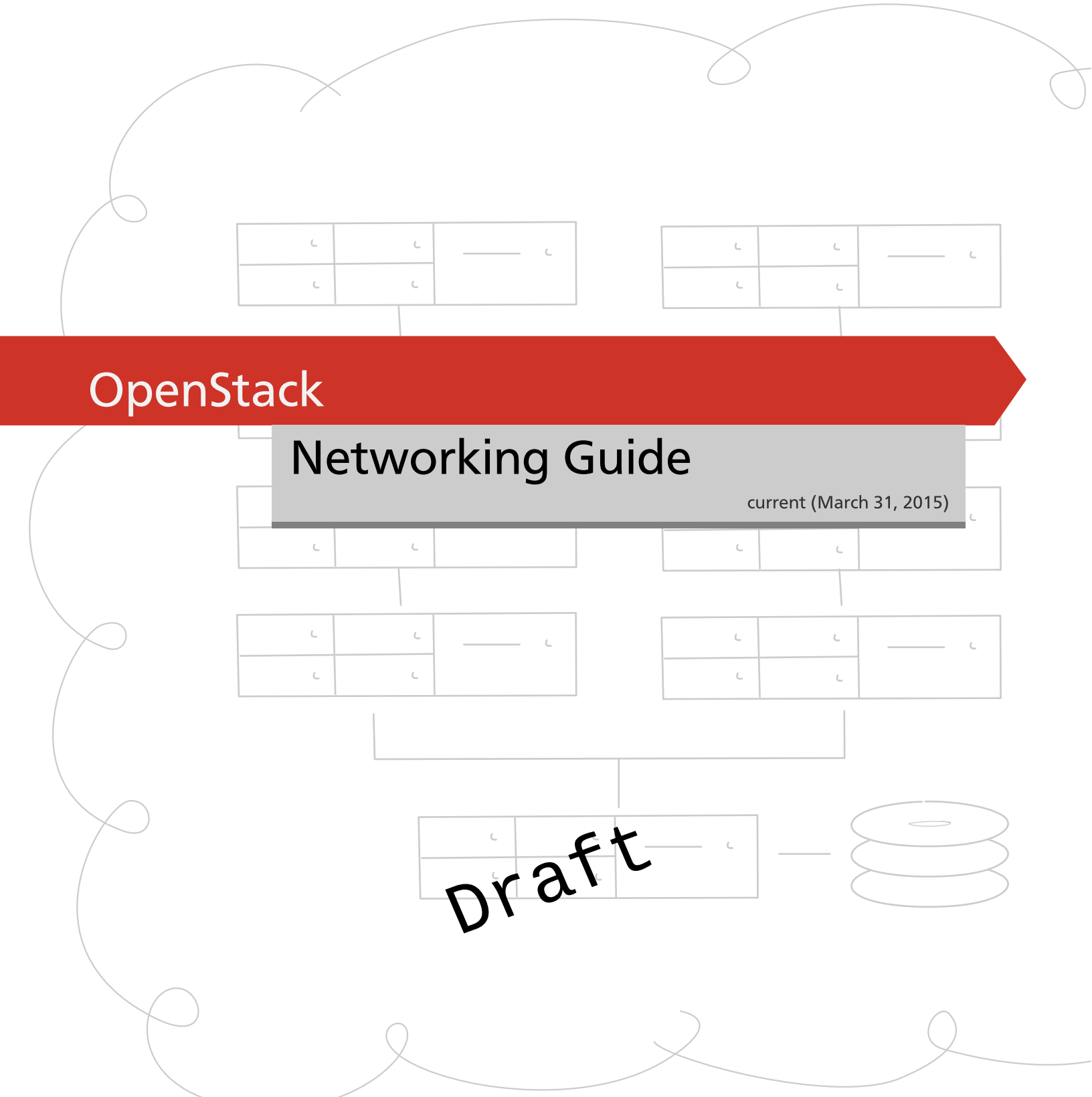

OpenStack

Networking Guide

current (March 31, 2015)

Draft

openstack™

docs.openstack.org

OpenStack Networking Guide

current (2015-03-31)

This guide targets OpenStack administrators seeking to deploy and manage OpenStack Networking.

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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
August 8, 2014	• Creation of document.

1. Get started with OpenStack

Table of Contents

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

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

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

Table 1.1. OpenStack services

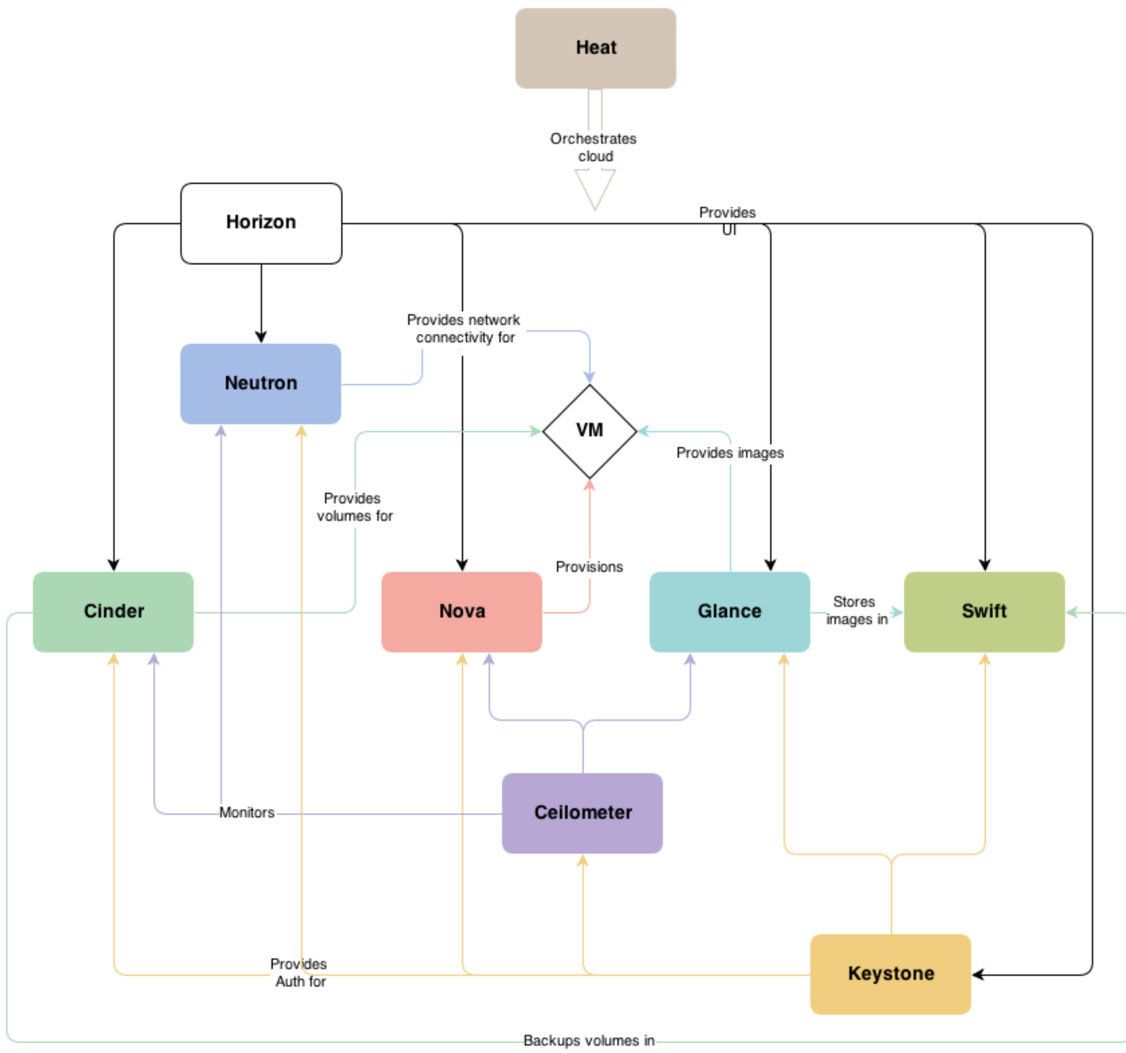
Service	Project name	Description
Dashboard	*Horizon*	Provides a web-based self-service portal to interact with underlying OpenStack services, such as launching an instance, assigning IP addresses and configuring access controls.
Compute	*Nova*	Manages the lifecycle of compute instances in an OpenStack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

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

Conceptual architecture

The following diagram shows the relationships among the OpenStack services:

Figure 1.1. OpenStack conceptual architecture



Logical architecture

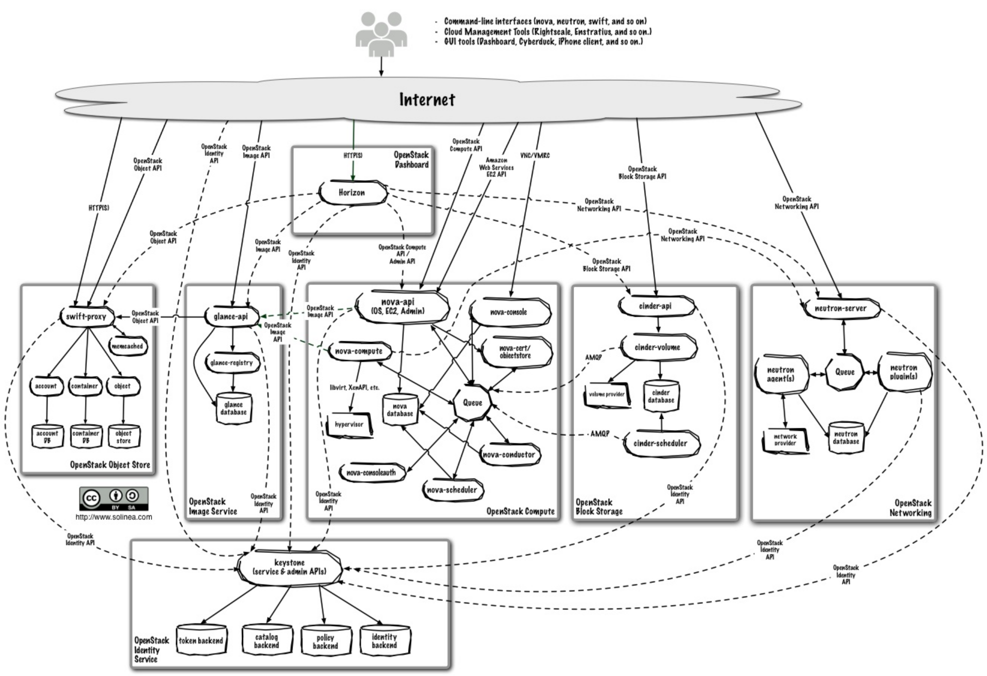
To design, deploy, and configure OpenStack, administrators must understand the logical architecture.

OpenStack modules are one of the following types:

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

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

Figure 1.2. Logical architecture



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

OpenStack services

This section describes OpenStack services in detail.

OpenStack Compute

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

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

OpenStack Compute consists of the following areas and their components:

API

`nova-api` service

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

`nova-api-metadata` service

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

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

Compute core

`nova-compute` service

A worker daemon that creates and terminates virtual machine instances through hypervisor APIs. For example:

- XenAPI for XenServer/XCP
- libvirt for KVM or QEMU
- VMwareAPI for VMware

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

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

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

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

Networking for VMs

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

Console interface

nova-consoleauth daemon	Authorizes tokens for users that console proxies provide. See `nova-novncproxy` and `nova-xvpnvcproxy`. This service must be running for console proxies to work. You can run proxies of either type against a single `nova-consoleauth` service in a cluster configuration. For information, see About nova-consoleauth.
nova-novncproxy daemon	Provides a proxy for accessing running instances through a VNC connection. Supports browser-based novnc clients.
nova-spicehtml5proxy daemon	Provides a proxy for accessing running instances through a SPICE connection. Supports browser-based HTML5 client.
nova-xvpnvncproxy daemon	Provides a proxy for accessing running instances through a VNC connection. Supports an OpenStack-specific Java client.
nova-cert daemon	x509 certificates.

In Debian, a unique nova-consoleproxy package provides the nova-novncproxy, nova-spicehtml5proxy, and nova-xvpvncproxy packages. To select packages, edit the `/etc/default/nova-consoleproxy` file or use the debconf interface. You can also manually edit the `/etc/default/nova-consoleproxy` file, and stop and start the console daemons.

Image management (EC2 scenario)

nova-objectstore daemon	An S3 interface for registering images with the OpenStack Image Service. Used primarily for installations that must support euca2ools. The euca2ools tools talk to `nova-objectstore` in *S3 language*, and `nova-objectstore` translates S3 requests into Image Service requests.
euca2ools client	A set of command-line interpreter commands for managing cloud resources. Although it is not an OpenStack module, you can configure `nova-api` to support this EC2 interface. For more information, see the Eucalyptus 3.4 Documentation.

Command-line clients and other interfaces

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

Other components

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

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

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

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

Storage concepts

The OpenStack stack uses the following storage types:

Table 1.2. Storage types

On-instance / ephemeral	Block storage (cinder)	Object Storage (swift)
Runs operating systems and provides scratch space	Used for adding additional persistent storage to a virtual machine (VM)	Used for storing virtual machine images and data
Persists until VM is terminated	Persists until deleted	Persists until deleted
Access associated with a VM	Access associated with a VM	Available from anywhere
Implemented as a filesystem underlying OpenStack Compute	Mounted via OpenStack Block Storage controlled protocol (for example, iSCSI)	REST API
Administrator configures size setting, based on flavors	Sizings based on need	Easily scalable for future growth
Example: 10 GB first disk, 30 GB/core second disk	Example: 1 TB "extra hard drive"	Example: 10s of TBs of data set storage

You should note that:

- *You cannot use OpenStack Object Storage like a traditional hard drive.* The Object Storage relaxes some of the constraints of a POSIX-style file system to get other gains. You can access the objects through an API which uses HTTP. Subsequently you don't have to provide atomic operations (that is, relying on eventual consistency), you can scale a storage system easily and avoid a central point of failure.

- *The OpenStack Image Service is used to manage the virtual machine images in an OpenStack cluster, not store them.* It provides an abstraction to different methods for storage - a bridge to the storage, not the storage itself.

- *The OpenStack Object Storage can function on its own.* The Object Storage (swift) product can be used independently of the Compute (nova) product.

Command-line clients and other interfaces

swift client
: Enables users to submit commands to the REST API through a command-line client authorized as either a admin user, reseller user, or swift user.

swift-init
: Script that initializes the building of the ring file, takes daemon names as parameter and offers commands. Documented in http://docs.openstack.org/developer/swift/admin_guide.html#managing-services.

swift-recon

swift-ring-builder
: Storage ring build and rebalance utility. Documented in http://docs.openstack.org/developer/swift/admin_guide.html#managing-the-rings.

OpenStack Object Storage

The OpenStack Object Storage is a multi-tenant object storage system. It is highly scalable and can manage large amounts of unstructured data at low cost through a RESTful HTTP API.

It includes the following components:

Proxy servers (`swift-proxy-server`)
: Accepts OpenStack Object Storage API and raw HTTP requests to upload files, modify metadata, and create containers. It also serves file or container listings to web browsers. To improve performance, the proxy server can use an optional cache that is usually deployed with memcache.

Account servers (`swift-account-server`)
: Manages accounts defined with Object Storage.

Container servers (`swift-container-server`)
: Manages the mapping of containers or folders, within Object Storage.

Object servers (`swift-object-server`)
: Manages actual objects,such as files, on the storage nodes.

Various periodic processes
: Performs housekeeping tasks on the large data store. The replication services ensure consistency and availability through the cluster. Other periodic processes include auditors, updaters, and reapers.

WSGI middleware
: Handles authentication and is usually OpenStack Identity.

OpenStack Block Storage

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

The Block Storage service consists of the following components:

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

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

`cinder-scheduler` daemon	Selects the optimal storage provider node on which to create the volume. A similar component to the `nova-scheduler`.
Messaging queue	Routes information between the Block Storage processes.

OpenStack Networking

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

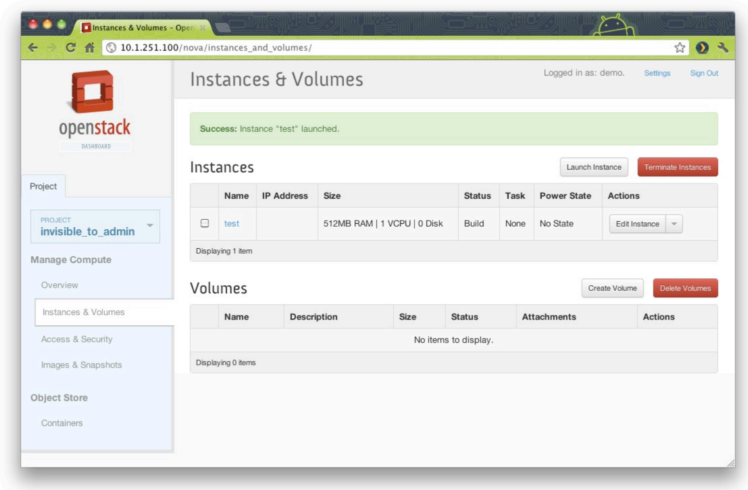
It includes the following components:

`neutron-server`	Accepts and routes API requests to the appropriate OpenStack Networking plug-in for action.
OpenStack Networking plug-ins and agents	Plugs and unplugs ports, creates networks or subnets, and provides IP addressing. These plug-ins and agents differ depending on the vendor and technologies used in the particular cloud. OpenStack Networking ships with plug-ins and agents for Cisco virtual and physical switches, NEC OpenFlow products, Open vSwitch, Linux bridging, and the VMware NSX product. The common agents are L3 (layer 3), DHCP (dynamic host IP addressing), and a plug-in agent.
Messaging queue	Used by most OpenStack Networking installations to route information between the neutron-server and various agents, as well as a database to store networking state for particular plug-ins.

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

OpenStack dashboard

The OpenStack dashboard is a modular Django web application that provides a graphical interface to OpenStack services.



The dashboard is usually deployed through mod_wsgi in Apache. You can modify the dashboard code to make it suitable for different sites.

From a network architecture point of view, this service must be accessible to customers and the public API for each OpenStack service. To use the administrator functionality for other services, it must also connect to Admin API endpoints, which should not be accessible by customers.

OpenStack Identity concepts

The OpenStack*Identity Service* performs the following functions:

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

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

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

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

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

Authentication The process of confirming the identity of a user. OpenStack Identity confirms an incoming request by validating a set of credentials supplied by the user.

These credentials are initially a user name and password, or a user name and API key. When user credentials are validated, OpenStack Identity issues an authentication token which the user provides in subsequent requests.

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

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

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

Service An OpenStack service, such as Compute (nova), Object Storage (swift), or Image Service (glance). It provides one or more endpoints in which users can access resources and perform operations.

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

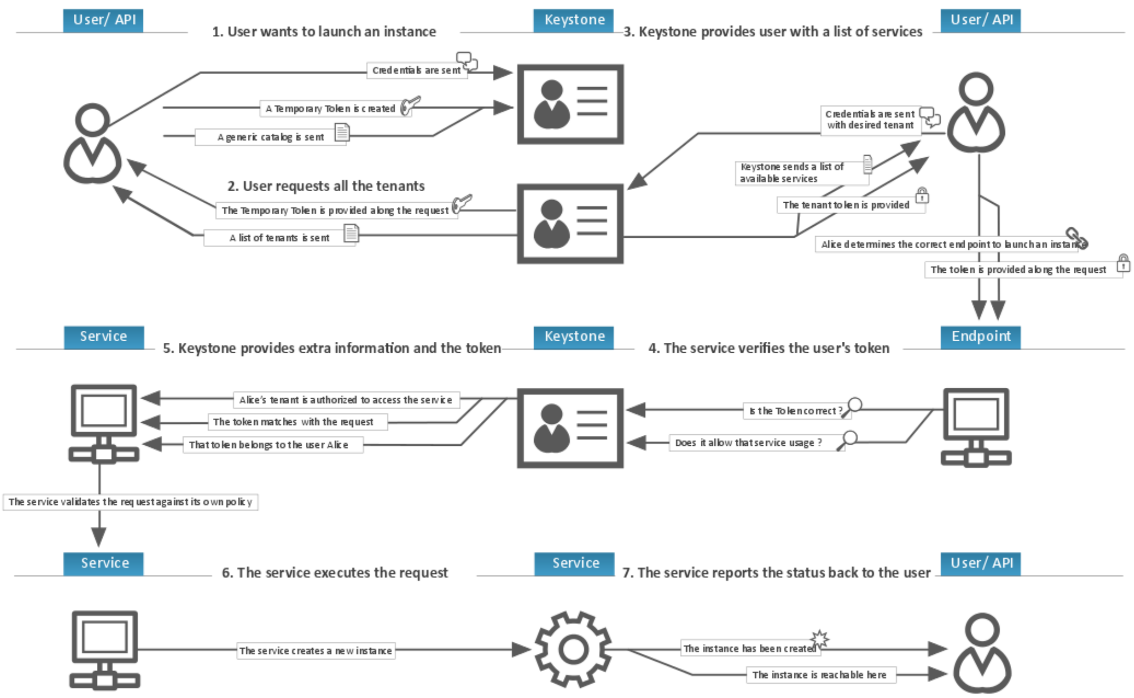
Role A personality with a defined set of user rights and privileges to perform a specific set of operations.

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

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

The following diagram shows the OpenStack Identity process flow:

The Keystone Identity Manager



OpenStack Image Service

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

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

The OpenStack Image Service includes the following components:

`glance-api`	Accepts Image API calls for image discovery, retrieval, and storage.
`glance-registry`	Stores, processes, and retrieves metadata about images. Metadata includes items such as size and type.

