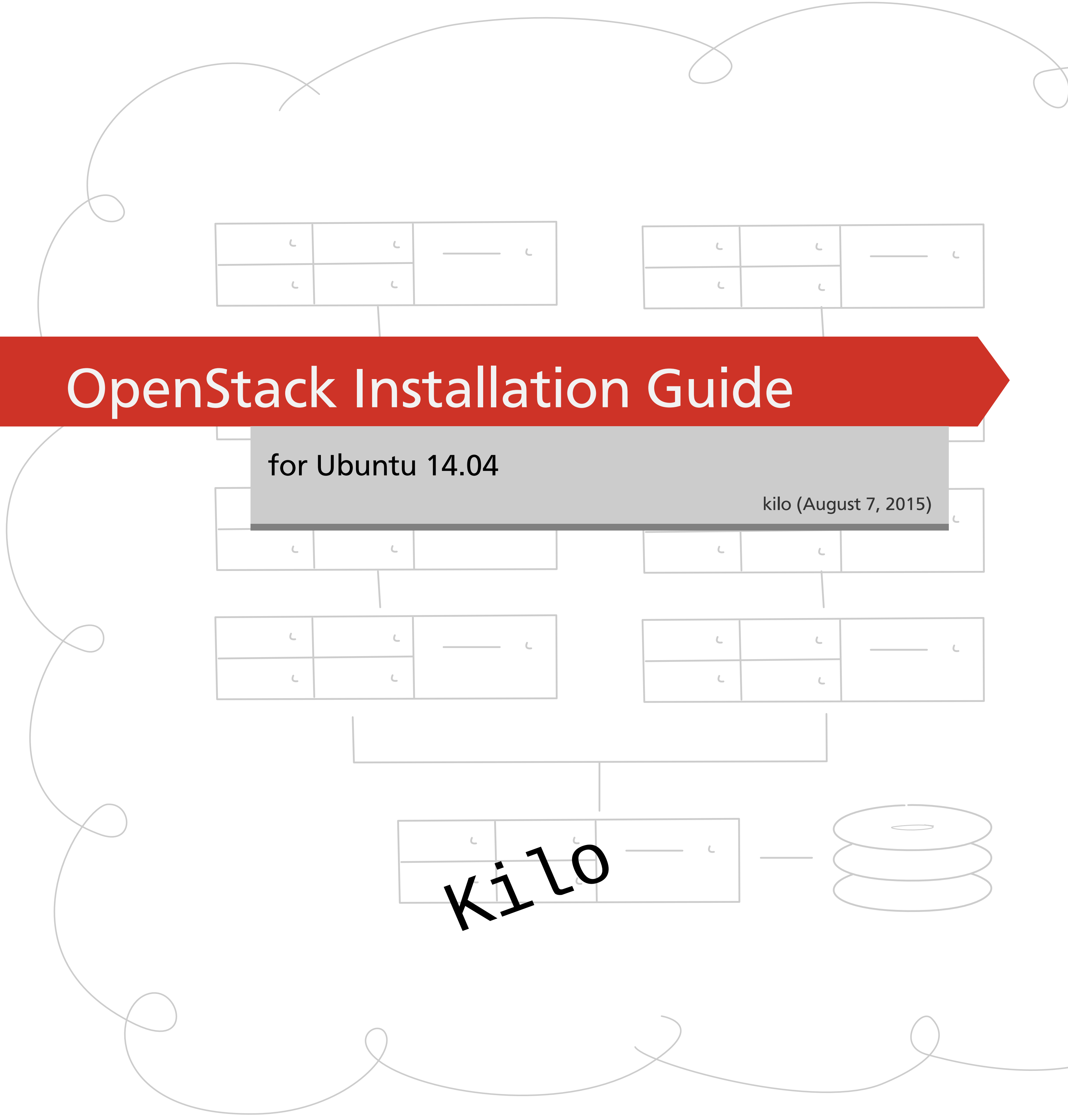
OpenStack Installation Guide

for Ubuntu 14.04

kilo (August 7, 2015)



openstack™

docs.openstack.org

OpenStack Installation Guide for Ubuntu 14.04

kilo (2015-08-07)

The OpenStack® system consists of several key projects that you install separately. These projects 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 walks through an installation by using packages available through Ubuntu 14.04. 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:

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. In this case, it writes objects and files to multiple drives, ensuring the data is replicated across a server cluster.
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.
Higher-level services		

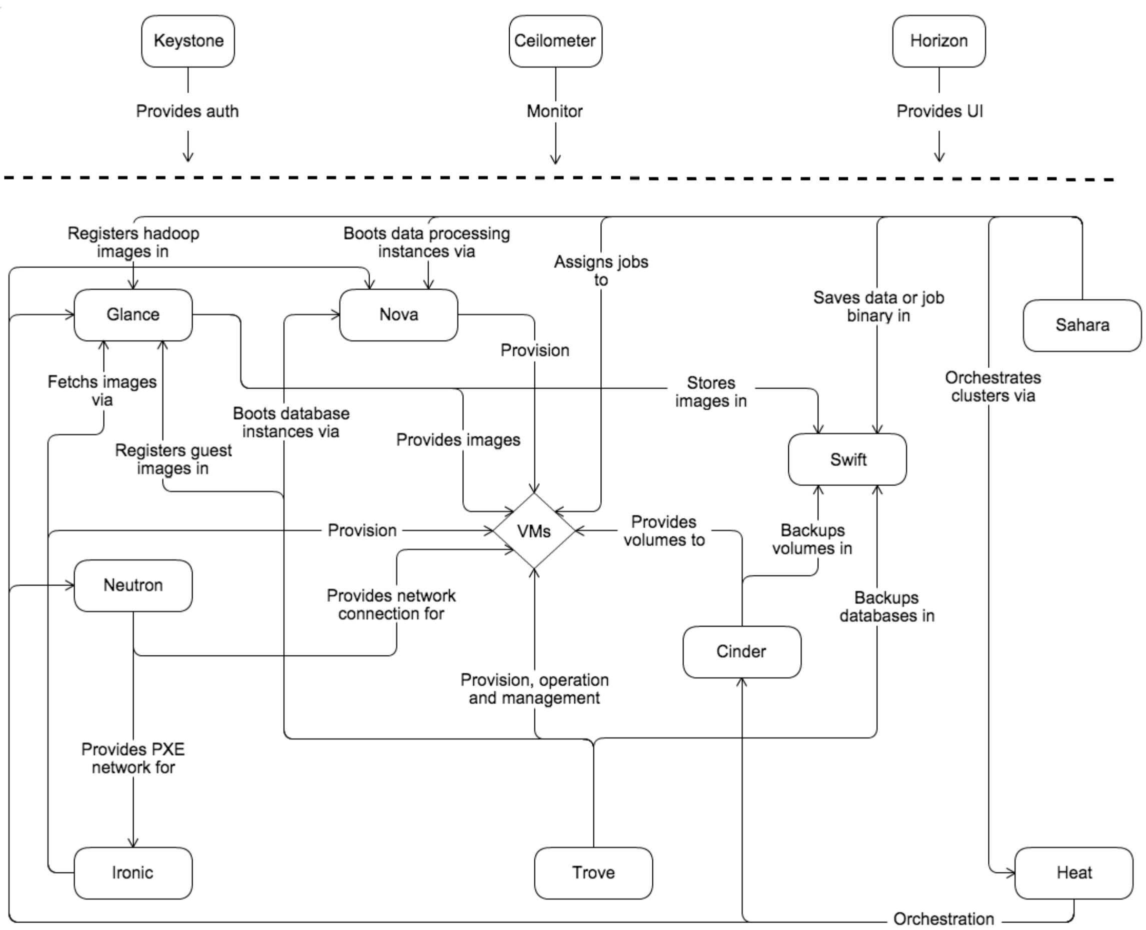
Service	Project name	Description
Orchestration	*Heat*	Orchestrates multiple composite cloud applications by using either the native *HOT* template format or the AWS CloudFormation template format, through both an OpenStack-native REST API and a CloudFormation-compatible Query API.
Database service	*Trove*	Provides scalable and reliable Cloud Database-as-a-Service functionality for both relational and non-relational database engines.
Data processing service	*Sahara*	Provides capabilties to provision and scale Hadoop clusters in OpenStack by specifying parameters like Hadoop version, cluster topology and nodes hardware details.

This guide describes how to deploy these services in a functional test environment and, by example, teaches you how to build a production environment. Realistically, you would use automation tools such as Ansible, Chef, and Puppet to deploy and manage 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 core and optional services. This guide uses the following example architectures:

- Three-node architecture with OpenStack Networking (neutron) and optional nodes for Block Storage and Object Storage services.

  - The *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 SQL database, *message queue*, and *Network Time Protocol (NTP)*.

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

  - The network node runs the Networking plug-in and several agents that provision tenant networks and provide switching, routing, *NAT*, and *DHCP* services. This node also handles external (Internet) connectivity for tenant virtual machine instances.

  - The *compute node* runs the *hypervisor* portion of Compute that operates *tenant virtual machines* or instances. By default, Compute uses *KVM* as the *hypervisor*. The compute node also runs the Networking plug-in and an agent that connect tenant networks to instances and provide firewalling (*security groups*) services. You can run more than one compute node.

    Optionally, the compute node runs a Telemetry agent to collect meters. Also, it can contain a third network interface on a separate storage network to improve performance of storage services.

  - The optional Block Storage node contains the disks that the Block Storage service provisions for tenant virtual machine instances. You can run more than one of these nodes.

    Optionally, the Block Storage node runs a Telemetry agent to collect meters. Also, it can contain a second network interface on a separate storage network to improve performance of storage services.

  - The optional Object Storage nodes contain the disks that the Object Storage service uses for storing accounts, containers, and objects. You can run more than two of these nodes. However, the minimal architecture example requires two nodes.

    Optionally, these nodes can contain a second network interface on a separate storage network to improve performance of storage services.

Note

When you implement this architecture, skip the section called “Legacy networking (nova-network)” [91] in Chapter 6, “Add a networking compo-

nent” [66]. Optional services might require additional nodes or additional resources on existing nodes.

Figure 1.2. Minimal architecture example with OpenStack Networking (neutron)—Hardware requirements

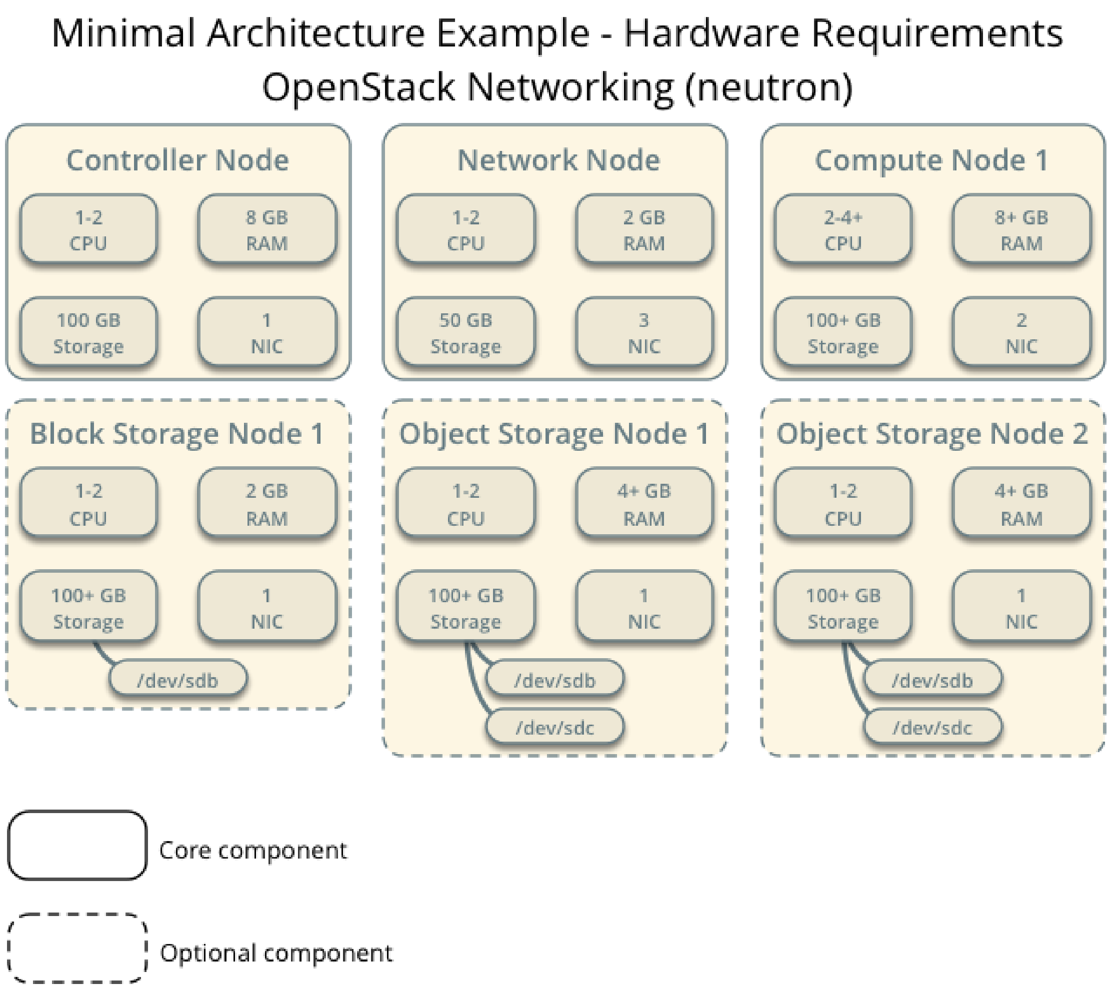


Figure 1.3. Minimal architecture example with OpenStack Networking (neutron)—Network layout

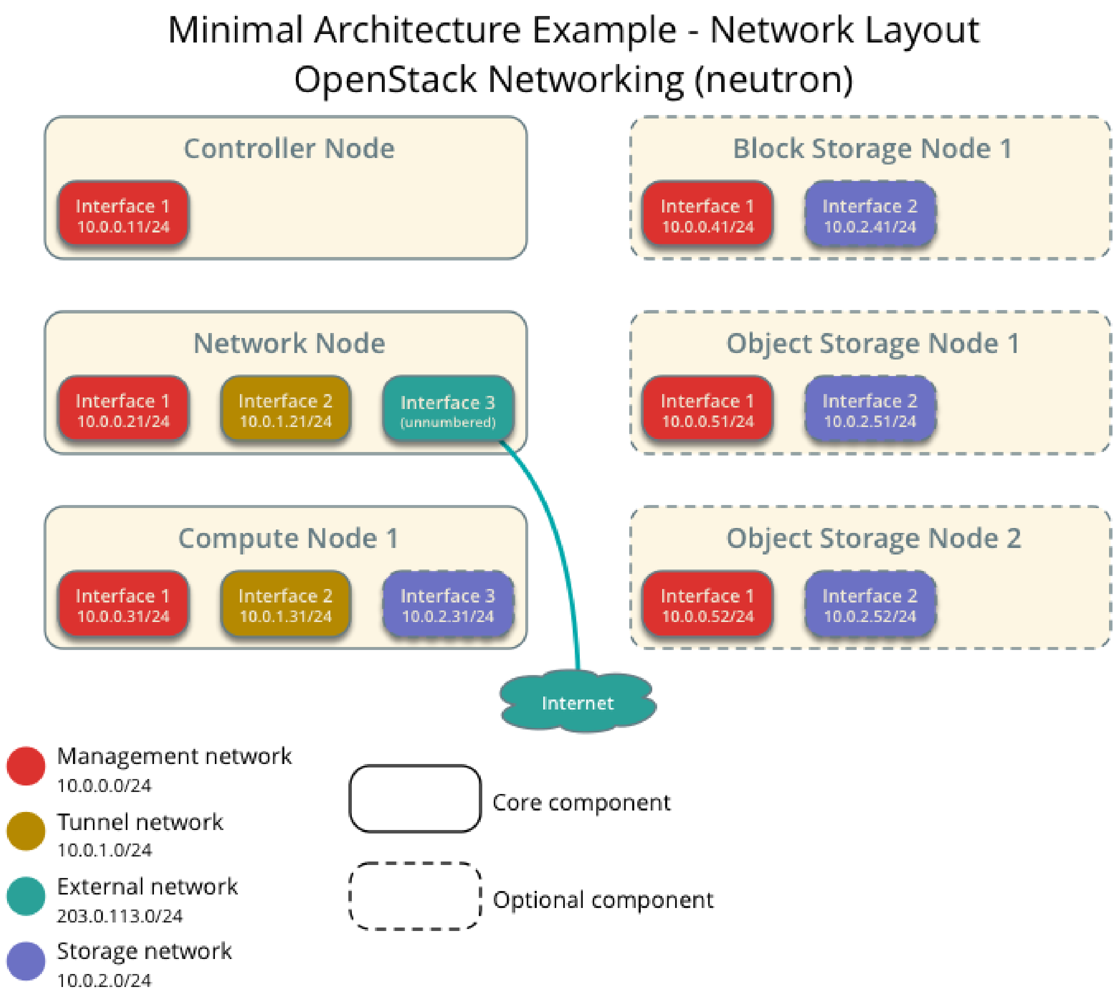
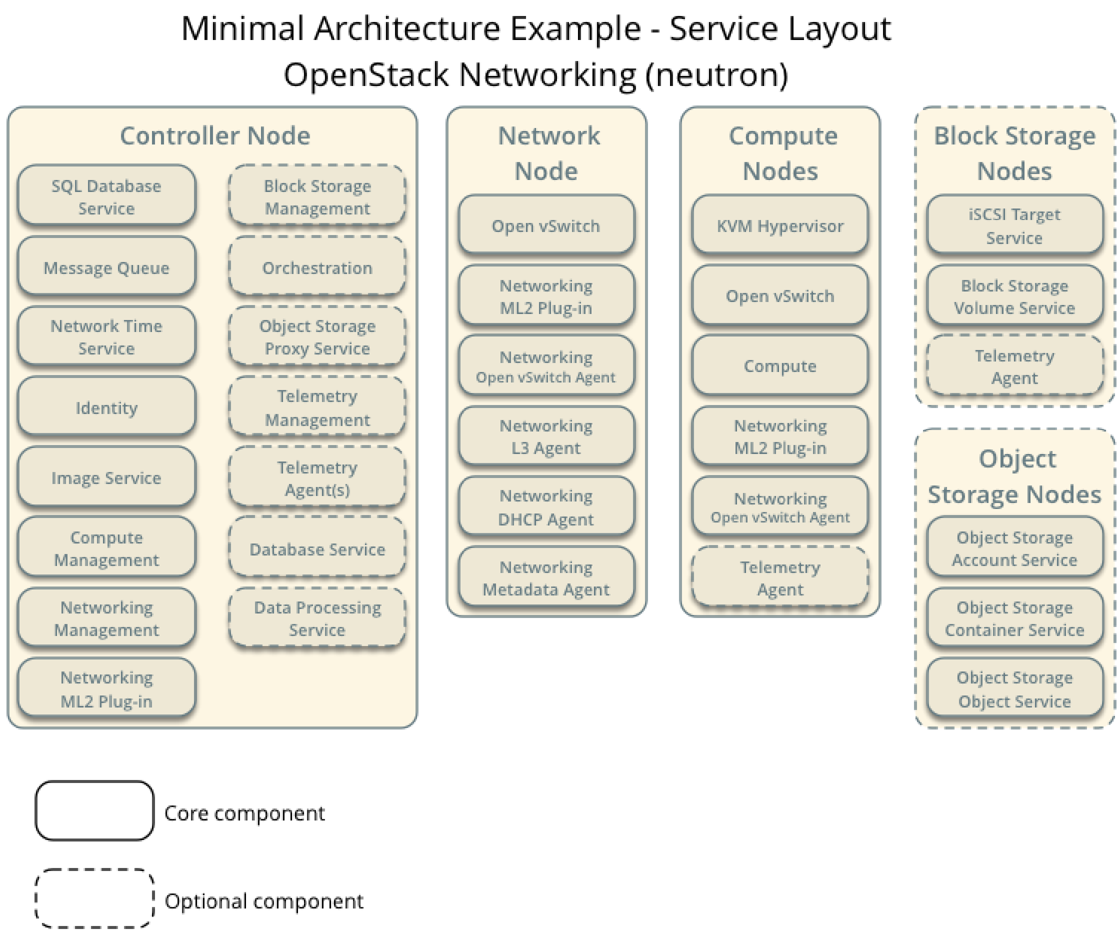


