

OpenStack Installation Guide for Red Hat Enterprise Linux, CentOS, and Fedora June 15, 2015

juno

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

juno (2015-06-15)

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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 shows you how to install OpenStack by using packages available through Fedora 20 as well as on Red Hat Enterprise Linux 7 and its derivatives through the EPEL repository. Explanations of configuration options and sample configuration files are included.

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# **Preface**

## **Conventions**

The OpenStack documentation uses several typesetting conventions.

## **Notices**

Notices take these forms:



#### Note

A handy tip or reminder.



## **Important**

Something you must be aware of before proceeding.



## Warning

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

## **Command prompts**

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

the \$ prompt.

# prompt The root user must run commands that are prefixed with the # prompt. You

can also prefix these commands with the **sudo** command, if available, to run

them.

# **Document change history**

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

The following table describes the most recent changes:

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

Revision Date Summary of Changes				
October 8, 2013	Complete reorganization for Havana.			
September 9, 2013	Build also for openSUSE.			
August 1, 2013	Fixes to Object Storage verification steps. Fix bug 1207347.			
July 25, 2013	Adds creation of cinder user and addition to the service tenant. Fix bug 1205057.			
May 8, 2013	Updated the book title for consistency.			
May 2, 2013	Updated cover and fixed small errors in appendix.			

# 1. Architecture

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## **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 et ment. Responsibilities include spawning, scheduling and decomposition sioning 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  Stores and retrieves arbitrary unstructured data objects via a RES HTTP based API. It is highly fault tolerant with its data replication scale out architecture. Its implementation is not like a file server with mountable directories.							
Block Storage	Cinder	Provides persistent block storage to running instances. Its pluggable driver architecture facilitates the creation and management of block storage devices.					
		Shared services					
Identity ser- vice	'						
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					

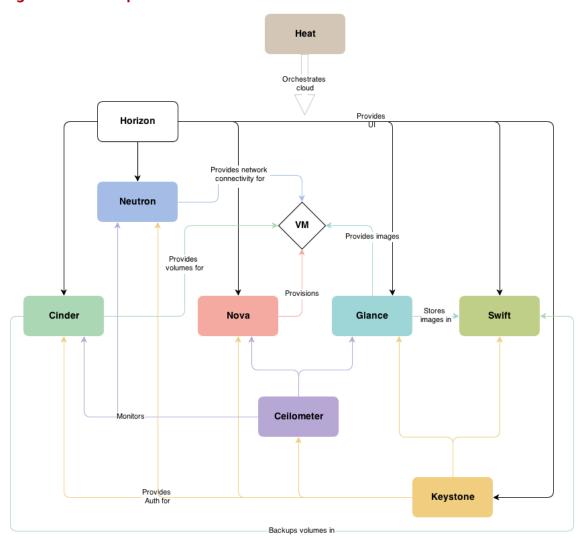
Service	Project name	Description
Orchestration	Heat	Orchestrates multiple composite cloud applications by using either the native <i>HOT</i> template format or the AWS CloudFormation template format, through both an OpenStack-native REST API and a CloudFormation-compatible Query API.
Database Ser- vice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

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



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# **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 metrics. 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 metrics. 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)" [83] in Chapter 6, "Add a networking compo-

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nent" [59]. Optional services might require additional nodes or additional resources on existing nodes.

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

# Minimal Architecture Example - Hardware Requirements OpenStack Networking (neutron)

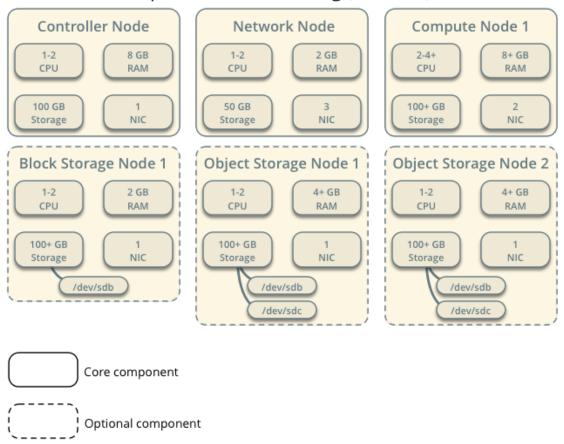
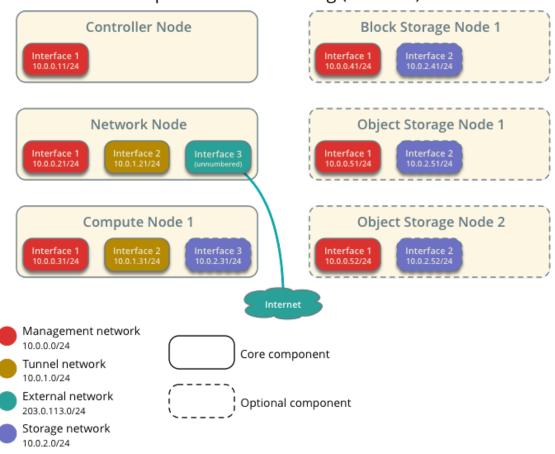


Figure 1.3. Minimal architecture example with OpenStack Networking (neutron)—Network layout

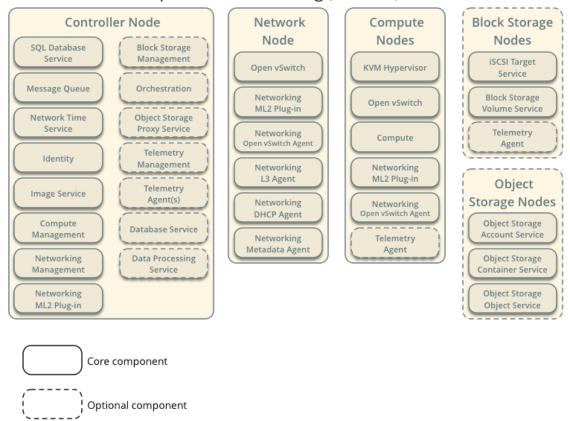
# Minimal Architecture Example - Network Layout OpenStack Networking (neutron)



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

## Minimal Architecture Example - Service Layout OpenStack Networking (neutron)



- 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 metrics. 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 metrics. 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**

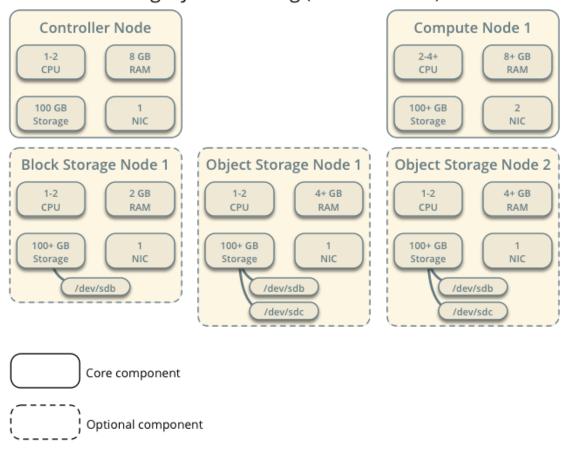
When you implement this architecture, skip the section called "OpenStack Networking (neutron)" [59] in Chapter 6, "Add a networking component" [59]. To use optional services, you might need to build additional nodes, as described in subsequent chapters.

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Figure 1.5. Minimal architecture example with legacy networking (novanetwork)—Hardware requirements

## Minimal Architecture Example - Hardware Requirements Legacy Networking (nova-network)



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Figure 1.6. Minimal architecture example with legacy networking (novanetwork)—Network layout

# Minimal Architecture Example - Network Layout Legacy Networking (nova-network)

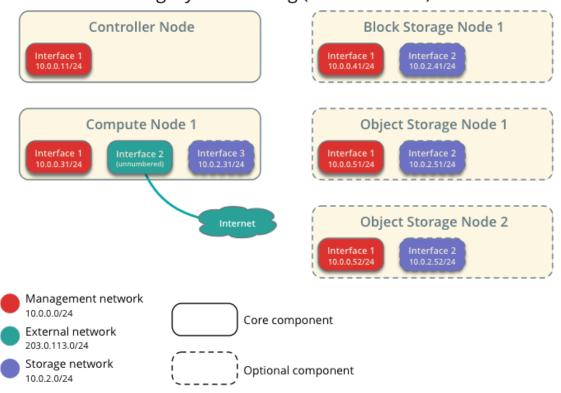
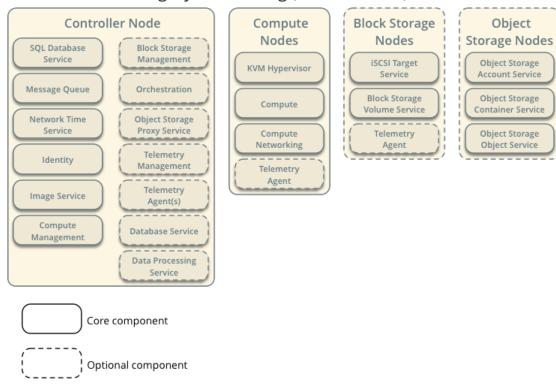


Figure 1.7. Minimal architecture example with legacy networking (novanetwork)—Service layout

## Minimal Architecture Example - Service Layout Legacy Networking (nova-network)



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# 2. Basic environment

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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 Open-Stack 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" [99] 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

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- 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
RABBIT_PASS	Password of user guest of RabbitMQ
KEYSTONE_DBPASS	Database password of Identity service
DEMO_PASS	Password of user demo
ADMIN_PASS	Password of user admin
GLANCE_DBPASS	Database password for Image Service
GLANCE_PASS	Password of Image Service user glance
NOVA_DBPASS	Database password for Compute service
NOVA_PASS	Password of Compute service user nova
DASH_DBPASS	Database password for the dashboard
CINDER_DBPASS	Database password for the Block Storage service
CINDER_PASS	Password of Block Storage service user cinder
NEUTRON_DBPASS	Database password for the Networking service
NEUTRON_PASS	Password of Networking service user neutron
HEAT_DBPASS	Database password for the Orchestration service
HEAT_PASS	Password of Orchestration service user heat
CEILOMETER_DBPASS	Database password for the Telemetry service
CEILOMETER_PASS	Password of Telemetry service user ceilometer
TROVE_DBPASS	Database password of Database service
TROVE_PASS	Password of Database Service user trove

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

# Networking

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

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

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

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#### Note

All nodes require Internet access to install OpenStack packages and perform maintenance tasks such as periodic updates. In most cases, nodes should obtain Internet access through the management network interface. For simplicity, the network diagrams in this guide only show Internet access for OpenStack network services.

## **OpenStack Networking (neutron)**

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

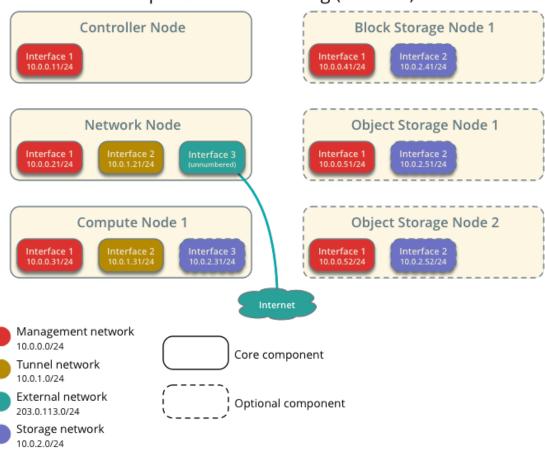


#### Note

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

Figure 2.1. Minimal architecture example with OpenStack Networking (neutron)—Network layout

# Minimal Architecture Example - Network Layout OpenStack Networking (neutron)



Unless you intend to use the exact configuration provided in this example architecture, you must modify the networks in this procedure to match your environment. Also, each node must resolve the other nodes by name in addition to IP address. For example, the continetroller name must resolve to 10.0.11, 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:

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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:

#### **Network node**

#### To configure networking:

1. Configure the first interface as the management interface:

IP address: 10.0.0.21

Network mask: 255.255.255.0 (or /24)

Default gateway: 10.0.0.1

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

IP address: 10.0.1.21

Network mask: 255.255.255.0 (or /24)

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

Replace *INTERFACE\_NAME* with the actual interface name. For example, *eth2* or *ens256*.