Security note

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

Database	Stores image metadata and you can choose your database depending on your preference. Most deployments use MySQL or SQLite.
Storage repository for image files	Various repository types are supported including normal file systems, Object Storage, RADOS block devices, HTTP, and Amazon S3. Note that some repositories will only support read-only usage.

Telemetry module

The Telemetry module performs the following functions:

- Efficiently collects the metering data about the CPU and network costs.
- Collects data by monitoring notifications sent from services or by polling the infrastructure.
- Configures the type of collected data to meet various operating requirements. It accesses and inserts the metering data through the REST API.
- Expands the framework to collect custom usage data by additional plug-ins.
- Produces signed metering messages that cannot be repudiated.

The Telemetry module consists of the following components:

A compute agent (`ceilometer-agent-compute`)	Runs on each compute node and polls for resource utilization statistics. There may be other types of agents in the future, but for now our focus is creating the compute agent.
A central agent (`ceilometer-agent-central`)	Runs on a central management server to poll for resource utilization statistics for resources not tied to instances or compute nodes.
A notification agent (`ceilometer-agent-notification`)	Runs on a central management server to initiate alarm actions, such as calling out to a webhook with a description of the alarm state transition.
A collector (`ceilometer-collector`)	Runs on central management server(s) to monitor the message queues (for notifications and for metering data coming from the agent). Notification messages are processed and turned into metering messages, which are sent to the message bus using the appropriate topic. Telemetry messages are written to the data store without modification.
An alarm evaluator (`ceilometer-alarm-evaluator`)	Runs on one or more central management servers to determine when alarms fire due to the associated statistic trend crossing a threshold over a sliding time window.
An alarm notifier (`ceilometer-alarm-notifier`)	Runs on one or more central management servers to allow alarms to be set based on the threshold evaluation for a collection of samples.
A data store	A database capable of handling concurrent writes (from one or more collector instances) and reads (from the API server).
An API server (`ceilometer-api`)	Runs on one or more central management servers to provide data access from the data store.

These services communicate by using the OpenStack messaging bus. Only the collector and API server have access to the data store.

Orchestration module concepts

The Orchestration module provides a template-based orchestration for describing a cloud application, by running OpenStack API calls to generate running cloud applications. The software integrates other core components of OpenStack into a one-file template system. The templates allow you to create most OpenStack resource types, such as instances, floating IPs, volumes, security groups and users. It also provides advanced functionality, such as instance high availability, instance auto-scaling, and nested stacks. This enables OpenStack core projects to receive a larger user base.

The service enables deployers to integrate with the Orchestration module directly or through custom plug-ins.

The Orchestration module consists of the following components:

heat command-line client	A CLI that communicates with the heat-api to run AWS CloudFormation APIs. End developers can directly use the Orchestration REST API.
`heat-api` component	An OpenStack-native REST API that processes API requests by sending them to the heat-engine over Remote Procedure Call (RPC).
`heat-api-cfn` component	An AWS Query API that is compatible with AWS CloudFormation. It processes API requests by sending them to the heat-engine over RPC.
`heat-engine`	Orchestrates the launching of templates and provides events back to the API consumer.

Database service overview

The Database service provides scalable and reliable cloud provisioning functionality for both relational and non-relational database engines. Users can quickly and easily use database features without the burden of handling complex administrative tasks. Cloud users and database administrators can provision and manage multiple database instances as needed.

The Database service provides resource isolation at high performance levels, and automates complex administrative tasks such as deployment, configuration, patching, backups, restores, and monitoring.

Process flow example. This example is a high-level process flow for using Database services:

1. The OpenStack Administrator configures the basic infrastructure using the following steps:
   a. Install the Database service.
   b. Create an image for each type of database. For example, one for MySQL and one for MongoDB.
   c. Use the **trove-manage** command to import images and offer them to tenants.
2. The OpenStack end user deploys the Database service using the following steps:
   a. Create a Database service instance using the **trove create** command.
   b. Use the **trove list** command to get the ID of the instance, followed by the **trove show** command to get the IP address of it.
   c. Access the Database service instance using typical database access commands. For example, with MySQL:

```
$ mysql -u myuser -p -h TROVE_IP_ADDRESS mydb
```

The Database service includes the following components:

`python-troveclient` command-line client	A CLI that communicates with the `trove-api` component.

`trove-api` component	Provides an OpenStack-native RESTful API that supports JSON to provision and manage Trove instances.
`trove-conductor` service	Runs on the host, and receives messages from guest instances that want to update information on the host.
`trove-taskmanager` service	Instruments the complex system flows that support provisioning instances, managing the lifecycle of instances, and performing operations on instances.
`trove-guestagent` service	Runs within the guest instance. Manages and performs operations on the database itself.

Data processing service

The Data processing service for OpenStack (sahara) aims to provide users with a simple means to provision data processing (Hadoop, Spark) clusters by specifying several parameters like Hadoop version, cluster topology, node hardware details and a few more. After a user fills in all the parameters, the Data processing service deploys the cluster in a few minutes. Sahara also provides a means to scale already provisioned clusters by adding/removing worker nodes on demand.

The solution addresses the following use cases:

- Fast provisioning of Hadoop clusters on OpenStack for development and QA.
- Utilization of unused compute power from general purpose OpenStack IaaS cloud.
- Analytics-as-a-Service for ad-hoc or bursty analytic workloads.

Key features are:

- Designed as an OpenStack component.
- Managed through REST API with UI available as part of OpenStack dashboard.
- Support for different Hadoop distributions:
  - Pluggable system of Hadoop installation engines.
  - Integration with vendor specific management tools, such as Apache Ambari or Cloudera Management Console.
- Predefined templates of Hadoop configurations with the ability to modify parameters.
- User-friendly UI for ad-hoc analytics queries based on Hive or Pig.

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.

2. Introduction to networking

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The OpenStack Networking service provides an API that allows users to set up and define network connectivity and addressing in the cloud. The project code-name for Networking services is neutron. OpenStack Networking handles the creation and management of a virtual networking infrastructure, including *networks*, switches, *subnets*, and *routers* for devices managed by the OpenStack Compute service (nova). Advanced services such as *firewalls* or *virtual private networks (VPNs)* can also be used.

OpenStack Networking consists of the `neutron-server`, a database for persistent storage, and any number of plugin *agents*, which provide other services such as interfacing with native Linux networking mechanisms, external devices, or SDN controllers.

OpenStack Networking is entirely standalone and can be deployed to a dedicated host. If your deployment uses a controller host to run centralized Compute components, you can deploy the Networking server to that specific host instead.

OpenStack Networking integrates with various other OpenStack components:

- OpenStack Identity (keystone) is used for authentication and authorization of API requests.
- OpenStack Compute (nova) is used to plug each virtual NIC on the VM into a particular network.
- OpenStack dashboard (horizon) for administrators and tenant users to create and manage network services through a web-based graphical interface.

Networking layers

Network communication is commonly described in terms of the OSI model. The OSI model is a seven-layer model that describes how various protocols and mechanisms fit together. Each layer depends on the protocols in the layer beneath it.

7 Application The Application layer of the OSI model is the user interface layer. Everything here is application specific. Some examples at this layer which could be Telnet, FTP, email.

6 Presentation Here is where data gets translated from the application into network format and back again. The presentation layer transforms data into a

	form that the application layer can accept. The presentation layer formats and encrypts data which prevents compatibility problems.
5 Session	The Session layer manages connections between applications. It is responsible for session and connection coordination.
4 Transport	This layer deals with transporting data usually over TCP or Transmission Control Protocol. TCP enables two hosts to establish, connect, and exchange streams of data together. TCP also guarantees delivery of data and the order in which packets are sent.
3 Network	This layer handles transmission for data from node to node. The network layer handles routing, forwarding, addressing, inter-networking, and error handling. Usually this is the IP portion of TCP/IP.
2 Data link	The data link layer is where most LAN technologies such as Ethernet live. This layer is divided into two sub layers: **MAC (Media Access Control):** Handles access to data and permissions to translate it. **LLC (Logical Link Control):** Manages traffic across the physical layer.
1 Physical	The physical layer is the description of the physical media or signals used in networking. Examples include the size of the Ethernet, hubs, or other physical devices used to establish a network.

OpenStack Networking is primarily concerned with Layer 2 and Layer 3.

Layer-3 protocols include the Internet Protocol Suite, which includes IPv4, IPv6, and the Internet Control Message Protocol (ICMP).

Switches

A switch is a device that is used to connect devices on a network. Switches forward packets on to other devices, using packet switching to pass data along only to devices that need to receive it. Switches operate at Layer 2 of the OSI model.

Routers

A router is a networking device that connects multiple networks together. Routers are connected to two or more networks. When they receive data packets, they use a routing table to determine which networks to pass the information to.

Firewalls

A firewall is a network security system that controls the network traffic using a set of rules. Firewalls can be implemented in both hardware and software, or a mix of the two. For example, a firewall might disallow traffic originating from a range of IP addresses or only allow traffic on specific ports. Firewalls are often used between internal networks, where data is trusted, and on external networks such as the Internet.

Many firewalls incorporate Network Address Translation (NAT). Network address translation masks the IP addresses of the devices on the internal network, so that external devices see only the single public IP address of the device hosting the firewall.

Tunnel (segmentation) technologies

Tunneling allows one network protocol to encapsulate another payload protocol, such that packets from the payload protocol are passed as data on the delivery protocol. This can be used, for example, to pass data securely over an untrusted network.

Layer 2

Virtual local area network (VLAN)
A VLAN partitions a single layer-2 network into multiple isolated broadcast domains.

Layer 3

Generic routing encapsulation (GRE)
GRE carries IP packets with private IP address over the Internet using delivery packets with public IP addresses.

Virtual extensible local area network (VXLAN)
VXLAN encapsulates layer-2 Ethernet frames over layer-4 UDP packets.

Namespaces

A namespace is a container for a set of identifiers. Namespaces provide a level of direction to specific identifiers and make it possible to differentiate between identifiers with the same exact name. With network namespaces, you can have different and separate instances of network interfaces and routing tables that operate separate from each other.

Neutron data model

FIXME: Explain Neutron terminology and how it maps to networking concepts presented in previous chapters. A small amount of terminology is at http://docs.openstack.org/admin-guide-cloud/content/api_abstractions.html . Probably not worth subsections as outlined here. table or variablelist?

Networks

FIXME

Subnets

FIXME

Ports

FIXME

Extensions

FIXME

3. Networking architecture

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A standard network architecture design includes a cloud controller host, a network gateway host, and a number of hypervisors for hosting virtual machines. The cloud controller and network gateway can be on the same host. However, if you expect VMs to send significant traffic to or from the Internet, a dedicated network gateway host helps avoid CPU contention between the `neutron-l3-agent` and other OpenStack services that forward packets.

You can run OpenStack Networking across multiple physical devices. It is also possible to run all service daemons on a single physical host for evaluation purposes. However, this is not generally robust enough for production purposes. For greater redundancy, you can run each service on a dedicated physical host and replicate any essential services across multiple hosts.

For more information about networking architecture options, see the Network Design section of the *OpenStack Operations Guide*.

A standard OpenStack Networking deployment usually includes one or more of the following physical networks:

Table 3.1. General distinct physical data center networks

Network	Description
Management network	Provides internal communication between OpenStack components. IP addresses on this network should be reachable only within the data center.
Data network	Provides VM data communication within the cloud deployment. The IP addressing requirements of this network depend on the Networking plug-in that is used.
External network	Provides VMs with Internet access in some deployment scenarios. Anyone on the Internet can reach IP addresses on this network.
API network	Exposes all OpenStack APIs, including the Networking API, to tenants. IP addresses on this network should be reachable by anyone on the Internet. The API network might be the same as the external network because it is possible to create an external-network subnet that has allocated IP ranges, which use less than the full range of IP addresses in an IP block.

Tenant and provider networks

The following diagram presents an overview of the tenant and provider network types, and illustrates how they interact within the overall Networking topology:

Tenant networks. Users create tenant networks for connectivity within projects; they are fully isolated by default and are not shared with other projects. Networking supports a range of tenant network types:

Flat
: All instances reside on the same network, which can also be shared with the hosts. No VLAN tagging or other network segregation takes place.

Local
: Instances reside on the local compute host and are effectively isolated from any external networks.

VLAN
: Networking allows users to create multiple provider or tenant networks using VLAN IDs (802.1Q tagged) that correspond to VLANs present in the physical network. This allows instances to communicate with each other across the environment. They can also communicate with dedicated servers, firewalls, load balancers, and other networking infrastructure on the same layer 2 VLAN.

VXLAN and GRE
: VXLAN and GRE use network overlays to support private communication between instances. A Networking router is required to enable traffic to traverse outside of the GRE or VXLAN tenant network. A router is also required to connect directly-connected tenant networks with external networks, including the Internet. The router provides the ability to connect to instances directly from an external network using floating IP addresses.

Provider networks. The OpenStack administrator creates provider networks. These networks map to existing physical networks in the data center. Useful network types in this category are flat (untagged) and VLAN (802.1Q tagged). It is possible to share provider networks among tenants as part of the network creation process.

VMware NSX integration

OpenStack Networking uses the NSX plug-in for Networking to integrate with an existing VMware vCenter deployment. When installed on the network nodes, the NSX plug-in enables a NSX controller to centrally manage configuration settings and push them to managed network nodes. Network nodes are considered managed when they're added as hypervisors to the NSX controller.

The following diagram depicts an example NSX deployment and illustrates the route inter-VM traffic takes between separate Compute nodes. Note the placement of the VMware NSX plug-in and the `neutron-server` service on the network node. The NSX controller features centrally with a green line to the network node to indicate the management relationship:

Overview

Bacon ipsum dolor sit amet biltong meatloaf andouille, turducken bresaola pork belly beef ribs ham hock capicola tail prosciutto landjaeger meatball pork loin. Swine turkey jowl, porchetta doner boudin meatloaf. Shoulder capicola prosciutto, shank landjaeger short ribs sirloin turducken pork belly boudin frankfurter chuck. Salami shankle bresaola cow filet mignon ham hock shank.

Service/component hierarchy

Neutron server -> plug-in -> agents

Example architectures

XIncluded below from Cloud Admin Guide. May need to be reworked. See also http://docs.openstack.org/grizzly/openstack-network/admin/content/use_cases.html and admin-guide-cloud/networking/section_networking-scenarios.xml .

Server

Bacon ipsum dolor sit amet biltong meatloaf andouille, turducken bresaola pork belly beef ribs ham hock capicola tail prosciutto landjaeger meatball pork loin. Swine turkey jowl, porchetta doner boudin meatloaf. Shoulder capicola prosciutto, shank landjaeger short ribs sirloin turducken pork belly boudin frankfurter chuck. Salami shankle bresaola cow filet mignon ham hock shank.

Plug-ins

The legacy networking (nova-network) implementation assumed a basic model of isolation through Linux VLANs and IP tables. Networking introduces support for vendor plug-ins, which offer a custom back-end implementation of the Networking API. A plugin can use a variety of technologies to implement the logical API requests. Some networking plug-ins might use basic Linux VLANs and IP tables, while others might use more advanced technologies, such as L2-in-L3 tunneling or OpenFlow, to provide similar benefits.

Agents

Bacon ipsum dolor sit amet ribeye rump pork loin shankle jowl pancetta bacon. Chicken andouille capicola filet mignon shoulder, turducken corned beef boudin hamburger fatback pork chop t-bone kevin. Leberkas turducken short loin t-bone pork belly pig prosciutto chicken beef ribs pork loin short ribs shoulder jerky bacon strip steak.

`neutron-server`
: A Python daemon, which manages user requests (and exposes the API). It is configured with a plugin that implements the OpenStack Networking API operations using a specific set of networking mechanisms. A wide choice of plugins are also available. For example, the open vSwitch and linuxbridge plugins utilize native Linux networking mechanisms, while other plugins interface with external devices or SDN controllers.

`neutron-l3-agent`
: An agent providing L3/NAT forwarding.

`neutron-*-agent`
: A plug-in agent that runs on each node to perform local networking configuration for the node's virtual machines and networking services.

`neutron-dhcp-agent`
: An agent providing DHCP services to tenant networks.

Database	Provides persistent storage.

Overview

provide layer-2/3 connectivity to instances, handle physical-virtual network transition, handle metadata, etc

Layer 2

Linux Bridge	overview/concepts
	configuration file
Open vSwitch	overview/concepts
	configuration file

Layer 3 (IP/Routing)

l3	overview/concepts
	configuration file
DHCP	overview/concepts
	configuration file

Miscellaneous

Metadata	overview/concepts
	configuration file

4. Plugins

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Bacon ipsum dolor sit amet biltong meatloaf andouille, turducken bresaola pork belly beef ribs ham hock capicola tail prosciutto landjaeger meatball pork loin. Swine turkey jowl, porchetta doner boudin meatloaf. Shoulder capicola prosciutto, shank landjaeger short ribs sirloin turducken pork belly boudin frankfurter chuck. Salami shankle bresaola cow filet mignon ham hock shank.

ML2

Overview

architecture

configuration file organization, relationships, etc

Network type drivers

Flat FIXME

VLAN FIXME

GRE FIXME

VXLAN FIXME

Tenant network types

- Local
- VLAN, VLAN ID ranges
- GRE, Tunnel ID ranges
- VXLAN, VNI ID ranges

See admin-guide-cloud/networking/section_networking_arch.xml

Mechanisms

Linux Bridge FIXME

Open vSwitch FIXME

Open Daylight FIXME

L2 Population FIXME

Proprietary FIXME

Security

Options FIXME

Proprietary

FIXME

5. Deployment

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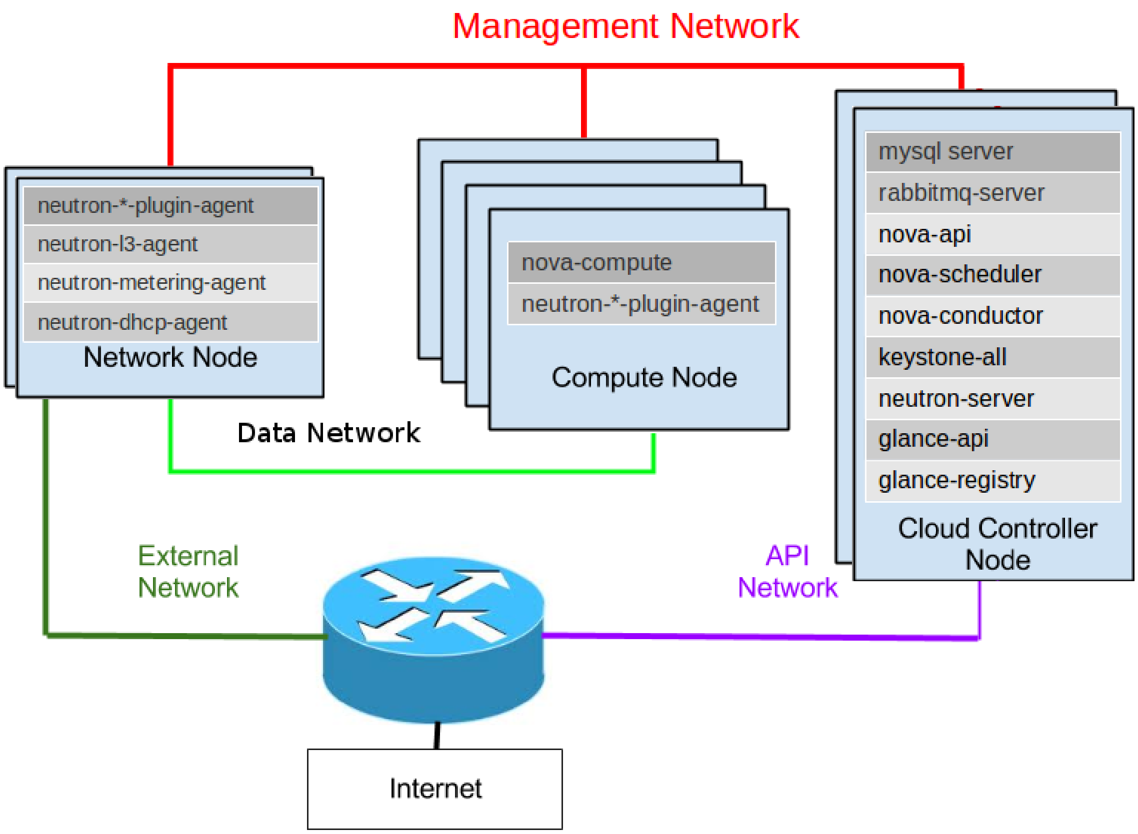
OpenStack Networking provides an extreme amount of flexibility when deploying networking in support of a compute environment. As a result, the exact layout of a deployment will depend on a combination of expected workloads, expected scale, and available hardware.



For demonstration purposes, this chapter concentrates on a networking deployment that consists of these types of nodes:

- *Service node:* The service node exposes the networking API to clients and handles incoming requests before forwarding them to a message queue. Requests are then actioned by the other nodes. The service node hosts both the networking service itself and the active networking plug-in. In environments that use controller nodes to host the client-facing APIs, and schedulers for all services, the controller node would also fulfill the role of service node as it is applied in this chapter.

  Network node: The network node handles the majority of the networking workload. It hosts the DHCP agent, the Layer-3 (L3) agent, the Layer-2 (L2) agent, and the metada-

ta proxy. In addition to plug-ins that require an agent, it runs an instance of the plug-in agent (as do all other systems that handle data packets in an environment where such plug-ins are in use). Both the Open vSwitch and Linux Bridge mechanism drivers include an agent.

