder add r1z1-10.0.0.51:6001/sdb1 100
```

Repeat this command for each storage device on each storage node. The example architecture requires four variations of this command.

4. Verify the ring contents:

```
# swift-ring-builder container.builder
container.builder, build version 4
1024 partitions, 3.000000 replicas, 1 regions, 1 zones, 4 devices, 0.00
 balance
The minimum number of hours before a partition can be reassigned is 1
Devices:    id  region  zone      ip address  port  replication ip
 replication port      name weight partitions balance meta
             0       1     1       10.0.0.51  6001       10.0.0.51
       6001      sdb1 100.00        768    0.00
             1       1     1       10.0.0.51  6001       10.0.0.51
       6001      sdc1 100.00        768    0.00
             2       1     1       10.0.0.52  6001       10.0.0.52
       6001      sdb1 100.00        768    0.00
             3       1     1       10.0.0.52  6001       10.0.0.52
       6001      sdc1 100.00        768    0.00
```

5. Rebalance the ring:

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

Note

This process can take a while.

Object ring

The object server uses the object ring to maintain lists of object locations on local devices.

To create the ring

Note

Perform these steps on the controller node.

1. Change to the /etc/swift directory.

2. Create the base object.builder file:

```
# swift-ring-builder object.builder create 10 3 1
```

3. Add each storage node to the ring:

```
# swift-ring-builder object.builder \
  add
 r1z1-STORAGE_NODE_MANAGEMENT_INTERFACE_IP_ADDRESS:6000/DEVICE_NAME DEVICE_WEIGHT
```

Replace *`STORAGE_NODE_MANAGEMENT_INTERFACE_IP_ADDRESS`* with the IP address of the management network on the storage node. Replace *`DEVICE_NAME`* with a storage device name on the same storage node. For example, using the first storage node in the section called “Install and configure the storage nodes” [97] with the `/dev/sdb1` storage device and weight of 100:

```
# swift-ring-builder object.builder add r1z1-10.0.0.51:6000/sdb1 100
```

Repeat this command for each storage device on each storage node. The example architecture requires four variations of this command.

4. Verify the ring contents:

```
# swift-ring-builder object.builder
object.builder, build version 4
1024 partitions, 3.000000 replicas, 1 regions, 1 zones, 4 devices, 0.00
 balance
The minimum number of hours before a partition can be reassigned is 1
Devices:    id  region  zone      ip address  port  replication ip
 replication port      name weight partitions balance meta
             0       1     1       10.0.0.51  6000       10.0.0.51
       6000      sdb1 100.00        768    0.00
             1       1     1       10.0.0.51  6000       10.0.0.51
       6000      sdc1 100.00        768    0.00
             2       1     1       10.0.0.52  6000       10.0.0.52
       6000      sdb1 100.00        768    0.00
             3       1     1       10.0.0.52  6000       10.0.0.52
       6000      sdc1 100.00        768    0.00
```

5. Rebalance the ring:

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

Note

This process can take a while.

Distribute ring configuration files

Copy the `account.ring.gz`, `container.ring.gz`, and `object.ring.gz` files to the `/etc/swift` directory on each storage node and any additional nodes running the proxy service.

Finalize installation

Configure hashes and default storage policy

1. Obtain the `/etc/swift/swift.conf` file from the Object Storage source repository:

```
# curl -o /etc/swift/swift.conf \
  https://raw.githubusercontent.com/openstack/swift/stable/juno/etc/swift.
conf-sample
```

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

a. In the [swift-hash] section, configure the hash path prefix and suffix for your environment.

```
[swift-hash]
...
swift_hash_path_suffix = HASH_PATH_PREFIX
swift_hash_path_prefix = HASH_PATH_SUFFIX
```

Replace *HASH_PATH_PREFIX* and *HASH_PATH_SUFFIX* with unique values.

Warning

Keep these values secret and do not change or lose them.

b. In the [storage-policy:0] section, configure the default storage policy:

```
[storage-policy:0]
...
name = Policy-0
default = yes
```

3. Copy the swift.conf file to the /etc/swift directory on each storage node and any additional nodes running the proxy service.

4. On all nodes, ensure proper ownership of the configuration directory:

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

5. On the controller node and any other nodes running the proxy service, start the Object Storage proxy service including its dependencies and configure them to start when the system boots:

```
# systemctl enable openstack-swift-proxy.service memcached.service
# systemctl start openstack-swift-proxy.service memcached.service
```

6. On the storage nodes, start the Object Storage services and configure them to start when the system boots:

```
# systemctl enable openstack-swift-account.service openstack-swift-account-auditor.service \
  openstack-swift-account-reaper.service openstack-swift-account-replicator.service
# systemctl start openstack-swift-account.service openstack-swift-account-auditor.service \
  openstack-swift-account-reaper.service openstack-swift-account-replicator.service
# systemctl enable openstack-swift-container.service openstack-swift-container-auditor.service \
  openstack-swift-container-replicator.service openstack-swift-container-updater.service
# systemctl start openstack-swift-container.service openstack-swift-container-auditor.service \
  openstack-swift-container-replicator.service openstack-swift-container-updater.service
# systemctl enable openstack-swift-object.service openstack-swift-object-auditor.service \
  openstack-swift-object-replicator.service openstack-swift-object-updater.service
```

```
# systemctl start openstack-swift-object.service openstack-swift-object-
auditor.service \
  openstack-swift-object-replicator.service openstack-swift-object-
updater.service
```

Verify operation

This section describes how to verify operation of the Object Storage service.

Note

Perform these steps on the controller node.

1. Source the demo tenant credentials:

   ```
   $ source demo-openrc.sh
   ```

2. Show the service status:

   ```
   $ swift 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. Upload a test file:

   ```
   $ swift upload demo-container1 FILE
   ```

   Replace *FILE* with the name of a local file to upload to the demo-container1 container.

4. List containers:

   ```
   $ swift list
   demo-container1
   ```

5. Download a test file:

   ```
   $ swift download demo-container1 FILE
   ```

   Replace *FILE* with the name of the file uploaded to the demo-container1 container.

Next steps

Your OpenStack environment now includes Object Storage. You can launch an instance or add more services to your environment in the following chapters.

10. Add the Orchestration module

Table of Contents

The Orchestration module (heat) uses a heat orchestration template (HOT) to create and manage cloud resources.

Orchestration module concepts

The Orchestration module 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 allow you to create most OpenStack resource types, such as instances, floating IPs, volumes, security groups and users. It also provides advanced functionality, such as instance high availability, instance auto-scaling, and nested stacks. This enables OpenStack core projects to receive a larger user base.

The service enables deployers to integrate with the Orchestration module directly or through custom plug-ins.

The Orchestration module consists of the following components:

`heat` command-line client A CLI that communicates with the heat-api to run AWS CloudFormation APIs. End developers can directly use the Orchestration REST API.

`heat-api` component An OpenStack-native REST API that processes API requests by sending them to the heat-engine over Remote Procedure Call (RPC).

`heat-api-cfn` component An AWS Query API that is compatible with AWS CloudFormation. It 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 and configure Orchestration

This section describes how to install and configure the Orchestration module, code-named heat, on the controller node.

To configure prerequisites

Before you install and configure Orchestration, you must create a database and Identity service credentials including endpoints.

1. To create the database, complete these steps:

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

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

   b. Create the `heat` database:

   ```
   CREATE DATABASE heat;
   ```

   c. Grant proper access to the `heat` database:

   ```
   GRANT ALL PRIVILEGES ON heat.* TO 'heat'@'localhost' \
     IDENTIFIED BY 'HEAT_DBPASS';
   GRANT ALL PRIVILEGES ON heat.* TO 'heat'@'%' \
     IDENTIFIED BY 'HEAT_DBPASS';
   ```

   Replace *HEAT_DBPASS* with a suitable password.

   d. Exit the database access client.

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

   ```
   $ source admin-openrc.sh
   ```

3. To create the Identity service credentials, complete these steps:

   a. Create the `heat` user:

   ```
   $ keystone user-create --name heat --pass HEAT_PASS
   +----------+----------------------------------+
   | Property |              Value               |
   +----------+----------------------------------+
   |  email   |                                  |
   | enabled  |               True               |
   |    id    | 7fd67878dcd04d0393469ef825a7e005 |
   |   name   |               heat               |
   | username |               heat               |
   +----------+----------------------------------+
   ```

   Replace *HEAT_PASS* with a suitable password.

   b. Link the `heat` user to the `service` tenant and `admin` role:

   ```
   $ keystone user-role-add --user heat --tenant service --role admin
   ```

   Note

   This command provides no output.

   c. Create the `heat_stack_user` and `heat_stack_owner` roles:

   ```
   $ keystone role-create --name heat_stack_user
   $ keystone role-create --name heat_stack_owner
   ```

By default, users created by Orchestration use the `heat_stack_user` role.

d. Create the `heat` and `heat-cfn` services:

```
$ keystone service-create --name heat --type orchestration \
  --description "Orchestration"
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
| description |          Orchestration           |
|   enabled   |               True               |
|      id     | 031112165cad4c2bb23e84603957de29 |
|     name    |               heat               |
|     type    |          orchestration           |
+-------------+----------------------------------+
$ keystone service-create --name heat-cfn --type cloudformation \
  --description "Orchestration"
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
| description |          Orchestration           |
|   enabled   |               True               |
|      id     | 297740d74c0a446bbff867acdccb33fa |
|     name    |             heat-cfn             |
|     type    |          cloudformation          |
+-------------+----------------------------------+
```

e. Create the Identity service endpoints:

```
$ keystone endpoint-create \
  --service-id $(keystone service-list | awk '/ orchestration / {print
 $2}') \
  --publicurl http://controller:8004/v1/%\(tenant_id\)s \
  --internalurl http://controller:8004/v1/%\(tenant_id\)s \
  --adminurl http://controller:8004/v1/%\(tenant_id\)s \
  --region regionOne
+-------------+-----------------------------------------+
|   Property  |                  Value                  |
+-------------+-----------------------------------------+
|   adminurl  | http://controller:8004/v1/%(tenant_id)s |
|      id     |     f41225f665694b95a46448e8676b0dc2    |
| internalurl | http://controller:8004/v1/%(tenant_id)s |
|  publicurl  | http://controller:8004/v1/%(tenant_id)s |
|    region   |                regionOne                |
|  service_id |     031112165cad4c2bb23e84603957de29    |
+-------------+-----------------------------------------+
$ keystone endpoint-create \
  --service-id $(keystone service-list | awk '/ cloudformation /
 {print $2}') \
  --publicurl http://controller:8000/v1 \
  --internalurl http://controller:8000/v1 \
  --adminurl http://controller:8000/v1 \
  --region regionOne
+-------------+----------------------------------+
|   Property  |              Value               |
+-------------+----------------------------------+
|   adminurl  |    http://controller:8000/v1     |
|      id     | f41225f665694b95a46448e8676b0dc2 |
| internalurl |    http://controller:8000/v1     |
|  publicurl  |    http://controller:8000/v1     |
|    region   |            regionOne             |
|  service_id | 297740d74c0a446bbff867acdccb33fa |
+-------------+----------------------------------+
```