Figure 1.4. Minimal architecture example with OpenStack Networking (neutron)—Service layout



- Two-node architecture with legacy networking (nova-network) and optional nodes for Block Storage and Object Storage services.
  - The *controller node* runs the Identity service, Image service, management portion of Compute, and the dashboard. It also includes supporting services such as a SQL database, *message queue*, and *Network Time Protocol (NTP)*.

    Optionally, the controller node runs portions of Block Storage, Object Storage, Orchestration, Telemetry, Database, and Data processing services. These components provide additional features for your environment.
  - The *compute node* runs the *hypervisor* portion of Compute that operates *tenant virtual machines* or instances. By default, Compute uses *KVM* as the *hypervisor*. Compute also provisions tenant networks and provides firewalling (*security groups*) services. You can run more than one compute node.

Optionally, the compute node runs a Telemetry agent to collect meters. Also, it can contain a third network interface on a separate storage network to improve performance of storage services.

- The optional Block Storage node contains the disks that the Block Storage service provisions for tenant virtual machine instances. You can run more than one of these nodes.

  Optionally, the Block Storage node runs a Telemetry agent to collect meters. Also, it can contain a second network interface on a separate storage network to improve performance of storage services.

- The optional Object Storage nodes contain the disks that the Object Storage service uses for storing accounts, containers, and objects. You can run more than two of these nodes. However, the minimal architecture example requires two nodes.

  Optionally, these nodes can contain a second network interface on a separate storage network to improve performance of storage services.

Note

When you implement this architecture, skip the section called "OpenStack Networking (neutron)" [66] in Chapter 6, "Add a networking component" [66]. To use optional services, you might need to build additional nodes, as described in subsequent chapters.

Figure 1.5. Minimal architecture example with legacy networking (nova-network)—Hardware requirements

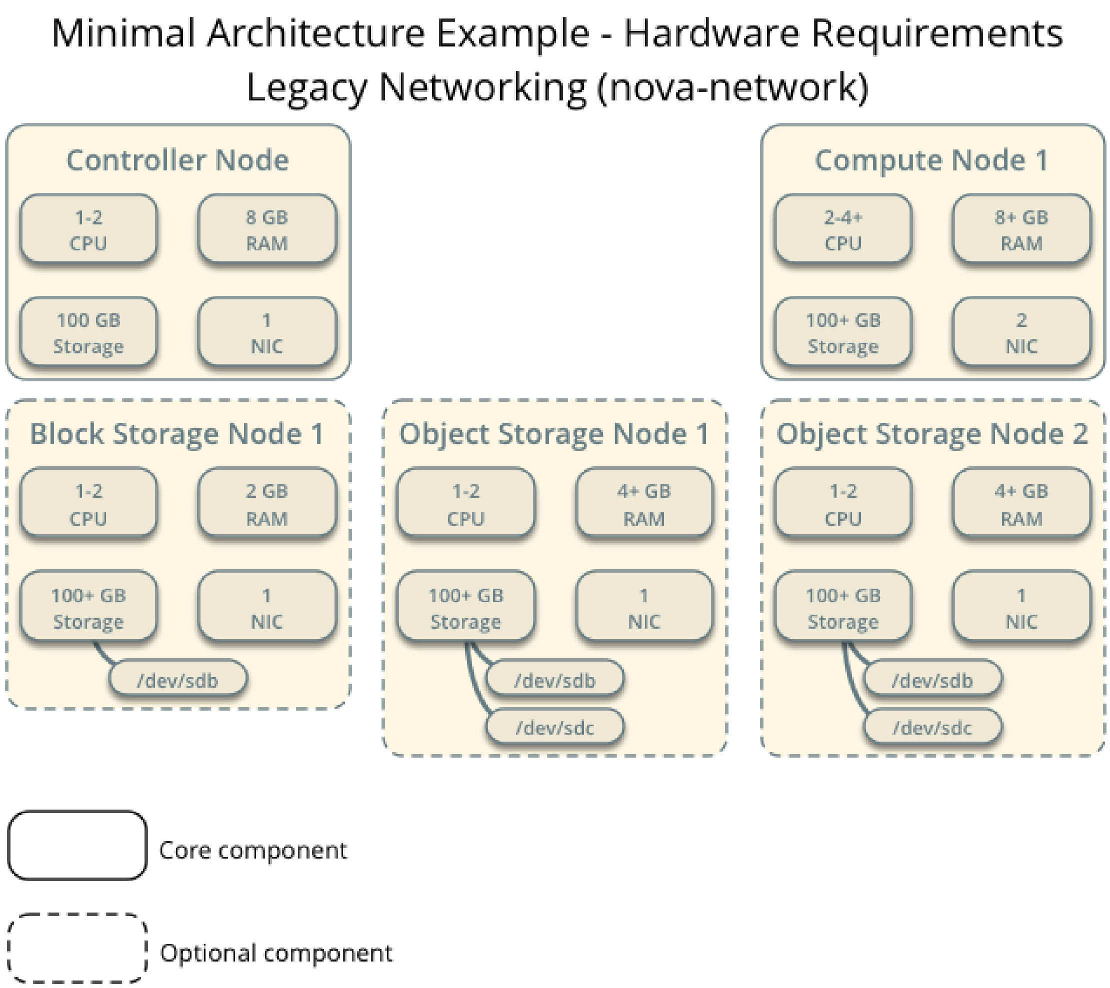


Figure 1.6. Minimal architecture example with legacy networking (nova-network)—Network layout

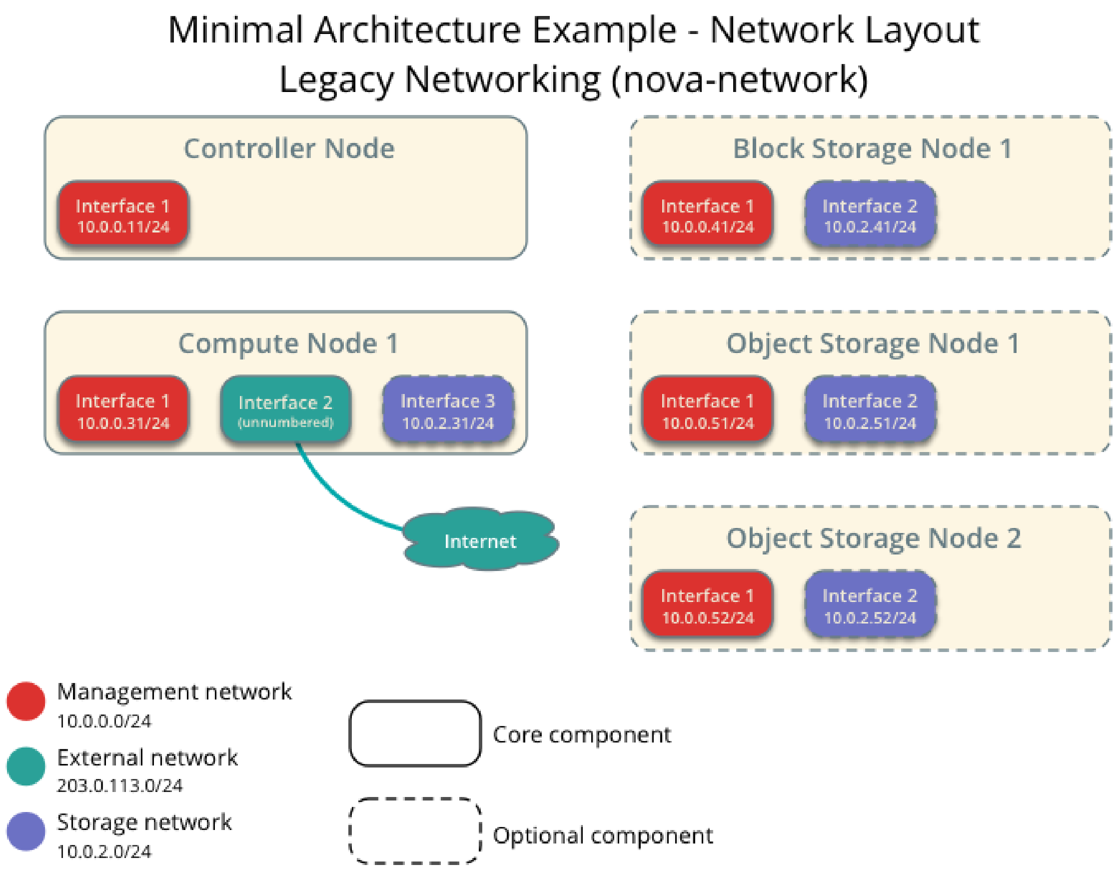
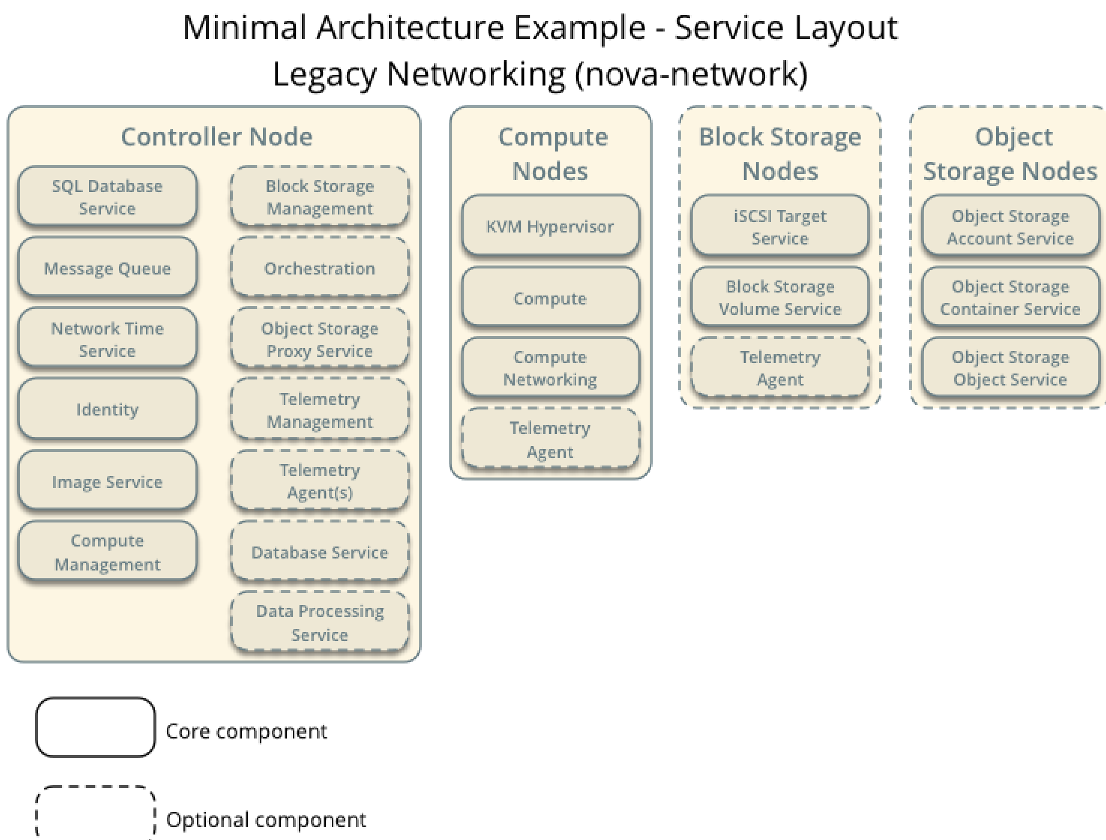


Figure 1.7. Minimal architecture example with legacy networking (nova-network)—Service layout



2. Basic environment

Table of Contents

Note

The trunk version of this guide focuses on the future Kilo release and will not work for the current Juno release. If you want to install Juno, you must use the Juno 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 Identity, Image service, Compute, at least one networking service, and the dashboard, the Object Storage service can operate independently. If your use case only involves Object Storage, you can skip to Chapter 9, "Add Object Storage" [109] after configuring the appropriate nodes for it. However, the dashboard requires at least the 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 best performance, we recommend that your environment meets or exceeds the hardware requirements in Figure 1.2, "Minimal architecture example with OpenStack Networking (neutron)—Hardware requirements" [4] or Figure 1.5, "Minimal architecture example with legacy networking (nova-network)—Hardware requirements” [8]. However, OpenStack does not require a significant amount of resources and the following minimum requirements should support a proof-of-concept environment with core services and several *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* and disables MAC address filtering 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
ADMIN_PASS	Password of user `admin`
CEILOMETER_DBPASS	Database password for the Telemetry service
CEILOMETER_PASS	Password of Telemetry service user `ceilometer`
CINDER_DBPASS	Database password for the Block Storage service
CINDER_PASS	Password of Block Storage service user `cinder`
DASH_DBPASS	Database password for the dashboard
DEMO_PASS	Password of user `demo`
GLANCE_DBPASS	Database password for Image service
GLANCE_PASS	Password of Image service user `glance`
HEAT_DBPASS	Database password for the Orchestration service
HEAT_DOMAIN_PASS	Password of Orchestration domain
HEAT_PASS	Password of Orchestration service user `heat`
KEYSTONE_DBPASS	Database password of Identity service
NEUTRON_DBPASS	Database password for the Networking service
NEUTRON_PASS	Password of Networking service user `neutron`
NOVA_DBPASS	Database password for Compute service
NOVA_PASS	Password of Compute service user `nova`
RABBIT_PASS	Password of user guest of RabbitMQ
SAHARA_DBPASS	Database password of Data processing service
SWIFT_PASS	Password of Object Storage service user `swift`
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.

All nodes require Internet access for administrative purposes such as package installation, security updates, *DNS*, and *NTP*. In most cases, nodes should obtain Internet access through the management network interface. To highlight the importance of network separation, the example architectures use private address space for the management network and assume that network infrastructure provides Internet access via *NAT*. To illustrate the flexibility of *IaaS*, the example architectures use public IP address space for the external network and assume that network infrastructure provides direct Internet access to instances in your OpenStack environment. In environments with only one block of public IP address space, both the management and external networks must ultimately obtain Internet access using it. For simplicity, the diagrams in this guide only show Internet access for OpenStack services.

Note

Your distribution does not enable a restrictive *firewall* by default. 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.

The example architecture assumes use of the following networks:

- Management on 10.0.0.0/24 with gateway 10.0.0.1

  ### Note

  This network requires a gateway to provide Internet access to all nodes for administrative purposes such as package installation, security updates, *DNS*, and *NTP*.

- Instance tunnels on 10.0.1.0/24 without a gateway

  ### Note

  This network does not require a gateway because communication only occurs among network and compute nodes in your OpenStack environment.