Compute node: The compute node hosts the compute instances themselves. To connect compute instances to the networking services, compute nodes must also run the L2 agent. Like all other systems that handle data packets it must also run an instance of the plug-in agent.

Example architecture

Controller node

Functions (provides API)

Network node

Functions (handles routing, NAT, floating IPs, etc)

Compute nodes

Functions (implements security groups

Authentication

Bacon ipsum dolor sit amet biltong meatloaf andouille, turducken bresaola pork belly beef ribs ham hock capicola tail prosciutto landjaeger meatball pork loin. Swine turkey jowl, porchetta doner boudin meatloaf. Shoulder capicola prosciutto, shank landjaeger short ribs sirloin turducken pork belly boudin frankfurter chuck. Salami shankle bresaola cow filet mignon ham hock shank.

Scenarios

(provide configuration, diagrams, and flow of communications when launching an instance)

- Linux Bridge using VLAN
- Linux Bridge using GRE
- Linux Bridge using VXLAN
- Open vSwitch with VLAN
- Open vSwitch with GRE
- Open vSwitch with VXLAN
- Mixed Linux Bridge and Open vSwitch

XIncluded content for possible reuse below

Networking scenarios

This chapter describes two networking scenarios and how the Open vSwitch plug-in and the Linux Bridge plug-in implement these scenarios.

Open vSwitch

This section describes how the Open vSwitch plug-in implements the Networking abstractions.

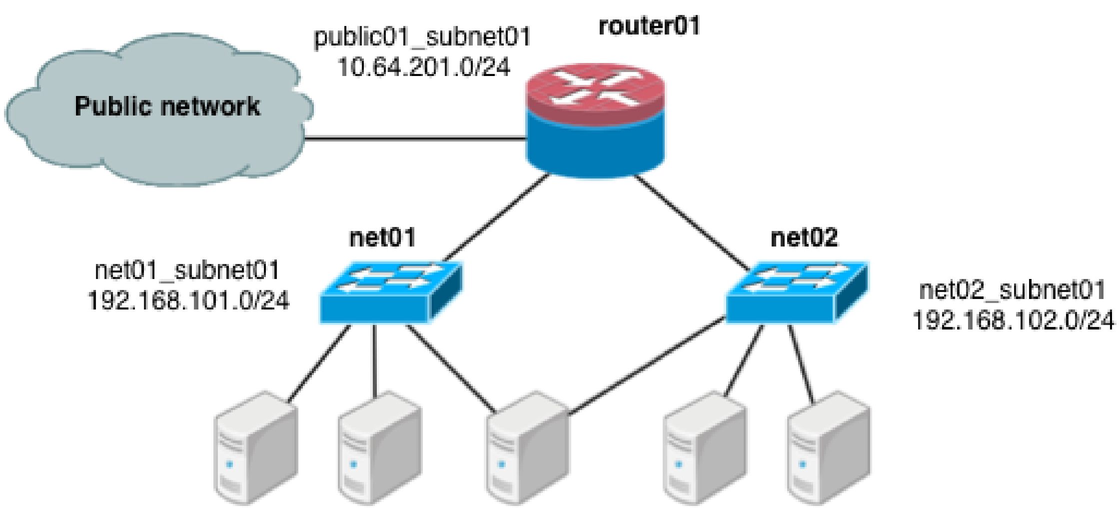
Configuration

This example uses VLAN segmentation on the switches to isolate tenant networks. This configuration labels the physical network associated with the public network as `physnet1`, and the physical network associated with the data network as `physnet2`, which leads to the following configuration options in `ovs_neutron_plugin.ini`:

```
[ovs]
tenant_network_type = vlan
network_vlan_ranges = physnet1,physnet2:100:110
integration_bridge = br-int
bridge_mappings = physnet2:br-eth1
```

Scenario 1: one tenant, two networks, one router

The first scenario has two private networks (`net01`, and `net02`), each with one subnet (`net01_subnet01`: 192.168.101.0/24, `net02_subnet01`, 192.168.102.0/24). Both private networks are attached to a router that connects them to the public network (10.64.201.0/24).



Under the `service` tenant, create the shared router, define the public network, and set it as the default gateway of the router

```
$ tenant=$(keystone tenant-list | awk '/service/ {print $2}')
$ neutron router-create router01
$ neutron net-create --tenant-id $tenant public01 \
          --provider:network_type flat \
          --provider:physical_network physnet1 \
```

```
        --router:external True
$ neutron subnet-create --tenant-id $tenant --name public01_subnet01 \
        --gateway 10.64.201.254 public01 10.64.201.0/24 --disable-dhcp
$ neutron router-gateway-set router01 public01
```

Under the `demo` user tenant, create the private network `net01` and corresponding subnet, and connect it to the `router01` router. Configure it to use VLAN ID 101 on the physical switch.

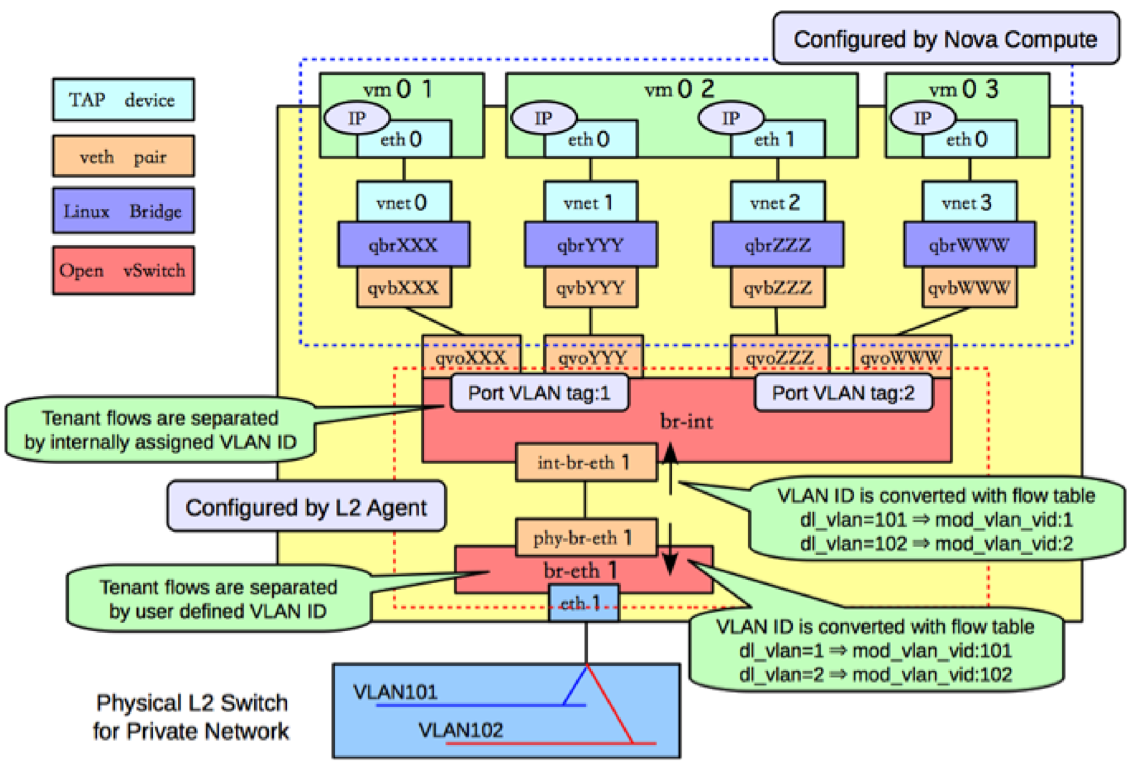
```
$ tenant=$(keystone tenant-list|awk '/demo/ {print $2}'
$ neutron net-create --tenant-id $tenant net01 \
        --provider:network_type vlan \
        --provider:physical_network physnet2 \
        --provider:segmentation_id 101
$ neutron subnet-create --tenant-id $tenant --name net01_subnet01 net01 192.
168.101.0/24
$ neutron router-interface-add router01 net01_subnet01
```

Similarly, for `net02`, using VLAN ID 102 on the physical switch:

```
$ neutron net-create --tenant-id $tenant net02 \
        --provider:network_type vlan \
        --provider:physical_network physnet2 \
        --provider:segmentation_id 102
$ neutron subnet-create --tenant-id $tenant --name net02_subnet01 net02 192.
168.102.0/24
$ neutron router-interface-add router01 net02_subnet01
```

Scenario 1: Compute host config

The following figure shows how to configure various Linux networking devices on the compute host:



Types of network devices

Note

There are four distinct type of virtual networking devices: TAP devices, veth pairs, Linux bridges, and Open vSwitch bridges. For an Ethernet frame to travel from `eth0` of virtual machine `vm01` to the physical network, it must pass through nine devices inside of the host: TAP `vnet0`, Linux bridge `qbr`*`NNN`*, veth pair (`qvb`*`NNN`*, `qvo`*`NNN`*), Open vSwitch bridge `br-int`, veth pair (`int-br-eth1`, `phy-br-eth1`), and, finally, the physical network interface card `eth1`.

A *TAP device*, such as `vnet0` is how hypervisors such as KVM and Xen implement a virtual network interface card (typically called a VIF or vNIC). An Ethernet frame sent to a TAP device is received by the guest operating system.

A *veth pair* is a pair of directly connected virtual network interfaces. An Ethernet frame sent to one end of a veth pair is received by the other end of a veth pair. Networking uses veth pairs as virtual patch cables to make connections between virtual bridges.

A *Linux bridge* behaves like a simple MAC learning switch: you can connect multiple (physical or virtual) network interfaces devices to a Linux bridge. The Linux bridge uses a MAC caching table to record which interface on the bridge is used to communicate with a host on the link. For any Ethernet frames that come in from one interface attached to the bridge, the host MAC address and port on which the frame was received is recorded in the MAC caching table for a limited time. When the bridge needs to forward a frame, it will check to see if the frame's destination MAC address is recorded in the table. If so, the Linux bridge forwards the frame through only that port. If not, the frame is flooded to all network ports in the bridge, with the exception of the port where the frame was received.

An *Open vSwitch bridge* behaves like a virtual switch: network interface devices connect to Open vSwitch bridge's ports, and the ports can be configured much like a physical switch's ports, including VLAN configurations.

Integration bridge

The `br-int` Open vSwitch bridge is the integration bridge: all guests running on the compute host connect to this bridge. Networking implements isolation across these guests by configuring the `br-int` ports.

Physical connectivity bridge

The `br-eth1` bridge provides connectivity to the physical network interface card, `eth1`. It connects to the integration bridge by a veth pair: (`int-br-eth1`, `phy-br-eth1`).

VLAN translation

In this example, net01 and net02 have VLAN ids of 1 and 2, respectively. However, the physical network in our example only supports VLAN IDs in the range 101 through 110. The Open vSwitch agent is responsible for configuring flow rules on `br-int` and `br-eth1` to do VLAN translation. When `br-eth1` receives a frame marked with VLAN ID 1 on the port associated with `phy-br-eth1`, it modifies the VLAN ID in the frame to 101. Similar-

ly, when `br-int` receives a frame marked with VLAN ID 101 on the port associated with `int-br-eth1`, it modifies the VLAN ID in the frame to 1.

Security groups: iptables and Linux bridges

Ideally, the TAP device `vnet0` would be connected directly to the integration bridge, `br-int`. Unfortunately, this isn't possible because of how OpenStack security groups are currently implemented. OpenStack uses iptables rules on the TAP devices such as `vnet0` to implement security groups, and Open vSwitch is not compatible with iptables rules that are applied directly on TAP devices that are connected to an Open vSwitch port.

Networking uses an extra Linux bridge and a veth pair as a workaround for this issue. Instead of connecting `vnet0` to an Open vSwitch bridge, it is connected to a Linux bridge, `qbr`*`XXX`*. This bridge is connected to the integration bridge, `br-int`, through the `(qvb`*`XXX`*`, qvo`*`XXX`*`)` veth pair.

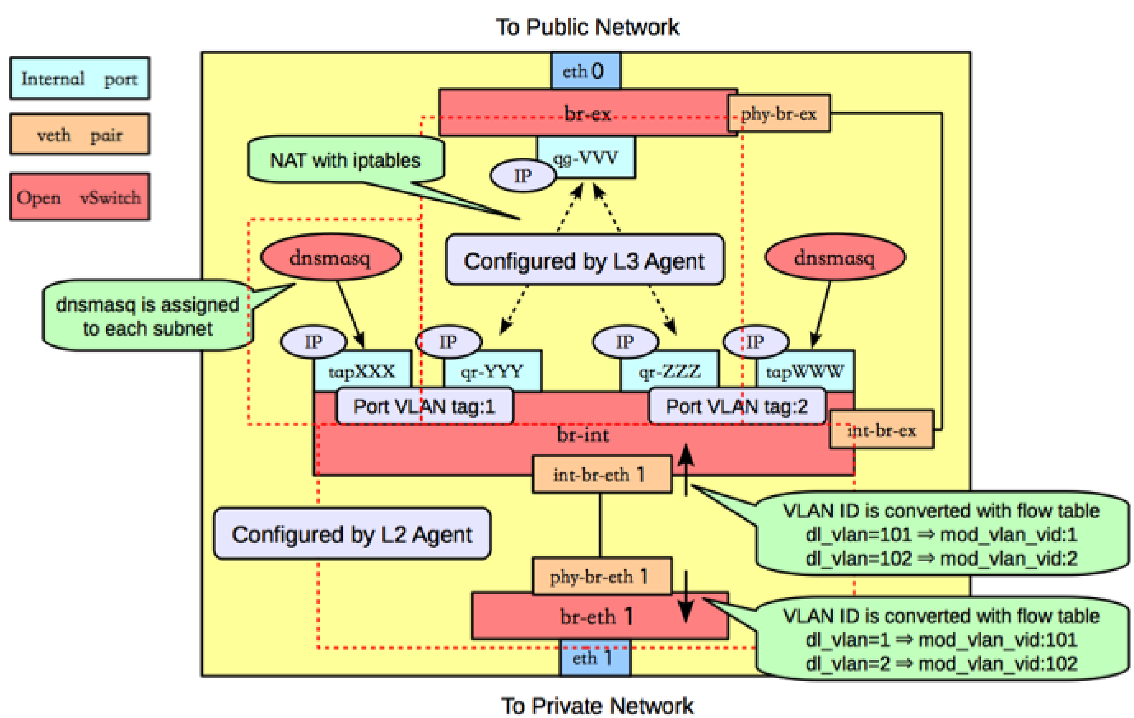
Scenario 1: Network host config

The network host runs the neutron-openvswitch-plugin-agent, the neutron-dhcp-agent, neutron-l3-agent, and neutron-metadata-agent services.

On the network host, assume that eth0 is connected to the external network, and eth1 is connected to the data network, which leads to the following configuration in the `ovs_neutron_plugin.ini` file:

```
[ovs]
tenant_network_type = vlan
network_vlan_ranges = physnet1,physnet2:101:110
integration_bridge = br-int
bridge_mappings = physnet1:br-ex,physnet2:br-eth1
```

The following figure shows the network devices on the network host:



As on the compute host, there is an Open vSwitch integration bridge (`br-int`) and an Open vSwitch bridge connected to the data network (`br-eth1`), and the two are connected by a veth pair, and the neutron-openvswitch-plugin-agent configures the ports on both switches to do VLAN translation.

An additional Open vSwitch bridge, `br-ex`, connects to the physical interface that is connected to the external network. In this example, that physical interface is `eth0`.

> **Note**
>
> While the integration bridge and the external bridge are connected by a veth pair `(int-br-ex, phy-br-ex)`, this example uses layer 3 connectivity to route packets from the internal networks to the public network: no packets traverse that veth pair in this example.

Open vSwitch internal ports

The network host uses Open vSwitch *internal ports*. Internal ports enable you to assign one or more IP addresses to an Open vSwitch bridge. In previous example, the `br-int` bridge has four internal ports: `tapXXX`, `qr-YYY`, `qr-ZZZ`, and `tapWWW`. Each internal port has a separate IP address associated with it. An internal port, `qg-VVV`, is on the `br-ex` bridge.

DHCP agent

By default, the Networking DHCP agent uses a process called dnsmasq to provide DHCP services to guests. Networking must create an internal port for each network that requires DHCP services and attach a dnsmasq process to that port. In the previous example, the `tapXXX` interface is on `net01_subnet01`, and the `tapWWW` interface is on `net02_subnet01`.

L3 agent (routing)

The Networking L3 agent uses Open vSwitch internal ports to implement routing and relies on the network host to route the packets across the interfaces. In this example, the `qr-YYY` interface is on `net01_subnet01` and has the IP address 192.168.101.1/24. The `qr-ZZZ`, interface is on `net02_subnet01` and has the IP address `192.168.102.1/24`. The `qg-VVV` interface has the IP address `10.64.201.254/24`. Because each of these interfaces is visible to the network host operating system, the network host routes the packets across the interfaces, as long as an administrator has enabled IP forwarding.

The L3 agent uses iptables to implement floating IPs to do the network address translation (NAT).

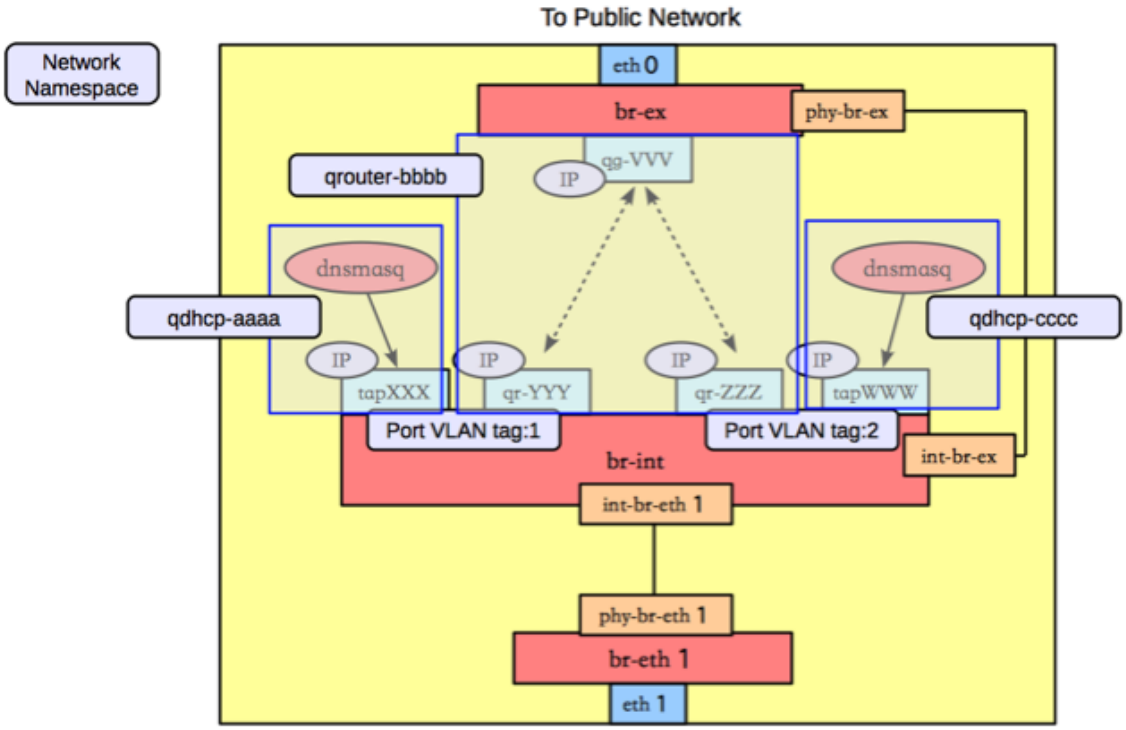
Overlapping subnets and network namespaces

One problem with using the host to implement routing is that one of the Networking subnets might overlap with one of the physical networks that the host uses. For example, if the management network is implemented on `eth2` and also happens to be on the `192.168.101.0/24` subnet, routing problems will occur because the host can't determine whether to send a packet on this subnet to `qr-YYY` or `eth2`. If end users are permitted to create their own logical networks and subnets, you must design the system so that such collisions do not occur.

Networking uses Linux *network namespaces* to prevent collisions between the physical networks on the network host, and the logical networks used by the virtual machines. It also prevents collisions across different logical networks that are not routed to each other, as the following scenario shows.

A network namespace is an isolated environment with its own networking stack. A network namespace has its own network interfaces, routes, and iptables rules. Consider it a chroot jail, except for networking instead of for a file system. LXC (Linux containers) use network namespaces to implement networking virtualization.

Networking creates network namespaces on the network host to avoid subnet collisions.