To install and configure the Orchestration components

1. Run the following commands to install the packages:

   ```
   # yum install openstack-heat-api openstack-heat-api-cfn openstack-heat-
   engine \
     python-heatclient
   ```

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

   a. In the [database] section, configure database access:

      ```
      [database]
      ...
      connection = mysql://heat:HEAT_DBPASS@controller/heat
      ```

      Replace *HEAT_DBPASS* with the password you chose for the Orchestration database.

   b. In the [DEFAULT] section, configure RabbitMQ message broker access:

      ```
      [DEFAULT]
      ...
      rpc_backend = rabbit
      rabbit_host = controller
      rabbit_password = RABBIT_PASS
      ```

      Replace *RABBIT_PASS* with the password you chose for the guest account in RabbitMQ.

   c. In the [keystone_authtoken] and [ec2authtoken] sections, configure Identity service access:

      ```
      [keystone_authtoken]
      ...
      auth_uri = http://controller:5000/v2.0
      identity_uri = http://controller:35357
      admin_tenant_name = service
      admin_user = heat
      admin_password = HEAT_PASS

      [ec2authtoken]
      ...
      auth_uri = http://controller:5000/v2.0
      ```

      Replace *HEAT_PASS* with the password you chose for the heat user in the Identity service.

      Note

      Comment out any auth_host, auth_port, and auth_protocol options because the identity_uri option replaces them.

d. In the `[DEFAULT]` section, configure the metadata and wait condition URLs:

```
[DEFAULT]
...
heat_metadata_server_url = http://controller:8000
heat_waitcondition_server_url = http://controller:8000/v1/
waitcondition
```

e. (Optional) To assist with troubleshooting, enable verbose logging in the `[DEFAULT]` section:

```
[DEFAULT]
...
verbose = True
```

3. Populate the Orchestration database:

```
# su -s /bin/sh -c "heat-manage db_sync" heat
```

To finalize installation

- Start the Orchestration services and configure them to start when the system boots:

```
# systemctl enable openstack-heat-api.service openstack-heat-api-cfn.
service \
  openstack-heat-engine.service
# systemctl start openstack-heat-api.service openstack-heat-api-cfn.
service \
  openstack-heat-engine.service
```

Verify operation

This section describes how to verify operation of the Orchestration module (heat).

1. Source the `demo` tenant credentials:

```
$ source demo-openrc.sh
```

2. The Orchestration module uses templates to describe stacks. To learn about the template language, see the Template Guide in the Heat developer documentation.

   Create a test template in the `test-stack.yml` file with the following content:

```
heat_template_version: 2013-05-23

description: Test Template

parameters:
  ImageID:
    type: string
    description: Image use to boot a server
  NetID:
    type: string
    description: Network ID for the server

resources:
  server1:
    type: OS::Nova::Server
    properties:
      name: "Test server"
      image: { get_param: ImageID }
      flavor: "m1.tiny"
      networks:
      - network: { get_param: NetID }

outputs:
  server1_private_ip:
    description: IP address of the server in the private network
    value: { get_attr: [ server1, first_address ] }
```

3. Use the **heat stack-create** command to create a stack from the template:

```
$ NET_ID=$(nova net-list | awk '/ demo-net / { print $2 }')
$ heat stack-create -f test-stack.yml \
  -P "ImageID=cirros-0.3.3-x86_64;NetID=$NET_ID" testStack
+--------------------------------------+------------+--------------------
+----------------------+
| id                                   | stack_name | stack_status       |
 creation_time        |
+--------------------------------------+------------+--------------------
+----------------------+
| 477d96b4-d547-4069-938d-32ee990834af | testStack  | CREATE_IN_PROGRESS |
 2014-04-06T15:11:01Z |
+--------------------------------------+------------+--------------------
+----------------------+
```

4. Use the **heat stack-list** command to verify successful creation of the stack:

```
$ heat stack-list
+--------------------------------------+------------+-----------------
+----------------------+
| id                                   | stack_name | stack_status    |
 creation_time        |
+--------------------------------------+------------+-----------------
+----------------------+
| 477d96b4-d547-4069-938d-32ee990834af | testStack  | CREATE_COMPLETE |
 2014-04-06T15:11:01Z |
+--------------------------------------+------------+-----------------
+----------------------+
```

Next steps

Your OpenStack environment now includes Orchestration. You can launch an instance or add more services to your environment in the following chapters.

11. Add the Telemetry module

Table of Contents

Telemetry provides a framework for monitoring and metering the OpenStack cloud. It is also known as the ceilometer project.

Telemetry module

The Telemetry module performs the following functions:

- Efficiently collects the metering data about the CPU and network costs.
- Collects data by monitoring notifications sent from services or by polling the infrastructure.
- Configures the type of collected data to meet various operating requirements. It accesses and inserts the metering data through the REST API.
- Expands the framework to collect custom usage data by additional plug-ins.
- Produces signed metering messages that cannot be repudiated.

The Telemetry module consists of the following 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 our focus is 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 central management server(s) to monitor the message queues (for notifications and for metering data coming from the agent). Notification messages are processed and turned into metering messages, which are sent to the message bus using the appropriate topic. Telemetry 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 alarms to be set based on the 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 data access from the data store.

These services communicate by using the OpenStack messaging bus. Only the collector and API server have access to the data store.

Install and configure controller node

This section describes how to install and configure the Telemetry module, code-named ceilometer, on the controller node. The Telemetry module uses separate agents to collect measurements from each OpenStack service in your environment.

To configure prerequisites

Before you install and configure Telemetry, you must install MongoDB, create a MongoDB database, and create Identity service credentials including endpoints.

1. Install the MongoDB package:

   ```
   # yum install mongodb-server mongodb
   ```

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

   a. Configure the `bind_ip` key to use the management interface IP address of the controller node.

      ```
      bind_ip = 10.0.0.11
      ```

   b. By default, MongoDB creates several 1 GB journal files in the `/var/lib/mongodb/journal` directory. If you want to reduce the size of each journal file to 128 MB and limit total journal space consumption to 512 MB, assert the `smallfiles` key:

      ```
      smallfiles = true
      ```

      You can also disable journaling. For more information, see the MongoDB manual.

   c. Start the MongoDB services and configure them to start when the system boots:

      ```
      # service mongod start
      # chkconfig mongod on
      ```

3. Create the `ceilometer` database:

   ```
   # mongo --host controller --eval '
     db = db.getSiblingDB("ceilometer");
     db.addUser({user: "ceilometer",
     pwd: "CEILOMETER_DBPASS",
     roles: [ "readWrite", "dbAdmin" ]})'
   ```

Replace *CEILOMETER_DBPASS* with a suitable password.

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

```
$ source admin-openrc.sh
```

5. To create the Identity service credentials:

   a. Create the `ceilometer` user:

   ```
   $ keystone user-create --name ceilometer --pass CEILOMETER_PASS
   ```

   Replace *CEILOMETER_PASS* with a suitable password.

   b. Link the `ceilometer` user to the `service` tenant and `admin` role:

   ```
   $ keystone user-role-add --user ceilometer --tenant service --role
    admin
   ```

   c. Create the `ceilometer` service:

   ```
   $ keystone service-create --name ceilometer --type metering \
     --description "Telemetry"
   ```

   d. Create the Identity service endpoints:

   ```
   $ keystone endpoint-create \
     --service-id $(keystone service-list | awk '/ metering / {print
    $2}') \
     --publicurl http://controller:8777 \
     --internalurl http://controller:8777 \
     --adminurl http://controller:8777 \
     --region regionOne
   ```

To install and configure the Telemetry module components

1. Install the packages:

```
# yum install openstack-ceilometer-api openstack-ceilometer-collector \
  openstack-ceilometer-notification openstack-ceilometer-central
 openstack-ceilometer-alarm \
  python-ceilometerclient
```

2. Generate a random value to use as the metering secret:

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

3. Edit the `/etc/ceilometer/ceilometer.conf` file and complete the following actions:

   a. In the `[database]` section, configure database access:

   ```
   [database]
   ...
   connection = mongodb://ceilometer:CEILOMETER_DBPASS@controller:27017/
   ceilometer
   ```

   Replace *CEILOMETER_DBPASS* with the password you chose for the Telemetry module database.

b. In the [DEFAULT] section, configure RabbitMQ message broker access:

```
[DEFAULT]
...
rpc_backend = rabbit
rabbit_host = controller
rabbit_password = RABBIT_PASS
```

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

c. In the [DEFAULT] and [keystone_authtoken] sections, configure Identity service access:

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

[keystone_authtoken]
...
auth_uri = http://controller:5000/v2.0
identity_uri = http://controller:35357
admin_tenant_name = service
admin_user = ceilometer
admin_password = CEILOMETER_PASS
```

Replace *CEILOMETER_PASS* with the password you chose for the `celiometer` user in the Identity service.

Note

Comment out any `auth_host`, `auth_port`, and `auth_protocol` options because the `identity_uri` option replaces them.

d. In the [service_credentials] section, configure service credentials:

```
[service_credentials]
...
os_auth_url = http://controller:5000/v2.0
os_username = ceilometer
os_tenant_name = service
os_password = CEILOMETER_PASS
```

Replace *CEILOMETER_PASS* with the password you chose for the `ceilometer` user in the Identity service.

e. In the [publisher] section, configure the metering secret:

```
[publisher]
...
metering_secret = METERING_SECRET
```

Replace *METERING_SECRET* with the random value that you generated in a previous step.

To finalize installation

- Start the Telemetry services and configure them to start when the system boots:

```
# systemctl enable openstack-ceilometer-api.service openstack-ceilometer-notification.service \
  openstack-ceilometer-central.service openstack-ceilometer-collector.service \
  openstack-ceilometer-alarm-evaluator.service openstack-ceilometer-alarm-notifier.service
# systemctl start openstack-ceilometer-api.service openstack-ceilometer-notification.service \
  openstack-ceilometer-central.service openstack-ceilometer-collector.service \
  openstack-ceilometer-alarm-evaluator.service openstack-ceilometer-alarm-notifier.service
```

Install the Compute agent for Telemetry

Telemetry is composed of an API service, a collector and a range of disparate agents. This section explains how to install and configure the agent that runs on the compute node.

To configure prerequisites

1. Install the package:

```
# yum install openstack-ceilometer-compute python-ceilometerclient python-pecan
```

2. Edit the /etc/nova/nova.conf file and add the following lines 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. Restart the Compute service:

```
# systemctl restart openstack-nova-compute.service
```

To configure the Compute agent for Telemetry

Edit the /etc/ceilometer/ceilometer.conf file and complete the following actions:

1. In the [publisher] section, set the secret key for Telemetry service nodes:

```
[publisher]
# Secret value for signing metering messages (string value)
metering_secret = CEILOMETER_TOKEN
```

   Replace *CEILOMETER_TOKEN* with the ceilometer token that you created previously.

2. In the [DEFAULT] section, configure RabbitMQ broker access:

```
[DEFAULT]
rabbit_host = controller
rabbit_password = RABBIT_PASS
```

Replace *RABBIT_PASS* with the password you chose for the guest account in RabbitMQ.

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

```
[keystone_authtoken]
auth_uri = http://controller:5000/v2.0
identity_uri = http://controller:35357
admin_tenant_name = service
admin_user = ceilometer
admin_password = CEILOMETER_PASS
```

Replace *CEILOMETER_PASS* with the password you chose for the Telemetry module database.

> **Note**
>
> Comment out the `auth_host`, `auth_port`, and `auth_protocol` keys, since they are replaced by the `identity_uri` and `auth_uri` keys.

4. In the `[service_credentials]` section, configure service credentials:

```
[service_credentials]
os_auth_url = http://controller:5000/v2.0
os_username = ceilometer
os_tenant_name = service
os_password = CEILOMETER_PASS
os_endpoint_type = internalURL
```

Replace CEILOMETER_PASS with the password you chose for the ceilometer user in the Identity service.

To finish installation

- Start the service and configure it to start when the system boots:

```
# systemctl enable openstack-ceilometer-compute.service
# systemctl start openstack-ceilometer-compute.service
```

Configure the Image Service for Telemetry

1. To retrieve image samples, you must configure the Image Service to send notifications to the bus.

   Edit `/etc/glance/glance-api.conf` and modify the `[DEFAULT]` section:

```
notification_driver = messaging
rpc_backend = rabbit
rabbit_host = controller
rabbit_password = RABBIT_PASS
```

2. Restart the Image Services with their new settings:

```
# systemctl restart openstack-glance-api.service openstack-glance-
registry.service
```

Add the Block Storage service agent for Telemetry

1. To retrieve volume samples, you must configure the Block Storage service to send notifications to the bus.

   Edit `/etc/cinder/cinder.conf` and add in the `[DEFAULT]` section on the controller and volume nodes:

   ```
   control_exchange = cinder
   notification_driver = cinder.openstack.common.notifier.rpc_notifier
   ```

2. Restart the Block Storage services with their new settings.

   On the controller node:

   ```
   # systemctl restart openstack-cinder-api.service openstack-cinder-
   scheduler.service
   ```

   On the storage node:

   ```
   # systemctl restart openstack-cinder-volume.service
   ```

3. If you want to collect OpenStack Block Storage notification on demand, you can use **cinder-volume-usage-audit** from OpenStack Block Storage. For more information, *Block Storage audit script setup to get notifications*.

Configure the Object Storage service for Telemetry

1. Install the python-ceilometerclient package on your Object Storage proxy server:

   ```
   # yum install python-ceilometerclient
   ```

2. To retrieve object store statistics, the Telemetry service needs access to Object Storage with the `ResellerAdmin` role. Give this role to your `os_username` user for the `os_tenant_name` tenant:

   ```
   $ keystone role-create --name ResellerAdmin
   +----------+----------------------------------+
   | Property |              Value               |
   +----------+----------------------------------+
   |    id    | 462fa46c13fd4798a95a3bfbe27b5e54 |
   |   name   |          ResellerAdmin           |
   +----------+----------------------------------+
   ```

   ```
   $ keystone user-role-add --tenant service --user ceilometer \
         --role 462fa46c13fd4798a95a3bfbe27b5e54
   ```

3. You must also add the Telemetry middleware to Object Storage to handle incoming and outgoing traffic. Add these lines to the `/etc/swift/proxy-server.conf` file:

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

4. Add `ceilometer` to the `pipeline` parameter of that same file:

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

5. Add the system user `swift` to the system group `ceilometer` to give Object Storage access to the `ceilometer.conf` file.

```
# usermod -a -G ceilometer swift
```

6. Add `ResellerAdmin` to the `operator_roles` parameter of that same file:

```
operator_roles = Member,admin,swiftoperator,_member_,ResellerAdmin
```

7. Restart the service with its new settings:

```
# systemctl restart openstack-swift-proxy.service
```

Verify the Telemetry installation

To test the Telemetry installation, download an image from the Image Service, and use the **ceilometer** command to display usage statistics.

1. Use the `ceilometer meter-list` command to test the access to Telemetry:

```
$ ceilometer meter-list
```

```
+------------+-------+-------+--------------------------------------
+---------+----------------------------------+
| Name       | Type  | Unit  | Resource ID                          | User
 ID | Project ID                       |
+------------+-------+-------+--------------------------------------
+---------+----------------------------------+
| image      | gauge | image | acafc7c0-40aa-4026-9673-b879898e1fc2 | None
    | efa984b0a914450e9a47788ad330699d |
| image.size | gauge | B     | acafc7c0-40aa-4026-9673-b879898e1fc2 | None
    | efa984b0a914450e9a47788ad330699d |
+------------+-------+-------+--------------------------------------
+---------+----------------------------------+
```

2. Download an image from the Image Service:

```
$ glance image-download "cirros-0.3.3-x86_64" > cirros.img
```

3. Call the `ceilometer meter-list` command again to validate that the download has been detected and stored by the Telemetry:

```
$ ceilometer meter-list
```

```
+----------------+-------+-------+--------------------------------------
+---------+----------------------------------+
| Name           | Type  | Unit  | Resource ID                          |
 User ID | Project ID                       |
+----------------+-------+-------+--------------------------------------
+---------+----------------------------------+
| image          | gauge | image | acafc7c0-40aa-4026-9673-b879898e1fc2 |
 None    | efa984b0a914450e9a47788ad330699d |
| image.download | delta | B     | acafc7c0-40aa-4026-9673-b879898e1fc2 |
 None    | efa984b0a914450e9a47788ad330699d |
| image.serve    | delta | B     | acafc7c0-40aa-4026-9673-b879898e1fc2 |
 None    | efa984b0a914450e9a47788ad330699d |
| image.size     | gauge | B     | acafc7c0-40aa-4026-9673-b879898e1fc2 |
 None    | efa984b0a914450e9a47788ad330699d |
+----------------+-------+-------+------------------------------------
+---------+----------------------------------+
```

4. You can now get usage statistics for the various meters:

```
$ ceilometer statistics -m image.download -p 60
```

```
+--------+---------------------+---------------------+-------
+------------+------------+------------+------------+----------
+----------------------------+----------------------------+
| Period | Period Start        | Period End          | Count | Min
 | Max        | Sum        | Avg        | Duration | Duration Start
      | Duration End               |
+--------+---------------------+---------------------+-------
+------------+------------+------------+------------+----------
+----------------------------+----------------------------+
| 60     | 2013-11-18T18:08:50 | 2013-11-18T18:09:50 | 1     | 13167616.0
 | 13167616.0 | 13167616.0 | 13167616.0 | 0.0        | 2013-11-18T18:09:05.
334000 | 2013-11-18T18:09:05.334000 |
+--------+---------------------+---------------------+-------
+------------+------------+------------+------------+----------
+----------------------------+----------------------------+
```

Next steps

Your OpenStack environment now includes Telemetry. You can launch an instance or add more services to your environment in the previous chapters.

12. Add the Database service

Table of Contents

Use the *Database module* to create cloud database resources. The integrated project name is *trove*.

Warning

This chapter is a work in progress. It may contain incorrect information, and will be updated frequently.

Database service overview

The Database service provides scalable and reliable cloud provisioning functionality for both relational and non-relational database engines. Users can quickly and easily use database features without the burden of handling complex administrative tasks. Cloud users and database administrators can provision and manage multiple database instances as needed.

The Database service provides resource isolation at high performance levels, and automates complex administrative tasks such as deployment, configuration, patching, backups, restores, and monitoring.

Process flow example. This example is a high-level process flow for using Database services:

1. The OpenStack Administrator configures the basic infrastructure using the following steps:

   a. Install the Database service.

   b. Create an image for each type of database. For example, one for MySQL and one for MongoDB.

   c. Use the **trove-manage** command to import images and offer them to tenants.

2. The OpenStack end user deploys the Database service using the following steps:

   a. Create a Database service instance using the **trove create** command.

   b. Use the **trove list** command to get the ID of the instance, followed by the **trove show** command to get the IP address of it.

   c. Access the Database service instance using typical database access commands. For example, with MySQL:

   ```
   $ mysql -u myuser -p -h TROVE_IP_ADDRESS mydb
   ```

The Database service includes the following components:

`python-troveclient` command-line client
A CLI that communicates with the `trove-api` component.

`trove-api` component
Provides an OpenStack-native RESTful API that supports JSON to provision and manage Trove instances.

`trove-conductor` service
Runs on the host, and receives messages from guest instances that want to update information on the host.

`trove-taskmanager` service
Instruments the complex system flows that support provisioning instances, managing the lifecycle of instances, and performing operations on instances.

`trove-guestagent` service
Runs within the guest instance. Manages and performs operations on the database itself.

Install the Database service

This procedure installs the Database module on the controller node.

Prerequisites. This chapter assumes that you already have a working OpenStack environment with at least the following components installed: Compute, Image Service, Identity.

- If you want to do backup and restore, you also need Object Storage.
- If you want to provision datastores on block-storage volumes, you also need Block Storage.

To install the Database module on the controller:

1. Install required packages:

   ```
   # yum install openstack-trove python-troveclient
   ```

2. Prepare OpenStack:

   a. Source the `admin-openrc.sh` file.

      ```
      $ source ~/admin-openrc.sh
      ```

   b. Create a `trove` user that Compute uses to authenticate with the Identity service. Use the `service` tenant and give the user the `admin` role:

      ```
      $ keystone user-create --name trove --pass TROVE_PASS
      $ keystone user-role-add --user trove --tenant service --role admin
      ```

      Replace *TROVE_PASS* with a suitable password.

3. Edit the following configuration files, taking the below actions for each file:

   - `trove.conf`
   - `trove-taskmanager.conf`
   - `trove-conductor.conf`

a. Edit the [DEFAULT] section of each file and set appropriate values for the OpenStack service URLs, logging and messaging configuration, and SQL connections:

```
[DEFAULT]
log_dir = /var/log/trove
trove_auth_url = http://controller:5000/v2.0
nova_compute_url = http://controller:8774/v2
cinder_url = http://controller:8776/v1
swift_url = http://controller:8080/v1/AUTH_
sql_connection = mysql://trove:TROVE_DBPASS@controller/trove
notifier_queue_hostname = controller
```

b. Configure the Database module to use the RabbitMQ message broker by setting the following options in the [DEFAULT] configuration group of each file:

```
[DEFAULT]
...
rpc_backend = rabbit
rabbit_host = controller
rabbit_password = RABBIT_PASS
```

4. Edit the [filter:authtoken] section of the api-paste.ini file so it matches the listing shown below:

```
[filter:authtoken]
auth_uri = http://controller:5000/v2.0
identity_uri = http://controller:35357
admin_user = trove
admin_password = ADMIN_PASS
admin_tenant_name = service
signing_dir = /var/cache/trove
```

5. Edit the trove.conf file so it includes appropriate values for the default datastore and network label regex as shown below:

```
[DEFAULT]
default_datastore = mysql
....
# Config option for showing the IP address that nova doles out
add_addresses = True
network_label_regex = ^NETWORK_LABEL$
....
```

6. Edit the trove-taskmanager.conf file so it includes the required settings to connect to the OpenStack Compute service as shown below:

```
[DEFAULT]
....
# Configuration options for talking to nova via the novaclient.
# These options are for an admin user in your keystone config.
# It proxy's the token received from the user to send to nova via this
 admin users creds,
# basically acting like the client via that proxy token.
nova_proxy_admin_user = admin
nova_proxy_admin_pass = ADMIN_PASS
nova_proxy_admin_tenant_name = service
taskmanager_manager = trove.taskmanager.manager.Manager
...
```

7. Prepare the trove admin database:

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

8. Prepare the Database service:

   a. Initialize the database:

      ```
      # su -s /bin/sh -c "trove-manage db_sync" trove
      ```

   b. Create a datastore. You need to create a separate datastore for each type of database you want to use, for example, MySQL, MongoDB, Cassandra. This example shows you how to create a datastore for a MySQL database:

      ```
      # su -s /bin/sh -c "trove-manage datastore_update mysql ''" trove
      ```

9. Create a trove image.

   Create an image for the type of database you want to use, for example, MySQL, MongoDB, Cassandra.

   This image must have the trove guest agent installed, and it must have the `trove-guestagent.conf` file configured to connect to your OpenStack environment. To correctly configure the `trove-guestagent.conf` file, follow these steps on the guest instance you are using to build your image:

   - Add the following lines to `trove-guestagent.conf`:

     ```
     rabbit_host = controller
     rabbit_password = RABBIT_PASS
     nova_proxy_admin_user = admin
     nova_proxy_admin_pass = ADMIN_PASS
     nova_proxy_admin_tenant_name = service
     trove_auth_url = http://controller:35357/v2.0
     ```

10. Update the datastore to use the new image, using the **trove-manage** command.

    This example shows you how to create a MySQL 5.5 datastore:

    ```
    # trove-manage --config-file /etc/trove/trove.conf
     datastore_version_update \
      mysql mysql-5.5 mysql glance_image_ID mysql-server-5.5 1
    ```

11. You must register the Database module with the Identity service so that other OpenStack services can locate it. Register the service and specify the endpoint:

    ```
    $ keystone service-create --name trove --type database \
      --description "OpenStack Database Service"
    $ keystone endpoint-create \
      --service-id $(keystone service-list | awk '/ trove / {print $2}') \
      --publicurl http://controller:8779/v1.0/%\(tenant_id\)s \
      --internalurl http://controller:8779/v1.0/%\(tenant_id\)s \
      --adminurl http://controller:8779/v1.0/%\(tenant_id\)s \
      --region regionOne
    ```

12. Start the Database services and configure them to start when the system boots:

    ```
    # systemctl enable openstack-trove-api.service openstack-trove-
    taskmanager.service \
      openstack-trove-conductor.service
    # systemctl start openstack-trove-api.service openstack-trove-taskmanager.
    service \
      openstack-trove-conductor.service
    ```

Verify the Database service installation

To verify that the Database service is installed and configured correctly, try executing a Trove command:

1. Source the `demo-openrc.sh` file.

   ```
   $ source ~/demo-openrc.sh
   ```

2. Retrieve the Trove instances list:

   ```
   $ trove list
   ```

   You should see output similar to this:

   ```
   +----+------+-----------+-------------------+--------+-----------+------+
   | id | name | datastore | datastore_version | status | flavor_id | size |
   +----+------+-----------+-------------------+--------+-----------+------+
   +----+------+-----------+-------------------+--------+-----------+------+
   ```

3. Assuming you have created an image for the type of database you want, and have updated the datastore to use that image, you can now create a Trove instance (database). To do this, use the trove **create** command.

   This example shows you how to create a MySQL 5.5 database:

   ```
   $ trove create name 2 --size=2 --databases DBNAME \
     --users USER:PASSWORD --datastore_version mysql-5.5 \
     --datastore mysql
   ```

13. Add the Data processing service

Table of Contents

The Data processing service (sahara) enables users to provide a scalable data processing stack and associated management interfaces. This includes provision and operation of data processing clusters as well as scheduling and operation of data processing jobs.

Warning

This chapter is a work in progress. It may contain incorrect information, and will be updated frequently.

Data processing service

The Data processing service for OpenStack (sahara) aims to provide users with simple means to provision data processing (Hadoop, Spark) clusters by specifying several parameters like Hadoop version, cluster topology, nodes hardware details and a few more. After user fills in all the parameters, the Data processing service deploys the cluster in a few minutes. Also sahara provides means to scale already provisioned clusters by adding/removing worker nodes on demand.

The solution addresses the following use cases:

- Fast provisioning of Hadoop clusters on OpenStack for development and QA.
- Utilization of unused compute power from general purpose OpenStack IaaS cloud.
- Analytics-as-a-Service for ad-hoc or bursty analytic workloads.

Key features are:

- Designed as an OpenStack component.
- Managed through REST API with UI available as part of OpenStack dashboard.
- Support for different Hadoop distributions:
  - Pluggable system of Hadoop installation engines.
  - Integration with vendor specific management tools, such as Apache Ambari or Cloudera Management Console.
- Predefined templates of Hadoop configurations with ability to modify parameters.
- User-friendly UI for ad-hoc analytics queries based on Hive or Pig.

Install the Data processing service

This procedure installs the Data processing service (sahara) on the controller node.

To install the Data processing service on the controller:

1. Install required packages:

   ```
   # yum install openstack-sahara python-saharaclient
   ```

2. Edit /etc/sahara/sahara.conf configuration file

   a. First, edit connection parameter in the [database] section. The URL provided here should point to an empty database. For instance, connection string for MySQL database will be:

      ```
      connection = mysql://sahara:SAHARA_DBPASS@controller/sahara
      ```

   b. Switch to the [keystone_authtoken] section. The auth_uri parameter should point to the public Identity API endpoint. identity_uri should point to the admin Identity API endpoint. For example:

      ```
      auth_uri = http://controller:5000/v2.0
      identity_uri = http://controller:35357
      ```

   c. Next specify admin_user, admin_password and admin_tenant_name. These parameters must specify a keystone user which has the admin role in the given tenant. These credentials allow sahara to authenticate and authorize its users.

   d. Switch to the [DEFAULT] section. Proceed to the networking parameters. If you are using Neutron for networking, then set use_neutron=true. Otherwise if you are using nova-network set the given parameter to false.

   e. That should be enough for the first run. If you want to increase logging level for troubleshooting, there are two parameters in the config: verbose and debug. If the former is set to true, sahara will start to write logs of INFO level and above. If debug is set to true, sahara will write all the logs, including the DEBUG ones.

3. If you use the Data processing service with MySQL database, then for storing big job binaries in sahara internal database you must configure size of max allowed packet. Edit my.cnf file and change parameter:

   ```
   [mysqld]
   max_allowed_packet = 256M
   ```

   and restart MySQL server.

4. Create database schema:

   ```
   # sahara-db-manage --config-file /etc/sahara/sahara.conf upgrade head
   ```

5. You must register the Data processing service with the Identity service so that other OpenStack services can locate it. Register the service and specify the endpoint:

   ```
   $ keystone service-create --name sahara --type data_processing \
     --description "Data processing service"
   ```