• Edit the /etc/sysconfig/network-scripts/ifcfg-INTERFACE\_NAME file to contain the following:

Do not change the HWADDR and UUID keys.

```
DEVICE=INTERFACE_NAME

TYPE=Ethernet

ONBOOT="yes"

BOOTPROTO="none"
```

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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:

## **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.

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:

## 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=3 ttl=54 time=17.4 ms
--- openstack.org ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3022ms
rtt min/avg/max/mdev = 17.489/17.715/18.346/0.364 ms
```

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

```
# ping -c 4 network
PING network (10.0.0.21) 56(84) bytes of data.
64 bytes from network (10.0.0.21): icmp_seq=1 ttl=64 time=0.263 ms
64 bytes from network (10.0.0.21): icmp_seq=2 ttl=64 time=0.202 ms
64 bytes from network (10.0.0.21): icmp_seq=3 ttl=64 time=0.203 ms
64 bytes from network (10.0.0.21): icmp_seq=4 ttl=64 time=0.202 ms
--- network ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.202/0.217/0.263/0.030 ms
```

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

```
# ping -c 4 compute1
PING compute1 (10.0.0.31) 56(84) bytes of data.
64 bytes from compute1 (10.0.0.31): icmp_seq=1 ttl=64 time=0.263 ms
64 bytes from compute1 (10.0.0.31): icmp_seq=2 ttl=64 time=0.202 ms
64 bytes from compute1 (10.0.0.31): icmp_seq=3 ttl=64 time=0.203 ms
64 bytes from compute1 (10.0.0.31): icmp_seq=4 ttl=64 time=0.202 ms
--- network ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.202/0.217/0.263/0.030 ms
```

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

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

```
64 bytes from 174.143.194.225: icmp_seq=3 ttl=54 time=17.5 ms
64 bytes from 174.143.194.225: icmp_seq=4 ttl=54 time=17.4 ms

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

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

```
# ping -c 4 controller
PING controller (10.0.0.11) 56(84) bytes of data.
64 bytes from controller (10.0.0.11): icmp_seq=1 ttl=64 time=0.263 ms
64 bytes from controller (10.0.0.11): icmp_seq=2 ttl=64 time=0.202 ms
64 bytes from controller (10.0.0.11): icmp_seq=3 ttl=64 time=0.203 ms
64 bytes from controller (10.0.0.11): icmp_seq=4 ttl=64 time=0.202 ms
--- controller ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.202/0.217/0.263/0.030 ms
```

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

```
# ping -c 4 10.0.1.31
PING 10.0.1.31 (10.0.1.31) 56(84) bytes of data.
64 bytes from 10.0.1.31 (10.0.1.31): icmp_seq=1 ttl=64 time=0.263 ms
64 bytes from 10.0.1.31 (10.0.1.31): icmp_seq=2 ttl=64 time=0.202 ms
64 bytes from 10.0.1.31 (10.0.1.31): icmp_seq=3 ttl=64 time=0.203 ms
64 bytes from 10.0.1.31 (10.0.1.31): icmp_seq=4 ttl=64 time=0.202 ms
--- 10.0.1.31 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.202/0.217/0.263/0.030 ms
```

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

```
# ping -c 4 openstack.org
PING openstack.org (174.143.194.225) 56(84) bytes of data.
64 bytes from 174.143.194.225: icmp_seq=1 ttl=54 time=18.3 ms
64 bytes from 174.143.194.225: icmp_seq=2 ttl=54 time=17.5 ms
64 bytes from 174.143.194.225: icmp_seq=3 ttl=54 time=17.5 ms
64 bytes from 174.143.194.225: icmp_seq=4 ttl=54 time=17.4 ms
--- openstack.org ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3022ms
rtt min/avg/max/mdev = 17.489/17.715/18.346/0.364 ms
```

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

```
# ping -c 4 controller
PING controller (10.0.0.11) 56(84) bytes of data.
64 bytes from controller (10.0.0.11): icmp_seq=1 ttl=64 time=0.263 ms
64 bytes from controller (10.0.0.11): icmp_seq=2 ttl=64 time=0.202 ms
64 bytes from controller (10.0.0.11): icmp_seq=3 ttl=64 time=0.203 ms
64 bytes from controller (10.0.0.11): icmp_seq=4 ttl=64 time=0.202 ms
--- controller ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.202/0.217/0.263/0.030 ms
```

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

```
# ping -c 4 10.0.1.21
PING 10.0.1.21 (10.0.1.21) 56(84) bytes of data.
64 bytes from 10.0.1.21 (10.0.1.21): icmp_seq=1 ttl=64 time=0.263 ms
64 bytes from 10.0.1.21 (10.0.1.21): icmp_seq=2 ttl=64 time=0.202 ms
64 bytes from 10.0.1.21 (10.0.1.21): icmp_seq=3 ttl=64 time=0.203 ms
64 bytes from 10.0.1.21 (10.0.1.21): icmp_seq=4 ttl=64 time=0.202 ms
--- 10.0.1.21 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.202/0.217/0.263/0.030 ms
```

## Legacy networking (nova-network)

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



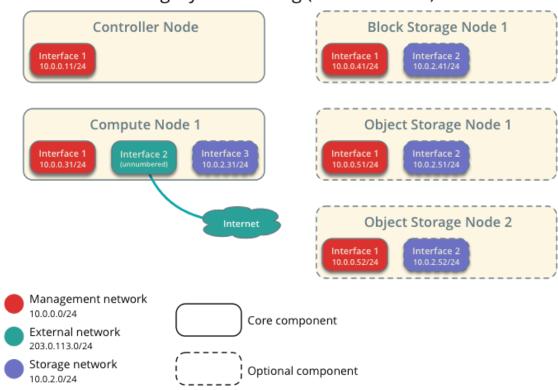
#### **Note**

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

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Figure 2.2. Minimal architecture example with legacy networking (novanetwork)—Network layout

# Minimal Architecture Example - Network Layout Legacy Networking (nova-network)



Unless you intend to use the exact configuration provided in this example architecture, you must modify the networks in this procedure to match your environment. Also, each node must resolve the other nodes by name in addition to IP address. For example, the controller name must resolve to 10.0.11, 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)

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Default gateway: 10.0.0.1

Reboot the system to activate the changes.

### To configure name resolution:

- 1. Set the hostname of the node to controller.
- 2. Edit the /etc/hosts file to contain the following:

```
# controller
10.0.0.11
                controller
# compute1
10.0.0.31
                compute1
```

## Compute node

## To configure networking:

1. Configure the first interface as the management interface:

IP address: 10.0.0.31

Network mask: 255.255.255.0 (or /24)

Default gateway: 10.0.0.1



#### Note

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

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

Replace INTERFACE\_NAME with the actual interface name. For example, eth1 or ens224.

Edit the /etc/sysconfig/network-scripts/ifcfg-INTERFACE\_NAME file to contain the following:

Do not change the HWADDR and UUID keys.

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

Reboot the system to activate the changes.

#### To configure name resolution:

- Set the hostname of the node to compute1.
- Edit the /etc/hosts file to contain the following:

## **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=3 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
```

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juno

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

# **Network Time Protocol (NTP)**

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

## **Controller node**

#### To install the NTP service

# yum install ntp

### To configure the NTP service

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

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

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

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



#### Note

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

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

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

## Other nodes

#### To install the NTP service

# yum install ntp

#### To configure the NTP service

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

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

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

```
server controller iburst
```

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

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

# **Verify operation**

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

1. Run this command on the controller node:

<pre># ntpq -c peers     remote     jitter</pre>	refid	stt	when p	oll :	reach	delay	offset
===========	=========	=====	=====	====	=====:	======	
====							
*ntp-server1 5.483	192.0.2.11	2 u	169 1	024	377	1.901	-0.611
+ntp-server2 2.864	192.0.2.12	2 u	887 1	024	377	0.922	-0.246

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:

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

3. Run this command on all other nodes:

<pre># ntpq -c peers     remote jitter</pre>	refid	st t w	hen pol	ll reach	delay	offset
*controller	192.0.2.21	3 u	47 (	54 37	0.308	-0.251

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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:

Contents in the condition column should indicate sys.peer.

# **OpenStack packages**

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



#### Note

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

## To configure prerequisites

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

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

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

```
# yum install http://dl.fedoraproject.org/pub/epel/7/x86_64/e/epel-
release-7-5.noarch.rpm
```



#### Note

Fedora does not require this package.

## To enable the OpenStack repository

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

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

#### To finalize installation

Upgrade the packages on your system:

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# yum upgrade



#### Note

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

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

# yum install openstack-selinux



#### Note

Fedora does not require this package.



#### Note

The installation process for this package can take a while.

## **Database**

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

### To install and configure the database server

Install the packages:



#### **Note**

The Python MySQL library is compatible with MariaDB.

# yum install mariadb mariadb-server MySQL-python

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

<u>'</u>

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

#### To finalize installation

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

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

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

```
# mysql_secure_installation
```

# **Messaging server**

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

- RabbitMQ
- Qpid
- ZeroMQ

#### To install the RabbitMQ message broker service

# yum install rabbitmq-server

#### To configure the message broker service

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

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

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

Run the following command:

Replace RABBIT\_PASS with a suitable password.

```
# rabbitmqctl change_password guest RABBIT_PASS
```

```
Changing password for user "guest" ...
```

You must configure the rabbit\_password key in the configuration file for each OpenStack service that uses the message broker.



### Note

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

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

- 3. For RabbitMQ version 3.3.0 or newer, you must enable remote access for the guest account.
  - a. Check the RabbitMQ version:

```
# rabbitmqctl status | grep rabbit
Status of node 'rabbit@controller' ...
{running_applications,[{rabbit,"RabbitMQ","3.4.2"},
```

b. If necessary, edit the /etc/rabbitmq/rabbitmq.config file and configure loopback\_users to reference an empty list:

```
[{rabbit, [{loopback_users, []}]}].
```



## Note

Contents of the original file might vary depending on the source of the RabbitMQ package. In some cases, you might need to create this file.

c. Restart the message broker service:

```
# systemctl restart rabbitmq-server.service
```

# 3. Add the Identity service

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# **OpenStack Identity concepts**

The OpenStackIdentity 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 Open-Stack 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 incom-
	ing 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 pro-

vided 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 sup-

plied 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 fi-

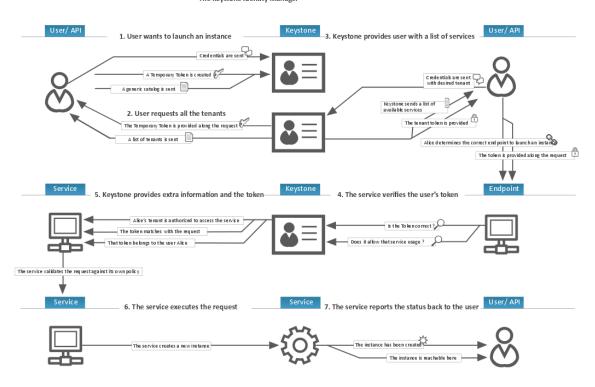
nite duration.

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and reading	While OpenStack Identity supports token-based authentication in this release, the intention is to support additional protocols in the ture. Its main purpose is to be an integration service, and not aspir 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 te ant 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 endpoir 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 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 <b>keystone service-create</b> and <b>keystone end-point-create</b> commands to register services in their OpenStack inst

enStack Identity API. For examice-create and keystone endpoint-create commands to register services in their OpenStack installations.

The following diagram shows the OpenStack Identity process flow:

The Keystone Identity Manager



# Install and configure

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

## To configure prerequisites

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

- 1. To create the database, complete these steps:
  - a. Use the database access client to connect to the database server as the root user:

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

b. Create the keystone database:

```
CREATE DATABASE keystone;
```

c. Grant proper access to the keystone database:

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

Replace KEYSTONE\_DBPASS with a suitable password.

<u>'</u>

- d. Exit the database access client.
- 2. Generate a random value to use as the administration token during initial configura-

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

## To install and configure the components

1. Run the following command to install the packages:

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

- 2. Edit the /etc/keystone/keystone.conf file and complete the following actions:
  - a. In the [DEFAULT] section, define the value of the initial administration token:

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

Replace ADMIN\_TOKEN with the random value that you generated in a previous step.

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

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

Replace KEYSTONE DBPASS with the password you chose for the database.

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

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

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

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

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

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

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

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

```
# chmod -R o-rwx /etc/keystone/ssl
```

4. Populate the Identity service database:

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

### To finalize installation

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

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

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

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

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

# Create tenants, users, and roles

After you install the Identity service, create *tenants* (projects), *users*, and *roles* for your environment. You must use the temporary administration token that you created in the section called "Install and configure" [32] and manually configure the location (endpoint) of the Identity service before you run **keystone** commands.

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

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

## To configure prerequisites

1. Configure the administration token:

```
$ export OS_SERVICE_TOKEN=ADMIN_TOKEN
```

Replace ADMIN\_TOKEN with the administration token that you generated in the section called "Install and configure" [32]. For example:

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

2. Configure the endpoint:

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

oun - Juno - Juno

## To create tenants, users, and roles

- Create an administrative tenant, user, and role for administrative operations in your environment:
  - Create the admin tenant:





### Note

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

Create the admin user:



Replace ADMIN\_PASS with a suitable password and EMAIL\_ADDRESS with a suitable e-mail address.

Create the admin role:

Property   Value	\$ keystone	role-createname admin
	Property	Value
		<u> </u>

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

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



### Note

This command provides no output.

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### Note

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

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

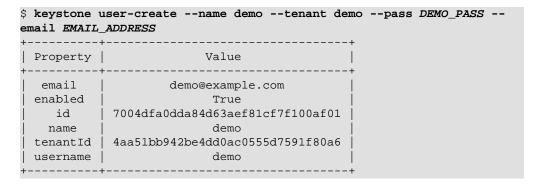
\$ keystone tena	ant-createname demodescription	"Demo Tenant"
Property	Value	
description enabled id name	Demo Tenant   True   4aa51bb942be4dd0ac0555d7591f80a6   demo	



## **Note**

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

b. Create the demo user under the demo tenant:



Replace <code>DEMO\_PASS</code> with a suitable password and <code>EMAIL\_ADDRESS</code> with a suitable e-mail address.



### Note

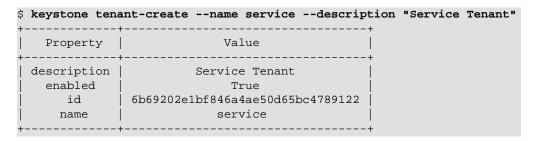
Using the --tenant option automatically assigns the \_member\_ role to a user. This option will also create the \_member\_ role if it does not exist.



### Note

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

- 3. OpenStack services also require a tenant, user, and role to interact with other services. Each service typically requires creating one or more unique users with the admin role under the service tenant.
  - Create the service tenant:



# Create the service entity and API endpoint

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

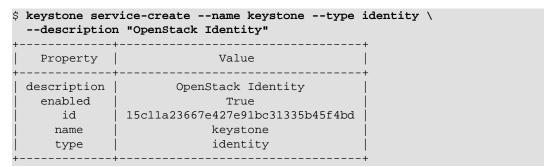
## To configure prerequisites

• Set the OS\_SERVICE\_TOKEN and OS\_SERVICE\_ENDPOINT environment variables, as described in the section called "Create tenants, users, and roles" [34].

## To create the service entity and API endpoints

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

Create the service entity for the Identity service:





### Note

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

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

OpenStack provides three API endpoint variations for each service: admin, internal, and public. In a production environment, the variants might reside on separate net-

works that service different types of users for security reasons. Also, OpenStack supports multiple regions for scalability. For simplicity, this configuration uses the management network for all endpoint variations and the regionOne region.

Create the Identity service API endpoints:



### Note

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



### Note

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

# **Verify operation**

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

1. Unset the temporary OS\_SERVICE\_TOKEN and OS\_SERVICE\_ENDPOINT environment variables:

```
$ unset OS_SERVICE_TOKEN OS_SERVICE_ENDPOINT
```

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

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

3. As the admin tenant and user, list tenants to verify that the admin tenant and user can execute admin-only CLI commands and that the Identity service contains the tenants that you created in the section called "Create tenants, users, and roles" [34]:



## Note

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

4. As the admin tenant and user, list users to verify that the Identity service contains the users that you created in the section called "Create tenants, users, and roles" [34]:

5. As the admin tenant and user, list roles to verify that the Identity service contains the role that you created in the section called "Create tenants, users, and roles" [34]:

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

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Replace *DEMO\_PASS* with the password you chose for the demo user in the Identity service.

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

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



## Note

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

# **Create OpenStack client environment scripts**

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

## To create the scripts

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

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

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

Replace ADMIN\_PASS with the password you chose for the admin user in the Identity service.

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

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

Replace DEMO\_PASS with the password you chose for the demo user in the Identity service.



# **Identity ports**

Note the two different ports used above. Port 35357 is used for administrative functions only. Port 5000 is for normal user functions and is the most commonly used.

# To load client environment scripts

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

\$ source admin-openrc.sh

# 4. Add the Image Service

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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 (laaS) 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.

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# 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 deploy-

ments 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" [32] and the section called "Verify operation" [38].

## To configure prerequisites

Before you install and configure the Image Service, 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 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:

\$ keystone u	user-createname glancepass GI	LANCE_PASS
Property	Value	-+
email enabled id name username	True   f89cca5865dc42b18e2421fa5f5cce66   glance   glance	       

Replace GLANCE\_PASS with a suitable password.

b. Add the admin role to the glance user:

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



### Note

This command provides no output.

c. Create the glance service entity:

4. Create the Image Service API endpoints:

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

\_

## To install and configure the Image Service components

1. Install the packages:

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

- 2. Edit the /etc/glance/glance-api.conf file and complete the following actions:
  - a. In the [database] section, configure database access:

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

Replace *GLANCE\_DBPASS* with the password you chose for the Image Service database.

b. In the [keystone\_authtoken] and [paste\_deploy] sections, configure Identity service access:

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

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

Replace *GLANCE\_PASS* with the password you chose for the glance user in the Identity service.



## Note

Comment out any auth\_host, auth\_port, and auth\_protocol options because the identity\_uri option replaces them.

c. In the [glance\_store] section, configure the local file system store and location of image files:

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

d. 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 [DE-FAULT] section:

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

- 3. Edit the /etc/glance/glance-registry.conf file and complete the following actions:
  - a. In the [database] section, configure database access:

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

Replace *GLANCE\_DBPASS* with the password you chose for the Image Service database.

b. In the [keystone\_authtoken] and [paste\_deploy] sections, configure Identity service access:

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

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

Replace *GLANCE\_PASS* with the password you chose for the glance user in the Identity service.



### Note

Comment out any auth\_host, auth\_port, and auth\_protocol options because the identity\_uri option replaces them.

c. In the <code>[DEFAULT]</code> section, configure the <code>noop</code> 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 [DE-FAULT] section:

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

4. Populate the Image Service database:

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

### To finalize installation

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

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

# **Verify operation**

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

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

1. Create and change into a temporary local directory:

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

2. Download the image to the temporary local directory:

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

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

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

4. Upload the image to the Image Service:

```
$ glance image-create --name "cirros-0.3.3-x86_64" --file /tmp/images/
cirros-0.3.3-x86_64-disk.img \
 --disk-format qcow2 --container-format bare --is-public True --progress
[========] 100%
Property
                Value
 checksum | 133eae9fb1c98f45894a4e60d8736619
 container_format | bare
 created_at
                2014-10-10T13:14:42
 deleted
                 False
 deleted at
                 None
 disk_format
                 | qcow2
                 acafc7c0-40aa-4026-9673-b879898e1fc2
 id
                  True
 is_public
 min_disk
```

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min_ram	0
name	cirros-0.3.3-x86_64
owner	ea8c352d253443118041c9c8b8416040
protected	False
size	13200896
status	active
updated_at	2014-10-10T13:14:43
virtual_size	None
+	++

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

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



## **Note**

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

5. Confirm upload of the image and validate attributes:

6. Remove the temporary local directory:

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

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# 5. Add the Compute service

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# **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 ADI th

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 no-

va-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  ${\tt nova-api}$  pack-

age, 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

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nStack Installation Guide for Hat Enterprise Linux, CentOS,	June 15, 2015 juno
Fedora	libvirt for KVM or QEMU
	VMwareAPI for VMware
	Processing is fairly complex. Basically, the daemon accepts actions from the queue and performs a series of system commands such as launching a KVM instance and updating its state in the database.
nova-scheduler service	Takes a virtual machine instance request from the queue and determines on which compute server host it runs.
nova-conductor module	Mediates interactions between the nova-compute service and the database. It eliminates direct accesses to the cloud database made by the nova-compute service. The nova-conductor module scales horizontally. However, do not deploy it on nodes where the nova-compute service runs. For more information, see A new Nova service: nova-conductor.
Networking for VMs	
nova-network worker dae- mon	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.
nova-conductor module  Networking for VMs  nova-network worker dae-	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.  Takes a virtual machine instance request from the queue and determines on which compute server host i runs.  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.  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

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### **Console interface**

nova-consoleauth daemon Authorizes tokens for users that console proxies pro-

vide. See nova-novncproxy and nova-xvpn-

vcproxy. 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 dae-

mon

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

HTML5 client.

nova-xvpnvncproxy daemon Provides a proxy for accessing running instances

through a VNC connection. Supports an OpenStack-spe-

cific Java client.

nova-cert daemon x509 certificates.

## Image management (EC2 scenario)

nova-objectstore daemon An S3 interface for registering images with the Open-

Stack 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 man-

aging 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 imple-

mented with RabbitMQ, but can be implemented with an AMQP mes-

sage queue, such as Apache Qpid or Zero MQ.

**SQL database** Stores most build-time and run-time states for a cloud infrastructure, in-

cluding:

· 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 endpoints.

- 1. To create the database, complete these steps:
  - a. Use the database access client to connect to the database server as the root user:

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

b. Create the nova database:

```
CREATE DATABASE nova;
```

c. Grant proper access to the nova database:

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

Replace NOVA\_DBPASS with a suitable password.

- d. Exit the database access client.
- 2. Source the admin credentials to gain access to admin-only CLI commands:

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

- 3. To create the service credentials, complete these steps:
  - a. Create the nova user:

+-----+

Replace NOVA PASS with a suitable password.

b. Add the admin role to the nova user:

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



## **Note**

This command provides no output.

c. Create the nova service entity:

4. Create the Compute service API endpoints:

## To install and configure Compute controller components

1. Install the packages:

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

- 2. Edit the /etc/nova/nova.conf file and complete the following actions:
  - a. In the [database] section, configure database access:

\_

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

Replace NOVA\_DBPASS with the password you chose for the Compute database.

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

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

Replace RABBIT\_PASS with the password you chose for the guest account in RabbitMQ.

c. In the [DEFAULT] and [keystone\_authtoken] sections, configure Identity service access:

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

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

Replace  $NOVA\_PASS$  with the password you chose for the nova user in the Identity service.



### Note

Comment out any auth\_host, auth\_port, and auth\_protocol options because the identity\_uri option replaces them.

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

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

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

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

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

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

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

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

3. Populate the Compute database:

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

## To finalize installation

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

# 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

1. Install the packages:

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

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

<u>'</u>

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

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

Replace RABBIT\_PASS with the password you chose for the guest account in RabbitMQ.

b. In the [DEFAULT] and [keystone\_authtoken] sections, configure Identity service access:

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

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

Replace NOVA\_PASS with the password you chose for the nova user in the Identity service.



### Note

Comment out any auth\_host, auth\_port, and auth\_protocol options because the identity\_uri option replaces them.

c. In the [DEFAULT] section, configure the my\_ip option:

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

Replace MANAGEMENT\_INTERFACE\_IP\_ADDRESS with the IP address of the management network interface on your compute node, typically 10.0.0.31 for the first node in the example architecture.

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

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

The server component listens on all IP addresses and the proxy component only listens on the management interface IP address of the compute node. The base URL

ı

indicates the location where you can use a web browser to access remote consoles of instances on this compute node.

Replace MANAGEMENT\_INTERFACE\_IP\_ADDRESS with the IP address of the management network interface on your compute node, typically 10.0.0.31 for the first node in the example architecture.



## Note

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

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

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

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

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

### To finalize installation

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

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

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

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

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

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

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

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

# **Verify operation**

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

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## Note

Perform these commands on the controller node.

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

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

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

nova service-list				
<del>-</del>			+	+
Id   Binary	Host	Zone	Status	State
Updated_at	Disabled	l Reason		
+			+	+
1   nova-conductor	controller	internal	enabled	up
2014-09-16T23:54:02.000	000   -			
2 nova-consoleauth	controller	internal	enabled	up
2014-09-16T23:54:04.000	000   -			
3   nova-scheduler	controller	internal	enabled	up
2014-09-16T23:54:07.000				
4   nova-cert	controller	internal	enabled	up
2014-09-16T23:54:00.000	000   -		'	· '
5   nova-compute	compute1	nova	enabled	up
2014-09-16T23:54:06.000	' - '	1		
+			+	+
	+	+		



## Note

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

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

# 6. Add a networking component

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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. Open-Stack 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:

Accepts and routes API requests to the appropriate neutron-server

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, Ryu Network Operating System, 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.

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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 endpoints.

- 1. To create the database, complete these steps:
  - a. Use the database access client to connect to the database server as the root user:

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

b. Create the neutron database:

```
CREATE DATABASE neutron;
```

c. Grant proper access to the neutron database:

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

Replace NEUTRON DBPASS with a suitable password.

- d. Exit the database access client.
- 2. Source the admin credentials to gain access to admin-only CLI commands:

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

- 3. To create the service credentials, complete these steps:
  - a. Create the neutron user:

Property   Value   email	_	ser-createname neutronpass N	EUTRON_PASS
enabled   True   id   7fd67878dcd04d0393469ef825a7e005	Property		
username neutron	enabled id	7fd67878dcd04d0393469ef825a7e005 neutron	+       

Replace NEUTRON\_PASS with a suitable password.

b. Add the admin role to the neutron user:

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



# **Note**

This command provides no output.

c. Create the neutron service entity:

4. Create the Networking service API endpoints:

# To install the Networking components

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

# To configure the Networking server component

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

- Edit the /etc/neutron/neutron.conf file and complete the following actions:
  - a. In the [database] section, configure database access:

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

Replace NEUTRON\_DBPASS with the password you chose for the database.

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

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

\_

Replace RABBIT\_PASS with the password you chose for the guest account in RabbitMO.

c. In the [DEFAULT] and [keystone\_authtoken] sections, configure Identity service access:

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

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

Replace NEUTRON\_PASS with the password you chose or the neutron user in the Identity service.



### Note

Comment out any auth\_host, auth\_port, and auth\_protocol options because the identity\_uri option replaces them.

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

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

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

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

Replace SERVICE\_TENANT\_ID with the service tenant identifier (id) in the Identity service and NOVA\_PASS with the password you chose for the nova user in the Identity service.



### Note

To obtain the service tenant identifier (id):

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

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

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

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

- Edit the /etc/neutron/plugins/ml2/ml2\_conf.ini file and complete the following actions:
  - a. In the [ml2] section, enable the *flat* and *generic routing encapsulation (GRE)* network type drivers, GRE tenant networks, and the OVS mechanism driver:

```
[m12]
...
type_drivers = flat,gre
tenant_network_types = gre
mechanism drivers = openvswitch
```



# Warning

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

b. In the [ml2\_type\_gre] section, configure the tunnel identifier (id) range:

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

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
```

<u>'</u>

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

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

2. Populate the database:

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



#### Note

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

3. Restart the Compute services:

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

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

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

### **Verify operation**



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#### 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:

alias	<pre>\$ neutron ext-list +</pre>	
13_agent_scheduler	alias	name
extra_dhcp_opt	13_agent_scheduler   ext-gw-mode   binding   provider   agent   quotas   dhcp_agent_scheduler   13-ha   multi-provider   external-net   router   allowed-address-pairs   extraroute   extra_dhcp_opt	L3 Agent Scheduler  Neutron L3 Configurable external gateway mode  Port Binding  Provider Network  agent  Quota management support  DHCP Agent Scheduler  HA Router extension  Multi Provider Network  Neutron external network  Neutron L3 Router  Allowed Address Pairs  Neutron Extra Route  Neutron Extra DHCP opts

# Install and configure network node

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

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## To configure prerequisites

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

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

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

2. Implement the changes:

```
# sysctl -p
```

#### To install the Networking components

 # yum install openstack-neutron openstack-neutron-ml2 openstack-neutronopenvswitch

## To configure the Networking common components

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

- Edit the /etc/neutron/neutron.conf file and complete the following actions:
  - a. In the [database] section, comment out any connection options because network nodes do not directly access the database.
  - b. In the [DEFAULT] section, configure RabbitMQ message broker access:

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

Replace RABBIT\_PASS with the password you chose for the guest account in RabbitMO.

c. In the [DEFAULT] and [keystone\_authtoken] sections, configure Identity service access:

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

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

Replace NEUTRON\_PASS with the password you chose or the neutron user in the Identity service.