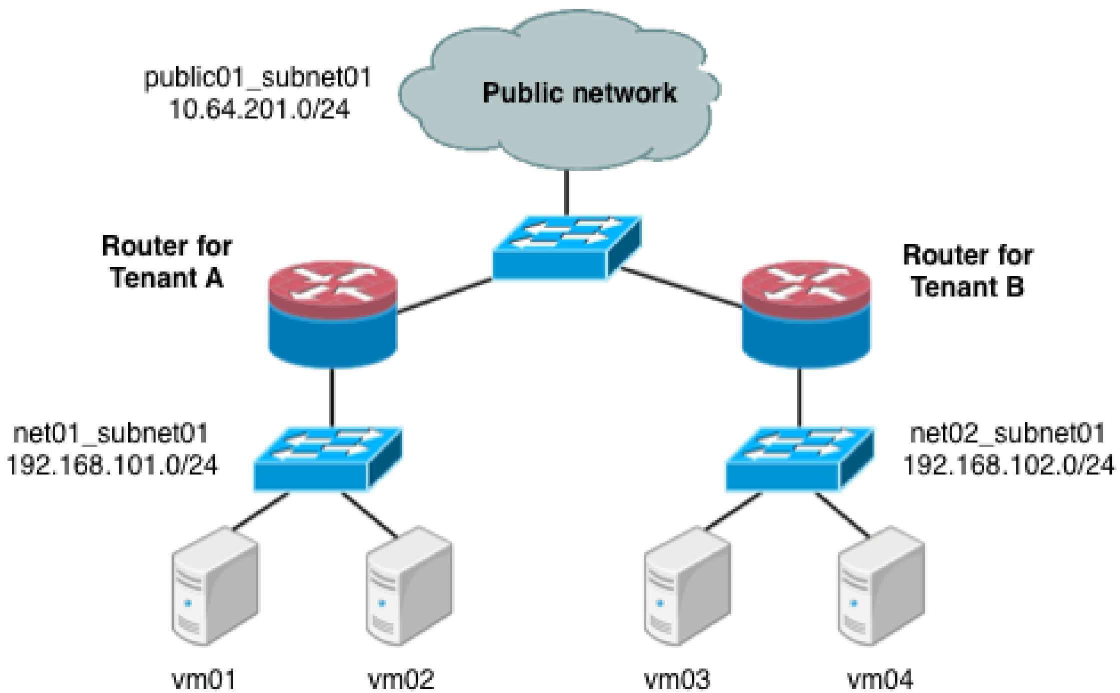


In this example, there are three network namespaces, as shown in the figure above:

- `qdhcp-`*AAA*: contains the `tap`*XXX* interface and the dnsmasq process that listens on that interface to provide DHCP services for `net01_subnet01`. This allows overlapping IPs between `net01_subnet01` and any other subnets on the network host.
- `qrouter-`*BBBB*: contains the `qr-`*YYY*, `qr-`*ZZZ*, and `qg-`*VVV* interfaces, and the corresponding routes. This namespace implements `router01` in our example.
- `qdhcp-`*CCC*: contains the `tap`*WWW* interface and the dnsmasq process that listens on that interface, to provide DHCP services for `net02_subnet01`. This allows overlapping IPs between `net02_subnet01` and any other subnets on the network host.

Scenario 2: two tenants, two networks, two routers

In this scenario, tenant A and tenant B each have a network with one subnet and one router that connects the tenants to the public Internet.



Under the `service` tenant, define the public network:

```
$ tenant=$(keystone tenant-list | awk '/service/ {print $2}')
$ neutron net-create --tenant-id $tenant public01 \
          --provider:network_type flat \
          --provider:physical_network physnet1 \
          --router:external True
$ neutron subnet-create --tenant-id $tenant --name public01_subnet01 \
          --gateway 10.64.201.254 public01 10.64.201.0/24 --disable-dhcp
```

Under the `tenantA` user tenant, create the tenant router and set its gateway for the public network.

```
$ tenant=$(keystone tenant-list|awk '/tenantA/ {print $2}')
$ neutron router-create --tenant-id $tenant router01
$ neutron router-gateway-set router01 public01
```

Then, define private network `net01` using VLAN ID 101 on the physical switch, along with its subnet, and connect it to the router.

```
$ neutron net-create --tenant-id $tenant net01 \
          --provider:network_type vlan \
          --provider:physical_network physnet2 \
          --provider:segmentation_id 101
$ neutron subnet-create --tenant-id $tenant --name net01_subnet01 net01 192.
168.101.0/24
$ neutron router-interface-add router01 net01_subnet01
```

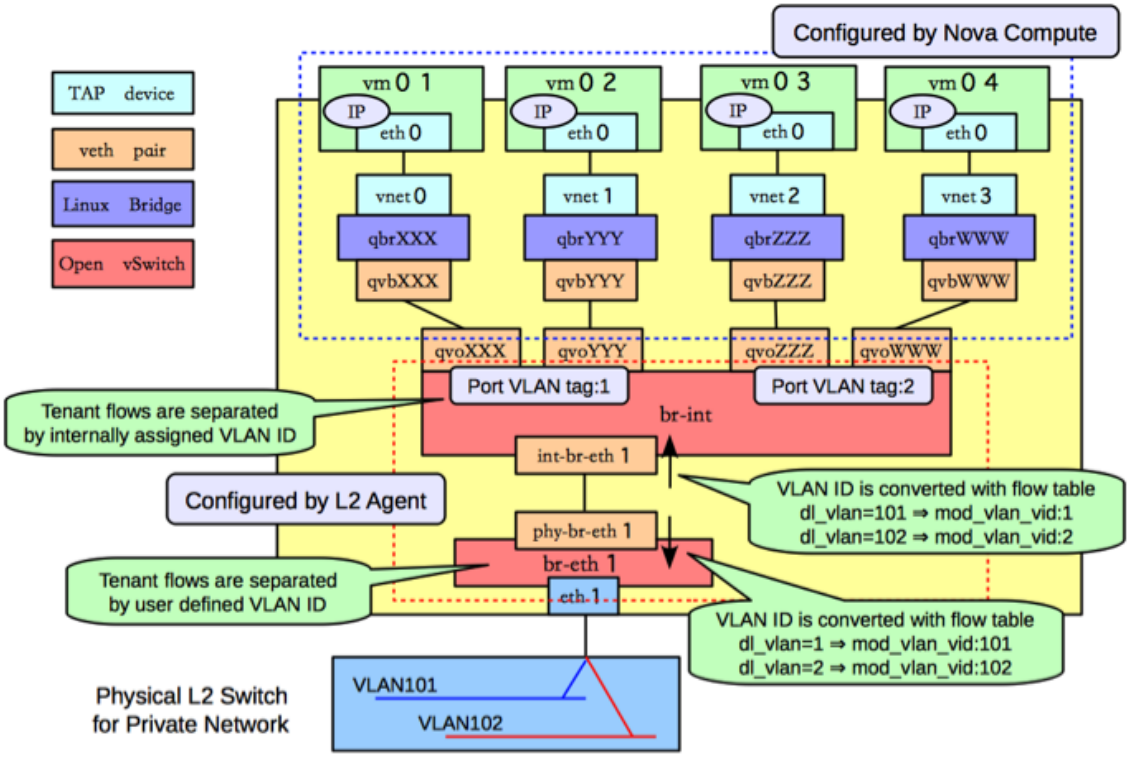
Similarly, for `tenantB`, create a router and another network, using VLAN ID 102 on the physical switch:

```
$ tenant=$(keystone tenant-list|awk '/tenantB/ {print $2}')
```

```
$ neutron router-create --tenant-id $tenant router02
$ neutron router-gateway-set router02 public01
$ neutron net-create --tenant-id $tenant net02 \
          --provider:network_type vlan \
          --provider:physical_network physnet2 \
          --provider:segmentation_id 102
$ neutron subnet-create --tenant-id $tenant --name net02_subnet01 net02 192.
168.102.0/24
$ neutron router-interface-add router02 net02_subnet01
```

Scenario 2: Compute host config

The following figure shows how to configure Linux networking devices on the compute host:

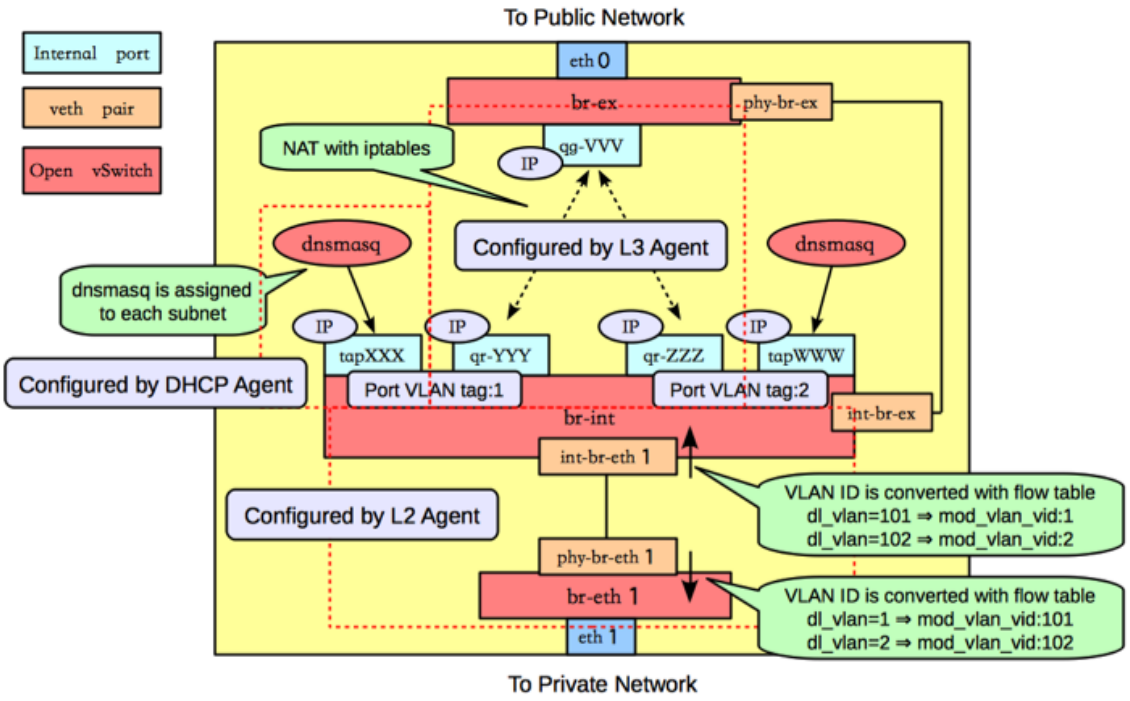


Note

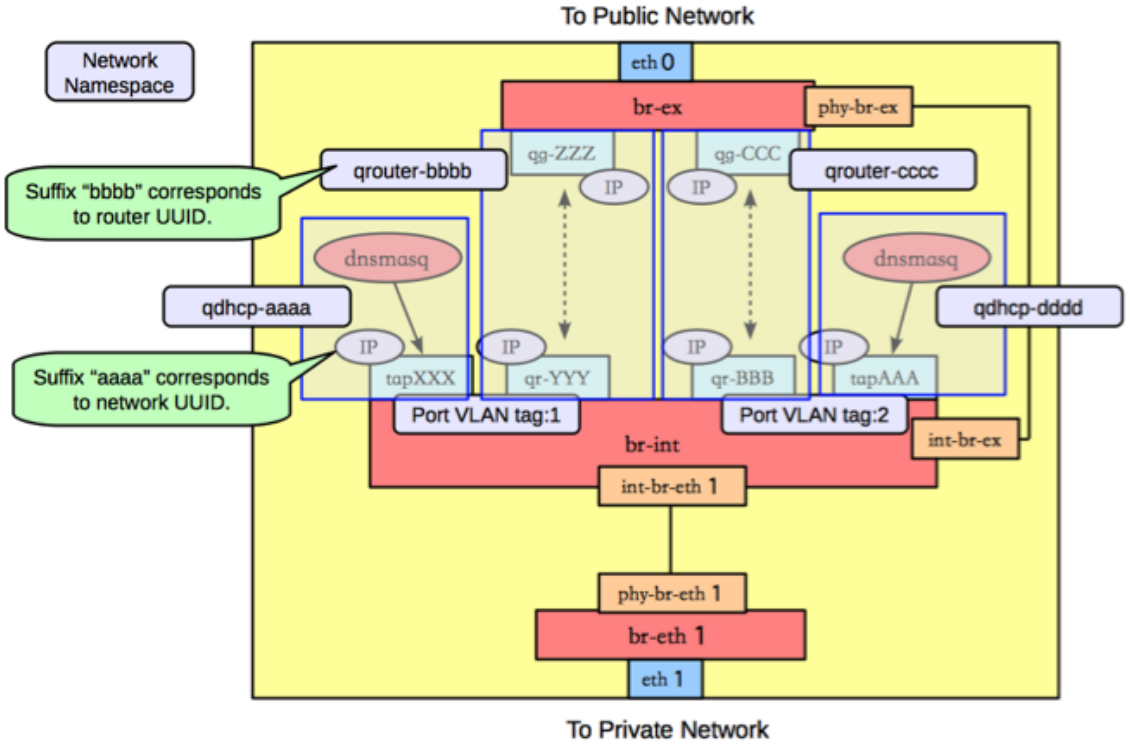
The compute host configuration resembles the configuration in scenario 1. However, in scenario 1, a guest connects to two subnets while in this scenario, the subnets belong to different tenants.

Scenario 2: Network host config

The following figure shows the network devices on the network host for the second scenario.



In this configuration, the network namespaces are organized to isolate the two subnets from each other as shown in the following figure.

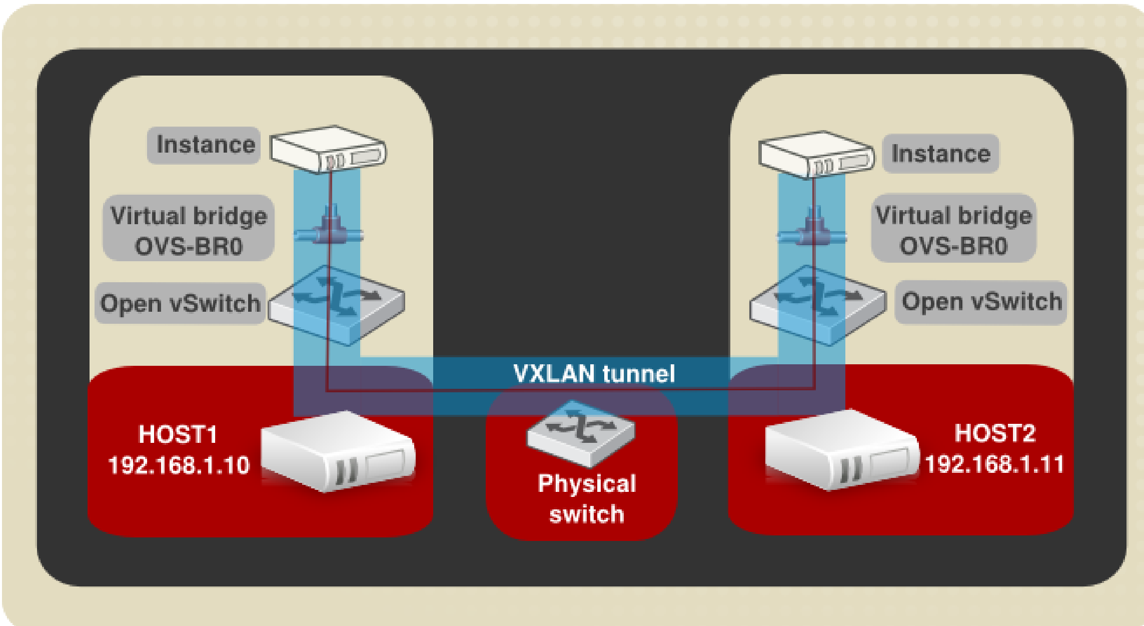


In this scenario, there are four network namespaces (`qhdcp-`*AAA*, `qrouter-`*BBBB*, `qrouter-`*CCCC*, and `qhdcp-`*DDDD*), instead of three. Because there is no connectivity between the two networks, each router is implemented by a separate namespace.

Configure Open vSwitch tunneling

Tunneling encapsulates network traffic between physical Networking hosts and allows VLANs to span multiple physical hosts. Instances communicate as if they share the same layer 2 network. Open vSwitch supports tunneling with the VXLAN and GRE encapsulation protocols.

Figure 5.1. Example VXLAN tunnel



This diagram shows two instances running on separate hosts connected by a VXLAN tunnel. The required physical and virtual components are also illustrated. The following procedure creates a VXLAN or GRE tunnel between two Open vSwitches running on separate Networking hosts:

Example tunnel configuration

1. Create a virtual bridge named OVS-BR0 on each participating host:

   ```
   ovs-vsctl add-br OVS-BR0
   ```

2. Create a tunnel to link the OVS-BR0 virtual bridges. Run the ovs-vsctl command on HOST1 to create the tunnel and link it to the bridge on HOST2:

   GRE tunnel command:

   ```
   ovs-vsctl add-port OVS-BR0 gre1 -- set Interface gre1 type=gre
    options:remote_ip=192.168.1.11
   ```

   VXLAN tunnel command:

```
ovs-vsctl add-port OVS-BR0 vxlan1 -- set Interface vxlan1 type=vxlan
 options:remote_ip=192.168.1.11
```

3. Run the ovs-vsctl command on HOST2 to create the tunnel and link it to the bridge on HOST1.

   GRE tunnel command:

```
ovs-vsctl add-port OVS-BR0 gre1 -- set Interface gre1 type=gre
 options:remote_ip=192.168.1.10
```

   VXLAN tunnel command:

```
ovs-vsctl add-port OVS-BR0 vxlan1 -- set Interface vxlan1 type=vxlan
 options:remote_ip=192.168.1.10
```

Successful completion of these steps results in the two instances sharing a layer 2 network.

Linux Bridge

This section describes how the Linux Bridge plug-in implements the Networking abstractions. For information about DHCP and L3 agents, see the section called “Scenario 1: one tenant, two networks, one router” [30].

Configuration

This example uses VLAN isolation on the switches to isolate tenant networks. This configuration labels the physical network associated with the public network as `physnet1`, and the physical network associated with the data network as `physnet2`, which leads to the following configuration options in `linuxbridge_conf.ini`:

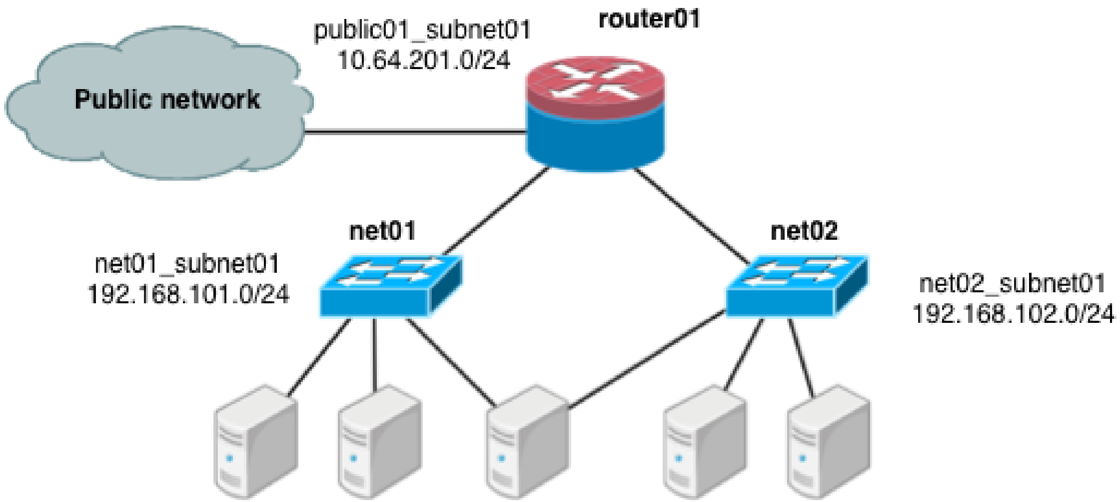
```
[vlans]
tenant_network_type = vlan
network_vlan_ranges = physnet1,physnet2:100:110

[linux_bridge]
physical_interface_mappings = physnet2:eth1
```

Note

In this configuration there isn't a bridge mapping for `physnet1` as it is only needed on the network host, which maps it to the Open vSwitch bridge `br-ex` connected to the external network as seen below.

Scenario 1: one tenant, two networks, one router

The first scenario has two private networks (`net01`, and `net02`), each with one subnet (`net01_subnet01`: 192.168.101.0/24, `net02_subnet01`, 192.168.102.0/24). Both private networks are attached to a router that connects them to the public network (10.64.201.0/24).



Under the `service` tenant, create the shared router, define the public network, and set it as the default gateway of the router

```
$ tenant=$(keystone tenant-list | awk '/service/ {print $2}')
$ neutron router-create router01
$ neutron net-create --tenant-id $tenant public01 \
          --provider:network_type flat \
          --provider:physical_network physnet1 \
          --router:external True
$ neutron subnet-create --tenant-id $tenant --name public01_subnet01 \
          --gateway 10.64.201.254 public01 10.64.201.0/24 --disable-dhcp
$ neutron router-gateway-set router01 public01
```

Under the `demo` user tenant, create the private network `net01` and corresponding subnet, and connect it to the `router01` router. Configure it to use VLAN ID 101 on the physical switch.