- External on 203.0.113.0/24 with gateway 203.0.113.1

Note

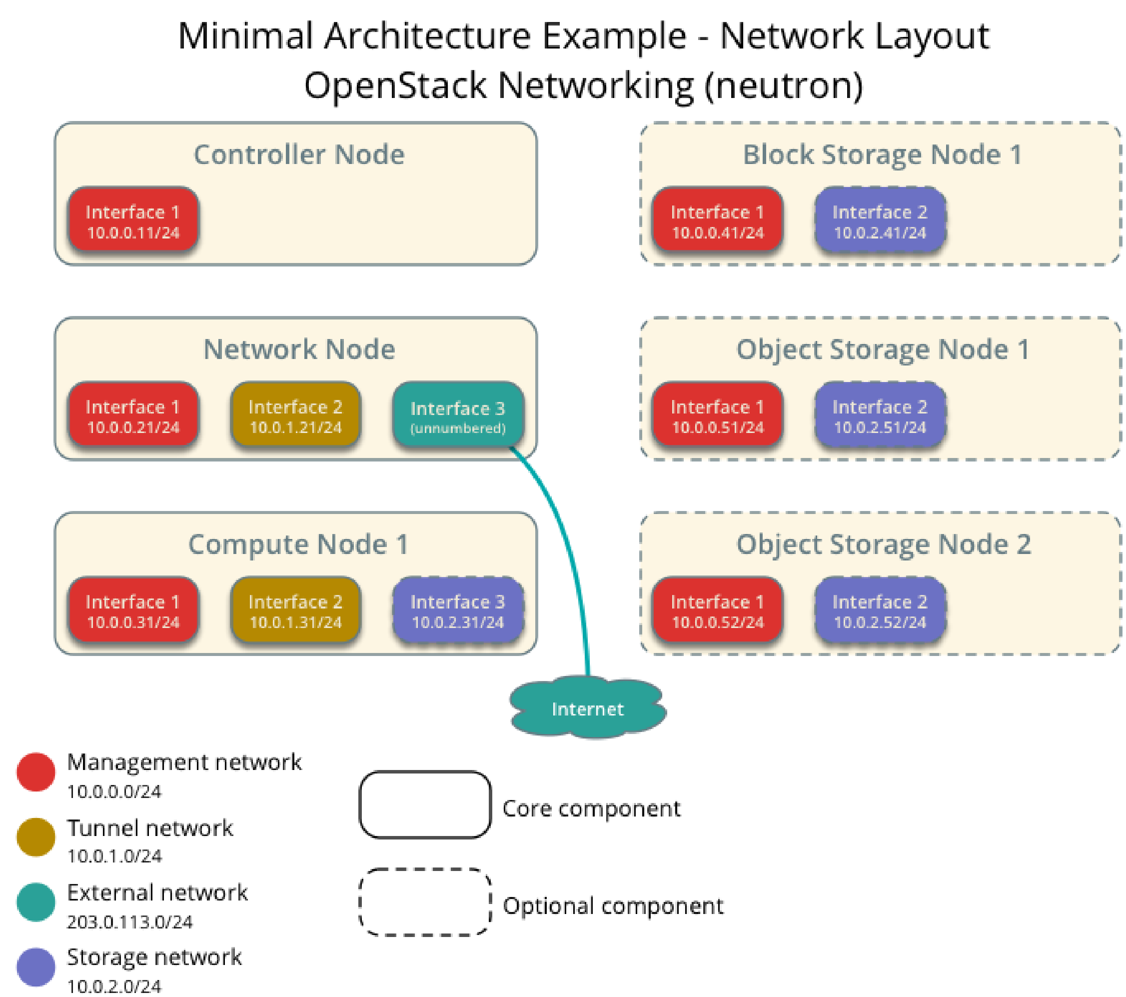
This network requires a gateway to provide Internet access to instances in your OpenStack environment.

You can modify these ranges and gateways to work with your particular network infrastructure.

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. Minimal architecture example with OpenStack Networking (neutron)—Network layout



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
```

Warning

Some distributions add an extraneous entry in the `/etc/hosts` file that resolves the actual hostname to another loopback IP address such as `127.0.1.1`. You must comment out or remove this entry to prevent name resolution problems.

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/network/interfaces` file to contain the following:

```
# The external network interface
auto INTERFACE_NAME
iface INTERFACE_NAME inet manual
        up ip link set dev $IFACE up
        down ip link set dev $IFACE down
```

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
```

Warning

Some distributions add an extraneous entry in the `/etc/hosts` file that resolves the actual hostname to another loopback IP address such as `127.0.1.1`. You must comment out or remove this entry to prevent name resolution problems.

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
```

Warning

Some distributions add an extraneous entry in the `/etc/hosts` file that resolves the actual hostname to another loopback IP address such as `127.0.1.1`. You must comment out or remove this entry to prevent name resolution problems.

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*.

The example architecture assumes use of the following networks:

- Management on 10.0.0.0/24 with gateway 10.0.0.1

  Note

  This network requires a gateway to provide Internet access to all nodes for administrative purposes such as package installation, security updates, *DNS*, and *NTP*.

- External on 203.0.113.0/24 with gateway 203.0.113.1

  Note

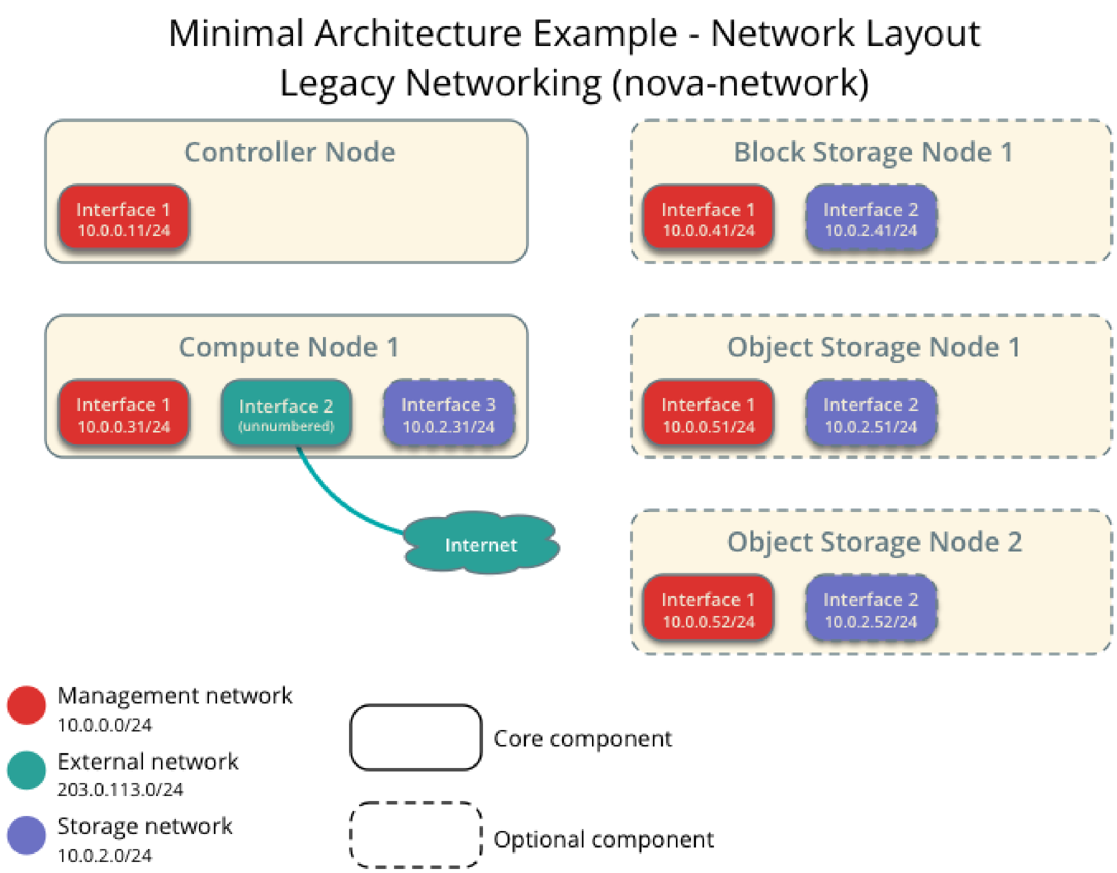
  This network requires a gateway to provide Internet access to instances in your OpenStack environment.

You can modify these ranges and gateways to work with your particular network infrastructure.

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. Minimal architecture example with legacy networking (nova-network)—Network layout



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
```

> **Warning**
>
> Some distributions add an extraneous entry in the `/etc/hosts` file that resolves the actual hostname to another loopback IP address such as `127.0.1.1`. You must comment out or remove this entry to prevent name resolution problems.

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/network/interfaces` file to contain the following:

```
# The external network interface
auto INTERFACE_NAME
iface INTERFACE_NAME inet manual
        up ip link set dev $IFACE up
        down ip link set dev $IFACE down
```

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
```

> **Warning**
>
> Some distributions add an extraneous entry in the `/etc/hosts` file that resolves the actual hostname to another loopback IP address such as `127.0.1.1`. You must comment out or remove this entry to prevent name resolution problems.

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

- `# apt-get 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.

Note

Remove the `/var/lib/ntp/ntp.conf.dhcp` file if it exists.

2. Restart the NTP service:

```
# service ntp restart
```

Other nodes

To install the NTP service

- ```
  # apt-get 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
   ```

   Note

   Remove the `/var/lib/ntp/ntp.conf.dhcp` file if it exists.

2. Restart the NTP service:

   ```
   # service ntp restart
   ```

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 enable the OpenStack repository

- Install the Ubuntu Cloud archive keyring and repository:

```
# apt-get install ubuntu-cloud-keyring
# echo "deb http://ubuntu-cloud.archive.canonical.com/ubuntu" \
  "trusty-updates/kilo main" > /etc/apt/sources.list.d/cloudarchive-kilo.
list
```

To finalize installation

- Upgrade the packages on your system:

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

Note

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

SQL 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.

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

2. Choose a suitable password for the database root account.

3. Create and edit the `/etc/mysql/conf.d/mysqld_openstack.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. Restart the database service:

   ```
   # service mysql restart
   ```

2. Secure the database service:

   ```
   # mysql_secure_installation
   ```

```
NOTE: RUNNING ALL PARTS OF THIS SCRIPT IS RECOMMENDED FOR ALL MariaDB
      SERVERS IN PRODUCTION USE!  PLEASE READ EACH STEP CAREFULLY!

In order to log into MariaDB to secure it, we'll need the current
password for the root user.  If you've just installed MariaDB, and
you haven't set the root password yet, the password will be blank,
so you should just press enter here.

Enter current password for root (enter for none):
OK, successfully used password, moving on...

Setting the root password ensures that nobody can log into the MariaDB
root user without the proper authorisation.

Set root password? [Y/n] Y
New password:
Re-enter new password:
Password updated successfully!
Reloading privilege tables..
 ... Success!


By default, a MariaDB installation has an anonymous user, allowing anyone
to log into MariaDB without having to have a user account created for
them.  This is intended only for testing, and to make the installation
go a bit smoother.  You should remove them before moving into a
production environment.

Remove anonymous users? [Y/n] Y
 ... Success!

Normally, root should only be allowed to connect from 'localhost'.  This
ensures that someone cannot guess at the root password from the network.

Disallow root login remotely? [Y/n] Y
 ... Success!

By default, MariaDB comes with a database named 'test' that anyone can
access.  This is also intended only for testing, and should be removed
before moving into a production environment.

Remove test database and access to it? [Y/n] Y
 - Dropping test database...
 ... Success!
 - Removing privileges on test database...
 ... Success!

Reloading the privilege tables will ensure that all changes made so far
will take effect immediately.

Reload privilege tables now? [Y/n] Y
 ... Success!

Cleaning up...

All done!  If you've completed all of the above steps, your MariaDB
installation should now be secure.

Thanks for using MariaDB!
```

Message queue

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

To install the message queue service

- Install the package:

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

To configure the message queue service

1. Add the `openstack` user:

```
# rabbitmqctl add_user openstack RABBIT_PASS
Creating user "openstack" ...
...done.
```

   Replace *RABBIT_PASS* with a suitable password.

2. Permit configuration, write, and read access for the `openstack` user:

```
# rabbitmqctl set_permissions openstack ".*" ".*" ".*"
Setting permissions for user "openstack" in vhost "/" ...
...done.
```

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.

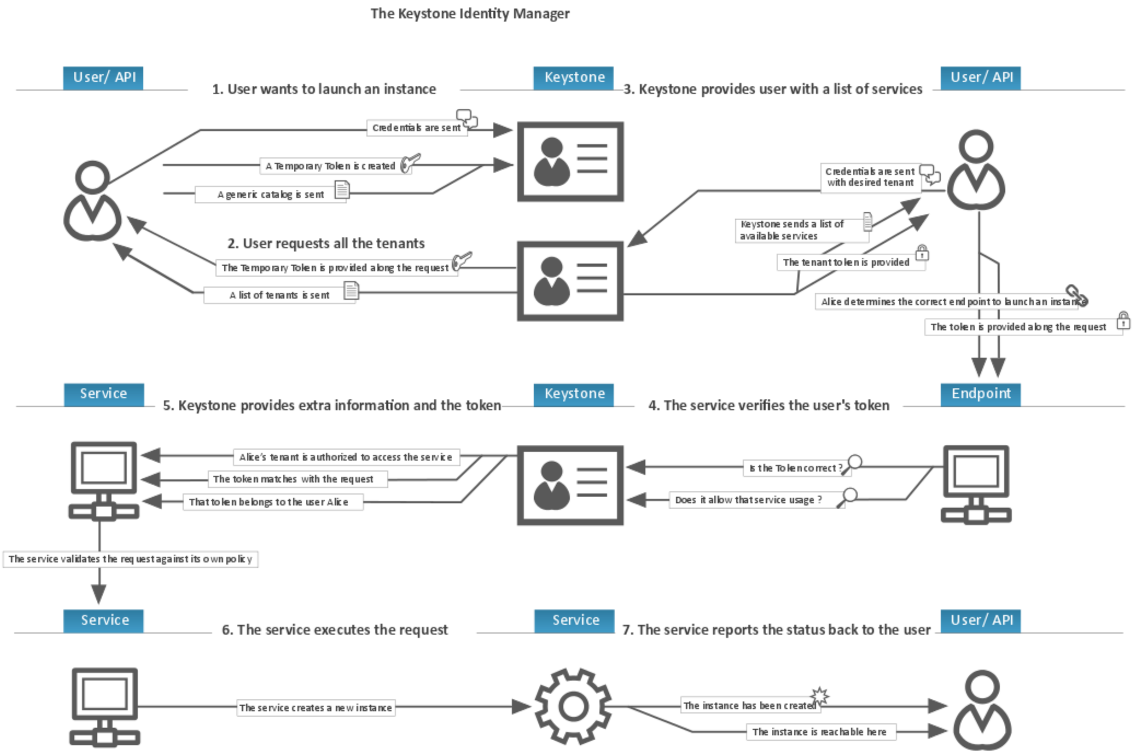
Endpoint A network-accessible address where you access a service, usually a URL address. If you are using an extension for templates, an endpoint template can be created, which represents the templates of all the consumable services that are available across the regions.

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:



Install and configure

This section describes how to install and configure the OpenStack Identity service, code-named keystone, on the controller node. For performance, this configuration deploys the Apache HTTP server to handle requests and Memcached to store tokens instead of a SQL database.

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 Identity service components

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

> **Note**
>
> In Kilo, the keystone project deprecates Eventlet in favor of a WSGI server. This guide uses the Apache HTTP server with `mod_wsgi` to serve keystone requests on ports 5000 and 35357. By default, the `keystone` service still listens on ports 5000 and 35357. Therefore, this guide disables the `keystone` service.

1. Disable the `keystone` service from starting automatically after installation:

```
# echo "manual" > /etc/init/keystone.override
```

2. Run the following command to install the packages:

```
# apt-get install keystone python-openstackclient apache2 libapache2-mod-wsgi memcached python-memcache
```

3. 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 `[memcache]` section, configure the Memcache service:

```
[memcache]
...
servers = localhost:11211
```

d. In the `[token]` section, configure the UUID token provider and Memcached driver:

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

e. In the `[revoke]` section, configure the SQL revocation driver:

```
[revoke]
...
driver = keystone.contrib.revoke.backends.sql.Revoke
```

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

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

4. Populate the Identity service database:

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

To configure the Apache HTTP server

1. Edit the `/etc/apache2/apache2.conf` file and configure the `ServerName` option to reference the controller node:

```
ServerName controller
```

2. Create the `/etc/apache2/sites-available/wsgi-keystone.conf` file with the following content:

```
Listen 5000
Listen 35357

<VirtualHost *:5000>
    WSGIDaemonProcess keystone-public processes=5 threads=1 user=keystone
 display-name=%{GROUP}
    WSGIProcessGroup keystone-public
    WSGIScriptAlias / /var/www/cgi-bin/keystone/main
    WSGIApplicationGroup %{GLOBAL}
    WSGIPassAuthorization On
    <IfVersion >= 2.4>
      ErrorLogFormat "%{cu}t %M"
    </IfVersion>
    LogLevel info
    ErrorLog /var/log/apache2/keystone-error.log
    CustomLog /var/log/apache2/keystone-access.log combined
</VirtualHost>

<VirtualHost *:35357>
```

```
    WSGIDaemonProcess keystone-admin processes=5 threads=1 user=keystone
 display-name=%{GROUP}
    WSGIProcessGroup keystone-admin
    WSGIScriptAlias / /var/www/cgi-bin/keystone/admin
    WSGIApplicationGroup %{GLOBAL}
    WSGIPassAuthorization On
    <IfVersion >= 2.4>
      ErrorLogFormat "%{cu}t %M"
    </IfVersion>
    LogLevel info
    ErrorLog /var/log/apache2/keystone-error.log
    CustomLog /var/log/apache2/keystone-access.log combined
</VirtualHost>
```

3. Enable the Identity service virtual hosts:

```
# ln -s /etc/apache2/sites-available/wsgi-keystone.conf /etc/apache2/
sites-enabled
```

4. Create the directory structure for the WSGI components:

```
# mkdir -p /var/www/cgi-bin/keystone
```

5. Copy the WSGI components from the upstream repository into this directory:

```
# curl http://git.openstack.org/cgit/openstack/keystone/plain/httpd/
keystone.py?h=stable/kilo \
  | tee /var/www/cgi-bin/keystone/main /var/www/cgi-bin/keystone/admin
```

6. Adjust ownership and permissions on this directory and the files in it:

```
# chown -R keystone:keystone /var/www/cgi-bin/keystone
# chmod 755 /var/www/cgi-bin/keystone/*
```

To finalize installation

1. Restart the Apache HTTP server:

```
# service apache2 restart
```

2. By default, the Ubuntu packages create a SQLite database.

   Because this configuration uses a SQL database server, you can remove the SQLite database file:

```
# rm -f /var/lib/keystone/keystone.db
```

Create the service entity and API endpoint

The Identity service provides a catalog of services and their locations. Each service that you add to your OpenStack environment requires a *service* entity and several *API endpoint* in the catalog.

To configure prerequisites

By default, the Identity service database contains no information to support conventional authentication and catalog services. You must use a temporary authentication token that you created in the section called “Install and configure” [33] to initialize the service entity and API endpoint for the Identity service.

You must pass the value of the authentication token to the **openstack** command with the *--os-token* parameter or set the OS_TOKEN environment variable. Similarly, you must also pass the value of the Identity service URL to the **openstack** command with the *--os-url* parameter or set the OS_URL environment variable. This guide uses environment variables to reduce command length.

Warning

For security reasons, do not use the temporary authentication token for longer than necessary to initialize the Identity service.

1. Configure the authentication token:

   ```
   $ export OS_TOKEN=ADMIN_TOKEN
   ```

   Replace *ADMIN_TOKEN* with the authentication token that you generated in the section called “Install and configure” [33]. For example:

   ```
   $ export OS_TOKEN=294a4c8a8a475f9b9836
   ```

2. Configure the endpoint URL:

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

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 determine the other services available in your environment.

   Create the service entity for the Identity service:

   ```
   $ openstack service create \
     --name keystone --description "OpenStack Identity" identity
   ```

   ```
   +-------------+----------------------------------+
   | Field       | Value                            |
   +-------------+----------------------------------+
   | description | OpenStack Identity               |
   | enabled     | True                             |
   | id          | 4ddaae90388b4ebc9d252ec2252d8d10 |
   | name        | keystone                         |
   | type        | identity                         |
   +-------------+----------------------------------+
   ```

   ### Note

   OpenStack generates IDs dynamically, so you will see different values in the 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 uses three API endpoint variants for each service: admin, internal, and public. The admin API endpoint allows modifying users and tenants by default, while the public and internal APIs do not. In a production environment, the variants might reside on separate networks that service different types of users for security reasons. For instance, the public API network might be reachable from outside the cloud for management tools, the admin API network might be protected, while the internal API network is connected to each host. Also, OpenStack supports multiple regions for scalability. For simplicity, this guide uses the management network for all endpoint variations and the default `RegionOne` region.

Create the Identity service API endpoint:

```
$ openstack endpoint create \
  --publicurl http://controller:5000/v2.0 \
  --internalurl http://controller:5000/v2.0 \
  --adminurl http://controller:35357/v2.0 \
  --region RegionOne \
  identity
+--------------+----------------------------------+
| Field        | Value                            |
+--------------+----------------------------------+
| adminurl     | http://controller:35357/v2.0     |
| id           | 4a9ffc04b8eb4848a49625a3df0170e5 |
| internalurl  | http://controller:5000/v2.0      |
| publicurl    | http://controller:5000/v2.0      |
| region       | RegionOne                        |
| service_id   | 4ddaae90388b4ebc9d252ec2252d8d10 |
| service_name | keystone                         |
| service_type | identity                         |
+--------------+----------------------------------+
```

Note

Each service that you add to your OpenStack environment requires one or more service entities and one API endpoint in the Identity service.

Create projects, users, and roles

The Identity service provides authentication services for each OpenStack service. The authentication service uses a combination of *domains*, *projects* (tenants), *users*, and *roles*.

Note

For simplicity, this guide implicitly uses the `default` domain.

To create tenants, users, and roles

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

    a. Create the `admin` project:

    ```
    $ openstack project create --description "Admin Project" admin
    +-------------+----------------------------------+
    ```

```
| Field       | Value                            |
+-------------+----------------------------------+
| description | Admin Project                    |
| enabled     | True                             |
| id          | cf12a15c5ea84b019aec3dc45580896b |
| name        | admin                            |
+-------------+----------------------------------+
```

Note

OpenStack generates IDs dynamically, so you will see different values in the example command output.

b. Create the `admin` user:

```
$ openstack user create --password-prompt admin
User Password:
Repeat User Password:
+----------+----------------------------------+
| Field    | Value                            |
+----------+----------------------------------+
| email    | None                             |
| enabled  | True                             |
| id       | 4d411f2291f34941b30eef9bd797505a |
| name     | admin                            |
| username | admin                            |
+----------+----------------------------------+
```

c. Create the `admin` role:

```
$ openstack role create admin
+-------+----------------------------------+
| Field | Value                            |
+-------+----------------------------------+
| id    | cd2cb9a39e874ea69e5d4b896eb16128 |
| name  | admin                            |
+-------+----------------------------------+
```

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

```
$ openstack role add --project admin --user admin admin
+-------+----------------------------------+
| Field | Value                            |
+-------+----------------------------------+
| id    | cd2cb9a39e874ea69e5d4b896eb16128 |
| name  | admin                            |
+-------+----------------------------------+
```

Note

Any roles that you create must map to roles specified in the `policy.json` file in the configuration file directory of 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. This guide uses a service project that contains a unique user for each service that you add to your environment.

- Create the `service` project:

```
$ openstack project create --description "Service Project" service
+-------------+----------------------------------+
| Field       | Value                            |
+-------------+----------------------------------+
| description | Service Project                  |
| enabled     | True                             |
| id          | 55cbd79c0c014c8a95534ebd16213ca1 |
| name        | service                          |
+-------------+----------------------------------+
```

3. Regular (non-admin) tasks should use an unprivileged project and user. As an example, this guide creates the `demo` project and user.

   a. Create the `demo` project:

```
$ openstack project create --description "Demo Project" demo
+-------------+----------------------------------+
| Field       | Value                            |
+-------------+----------------------------------+
| description | Demo Project                     |
| enabled     | True                             |
| id          | ab8ea576c0574b6092bb99150449b2d3 |
| name        | demo                             |
+-------------+----------------------------------+
```

Note

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

   b. Create the `demo` user:

```
$ openstack user create --password-prompt demo
User Password:
Repeat User Password:
+------------+----------------------------------+
| Field      | Value                            |
+------------+----------------------------------+
| email      | None                             |
| enabled    | True                             |
| id         | 3a81e6c8103b46709ef8d141308d4c72 |
| name       | demo                             |
| project_id | ab8ea576c0574b6092bb99150449b2d3 |
| username   | demo                             |
+------------+----------------------------------+
```

   c. Create the `user` role:

```
$ openstack role create user
+-------+----------------------------------+
| Field | Value                            |
+-------+----------------------------------+
| id    | 9fe2ff9ee4384b1894a90878d3e92bab |
| name  | user                             |
+-------+----------------------------------+
```

   d. Add the `user` role to the `demo` project and user:

```
$ openstack role add --project demo --user demo user
+-------+----------------------------------+
| Field | Value                            |
+-------+----------------------------------+
| id    | 9fe2ff9ee4384b1894a90878d3e92bab |
| name  | user                             |
+-------+----------------------------------+
```

Note

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

Verify operation

Verify operation of the Identity service before installing other services.

1. For security reasons, disable the temporary authentication token mechanism:

   Edit the `/etc/keystone/keystone-paste.ini` file and remove `admin_token_auth` from the `[pipeline:public_api]`, `[pipeline:admin_api]`, and `[pipeline:api_v3]` sections.

2. Unset the temporary `OS_TOKEN` and `OS_URL` environment variables:

```
$ unset OS_TOKEN OS_URL
```

3. As the `admin` user, request an authentication token from the Identity version 2.0 API:

```
$ openstack --os-auth-url http://controller:35357 \
  --os-project-name admin --os-username admin --os-auth-type password \
  token issue
Password:
+------------+----------------------------------+
| Field      | Value                            |
+------------+----------------------------------+
| expires    | 2015-03-24T18:55:01Z             |
| id         | ff5ed908984c4a4190f584d826d75fed |
| project_id | cf12a15c5ea84b019aec3dc45580896b |
| user_id    | 4d411f2291f34941b30eef9bd797505a |
+------------+----------------------------------+
```

   Note

   This command uses the password for the `admin` user.

4. The Identity version 3 API adds support for domains that contain projects and users. Projects and users can use the same names in different domains. Therefore, in order to use the version 3 API, requests must also explicitly contain at least the `default` domain or use IDs. For simplicity, this guide explicitly uses the `default` domain so examples can use names instead of IDs.

```
$ openstack --os-auth-url http://controller:35357 \
  --os-project-domain-id default --os-user-domain-id default \
  --os-project-name admin --os-username admin --os-auth-type password \
  token issue
```

```
Password:
+------------+----------------------------------+
| Field      | Value                            |
+------------+----------------------------------+
| expires    | 2015-03-24T18:55:01Z             |
| id         | ff5ed908984c4a4190f584d826d75fed |
| project_id | cf12a15c5ea84b019aec3dc45580896b |
| user_id    | 4d411f2291f34941b30eef9bd797505a |
+------------+----------------------------------+
```

Note

This command uses the password for the `admin` user.

5. As the `admin` user, list projects to verify that the `admin` user can execute admin-only CLI commands and that the Identity service contains the projects that you created in the section called "Create projects, users, and roles" [38]:

```
$ openstack --os-auth-url http://controller:35357 \
  --os-project-name admin --os-username admin --os-auth-type password \
  project list
Password:
+----------------------------------+---------+
| ID                               | Name    |
+----------------------------------+---------+
| 55cbd79c0c014c8a95534ebd16213ca1 | service |
| ab8ea576c0574b6092bb99150449b2d3 | demo    |
| cf12a15c5ea84b019aec3dc45580896b | admin   |
+----------------------------------+---------+
```

Note

This command uses the password for the `admin` user.

6. As the `admin` user, list users to verify that the Identity service contains the users that you created in the section called "Create projects, users, and roles" [38]:

```
$ openstack --os-auth-url http://controller:35357 \
  --os-project-name admin --os-username admin --os-auth-type password \
  user list
Password:
+----------------------------------+-------+
| ID                               | Name  |
+----------------------------------+-------+
| 4d411f2291f34941b30eef9bd797505a | admin |
| 3a81e6c8103b46709ef8d141308d4c72 | demo  |
+----------------------------------+-------+
```

Note

This command uses the password for the `admin` user.

7. As the `admin` user, list roles to verify that the Identity service contains the role that you created in the section called "Create projects, users, and roles" [38]:

```
$ openstack --os-auth-url http://controller:35357 \
  --os-project-name admin --os-username admin --os-auth-type password \
  role list
```

```
Password:
+----------------------------------+-------+
| ID                               | Name  |
+----------------------------------+-------+
| 9fe2ff9ee4384b1894a90878d3e92bab | user  |
| cd2cb9a39e874ea69e5d4b896eb16128 | admin |
+----------------------------------+-------+
```

> **Note**
>
> This command uses the password for the `admin` user.

8. As the `demo` user, request an authentication token from the Identity version 3 API:

```
$ openstack --os-auth-url http://controller:5000 \
  --os-project-domain-id default --os-user-domain-id default \
  --os-project-name demo --os-username demo --os-auth-type password \
  token issue
Password:
+------------+----------------------------------+
|  Property  |              Value               |
+------------+----------------------------------+
|   expires  |       2014-10-10T12:51:33Z       |
|     id     | 1b87ceae9e08411ba4a16e4dada04802 |
| project_id | 4aa51bb942be4dd0ac0555d7591f80a6 |
|  user_id   | 7004dfa0dda84d63aef81cf7f100af01 |
+------------+----------------------------------+
```

> **Note**
>
> This command uses the password for the `demo` user and API port 5000 which only allows regular (non-admin) access to the Identity service API.

9. As the `demo` user, attempt to list users to verify that it cannot execute admin-only CLI commands:

```
$ openstack --os-auth-url http://controller:5000 \
  --os-project-domain-id default --os-user-domain-id default \
  --os-project-name demo --os-username demo --os-auth-type password \
  user list
ERROR: openstack You are not authorized to perform the requested action,
 admin_required. (HTTP 403)
```

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 **openstack** 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` projects 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_PROJECT_DOMAIN_ID=default
export OS_USER_DOMAIN_ID=default
export OS_PROJECT_NAME=admin
export OS_TENANT_NAME=admin
export OS_USERNAME=admin
export OS_PASSWORD=ADMIN_PASS
export OS_AUTH_URL=http://controller:35357/v3
```

   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_PROJECT_DOMAIN_ID=default
export OS_USER_DOMAIN_ID=default
export OS_PROJECT_NAME=demo
export OS_TENANT_NAME=demo
export OS_USERNAME=demo
export OS_PASSWORD=DEMO_PASS
export OS_AUTH_URL=http://controller:5000/v3
```

   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 specific project and user, you can simply load the associated client environment script prior to running them. For example:

1. Load the `admin-openrc.sh` file to populate environment variables with the location of the Identity service and the `admin` project and user credentials:

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

2. Request an authentication token:

```
$ openstack token issue
+------------+----------------------------------+
| Field      | Value                            |
+------------+----------------------------------+
| expires    | 2015-03-25T01:45:49.950092Z      |
| id         | cd4110152ac24bdeaa82e1443c910c36 |
| project_id | cf12a15c5ea84b019aec3dc45580896b |
| user_id    | 4d411f2291f34941b30eef9bd797505a |
+------------+----------------------------------+
```

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” [33] and the section called “Verify operation” [41] as well as setup of the `admin-openrc.sh` script as described in the section called “Create OpenStack client environment scripts” [43].

To configure prerequisites

Before you install and configure the Image service, you must create a database, service credentials, and API endpoint.

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 service credentials, complete these steps:

a. Create the `glance` user:

```
$ openstack user create --password-prompt glance
User Password:
Repeat User Password:
+----------+----------------------------------+
| Field    | Value                            |
+----------+----------------------------------+
| email    | None                             |
| enabled  | True                             |
| id       | 1dc206e084334db2bee88363745da014 |
| name     | glance                           |
| username | glance                           |
+----------+----------------------------------+
```

b. Add the `admin` role to the `glance` user and `service` project:

```
$ openstack role add --project service --user glance admin
+-------+----------------------------------+
| Field | Value                            |
+-------+----------------------------------+
| id    | cd2cb9a39e874ea69e5d4b896eb16128 |
| name  | admin                            |
+-------+----------------------------------+
```

c. Create the `glance` service entity:

```
$ openstack service create --name glance \
  --description "OpenStack Image service" image
```

```
+-------------+----------------------------------+
| Field       | Value                            |
+-------------+----------------------------------+
| description | OpenStack Image service          |
| enabled     | True                             |
| id          | 178124d6081c441b80d79972614149c6 |
| name        | glance                           |
| type        | image                            |
+-------------+----------------------------------+
```

4. Create the Image service API endpoint:

```
$ openstack endpoint create \
  --publicurl http://controller:9292 \
  --internalurl http://controller:9292 \
  --adminurl http://controller:9292 \
  --region RegionOne \
  image
+--------------+----------------------------------+
| Field        | Value                            |
+--------------+----------------------------------+
```

```
| adminurl     | http://controller:9292           |
| id           | 805b1dbc90ab47479111102bc6423313 |
| internalurl  | http://controller:9292           |
| publicurl    | http://controller:9292           |
| region       | RegionOne                        |
| service_id   | 178124d6081c441b80d79972614149c6 |
| service_name | glance                           |
| service_type | image                            |
+--------------+----------------------------------+
```

To install and configure the Image service components

Note

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

1. Install the packages:

   ```
   # apt-get install 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
      auth_url = http://controller:35357
      auth_plugin = password
      project_domain_id = default
      user_domain_id = default
      project_name = service
      username = glance
      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 or remove any other options in the `[keystone_authtoken]` section.