```
$ keystone endpoint-create \
  --service-id $(keystone service-list | awk '/ sahara / {print $2}') \
  --publicurl http://controller:8386/v1.1/%\(tenant_id\)s \
  --internalurl http://controller:8386/v1.1/%\(tenant_id\)s \
  --adminurl http://controller:8386/v1.1/%\(tenant_id\)s \
  --region regionOne
```

6. Start the sahara service:

   ```
   # systemctl start openstack-sahara-all
   ```

7. (Optional) Enable the Data processing service to start on boot

   ```
   # systemctl enable openstack-sahara-all
   ```

Verify the Data processing service installation

To verify that the Data processing service (sahara) is installed and configured correctly, try requesting clusters list using sahara client.

1. Source the `demo` tenant credentials:

   ```
   $ source demo-openrc.sh
   ```

2. Retrieve sahara clusters list:

   ```
   $ sahara cluster-list
   ```

   You should see output similar to this:

   ```
   +------+----+--------+------------+
   | name | id | status | node_count |
   +------+----+--------+------------+
   +------+----+--------+------------+
   ```

14. Launch an instance

Table of Contents

An instance is a VM that OpenStack provisions on a compute node. This guide shows you how to launch a minimal instance using the *CirrOS* image that you added to your environment in the Chapter 4, “Add the Image Service” [36] chapter. In these steps, you use the command-line interface (CLI) on your controller node or any system with the appropriate OpenStack client libraries. To use the dashboard, see the *OpenStack User Guide*.

Launch an instance using OpenStack Networking (neutron) or legacy networking (nova-network) . For more information, see the *OpenStack User Guide*.

Note

These steps reference example components created in previous chapters. You must adjust certain values such as IP addresses to match your environment.

Launch an instance with OpenStack Networking (neutron)

To generate a key pair

Most cloud images support *public key authentication* rather than conventional user name/password authentication. Before launching an instance, you must generate a public/private key pair using **ssh-keygen** and add the public key to your OpenStack environment.

1. Source the `demo` tenant credentials:

   ```
   $ source demo-openrc.sh
   ```

2. Generate a key pair:

   ```
   $ ssh-keygen
   ```

3. Add the public key to your OpenStack environment:

   ```
   $ nova keypair-add --pub-key ~/.ssh/id_rsa.pub demo-key
   ```

   #### Note

   This command provides no output.

4. Verify addition of the public key:

   ```
   $ nova keypair-list
   +----------+-------------------------------------------------+
   | Name     | Fingerprint                                     |
   ```

```
+----------+-------------------------------------------------+
| demo-key | 6c:74:ec:3a:08:05:4e:9e:21:22:a6:dd:b2:62:b8:28 |
+----------+-------------------------------------------------+
```

To launch an instance

To launch an instance, you must at least specify the flavor, image name, network, security group, key, and instance name.

1. A flavor specifies a virtual resource allocation profile which includes processor, memory, and storage.

   List available flavors:

   ```
   $ 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      |
   +----+-----------+-----------+------+-----------+------+-------
   +-------------+-----------+
   ```

   Your first instance uses the `m1.tiny` flavor.

   > **Note**
   >
   > You can also reference a flavor by ID.

2. List available images:

   ```
   $ nova image-list
   +--------------------------------------+---------------------+--------
   +--------+
   | ID                                   | Name                | Status |
    Server |
   +--------------------------------------+---------------------+--------
   +--------+
   | acafc7c0-40aa-4026-9673-b879898e1fc2 | cirros-0.3.3-x86_64 | ACTIVE |
        |
   +--------------------------------------+---------------------+--------
   +--------+
   ```

   Your first instance uses the `cirros-0.3.3-x86_64` image.

3. List available networks:

   ```
   $ neutron net-list
   ```

```
+--------------------------------------+----------
+-------------------------------------------------------+
| id                                   | name     | subnets
                                |
+--------------------------------------+----------
+-------------------------------------------------------+
| 3c612b5a-d1db-498a-babb-a4c50e344cb1 | demo-net | 20bcd3fd-5785-41fe-
ac42-55ff884e3180 192.168.1.0/24   |
| 9bce64a3-a963-4c05-bfcd-161f708042d1 | ext-net  | b54a8d85-b434-4e85-
a8aa-74873841a90d 203.0.113.0/24   |
+--------------------------------------+----------
+-------------------------------------------------------+
```

Your first instance uses the demo-net tenant network. However, you must reference this network using the ID instead of the name.

4. List available security groups:

```
$ nova secgroup-list
+--------------------------------------+---------+-------------+
| Id                                   | Name    | Description |
+--------------------------------------+---------+-------------+
| ad8d4ea5-3cad-4f7d-b164-ada67ec59473 | default | default     |
+--------------------------------------+---------+-------------+
```

Your first instance uses the default security group. By default, this security group implements a firewall that blocks remote access to instances. If you would like to permit remote access to your instance, launch it and then configure remote access.

5. Launch the instance:

Replace *DEMO_NET_ID* with the ID of the demo-net tenant network.

```
$ nova boot --flavor m1.tiny --image cirros-0.3.3-x86_64 --nic net-
id=DEMO_NET_ID \
  --security-group default --key-name demo-key demo-instance1
+--------------------------------------
+-------------------------------------------------------------+
| Property                             | Value
                          |
+--------------------------------------
+-------------------------------------------------------------+
| OS-DCF:diskConfig                    | MANUAL
                          |
| OS-EXT-AZ:availability_zone          | nova
                          |
| OS-EXT-STS:power_state               | 0
                          |
| OS-EXT-STS:task_state                | scheduling
                          |
| OS-EXT-STS:vm_state                  | building
                          |
| OS-SRV-USG:launched_at               | -
                          |
| OS-SRV-USG:terminated_at             | -
                          |
| accessIPv4                           |
                          |
| accessIPv6                           |
                          |
| adminPass                            | vFW7Bp8PQGNo
                          |
| config_drive                         |
                          |
| created                              | 2014-04-09T19:24:27Z
                          |
| flavor                               | m1.tiny (1)
                          |
| hostId                               |
                          |
| id                                   |
 05682b91-81a1-464c-8f40-8b3da7ee92c5                    |
| image                                | cirros-0.3.3-x86_64
 (acafc7c0-40aa-4026-9673-b879898e1fc2) |
| key_name                             | demo-key
                          |
| metadata                             | {}
                          |
| name                                 | demo-instance1
                          |
| os-extended-volumes:volumes_attached | []
                          |
| progress                             | 0
                          |
| security_groups                      | default
                          |
| status                               | BUILD
                          |
| tenant_id                            | 7cf50047f8df4824bc76c2fdf66d11ec
                          |
| updated                              | 2014-04-09T19:24:27Z
                          |
| user_id                              | 0e47686e72114d7182f7569d70c519c9
                          |
+--------------------------------------
+------------------------------------------------------------+
```

6. Check the status of your instance:

```
$ nova list
+--------------------------------------+----------------+--------
+------------+-------------+--------------------------+
| ID                                   | Name           | Status | Task
 State | Power State | Networks                |
+--------------------------------------+----------------+--------
+------------+-------------+--------------------------+
| 05682b91-81a1-464c-8f40-8b3da7ee92c5 | demo-instance1 | ACTIVE | -
    | Running     | demo-net=192.168.1.3    |
+--------------------------------------+----------------+--------
+------------+-------------+--------------------------+
```

The status changes from `BUILD` to `ACTIVE` when your instance finishes the build process.

To access your instance using a virtual console

- Obtain a *Virtual Network Computing (VNC)* session URL for your instance and access it from a web browser:

```
$ nova get-vnc-console demo-instance1 novnc
+-------
+------------------------------------------------------------------------------------
+
| Type  | Url
                    |
+-------
+------------------------------------------------------------------------------------
+
| novnc | http://controller:6080/vnc_auto.html?token=2f6dd985-f906-4bfc-
b566-e87ce656375b    |
+-------
+------------------------------------------------------------------------------------
+
```

Note

If your web browser runs on a host that cannot resolve the *controller* host name, you can replace *controller* with the IP address of the management interface on your controller node.

The CirrOS image includes conventional user name/password authentication and provides these credentials at the login prompt. After logging into CirrOS, we recommend that you verify network connectivity using **ping**.

Verify the demo-net tenant network gateway:

```
$ ping -c 4 192.168.1.1
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=0.357 ms
64 bytes from 192.168.1.1: icmp_req=2 ttl=64 time=0.473 ms
64 bytes from 192.168.1.1: icmp_req=3 ttl=64 time=0.504 ms
64 bytes from 192.168.1.1: icmp_req=4 ttl=64 time=0.470 ms

--- 192.168.1.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 2998ms
rtt min/avg/max/mdev = 0.357/0.451/0.504/0.055 ms
```

Verify the ext-net external network:

```
$ ping -c 4 openstack.org
PING openstack.org (174.143.194.225) 56(84) bytes of data.
64 bytes from 174.143.194.225: icmp_req=1 ttl=53 time=17.4 ms
64 bytes from 174.143.194.225: icmp_req=2 ttl=53 time=17.5 ms
64 bytes from 174.143.194.225: icmp_req=3 ttl=53 time=17.7 ms
64 bytes from 174.143.194.225: icmp_req=4 ttl=53 time=17.5 ms