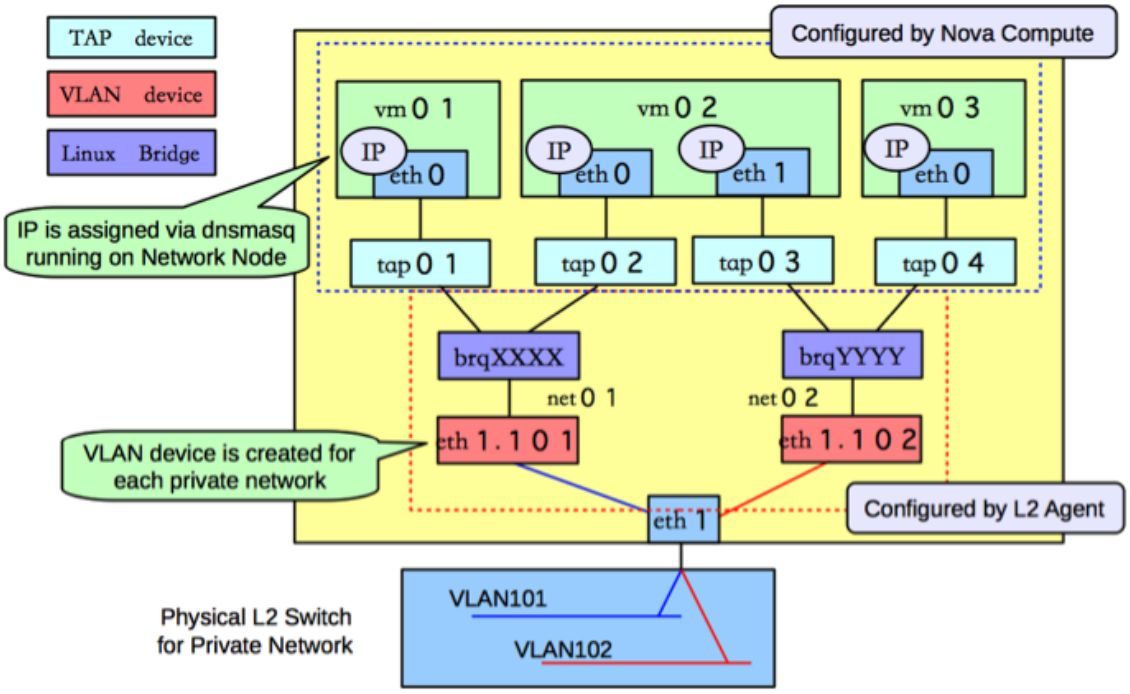
```
$ tenant=$(keystone tenant-list|awk '/demo/ {print $2}'
$ neutron net-create --tenant-id $tenant net01 \
          --provider:network_type vlan \
          --provider:physical_network physnet2 \
          --provider:segmentation_id 101
$ neutron subnet-create --tenant-id $tenant --name net01_subnet01 net01 192.
168.101.0/24
$ neutron router-interface-add router01 net01_subnet01
```

Similarly, for `net02`, using VLAN ID 102 on the physical switch:

```
$ neutron net-create --tenant-id $tenant net02 \
          --provider:network_type vlan \
          --provider:physical_network physnet2 \
          --provider:segmentation_id 102
$ neutron subnet-create --tenant-id $tenant --name net02_subnet01 net02 192.
168.102.0/24
$ neutron router-interface-add router01 net02_subnet01
```

Scenario 1: Compute host config

The following figure shows how to configure the various Linux networking devices on the compute host.



Types of network devices

Note

There are three distinct type of virtual networking devices: TAP devices, VLAN devices, and Linux bridges. For an Ethernet frame to travel from `eth0` of virtual machine `vm01`, to the physical network, it must pass through four devices inside of the host: TAP `vnet0`, Linux bridge `brq`*XXX*, VLAN `eth1.101`), and, finally, the physical network interface card `eth1`.

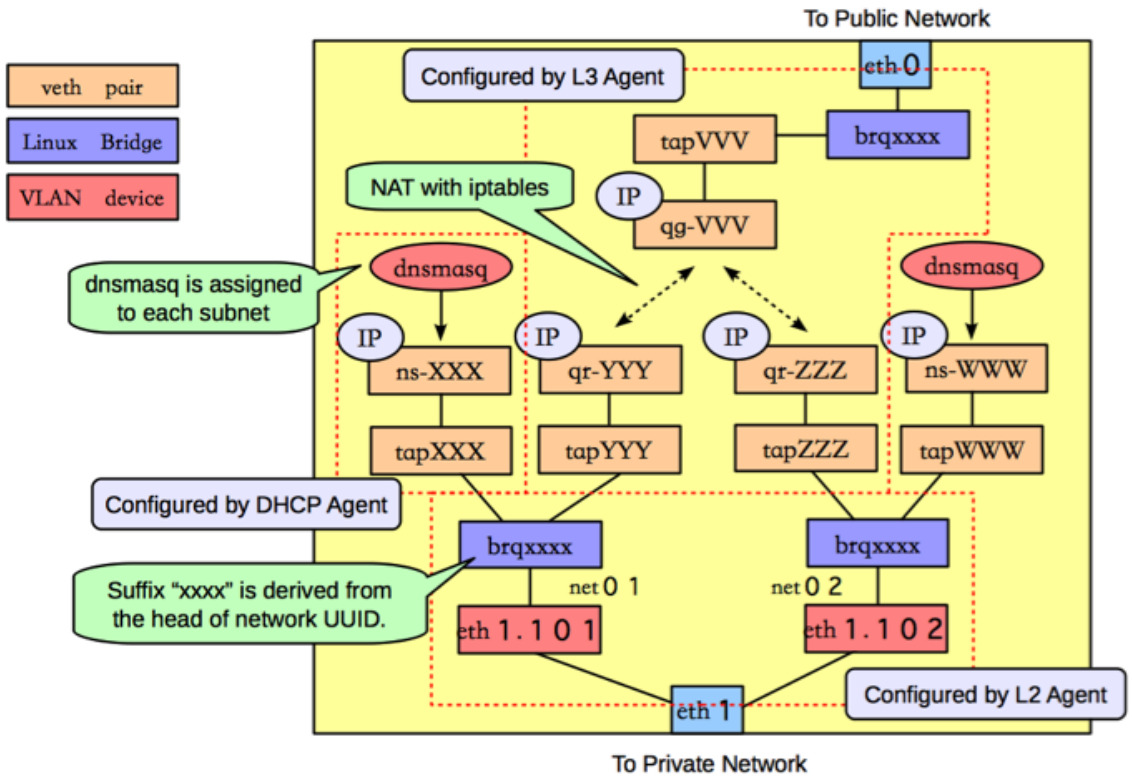
A *TAP device*, such as `vnet0` is how hypervisors such as KVM and Xen implement a virtual network interface card (typically called a VIF or vNIC). An Ethernet frame sent to a TAP device is received by the guest operating system.

A *VLAN device* is associated with a VLAN tag attaches to an existing interface device and adds or removes VLAN tags. In the preceding example, VLAN device `eth1.101` is associated with VLAN ID 101 and is attached to interface `eth1`. Packets received from the outside by `eth1` with VLAN tag 101 will be passed to device `eth1.101`, which will then strip the tag. In the other direction, any Ethernet frame sent directly to eth1.101 will have VLAN tag 101 added and will be forward to `eth1` for sending out to the network.

A *Linux bridge* behaves like a hub: you can connect multiple (physical or virtual) network interfaces devices to a Linux bridge. Any Ethernet frames that come in from one interface attached to the bridge is transmitted to all of the other devices.

Scenario 1: Network host config

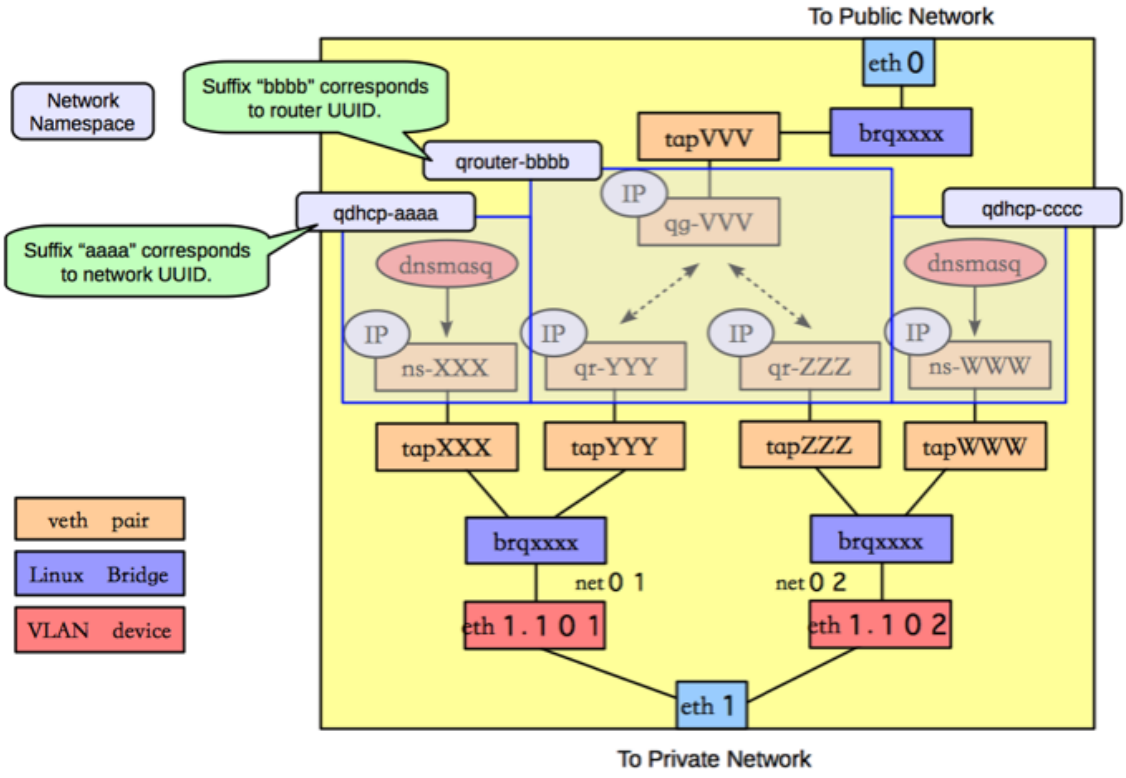
The following figure shows the network devices on the network host.



The following figure shows how the Linux Bridge plug-in uses network namespaces to provide isolation.

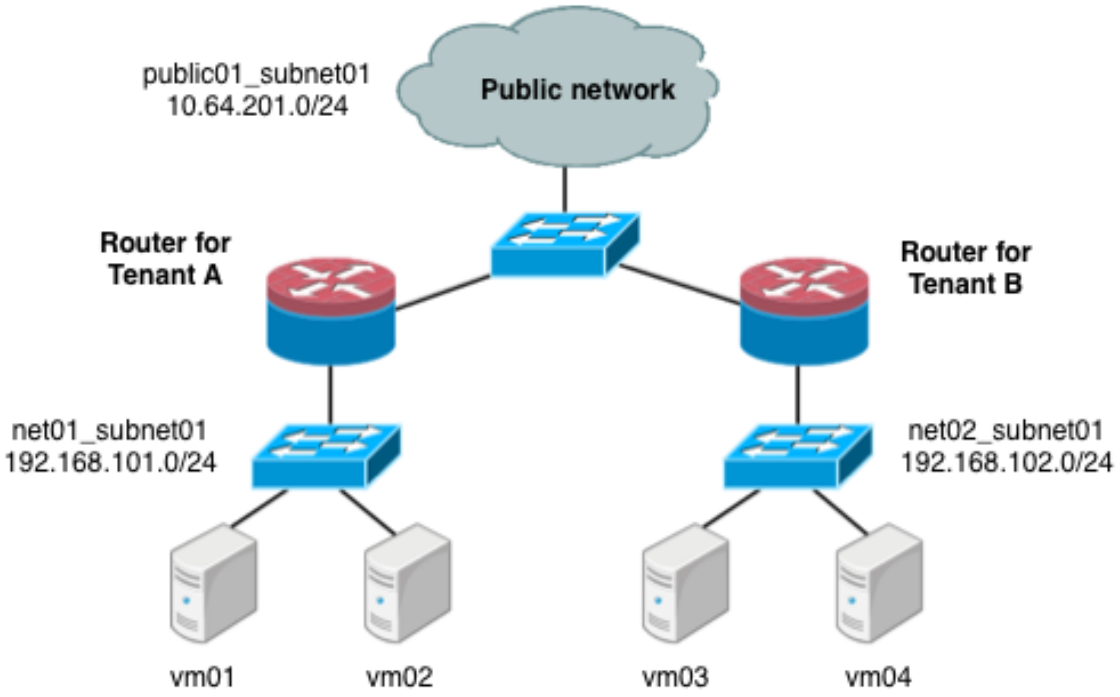
Note

veth pairs form connections between the Linux bridges and the network namespaces.



Scenario 2: two tenants, two networks, two routers

The second scenario has two tenants (A, B). Each tenant has a network with one subnet, and each one has a router that connects them to the public Internet.



Under the `service` tenant, define the public network:

```
$ tenant=$(keystone tenant-list | awk '/service/ {print $2}')
$ neutron net-create --tenant-id $tenant public01 \
          --provider:network_type flat \
          --provider:physical_network physnet1 \
          --router:external True
$ neutron subnet-create --tenant-id $tenant --name public01_subnet01 \
          --gateway 10.64.201.254 public01 10.64.201.0/24 --disable-dhcp
```

Under the `tenantA` user tenant, create the tenant router and set its gateway for the public network.

```
$ tenant=$(keystone tenant-list|awk '/tenantA/ {print $2}')
$ neutron router-create --tenant-id $tenant router01
$ neutron router-gateway-set router01 public01
```

Then, define private network `net01` using VLAN ID 102 on the physical switch, along with its subnet, and connect it to the router.

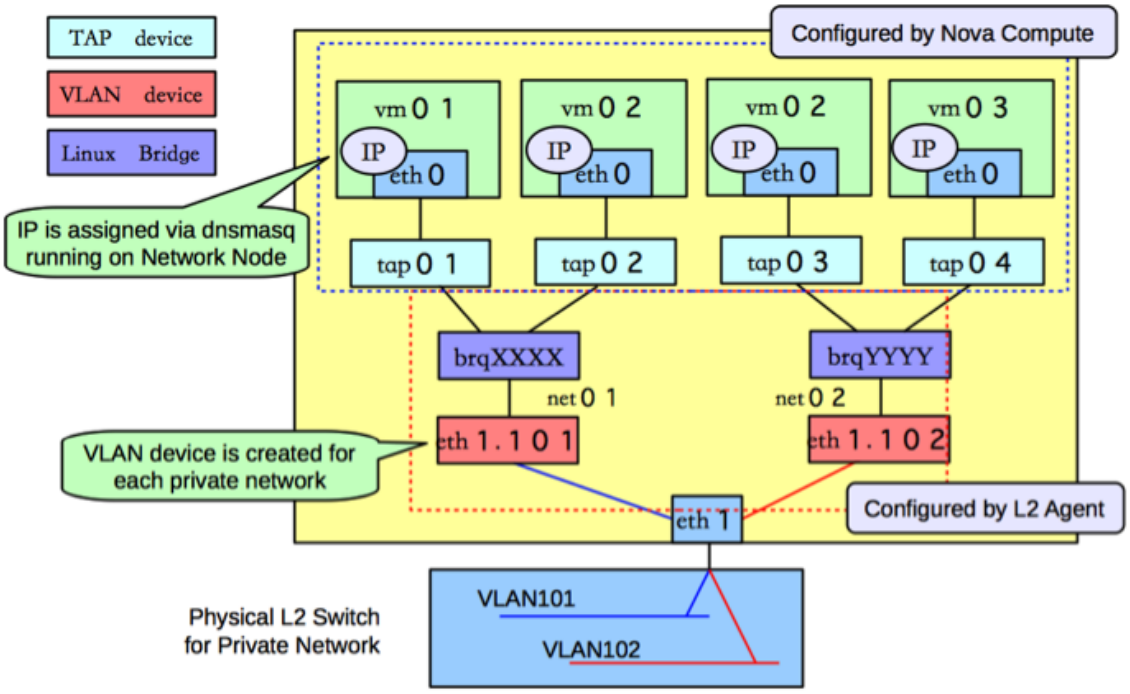
```
$ neutron net-create --tenant-id $tenant net01 \
          --provider:network_type vlan \
          --provider:physical_network physnet2 \
          --provider:segmentation_id 101
$ neutron subnet-create --tenant-id $tenant --name net01_subnet01 net01 192.
168.101.0/24
$ neutron router-interface-add router01 net01_subnet01
```

Similarly, for `tenantB`, create a router and another network, using VLAN ID 102 on the physical switch:

```
$ tenant=$(keystone tenant-list|awk '/tenantB/ {print $2}')
$ neutron router-create --tenant-id $tenant router02
$ neutron router-gateway-set router02 public01
$ neutron net-create --tenant-id $tenant net02 \
          --provider:network_type vlan \
          --provider:physical_network physnet2 \
          --provider:segmentation_id 102
$ neutron subnet-create --tenant-id $tenant --name net02_subnet01 net01 192.
168.101.0/24
$ neutron router-interface-add router02 net02_subnet01
```

Scenario 2: Compute host config

The following figure shows how the various Linux networking devices would be configured on the compute host under this scenario.

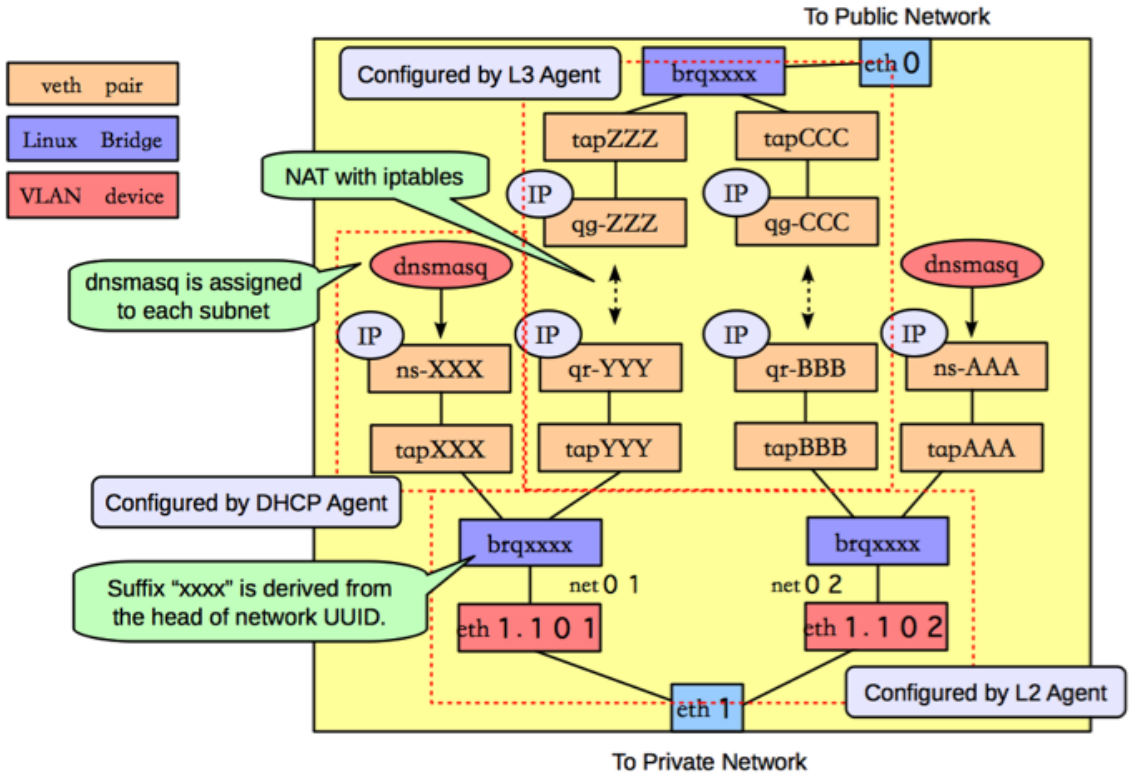


Note

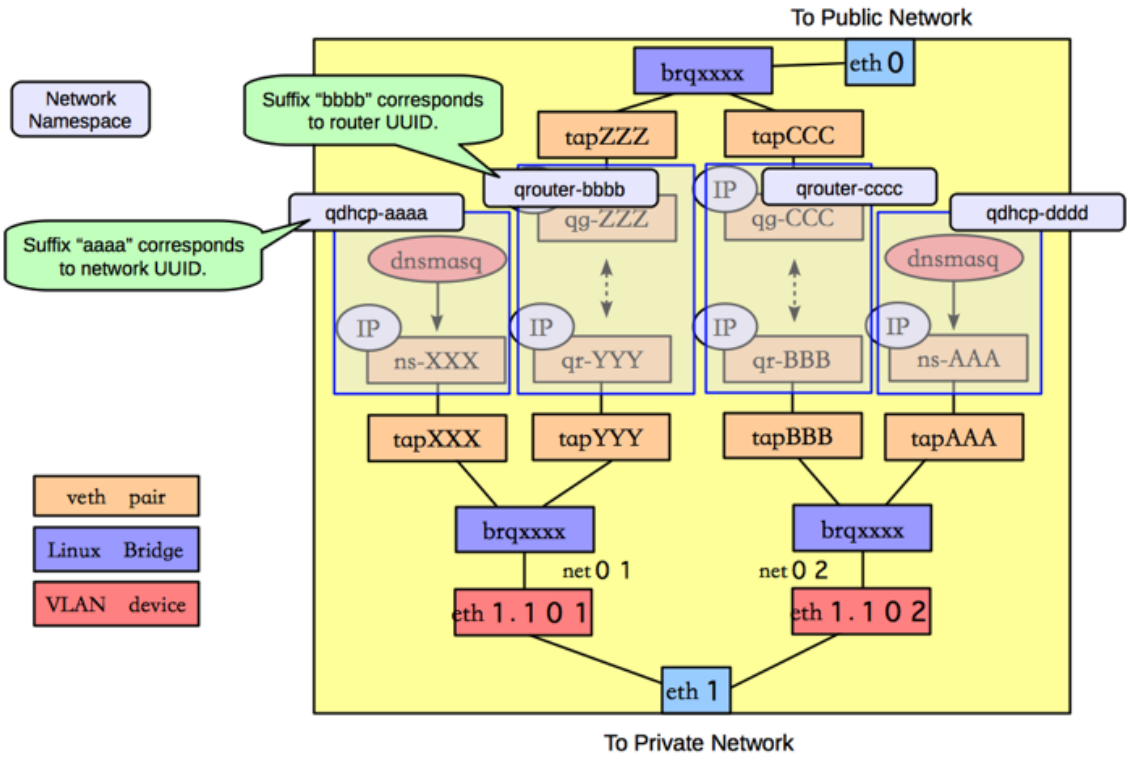
The configuration on the compute host is very similar to the configuration in scenario 1. The only real difference is that scenario 1 had a guest connected to two subnets, and in this scenario the subnets belong to different tenants.