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. In the `[DEFAULT]` section, configure the `noop` notification driver to disable notifications because they only pertain to the optional Telemetry service:

```
[DEFAULT]
...
notification_driver = noop
```

The Telemetry chapter provides an Image service configuration that enables notifications.

e. (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
auth_url = http://controller:35357
auth_plugin = password
project_domain_id = default
user_domain_id = default
project_name = service
username = glance
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 or remove any other options in the `[keystone_authtoken]` section.

c. In the `[DEFAULT]` section, configure the `noop` notification driver to disable notifications because they only pertain to the optional Telemetry service:

```
[DEFAULT]
...
notification_driver = noop
```

The Telemetry chapter provides an Image service configuration that enables notifications.

d. (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

1. Restart the Image service services:

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

2. By default, the Ubuntu packages create an SQLite database.

   Because this configuration uses a SQL database server, you can remove the SQLite database file:

```
# rm -f /var/lib/glance/glance.sqlite
```

Verify operation

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. In each client environment script, configure the Image service client to use API version 2.0:

   ```
   $ echo "export OS_IMAGE_API_VERSION=2" | tee -a admin-openrc.sh demo-
   openrc.sh
   ```

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

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

3. Create a temporary local directory:

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

4. Download the source image into it:

   ```
   $ wget -P /tmp/images http://download.cirros-cloud.net/0.3.4/cirros-0.3.4-
   x86_64-disk.img
   ```

5. Upload the image to the Image service using the *QCOW2* disk format, *bare* container format, and public visibility so all projects can access it:

   ```
   $ glance image-create --name "cirros-0.3.4-x86_64" --file /tmp/images/
   cirros-0.3.4-x86_64-disk.img \
     --disk-format qcow2 --container-format bare --visibility public --
   progress
   [=============================>] 100%
   +------------------+--------------------------------------+
   | Property         | Value                                |
   +------------------+--------------------------------------+
   | checksum         | 133eae9fb1c98f45894a4e60d8736619     |
   | container_format | bare                                 |
   | created_at       | 2015-03-26T16:52:10Z                 |
   | disk_format      | qcow2                                |
   | id               | 38047887-61a7-41ea-9b49-27987d5e8bb9 |
   | min_disk         | 0                                    |
   | min_ram          | 0                                    |
   | name             | cirros-0.3.4-x86_64                  |
   | owner            | ae7a98326b9c455588edd2656d723b9d     |
   | protected        | False                                |
   | size             | 13200896                             |
   | status           | active                               |
   | tags             | []                                   |
   | updated_at       | 2015-03-26T16:52:10Z                 |
   | virtual_size     | None                                 |
   | visibility       | public                               |
   +------------------+--------------------------------------+
   ```

   For information about the **glance image-create** parameters, 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

OpenStack generates IDs dynamically, so you will see different values in the example command output.

6. Confirm upload of the image and validate attributes:

```
$ glance image-list
+--------------------------------------+---------------------+
| ID                                   | Name                |
+--------------------------------------+---------------------+
| 38047887-61a7-41ea-9b49-27987d5e8bb9 | cirros-0.3.4-x86_64 |
+--------------------------------------+---------------------+
```

7. Remove the temporary local directory and source image:

```
$ 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.

`nova-cert` module
: A server daemon that serves the Nova Cert service for X509 certificates. Used to generate certificates for **euca-bundle-image**. Only needed for the EC2 API.

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-xvpvncproxy. 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-xvpvncproxy 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 the Compute service, you must create a database, service credentials, and API endpoint.

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 service credentials, complete these steps:

   a. Create the `nova` user:

   ```
   $ openstack user create --password-prompt nova
   User Password:
   Repeat User Password:
   +----------+----------------------------------+
   | Field    | Value                            |
   +----------+----------------------------------+
   | email    | None                             |
   | enabled  | True                             |
   | id       | 8e0b71d732db4bfba04943a96230c8c0 |
   | name     | nova                             |
   ```

```
| username | nova                             |
+----------+----------------------------------+
```

b. Add the `admin` role to the `nova` user:

```
$ openstack role add --project service --user nova admin
+-------+----------------------------------+
| Field | Value                            |
+-------+----------------------------------+
| id    | cd2cb9a39e874ea69e5d4b896eb16128 |
| name  | admin                            |
+-------+----------------------------------+
```

c. Create the `nova` service entity:

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

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

4. Create the Compute service API endpoint:

```
$ openstack endpoint create \
  --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 \
  compute
+--------------+-----------------------------------------+
| Field        | Value                                   |
+--------------+-----------------------------------------+
| adminurl     | http://controller:8774/v2/%(tenant_id)s |
| id           | 4e885d4ad43f4c4fbf2287734bc58d6b        |
| internalurl  | http://controller:8774/v2/%(tenant_id)s |
| publicurl    | http://controller:8774/v2/%(tenant_id)s |
| region       | RegionOne                               |
| service_id   | 060d59eac51b4594815603d75a00aba2        |
| service_name | nova                                    |
| service_type | compute                                 |
+--------------+-----------------------------------------+
```

To install and configure Compute controller components

Note

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

1. Install the packages:

```
# apt-get install nova-api nova-cert nova-conductor nova-consoleauth \
  nova-novncproxy nova-scheduler python-novaclient
```

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

   a. Add a `[database]` section, and 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]` and `[oslo_messaging_rabbit]` sections, configure RabbitMQ message queue access:

   ```
   [DEFAULT]
   ...
   rpc_backend = rabbit

   [oslo_messaging_rabbit]
   ...
   rabbit_host = controller
   rabbit_userid = openstack
   rabbit_password = RABBIT_PASS
   ```

   Replace *RABBIT_PASS* with the password you chose for the `openstack` 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
   auth_url = http://controller:35357
   auth_plugin = password
   project_domain_id = default
   user_domain_id = default
   project_name = service
   username = nova
   password = NOVA_PASS
   ```

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

   ### Note

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

   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. In the [oslo_concurrency] section, configure the lock path:

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

h. (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

1. Restart the Compute services:

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

2. By default, the Ubuntu packages create an SQLite database.

   Because this configuration uses a SQL database server, you can remove the SQLite database file:

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

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.

Note

This section assumes that you are following the instructions in this guide step-by-step to configure the first compute node. If you want to configure additional compute nodes, prepare them in a similar fashion to the first compute node in the example architectures section using the same networking service as your existing environment. For either networking service, follow the NTP configuration and OpenStack packages instructions. For OpenStack Networking (neutron), also follow the OpenStack Networking compute node instructions. For legacy networking (nova-network), also follow the legacy networking compute node instructions. Each additional compute node requires unique IP addresses.

To install and configure the Compute hypervisor components

Note

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

1. Install the packages:

   ```
   # apt-get install nova-compute sysfsutils
   ```

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

   a. In the `[DEFAULT]` and `[oslo_messaging_rabbit]` sections, configure RabbitMQ message queue access:

      ```
      [DEFAULT]
      ...
      rpc_backend = rabbit

      [oslo_messaging_rabbit]
      ...
      rabbit_host = controller
      rabbit_userid = openstack
      rabbit_password = RABBIT_PASS
      ```

      Replace *RABBIT_PASS* with the password you chose for the `openstack` 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
auth_url = http://controller:35357
auth_plugin = password
project_domain_id = default
user_domain_id = default
project_name = service
username = nova
password = NOVA_PASS
```

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

Note

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

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 *con-*

troller 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. In the [oslo_concurrency] section, configure the lock path:

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

g. (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-compute.conf` file as follows:

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

2. Restart the Compute service:

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

3. By default, the Ubuntu packages create an SQLite database.

Because this configuration uses a SQL database server, you can remove the SQLite database file:

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

Verify operation

Verify operation of the Compute service.

Note

Perform these commands on the controller node.

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

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

2. List service components to verify successful launch and registration 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 service components enabled on the controller node and one service component enabled on the compute node.

3. List API endpoints in the Identity service to verify connectivity with the Identity service:

```
$ nova endpoints
+-----------+------------------------------------------------------------+
| nova      | Value                                                      |
+-----------+------------------------------------------------------------+
| id        | 1fb997666b79463fb68db4ccfe4e6a71                           |
| interface | public                                                     |
| region    | RegionOne                                                  |
| region_id | RegionOne                                                  |
| url       | http://controller:8774/v2/ae7a98326b9c455588edd2656d723b9d |
+-----------+------------------------------------------------------------+
+-----------+------------------------------------------------------------+
| nova      | Value                                                      |
+-----------+------------------------------------------------------------+
| id        | bac365db1ff34f08a31d4ae98b056924                           |
| interface | admin                                                      |
| region    | RegionOne                                                  |
| region_id | RegionOne                                                  |
| url       | http://controller:8774/v2/ae7a98326b9c455588edd2656d723b9d |
+-----------+------------------------------------------------------------+
+-----------+------------------------------------------------------------+
| nova      | Value                                                      |
+-----------+------------------------------------------------------------+
```

```
| id        | e37186d38b8e4b81a54de34e73b43f34                          |
| interface | internal                                                  |
| region    | RegionOne                                                 |
| region_id | RegionOne                                                 |
| url       | http://controller:8774/v2/ae7a98326b9c455588edd2656d723b9d |
+-----------+-----------------------------------------------------------+

+-----------+----------------------------------+
| glance    | Value                            |
+-----------+----------------------------------+
| id        | 41ad39f6c6444b7d8fd8318c18ae0043 |
| interface | admin                            |
| region    | RegionOne                        |
| region_id | RegionOne                        |
| url       | http://controller:9292           |
+-----------+----------------------------------+
+-----------+----------------------------------+
| glance    | Value                            |
+-----------+----------------------------------+
| id        | 50ecc4ce62724e319f4fae3861e50f7d |
| interface | internal                         |
| region    | RegionOne                        |
| region_id | RegionOne                        |
| url       | http://controller:9292           |
+-----------+----------------------------------+
+-----------+----------------------------------+
| glance    | Value                            |
+-----------+----------------------------------+
| id        | 7d3df077a20b4461a372269f603b7516 |
| interface | public                           |
| region    | RegionOne                        |
| region_id | RegionOne                        |
| url       | http://controller:9292           |
+-----------+----------------------------------+

+-----------+----------------------------------+
| keystone  | Value                            |
+-----------+----------------------------------+
| id        | 88150c2fdc9d406c9b25113701248192 |
| interface | internal                         |
| region    | RegionOne                        |
| region_id | RegionOne                        |
| url       | http://controller:5000/v2.0      |
+-----------+----------------------------------+
+-----------+----------------------------------+
| keystone  | Value                            |
+-----------+----------------------------------+
| id        | cecab58c0f024d95b36a4ffa3e8d81e1 |
| interface | public                           |
| region    | RegionOne                        |
| region_id | RegionOne                        |
| url       | http://controller:5000/v2.0      |
+-----------+----------------------------------+
+-----------+----------------------------------+
| keystone  | Value                            |
+-----------+----------------------------------+
| id        | fc90391ae7cd4216aca070042654e424 |
| interface | admin                            |
| region    | RegionOne                        |
| region_id | RegionOne                        |
```

```
| url       | http://controller:35357/v2.0     |
+-----------+----------------------------------+
```

4. List images in the Image service catalog to verify connectivity with the Image service:

```
$ nova image-list
+--------------------------------------+---------------------+--------
+--------+
| ID                                   | Name                | Status |
 Server |
+--------------------------------------+---------------------+--------
+--------+
| 38047887-61a7-41ea-9b49-27987d5e8bb9 | cirros-0.3.4-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` component. 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)

OpenStack Networking

OpenStack Networking allows you to create and attach interface devices managed by other OpenStack services to networks. Plug-ins can be implemented to accommodate different networking equipment and software, providing flexibility to OpenStack architecture and deployment.

It includes the following components:

`neutron-server`
: Accepts and routes API requests to the appropriate OpenStack Networking plug-in for action.

OpenStack Networking plug-ins and agents
: Plugs and unplugs ports, creates networks or subnets, and provides IP addressing. These plug-ins and agents differ depending on the vendor and technologies used in the particular cloud. OpenStack Networking ships with plug-ins and agents for Cisco virtual and physical switches, NEC OpenFlow products, Open vSwitch, Linux bridging, and the VMware NSX product.

: The common agents are L3 (layer 3), DHCP (dynamic host IP addressing), and a plug-in agent.

Messaging queue
: Used by most OpenStack Networking installations to route information between the neutron-server and various agents, as well as a database to store networking state for particular plug-ins.

OpenStack Networking mainly interacts with OpenStack Compute to provide networks and connectivity for its instances.

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 the OpenStack Networking (neutron) service, you must create a database, service credentials, and API endpoint.

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 service credentials, complete these steps:

   a. Create the `neutron` user:

   ```
   $ openstack user create --password-prompt neutron
   User Password:
   Repeat User Password:
   +----------+----------------------------------+
   | Field    | Value                            |
   +----------+----------------------------------+
   | email    | None                             |
   | enabled  | True                             |
   | id       | ab67f043d9304017aaa73d692eeb4945 |
   | name     | neutron                          |
   | username | neutron                          |
   +----------+----------------------------------+
   ```

   b. Add the `admin` role to the `neutron` user:

   ```
   $ openstack role add --project service --user neutron admin
   +-------+----------------------------------+
   | Field | Value                            |
   +-------+----------------------------------+
   | id    | cd2cb9a39e874ea69e5d4b896eb16128 |
   | name  | admin                            |
   +-------+----------------------------------+
   ```

c. Create the `neutron` service entity:

```
$ openstack service create --name neutron \
  --description "OpenStack Networking" network
```

```
+-------------+----------------------------------+
| Field       | Value                            |
+-------------+----------------------------------+
| description | OpenStack Networking             |
| enabled     | True                             |
| id          | f71529314dab4a4d8eca427e701d209e |
| name        | neutron                          |
| type        | network                          |
+-------------+----------------------------------+
```

4. Create the Networking service API endpoint:

```
$ openstack endpoint create \
  --publicurl http://controller:9696 \
  --adminurl http://controller:9696 \
  --internalurl http://controller:9696 \
  --region RegionOne \
  network
+--------------+----------------------------------+
| Field        | Value                            |
+--------------+----------------------------------+
| adminurl     | http://controller:9696           |
| id           | 04a7d3c1de784099aaba83a8a74100b3 |
| internalurl  | http://controller:9696           |
| publicurl    | http://controller:9696           |
| region       | RegionOne                        |
| service_id   | f71529314dab4a4d8eca427e701d209e |
| service_name | neutron                          |
| service_type | network                          |
+--------------+----------------------------------+
```

To install the Networking components

- ```
  # apt-get install neutron-server neutron-plugin-ml2 python-neutronclient
  ```

To configure the Networking server component

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

Note

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

- 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]` and `[oslo_messaging_rabbit]` sections, configure RabbitMQ message queue access:

```
[DEFAULT]
...
rpc_backend = rabbit

[oslo_messaging_rabbit]
...
rabbit_host = controller
rabbit_userid = openstack
rabbit_password = RABBIT_PASS
```

Replace *RABBIT_PASS* with the password you chose for the `openstack` 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
auth_url = http://controller:35357
auth_plugin = password
project_domain_id = default
user_domain_id = default
project_name = service
username = neutron
password = NEUTRON_PASS
```

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

Note

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

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] and [nova] sections, 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]
...
auth_url = http://controller:35357
auth_plugin = password
project_domain_id = default
user_domain_id = default
region_name = RegionOne
project_name = service
username = nova
password = NOVA_PASS
```

Replace NOVA_PASS with the password you chose for the nova user in the Identity 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*, *VLAN*, *generic routing encapsulation (GRE)*, and *virtual extensible LAN (VXLAN)* network type drivers, GRE tenant networks, and the OVS mechanism driver:

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

Warning

Once you configure the ML2 plug-in, changing values in the type_drivers option 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 on the controller node 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. 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 head" neutron
```

Note

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

2. Restart the Compute services:

```
# service nova-api restart
```

3. Restart the Networking service:

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

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

- ```
  # apt-get install neutron-plugin-ml2 neutron-plugin-openvswitch-agent \
    neutron-l3-agent neutron-dhcp-agent neutron-metadata-agent
  ```

To configure the Networking common components

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

Note

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

- 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]` and `[oslo_messaging_rabbit]` sections, configure RabbitMQ message queue access:

  ```
  [DEFAULT]
  ...
  rpc_backend = rabbit

  [oslo_messaging_rabbit]
  ...
  rabbit_host = controller
  rabbit_userid = openstack
  rabbit_password = RABBIT_PASS
  ```

  Replace *RABBIT_PASS* with the password you chose for the `openstack` 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
auth_url = http://controller:35357
auth_plugin = password
project_domain_id = default
user_domain_id = default
project_name = service
username = neutron
password = NEUTRON_PASS
```

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

Note

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

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*, *VLAN*, *generic routing encapsulation (GRE)*, and *virtual extensible LAN (VXLAN)* network type drivers, GRE tenant networks, and the OVS mechanism driver:

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

b. In the `[ml2_type_flat]` section, configure the external flat provider 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, enable tunnels, configure the local tunnel endpoint, and map the external flat provider network to the `br-ex` external network bridge:

```
[ovs]
...
local_ip = INSTANCE_TUNNELS_INTERFACE_IP_ADDRESS
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.

f. In the `[agent]` section, enable GRE tunnels:

```
[agent]
...
tunnel_types = gre
```

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 interface driver, external network bridge, and enable deletion of defunct router namespaces:

```
[DEFAULT]
...
interface_driver = neutron.agent.linux.interface.OVSInterfaceDriver
external_network_bridge =
router_delete_namespaces = True
```

Note

The `external_network_bridge` option intentionally lacks a value to enable multiple external networks on a single agent.

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 interface and DHCP drivers and enable deletion of defunct DHCP namespaces:

   ```
   [DEFAULT]
   ...
   interface_driver = neutron.agent.linux.interface.OVSInterfaceDriver
   dhcp_driver = neutron.agent.linux.dhcp.Dnsmasq
   dhcp_delete_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, a script, or another 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_uri = http://controller:5000
auth_url = http://controller:35357
auth_region = RegionOne
auth_plugin = password
project_domain_id = default
user_domain_id = default
project_name = service
username = neutron
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:

```
# service nova-api restart
```

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. Restart the OVS service:

```
# service openvswitch-switch restart
```

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

- Restart the Networking services:

```
# service neutron-plugin-openvswitch-agent restart
# service neutron-l3-agent restart
# service neutron-dhcp-agent restart
# service neutron-metadata-agent restart
```

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
net.bridge.bridge-nf-call-iptables=1
net.bridge.bridge-nf-call-ip6tables=1
```

2. Implement the changes:

```
# sysctl -p
```

To install the Networking components

-
```
# apt-get install neutron-plugin-ml2 neutron-plugin-openvswitch-agent
```

To configure the Networking common components

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

Note

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

- 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]` and `[oslo_messaging_rabbit]` sections, configure RabbitMQ message queue access:

```
[DEFAULT]
...
rpc_backend = rabbit

[oslo_messaging_rabbit]
...
rabbit_host = controller
rabbit_userid = openstack
rabbit_password = RABBIT_PASS
```

  Replace *RABBIT_PASS* with the password you chose for the `openstack` 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
auth_url = http://controller:35357
auth_plugin = password
project_domain_id = default
user_domain_id = default
project_name = service
username = neutron
password = NEUTRON_PASS
```

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

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

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*, *VLAN*, *generic routing encapsulation (GRE)*, and *virtual extensible LAN (VXLAN)* network type drivers, GRE tenant networks, and the OVS mechanism driver:

```
[ml2]
...
type_drivers = flat,vlan,gre,vxlan
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, enable tunnels and configure the local tunnel endpoint:

```
[ovs]
...
local_ip = INSTANCE_TUNNELS_INTERFACE_IP_ADDRESS
```

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

e. In the `[agent]` section, enable GRE tunnels:

```
[agent]
...
tunnel_types = gre
```

To configure the Open vSwitch (OVS) service

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

- Restart the OVS service:

```
# service openvswitch-switch restart
```

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. Restart the Compute service:

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

2. Restart the Open vSwitch (OVS) agent:

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

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        |
| a5a49051-05eb-4b4f-bfc7-d36235fe9131 | Open vSwitch agent | compute1
 | :-)   | True           | neutron-openvswitch-agent |
+--------------------------------------+--------------------+----------
+-------+----------------+---------------------------+
```

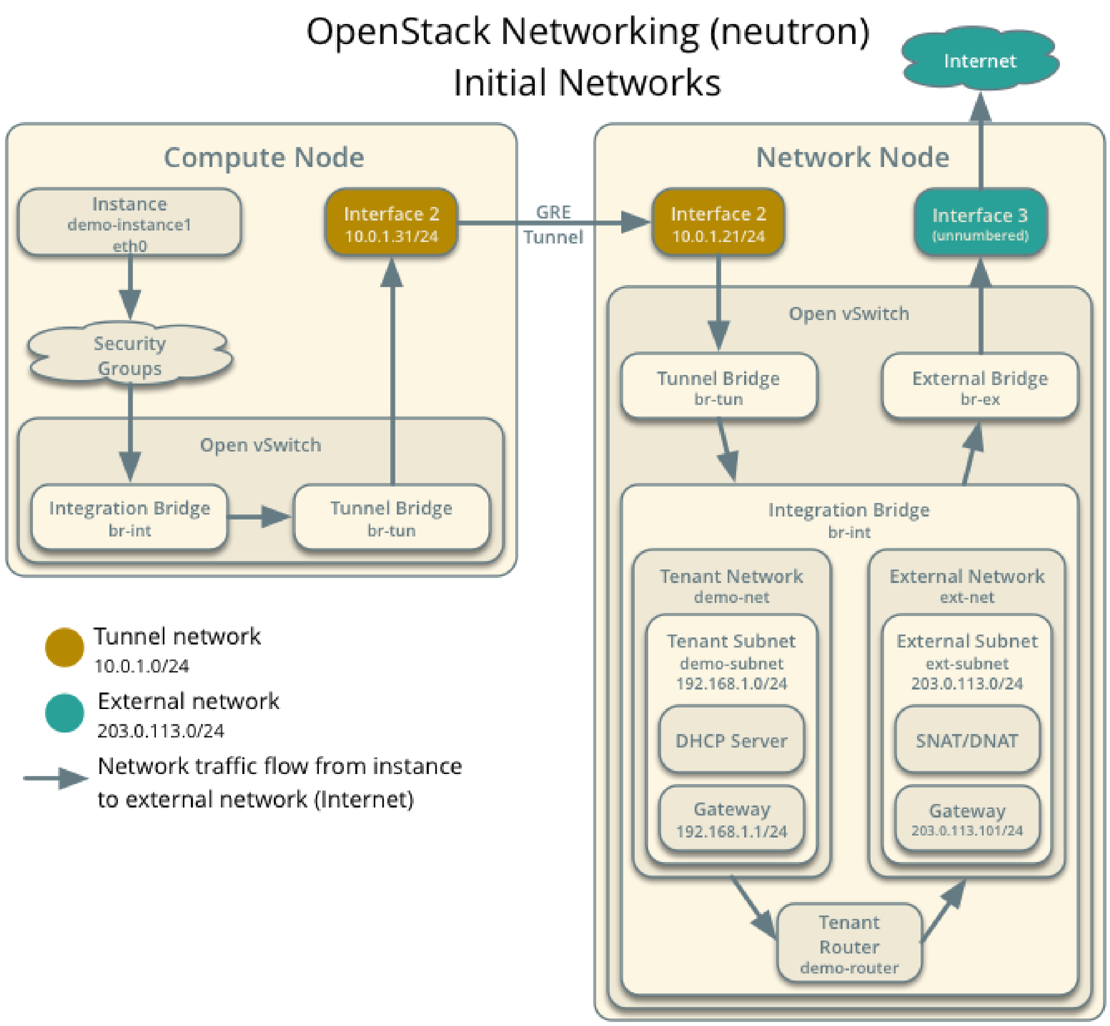
Note

This output should indicate four agents alive on the network node and one agent alive on the compute node.

Create initial networks

Before launching your first instance, you must create the necessary virtual network infrastructure to which the instances connect, including the external network and tenant network. See Figure 6.1, "Initial networks" [86]. After creating this infrastructure, we recommend that you verify connectivity and resolve any issues before proceeding further. Figure 6.1, "Initial networks" [86] provides a basic architectural overview of the components that Networking implements for the initial networks and shows how network traffic flows from the instance to the external network or Internet.

Figure 6.1. Initial networks



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.

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 --router:external \
  --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                    | False                                  |
| 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 EXTERNAL_NETWORK_CIDR --name ext-subnet \
  --allocation-pool start=FLOATING_IP_START,end=FLOATING_IP_END \
  --disable-dhcp --gateway EXTERNAL_NETWORK_GATEWAY
```

  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 203.0.113.0/24 --name ext-subnet \
  --allocation-pool start=203.0.113.101,end=203.0.113.200 \
  --disable-dhcp --gateway 203.0.113.1
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 uses DHCP so your instances can obtain IP addresses.

To create a subnet on the tenant network

- Create the subnet:

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

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 192.168.1.0/24 \
  --name demo-subnet --gateway 192.168.1.1
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 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

- From a host on the the external network, 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:

   ```
   # service nova-api restart
   # service nova-scheduler restart
   # service nova-conductor restart
   ```

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

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

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*. You can also leave these two parameters undefined if you are serving multiple networks with individual bridges for each.

2. Restart the services:

```
# service nova-network restart
# service nova-api-metadata restart
```

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 `203.0.113.31`:

```
$ 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 2.7. 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" [94]. 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.

This section assumes proper installation, configuration, and operation of the Identity service using the Apache HTTP server and Memcached as described in the section called "Install and configure" [33].

To install the dashboard components

- Install the packages:

```
# apt-get install openstack-dashboard
```

Note

Ubuntu installs the openstack-dashboard-ubuntu-theme package as a dependency. Some users reported issues with this theme in previous releases. If you encounter issues, remove this package to restore the original OpenStack theme.

To configure the dashboard

- Edit the `/etc/openstack-dashboard/local_settings.py` 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. Configure `user` as the default role for users that you create via the dashboard:

```
OPENSTACK_KEYSTONE_DEFAULT_ROLE = "user"
```

e. 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

- Reload the web server configuration:

```
# service apache2 reload
```

Verify operation

This section describes how to verify operation of the dashboard.

1. Access the dashboard using a web browser: `http://controller/horizon` .
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 guest instances. The method in which the storage is provisioned and consumed is determined by the Block Storage driver, or drivers in the case of a multi-backend configuration. There are a variety of drivers that are available: NAS/SAN, NFS, iSCSI, Ceph, and more. The Block Storage API and scheduler services typically run on the controller nodes. Depending upon the drivers used, the volume service can run on controllers, compute nodes, or standalone storage nodes. 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`.
`cinder-backup` daemon	The `cinder-backup` service provides backing up volumes of any type to a backup storage provider. Like the

	`cinder-volume` service, it can interact with a variety of storage providers through a driver architecture.
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, service credentials, and API endpoint.

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 service credentials, complete these steps:

   a. Create a `cinder` user:

   ```
   $ openstack user create --password-prompt cinder
   User Password:
   Repeat User Password:
   +----------+----------------------------------+
   | Field    | Value                            |
   +----------+----------------------------------+
   | email    | None                             |
   | enabled  | True                             |
   | id       | 881ab2de4f7941e79504a759a83308be |
   | name     | cinder                           |
   | username | cinder                           |
   ```

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

b. Add the `admin` role to the `cinder` user:

```
$ openstack role add --project service --user cinder admin
+-------+----------------------------------+
| Field | Value                            |
+-------+----------------------------------+
| id    | cd2cb9a39e874ea69e5d4b896eb16128 |
| name  | admin                            |
+-------+----------------------------------+
```

c. Create the `cinder` service entities:

```
$ openstack service create --name cinder \
  --description "OpenStack Block Storage" volume
+-------------+----------------------------------+
| Field       | Value                            |
+-------------+----------------------------------+
| description | OpenStack Block Storage          |
| enabled     | True                             |
| id          | 1e494c3e22a24baaafcaf777d4d467eb |
| name        | cinder                           |
| type        | volume                           |
+-------------+----------------------------------+
```

```
$ openstack service create --name cinderv2 \
  --description "OpenStack Block Storage" volumev2
+-------------+----------------------------------+
| Field       | Value                            |
+-------------+----------------------------------+
| description | OpenStack Block Storage          |
| enabled     | True                             |
| id          | 16e038e449c94b40868277f1d801edb5 |
| name        | cinderv2                         |
| type        | volumev2                         |
+-------------+----------------------------------+
```

Note

The Block Storage service requires both the `volume` and `volumev2` services. However, both services use the same API endpoint that references the Block Storage version 2 API.

4. Create the Block Storage service API endpoints:

```
$ openstack endpoint create \
  --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 \
  volume
+--------------+-----------------------------------------+
| Field        | Value                                   |
+--------------+-----------------------------------------+
| adminurl     | http://controller:8776/v2/%(tenant_id)s |
| id           | d1b7291a2d794e26963b322c7f2a55a4        |
| internalurl  | http://controller:8776/v2/%(tenant_id)s |
| publicurl    | http://controller:8776/v2/%(tenant_id)s |
```

```
| region       | RegionOne                               |
| service_id   | 1e494c3e22a24baaafcaf777d4d467eb        |
| service_name | cinder                                  |
| service_type | volume                                  |
+--------------+-----------------------------------------+
```

```
$ openstack endpoint create \
  --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 \
  volumev2
+--------------+-----------------------------------------+
| Field        | 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        |
| service_name | cinderv2                                |
| service_type | volumev2                                |
+--------------+-----------------------------------------+
```

To install and configure Block Storage controller components

1. Install the packages:

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

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]` and `[oslo_messaging_rabbit]` sections, configure RabbitMQ message queue access:

   ```
   [DEFAULT]
   ...
   rpc_backend = rabbit

   [oslo_messaging_rabbit]
   ...
   rabbit_host = controller
   rabbit_userid = openstack
   rabbit_password = RABBIT_PASS
   ```

   Replace *RABBIT_PASS* with the password you chose for the `openstack` 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
auth_url = http://controller:35357
auth_plugin = password
project_domain_id = default
user_domain_id = default
project_name = service
username = cinder
password = CINDER_PASS
```

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

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

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 [oslo_concurrency] section, configure the lock path:

```
[oslo_concurrency]
...
lock_path = /var/lock/cinder
```

f. (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

1. Restart the Block Storage services:

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

2. By default, the Ubuntu packages create an SQLite database.

Because this configuration uses a SQL database server, you can remove the SQLite database file:

```
# rm -f /var/lib/cinder/cinder.sqlite
```

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” [11].

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” [26].

5. If you intend to use non-raw image types such as QCOW2 and VMDK, install the QEMU support package:

   ```
   # apt-get install qemu
   ```

6. Install the LVM packages:

   ```
   # apt-get install lvm2
   ```

Note

Some distributions include LVM by default.

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 projects 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 project 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:

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

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]` and `[oslo_messaging_rabbit]` sections, configure RabbitMQ message queue access:

   ```
   [DEFAULT]
   ...
   rpc_backend = rabbit

   [oslo_messaging_rabbit]
   ...
   rabbit_host = controller
   rabbit_userid = openstack
   rabbit_password = RABBIT_PASS
   ```

   Replace *RABBIT_PASS* with the password you chose for the `openstack` 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
   auth_url = http://controller:35357
   auth_plugin = password
   project_domain_id = default
   user_domain_id = default
   project_name = service
   username = cinder
   password = CINDER_PASS
   ```

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

   ### Note

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

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 [lvm] section, configure the LVM back end with the LVM driver, cinder-volumes volume group, iSCSI protocol, and appropriate iSCSI service:

```
[lvm]
...
volume_driver = cinder.volume.drivers.lvm.LVMVolumeDriver
volume_group = cinder-volumes
iscsi_protocol = iscsi
iscsi_helper = tgtadm
```

f. In the [DEFAULT] section, enable the LVM back end:

```
[DEFAULT]
...
enabled_backends = lvm
```

Note

Back-end names are arbitrary. As an example, this guide uses the name of the driver as the name of the back end.

g. In the [DEFAULT] section, configure the location of the Image service:

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

h. In the [oslo_concurrency] section, configure the lock path:

```
[oslo_concurrency]
...
lock_path = /var/lock/cinder
```

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

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

To finalize installation

1. Restart the Block Storage volume service including its dependencies:

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

2. By default, the Ubuntu packages create an SQLite database. Because this configuration uses a SQL database server, remove the SQLite database file:

```
# rm -f /var/lib/cinder/cinder.sqlite
```

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. In each client environment script, configure the Block Storage client to use API version 2.0:

```
$ echo "export OS_VOLUME_API_VERSION=2" | tee -a admin-openrc.sh demo-
openrc.sh
```

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

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

3. 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@lvm | nova | enabled |   up  |
 2014-10-18T01:30:57.000000 |       None      |
+------------------+------------+------+---------+-------
+----------------------------+-----------------+
```

4. Source the `demo` credentials to perform the following steps as a non-administrative project:

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

5. Create a 1 GB volume:

```
$ cinder create --name demo-volume1 1
+---------------------------------------
+--------------------------------------+
|                Property                |                Value
     |
+---------------------------------------
+--------------------------------------+
|              attachments               |                  []
     |
```

```
|           availability_zone           |                 nova
     |
|                bootable               |                false
     |
|          consistencygroup_id          |                 None
     |
|               created_at              |      2015-04-21T23:46:08.000000
     |
|              description              |                 None
     |
|               encrypted               |                False
     |
|                   id                  | 6c7a3d28-e1ef-42a0-
b1f7-8d6ce9218412 |
|                metadata               |                  {}
     |
|              multiattach              |                False
     |
|                  name                 |             demo-volume1
     |
|       os-vol-tenant-attr:tenant_id    |
 ab8ea576c0574b6092bb99150449b2d3   |
|   os-volume-replication:driver_data   |                 None
     |
| os-volume-replication:extended_status |                 None
     |
|           replication_status          |               disabled
     |
|                  size                 |                  1
     |
|              snapshot_id              |                 None
     |
|              source_volid             |                 None
     |
|                 status                |               creating
     |
|                user_id                |
 3a81e6c8103b46709ef8d141308d4c72   |
|              volume_type              |                 None
     |
+---------------------------------------
+--------------------------------------+
```

6. Verify creation and availability of the volume:

```
$ cinder list
+--------------------------------------+-----------+--------------+------
+-------------+----------+-------------+
|                  ID                  |   Status  |     Name     | Size |
 Volume Type | Bootable | Attached to |
+--------------------------------------+-----------+--------------+------
+-------------+----------+-------------+
| 6c7a3d28-e1ef-42a0-b1f7-8d6ce9218412 | 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 (swift) work together to provide object storage and retrieval through a *REST* API. Your environment must at least include the Identity service (keystone) prior to deploying Object Storage.

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.

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” [31]. Before you configure the Object Storage service, you must create service credentials and an API endpoint.

Note

The Object Storage service does not use a SQL database on the controller node. Instead, it uses distributed SQLite databases on each storage node.

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

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

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

   a. Create the `swift` user:

```
$ openstack user create --password-prompt swift
User Password:
Repeat User Password:
+----------+----------------------------------+
| Field    | Value                            |
+----------+----------------------------------+
| email    | None                             |
| enabled  | True                             |
| id       | d535e5cbd2b74ac7bfb97db9cced3ed6 |
| name     | swift                            |
| username | swift                            |
+----------+----------------------------------+
```

   b. Add the `admin` role to the `swift` user:

```
$ openstack role add --project service --user swift admin
+-------+----------------------------------+
| Field | Value                            |
+-------+----------------------------------+
| id    | cd2cb9a39e874ea69e5d4b896eb16128 |
| name  | admin                            |
+-------+----------------------------------+
```

   c. Create the `swift` service entity:

```
$ openstack service create --name swift \
  --description "OpenStack Object Storage" object-store
+-------------+----------------------------------+
| Field       | Value                            |
+-------------+----------------------------------+
| description | OpenStack Object Storage         |
| enabled     | True                             |
| id          | 75ef509da2c340499d454ae96a2c5c34 |
| name        | swift                            |
| type        | object-store                     |
+-------------+----------------------------------+
```

3. Create the Object Storage service API endpoint:

```
$ openstack endpoint create \
  --publicurl 'http://controller:8080/v1/AUTH_%(tenant_id)s' \
  --internalurl 'http://controller:8080/v1/AUTH_%(tenant_id)s' \
  --adminurl http://controller:8080 \
  --region RegionOne \
  object-store
+--------------+----------------------------------------------+
| Field        | 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             |
| service_name | swift                                        |
| service_type | object-store                                 |
+--------------+----------------------------------------------+
```

To install and configure the controller node components

Note

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

1. Install the packages:

   #### Note

   Complete OpenStack environments already include some of these packages.