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#### Note

Comment out any auth\_host, auth\_port, and auth\_protocol options because the identity\_uri option replaces them.

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

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

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

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

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

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

- Edit the /etc/neutron/plugins/ml2/ml2\_conf.ini file and complete the following actions:
  - a. In the [ml2] section, enable the *flat* and *generic routing encapsulation (GRE)* network type drivers, GRE tenant networks, and the OVS mechanism driver:

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

b. In the [ml2\_type\_flat] section, configure the external 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
enable_tunneling = True
bridge_mappings = external:br-ex
```

Replace INSTANCE\_TUNNELS\_INTERFACE\_IP\_ADDRESS with the IP address of the instance tunnels network interface on your network node.

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/13\_agent.ini file and complete the following actions:
  - a. In the [DEFAULT] section, configure the driver, enable *network namespaces*, configure the external network bridge and enable deletion of defunct router namespaces:

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

b. (Optional) To assist with troubleshooting, enable verbose logging in the [DE-FAULT] section:

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

### To configure the DHCP agent

The DHCP agent provides DHCP services for virtual networks.

- 1. Edit the /etc/neutron/dhcp\_agent.ini file and complete the following actions:
  - a. In the [DEFAULT] section, configure the drivers, enable namespaces and enable deletion of defunct DHCP namespaces:

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

b. (Optional) To assist with troubleshooting, enable verbose logging in the [DE-FAULT] section:

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

#### 2. (Optional)

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

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



#### Note

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

- a. Edit the /etc/neutron/dhcp\_agent.ini file and complete the following action:
  - In the [DEFAULT] section, enable the dnsmasq configuration file:

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

- b. Create and edit the /etc/neutron/dnsmasq-neutron.conf file and complete the following action:
  - Enable the DHCP MTU option (26) and configure it to 1454 bytes:

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

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c. Kill any existing dnsmasq processes:

```
# pkill dnsmasq
```

## To configure the metadata agent

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

- Edit the /etc/neutron/metadata\_agent.ini file and complete the following actions:
  - a. In the [DEFAULT] section, configure access parameters:

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

Replace NEUTRON\_PASS with the password you chose for the neutron user in the Identity service.

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

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

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

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

Replace METADATA\_SECRET with a suitable secret for the metadata proxy.

d. (Optional) To assist with troubleshooting, enable verbose logging in the [DE-FAULT] section:

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

- 2. On the controller node, edit the /etc/nova/nova.conf file and complete the following action:
  - In the [neutron] section, enable the metadata proxy and configure the secret:

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

Replace METADATA\_SECRET with the secret you chose for the metadata proxy.

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

# systemctl restart openstack-nova-api.service

## To configure the Open vSwitch (OVS) service

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

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

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

2. Add the external bridge:

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

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

Replace INTERFACE\_NAME with the actual interface name. For example, eth2 or ens256

# ovs-vsctl add-port br-ex INTERFACE\_NAME



#### Note

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

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

# ethtool -K INTERFACE\_NAME gro off

#### To finalize the installation

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

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

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

# cp /usr/lib/systemd/system/neutron-openvswitch-agent.service \

```
/usr/lib/systemd/system/neutron-openvswitch-agent.service.orig

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

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

```
# systemctl enable neutron-openvswitch-agent.service neutron-13-agent.
service \
   neutron-dhcp-agent.service neutron-metadata-agent.service \
   neutron-ovs-cleanup.service
# systemctl start neutron-openvswitch-agent.service neutron-13-agent.
service \
   neutron-dhcp-agent.service neutron-metadata-agent.service
```



#### Note

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

#### **Verify operation**



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# **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:

# 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.

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

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

2. Implement the changes:

```
# sysctl -p
```

## To install the Networking components

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

## To configure the Networking common components

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

- Edit the /etc/neutron/neutron.conf file and complete the following actions:
  - a. In the [database] section, comment out any connection options because compute nodes do not directly access the database.
  - b. In the [DEFAULT] section, configure RabbitMQ message broker access:

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

Replace  ${\it RABBIT\_PASS}$  with the password you chose for the <code>guest</code> account in RabbitMQ.

c. In the [DEFAULT] and [keystone\_authtoken] sections, configure Identity service access:

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

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

Replace NEUTRON\_PASS with the password you chose or the neutron user in the Identity service.



#### Note

Comment out any auth\_host, auth\_port, and auth\_protocol options because the identity\_uri option replaces them.

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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 [DE-FAULT] section:

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

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

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

- Edit the /etc/neutron/plugins/ml2/ml2\_conf.ini file and complete the following actions:
  - a. In the [ml2] section, enable the *flat* and *generic routing encapsulation (GRE)* network type drivers, GRE tenant networks, and the OVS mechanism driver:

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

b. In the [m12\_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
enable_tunneling = True
```

Replace INSTANCE\_TUNNELS\_INTERFACE\_IP\_ADDRESS with the IP address of the instance tunnels network interface on your compute node.

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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.

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

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

## To configure Compute to use Networking

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

- Edit the /etc/nova/nova.conf file and complete the following actions:
  - a. In the [DEFAULT] section, configure the APIs and drivers:

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



#### Note

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

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

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

Replace  $NEUTRON\_PASS$  with the password you chose for the <code>neutron</code> user in the Identity service.

#### To finalize the installation

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

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

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

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

2. Restart the Compute service:

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

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

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

#### Verify operation



#### Note

Perform these commands on the controller node.

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

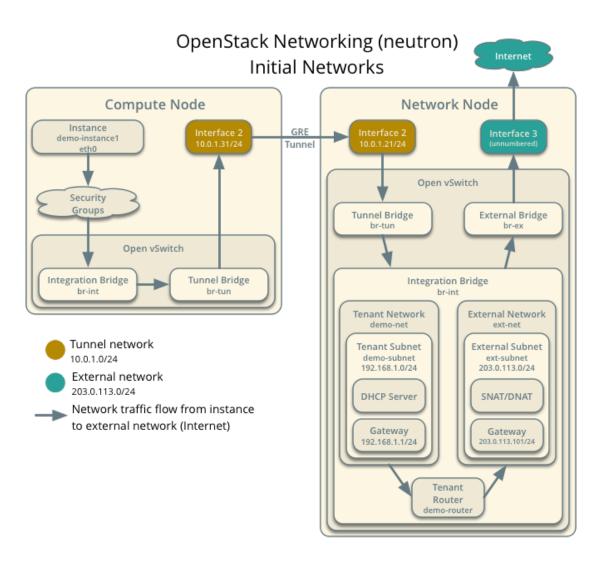
```
$ source admin-openrc.sh
```

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

# **Create initial networks**

Before launching your first instance, you must create the necessary virtual network infrastructure to which the instance will connect, including the external network and tenant network. See Figure 6.1, "Initial networks" [78]. After creating this infrastructure, we recommend that you verify connectivity and resolve any issues before proceeding further. Figure 6.1, "Initial networks" [78] 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 True \
 --provider:physical_network external --provider:network_type flat
Created a new network:
                        Value
 893aebb9-1c1e-48be-8908-6b947f3237b3
id
                        ext-net
name
 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 --name ext-subnet \
--allocation-pool start=FLOATING_IP_START,end=FLOATING_IP_END \
--disable-dhcp --gateway EXTERNAL_NETWORK_GATEWAY EXTERNAL_NETWORK_CIDR
```

Replace FLOATING\_IP\_START and FLOATING\_IP\_END with the first and last IP addresses of the range that you want to allocate for floating IP addresses. Replace EXTERNAL\_NETWORK\_CIDR with the subnet associated with the physical network. Replace EXTERNAL\_NETWORK\_GATEWAY with the gateway associated with the physical network, typically the ".1" IP address. You should disable DHCP on this subnet because instances do not connect directly to the external network and floating IP addresses require manual assignment.

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

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```
cidr
                  203.0.113.0/24
dns_nameservers
enable_dhcp
                  False
                  203.0.113.1
gateway_ip
host_routes
                  9159f0dc-2b63-41cf-bd7a-289309da1391
 id
 ip_version
 ipv6_address_mode |
 ipv6_ra_mode
                  ext-subnet
name
                 893aebb9-1c1e-48be-8908-6b947f3237b3
network_id
                 54cd044c64d5408b83f843d63624e0d8
 tenant_id
```

# **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:

<pre>\$ neutron net-creat Created a new netwo +</pre>	ork:	
Field	Value	
admin_state_up id name router:external shared status subnets tenant_id	True   ac108952-6096-4243-adf4-bb6615b3de28     demo-net	

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

#### To create a subnet on the tenant network

Create the subnet:

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

Replace TENANT\_NETWORK\_CIDR with the subnet you want to associate with the tenant network and TENANT\_NETWORK\_GATEWAY with the gateway you want to associate with it, typically the ".1" IP address.

Example using 192.168.1.0/24:

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

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

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

1. Create the router:

```
$ neutron router-create demo-router
Created a new router:
 Field
                     | Value
 admin_state_up
                       | True
 external_gateway_info |
 id
                        635660ae-a254-4feb-8993-295aa9ec6418
                         demo-router
 name
 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 bla894fd-aee8-475c-9262-4342afdc1b58 to router demo-
router.
```

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

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

# Verify connectivity

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



#### Note

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

### To verify network connectivity

Ping the tenant router gateway:

```
$ ping -c 4 203.0.113.101
PING 203.0.113.101 (203.0.113.101) 56(84) bytes of data.
64 bytes from 203.0.113.101: icmp_req=1 ttl=64 time=0.619 ms
64 bytes from 203.0.113.101: icmp_req=2 ttl=64 time=0.189 ms
64 bytes from 203.0.113.101: icmp_req=3 ttl=64 time=0.165 ms
64 bytes from 203.0.113.101: icmp_req=4 ttl=64 time=0.216 ms
--- 203.0.113.101 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 2999ms
```

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

# Legacy networking (nova-network)

# **Configure controller node**

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

## To configure legacy networking

- 1. Edit the /etc/nova/nova.conf file and complete the following actions:
  - In the [DEFAULT] section, configure the network and security group APIs:

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

2. Restart the Compute services:

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

# **Configure compute node**

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

### To install legacy networking components

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

#### To configure legacy networking

- 1. Edit the /etc/nova/nova.conf file and complete the following actions:
  - In the [DEFAULT] section, configure the network parameters:

```
[DEFAULT]
...

network_api_class = nova.network.api.API

security_group_api = nova

firewall_driver = nova.virt.libvirt.firewall.IptablesFirewallDriver

network_manager = nova.network.manager.FlatDHCPManager

network_size = 254

allow_same_net_traffic = False

multi_host = True

send_arp_for_ha = True

share_dhcp_address = True

force_dhcp_release = True

flat_network_bridge = br100
```

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```
flat_interface = INTERFACE_NAME
public_interface = INTERFACE_NAME
```

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

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

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

# **Create initial network**

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

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



#### Note

Perform these commands on the controller node.

### To create the network

1. Source the admin tenant credentials:

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

2. Create the network:

Replace NETWORK\_CIDR with the subnet associated with the physical network.

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

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

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



#### Note

This command provides no output.

3. Verify creation of the network:

```
$ nova net-list
+----+
```

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_	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

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

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

Horizon enables you to customize the brand of the dashboard.

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

This example deployment uses an Apache web server.

# **System requirements**

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

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

Note the URLs of the Identity Service and Compute endpoints.

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

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

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

- The public IP address from which they can access the dashboard
- The user name and password with which they can access the dashboard

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

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#### 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/kana-ka/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" [86]. Also, the dashboard relies on functional core services including Identity, Image Service, Compute, and either Networking (neutron) or legacy networking (nova-network). Environments with stand-alone services such as Object Storage cannot use the dashboard. For more information, see the developer documentation.