Scenario 2: Network host config

The following figure shows the network devices on the network host for the second scenario.



The main difference between the configuration in this scenario and the previous one is the organization of the network namespaces, in order to provide isolation across the two subnets, as shown in the following figure.



In this scenario, there are four network namespaces (`qhdcp-`*AAA*, `qrouter-`*BBBB*, `qrouter-`*CCCC*, and `qhdcp-`*DDDD*), instead of three. Each router is implemented by a separate namespace, since there is no connectivity between the two networks.

ML2

The Modular Layer 2 plug-in allows OpenStack Networking to simultaneously utilize the variety of layer 2 networking technologies found in complex real-world data centers. It currently includes drivers for the local, flat, VLAN, GRE and VXLAN network types and works with the existing *Open vSwitch*, *Linux Bridge* , and *HyperV* L2 agents. The *ML2* plug-in can be extended through mechanism drivers, allowing multiple mechanisms to be used simultaneously. This section describes different *ML2* plug-in and agent configurations with different type drivers and mechanism drivers.

Note

Currently, there is no need to define `SEGMENTATION_ID` network provider attribute for GRE and VXLAN network types. The choice can be delegated to Networking, in such case ML2 plug-in tries to find a network in tenant network pools which respects specified provider network attributes.

Previously, Networking deployments were only able to use the plug-in that had been selected at implementation time. For example, a deployment running the Open vSwitch plug-in was only able to use Open vSwitch exclusively; it wasn't possible to simultaneously run another plug-in such as Linux Bridge. This was found to be a limitation in environments with heterogeneous requirements.

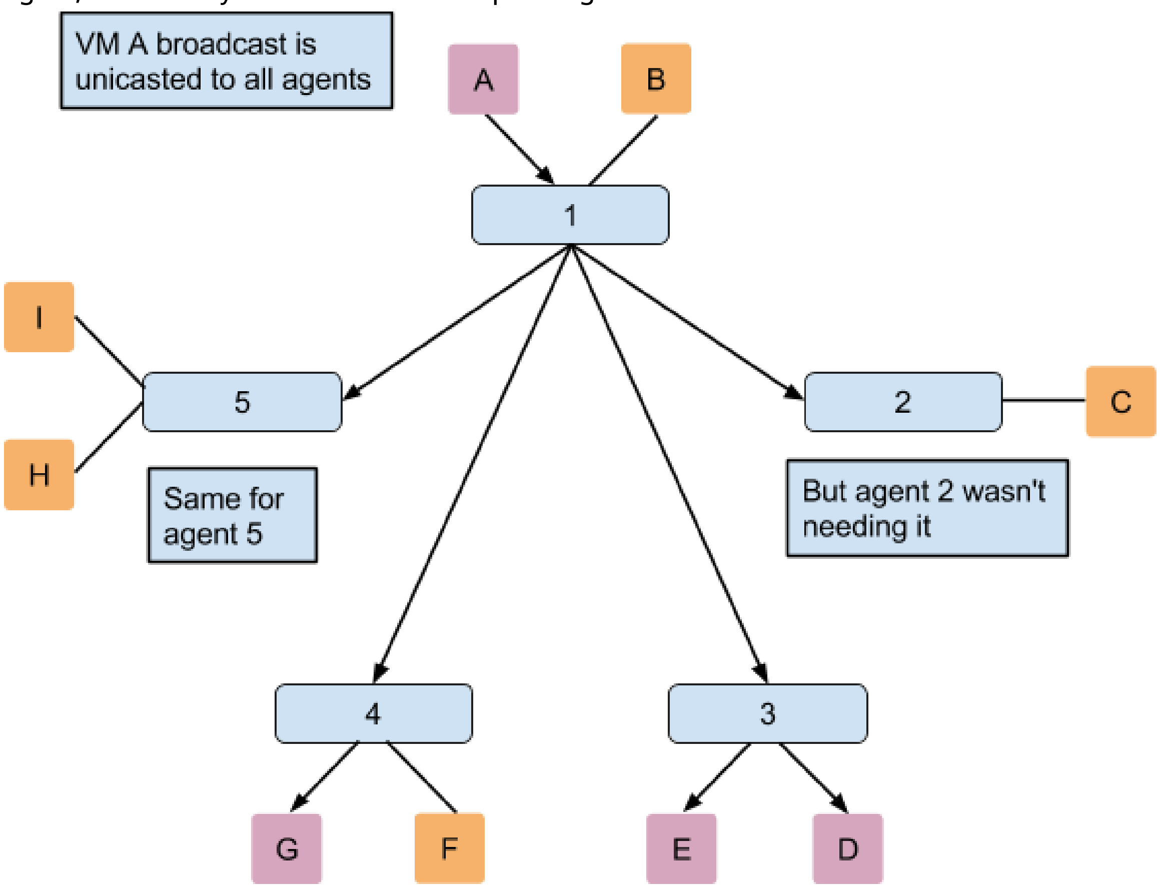
Warning

Disabling a ML2 type driver and re-enabling it later may lead to database inconsistencies if ML2 is reconfigured without support for that type.

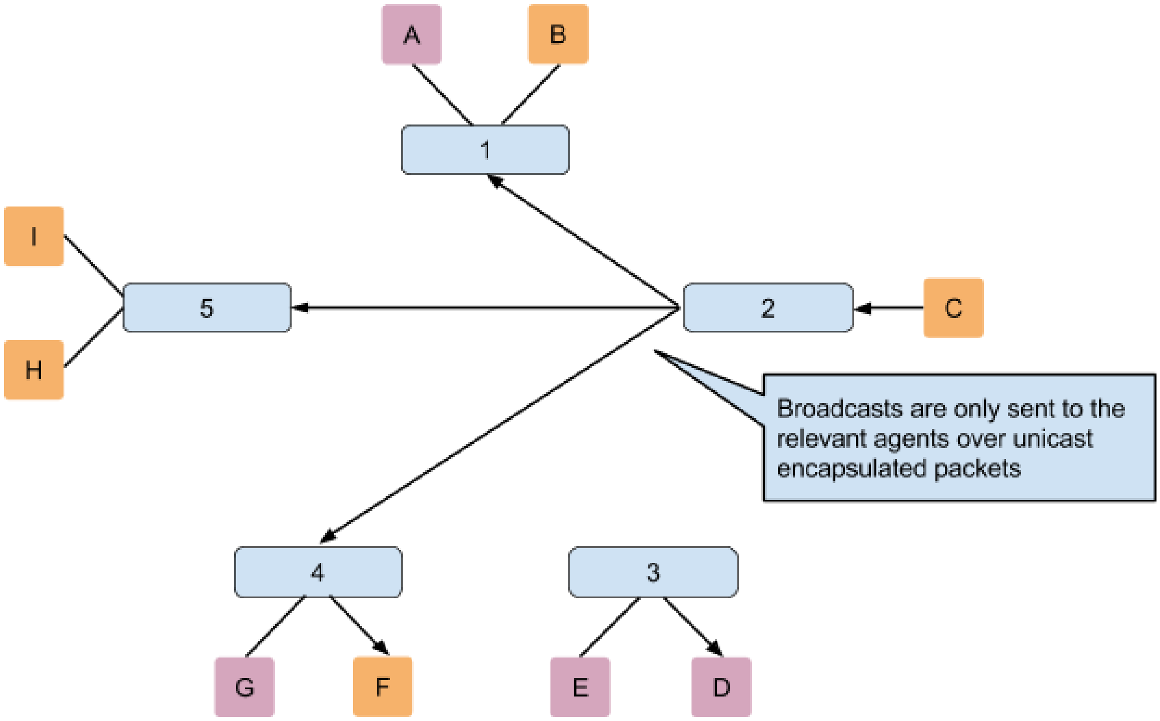
ML2 with L2 population mechanism driver

The L2 Population driver enables broadcast, multicast, and unicast traffic to scale out on large overlay networks. This traffic is sent to the relevant agent via encapsulation as a targeted unicast.

Current *Open vSwitch* and *Linux Bridge* tunneling implementations broadcast to every agent, even if they don't host the corresponding network as illustrated below.



As broadcast emulation on overlay is costly, it may be better to avoid its use for MAC learning and ARP resolution. This supposes the use of proxy ARP on the agent to answer VM requests, and to populate forwarding table. Currently only the *Linux Bridge* Agent implements an ARP proxy. The pre-population limits L2 broadcasts in overlay, however it may anyway be necessary to provide broadcast emulation. This is achieved by broadcasting packets via unicast only to the relevant agents as illustrated below.



The partial-mesh is available with the *Open vSwitch* and *Linux Bridge* agents. The following scenarios will use the L2 population mechanism driver with an *Open vSwitch* agent and a *Linux Bridge* agent. Enable the l2 population driver by adding it to the list of mechanism drivers. In addition, a tunneling driver must be selected. Supported options are GRE, VXLAN, or a combination of both. Configuration settings are enabled in `ml2_conf.ini`:

```
[ml2]
type_drivers = local,flat,vlan,gre,vxlan
mechanism_drivers = openvswitch,linuxbridge,l2population
```

Scenario 1: L2 population with Open vSwitch agent

Enable the l2 population extension in the *Open vSwitch* agent, and configure the `local_ip` and `tunnel_types` parameters in the `ml2_conf.ini` file:

```
[ovs]
local_ip = 192.168.1.10

[agent]
tunnel_types = GRE,VXLAN
l2_population = True
```

Scenario 2: L2 population with *Linux Bridge* agent

Enable the l2 population extension on the *Linux Bridge* agent. Enable VXLAN and configure the local_ip parameter in `ml2_conf.ini`.

```
[vxlan]
enable_vxlan = True
local_ip = 192.168.1.10
l2_population = True
```

Enable security group API

The ML2 plug-in can concurrently support different L2 agents (or other mechanisms) with different configuration files, so each L2 agent configuration file (such as `ovs_neutron_plugin.ini` or `linuxbridge_conf.ini`) should contain the appropriate `firewall_driver` value for that agent in addition to setting `enable_security_group` to `True` (which is the default).

The `firewall_driver` value in the API server's `ml2_conf.ini` file does not matter.

To disable the securitygroup API, edit the `ml2_conf.ini` file on the API server, and `ovs_neutron_plugin.ini`, `linuxbridge_conf.ini` or other L2 agent configuration files on the agent servers :

```
[securitygroup]
enable_security_group = False
firewall_driver = neutron.agent.firewall.NoopFirewallDriver
```

6. Scalability and high availability

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Bacon ipsum dolor sit amet biltong meatloaf andouille, turducken bresaola pork belly beef ribs ham hock capicola tail prosciutto landjaeger meatball pork loin. Swine turkey jowl, porchetta doner boudin meatloaf. Shoulder capicola prosciutto, shank landjaeger short ribs sirloin turducken pork belly boudin frankfurter chuck. Salami shankle bresaola cow filet mignon ham hock shank.

DHCP Agents

Bacon ipsum dolor sit amet biltong meatloaf andouille, turducken bresaola pork belly beef ribs ham hock capicola tail prosciutto landjaeger meatball pork loin. Swine turkey jowl, porchetta doner boudin meatloaf. Shoulder capicola prosciutto, shank landjaeger short ribs sirloin turducken pork belly boudin frankfurter chuck. Salami shankle bresaola cow filet mignon ham hock shank.

L3 Agents

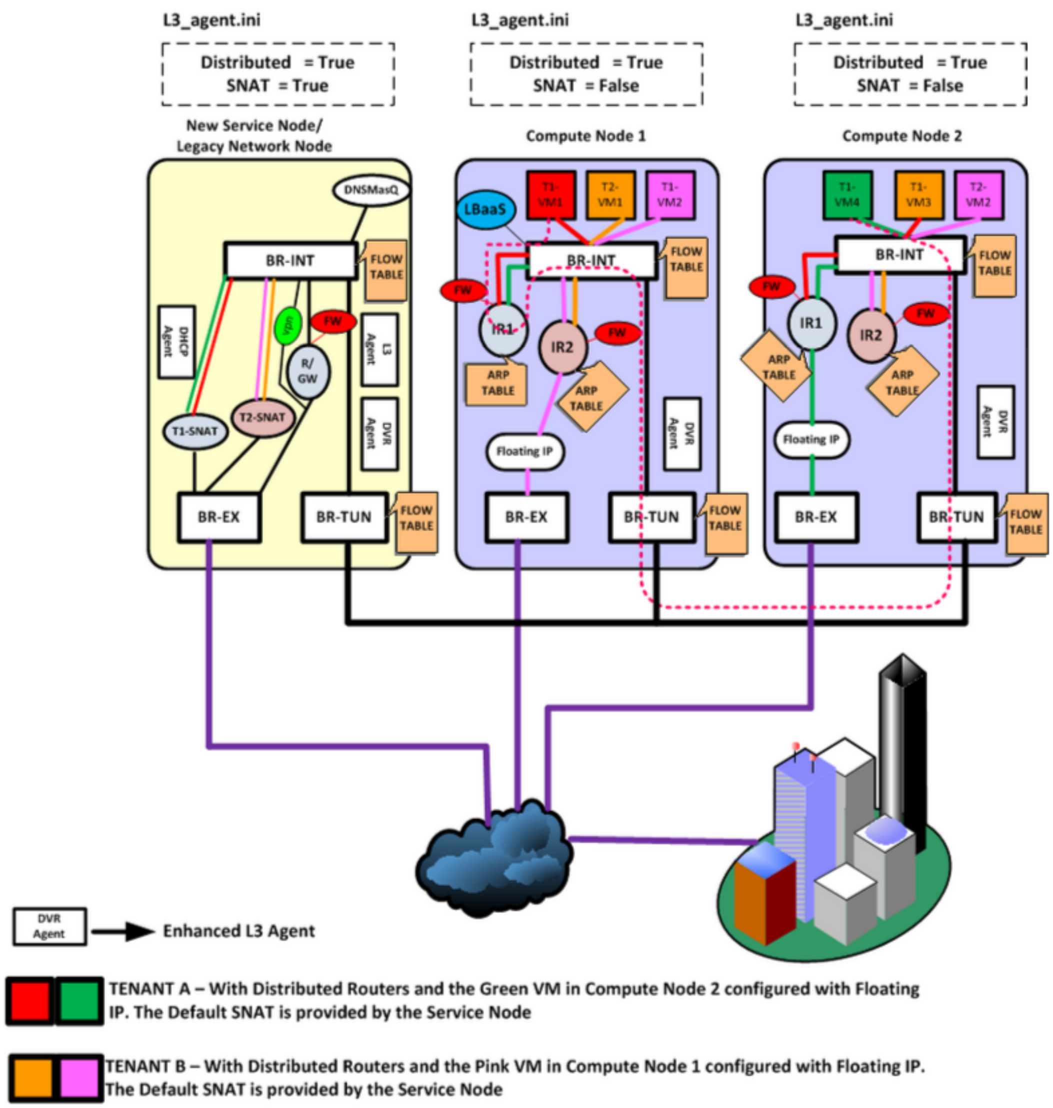
The Neutron L3 Agent enables layer 3 forwarding and floating IP support. It provides L3/NAT forwarding to ensure external network access for VMs on tenant networks. The L3 agent achieves High Availability by adopting Pacemaker.

Distributed Virtual Router (DVR)

DVR stands for *Distributed Virtual Router*. For OpenStack Networking you can provide high availability across compute nodes using a DVR configuration. Both the layer-2 and layer-3 agents work together on a compute node, and the L2 agent works in an enhanced mode for DVR, providing management for OVS rules. In this scenario you do not use a separate networking node unless a legacy one is in place already.

Here is a sample network topology showing how distributed routing occurs.

Figure 6.1. DVR configuration diagram



The DVR agent takes responsibility for creating, updating, or deleting the routers in the router namespaces. For all clients in the network owned by the router, the DVR agent populates the ARP entry. By pre-populating ARP entries across compute nodes, the distributed virtual router ensures traffic goes to the correct destination. The integration bridge on a particular compute node identifies the incoming frame's source MAC address as a DVR-unique MAC address because every compute node l2 agent knows all configured unique MAC addresses for DVR used in the cloud. The agent replaces the DVR-unique MAC Address with the green subnet interface MAC address and forwards the frame to the instance. By default, distributed routing is not turned on. When set to true, the layer-2 agent handles the DVR ports detected on the integration bridge. Also, when a tenant creates a router with `neutron router-create`, the Networking services creates only distributed routers after you have enabled distributed routing.

Configure Distributed Virtual Router (DVR)

1. Edit the `ovs_neutron_plugin.ini` file to change `enable_distributed_routing` to `True`:

```
enable_distributed_routing = True
```

2. Edit the `/etc/neutron/neutron.conf` file to set the base MAC address that the DVR system uses for unique MAC allocation with the `dvr_base_mac` setting:

```
dvr_base_mac = fa:16:3f:00:00:00
```

Note

This `dvr_base_mac` value must be different from the `base_mac` value assigned for virtual ports to ensure port isolation and for troubleshooting purposes. The default is `fa:16:3f:00:00:00`. If you want four octets used, substitute again for the fourth octet (00), otherwise three octets are kept the same and the others are randomly generated.

3. Edit the `/etc/neutron/neutron.conf` file to set `router_distributed` to `True`.

```
router_distributed = True
```

4. Edit the `l3_agent.ini` file to set `agent_mode` to `dvr` on compute nodes for multi-node deployments:

```
agent_mode = dvr
```

Note

When using a separate networking host, set `agent_mode` to `dvr_snat`. Use `dvr_snat` for Devstack or other single-host deployments also.

5. In the `[ml2]` section, edit the `ml2_conf.ini` file to add `l2population`:

```
[ml2]
mechanism_drivers = openvswitch,l2population
```

6. In the `[agent]` section of the `ml2_conf.ini` file, set these configuration options to these values:

```
[agent]
l2_population = True
tunnel_types = vxlan
enable_distributed_routing = True
```

7. Restart the OVS L2 agent.

   - Ubuntu/Debian:

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

   - RHEL/CentOS/Fedora:

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

- SLES/openSUSE:

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

DVR requirements

- You must use the ML2 plug-in for Open vSwitch (OVS) to enable DVR.
- Be sure that your firewall or security groups allows UDP traffic over the VLAN, GRE, or VXLAN port to pass between the compute hosts.

DVR limitations

- Distributed virtual router configurations work with the Open vSwitch Modular Layer 2 driver only for Juno.
- In order to enable true north-south bandwidth between hypervisors (compute nodes), you must use public IP addresses for every compute node and enable floating IPs.
- For now, based on the current neutron design and architecture, DHCP cannot become distributed across compute nodes.

7. Advanced configuration options

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The following topics describe advanced configuration options for various system components. For example, configuration options where the default works but that the user wants to customize options. After installing from packages, `$NEUTRON_CONF_DIR` is `/etc/neutron`.

Advanced agent options

This section describes advanced configuration options for server plug-ins and agents.

OpenStack Networking server with plug-in

This web server runs the OpenStack Networking API Web Server. It loads a plug-in and passes the API calls to the plug-in for processing. The `neutron-server` service receives one or more configuration files as input. For example:

```
neutron-server --config-file NEUTRON_CONFIG_FILE --config-file PLUGIN_CONFIG_FILE
```

The neutron configuration file contains the common neutron configuration options.

The plug-in configuration file contains the plug-in specific options.

The plug-in that runs on the service is loaded through the `core_plugin` configuration option. In some cases, a plug-in might have an agent that performs the actual networking.

Most plug-ins require an SQL database. After you install and start the database server, set a password for the root account and delete the anonymous accounts:

```
$ > mysql -u root
mysql> update mysql.user set password = password('iamroot') where user =
 'root';
mysql> delete from mysql.user where user = '';
```

Create a database and user account specifically for plug-in:

```
mysql> create database DATABASE_NAME
mysql> create user 'USER_NAME'@'localhost' identified by 'USER_NAME';
mysql> create user 'USER_NAME'@'%' identified by 'USER_NAME';
mysql> grant all on DATABASE_NAME.* to 'USER_NAME'@'%';
```

After this step completes, you can update the settings in the relevant plug-in configuration files. Find the plug-in specific configuration files at `$NEUTRON_CONF_DIR/plugins`.

Some plug-ins have an L2 agent that performs the actual networking. That is, the agent attaches the virtual machine NIC to the OpenStack Networking network. Each node should run an L2 agent. Note that the agent receives the following input parameters:

```
neutron-plugin-agent --config-file NEUTRON_CONFIG_FILE --config-
file PLUGIN_CONFIG_FILE
```

You must complete these tasks before you can work with the plug-in:

1. Ensure that the core plug-in is updated.

2. Ensure that the database connection is correctly set.

The following table shows sample values for the configuration options. Some Linux packages might provide installation utilities that configure these values.

Table 7.1. Settings

Option	Value
Open vSwitch	
core_plugin ($NEUTRON_CONF_DIR/neutron.conf)	openvswitch
connection (in the plugin configuration file, section `[database]`)	mysql://*USERNAME*:*PASSWORD*@localhost/ovs_neutron?charset=utf8
Plug-in Configuration File	$NEUTRON_CONF_DIR/plugins/openvswitch/ovs_neutron_plugin.ini
Agent	neutron-openvswitch-agent
Linux Bridge	
core_plugin ($NEUTRON_CONF_DIR/neutron.conf)	linuxbridge
connection (in the plug-in configuration file, section `[database]`)	mysql://*USERNAME*:*PASSWORD*@localhost/neutron_linux_bridge?charset=utf8
Plug-in Configuration File	$NEUTRON_CONF_DIR/plugins/linuxbridge/linuxbridge_conf.ini
Agent	neutron-linuxbridge-agent

DHCP agent

You can run a DHCP server that allocates IP addresses to virtual machines that run on the network. When a subnet is created, by default, the subnet has DHCP enabled.