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

2. Create the `/etc/swift` directory.

3. Obtain the proxy service configuration file from the Object Storage source repository:

```
# curl -o /etc/swift/proxy-server.conf \
  https://git.openstack.org/cgit/openstack/swift/plain/etc/proxy-server.
conf-sample?h=stable/kilo
```

4. 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 = catch_errors gatekeeper healthcheck proxy-logging cache
    container_sync bulk ratelimit authtoken keystoneauth container-quotas
    account-quotas slo dlo 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 automatic account creation:

   ```
   [app:proxy-server]
   ...
   account_autocreate = true
   ```

   d. In the `[filter:keystoneauth]` section, configure the operator roles:

   ```
   [filter:keystoneauth]
   use = egg:swift#keystoneauth
   ...
   operator_roles = admin,user
   ```

   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
   auth_url = http://controller:35357
   auth_plugin = password
   project_domain_id = default
   user_domain_id = default
   project_name = service
   username = swift
   password = SWIFT_PASS
   delay_auth_decision = true
   ```

   Replace *SWIFT_PASS* with the password you chose for the `swift` user in the Identity service.

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

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 *extended 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" [11].

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” [26].

   c. Install the supporting utility packages:

```
# apt-get 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. Edit the `/etc/default/rsync` file and enable the `rsync` service:

```
RSYNC_ENABLE=true
```

6. Start the `rsync` service:

```
# service rsync start
```

Install and configure storage node components

Note

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

Note

Perform these steps on each storage node.

1. Install the packages:

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

2. Obtain the accounting, container, object, container-reconciler, and object-expirer service configuration files from the Object Storage source repository:

```
# curl -o /etc/swift/account-server.conf \
  https://git.openstack.org/cgit/openstack/swift/plain/etc/account-server.
conf-sample?h=stable/kilo
```

```
# curl -o /etc/swift/container-server.conf \
  https://git.openstack.org/cgit/openstack/swift/plain/etc/container-
server.conf-sample?h=stable/kilo
```

```
# curl -o /etc/swift/object-server.conf \
  https://git.openstack.org/cgit/openstack/swift/plain/etc/object-server.
conf-sample?h=stable/kilo
```

```
# curl -o /etc/swift/container-reconciler.conf \
  https://git.openstack.org/cgit/openstack/swift/plain/etc/container-
reconciler.conf-sample?h=stable/kilo
```

```
# curl -o /etc/swift/object-expirer.conf \
  https://git.openstack.org/cgit/openstack/swift/plain/etc/object-expirer.
conf-sample?h=stable/kilo
```

3. Edit the `/etc/swift/account-server.conf` file 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. Edit the `/etc/swift/container-server.conf` file 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 = 6001
      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 container-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
```

5. Edit the `/etc/swift/object-server.conf` file 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 = 6000
   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 object-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 and lock directories:

   ```
   [filter:recon]
   ...
   recon_cache_path = /var/cache/swift
   recon_lock_path = /var/lock
   ```

6. Ensure proper ownership of the mount point directory structure:

   ```
   # chown -R swift:swift /srv/node
   ```

7. 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
   ```

   Note

   This command provides no output.

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” [113] 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. In the example architecture, use the command in four variations:

   ```
   # swift-ring-builder account.builder add r1z1-10.0.0.51:6002/sdb1 100
   Device d0r1z1-10.0.0.51:6002R10.0.0.51:6002/sdb1_"" with 100.0 weight got
    id 0
   ```

```
# swift-ring-builder account.builder add r1z2-10.0.0.51:6002/sdc1 100
Device d1r1z2-10.0.0.51:6002R10.0.0.51:6002/sdc1_"" with 100.0 weight got
 id 1
# swift-ring-builder account.builder add r1z3-10.0.0.52:6002/sdb1 100
Device d2r1z3-10.0.0.52:6002R10.0.0.52:6002/sdb1_"" with 100.0 weight got
 id 2
# swift-ring-builder account.builder add r1z4-10.0.0.52:6002/sdc1 100
Device d3r1z4-10.0.0.52:6002R10.0.0.52:6002/sdc1_"" with 100.0 weight got
 id 3
```

4. Verify the ring contents:

```
# swift-ring-builder account.builder
account.builder, build version 4
1024 partitions, 3.000000 replicas, 1 regions, 4 zones, 4 devices, 100.00
 balance, 0.00 dispersion
The minimum number of hours before a partition can be reassigned is 1
The overload factor is 0.00% (0.000000)
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          0 -100.00
             1       1     2       10.0.0.51  6002       10.0.0.51
      6002      sdc1 100.00          0 -100.00
             2       1     3       10.0.0.52  6002       10.0.0.52
      6002      sdb1 100.00          0 -100.00
             3       1     4       10.0.0.52  6002       10.0.0.52
      6002      sdc1 100.00          0 -100.00
```

5. Rebalance the ring:

```
# swift-ring-builder account.builder rebalance
Reassigned 1024 (100.00%) partitions. Balance is now 0.00.  Dispersion is
 now 0.00
```

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
```

Note

This command provides no output.

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” [113] 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. In the example architecture, use the command in four variations:

```
# swift-ring-builder container.builder add r1z1-10.0.0.51:6001/sdb1 100
Device d0r1z1-10.0.0.51:6001R10.0.0.51:6001/sdb1_"" with 100.0 weight got
 id 0
# swift-ring-builder container.builder add r1z2-10.0.0.51:6001/sdc1 100
Device d1r1z2-10.0.0.51:6001R10.0.0.51:6001/sdc1_"" with 100.0 weight got
 id 1
# swift-ring-builder container.builder add r1z3-10.0.0.52:6001/sdb1 100
Device d2r1z3-10.0.0.52:6001R10.0.0.52:6001/sdb1_"" with 100.0 weight got
 id 2
# swift-ring-builder container.builder add r1z4-10.0.0.52:6001/sdc1 100
Device d3r1z4-10.0.0.52:6001R10.0.0.52:6001/sdc1_"" with 100.0 weight got
 id 3
```

4. Verify the ring contents:

```
# swift-ring-builder container.builder
container.builder, build version 4
1024 partitions, 3.000000 replicas, 1 regions, 4 zones, 4 devices, 100.00
 balance, 0.00 dispersion
The minimum number of hours before a partition can be reassigned is 1
The overload factor is 0.00% (0.000000)
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          0 -100.00
             1       1     2       10.0.0.51  6001       10.0.0.51
      6001      sdc1 100.00          0 -100.00
             2       1     3       10.0.0.52  6001       10.0.0.52
      6001      sdb1 100.00          0 -100.00
             3       1     4       10.0.0.52  6001       10.0.0.52
      6001      sdc1 100.00          0 -100.00
```

5. Rebalance the ring:

```
# swift-ring-builder container.builder rebalance
Reassigned 1024 (100.00%) partitions. Balance is now 0.00.  Dispersion is
 now 0.00
```

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
```

Note

This command provides no output.

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” [113] 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. In the example architecture, use the command in four variations:

```
# swift-ring-builder object.builder add r1z1-10.0.0.51:6000/sdb1 100
Device d0r1z1-10.0.0.51:6000R10.0.0.51:6000/sdb1_"" with 100.0 weight got
 id 0
# swift-ring-builder object.builder add r1z2-10.0.0.51:6000/sdc1 100
Device d1r1z2-10.0.0.51:6000R10.0.0.51:6000/sdc1_"" with 100.0 weight got
 id 1
# swift-ring-builder object.builder add r1z3-10.0.0.52:6000/sdb1 100
Device d2r1z3-10.0.0.52:6000R10.0.0.52:6000/sdb1_"" with 100.0 weight got
 id 2
# swift-ring-builder object.builder add r1z4-10.0.0.52:6000/sdc1 100
Device d3r1z4-10.0.0.52:6000R10.0.0.52:6000/sdc1_"" with 100.0 weight got
 id 3
```

4. Verify the ring contents:

```
# swift-ring-builder object.builder
object.builder, build version 4
1024 partitions, 3.000000 replicas, 1 regions, 4 zones, 4 devices, 100.00
 balance, 0.00 dispersion
The minimum number of hours before a partition can be reassigned is 1
The overload factor is 0.00% (0.000000)
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          0 -100.00
```

```
             1        1      2        10.0.0.51  6000        10.0.0.51
      6000        sdc1 100.00           0 -100.00
             2        1      3        10.0.0.52  6000        10.0.0.52
      6000        sdb1 100.00           0 -100.00
             3        1      4        10.0.0.52  6000        10.0.0.52
      6000        sdc1 100.00           0 -100.00
```

5. Rebalance the ring:

```
# swift-ring-builder object.builder rebalance
Reassigned 1024 (100.00%) partitions. Balance is now 0.00.  Dispersion is
 now 0.00
```

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

Note

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

1. Obtain the `/etc/swift/swift.conf` file from the Object Storage source repository:

```
# curl -o /etc/swift/swift.conf \
  https://git.openstack.org/cgit/openstack/swift/plain/etc/swift.conf-
sample?h=stable/kilo
```

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, restart the Object Storage proxy service including its dependencies:

```
# service memcached restart
# service swift-proxy restart
```

6. On the storage nodes, start the Object Storage services:

```
# swift-init all start
```

Note

The storage node runs many Object Storage services and the **swift-init** command makes them easier to manage. You can ignore errors from services not running on the storage node.

Verify operation

This section describes how to verify operation of the Object Storage service.

Note

The `swift` client requires the `-V 3` parameter to use the Identity version 3 API.

Note

Perform these steps on the controller node.

1. Source the `demo` credentials:

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

2. Show the service status:

```
$ swift -V 3 stat
Account: AUTH_c75cafb58f5049b8a976506737210756
     Containers: 0
        Objects: 0
          Bytes: 0
X-Put-Timestamp: 1429736713.92936
    X-Timestamp: 1429736713.92936
     X-Trans-Id: txdea07add01ca4dbdb49a2-0055380d09
```

```
   Content-Type: text/plain; charset=utf-8
```

3. Upload a test file:

   ```
   $ swift -V 3 upload demo-container1 FILE
   FILE
   ```

   Replace *FILE* with the name of a local file to upload to the `demo-container1` container.

4. List containers:

   ```
   $ swift -V 3 list
   demo-container1
   ```

5. Download a test file:

   ```
   $ swift -V 3 download demo-container1 FILE
   FILE [auth 0.295s, headers 0.339s, total 0.339s, 0.005 MB/s]
   ```

   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, service credentials, and API 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 service credentials, complete these steps:

   a. Create the `heat` user:

   ```
   $ openstack user create --password-prompt heat
   User Password:
   Repeat User Password:
   +----------+----------------------------------+
   | Field    | Value                            |
   +----------+----------------------------------+
   | email    | None                             |
   | enabled  | True                             |
   | id       | 7fd67878dcd04d0393469ef825a7e005 |
   | name     | heat                             |
   | username | heat                             |
   +----------+----------------------------------+
   ```

   b. Add the `admin` role to the `heat` user:

   ```
   $ openstack role add --project service --user heat admin
   +-------+----------------------------------+
   | Field | Value                            |
   +-------+----------------------------------+
   | id    | cd2cb9a39e874ea69e5d4b896eb16128 |
   | name  | admin                            |
   +-------+----------------------------------+
   ```

   c. Create the `heat_stack_owner` role:

   ```
   $ openstack role create heat_stack_owner
   ```

```
+-------+----------------------------------+
| Field | Value                            |
+-------+----------------------------------+
| id    | c0a1cbee7261446abc873392f616de87 |
| name  | heat_stack_owner                 |
+-------+----------------------------------+
```

d. Add the `heat_stack_owner` role to the `demo` tenant and user:

```
$ openstack role add --project demo --user demo heat_stack_owner
+-------+----------------------------------+
| Field | Value                            |
+-------+----------------------------------+
| id    | c0a1cbee7261446abc873392f616de87 |
| name  | heat_stack_owner                 |
+-------+----------------------------------+
```

Note

You must add the `heat_stack_owner` role to users that manage stacks.

e. Create the `heat_stack_user` role:

```
$ openstack role create heat_stack_user
+-------+----------------------------------+
| Field | Value                            |
+-------+----------------------------------+
| id    | e01546b1a81c4e32a6d14a9259e60154 |
| name  | heat_stack_user                  |
+-------+----------------------------------+
```

Note

The Orchestration service automatically assigns the `heat_stack_user` role to users that it creates during stack deployment. By default, this role restricts *API* operations. To avoid conflicts, do not add this role to users with the `heat_stack_owner` role.

f. Create the `heat` and `heat-cfn` service entities:

```
$ openstack service create --name heat \
  --description "Orchestration" orchestration
+-------------+----------------------------------+
| Field       | Value                            |
+-------------+----------------------------------+
| description | Orchestration                    |
| enabled     | True                             |
| id          | 031112165cad4c2bb23e84603957de29 |
| name        | heat                             |
| type        | orchestration                    |
+-------------+----------------------------------+
$ openstack service create --name heat-cfn \
  --description "Orchestration"  cloudformation
+-------------+----------------------------------+
| Field       | Value                            |
+-------------+----------------------------------+
| description | Orchestration                    |
```

```
| enabled      | True                             |
| id           | 297740d74c0a446bbff867acdccb33fa |
| name         | heat-cfn                         |
| type         | cloudformation                   |
+--------------+----------------------------------+
```

4. Create the Orchestration service API endpoints:

```
$ openstack endpoint create \
  --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 \
  orchestration
+--------------+-----------------------------------------+
|        Field | 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        |
| service_name | heat                                    |
| service_type | orchestration                           |
+--------------+-----------------------------------------+
$ openstack endpoint create \
  --publicurl http://controller:8000/v1 \
  --internalurl http://controller:8000/v1 \
  --adminurl http://controller:8000/v1 \
  --region RegionOne \
  cloudformation
+--------------+----------------------------------+
| Field        | Value                            |
+--------------+----------------------------------+
| adminurl     | http://controller:8000/v1        |
| id           | f41225f665694b95a46448e8676b0dc2 |
| internalurl  | http://controller:8000/v1        |
| publicurl    | http://controller:8000/v1        |
| region       | RegionOne                        |
| service_id   | 297740d74c0a446bbff867acdccb33fa |
| service_name | heat-cfn                         |
| service_type | cloudformation                   |
+--------------+----------------------------------+
```

To install and configure the Orchestration components

1. Run the following commands to install the packages:

```
# apt-get install heat-api heat-api-cfn 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]` and `[oslo_messaging_rabbit]` sections, configure RabbitMQ message queue access:

```
[DEFAULT]
...
rpc_backend = rabbit

[oslo_messaging_rabbit]
...
rabbit_host = controller
rabbit_userid = openstack
rabbit_password = RABBIT_PASS
```

Replace *RABBIT_PASS* with the password you chose for the `openstack` 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. In the `[DEFAULT]` section, configure information about the heat Identity service domain:

```
[DEFAULT]
...
stack_domain_admin = heat_domain_admin
stack_domain_admin_password = HEAT_DOMAIN_PASS
stack_user_domain_name = heat_user_domain
```

Replace *HEAT_DOMAIN_PASS* with the password you chose for the admin user of the `heat` user domain in the Identity service.

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

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

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

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

b. Create the heat domain in Identity service:

```
$ heat-keystone-setup-domain \
  --stack-user-domain-name heat_user_domain \
  --stack-domain-admin heat_domain_admin \
  --stack-domain-admin-password HEAT_DOMAIN_PASS
```

Replace *HEAT_DOMAIN_PASS* with a suitable password.

4. Populate the Orchestration database:

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

To finalize installation

1. Restart the Orchestration services:

```
# service heat-api restart
# service heat-api-cfn restart
# service heat-engine restart
```

2. By default, the Ubuntu packages create a SQLite database.

   Because this configuration uses a SQL database server, you can remove the SQLite database file:

```
# rm -f /var/lib/heat/heat.sqlite
```

Verify operation

This section describes how to verify operation of the Orchestration module (heat).

1. Source the `admin` tenant credentials:

```
$ source admin-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: 2014-10-16
description: A simple server.

parameters:
  ImageID:
    type: string
    description: Image use to boot a server
  NetID:
    type: string
    description: Network ID for the server

resources:
  server:
    type: OS::Nova::Server
    properties:
      image: { get_param: ImageID }
      flavor: m1.tiny
      networks:
      - network: { get_param: NetID }

outputs:
  private_ip:
    description: IP address of the server in the private network
    value: { get_attr: [ server, 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-0.3.4-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 polls metering data related to OpenStack services.
- Collects event and metering data by monitoring notifications sent from services.
- Publishes collected data to various targets including data stores and message queues.
- Creates alarms when collected data breaks defined rules.

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. Multiple agents can be started to scale service horizontally.
A notification agent (`ceilometer-agent-notification`)	Runs on a central management server(s) and consumes messages from the message queue(s) to build event and metering data.
A collector (`ceilometer-collector`)	Runs on central management server(s) and dispatches collected telemetry data to a data store or external consumer without modification.