## To install the dashboard components

Install the packages:

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

#### To configure the dashboard

- Edit the /etc/openstack-dashboard/local\_settings file and complete the following actions:
  - a. Configure the dashboard to use OpenStack services on the controller node:

```
OPENSTACK HOST = "controller"
```

b. Allow all hosts to access the dashboard:

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

c. Configure the memcached session storage service:

```
CACHES = {
   'default': {
        'BACKEND': 'django.core.cache.backends.memcached.

MemcachedCache',
        'LOCATION': '127.0.0.1:11211',
   }
}
```



#### Note

Comment out any other session storage configuration.

d. Optionally, configure the time zone:

1

```
TIME_ZONE = "TIME_ZONE"
```

Replace TIME\_ZONE with an appropriate time zone identifier. For more information, see the list of time zones.

#### To finalize installation

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

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

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

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

For more information, see the bug report.

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

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

# **Verify operation**

This section describes how to verify operation of the dashboard.

- 1. Access the dashboard using a web browser: http://controller/dashboard.
- 2. Authenticate using admin or demo user credentials.

# **Next steps**

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

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

- Customize your dashboard. See section Customize the dashboard in the *OpenStack Cloud Administrator Guide* for information on setting up colors, logos, and site titles.
- Set up session storage. See section Set up session storage for the dashboard in the *Open-Stack Cloud Administrator Guide* for information on user session data.

# 8. Add the Block Storage service

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



#### Note

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

# **OpenStack Block Storage**

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

The Block Storage service consists of the following components:

cinder-api

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

cinder-volume

Interacts directly with the Block Storage service, and processes such as the cinder-scheduler. It also in

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  ${\tt no-}$ 

va-scheduler.

Messaging queue Routes information between the Block Storage process-

es.

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# 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 endpoints.

- 1. To create the database, complete these steps:
  - a. Use the database access client to connect to the database server as the root user:

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

b. Create the cinder database:

```
CREATE DATABASE cinder;
```

c. Grant proper access to the cinder database:

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

Replace CINDER\_DBPASS with a suitable password.

- d. Exit the database access client.
- 2. Source the admin credentials to gain access to admin-only CLI commands:

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

- 3. To create the service credentials, complete these steps:
  - a. Create a cinder user:

Replace CINDER\_PASS with a suitable password.

b. Add the admin role to the cinder user:

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

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#### Note

This command provides no output.

c. Create the cinder service entities:

```
$ keystone service-create --name cinder --type volume \
 --description "OpenStack Block Storage"
  -----
   Property
                       Value
              OpenStack Block Storage
 description
   enabled
                        True
    id
           le494c3e22a24baaafcaf777d4d467eb
    name
                      cinder
                       volume
    type
$ keystone service-create --name cinderv2 --type volumev2 \
 --description "OpenStack Block Storage"
 Property
               Value
 description | OpenStack Block Storage
   enabled
                        True
    id
           16e038e449c94b40868277f1d801edb5
    name
                     cinderv2
                      volumev2
    type
```



#### **Note**

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

4. Create the Block Storage service API endpoints:

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

<pre>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</pre>



#### Note

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

### To install and configure Block Storage controller components

1. Install the packages:

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

- 2. Edit the /etc/cinder/cinder.conf file and complete the following actions:
  - a. In the [database] section, configure database access:

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

Replace CINDER\_DBPASS with the password you chose for the Block Storage database.

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

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

Replace RABBIT\_PASS with the password you chose for the guest account in RabbitMQ.

c. In the [DEFAULT] and [keystone\_authtoken] sections, configure Identity service access:

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

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

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Replace CINDER\_PASS with the password you chose for the cinder user in the Identity service.



#### **Note**

Comment out any auth\_host, auth\_port, and auth\_protocol options because the identity\_uri option replaces them.

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

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

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

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

3. Populate the Block Storage database:

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

#### To finalize installation

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

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

# Install and configure a storage node

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

# To configure prerequisites

You must configure the storage node before you install and configure the volume service on it. Similar to the controller node, the storage node contains one network interface on the *management network*. The storage node also needs an empty block storage device of suitable size for your environment. For more information, see Chapter 2, "Basic environment" [11].

1. Configure the management interface:

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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" [24].
- 5. Install the LVM packages:

```
# yum install lvm2
```



#### Note

Some distributions include LVM by default.

6. Start the LVM metadata service and configure it to start when the system boots:

```
# systemctl enable lvm2-lvmetad.service
# systemctl start lvm2-lvmetad.service
```

7. Create the LVM physical volume /dev/sdb1:

```
# pvcreate /dev/sdb1
Physical volume "/dev/sdb1" successfully created
```



#### Note

If your system uses a different device name, adjust these steps accordingly.

8. Create the LVM volume group cinder-volumes:

```
# vgcreate cinder-volumes /dev/sdb1
Volume group "cinder-volumes" successfully created
```

The Block Storage service creates logical volumes in this volume group.

9. Only instances can access Block Storage volumes. However, the underlying operating system manages the devices associated with the volumes. By default, the LVM volume scanning tool scans the /dev directory for block storage devices that contain volumes. If tenants use LVM on their volumes, the scanning tool detects these volumes and attempts to cache them which can cause a variety of problems with both the underlying operating system and tenant volumes. You must reconfigure LVM to scan only the devices that contain the cinder-volume volume group. Edit the /etc/lvm/lvm.conf file and complete the following actions:

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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**

Install the packages:

```
# yum install openstack-cinder targetcli python-oslo-db MySQL-python
```

- 2. Edit the /etc/cinder/cinder.conf file and complete the following actions:
  - a. In the [database] section, configure database access:

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

Replace CINDER\_DBPASS with the password you chose for the Block Storage database.

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

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

Replace RABBIT\_PASS with the password you chose for the guest account in RabbitMQ.

c. In the [DEFAULT] and [keystone\_authtoken] sections, configure Identity service access:

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

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

Replace CINDER\_PASS with the password you chose for the cinder user in the Identity service.



#### Note

Comment out any auth\_host, auth\_port, and auth\_protocol options because the identity\_uri option replaces them.

d. In the [DEFAULT] section, configure the my\_ip option:

```
[DEFAULT]
...

my_ip = MANAGEMENT_INTERFACE_IP_ADDRESS
```

Replace MANAGEMENT\_INTERFACE\_IP\_ADDRESS with the IP address of the management network interface on your storage node, typically 10.0.0.41 for the first node in the example architecture.

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

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

f. In the [DEFAULT] section, configure Block Storage to use the **lioadm** iSCSI service:

```
[DEFAULT]
...
iscsi helper = lioadm
```

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

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

#### To finalize installation

• Start the Block Storage volume service including its dependencies and configure them to start when the system boots:

```
# systemctl enable openstack-cinder-volume.service target.service
# systemctl start openstack-cinder-volume.service target.service
```

# Verify operation

This section describes how to verify operation of the Block Storage service by creating a volume.

For more information about how to manage volumes, see the OpenStack User Guide.



#### Note

Perform these commands on the controller node.

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

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

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

3. Source the demo tenant credentials to perform the following steps as a non-administrative tenant:

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

4. Create a 1 GB volume:

Property	Value
attachments	[]
availability_zone	nova
bootable	false
created_at	2014-10-14T23:11:50.870239
display_description	None
display_name	demo-volume1
encrypted	False
id	158bea89-07db-4ac2-8115-66c0d6a4bb48
metadata	{}
size	1
snapshot_id	None
source_volid	None
status	creating
volume_type	None

5. Verify creation and availability of the volume:

\$ cinder list	
+	Status   Display Name   Size
+	-
+	++++++

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

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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-ac-count-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-ob- ject-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 Identi-

ty.

# 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

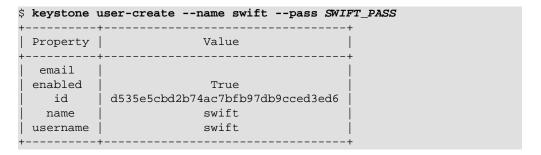
The proxy service relies on an authentication and authorization mechanism such as the Identity service. However, unlike other services, it also offers an internal mechanism that allows it to operate without any other OpenStack services. However, for simplicity, this guide references the Identity service in Chapter 3, "Add the Identity service" [30]. Before you configure the Object Storage service, you must create service credentials and API endpoints.



#### Note

The Object Storage service does not use a SQL database on the controller node.

- 1. To create the Identity service credentials, complete these steps:
  - a. Create the swift user:



Replace SWIFT PASS with a suitable password.

b. Add the admin role to the swift user:

\$ keystone user-role-add --user swift --tenant service --role admin



### Note

This command provides no output.

c. Create the swift service entity:

5		rice-createname swifttype object-store ' n "OpenStack Object Storage"	\
	Property	Value	
	description	OpenStack Object Storage	

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_	enabled	True	
	id	75ef509da2c340499d454ae96a2c5c34	
	name	swift	
	type	object-store	
+		+	+

2. Create the Object Storage service API endpoints:

```
$ keystone endpoint-create \
  --service-id $(keystone service-list | awk '/ object-store / {print
 $2}') \
  --publicurl 'http://controller:8080/v1/AUTH_%(tenant_id)s' \
 --internalurl 'http://controller:8080/v1/AUTH_%(tenant_id)s' \
  --adminurl http://controller:8080 \
 --region regionOne
   Property |
                                      Value
                http://controller:8080/
af534fb8b7ff40a6acf725437c586ebe
   adminurl
 internalurl | http://controller:8080/v1/AUTH_%(tenant_id)s
  publicurl | http://controller:8080/v1/AUTH_%(tenant_id)s
    region
                                    regionOne
   service_id |
                         75ef509da2c340499d454ae96a2c5c34
```

### To install and configure the controller node components

1. Install the packages:



### **Note**

Complete OpenStack environments already include some of these packages.

```
# yum install openstack-swift-proxy python-swiftclient python-keystone-
auth-token \
    python-keystonemiddleware memcached
```

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

```
# curl -o /etc/swift/proxy-server.conf \
  https://raw.githubusercontent.com/openstack/swift/stable/juno/etc/proxy-
server.conf-sample
```

- 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:

\_

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



### Note

For more information on other modules that enable additional features, see the Deployment Guide.

c. In the [app:proxy-server] section, enable account management:

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

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

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



#### Note

You might need to uncomment this section.

e. In the [filter:authtoken] section, configure Identity service access:

```
[filter:authtoken]
paste.filter_factory = keystonemiddleware.auth_token:filter_factory
...
auth_uri = http://controller:5000/v2.0
identity_uri = http://controller:35357
admin_tenant_name = service
admin_user = swift
admin_password = SWIFT_PASS
delay_auth_decision = true
```

Replace  $SWIFT\_PASS$  with the password you chose for the swift user in the Identity service.



#### Note

You might need to uncomment this section.



#### Note

Comment out any auth\_host, auth\_port, and auth\_protocol options because the identity\_uri option replaces them.

f. In the [filter:cache] section, configure the memcached location:

```
[filter:cache]
...
memcache_servers = 127.0.0.1:11211
```

ounf - ounf

# 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, <code>/dev/sdb</code> and <code>/dev/sdc</code>, must contain a suitable partition table with one partition occupying the entire device. Although the Object Storage service supports any file system with <code>extended attributes</code> (<code>xattr</code>), testing and benchmarking indicate the best performance and reliability on <code>XFS</code>. For more information on horizontally scaling your environment, see the <code>Deployment Guide</code>.

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### 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" [24].
- c. Install the supporting utility packages:

```
# yum install xfsprogs rsync
```

d. Format the /dev/sdb1 and /dev/sdc1 partitions as XFS:

```
# mkfs.xfs /dev/sdb1
# mkfs.xfs /dev/sdc1
```

e. Create the mount point directory structure:

```
# mkdir -p /srv/node/sdb1
# mkdir -p /srv/node/sdc1
```

f. Edit the /etc/fstab file and add the following to it:

```
/dev/sdb1 /srv/node/sdb1 xfs noatime,nodiratime,nobarrier,logbufs=8 0
2
/dev/sdc1 /srv/node/sdc1 xfs noatime,nodiratime,nobarrier,logbufs=8 0
2
```

g. Mount the devices:

```
# mount /srv/node/sdb1
# mount /srv/node/sdc1
```

4. Edit the /etc/rsyncd.conf file and add the following to it:

```
uid = swift
gid = swift
log file = /var/log/rsyncd.log
pid file = /var/run/rsyncd.pid
address = MANAGEMENT_INTERFACE_IP_ADDRESS
[account]
max connections = 2
path = /srv/node/
read only = false
lock file = /var/lock/account.lock
[container]
max connections = 2
path = /srv/node/
read only = false
lock file = /var/lock/container.lock
[object]
max connections = 2
path = /srv/node/
read only = false
lock file = /var/lock/object.lock
```

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ounf - ounf

Replace MANAGEMENT\_INTERFACE\_IP\_ADDRESS with the IP address of the management network on the storage node.



#### Note

The rsync service requires no authentication, so consider running it on a private network.

5. Start the rsyncd service and configure it to start when the system boots:

```
# systemctl enable rsyncd.service
# systemctl start rsyncd.service
```

### Install and configure storage node components



#### Note

Perform these steps on each storage node.

1. Install the packages:

```
# yum install openstack-swift-account openstack-swift-container \
    openstack-swift-object
```

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

```
# curl -o /etc/swift/account-server.conf \
   https://raw.githubusercontent.com/openstack/swift/stable/juno/etc/
account-server.conf-sample

# curl -o /etc/swift/container-server.conf \
   https://raw.githubusercontent.com/openstack/swift/stable/juno/etc/
container-server.conf-sample

# curl -o /etc/swift/object-server.conf \
   https://raw.githubusercontent.com/openstack/swift/stable/juno/etc/
object-server.conf-sample
```

- 3. Edit the /etc/swift/account-server.conf 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:

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```
[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:
  - In the [DEFAULT] section, configure the bind IP address, bind port, user, configuration directory, and mount point directory:

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```
[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 directory:

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

5. 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.