The node that runs the DHCP agent should run:

```
neutron-dhcp-agent --config-file NEUTRON_CONFIG_FILE --config-
file DHCP_CONFIG_FILE
```

Currently the DHCP agent uses `dnsmasq` to perform that static address assignment.

You must configure a driver that matches the plug-in that runs on the service.

Table 7.2. Settings

Option	Value
Open vSwitch	
interface_driver ($NEUTRON_CONF_DIR/dhcp_agent.ini)	neutron.agent.linux.interface.OVSInterfaceDriver
Linux Bridge	

Option	Value
interface_driver ($NEUTRON_CONF_DIR/dhcp_agent.ini)	neutron.agent.linux.interface.BridgeInterfaceDriver

Namespace

By default, the DHCP agent uses Linux network namespaces to support overlapping IP addresses. For information about network namespaces support, see the Limitations section.

If the Linux installation does not support network namespaces, you must disable network namespaces in the DHCP agent configuration file. The default value of `use_namespaces` is `True`.

```
use_namespaces = False
```

L3 agent

You can run an L3 agent that enables layer 3 forwarding and floating IP support.

The node that runs the L3 agent should run:

```
neutron-l3-agent --config-file NEUTRON_CONFIG_FILE --config-
file L3_CONFIG_FILE
```

You must configure a driver that matches the plug-in that runs on the service. This driver creates the routing interface.

Table 7.3. Settings

Option	Value
Open vSwitch	
interface_driver ($NEUTRON_CONF_DIR/l3_agent.ini)	neutron.agent.linux.interface.OVSInterfaceDriver
external_network_bridge ($NEUTRON_CONF_DIR/l3_agent.ini)	br-ex
Linux Bridge	
interface_driver ($NEUTRON_CONF_DIR/l3_agent.ini)	neutron.agent.linux.interface.BridgeInterfaceDriver
external_network_bridge ($NEUTRON_CONF_DIR/l3_agent.ini)	This field must be empty (or the bridge name for the external network).

The L3 agent communicates with the OpenStack Networking server through the OpenStack Networking API, so the following configuration is required:

1. OpenStack Identity authentication:

   ```
   auth_url="$KEYSTONE_SERVICE_PROTOCOL://$KEYSTONE_AUTH_HOST:
   $KEYSTONE_AUTH_PORT/v2.0"
   ```

   For example:

   ```
   http://10.56.51.210:5000/v2.0
   ```

2. Administrative user details:

   ```
   admin_tenant_name $SERVICE_TENANT_NAME
   admin_user $Q_ADMIN_USERNAME
   admin_password $SERVICE_PASSWORD
   ```

Namespace

By default, the L3 agent uses Linux network namespaces to support overlapping IP addresses.

For information about network namespaces support, see the Limitation section.

If the Linux installation does not support network namespaces, you must disable network namespaces in the L3 agent configuration file. The default value of `use_namespaces` is `True`.

```
use_namespaces = False
```

When you set `use_namespaces` to `False`, only one router ID is supported per node.

Use the `router_id` configuration option to configure the router:

```
# If use_namespaces is set to False then the agent can only configure one
 router.
# This is done by setting the specific router_id.
router_id = 1064ad16-36b7-4c2f-86f0-daa2bcbd6b2a
```

To configure it, you must run the OpenStack Networking service, create a router, and set the router ID value to the `router_id` value in the L3 agent configuration file.

```
$ neutron router-create myrouter1
Created a new router:
+-----------------------+--------------------------------------+
| Field                 | Value                                |
+-----------------------+--------------------------------------+
| admin_state_up        | True                                 |
| external_gateway_info |                                      |
| id                    | 338d42d7-b22e-42c5-9df6-f3674768fe75 |
| name                  | myrouter1                            |
| status                | ACTIVE                               |
| tenant_id             | 0c236f65baa04e6f9b4236b996555d56     |
+-----------------------+--------------------------------------+
```

Multiple external networks

Use one of these methods to support multiple external networks:

- Assign multiple subnets to an external network.
- Use multiple floating IP pools.

The following sections describe these options.

Assign multiple subnets to an external network

This approach leverages the addition of on-link routes, which enables a router to host floating IPs from any subnet on an external network regardless of which subnet the primary router IP address comes from. This method does not require the creation of multiple external networks.

To add a subnet to the external network, use the following command template:

```
$ neutron subnet-create EXT_NETWORK_NAME CIDR
```

For example:

```
$ neutron subnet-create my-ext_network 10.0.0.0/29
```

Multiple floating IP pools

The L3 API in OpenStack Networking supports multiple floating IP pools. In OpenStack Networking, a floating IP pool is represented as an external network, and a floating IP is allocated from a subnet associated with the external network. You can associate a L3 agent with multiple external networks.

Before starting a L3 agent, you must update the configuration files with the UUID of the external network.

To enable the L3 agent to support multiple external networks, edit the `l3_agent.ini` file and leave the `gateway_external_network_id` and `external_network_bridge` parameters unset:

```
handle_internal_only_routers = True
                    gateway_external_network_id =
                    external_network_bridge =
```

L3 metering agent

You can run an L3 metering agent that enables layer 3 traffic metering. In general, you should launch the metering agent on all nodes that run the L3 agent:

```
neutron-metering-agent --config-file NEUTRON_CONFIG_FILE --config-
file L3_METERING_CONFIG_FILE
```

You must configure a driver that matches the plug-in that runs on the service. The driver adds metering to the routing interface.

Table 7.4. Settings

Option	Value
Open vSwitch	
interface_driver ($NEUTRON_CONF_DIR/metering_agent.ini)	neutron.agent.linux.interface.OVSInterfaceDriver
Linux Bridge	
interface_driver ($NEUTRON_CONF_DIR/metering_agent.ini)	neutron.agent.linux.interface.BridgeInterfaceDriver

Namespace

The metering agent and the L3 agent must have the same network namespaces configuration.

Note

If the Linux installation does not support network namespaces, you must disable network namespaces in the L3 metering configuration file. The default value of the `use_namespaces` option is `True`.

```
use_namespaces = False
```

L3 metering driver

You must configure any driver that implements the metering abstraction. Currently the only available implementation uses iptables for metering.

```
driver = neutron.services.metering.drivers.iptables.iptables_driver.
IptablesMeteringDriver
```

L3 metering service driver

To enable L3 metering, you must set the following option in the `neutron.conf` file on the host that runs `neutron-server`:

```
service_plugins = metering
```

Limitations

- *No equivalent for nova-network `--multi_host` option*. Nova-network has a model where the L3, NAT, and DHCP processing happen on the compute node itself, rather than a dedicated networking node. OpenStack Networking now support running multiple l3-agent and dhcp-agents with load being split across those agents, but the tight coupling of that scheduling with the location of the VM is not supported in Icehouse. The Juno release is expected to include an exact replacement for the `--multi_host` option in nova-network.

- *Linux network namespace required on nodes running `neutron-l3-agent` or `neutron-dhcp-agent` if overlapping IPs are in use*. To support overlapping IP addresses, the OpenStack Networking DHCP and L3 agents use Linux network namespaces by default. The hosts running these processes must support network namespaces. To support network namespaces, the following are required:

  - Linux kernel 2.6.24 or later (with `CONFIG_NET_NS=y` in kernel configuration)

  - iproute2 utilities ('ip' command) version 3.1.0 (aka 20111117) or later

  To check whether your host supports namespaces, run these commands as root:

  ```
  # ip netns add test-ns
  # ip netns exec test-ns ifconfig
  ```

  If these commands succeed, your platform is likely sufficient to use the dhcp-agent or l3-agent with namespaces. In our experience, Ubuntu 12.04 or later support namespaces as does Fedora 17 and later, but some earlier RHEL platforms do not by default. It might be possible to upgrade the `iproute2` package on a platform that does not support namespaces by default.

  If you must disable namespaces, make sure that the `neutron.conf` file that is used by `neutron-server` has the following setting:

  ```
  allow_overlapping_ips=False
  ```

  Also, ensure that the `dhcp_agent.ini` and `l3_agent.ini` files have the following setting:

  ```
  use_namespaces=False
  ```

Note

If the host does not support namespaces, the `neutron-l3-agent` and `neutron-dhcp-agent` should run on different hosts because there is no isolation between the IP addresses created by the L3 agent and by the DHCP agent. By manipulating the routing, the user can ensure that these networks have access to one another.

If you run both L3 and DHCP services on the same node, you should enable namespaces to avoid conflicts with routes:

```
use_namespaces=True
```

- *No IPv6 support for L3 agent*. The `neutron-l3-agent`, used by many plug-ins to implement L3 forwarding, supports only IPv4 forwarding. Currently, there are no errors provided if you configure IPv6 addresses via the API.

- *ZeroMQ support is experimental*. Some agents, including `neutron-dhcp-agent`, `neutron-openvswitch-agent`, and `neutron-linuxbridge-agent` use RPC to communicate. ZeroMQ is an available option in the configuration file, but has not been tested and should be considered experimental. In particular, issues might occur with ZeroMQ and the dhcp agent.

- *MetaPlugin is experimental*. This release includes a MetaPlugin that is intended to support multiple plug-ins at the same time for different API requests, based on the content of those API requests. The core team has not thoroughly reviewed or tested this functionality. Consider this functionality to be experimental until further validation is performed.

Advanced operational features

Logging settings

Networking components use Python logging module to do logging. Logging configuration can be provided in `neutron.conf` or as command-line options. Command options override ones in `neutron.conf`.

To configure logging for Networking components, use one of these methods:

- Provide logging settings in a logging configuration file.

  See Python logging how-to to learn more about logging.

- Provide logging setting in `neutron.conf`

```
[DEFAULT]
# Default log level is WARNING
# Show debugging output in logs (sets DEBUG log level output)
# debug = False

# Show more verbose log output (sets INFO log level output) if debug is
 False
```

```
# verbose = False

# log_format = %(asctime)s %(levelname)8s [%(name)s] %(message)s
# log_date_format = %Y-%m-%d %H:%M:%S

# use_syslog = False
# syslog_log_facility = LOG_USER

# if use_syslog is False, we can set log_file and log_dir.
# if use_syslog is False and we do not set log_file,
# the log will be printed to stdout.
# log_file =
# log_dir =
```

Notifications

Notifications can be sent when Networking resources such as network, subnet and port are created, updated or deleted.

Notification options

To support DHCP agent, rpc_notifier driver must be set. To set up the notification, edit notification options in `neutron.conf`:

```
# Driver or drivers to handle sending notifications. (multi
# valued)
#notification_driver=

# AMQP topic used for OpenStack notifications. (list value)
# Deprecated group/name - [rpc_notifier2]/topics
notification_topics = notifications
```

Setting cases

Logging and RPC

These options configure the Networking server to send notifications through logging and RPC. The logging options are described in *OpenStack Configuration Reference* . RPC notifications go to 'notifications.info' queue bound to a topic exchange defined by 'control_exchange' in `neutron.conf`.

```
# ============ Notification System Options =====================

# Notifications can be sent when network/subnet/port are create, updated or
 deleted.
# There are three methods of sending notifications: logging (via the
# log_file directive), rpc (via a message queue) and
# noop (no notifications sent, the default)

# Notification_driver can be defined multiple times
# Do nothing driver
# notification_driver = neutron.openstack.common.notifier.no_op_notifier
# Logging driver
notification_driver = neutron.openstack.common.notifier.log_notifier
# RPC driver
notification_driver = neutron.openstack.common.notifier.rpc_notifier
```

```
# default_notification_level is used to form actual topic names or to set
 logging level
default_notification_level = INFO

# default_publisher_id is a part of the notification payload
# host = myhost.com
# default_publisher_id = $host

# Defined in rpc_notifier for rpc way, can be comma-separated values.
# The actual topic names will be %s.%(default_notification_level)s
notification_topics = notifications
```

Multiple RPC topics

These options configure the Networking server to send notifications to multiple RPC topics. RPC notifications go to 'notifications_one.info' and 'notifications_two.info' queues bound to a topic exchange defined by 'control_exchange' in `neutron.conf`.

```
# ============ Notification System Options =====================

# Notifications can be sent when network/subnet/port are create, updated or
 deleted.
# There are three methods of sending notifications: logging (via the
# log_file directive), rpc (via a message queue) and
# noop (no notifications sent, the default)

# Notification_driver can be defined multiple times
# Do nothing driver
# notification_driver = neutron.openstack.common.notifier.no_op_notifier
# Logging driver
# notification_driver = neutron.openstack.common.notifier.log_notifier
# RPC driver
notification_driver = neutron.openstack.common.notifier.rpc_notifier

# default_notification_level is used to form actual topic names or to set
 logging level
default_notification_level = INFO

# default_publisher_id is a part of the notification payload
# host = myhost.com
# default_publisher_id = $host

# Defined in rpc_notifier for rpc way, can be comma-separated values.
# The actual topic names will be %s.%(default_notification_level)s
notification_topics = notifications_one,notifications_two
```

Advanced features through API extensions

Several plug-ins implement API extensions that provide capabilities similar to what was available in nova-network: These plug-ins are likely to be of interest to the OpenStack community.

Provider networks

Networks can be categorized as either tenant networks or provider networks. Tenant networks are created by normal users. Details about how these networks are physically realized remain hidden from those users. Provider networks are created with administrative

credentials, specifying the details of how the network is physically realized. Provider networks usually match an existing network in the data center.

Provider networks enable cloud administrators to create virtual networks that map directly to the physical networks in the data center. This is commonly used to give tenants direct access to a public network, which can be used to reach the Internet. It might also be used to integrate with VLANs in the network that already have a defined meaning (for example, enable a VM from the "marketing" department to be placed on the same VLAN as bare-metal marketing hosts in the same data center).

The provider extension allows administrators to explicitly manage the relationship between virtual networks and underlying physical mechanisms such as VLANs and tunnels. When this extension is supported, client users with administrative privileges see additional provider attributes on all virtual networks and are able to specify these attributes in order to create provider networks.

The provider extension is supported by the Open vSwitch and Linux Bridge plug-ins. Configuration of these plug-ins requires familiarity with this extension.

Terminology

A number of terms are used in the provider extension and in the configuration of plug-ins supporting the provider extension:

Table 7.5. Provider extension terminology

Term	Description
virtual network	An Networking L2 network (identified by a UUID and optional name) whose ports can be attached as vNICs to Compute instances and to various Networking agents. The Open vSwitch and Linux Bridge plug-ins each support several different mechanisms to realize virtual networks.
physical network	A network connecting virtualization hosts (such as compute nodes) with each other and with other network resources. Each physical network might support multiple virtual networks. The provider extension and the plug-in configurations identify physical networks using simple string names.
tenant network	A virtual network that a tenant or an administrator creates. The physical details of the network are not exposed to the tenant.
provider network	A virtual network administratively created to map to a specific network in the data center, typically to enable direct access to non-OpenStack resources on that network. Tenants can be given access to provider networks.
VLAN network	A virtual network implemented as packets on a specific physical network containing IEEE 802.1Q headers with a specific VID field value. VLAN networks sharing the same physical network are isolated from each other at L2 and can even have overlapping IP address spaces. Each distinct physical network supporting VLAN networks is treated as a separate VLAN trunk, with a distinct space of VID values. Valid VID values are 1 through 4094.
flat network	A virtual network implemented as packets on a specific physical network containing no IEEE 802.1Q header. Each physical network can realize at most one flat network.
local network	A virtual network that allows communication within each host, but not across a network. Local networks are intended mainly for single-node test scenarios, but can have other uses.
GRE network	A virtual network implemented as network packets encapsulated using GRE. GRE networks are also referred to as *tunnels*. GRE tunnel packets are routed by the IP routing table for the host, so GRE networks are not associated by Networking with specific physical networks.
Virtual Extensible LAN (VXLAN) network	VXLAN is a proposed encapsulation protocol for running an overlay network on existing Layer 3 infrastructure. An overlay network is a virtual network that is built on top of existing network Layer 2 and Layer 3 technologies to support elastic compute architectures.

The ML2, Open vSwitch, and Linux Bridge plug-ins support VLAN networks, flat networks, and local networks. Only the ML2 and Open vSwitch plug-ins currently support GRE and VXLAN networks, provided that the required features exist in the hosts Linux kernel, Open vSwitch, and iproute2 packages.

Provider attributes

The provider extension extends the Networking network resource with these attributes:

Table 7.6. Provider network attributes

Attribute name	Type	Default Value	Description
provider:network_type	String	N/A	The physical mechanism by which the virtual network is implemented. Possible values are `flat`, `vlan`, `local`, and `gre`, corresponding to flat networks, VLAN networks, local networks, and GRE networks as defined above. All types of provider networks can be created by administrators, while tenant networks can be implemented as `vlan`, `gre`, or `local` network types depending on plug-in configuration.
provider:physical_network	String	If a physical network named "default" has been configured and if provider:network_type is `flat` or `vlan`, then "default" is used.	The name of the physical network over which the virtual network is implemented for flat and VLAN networks. Not applicable to the `local` or `gre` network types.
provider:segmentation_id	Integer	N/A	For VLAN networks, the VLAN VID on the physical network that realizes the virtual network. Valid VLAN VIDs are 1 through 4094. For GRE networks, the tunnel ID. Valid tunnel IDs are any 32 bit unsigned integer. Not applicable to the `flat` or `local` network types.

To view or set provider extended attributes, a client must be authorized for the `extension:provider_network:view` and `extension:provider_network:set` actions in the Networking policy configuration. The default Networking configuration authorizes both actions for users with the admin role. An authorized client or an administrative user can view and set the provider extended attributes through Networking API calls.

Provider extension API operations

To use the provider extension with the default policy settings, you must have the administrative role.

This list shows example neutron commands that enable you to complete basic provider extension API operations:

- Shows all attributes of a network, including provider attributes:

```
$ neutron net-show NAME_OR_NET_ID
```

- Creates a local provider network:

```
$ neutron net-create NAME --tenant_id TENANT_ID --provider:network_type
 local
```

- When you create flat networks, *PHYS_NET_NAME* must be known to the plug-in. See the *OpenStack Configuration Reference* for details. Creates a flat provider network:

```
$ neutron net-create NAME --tenant_id TENANT_ID --provider:network_type flat
 --provider:physical_network PHYS_NET_NAME
```

- When you create VLAN networks, *PHYS_NET_NAME* must be known to the plug-in. See the *OpenStack Configuration Reference* for details on configuring network_vlan_ranges to identify all physical networks. When you create VLAN networks, *VID* can fall either within or outside any configured ranges of VLAN IDs from which tenant networks are allocated. Creates a VLAN provider network:

```
$ neutron net-create NAME --tenant_id TENANT_ID --provider:network_type vlan
 --provider:physical_network PHYS_NET_NAME --provider:segmentation_id VID
```

- When you create GRE networks, *TUNNEL_ID* can be either inside or outside any tunnel ID ranges from which tenant networks are allocated.

  After you create provider networks, you can allocate subnets, which you can use in the same way as other virtual networks, subject to authorization policy based on the specified *TENANT_ID*. Creates a GRE provider network:

```
$ neutron net-create NAME --tenant_id TENANT_ID --provider:network_type gre
 --provider:segmentation_id TUNNEL_ID
```

L3 routing and NAT

The Networking API provides abstract L2 network segments that are decoupled from the technology used to implement the L2 network. Networking includes an API extension that provides abstract L3 routers that API users can dynamically provision and configure. These Networking routers can connect multiple L2 Networking networks and can also provide a gateway that connects one or more private L2 networks to a shared external network. For example, a public network for access to the Internet. See the *OpenStack Configuration Reference* for details on common models of deploying Networking L3 routers.

The L3 router provides basic NAT capabilities on gateway ports that uplink the router to external networks. This router SNATs all traffic by default and supports floating IPs, which creates a static one-to-one mapping from a public IP on the external network to a private IP on one of the other subnets attached to the router. This allows a tenant to selectively expose VMs on private networks to other hosts on the external network (and often to all hosts on the Internet). You can allocate and map floating IPs from one port to another, as needed.

L3 API abstractions

Table 7.7. Router

Attribute name	Type	Default Value	Description
id	uuid-str	generated	UUID for the router.
name	String	None	Human-readable name for the router. Might not be unique.
admin_state_up	Bool	True	The administrative state of router. If false (down), the router does not forward packets.
status	String	N/A	Indicates whether router is currently operational.
tenant_id	uuid-str	N/A	Owner of the router. Only admin users can specify a tenant_id other than its own.
external_gateway_info	dict contain 'network_id' key-value pair	Null	External network that this router connects to for gateway services (for example, NAT)

Table 7.8. Floating IP

Attribute name	Type	Default Value	Description
id	uuid-str	generated	UUID for the floating IP.
floating_ip_address	string (IP address)	allocated by Networking	The external network IP address available to be mapped to an internal IP address.
floating_network_id	uuid-str	N/A	The network indicating the set of subnets from which the floating IP should be allocated
router_id	uuid-str	N/A	Read-only value indicating the router that connects the external network to the associated internal port, if a port is associated.
port_id	uuid-str	Null	Indicates the internal Networking port associated with the external floating IP.
fixed_ip_address	string (IP address)	Null	Indicates the IP address on the internal port that the floating IP maps to (since Networking ports might have more than one IP address).
tenant_id	uuid-str	N/A	Owner of the Floating IP. Only admin users can specify a tenant_id other than its own.

Basic L3 operations

External networks are visible to all users. However, the default policy settings enable only administrative users to create, update, and delete external networks.