--- openstack.org ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3003ms
rtt min/avg/max/mdev = 17.431/17.575/17.734/0.143 ms
```

To access your instance remotely

1. Add rules to the `default` security group:

   a. Permit *ICMP* (ping):

   ```
   $ nova secgroup-add-rule default icmp -1 -1 0.0.0.0/0
   +-------------+-----------+---------+-----------+--------------+
   | IP Protocol | From Port | To Port | IP Range  | Source Group |
   +-------------+-----------+---------+-----------+--------------+
   | icmp        | -1        | -1      | 0.0.0.0/0 |              |
   +-------------+-----------+---------+-----------+--------------+
   ```

   b. Permit secure shell (SSH) access:

   ```
   $ nova secgroup-add-rule default tcp 22 22 0.0.0.0/0
   +-------------+-----------+---------+-----------+--------------+
   | IP Protocol | From Port | To Port | IP Range  | Source Group |
   +-------------+-----------+---------+-----------+--------------+
   | tcp         | 22        | 22      | 0.0.0.0/0 |              |
   +-------------+-----------+---------+-----------+--------------+
   ```

2. Create a *floating IP address* on the `ext-net` external network:

   ```
   $ neutron floatingip-create ext-net
   Created a new floatingip:
   +---------------------+--------------------------------------+
   | Field               | Value                                |
   +---------------------+--------------------------------------+
   | fixed_ip_address    |                                      |
   | floating_ip_address | 203.0.113.102                        |
   | floating_network_id | 9bce64a3-a963-4c05-bfcd-161f708042d1 |
   | id                  | 05e36754-e7f3-46bb-9eaa-3521623b3722 |
   | port_id             |                                      |
   | router_id           |                                      |
   | status              | DOWN                                 |
   | tenant_id           | 7cf50047f8df4824bc76c2fdf66d11ec     |
   +---------------------+--------------------------------------+
   ```

3. Associate the floating IP address with your instance:

   ```
   $ nova floating-ip-associate demo-instance1 203.0.113.102
   ```

   Note

   This command provides no output.

4. Check the status of your floating IP address:

   ```
   $ nova list
   +--------------------------------------+----------------+--------
   +------------+-------------+-----------------------------------------+
   | ID                                   | Name           | Status | Task
    State | Power State | Networks                                |
   +--------------------------------------+----------------+--------
   +------------+-------------+-----------------------------------------+
   | 05682b91-81a1-464c-8f40-8b3da7ee92c5 | demo-instance1 | ACTIVE | -
       | Running     | demo-net=192.168.1.3, 203.0.113.102     |
   +--------------------------------------+----------------+--------
   +------------+-------------+-----------------------------------------+
   ```

5. Verify network connectivity using **ping** from the controller node or any host on the external network:

```
$ ping -c 4 203.0.113.102
PING 203.0.113.102 (203.0.113.112) 56(84) bytes of data.
64 bytes from 203.0.113.102: icmp_req=1 ttl=63 time=3.18 ms
64 bytes from 203.0.113.102: icmp_req=2 ttl=63 time=0.981 ms
64 bytes from 203.0.113.102: icmp_req=3 ttl=63 time=1.06 ms
64 bytes from 203.0.113.102: icmp_req=4 ttl=63 time=0.929 ms

--- 203.0.113.102 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3002ms
rtt min/avg/max/mdev = 0.929/1.539/3.183/0.951 ms
```

6. Access your instance using SSH from the controller node or any host on the external network:

```
$ ssh cirros@203.0.113.102
The authenticity of host '203.0.113.102 (203.0.113.102)' can't be
 established.
RSA key fingerprint is ed:05:e9:e7:52:a0:ff:83:68:94:c7:d1:f2:f8:e2:e9.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '203.0.113.102' (RSA) to the list of known
 hosts.
$
```

Note

If your host does not contain the public/private key pair created in an earlier step, SSH prompts for the default password associated with the `cirros` user.

To attach a Block Storage volume to your instance

If your environment includes the Block Storage service, you can attach a volume to the instance.

1. Source the `demo` tenant credentials:

```
$ source demo-openrc.sh
```

2. List volumes:

```
$ nova volume-list
+--------------------------------------+-----------+--------------+------
+-------------+-------------+
| ID                                   | Status    | Display Name | Size |
 Volume Type | Attached to |
+--------------------------------------+-----------+--------------+------
+-------------+-------------+
| 158bea89-07db-4ac2-8115-66c0d6a4bb48 | available | demo-volume1 | 1    |
 None        |             |
+--------------------------------------+-----------+--------------+------
+-------------+-------------+
```

3. Attach the `demo-volume1` volume to the `demo-instance1` instance:

```
$ nova volume-attach demo-instance1 158bea89-07db-4ac2-8115-66c0d6a4bb48
+----------+--------------------------------------+
| Property | Value                                |
+----------+--------------------------------------+
| device   | /dev/vdb                             |
| id       | 158bea89-07db-4ac2-8115-66c0d6a4bb48 |
| serverId | 05682b91-81a1-464c-8f40-8b3da7ee92c5 |
| volumeId | 158bea89-07db-4ac2-8115-66c0d6a4bb48 |
+----------+--------------------------------------+
```

Note

You must reference volumes using the IDs instead of names.

4. List volumes:

```
$ nova volume-list
+--------------------------------------+-----------+--------------+------
+-------------+--------------------------------------+
| ID                                   | Status    | Display Name | Size |
 Volume Type | Attached to                          |
+--------------------------------------+-----------+--------------+------
+-------------+--------------------------------------+
| 158bea89-07db-4ac2-8115-66c0d6a4bb48 | in-use    | demo-volume1 | 1    |
 None        | 05682b91-81a1-464c-8f40-8b3da7ee92c5 |
+--------------------------------------+-----------+--------------+------
+-------------+--------------------------------------+
```

The `demo-volume1` volume status should indicate `in-use` by the ID of the `demo-instance1` instance.

5. Access your instance using SSH from the controller node or any host on the external network and use the **fdisk** command to verify presence of the volume as the `/dev/vdb` block storage device:

```
$ ssh cirros@203.0.113.102
$ sudo fdisk -l

Disk /dev/vda: 1073 MB, 1073741824 bytes
255 heads, 63 sectors/track, 130 cylinders, total 2097152 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x00000000

   Device Boot      Start         End      Blocks   Id  System
/dev/vda1   *       16065     2088449     1036192+  83  Linux

Disk /dev/vdb: 1073 MB, 1073741824 bytes
16 heads, 63 sectors/track, 2080 cylinders, total 2097152 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x00000000

Disk /dev/vdb doesn't contain a valid partition table
```

Note

You must create a partition table and file system to use the volume.

If your instance does not launch or seem to work as you expect, see the *OpenStack Operations Guide* for more information or use one of the many other options to seek assistance. We want your environment to work!

Launch an instance with legacy networking (nova-network)

To generate a key pair

Most cloud images support *public key authentication* rather than conventional user name/password authentication. Before launching an instance, you must generate a public/private key pair using **ssh-keygen** and add the public key to your OpenStack environment.

1. Source the `demo` tenant credentials:

```
$ source demo-openrc.sh
```

2. Generate a key pair:

```
$ ssh-keygen
```

3. Add the public key to your OpenStack environment:

```
$ nova keypair-add --pub-key ~/.ssh/id_rsa.pub demo-key
```

Note

This command provides no output.

4. Verify addition of the public key:

```
$ nova keypair-list
+----------+-------------------------------------------------+
| Name     | Fingerprint                                     |
+----------+-------------------------------------------------+
| demo-key | 6c:74:ec:3a:08:05:4e:9e:21:22:a6:dd:b2:62:b8:28 |
+----------+-------------------------------------------------+
```

To launch an instance

To launch an instance, you must at least specify the flavor, image name, network, security group, key, and instance name.

1. A flavor specifies a virtual resource allocation profile which includes processor, memory, and storage.

List available flavors:

```
$ 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      |
+----+-----------+-----------+------+-----------+------+-------
+-------------+-----------+
```

Your first instance uses the `m1.tiny` flavor.

Note

You can also reference a flavor by ID.

2. List available images:

```
$ nova image-list
+--------------------------------------+---------------------+--------
+--------+
| ID                                   | Name                | Status |
 Server |
+--------------------------------------+---------------------+--------
+--------+
| acafc7c0-40aa-4026-9673-b879898e1fc2 | cirros-0.3.3-x86_64 | ACTIVE |
     |
+--------------------------------------+---------------------+--------
+--------+
```

Your first instance uses the `cirros-0.3.3-x86_64` image.

3. List available networks:

Note

You must source the `admin` tenant credentials for this step and then source the `demo` tenant credentials for the remaining steps.

```
$ source admin-openrc.sh
```

```
$ nova net-list
+--------------------------------------+----------+------------------+
| ID                                   | Label    | CIDR             |
+--------------------------------------+----------+------------------+
| 7f849be3-4494-495a-95a1-0f99ccb884c4 | demo-net | 203.0.113.24/29  |
+--------------------------------------+----------+------------------+
```

Your first instance uses the `demo-net` tenant network. However, you must reference this network using the ID instead of the name.

4. List available security groups:

```
$ nova secgroup-list
+--------------------------------------+---------+-------------+
| Id                                   | Name    | Description |
+--------------------------------------+---------+-------------+
| ad8d4ea5-3cad-4f7d-b164-ada67ec59473 | default | default     |
+--------------------------------------+---------+-------------+
```

Your first instance uses the `default` security group. By default, this security group implements a firewall that blocks remote access to instances. If you would like to permit remote access to your instance, launch it and then configure remote access.

5. Launch the instance:

   Replace *`DEMO_NET_ID`* with the ID of the `demo-net` tenant network.