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- 1. Change to the /etc/swift directory.
- 2. Create the base account.builder file:

```
# swift-ring-builder account.builder create 10 3 1
```

3. Add each storage node to the ring:

```
# swift-ring-builder account.builder \
  add
r1z1-STORAGE_NODE_MANAGEMENT_INTERFACE_IP_ADDRESS:6002/DEVICE_NAME DEVICE_WEIGHT
```

Replace STORAGE\_NODE\_MANAGEMENT\_INTERFACE\_IP\_ADDRESS with the IP address of the management network on the storage node. Replace DEVICE\_NAME with a storage device name on the same storage node. For example, using the first storage node in the section called "Install and configure the storage nodes" [103] with the / dev/sdb1 storage device and weight of 100:

```
# swift-ring-builder account.builder add r1z1-10.0.0.51:6002/sdb1 100
```

Repeat this command for each storage device on each storage node. The example architecture requires four variations of this command.

4. Verify the ring contents:

```
# swift-ring-builder account.builder
account.builder, build version 4
1024 partitions, 3.000000 replicas, 1 regions, 1 zones, 4 devices, 0.00
balance
The minimum number of hours before a partition can be reassigned is 1
Devices:
          id region zone ip address port replication ip
                   name weight partitions balance meta
replication port
                     1
                               10.0.0.51 6002
           0
                   1
                                                    10.0.0.51
      6002
               sdb1 100.00
                                768
                                      0.00
           1
                 1 1
                               10.0.0.51 6002
                                                    10.0.0.51
               sdc1 100.00
      6002
                                768 0.00
           2
                 1 1
                               10.0.0.52 6002
                                                    10.0.0.52
      6002
               sdb1 100.00
                                768 0.00
                               10.0.0.52 6002
                  1 1
                                                    10.0.0.52
      6002
               sdc1 100.00
                                768
                                     0.00
```

5. Rebalance the ring:

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



#### Note

This process can take a while.

### **Container ring**

The container server uses the container ring to maintain lists of objects. However, it does not track object locations.

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### To create the ring



#### Note

Perform these steps on the controller node.

- 1. Change to the /etc/swift directory.
- 2. Create the base container . builder file:

```
# swift-ring-builder container.builder create 10 3 1
```

3. Add each storage node to the ring:

```
# swift-ring-builder container.builder \
  add
rlz1-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" [103] with the / dev/sdb1 storage device and weight of 100:

```
# swift-ring-builder container.builder add r1z1-10.0.0.51:6001/sdb1 100
```

Repeat this command for each storage device on each storage node. The example architecture requires four variations of this command.

4. Verify the ring contents:

```
# swift-ring-builder container.builder
container.builder, build version 4
1024 partitions, 3.000000 replicas, 1 regions, 1 zones, 4 devices, 0.00
The minimum number of hours before a partition can be reassigned is 1
Devices:
           id region zone ip address port replication ip
replication port
                    name weight partitions balance meta
            0
                   1
                      1
                                10.0.0.51 6001
                                                      10.0.0.51
      6001
                sdb1 100.00
                                 768
                                        0.00
                                 10.0.0.51 6001
                                                      10.0.0.51
            1
                   1 1
      6001
                sdc1 100.00
                                         0.00
                                 768
                                 10.0.0.52 6001
                                                      10.0.0.52
                   1 1
      6001
                sdb1 100.00
                                         0.00
                                  768
                                 10.0.0.52 6001
                                                      10.0.0.52
                   1 1
      6001
                sdc1 100.00
                                  768
                                         0.00
```

Rebalance the ring:

# swift-ring-builder container.builder rebalance



### Note

This process can take a while.

### **Object ring**

ounf - ounf

The object server uses the object ring to maintain lists of object locations on local devices.

### To create the ring



### Note

Perform these steps on the controller node.

- 1. Change to the /etc/swift directory.
- 2. Create the base object.builder file:

```
# swift-ring-builder object.builder create 10 3 1
```

3. Add each storage node to the ring:

```
# swift-ring-builder object.builder \
  add
r1z1-STORAGE_NODE_MANAGEMENT_INTERFACE_IP_ADDRESS:6000/DEVICE_NAME DEVICE_WEIGHT
```

Replace STORAGE\_NODE\_MANAGEMENT\_INTERFACE\_IP\_ADDRESS with the IP address of the management network on the storage node. Replace DEVICE\_NAME with a storage device name on the same storage node. For example, using the first storage node in the section called "Install and configure the storage nodes" [103] with the / dev/sdb1 storage device and weight of 100:

```
# swift-ring-builder object.builder add rlz1-10.0.0.51:6000/sdb1 100
```

Repeat this command for each storage device on each storage node. The example architecture requires four variations of this command.

4. Verify the ring contents:

```
# swift-ring-builder object.builder
object.builder, build version 4
1024 partitions, 3.000000 replicas, 1 regions, 1 zones, 4 devices, 0.00
The minimum number of hours before a partition can be reassigned is 1
Devices:
          id region zone ip address port replication ip
replication port
                   name weight partitions balance meta
            0
                   1
                      1 10.0.0.51 6000
                                                    10.0.0.51
      6000
               sdb1 100.00
                                 768
                                       0.00
                                10.0.0.51 6000
                                                    10.0.0.51
            1
                  1 1
                                     0.00
      6000
               sdc1 100.00
                                 768
                                10.0.0.52 6000
            2
                  1 1
                                                    10.0.0.52
      6000
               sdb1 100.00
                                     0.00
                                 768
                                10.0.0.52 6000
            3
                                                    10.0.0.52
                       1
                  1
      6000
               sdc1 100.00
                                       0.00
                                 768
```

5. Rebalance the ring:

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

<u>'</u>

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juno



#### Note

This process can take a while.

### Distribute ring configuration files

Copy the account.ring.gz, container.ring.gz, and object.ring.gz files to the /etc/swift directory on each storage node and any additional nodes running the proxy service.

### Finalize installation

### Configure hashes and default storage policy

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

```
# curl -o /etc/swift/swift.conf \
   https://raw.githubusercontent.com/openstack/swift/stable/juno/etc/swift.
conf-sample
```

- 2. Edit the /etc/swift/swift.conf file and complete the following actions:
  - a. In the [swift-hash] section, configure the hash path prefix and suffix for your environment.

```
[swift-hash]
...
swift_hash_path_suffix = HASH_PATH_PREFIX
swift_hash_path_prefix = HASH_PATH_SUFFIX
```

Replace HASH\_PATH\_PREFIX and HASH\_PATH\_SUFFIX with unique values.



### Warning

Keep these values secret and do not change or lose them.

b. In the [storage-policy:0] section, configure the default storage policy:

```
[storage-policy:0]
...
name = Policy-0
default = yes
```

- 3. Copy the swift.conf file to the /etc/swift directory on each storage node and any additional nodes running the proxy service.
- 4. On all nodes, ensure proper ownership of the configuration directory:

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

5. On the controller node and any other nodes running the proxy service, start the Object Storage proxy service including its dependencies and configure them to start when the system boots:

```
# systemctl enable openstack-swift-proxy.service memcached.service # systemctl start openstack-swift-proxy.service memcached.service
```

6. On the storage nodes, start the Object Storage services and configure them to start when the system boots:

```
# systemctl enable openstack-swift-account.service openstack-swift-
account-auditor.service \
 openstack-swift-account-reaper.service openstack-swift-account-
replicator.service
# systemctl start openstack-swift-account.service openstack-swift-account-
auditor.service \
  openstack-swift-account-reaper.service openstack-swift-account-
replicator.service
# systemctl enable openstack-swift-container.service openstack-swift-
container-auditor.service \
 openstack-swift-container-replicator.service openstack-swift-container-
updater.service
# systemctl start openstack-swift-container.service openstack-swift-
container-auditor.service \
 openstack-swift-container-replicator.service openstack-swift-container-
updater.service
# systemctl enable openstack-swift-object.service openstack-swift-object-
auditor.service \
 openstack-swift-object-replicator.service openstack-swift-object-
updater.service
# systemctl start openstack-swift-object.service openstack-swift-object-
auditor.service \
 openstack-swift-object-replicator.service openstack-swift-object-
updater.service
```

# **Verify operation**

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



### **Note**

Perform these steps on the controller node.

1. Source the demo tenant credentials:

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

2. Show the service status:

```
$ swift stat
Account: AUTH_11b9758b7049476d9b48f7a91ea11493
Containers: 0
    Objects: 0
    Bytes: 0
Content-Type: text/plain; charset=utf-8
X-Timestamp: 1381434243.83760
X-Trans-Id: txdcdd594565214fb4a2d33-0052570383
X-Put-Timestamp: 1381434243.83760
```

3. Upload a test file:

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

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

4. List containers:

\$ swift list
demo-container1

5. Download a test file:

\$ swift download demo-container1 FILE

Replace  $\it{FILE}$  with the name of the file uploaded to the <code>demo-container1</code> 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.

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# 10. Add the Orchestration module

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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 re-

quests 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 Cloud-

Formation. 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.

ounf - ounf

### To configure prerequisites

Before you install and configure Orchestration, you must create a database, service credentials, and API endpoints.

- To create the database, complete these steps:
  - 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;
```

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.

- Exit the database access client.
- Source the admin credentials to gain access to admin-only CLI commands:

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

- To create the service credentials, complete these steps:
  - Create the heat user:

\$ keystone :	user-createname heatpass HEAT
Property	Value
+   email   enabled	+   
id	7fd67878dcd04d0393469ef825a7e005
name	heat
username	heat
+	+

Replace *HEAT\_PASS* with a suitable password.

- b. Add the admin role to the heat user:
  - \$ keystone user-role-add --user heat --tenant service --role admin



#### Note

This command provides no output.

- **Create the** heat\_stack\_owner **role**:
- \$ keystone role-create --name heat\_stack\_owner

- Juno - Juno

juno

d. Add the heat\_stack\_owner role to the demo tenant and user:

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



#### Note

You must add the heat\_stack\_owner role to users that manage stacks.

- e. Create the heat\_stack\_user role:
  - \$ keystone role-create --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:

```
$ keystone service-create --name heat --type orchestration \
 --description "Orchestration"
  ----
  Property
                    Value
 description | Orchestration
  enabled
                  True
    id | 031112165cad4c2bb23e84603957de29
    name
                    heat.
               orchestration
   type
$ keystone service-create --name heat-cfn --type cloudformation \
 --description "Orchestration"
  Property | Value
  _____
 description | Orchestration
  enabled
                  True
    id
          297740d74c0a446bbff867acdccb33fa
                  heat-cfn
    name
                cloudformation
    type
```

4. Create the Orchestration service API endpoints:

```
adminurl | http://controller:8004/v1/%(tenant_id)s
      id
                 f41225f665694b95a46448e8676b0dc2
 internalurl | http://controller:8004/v1/%(tenant_id)s
  publicurl | http://controller:8004/v1/%(tenant_id)s
    region |
                            regionOne
  service_id | 031112165cad4c2bb23e84603957de29
$ keystone endpoint-create \
 --service-id $(keystone service-list | awk '/ cloudformation / {print
 --publicurl http://controller:8000/v1 \
 --internalurl http://controller:8000/v1 \
 --adminurl http://controller:8000/v1 \
 --region regionOne
   Property
                    Value
   adminurl | http://controller:8000/v1
     id | f41225f665694b95a46448e8676b0dc2
 internalurl http://controller:8000/v1
              http://controller:8000/v1
  publicurl
                        regionOne
   region
  service_id | 297740d74c0a446bbff867acdccb33fa
```

### To install and configure the Orchestration components

1. Run the following commands to install the packages:

```
# yum install openstack-heat-api openstack-heat-api-cfn openstack-heat-
engine \
   python-heatclient
```

- 2. Edit the /etc/heat/heat.conf file and complete the following actions:
  - a. In the [database] section, configure database access:

```
[database]
...
connection = mysql://heat:HEAT_DBPASS@controller/heat
```

Replace *HEAT\_DBPASS* with the password you chose for the Orchestration database.

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

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

Replace RABBIT\_PASS with the password you chose for the guest account in RabbitMQ.

c. In the [keystone\_authtoken] and [ec2authtoken] sections, configure Identity service access:

\_

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juno

```
[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 <code>HEAT\_PASS</code> with the password you chose for the <code>heat</code> user in the Identity service.



### **Note**

Comment out any auth\_host, auth\_port, and auth\_protocol options because the identity\_uri option replaces them.

d. In the [DEFAULT] section, configure the metadata and wait condition URLs:

```
[DEFAULT]
...
heat_metadata_server_url = http://controller:8000
heat_waitcondition_server_url = http://controller:8000/v1/
waitcondition
```

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

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

3. Populate the Orchestration database:

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

#### To finalize installation

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

```
# systemctl enable openstack-heat-api.service openstack-heat-api-cfn.
service \
   openstack-heat-engine.service
# systemctl start openstack-heat-api.service openstack-heat-api-cfn.
service \
   openstack-heat-engine.service
```

### **Verify operation**

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

1. Source the demo tenant credentials:

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

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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:

4. Use the **heat stack-list** command to verify successful creation of the stack:

# **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

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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 (ceilome- ter-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 (ceilome- ter-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.

dora	
An alarm evaluator (ceilometer-alarm-evaluator)	Runs on one or more central management servers to de- termine when alarms fire due to the associated statistic trend crossing a threshold over a sliding time window.
An alarm notifier (ceilome- ter-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 (ceilome-	Runs on one or more central management servers to

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ter-api)

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and Fed

provide data access from the data store.

juno

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 endpoints.

1. Install the MongoDB package:

```
# yum install mongodb-server mongodb
```

- 2. Edit the /etc/mongodb.conf file and complete the following actions:
  - a. Configure the bind\_ip key to use the management interface IP address of the controller node.