An alarm evaluator (`ceilometer-alarm-evaluator`)	Runs on one or more central management servers to determine when alarms fire due to the associated statistic trend crossing a threshold over a sliding time window.
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.
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, service credentials, and API endpoint.

1. Install the MongoDB package:

   ```
   # apt-get install mongodb-server mongodb-clients python-pymongo
   ```

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
      ```

      If you change the journaling configuration, stop the MongoDB service, remove the initial journal files, and start the service:

      ```
      # service mongodb stop
      # rm /var/lib/mongodb/journal/prealloc.*
      # service mongodb start
      ```

      You can also disable journaling. For more information, see the MongoDB manual.

   c. Restart the MongoDB service:

      ```
      # service mongodb restart
      ```

3. Create the `ceilometer` database:

```
# mongo --host controller --eval '
  db = db.getSiblingDB("ceilometer");
  db.addUser({user: "ceilometer",
  pwd: "CEILOMETER_DBPASS",
  roles: [ "readWrite", "dbAdmin" ]})'

MongoDB shell version: 2.4.x
connecting to: controller:27017/test
{
 "user" : "ceilometer",
 "pwd" : "72f25aeee7ad4be52437d7cd3fc60f6f",
 "roles" : [
  "readWrite",
  "dbAdmin"
 ],
 "_id" : ObjectId("5489c22270d7fad1ba631dc3")
}
```

   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 service credentials, complete these steps:

   a. Create the `ceilometer` user:

```
$ openstack user create --password-prompt ceilometer
User Password:
Repeat User Password:
+----------+----------------------------------+
| Field    | Value                            |
+----------+----------------------------------+
| email    | None                             |
| enabled  | True                             |
| id       | b7657c9ea07a4556aef5d34cf70713a3 |
| name     | ceilometer                       |
| username | ceilometer                       |
+----------+----------------------------------+
```

   b. Add the `admin` role to the `ceilometer` user.

```
$ openstack role add --project service --user ceilometer admin
+-------+----------------------------------+
| Field | Value                            |
+-------+----------------------------------+
| id    | cd2cb9a39e874ea69e5d4b896eb16128 |
| name  | admin                            |
+-------+----------------------------------+
```

   c. Create the `ceilometer` service entity:

```
$ openstack service create --name ceilometer \
  --description "Telemetry" metering
+-------------+----------------------------------+
| Field       | Value                            |
+-------------+----------------------------------+
```

```
| description | Telemetry                        |
| enabled     | True                             |
| id          | 3405453b14da441ebb258edfeba96d83 |
| name        | ceilometer                       |
| type        | metering                         |
+-------------+----------------------------------+
```

6. Create the Telemetry module API endpoint:

```
$ openstack endpoint create \
  --publicurl http://controller:8777 \
  --internalurl http://controller:8777 \
  --adminurl http://controller:8777 \
  --region RegionOne \
  metering
+--------------+----------------------------------+
| Field        | Value                            |
+--------------+----------------------------------+
| adminurl     | http://controller:8777           |
| id           | d3716d85b10d4e60a67a52c6af0068cd |
| internalurl  | http://controller:8777           |
| publicurl    | http://controller:8777           |
| region       | RegionOne                        |
| service_id   | 3405453b14da441ebb258edfeba96d83 |
| service_name | ceilometer                       |
| service_type | metering                         |
+--------------+----------------------------------+
```

To install and configure the Telemetry module components

1. Install the packages:

```
# apt-get install ceilometer-api ceilometer-collector ceilometer-agent-
central \
  ceilometer-agent-notification ceilometer-alarm-evaluator ceilometer-
alarm-notifier \
  python-ceilometerclient
```

2. Generate a random value to use as the telemetry 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. You must escape special characters such as ':', '/', '+', and '@' in the connection string in accordance with RFC2396.

   b. In the `[DEFAULT]` and `[oslo_messaging_rabbit]` sections, configure RabbitMQ message queue access:

```
[DEFAULT]
...
rpc_backend = rabbit

[oslo_messaging_rabbit]
...
rabbit_host = controller
rabbit_userid = openstack
rabbit_password = RABBIT_PASS
```

Replace *RABBIT_PASS* with the password you chose for the `openstack` 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
os_endpoint_type = internalURL
os_region_name = RegionOne
```

Replace *CEILOMETER_PASS* with the password you chose for the `ceilometer` user in the Identity service.

e. In the `[publisher]` section, configure the telemetry secret:

```
[publisher]
...
telemetry_secret = TELEMETRY_SECRET
```

Replace *TELEMETRY_SECRET* with the telemetry secret that you generated in a previous step.

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

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

To finalize installation

- Restart the Telemetry services:

```
# service ceilometer-agent-central restart
# service ceilometer-agent-notification restart
# service ceilometer-api restart
# service ceilometer-collector restart
# service ceilometer-alarm-evaluator restart
# service ceilometer-alarm-notifier restart
```

Configure the Compute service

Telemetry uses a combination of notifications and an agent to collect Compute metrics. Perform these steps on each compute node.

To install and configure the agent

1. Install the packages:

```
# apt-get install ceilometer-agent-compute
```

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

   a. In the [publisher] section, configure the telemetry secret:

   ```
   [publisher]
   ...
   telemetry_secret = TELEMETRY_SECRET
   ```

   Replace *TELEMETRY_SECRET* with the telemetry secret you chose for the Telemetry module.

   b. In the [DEFAULT] and [oslo_messaging_rabbit] sections, configure RabbitMQ message queue access:

   ```
   [DEFAULT]
   ...
   rpc_backend = rabbit

   [oslo_messaging_rabbit]
   ...
   rabbit_host = controller
   rabbit_userid = openstack
   rabbit_password = RABBIT_PASS
   ```

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

c. 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 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
os_endpoint_type = internalURL
os_region_name = RegionOne
```

Replace *CEILOMETER_PASS* with the password you chose for the `ceilometer` user in the Identity service.

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

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

To configure notifications

Configure the Compute service to send notifications to the message bus.

- Edit the `/etc/nova/nova.conf` file and configure notifications in the `[DEFAULT]` section:

```
[DEFAULT]
...
instance_usage_audit = True
instance_usage_audit_period = hour
notify_on_state_change = vm_and_task_state
notification_driver = messagingv2
```

To finalize installation

1. Restart the agent:

```
# service ceilometer-agent-compute restart
```

2. Restart the Compute service:

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

Configure the Image service

To retrieve image-oriented events and samples, configure the Image service to send notifications to the message bus. Perform these steps on the controller node.

Edit the `/etc/glance/glance-api.conf` and `/etc/glance/glance-registry.conf` files and complete the following actions:

1. In the `[DEFAULT]` section, configure notifications and RabbitMQ message broker access:

```
[DEFAULT]
...
notification_driver = messagingv2
rpc_backend = rabbit
rabbit_host = controller
rabbit_userid = openstack
rabbit_password = RABBIT_PASS
```

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

2. Restart the Image service:

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

Configure the Block Storage service

To retrieve volume-oriented events and samples, you must configure the Block Storage service to send notifications to the message bus. Perform these steps on the controller and storage nodes.

To configure prerequisites

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

1. In the `[DEFAULT]` section, configure notifications:

```
[DEFAULT]
...
control_exchange = cinder
notification_driver = messagingv2
```

2. Restart the Block Storage services on the controller node:

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

3. Restart the Block Storage services on the storage nodes:

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

4. Use the **cinder-volume-usage-audit** command to retrieve metrics on demand. For more information, see *Block Storage audit script setup to get notifications*.

Configure the Object Storage service

To retrieve storage-oriented events and samples, configure the Object Storage service to send notifications to the message bus.

To configure prerequisites

The Telemetry service requires access to the Object Storage service using the `ResellerAdmin` role. Perform these steps on the controller node.

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

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

2. Create the `ResellerAdmin` role:

```
$ openstack role create ResellerAdmin
+-------+----------------------------------+
| Field | Value                            |
+-------+----------------------------------+
| id    | 462fa46c13fd4798a95a3bfbe27b5e54 |
| name  | ResellerAdmin                    |
+-------+----------------------------------+
```

3. Add the `ResellerAdmin` role to the `service` tenant and `ceilometer` user:

```
$ openstack role add --project service --user ceilometer ResellerAdmin
+-------+----------------------------------+
| Field | Value                            |
+-------+----------------------------------+
| id    | 462fa46c13fd4798a95a3bfbe27b5e54 |
| name  | ResellerAdmin                    |
+-------+----------------------------------+
```

To configure notifications

Perform these steps on the controller and any other nodes that run the Object Storage proxy service.

1. Edit the `/etc/swift/proxy-server.conf` file and complete the following actions:

   a. In the `[filter:keystoneauth]` section, add the `ResellerAdmin` role:

```
[filter:keystoneauth]
...
operator_roles = admin,user,ResellerAdmin
```

b. In the `[pipeline:main]` section, add `ceilometer`:

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

c. In the `[filter:ceilometer]` section, configure notifications:

```
[filter:ceilometer]
...
paste.filter_factory = ceilometermiddleware.swift:filter_factory
control_exchange = swift
url = rabbit://openstack:RABBIT_PASS@controller:5672/
driver = messagingv2
topic = notifications
log_level = WARN
```

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

2. Add the `swift` system user to the `ceilometer` system group to permit access to the Telemetry configuration files by the Object Storage service:

```
# usermod -a -G ceilometer swift
```

3. Restart the Object Storage proxy service:

```
# service swift-proxy restart
```

Verify the Telemetry installation

This section describes how to verify operation of the Telemetry module.

Note

Perform these steps on the controller node.

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

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

2. List available meters:

```
$ ceilometer meter-list
+--------------+-------+-------+-------------------------------------
+---------+----------------------------------+
| Name         | Type  | Unit  | Resource ID                          |
 User ID | Project ID                       |
+--------------+-------+-------+-------------------------------------
+---------+----------------------------------+
| image        | gauge | image | acafc7c0-40aa-4026-9673-b879898e1fc2 |
 None    | cf12a15c5ea84b019aec3dc45580896b |
| image.size   | gauge | B     | acafc7c0-40aa-4026-9673-b879898e1fc2 |
 None    | cf12a15c5ea84b019aec3dc45580896b |
| image.update | delta | image | acafc7c0-40aa-4026-9673-b879898e1fc2 |
 None    | cf12a15c5ea84b019aec3dc45580896b |
```

```
| image.upload | delta | image | acafc7c0-40aa-4026-9673-b879898e1fc2 |
 None    | cf12a15c5ea84b019aec3dc45580896b |
+--------------+-------+-------+--------------------------------------
+---------+----------------------------------+
```

3. Download an image from the Image service:

```
$ IMAGE_ID=$(glance image-list | grep 'cirros-0.3.4-x86_64' | awk '{ print
 $2 }')
$ glance image-download $IMAGE_ID > /tmp/cirros.img
```

4. List available meters again to validate detection of the image download:

```
$ ceilometer meter-list
+----------------+-------+-------+--------------------------------------
+---------+----------------------------------+
| Name           | Type  | Unit  | Resource ID                          |
 User ID | Project ID                       |
+----------------+-------+-------+--------------------------------------
+---------+----------------------------------+
| image          | gauge | image | acafc7c0-40aa-4026-9673-b879898e1fc2 |
 None    | cf12a15c5ea84b019aec3dc45580896b |
| image.download | delta | B     | acafc7c0-40aa-4026-9673-b879898e1fc2 |
 None    | cf12a15c5ea84b019aec3dc45580896b |
| image.serve    | delta | B     | acafc7c0-40aa-4026-9673-b879898e1fc2 |
 None    | cf12a15c5ea84b019aec3dc45580896b |
| image.size     | gauge | B     | acafc7c0-40aa-4026-9673-b879898e1fc2 |
 None    | cf12a15c5ea84b019aec3dc45580896b |
| image.update   | delta | image | acafc7c0-40aa-4026-9673-b879898e1fc2 |
 None    | cf12a15c5ea84b019aec3dc45580896b |
| image.upload   | delta | image | acafc7c0-40aa-4026-9673-b879898e1fc2 |
 None    | cf12a15c5ea84b019aec3dc45580896b |
+----------------+-------+-------+--------------------------------------
+---------+----------------------------------+
```

5. Retrieve usage statistics from the `image.download` meter:

```
$ ceilometer statistics -m image.download -p 60
+--------+---------------------+---------------------+------------
+------------+------------+------------+-------+----------
+----------------------------+----------------------------+
| Period | Period Start        | Period End          | Max        | Min
     | Avg        | Sum        | Count | Duration | Duration Start
     | Duration End               |
+--------+---------------------+---------------------+------------
+------------+------------+------------+-------+----------
+----------------------------+----------------------------+
| 60     | 2015-04-21T12:21:45 | 2015-04-21T12:22:45 | 13200896.
0 | 13200896.0 | 13200896.0 | 13200896.0 | 1     | 0.0      |
 2015-04-21T12:22:12.983000 | 2015-04-21T12:22:12.983000 |
+--------+---------------------+---------------------+------------
+------------+------------+------------+-------+----------
+----------------------------+----------------------------+
```

6. Remove the previously downloaded image file `/tmp/cirros.img`:

```
$ rm /tmp/cirros.img
```

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. 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" [45] 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.

1. Source the demo tenant credentials:

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

2. Generate and add a key pair:

```
$ nova keypair-add demo-key
```

3. Verify addition of the key pair:

```
$ 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-0.3.4-x86_64 | ACTIVE |
     |
+--------------------------------------+---------------------+--------
+--------+
```

   Your first instance uses the `cirros-0.3.4-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-0.3.4-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-0.3.4-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` 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 |              | 1    |
 -           |             |
+--------------------------------------+-----------+--------------+------
+-------------+-------------+
```

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    |              | 1    |
 -           | 05682b91-81a1-464c-8f40-8b3da7ee92c5 |
+--------------------------------------+-----------+--------------+------
+-------------+--------------------------------------+
```

The ID of the `demo-volume1` volume should indicate `in-use` status 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-0.3.4-x86_64 | ACTIVE |
     |
+--------------------------------------+---------------------+--------
+--------+
```

Your first instance uses the `cirros-0.3.4-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-0.3.4-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-0.3.4-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` 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 |              | 1    |
 -           |             |
+--------------------------------------+-----------+--------------+------
+-------------+-------------+
```

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    |              | 1    |
 -           | 45ea195c-c469-43eb-83db-1a663bbad2fc |
+--------------------------------------+-----------+--------------+------
+-------------+--------------------------------------+
```

The ID of the `demo-volume1` volume should indicate `in-use` status 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.

Note

Some OpenStack packages generate and assign user IDs automatically during package installation. In these cases, the user ID value is not important. The existence of the user ID is what matters.

Table A.1. Reserved user IDs

Name	Description	ID
ceilometer	OpenStack ceilometer daemons	Assigned during package installation
cinder	OpenStack cinder daemons	Assigned during package installation
glance	OpenStack glance daemons	Assigned during package installation
heat	OpenStack heat daemons	Assigned during package installation
keystone	OpenStack keystone daemons	Assigned during package installation
neutron	OpenStack neutron daemons	Assigned during package installation
nova	OpenStack nova daemons	Assigned during package installation
swift	OpenStack swift daemons	Assigned during package installation
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 openSUSE 13.2 and SUSE Linux Enterprise Server 12*
- *Installation Guide for Red Hat Enterprise Linux 7, CentOS 7, and Fedora 21*
- *Installation Guide for Ubuntu 14.04 (LTS)*

The following books explain how to configure and run an OpenStack cloud:

- *Architecture Design Guide*
- *Cloud Administrator Guide*
- *Configuration Reference*
- *Operations Guide*
- *Networking 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)

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 OpenStack Compute, 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 service (ironic)
- Bugs: Data processing service (sahara)
- Bugs: Database service (trove)
- Bugs: Orchestration (heat)
- Bugs: Telemetry (ceilometer)
- Bugs: Message Service (zaqar)
- 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 https://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:** https://www.rdoproject.org/
- **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.

bare
: An Image service container format that indicates that no container exists for the VM image.

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.

Data processing service
: OpenStack project that provides a scalable data-processing stack and associated management interfaces. The code name for the project is sahara.

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.

DNS
: Domain Name Server. A hierarchical and distributed naming system for computers, services, and resources connected to the Internet or a private network. Associates a human-friendly names to IP addresses.

dnsmasq
: Daemon that provides DNS, DHCP, BOOTP, and TFTP services for virtual networks.

domain
: In the Identity service, provides isolation between projects and users.

  On the Internet, separates a website from other sites. Often, the domain name has two or more parts that are separated by dots. For example, yahoo.com, usa.gov, harvard.edu, or mail.yahoo.com.

  Also, a domain is an entity or container of all DNS-related information containing one or more records.

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 queue
: Passes requests from clients to the appropriate workers and returns the output to the client after the job completes.

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 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).

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.

project
: A logical grouping of users within Compute; defines quotas and access to VM images.

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.

QEMU Copy On Write 2 (QCOW2)
: One of the VM image disk formats supported by Image Service.

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.

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.

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 extensible LAN (VXLAN)
: A network virtualization technology that attempts to reduce the scalability problems associated with large cloud computing deployments. It uses a VLAN-like encapsulation technique to encapsulate Ethernet frames within UDP packets.

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.

VLAN network
: The Network Controller provides virtual networks to enable compute servers to interact with each other and with the public network. All machines must have a public and private network interface. A VLAN network is a private network interface, which is controlled by the `vlan_interface` option with VLAN managers.

XFS
: High-performance 64-bit file system created by Silicon Graphics. Excels in parallel I/O operations and data consistency.