```
$ nova boot --flavor m1.tiny --image cirros-0.3.3-x86_64 --nic net-
id=DEMO_NET_ID \
  --security-group default --key-name demo-key demo-instance1
+--------------------------------------
+------------------------------------------------------------+
| Property                             | Value
                          |
+--------------------------------------
+------------------------------------------------------------+
| OS-DCF:diskConfig                    | MANUAL
                          |
| OS-EXT-AZ:availability_zone          | nova
                          |
| OS-EXT-STS:power_state               | 0
                          |
| OS-EXT-STS:task_state                | scheduling
                          |
| OS-EXT-STS:vm_state                  | building
                          |
| OS-SRV-USG:launched_at               | -
                          |
| OS-SRV-USG:terminated_at             | -
                          |
| accessIPv4                           |
                          |
| accessIPv6                           |
                          |
| adminPass                            | ThZqrg7ach78
                          |
| config_drive                         |
                          |
| created                              | 2014-04-10T00:09:16Z
                          |
| flavor                               | m1.tiny (1)
                          |
| hostId                               |
                          |
| id                                   | 45ea195c-
c469-43eb-83db-1a663bbad2fc                       |
| image                                | cirros-0.3.3-x86_64
 (acafc7c0-40aa-4026-9673-b879898e1fc2) |
| key_name                             | demo-key
                          |
| metadata                             | {}
                          |
| name                                 | demo-instance1
                          |
| os-extended-volumes:volumes_attached | []
                          |
| progress                             | 0
                          |
| security_groups                      | default
                          |
| status                               | BUILD
                          |
| tenant_id                            | 93849608fe3d462ca9fa0e5dbfd4d040
                          |
| updated                              | 2014-04-10T00:09:16Z
                          |
| user_id                              | 8397567baf4746cca7a1e608677c3b23
                          |
+---------------------------------------
+-------------------------------------------------------------+
```

6. Check the status of your instance:

```
$ nova list
+--------------------------------------+----------------+--------
+------------+-------------+------------------------+
| ID                                   | Name             | Status | Task
 State | Power State | Networks                |
+--------------------------------------+----------------+--------
+------------+-------------+------------------------+
| 45ea195c-c469-43eb-83db-1a663bbad2fc | demo-instance1 | ACTIVE | -
    | Running     | demo-net=203.0.113.26  |
+--------------------------------------+----------------+--------
+------------+-------------+------------------------+
```

The status changes from `BUILD` to `ACTIVE` when your instance finishes the build process.

To access your instance using a virtual console

- Obtain a *Virtual Network Computing (VNC)* session URL for your instance and access it from a web browser:

```
$ nova get-vnc-console demo-instance1 novnc
+-------
+-------------------------------------------------------------------------------------
+
| Type  | Url
                   |
+-------
+-------------------------------------------------------------------------------------
+
| novnc | http://controller:6080/vnc_auto.html?token=2f6dd985-f906-4bfc-
b566-e87ce656375b     |
+-------
+-------------------------------------------------------------------------------------
+
```

Note

If your web browser runs on a host that cannot resolve the `controller` host name, you can replace `controller` with the IP address of the management interface on your controller node.

The CirrOS image includes conventional user name/password authentication and provides these credentials at the login prompt. After logging into CirrOS, we recommend that you verify network connectivity using **ping**.

Verify the `demo-net` network:

```
$ ping -c 4 openstack.org
PING openstack.org (174.143.194.225) 56(84) bytes of data.
64 bytes from 174.143.194.225: icmp_req=1 ttl=53 time=17.4 ms
64 bytes from 174.143.194.225: icmp_req=2 ttl=53 time=17.5 ms
64 bytes from 174.143.194.225: icmp_req=3 ttl=53 time=17.7 ms
64 bytes from 174.143.194.225: icmp_req=4 ttl=53 time=17.5 ms

--- openstack.org ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3003ms
rtt min/avg/max/mdev = 17.431/17.575/17.734/0.143 ms
```

To access your instance remotely

1. Add rules to the `default` security group:

   a. Permit *ICMP* (ping):

```
$ nova secgroup-add-rule default icmp -1 -1 0.0.0.0/0
+-------------+-----------+---------+-----------+--------------+
| IP Protocol | From Port | To Port | IP Range  | Source Group |
+-------------+-----------+---------+-----------+--------------+
| icmp        | -1        | -1      | 0.0.0.0/0 |              |
+-------------+-----------+---------+-----------+--------------+
```

   b. Permit secure shell (SSH) access:

```
$ nova secgroup-add-rule default tcp 22 22 0.0.0.0/0
+-------------+-----------+---------+-----------+--------------+
| IP Protocol | From Port | To Port | IP Range  | Source Group |
+-------------+-----------+---------+-----------+--------------+
| tcp         | 22        | 22      | 0.0.0.0/0 |              |
+-------------+-----------+---------+-----------+--------------+
```

2. Verify network connectivity using **ping** from the controller node or any host on the external network:

```
$ ping -c 4 203.0.113.26
PING 203.0.113.26 (203.0.113.26) 56(84) bytes of data.
64 bytes from 203.0.113.26: icmp_req=1 ttl=63 time=3.18 ms
64 bytes from 203.0.113.26: icmp_req=2 ttl=63 time=0.981 ms
64 bytes from 203.0.113.26: icmp_req=3 ttl=63 time=1.06 ms
64 bytes from 203.0.113.26: icmp_req=4 ttl=63 time=0.929 ms

--- 203.0.113.26 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3002ms
rtt min/avg/max/mdev = 0.929/1.539/3.183/0.951 ms
```

3. Access your instance using SSH from the controller node or any host on the external network:

```
$ ssh cirros@203.0.113.26
```

```
The authenticity of host '203.0.113.26 (203.0.113.26)' can't be
 established.
RSA key fingerprint is ed:05:e9:e7:52:a0:ff:83:68:94:c7:d1:f2:f8:e2:e9.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '203.0.113.26' (RSA) to the list of known
 hosts.
$
```

Note

If your host does not contain the public/private key pair created in an earlier step, SSH prompts for the default password associated with the `cirros` user.

To attach a Block Storage volume to your instance

If your environment includes the Block Storage service, you can attach a volume to the instance.

1. Source the `demo` tenant credentials:

```
$ source demo-openrc.sh
```

2. List volumes:

```
$ nova volume-list
+--------------------------------------+-----------+--------------+------
+-------------+-------------+
| ID                                   | Status    | Display Name | Size |
 Volume Type | Attached to |
+--------------------------------------+-----------+--------------+------
+-------------+-------------+
| 158bea89-07db-4ac2-8115-66c0d6a4bb48 | available | demo-volume1 | 1    |
 None        |             |
+--------------------------------------+-----------+--------------+------
+-------------+-------------+
```

3. Attach the `demo-volume1` volume to the `demo-instance1` instance:

```
$ nova volume-attach demo-instance1 158bea89-07db-4ac2-8115-66c0d6a4bb48
+----------+--------------------------------------+
| Property | Value                                |
+----------+--------------------------------------+
| device   | /dev/vdb                             |
| id       | 158bea89-07db-4ac2-8115-66c0d6a4bb48 |
| serverId | 45ea195c-c469-43eb-83db-1a663bbad2fc |
| volumeId | 158bea89-07db-4ac2-8115-66c0d6a4bb48 |
+----------+--------------------------------------+
```

Note

You must reference volumes using the IDs instead of names.

4. List volumes:

```
$ nova volume-list
+--------------------------------------+-----------+--------------+------
+-------------+--------------------------------------+
| ID                                   | Status    | Display Name | Size |
 Volume Type | Attached to                          |
+--------------------------------------+-----------+--------------+------
+-------------+--------------------------------------+
| 158bea89-07db-4ac2-8115-66c0d6a4bb48 | in-use    | demo-volume1 | 1    |
 None        | 45ea195c-c469-43eb-83db-1a663bbad2fc |
+--------------------------------------+-----------+--------------+------
+-------------+--------------------------------------+
```

The `demo-volume1` volume status should indicate `in-use` by the ID of the `demo-instance1` instance.

5. Access your instance using SSH from the controller node or any host on the external network and use the **fdisk** command to verify presence of the volume as the `/dev/vdb` block storage device:

```
$ ssh cirros@203.0.113.102
$ sudo fdisk -l

Disk /dev/vda: 1073 MB, 1073741824 bytes
255 heads, 63 sectors/track, 130 cylinders, total 2097152 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x00000000

   Device Boot      Start         End      Blocks   Id  System
/dev/vda1   *       16065     2088449     1036192+  83  Linux

Disk /dev/vdb: 1073 MB, 1073741824 bytes
16 heads, 63 sectors/track, 2080 cylinders, total 2097152 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x00000000