```
bind_ip = 10.0.0.11
```

b. By default, MongoDB creates several 1 GB journal files in the /var/lib/mon-godb/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 small-files key:

```
smallfiles = true
```

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

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

```
# systemctl enable mongod.service
# systemctl start mongod.service
```

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: X.Y.Z
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:

```
$ keystone user-create --name ceilometer --pass CEILOMETER_PASS
```

Replace CEILOMETER PASS with a suitable password.

b. Add the admin role to the ceilometer user.

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

c. Create the ceilometer service entity:

```
$ keystone service-create --name ceilometer --type metering \
    --description "Telemetry"
```

6. Create the Telemetry module API endpoints:

```
$ keystone endpoint-create \
   --service-id $(keystone service-list | awk '/ metering / {print $2}') \
   --publicurl http://controller:8777 \
   --internalurl http://controller:8777 \
   --adminurl http://controller:8777 \
   --region regionOne
```

### To install and configure the Telemetry module components

1. Install the packages:

```
# yum install openstack-ceilometer-api openstack-ceilometer-collector \
   openstack-ceilometer-notification openstack-ceilometer-central
   openstack-ceilometer-alarm \
   python-ceilometerclient
```

2. Generate a random value to use as the metering secret:

\_

juno

```
# 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. MongoDB connection string requires escaping special characters as per RFC2396.

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

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

Replace RABBIT\_PASS with the password you chose for the guest account in RabbitMQ.

c. In the [DEFAULT] and [keystone\_authtoken] sections, configure Identity service access:

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

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

Replace CEILOMETER\_PASS with the password you chose for the celiometer user in the Identity service.



#### Note

Comment out any auth\_host, auth\_port, and auth\_protocol options because the identity\_uri option replaces them.

d. In the [service\_credentials] section, configure service credentials:

```
[service_credentials]
...
os_auth_url = http://controller:5000/v2.0
os_username = ceilometer
os_tenant_name = service
os_password = CEILOMETER_PASS
```

Replace CEILOMETER\_PASS with the password you chose for the ceilometer user in the Identity service.

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

```
[publisher]
...
metering_secret = METERING_SECRET
```

Replace METERING\_SECRET with the random value that you generated in a previous step.

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

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

### To finalize installation

• Start the Telemetry services and configure them to start when the system boots:

```
# systemctl enable openstack-ceilometer-api.service openstack-ceilometer-
notification.service \
    openstack-ceilometer-central.service openstack-ceilometer-collector.
service \
    openstack-ceilometer-alarm-evaluator.service openstack-ceilometer-alarm-
notifier.service
# systemctl start openstack-ceilometer-api.service openstack-ceilometer-
notification.service \
    openstack-ceilometer-central.service openstack-ceilometer-collector.
service \
    openstack-ceilometer-alarm-evaluator.service openstack-ceilometer-alarm-
notifier.service
```

### **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

Install the packages:

```
# yum install openstack-ceilometer-compute python-ceilometerclient python-
pecan
```

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

\_

juno

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

```
[publisher]
...
metering_secret = METERING_SECRET
```

Replace METERING\_SECRET with the metering secret you chose for the Telemetry module.

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

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

Replace *RABBIT\_PASS* with the password you chose for the guest account in RabbitMQ.

c. In the [keystone\_authtoken] 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  $\it CEILOMETER\_PASS$  with the password you chose for the <code>ceilometer</code> user in the Identity service.

e. (Optional) To assist with troubleshooting, enable verbose logging in the [DE-FAULT] 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. Start the Telemetry agent and configure it to start when the system boots:

```
# systemctl enable openstack-ceilometer-compute.service
# systemctl start openstack-ceilometer-compute.service
```

2. Restart the Compute service:

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

# **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:

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

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

Replace RABBIT\_PASS with the password you chose for the guest account in Rabbit-MQ.

2. Restart the Image Service:

```
# systemctl restart openstack-glance-api.service openstack-glance-registry.service
```

### **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:

```
# systemctl restart openstack-cinder-api.service openstack-cinder-
scheduler.service
```

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

```
# systemctl restart openstack-cinder-volume.service
```

 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 Reseller-Admin role. Perform these steps on the controller node.

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

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

2. Create the ResellerAdmin role:

```
$ keystone role-create --name ResellerAdmin
+------+
| Property | Value |
+------+
| id | 462fa46c13fd4798a95a3bfbe27b5e54 |
| name | ResellerAdmin |
+-----+
```

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

```
$ keystone user-role-add --tenant service --user ceilometer \
    --role 462fa46c13fd4798a95a3bfbe27b5e54
```

### 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,_member_,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]
use = egg:ceilometer#swift
log_level = WARN
```

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:

```
# systemctl restart openstack-swift-proxy.service
```

### **Verify the Telemetry installation**

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



### 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 available meters:



### Note

Some meters might not appear until after you successfully launch at least one instance.

3. Download an image from the Image Service:

```
$ glance image-download "cirros-0.3.3-x86_64" > cirros.img
```

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

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

### **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

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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" [42] 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*.



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### Note

These steps reference example components created in previous chapters. You must adjust certain values such as IP addresses to match your environment.

# Launch an instance with OpenStack Networking (neutron)

### To generate a key pair

Most cloud images support *public key authentication* rather than conventional user name/ password authentication. Before launching an instance, you must generate a public/private key pair using **ssh-keygen** and add the public key to your OpenStack environment.

Source the demo tenant credentials:

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

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:

### 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			+			
+++++++	emory_MB	Disk	Ephemeral	Swap	VCPUs	I
+	+				1	
True     20   True   20   True     20	48	20	0	1	1	1.0
3   m1.medium   40   True	96	40	0	1	2	1.0
4   ml.large   81   True	.92	80	0		4	1.0
5   m1.xlarge   16   True	384	160	0		8	1.0
+++	+		+	-+	+	-

Your first instance uses the ml.tiny flavor.



#### Note

You can also reference a flavor by ID.

2. List available images:

Your first instance uses the cirros-0.3.3-x86\_64 image.

3. List available networks:

```
$ neutron net-list
```

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:

Id	\$ nova secgroup-list		
	1	1	
			:

Your first instance uses the default security group. By default, this security group implements a firewall that blocks remote access to instances. If you would like to permit remote access to your instance, launch it and then configure remote access.

### 5. Launch the instance:

Replace DEMO NET ID with the ID of the demo-net tenant network.

```
$ nova boot --flavor m1.tiny --image cirros-0.3.3-x86_64 --nic net-
id=DEMO_NET_ID \
 --security-group default --key-name demo-key demo-instance1
Property
                                 Value
OS-DCF:diskConfig
                       | MANUAL
OS-EXT-AZ:availability_zone
OS-EXT-STS:power_state
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
                                      2014-04-09T19:24:27Z
created
flavor
                                      | m1.tiny (1)
hostId
05682b91-81a1-464c-8f40-8b3da7ee92c5
                                      cirros-0.3.3-x86_64
(acafc7c0-40aa-4026-9673-b879898e1fc2) |
key_name
                                      | demo-key
metadata
                                      | {}
                                      | demo-instance1
name
os-extended-volumes:volumes_attached | []
                                      0
progress
                                      default
security_groups
                                      BUILD
status
tenant_id
                                      7cf50047f8df4824bc76c2fdf66d11ec
updated
                                      2014-04-09T19:24:27Z
user_id
                                      0e47686e72114d7182f7569d70c519c9
```

### 6. Check the status of your instance:

\$ nova list	+	+
++	•	
ID   State   Power State   Networks	Name	Status   Task
+	 +	+
+		
05682b91-81a1-464c-8f40-8b3da7ee92c5   Running	· .	ACTIVE   -
+	'	+
+	+	

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:



### 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 secgrou	p-add-rule d	-	•	
	From Port		IP Range	Source Group
icmp			0.0.0.0/0	   

b. Permit secure shell (SSH) access:

IP Protocol   From Port   To Port   IP Range   Source Group	\$ nova secgroup-add-rule default tcp 22 22 0.0.0.0/0							
+	Ī	Source Group	IP Range	To Port	From Port	IP Protocol		
tcp	Ī		:					

2. Create a *floating IP address* on the ext-net external network:

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:

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5. Verify network connectivity using **ping** from the controller node or any host on the external network:

```
$ ping -c 4 203.0.113.102
PING 203.0.113.102 (203.0.113.112) 56(84) bytes of data.
64 bytes from 203.0.113.102: icmp_req=1 ttl=63 time=3.18 ms
64 bytes from 203.0.113.102: icmp_req=2 ttl=63 time=0.981 ms
64 bytes from 203.0.113.102: icmp_req=3 ttl=63 time=1.06 ms
64 bytes from 203.0.113.102: icmp_req=4 ttl=63 time=0.929 ms
--- 203.0.113.102 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3002ms
rtt min/avg/max/mdev = 0.929/1.539/3.183/0.951 ms
```

6. Access your instance using SSH from the controller node or any host on the external network:

```
$ ssh cirros@203.0.113.102
The authenticity of host '203.0.113.102 (203.0.113.102)' can't be established.
RSA key fingerprint is ed:05:e9:e7:52:a0:ff:83:68:94:c7:d1:f2:f8:e2:e9.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '203.0.113.102' (RSA) to the list of known hosts.
$
```



#### **Note**

If your host does not contain the public/private key pair created in an earlier step, SSH prompts for the default password associated with the cirros user.

#### To attach a Block Storage volume to your instance

If your environment includes the Block Storage service, you can attach a volume to the instance.

1. Source the demo tenant credentials:

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

2. List volumes:

3. Attach the demo-volume1 volume to the demo-instance1 instance:

```
$ nova volume-attach demo-instance1 158bea89-07db-4ac2-8115-66c0d6a4bb48 +------
```

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device   /dev/vdb   id   158bea89-07db-4ac2-8115-66c0d6a4bb48   serverId   05682b91-81a1-464c-8f40-8b3da7ee92c5   volumeId   158bea89-07db-4ac2-8115-66c0d6a4bb48
<b>+</b>



#### Note

You must reference volumes using the IDs instead of names.

4. List volumes:

The demo-volume1 volume status should indicate in-use by the ID of the demo-instance1 instance.

5. Access your instance using SSH from the controller node or any host on the external network and use the **fdisk** command to verify presence of the volume as the /dev/vdb block storage device:

```
$ ssh cirros@203.0.113.102
$ sudo fdisk -l
Disk /dev/vda: 1073 MB, 1073741824 bytes
255 heads, 63 sectors/track, 130 cylinders, total 2097152 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x00000000

        Start
        End
        Blocks
        Id
        System

        16065
        2088449
        1036192+
        83
        Linux

   Device Boot Start
ev/vda1 * 16065
                                                Blocks Id System
/dev/vda1 *
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.

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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:

#### 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:

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1	m1.tiny   True	512	:	1		0		1	1.0
	m1.small	2048	:	20	l	0		1	1.0
	True	4096	4	40		0		2	1.0
	True     m1.large	8192	8	80		0		4	1.0
	True	16384	1 :	160	ı	0	I	8	1.0
	True		'						1
+	-+	+	-+-		+-		+	+	

Your first instance uses the ml.tiny flavor.



#### Note

You can also reference a flavor by ID.

2. List available images:

Your first instance uses the cirros-0.3.3-x86\_64 image.

3. List available networks:



### Note

You must source the admin tenant credentials for this step and then source the demo tenant credentials for the remaining steps.

\$ source admin-openrc.sh



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
+-----+
```

Your first instance uses the default security group. By default, this security group implements a firewall that blocks remote access to instances. If you would like to permit remote access to your instance, launch it and then configure remote access.

#### 5. Launch the instance:

Replace DEMO\_NET\_ID with the ID of the demo-net tenant network.

```
$ nova boot --flavor m1.tiny --image cirros-0.3.3-x86_64 --nic net-
id=DEMO_NET_ID \
 --security-group default --key-name demo-key demo-instance1
                                      | Value
                       OS-DCF:diskConfig
                                      MANUAL
OS-EXT-AZ:availability_zone
                                      nova
OS-EXT-STS:power_state
                                      0
OS-EXT-STS:task_state
                                      scheduling
                                      building
OS-EXT-STS:vm_state
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
                                      | 45ea195c-
id
c469-43eb-83db-1a663bbad2fc
                                      | cirros-0.3.3-x86_64
(acafc7c0-40aa-4026-9673-b879898e1fc2)
key_name
                                      | demo-key
 metadata
                                      | {}
                                      | demo-instance1
 name
```

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and Fedora			
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6. Check the status of your instance:

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:



#### Note

If your web browser runs on a host that cannot resolve the <code>controller</code> host name, you can replace <code>controller</code> 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

- Add rules to the default security group:
  - a. Permit ICMP (ping):

b. Permit secure shell (SSH) access:

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
```

Access your instance using SSH from the controller node or any host on the external network:

```
$ ssh cirros@203.0.113.26
```

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```
The authenticity of host '203.0.113.26 (203.0.113.26)' can't be established.

RSA key fingerprint is ed:05:e9:e7:52:a0:ff:83:68:94:c7:d1:f2:f8:e2:e9.

Are you sure you want to continue connecting (yes/no)? yes

Warning: Permanently added '203.0.113.26' (RSA) to the list of known hosts.
```



#### **Note**

If your host does not contain the public/private key pair created in an earlier step, SSH prompts for the default password associated with the cirros user.

### To attach a Block Storage volume to your instance

If your environment includes the Block Storage service, you can attach a volume to the instance.

1. Source the demo tenant credentials:

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

2. List volumes:

<pre>\$ nova volume-list +</pre>		
++   ID   Volume Type   Attached to	Status	Display Name   Size
++   158bea89-07db-4ac2-8115-66c0d6a4bb48   None	available	
++		

3. Attach the demo-volume1 volume to the demo-instance1 instance:



#### Note

You must reference volumes using the IDs instead of names.

4. List volumes:

The demo-volume1 volume status should indicate in-use by the ID of the demo-instance1 instance.

5. Access your instance using SSH from the controller node or any host on the external network and use the **fdisk** command to verify presence of the volume as the /dev/vdb block storage device:

```
$ ssh cirros@203.0.113.102
$ sudo fdisk -1
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
                                         Blocks Id System
  Device Boot
                  Start
                                End
/dev/vda1 *
                  16065
                            2088449
                                        1036192+ 83 Linux
Disk /dev/vdb: 1073 MB, 1073741824 bytes
16 heads, 63 sectors/track, 2080 cylinders, total 2097152 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x00000000
Disk /dev/vdb doesn't contain a valid partition table
```



#### Note

You must create a partition table and file system to use the volume.

If your instance does not launch or seem to work as you expect, see the *OpenStack Operations Guide* for more information or use one of the many other options to seek assistance. We want your environment to work!

# Appendix A. Reserved user IDs

OpenStack reserves certain user IDs to run specific services and own specific files. These user IDs are set up according to the distribution packages. The following table gives an overview.

**Table A.1. Reserved user IDs** 

Name	Description	ID
ceilometer	OpenStack Ceilometer Daemons	166
cinder	OpenStack Cinder Daemons	165
glance	OpenStack Glance Daemons	161
heat	OpenStack Heat Daemons	187
keystone	OpenStack Keystone Daemons	163
neutron	OpenStack Neutron Daemons	164
nova	OpenStack Nova Daemons	162
swift	OpenStack Swift Daemons	160
trove	OpenStack Trove Daemons	Assigned during package installation

Each user belongs to a user group with the same name as the user.

# **Appendix B. Community support**

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The following resources are available to help you run and use OpenStack. The OpenStack community constantly improves and adds to the main features of OpenStack, but if you have any questions, do not hesitate to ask. Use the following resources to get OpenStack support, and troubleshoot your installations.

### **Documentation**

For the available OpenStack documentation, see docs.openstack.org.

To provide feedback on documentation, join and use the <openstack-docs@lists.openstack.org> mailing list at OpenStack Documentation
Mailing List, or report a bug.

The following books explain how to install an OpenStack cloud and its associated components:

- Installation Guide for Debian 7
- Installation Guide for openSUSE 13.1 and SUSE Linux Enterprise Server 11 SP3
- Installation Guide for Red Hat Enterprise Linux 7, CentOS 7, and Fedora 20
- Installation Guide for Ubuntu 14.04

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

- Architecture Design Guide
- Cloud Administrator Guide
- Configuration Reference
- Operations Guide
- High Availability Guide
- Security Guide

Virtual Machine Image Guide

The following books explain how to use the OpenStack dashboard and command-line clients:

- API Quick Start
- End User Guide
- · Admin User Guide
- Command-Line Interface Reference

The following documentation provides reference and guidance information for the Open-Stack APIs:

- OpenStack API Complete Reference (HTML)
- API Complete Reference (PDF)
- OpenStack Block Storage Service API v2 Reference
- OpenStack Compute API v2 and Extensions Reference
- OpenStack Identity Service API v2.0 Reference
- OpenStack Image Service API v2 Reference
- OpenStack Networking API v2.0 Reference
- OpenStack Object Storage API v1 Reference

The Training Guides offer software training for cloud administration and management.

### ask.openstack.org

During the set up or testing of OpenStack, you might have questions about how a specific task is completed or be in a situation where a feature does not work correctly. Use the ask.openstack.org site to ask questions and get answers. When you visit the http://ask.openstack.org site, scan the recently asked questions to see whether your question has already been answered. If not, ask a new question. Be sure to give a clear, concise summary in the title and provide as much detail as possible in the description. Paste in your command output or stack traces, links to screen shots, and any other information which might be useful.

# **OpenStack mailing lists**

A great way to get answers and insights is to post your question or problematic scenario to the OpenStack mailing list. You can learn from and help others who might have similar issues. To subscribe or view the archives, go to <a href="http://lists.openstack.org/cgi-bin/mail-man/listinfo/openstack">http://lists.openstack.org/cgi-bin/mail-man/listinfo/openstack</a>. 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 <a href="http://wiki.openstack.org/MailingLists">http://wiki.openstack.org/MailingLists</a>.

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# The OpenStack wiki

The OpenStack wiki contains a broad range of topics but some of the information can be difficult to find or is a few pages deep. Fortunately, the wiki search feature enables you to search by title or content. If you search for specific information, such as about networking or nova, you can find a large amount of relevant material. More is being added all the time, so be sure to check back often. You can find the search box in the upper-right corner of any OpenStack wiki page.

## The Launchpad Bugs area

The OpenStack community values your set up and testing efforts and wants your feedback. To log a bug, you must sign up for a Launchpad account at https://launchpad.net/+login. You can view existing bugs and report bugs in the Launchpad Bugs area. Use the search feature to determine whether the bug has already been reported or already been fixed. If it still seems like your bug is unreported, fill out a bug report.

#### Some tips:

- Give a clear, concise summary.
- Provide as much detail as possible in the description. Paste in your command output or stack traces, links to screen shots, and any other information which might be useful.
- Be sure to include the software and package versions that you are using, especially if you are using a development branch, such as, "Juno release" vs git commit bc79c3ecc55929bac585d04a03475b72e06a3208.
- Any deployment-specific information is helpful, such as whether you are using Ubuntu 14.04 or are performing a multi-node installation.

The following Launchpad Bugs areas are available:

- Bugs: OpenStack Block Storage (cinder)
- Bugs: OpenStack Compute (nova)
- Bugs: OpenStack Dashboard (horizon)
- Bugs: OpenStack Identity (keystone)
- Bugs: OpenStack Image Service (glance)
- Bugs: OpenStack Networking (neutron)
- Bugs: OpenStack Object Storage (swift)
- Bugs: Bare Metal (ironic)
- Bugs: Data Processing Service (sahara)
- Bugs: Database Service (trove)

- Bugs: Orchestration (heat)
- Bugs: Telemetry (ceilometer)
- Bugs: Queue Service (marconi)
- Bugs: OpenStack API Documentation (developer.openstack.org)
- Bugs: OpenStack Documentation (docs.openstack.org)

# The OpenStack IRC channel

The OpenStack community lives in the #openstack IRC channel on the Freenode network. You can hang out, ask questions, or get immediate feedback for urgent and pressing issues. To install an IRC client or use a browser-based client, go to http://webchat.freenode.net/. You can also use Colloquy (Mac OS X, http://colloquy.info/), mIRC (Windows, http://www.mirc.com/), or XChat (Linux). When you are in the IRC channel and want to share code or command output, the generally accepted method is to use a Paste Bin. The OpenStack project has one at http://paste.openstack.org. Just paste your longer amounts of text or logs in the web form and you get a URL that you can paste into the channel. The OpenStack IRC channel is #openstack on irc.freenode.net. You can find a list of all OpenStack IRC channels at https://wiki.openstack.org/wiki/IRC.

### **Documentation feedback**

To provide feedback on documentation, join and use the <openstack-docs@lists.openstack.org> mailing list at OpenStack Documentation
Mailing List, or report a bug.

# **OpenStack distribution packages**

The following Linux distributions provide community-supported packages for OpenStack:

- Debian: http://wiki.debian.org/OpenStack
- CentOS, Fedora, and Red Hat Enterprise Linux: http://openstack.redhat.com/
- openSUSE and SUSE Linux Enterprise Server: http://en.opensuse.org/Portal:OpenStack
- Ubuntu: https://wiki.ubuntu.com/ServerTeam/CloudArchive

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# Glossary

#### API

Application programming interface.

#### API endpoint

The daemon, worker, or service that a client communicates with to access an API. API endpoints can provide any number of services, such as authentication, sales data, performance metrics, Compute VM commands, census data, and so on.

#### **Block Storage**

The OpenStack core project that enables management of volumes, volume snapshots, and volume types. The project name of Block Storage is cinder.

#### CirrOS

A minimal Linux distribution designed for use as a test image on clouds such as OpenStack.

#### cloud controller node

A node that runs network, volume, API, scheduler, and image services. Each service may be broken out into separate nodes for scalability or availability.

#### Compute

The OpenStack core project that provides compute services. The project name of Compute service is nova.

#### compute node

A node that runs the nova-compute daemon that manages VM instances that provide a wide range of services, such as web applications and analytics.

#### controller node

Alternative term for a cloud controller node.

#### **Database Service**

An integrated project that provide scalable and reliable Cloud Database-as-a-Service functionality for both relational and non-relational database engines. The project name of Database Service is trove.

#### **DHCP**

Dynamic Host Configuration Protocol. A network protocol that configures devices that are connected to a network so that they can communicate on that network by using the Internet Protocol (IP). The protocol is implemented in a client-server model where DHCP clients request configuration data, such as an IP address, a default route, and one or more DNS server addresses from a DHCP server.

#### **DHCP** agent

OpenStack Networking agent that provides DHCP services for virtual networks.

#### dnsmasq

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

### extended attributes (xattr)

File system option that enables storage of additional information beyond owner, group, permissions, modification time, and so on. The underlying Object Storage file system must support extended attributes.

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#### 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.

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#### 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 work-loads 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.

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#### message broker

The software package used to provide AMQP messaging capabilities within Compute. Default package is RabbitMQ.

#### 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 namespace

Linux kernel feature that provides independent virtual networking instances on a single host with separate routing tables and interfaces. Similar to virtual routing and forwarding (VRF) services on physical network equipment.

#### Network Address Translation (NAT)

The process of modifying IP address information while in transit. Supported by Compute and Networking.

#### Network Time Protocol (NTP)

A method of keeping a clock for a host or node correct through communications with a trusted, accurate time source.

#### Networking

A core OpenStack project that provides a network connectivity abstraction layer to OpenStack Compute. The project name of Networking is neutron.

#### **Object Storage**

The OpenStack core project that provides eventually consistent and redundant storage and retrieval of fixed digital content. The project name of OpenStack Object Storage is swift.

#### Open vSwitch

Open vSwitch is a production quality, multilayer virtual switch licensed under the open source Apache 2.0 license. It is designed to enable massive network automation through programmatic extension, while still supporting standard management interfaces and protocols (for example Net-Flow, 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.

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#### path MTU discovery (PMTUD)

Mechanism in IP networks to detect end-to-end MTU and adjust packet size accordingly.

#### plug-in

and Fedora

Software component providing the actual implementation for Networking APIs, or for Compute APIs, depending on the context.

#### promiscuous mode

Causes the network interface to pass all traffic it receives to the host rather than passing only the frames addressed to it.

#### public key authentication

Authentication method that uses keys rather than passwords.

#### Quick EMUlator (QEMU)

QEMU is a generic and open source machine emulator and virtualizer.

One of the hypervisors supported by OpenStack, generally used for development purposes.

#### **RESTful**

A kind of web service API that uses REST, or Representational State Transfer. REST is the style of architecture for hypermedia systems that is used for the World Wide Web.

#### role

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

#### router

A physical or virtual network device that passes network traffic between different networks.

#### security group

A set of network traffic filtering rules that are applied to a Compute instance.

#### SELinux

Linux kernel security module that provides the mechanism for supporting access control policies.

#### service

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

#### subnet

Logical subdivision of an IP network.

#### **Telemetry**

An integrated project that provides metering and measuring facilities for OpenStack. The project name of Telemetry is ceilometer.

#### tenant

A group of users; used to isolate access to Compute resources. An alternative term for a project.

#### user

In Identity Service, each user is associated with one or more tenants, and in Compute can be associated with roles, projects, or both.

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#### virtual machine (VM)

An operating system instance that runs on top of a hypervisor. Multiple VMs can run at the same time on the same physical host.

#### virtual networking

A generic term for virtualization of network functions such as switching, routing, load balancing, and security using a combination of VMs and overlays on physical network infrastructure.

#### Virtual Network Computing (VNC)

Open source GUI and CLI tools used for remote console access to VMs. Supported by Compute.

#### virtual private network (VPN)

Provided by Compute in the form of cloudpipes, specialized instances that are used to create VPNs on a per-project basis.

#### XFS

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