Disk /dev/vdb doesn't contain a valid partition table
```

Note

You must create a partition table and file system to use the volume.

If your instance does not launch or seem to work as you expect, see the *OpenStack Operations Guide* for more information or use one of the many other options to seek assistance. We want your environment to work!

Appendix A. Reserved user IDs

OpenStack reserves certain user IDs to run specific services and own specific files. These user IDs are set up according to the distribution packages. The following table gives an overview.

Table A.1. Reserved user IDs

Name	Description	ID
ceilometer	OpenStack Ceilometer Daemons	166
cinder	OpenStack Cinder Daemons	165
glance	OpenStack Glance Daemons	161
heat	OpenStack Heat Daemons	187
keystone	OpenStack Keystone Daemons	163
neutron	OpenStack Neutron Daemons	164
nova	OpenStack Nova Daemons	162
swift	OpenStack Swift Daemons	160
trove	OpenStack Trove Daemons	Assigned during package installation

Each user belongs to a user group with the same name as the user.

Appendix B. Community support

Table of Contents

The following resources are available to help you run and use OpenStack. The OpenStack community constantly improves and adds to the main features of OpenStack, but if you have any questions, do not hesitate to ask. Use the following resources to get OpenStack support, and troubleshoot your 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 associated components:

- *Installation Guide for Debian 7*
- *Installation Guide for openSUSE 13.1 and SUSE Linux Enterprise Server 11 SP3*
- *Installation Guide for Red Hat Enterprise Linux 7, CentOS 7, and Fedora 20*
- *Installation Guide for Ubuntu 14.04*

The following books explain how to configure and run an OpenStack cloud:

- *Architecture Design Guide*
- *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*
- *Command-Line Interface Reference*

The following documentation provides reference and guidance information for the OpenStack APIs:

- OpenStack API Complete Reference (HTML)
- API Complete Reference (PDF)
- *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*

The *Training Guides* offer software training for cloud administration and management.

ask.openstack.org

During the set up or testing of OpenStack, you might have questions about how a specific task is completed 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 has already been 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, links to screen shots, and any other information which might be useful.

OpenStack mailing lists

A great way to get answers and insights is to post your question or problematic scenario to the OpenStack mailing list. You can learn from and help others who might have similar issues. 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 a broad range of topics but some of the information can be difficult to find or is a few pages deep. 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 a large amount of relevant material. 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

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 has already been reported or already been 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, links to screen shots, and any other information which might be useful.
- Be sure to include the software and package versions that you are using, especially if you are using a development branch, such as, `"Juno release" vs git commit bc79c3ecc55929bac585d04a03475b72e06a3208`.
- Any deployment-specific information is helpful, such as whether you are using Ubuntu 14.04 or are performing a multi-node installation.

The following Launchpad Bugs areas are available:

- Bugs: OpenStack Block Storage (cinder)
- Bugs: OpenStack Compute (nova)
- Bugs: OpenStack Dashboard (horizon)
- Bugs: OpenStack Identity (keystone)
- Bugs: OpenStack Image Service (glance)
- Bugs: OpenStack Networking (neutron)
- Bugs: OpenStack Object Storage (swift)
- Bugs: Bare Metal (ironic)
- Bugs: Data Processing Service (sahara)
- Bugs: Database Service (trove)

- Bugs: Orchestration (heat)
- Bugs: Telemetry (ceilometer)
- Bugs: Queue Service (marconi)
- Bugs: OpenStack API Documentation (developer.openstack.org)
- Bugs: OpenStack Documentation (docs.openstack.org)

The OpenStack IRC channel

The OpenStack community lives 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 that you can paste into the channel. The OpenStack IRC channel is `#openstack` on `irc.freenode.net`. You can find a list of all OpenStack 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

Glossary

API

Application programming interface.

API endpoint

The daemon, worker, or service that a client communicates with to access an API. API endpoints can provide any number of services, such as authentication, sales data, performance metrics, Compute VM commands, census data, and so on.

Block Storage

The OpenStack core project that enables management of volumes, volume snapshots, and volume types. The project name of Block Storage is cinder.

CirrOS

A minimal Linux distribution designed for use as a test image on clouds such as OpenStack.

cloud controller node

A node that runs network, volume, API, scheduler, and image services. Each service may be broken out into separate nodes for scalability or availability.

Compute

The OpenStack core project that provides compute services. The project name of Compute service is nova.

compute node

A node that runs the `nova-compute` daemon that manages VM instances that provide a wide range of services, such as web applications and analytics.

controller node

Alternative term for a cloud controller node.

Database Service

An integrated project that provide scalable and reliable Cloud Database-as-a-Service functionality for both relational and non-relational database engines. The project name of Database Service is trove.

DHCP

Dynamic Host Configuration Protocol. A network protocol that configures devices that are connected to a network so that they can communicate on that network by using the Internet Protocol (IP). The protocol is implemented in a client-server model where DHCP clients request configuration data, such as an IP address, a default route, and one or more DNS server addresses from a DHCP server.

DHCP agent

OpenStack Networking agent that provides DHCP services for virtual networks.

dnsmasq

Daemon that provides DNS, DHCP, BOOTP, and TFTP services for virtual networks.

extended attributes (xattr)

File system option that enables storage of additional information beyond owner, group, permissions, modification time, and so on. The underlying Object Storage file system must support extended attributes.

external network

A network segment typically used for instance Internet access.

firewall

Used to restrict communications between hosts and/or nodes, implemented in Compute using iptables, arptables, ip6tables, and etables.

flat network

Virtual network type that uses neither VLANs nor tunnels to segregate tenant traffic. Each flat network typically requires a separate underlying physical interface defined by bridge mappings. However, a flat network can contain multiple subnets.

floating IP address

An IP address that a project can associate with a VM so that the instance has the same public IP address each time that it boots. You create a pool of floating IP addresses and assign them to instances as they are launched to maintain a consistent IP address for maintaining DNS assignment.

gateway

An IP address, typically assigned to a router, that passes network traffic between different networks.

generic receive offload (GRO)

Feature of certain network interface drivers that combines many smaller received packets into a large packet before delivery to the kernel IP stack.

generic routing encapsulation (GRE)

Protocol that encapsulates a wide variety of network layer protocols inside virtual point-to-point links.

hypervisor

Software that arbitrates and controls VM access to the actual underlying hardware.

IaaS

Infrastructure-as-a-Service. IaaS is a provisioning model in which an organization outsources physical components of a data center, such as storage, hardware, servers, and networking components. A service provider owns the equipment and is responsible for housing, operating and maintaining it. The client typically pays on a per-use basis. IaaS is a model for providing cloud services.

ICMP

Internet Control Message Protocol, used by network devices for control messages. For example, **ping** uses ICMP to test connectivity.

Identity Service

The OpenStack core project that provides a central directory of users mapped to the OpenStack services they can access. It also registers endpoints for OpenStack services. It acts as a common authentication system. The project name of the Identity Service is keystone.

Image Service

An OpenStack core project that provides discovery, registration, and delivery services for disk and server images. The project name of the Image Service is glance.

instance

A running VM, or a VM in a known state such as suspended, that can be used like a hardware server.

instance tunnels network
: A network segment used for instance traffic tunnels between compute nodes and the network node.

interface
: A physical or virtual device that provides connectivity to another device or medium.

Internet protocol (IP)
: Principal communications protocol in the internet protocol suite for relaying datagrams across network boundaries.

ipset
: Extension to iptables that allows creation of firewall rules that match entire "sets" of IP addresses simultaneously. These sets reside in indexed data structures to increase efficiency, particularly on systems with a large quantity of rules.

iptables
: Used along with arptables and ebtables, iptables create firewalls in Compute. iptables are the tables provided by the Linux kernel firewall (implemented as different Netfilter modules) and the chains and rules it stores. Different kernel modules and programs are currently used for different protocols: iptables applies to IPv4, ip6tables to IPv6, arptables to ARP, and ebtables to Ethernet frames. Requires root privilege to manipulate.

iSCSI
: The SCSI disk protocol tunneled within Ethernet, supported by Compute, Object Storage, and Image Service.

jumbo frame
: Feature in modern Ethernet networks that supports frames up to approximately 9000 bytes.

kernel-based VM (KVM)
: An OpenStack-supported hypervisor. KVM is a full virtualization solution for Linux on x86 hardware containing virtualization extensions (Intel VT or AMD-V), ARM, IBM Power, and IBM zSeries. It consists of a loadable kernel module, that provides the core virtualization infrastructure and a processor specific module.

Layer-3 (L3) agent
: OpenStack Networking agent that provides layer-3 (routing) services for virtual networks.

load balancer
: A load balancer is a logical device that belongs to a cloud account. It is used to distribute workloads between multiple back-end systems or services, based on the criteria defined as part of its configuration.

Logical Volume Manager (LVM)
: Provides a method of allocating space on mass-storage devices that is more flexible than conventional partitioning schemes.

management network
: A network segment used for administration, not accessible to the public Internet.

maximum transmission unit (MTU)
: Maximum frame or packet size for a particular network medium. Typically 1500 bytes for Ethernet networks.

message broker
: The software package used to provide AMQP messaging capabilities within Compute. Default package is RabbitMQ.

Metadata agent
: OpenStack Networking agent that provides metadata services for instances.

multi-host
: High-availability mode for legacy (nova) networking. Each compute node handles NAT and DHCP and acts as a gateway for all of the VMs on it. A networking failure on one compute node doesn't affect VMs on other compute nodes.

network namespace
: Linux kernel feature that provides independent virtual networking instances on a single host with separate routing tables and interfaces. Similar to virtual routing and forwarding (VRF) services on physical network equipment.

Network Address Translation (NAT)
: The process of modifying IP address information while in transit. Supported by Compute and Networking.

Network Time Protocol (NTP)
: A method of keeping a clock for a host or node correct through communications with a trusted, accurate time source.

Networking
: A core OpenStack project that provides a network connectivity abstraction layer to OpenStack Compute. The project name of Networking is neutron.

Object Storage
: The OpenStack core project that provides eventually consistent and redundant storage and retrieval of fixed digital content. The project name of OpenStack Object Storage is swift.

Open vSwitch
: Open vSwitch is a production quality, multilayer virtual switch licensed under the open source Apache 2.0 license. It is designed to enable massive network automation through programmatic extension, while still supporting standard management interfaces and protocols (for example NetFlow, sFlow, SPAN, RSPAN, CLI, LACP, 802.1ag).

Open vSwitch (OVS) agent
: Provides an interface to the underlying Open vSwitch service for the Networking plug-in.

OpenStack
: OpenStack is a cloud operating system that controls large pools of compute, storage, and networking resources throughout a data center, all managed through a dashboard that gives administrators control while empowering their users to provision resources through a web interface. OpenStack is an open source project licensed under the Apache License 2.0.

Orchestration
: An integrated project that orchestrates multiple cloud applications for OpenStack. The project name of Orchestration is heat.

path MTU discovery (PMTUD)
: Mechanism in IP networks to detect end-to-end MTU and adjust packet size accordingly.

plug-in
Software component providing the actual implementation for Networking APIs, or for Compute APIs, depending on the context.

promiscuous mode
Causes the network interface to pass all traffic it receives to the host rather than passing only the frames addressed to it.

public key authentication
Authentication method that uses keys rather than passwords.

Quick EMUlator (QEMU)
QEMU is a generic and open source machine emulator and virtualizer.

One of the hypervisors supported by OpenStack, generally used for development purposes.

RESTful
A kind of web service API that uses REST, or Representational State Transfer. REST is the style of architecture for hypermedia systems that is used for the World Wide Web.

role
A personality that a user assumes 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.

router
A physical or virtual network device that passes network traffic between different networks.

security group
A set of network traffic filtering rules that are applied to a Compute instance.

SELinux
Linux kernel security module that provides the mechanism for supporting access control policies.

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

subnet
Logical subdivision of an IP network.

Telemetry
An integrated project that provides metering and measuring facilities for OpenStack. The project name of Telemetry is ceilometer.

tenant
A group of users; used to isolate access to Compute resources. An alternative term for a project.

trove
OpenStack project that provides database services to applications.

user
In Identity Service, each user is associated with one or more tenants, and in Compute can be associated with roles, projects, or both.

virtual machine (VM)
An operating system instance that runs on top of a hypervisor. Multiple VMs can run at the same time on the same physical host.

virtual networking
A generic term for virtualization of network functions such as switching, routing, load balancing, and security using a combination of VMs and overlays on physical network infrastructure.

Virtual Network Computing (VNC)
Open source GUI and CLI tools used for remote console access to VMs. Supported by Compute.

virtual private network (VPN)
Provided by Compute in the form of cloudpipes, specialized instances that are used to create VPNs on a per-project basis.

XFS
High-performance 64-bit file system created by Silicon Graphics. Excels in parallel I/O operations and data consistency.