This table shows example **neutron** commands that enable you to complete basic L3 operations:

Table 7.9. Basic L3 operations

Operation	Command
Creates external networks.	`# neutron net-create public --router:external True` `$ neutron subnet-create public 172.16.1.0/24`
Lists external networks.	`$ neutron net-list -- --router:external True`

Creates an internal-only router that connects to multiple L2 networks privately.	`$ neutron net-create net1`
	`$ neutron subnet-create net1 10.0.0.0/24`
	`$ neutron net-create net2`
	`$ neutron subnet-create net2 10.0.1.0/24`
	`$ neutron router-create router1`
	`$ neutron router-interface-add router1 SUBNET1_UUID`
	`$ neutron router-interface-add router1 SUBNET2_UUID`

Connects a router to an external network, which enables that router to act as a NAT gateway for external connectivity.	`$ neutron router-gateway-set router1 EXT_NET_ID` The router obtains an interface with the gateway_ip address of the subnet and this interface is attached to a port on the L2 Networking network associated with the subnet. The router also gets a gateway interface to the specified external network. This provides SNAT connectivity to the external network as well as support for floating IPs allocated on that external networks. Commonly an external network maps to a network in the provider
Lists routers.	`$ neutron router-list`
Shows information for a specified router.	`$ neutron router-show ROUTER_ID`
Shows all internal interfaces for a router.	`$ neutron router-port-list ROUTER_ID` `$ neutron router-port-list ROUTER_NAME`
Identifies the *PORT_ID* that represents the VM NIC to which the floating IP should map.	`$ neutron port-list -c id -c fixed_ips -- --device_id INSTANCE_ID` This port must be on an Networking subnet that is attached to a router uplinked to the external network used to create the floating IP. Conceptually, this is because the router must be able to perform the Destination NAT (DNAT) rewriting of packets from the floating IP address (chosen from a subnet on the external network) to the internal fixed IP (chosen from a private subnet that is behind the router).
Creates a floating IP address and associates it with a port.	`$ neutron floatingip-create EXT_NET_ID` `$ neutron floatingip-associate FLOATING_IP_ID INTERNAL_VM_PORT_ID`
Creates a floating IP address, and associates it with a port, in a single step.	`$ neutron floatingip-create --port_id INTERNAL_VM_PORT_ID EXT_NET_ID`
Lists floating IPs.	`$ neutron floatingip-list`
Finds floating IP for a specified VM port.	`$ neutron floatingip-list -- --port_id ZZZ`
Disassociates a floating IP address.	`$ neutron floatingip-disassociate FLOATING_IP_ID`
Deletes the floating IP address.	`$ neutron floatingip-delete FLOATING_IP_ID`
Clears the gateway.	`$ neutron router-gateway-clear router1`
Removes the interfaces from the router.	`$ neutron router-interface-delete router1 SUBNET_ID`
Deletes the router.	`$ neutron router-delete router1`

Security groups

Security groups and security group rules allows administrators and tenants the ability to specify the type of traffic and direction (ingress/egress) that is allowed to pass through a port. A security group is a container for security group rules.

When a port is created in Networking it is associated with a security group. If a security group is not specified the port is associated with a 'default' security group. By default, this group drops all ingress traffic and allows all egress. Rules can be added to this group in order to change the behaviour.

To use the Compute security group APIs or use Compute to orchestrate the creation of ports for instances on specific security groups, you must complete additional configuration. You must configure the `/etc/nova/nova.conf` file and set the `security_group_api=neutron` option on every node that runs `nova-compute` and `nova-api`. After you make this change, restart `nova-api` and `nova-compute` to pick up this change. Then, you can use both the Compute and OpenStack Network security group APIs at the same time.

Note

- To use the Compute security group API with Networking, the Networking plug-in must implement the security group API. The following plug-ins currently implement this: ML2, Open vSwitch, Linux Bridge, NEC, and VMware NSX.
- You must configure the correct firewall driver in the `securitygroup` section of the plug-in/agent configuration file. Some plug-ins and agents, such as Linux Bridge Agent and Open vSwitch Agent, use the no-operation driver as the default, which results in non-working security groups.
- When using the security group API through Compute, security groups are applied to all ports on an instance. The reason for this is that Compute security group APIs are instances based unlike Networking, which is port based.

Security group API abstractions

Table 7.10. Security group attributes

Attribute name	Type	Default Value	Description
id	uuid-str	generated	UUID for the security group.
name	String	None	Human-readable name for the security group. Might not be unique. Cannot be named default as that is automatically created for a tenant.
description	String	None	Human-readable description of a security group.
tenant_id	uuid-str	N/A	Owner of the security group. Only admin users can specify a tenant_id other than their own.

Table 7.11. Security group rules

Attribute name	Type	Default Value	Description
id	uuid-str	generated	UUID for the security group rule.

Attribute name	Type	Default Value	Description
security_group_id	uuid-str or Integer	allocated by Networking	The security group to associate rule with.
direction	String	N/A	The direction the traffic is allow (ingress/egress) from a VM.
protocol	String	None	IP Protocol (icmp, tcp, udp, and so on).
port_range_min	Integer	None	Port at start of range
port_range_max	Integer	None	Port at end of range
ethertype	String	None	ethertype in L2 packet (IPv4, IPv6, and so on)
remote_ip_prefix	string (IP cidr)	None	CIDR for address range
remote_group_id	uuid-str or Integer	allocated by Networking or Compute	Source security group to apply to rule.
tenant_id	uuid-str	N/A	Owner of the security group rule. Only admin users can specify a tenant_id other than its own.

Basic security group operations

This table shows example neutron commands that enable you to complete basic security group operations:

Table 7.12. Basic security group operations

Operation	Command
Creates a security group for our web servers.	`$ neutron security-group-create webservers --description "security group for webservers"`
Lists security groups.	`$ neutron security-group-list`
Creates a security group rule to allow port 80 ingress.	`$ neutron security-group-rule-create --direction ingress --protocol tcp --port_range_min 80 --port_range_max 80 SECURITY_GROUP_UUID`
Lists security group rules.	`$ neutron security-group-rule-list`
Deletes a security group rule.	`$ neutron security-group-rule-delete SECURITY_GROUP_RULE_UUID`
Deletes a security group.	`$ neutron security-group-delete SECURITY_GROUP_UUID`
Creates a port and associates two security groups.	`$ neutron port-create --security-group SECURITY_GROUP_ID1 --security-group SECURITY_GROUP_ID2 NETWORK_ID`
Removes security groups from a port.	`$ neutron port-update --no-security-groups PORT_ID`

Basic Load-Balancer-as-a-Service operations

Note

The Load-Balancer-as-a-Service (LBaaS) API provisions and configures load balancers. The Havana release offers a reference implementation that is based on the HAProxy software load balancer.

This list shows example neutron commands that enable you to complete basic LBaaS operations:

- Creates a load balancer pool by using specific provider.

  --provider is an optional argument. If not used, the pool is created with default provider for LBaaS service. You should configure the default provider in the `[service_providers]` section of `neutron.conf` file. If no default provider is specified for LBaaS, the *--provider* option is required for pool creation.

```
$ neutron lb-pool-create --lb-method ROUND_ROBIN --name mypool --protocol
 HTTP --subnet-id SUBNET_UUID --provider PROVIDER_NAME
```

- Associates two web servers with pool.

```
$ neutron lb-member-create --address  WEBSERVER1_IP --protocol-port 80
 mypool
$ neutron lb-member-create --address  WEBSERVER2_IP --protocol-port 80
 mypool
```

- Creates a health monitor that checks to make sure our instances are still running on the specified protocol-port.

```
$ neutron lb-healthmonitor-create --delay 3 --type HTTP --max-retries 3 --
timeout 3
```

- Associates a health monitor with pool.

```
$ neutron lb-healthmonitor-associate  HEALTHMONITOR_UUID mypool
```

- Creates a virtual IP (VIP) address that, when accessed through the load balancer, directs the requests to one of the pool members.

```
$ neutron lb-vip-create --name myvip --protocol-port 80 --protocol HTTP --
subnet-id SUBNET_UUID mypool
```

Firewall-as-a-Service

The Firewall-as-a-Service (FWaaS) API is an experimental API that enables early adopters and vendors to test their networking implementations.

Firewall-as-a-Service API abstractions

Table 7.13. Firewall rules

Attribute name	Type	Default Value	Description
id	uuid-str	generated	UUID for the firewall rule.
tenant_id	uuid-str	N/A	Owner of the firewall rule. Only admin users can specify a tenant_id other than its own.
name	String	None	Human readable name for the firewall rule (255 characters limit).
description	String	None	Human-readable description for the firewall rule (1024 characters limit).
firewall_policy_id	uuid-str or None	allocated by Networking	This is a read-only attribute that gets populated with the UUID of the firewall policy when this firewall rule is associated with a firewall policy. A firewall rule can be associated with only one firewall policy at a time. However, the association can be changed to a different firewall policy.
shared	Boolean	False	When set to True makes this firewall rule visible to tenants other than its owner and it can be used in firewall policies not owned by its tenant.
protocol	String	None	IP protocol (icmp, tcp, udp, None).
ip_version	Integer or String	4	IP version (4, 6).
source_ip_address	String (IP address or CIDR)	None	Source IP address or CIDR.
destination_ip_address	String (IP address or CIDR)	None	Destination IP address or CIDR.
source_port	Integer or String (either as a single port number or in the format of a ':' separated range)	None	Source port number or a range.
destination_port	Integer or String (either as a single port number or in the format of a ':' separated range)	None	Destination port number or a range.
position	Integer	None	This is a read-only attribute that gets assigned to this rule when the rule is associated with a firewall policy. It indicates the position of this rule in that firewall policy.
action	String	deny	Action to be performed on the traffic matching the rule (allow, deny).
enabled	Boolean	True	When set to `False`, disables this rule in the firewall policy. Facilitates selectively turning off rules without having to disassociate the rule from the firewall policy.

Table 7.14. Firewall policies

Attribute name	Type	Default Value	Description
id	uuid-str	generated	UUID for the firewall policy.
tenant_id	uuid-str	N/A	Owner of the firewall policy. Only admin users can specify a tenant_id other their own.
name	String	None	Human readable name for the firewall policy (255 characters limit).
description	String	None	Human readable description for the firewall policy (1024 characters limit).
shared	Boolean	False	When set to True, the command makes this firewall policy visible to tenants other than its owner and can be used to associate with firewalls not owned by its tenant.
firewall_rules	List of uuid-str or None	None	This is an ordered list of firewall rule UUIDs. The firewall applies the rules in the order in which they appear in this list.
audited	Boolean	False	When set to True by the policy owner, the command indicates that the firewall policy has been audited. This attribute is meant to aid in the firewall policy audit work flows. Each time the firewall policy or the associated firewall rules are changed, this attribute is set to False and must be explicitly set to True through an update operation.

Table 7.15. Firewalls

Attribute name	Type	Default Value	Description
id	uuid-str	generated	UUID for the firewall.
tenant_id	uuid-str	N/A	Owner of the firewall. Only admin users can specify a tenant_id other than its own.
name	String	None	Human readable name for the firewall (255 characters limit).
description	String	None	Human readable description for the firewall (1024 characters limit).
admin_state_up	Boolean	True	The administrative state of the firewall. If False (down), the firewall does not forward any packets.
status	String	N/A	Indicates whether the firewall is currently operational. Possible values include: • ACTIVE • DOWN • PENDING_CREATE • PENDING_UPDATE • PENDING_DELETE • ERROR
firewall_policy_id	uuid-str or None	None	The firewall policy UUID that this firewall is associated with. This firewall implements the rules contained in the firewall policy represented by this UUID.

Plug-in specific extensions

Each vendor can choose to implement additional API extensions to the core API. This section describes the extensions for each plug-in.

VMware NSX extensions

These sections explain NSX plug-in extensions.

VMware NSX QoS extension

The VMware NSX QoS extension rate-limits network ports to guarantee a specific amount of bandwidth for each port. This extension, by default, is only accessible by a tenant with an admin role but is configurable through the `policy.json` file. To use this extension, create a queue and specify the min/max bandwidth rates (kbps) and optionally set the QoS Marking and DSCP value (if your network fabric uses these values to make forwarding decisions). Once created, you can associate a queue with a network. Then, when ports are created on that network they are automatically created and associated with the specific queue size that was associated with the network. Because one size queue for a every port on a network might not be optimal, a scaling factor from the nova flavor 'rxtx_factor' is passed in from Compute when creating the port to scale the queue.

Lastly, if you want to set a specific baseline QoS policy for the amount of bandwidth a single port can use (unless a network queue is specified with the network a port is created on) a default queue can be created in Networking which then causes ports created to be associated with a queue of that size times the rxtx scaling factor. Note that after a network or default queue is specified, queues are added to ports that are subsequently created but are not added to existing ports.

VMware NSX QoS API abstractions

Table 7.16. VMware NSX QoS attributes

Attribute name	Type	Default Value	Description
id	uuid-str	generated	UUID for the QoS queue.
default	Boolean	False by default	If True, ports are created with this queue size unless the network port is created or associated with a queue at port creation time.
name	String	None	Name for QoS queue.
min	Integer	0	Minimum Bandwidth Rate (kbps).
max	Integer	N/A	Maximum Bandwidth Rate (kbps).
qos_marking	String	untrusted by default	Whether QoS marking should be trusted or untrusted.
dscp	Integer	0	DSCP Marking value.
tenant_id	uuid-str	N/A	The owner of the QoS queue.

Basic VMware NSX QoS operations

This table shows example neutron commands that enable you to complete basic queue operations:

Table 7.17. Basic VMware NSX QoS operations

Operation	Command
Creates QoS queue (admin-only).	`$ neutron queue-create --min 10 --max 1000 myqueue`
Associates a queue with a network.	`$ neutron net-create network --queue_id QUEUE_ID`
Creates a default system queue.	`$ neutron queue-create --default True --min 10 --max 2000 default`
Lists QoS queues.	`$ neutron queue-list`
Deletes a QoS queue.	`$ neutron queue-delete QUEUE_ID_OR_NAME'`

VMware NSX provider networks extension

Provider networks can be implemented in different ways by the underlying NSX platform.

The *FLAT* and *VLAN* network types use bridged transport connectors. These network types enable the attachment of large number of ports. To handle the increased scale, the NSX plug-in can back a single OpenStack Network with a chain of NSX logical switches. You can specify the maximum number of ports on each logical switch in this chain on the `max_lp_per_bridged_ls` parameter, which has a default value of 5,000.

The recommended value for this parameter varies with the NSX version running in the back-end, as shown in the following table.

Table 7.18. Recommended values for max_lp_per_bridged_ls

NSX version	Recommended Value
2.x	64
3.0.x	5,000
3.1.x	5,000
3.2.x	10,000

In addition to these network types, the NSX plug-in also supports a special *l3_ext* network type, which maps external networks to specific NSX gateway services as discussed in the next section.

VMware NSX L3 extension

NSX exposes its L3 capabilities through gateway services which are usually configured out of band from OpenStack. To use NSX with L3 capabilities, first create an L3 gateway service in the NSX Manager. Next, in `/etc/neutron/plugins/vmware/nsx.ini` set `default_l3_gw_service_uuid` to this value. By default, routers are mapped to this gateway service.

VMware NSX L3 extension operations

Create external network and map it to a specific NSX gateway service:

```
$ neutron net-create public --router:external True --provider:network_type
 l3_ext \
--provider:physical_network L3_GATEWAY_SERVICE_UUID
```

Terminate traffic on a specific VLAN from a NSX gateway service:

```
$ neutron net-create public --router:external True --provider:network_type
 l3_ext \
--provider:physical_network L3_GATEWAY_SERVICE_UUID --
provider:segmentation_id VLAN_ID
```

Operational status synchronization in the VMware NSX plug-in

Starting with the Havana release, the VMware NSX plug-in provides an asynchronous mechanism for retrieving the operational status for neutron resources from the NSX back-end; this applies to *network*, *port* and *router* resources.

The back-end is polled periodically and the status for every resource is retrieved; then the status in the Networking database is updated only for the resources for which a status change occurred. As operational status is now retrieved asynchronously, performance for GET operations is consistently improved.

Data to retrieve from the back-end are divided in chunks in order to avoid expensive API requests; this is achieved leveraging NSX APIs response paging capabilities. The minimum chunk size can be specified using a configuration option; the actual chunk size is then determined dynamically according to: total number of resources to retrieve, interval between two synchronization task runs, minimum delay between two subsequent requests to the NSX back-end.

The operational status synchronization can be tuned or disabled using the configuration options reported in this table; it is however worth noting that the default values work fine in most cases.

Table 7.19. Configuration options for tuning operational status synchronization in the NSX plug-in

Option name	Group	Default value	Type and constraints	Notes
`state_sync_interval`	`nsx_sync`	120 seconds	Integer; no constraint.	Interval in seconds between two run of the synchronization task. If the synchronization task takes more than `state_sync_interval` seconds to execute, a new instance of the task is started as soon as the other is completed. Setting the value for this option to 0 will disable the synchronization task.
`max_random_sync_delay`	`nsx_sync`	0 seconds	Integer. Must not exceed `min_sync_req_delay`	When different from zero, a random delay between 0 and `max_random_sync_delay` will be added before processing the next chunk.
`min_sync_req_delay`	`nsx_sync`	10 seconds	Integer. Must not exceed `state_sync_interval`.	The value of this option can be tuned according to the observed load on the NSX controllers. Lower values will result in faster synchronization, but might increase the load on the controller cluster.
`min_chunk_size`	`nsx_sync`	500 resources	Integer; no constraint.	Minimum number of resources to retrieve from the back-end for each synchronization chunk. The expected number of synchronization chunks is given by the ratio between `state_sync_interval` and `min_sync_req_delay`. This size of a chunk might increase if the total number of resources is such that more than `min_chunk_size` resources must be fetched in one chunk with the current number of chunks.
`always_read_status`	`nsx_sync`	False	Boolean; no constraint.	When this option is enabled, the operational status will always be retrieved from the NSX back-end ad every GET request. In this case it is advisable to disable the synchronization task.

When running multiple OpenStack Networking server instances, the status synchronization task should not run on every node; doing so sends unnecessary traffic to the NSX back-end and performs unnecessary DB operations. Set the `state_sync_interval` configuration option to a non-zero value exclusively on a node designated for back-end status synchronization.

The `fields=status` parameter in Networking API requests always triggers an explicit query to the NSX back end, even when you enable asynchronous state synchronization. For example, `GET /v2.0/networks/`*`NET_ID`*`?fields=status&fields=name`.

Big Switch plug-in extensions

This section explains the Big Switch neutron plug-in-specific extension.

Big Switch router rules

Big Switch allows router rules to be added to each tenant router. These rules can be used to enforce routing policies such as denying traffic between subnets or traffic to external networks. By enforcing these at the router level, network segmentation policies can be enforced across many VMs that have differing security groups.

Router rule attributes

Each tenant router has a set of router rules associated with it. Each router rule has the attributes in this table. Router rules and their attributes can be set using the **neutron router-update** command, through the horizon interface or the Networking API.

Table 7.20. Big Switch Router rule attributes

Attribute name	Required	Input Type	Description
source	Yes	A valid CIDR or one of the keywords 'any' or 'external'	The network that a packet's source IP must match for the rule to be applied
destination	Yes	A valid CIDR or one of the keywords 'any' or 'external'	The network that a packet's destination IP must match for the rule to be applied
action	Yes	'permit' or 'deny'	Determines whether or not the matched packets will allowed to cross the router
nexthop	No	A plus-separated (+) list of next-hop IP addresses. For example, `1.1.1.1+1.1.1.2`.	Overrides the default virtual router used to handle traffic for packets that match the rule

Order of rule processing

The order of router rules has no effect. Overlapping rules are evaluated using longest prefix matching on the source and destination fields. The source field is matched first so it always takes higher precedence over the destination field. In other words, longest prefix matching is used on the destination field only if there are multiple matching rules with the same source.

Big Switch router rules operations

Router rules are configured with a router update operation in OpenStack Networking. The update overrides any previous rules so all rules must be provided at the same time.

Update a router with rules to permit traffic by default but block traffic from external networks to the 10.10.10.0/24 subnet:

```
$ neutron router-update ROUTER_UUID --router_rules type=dict list=true\
source=any,destination=any,action=permit \
source=external,destination=10.10.10.0/24,action=deny
```

Specify alternate next-hop addresses for a specific subnet:

```
$ neutron router-update ROUTER_UUID --router_rules type=dict list=true\
source=any,destination=any,action=permit \
source=10.10.10.0/24,destination=any,action=permit,nexthops=10.10.10.254+10.
10.10.253
```

Block traffic between two subnets while allowing everything else:

```
$ neutron router-update ROUTER_UUID --router_rules type=dict list=true\
source=any,destination=any,action=permit \
source=10.10.10.0/24,destination=10.20.20.20/24,action=deny
```

L3 metering

The L3 metering API extension enables administrators to configure IP ranges and assign a specified label to them to be able to measure traffic that goes through a virtual router.

The L3 metering extension is decoupled from the technology that implements the measurement. Two abstractions have been added: One is the metering label that can contain metering rules. Because a metering label is associated with a tenant, all virtual routers in this tenant are associated with this label.

L3 metering API abstractions

Table 7.21. Label

Attribute name	Type	Default Value	Description
id	uuid-str	generated	UUID for the metering label.
name	String	None	Human-readable name for the metering label. Might not be unique.
description	String	None	The optional description for the metering label.
tenant_id	uuid-str	N/A	Owner of the metering label.

Table 7.22. Rules

Attribute name	Type	Default Value	Description
id	uuid-str	generated	UUID for the metering rule.
direction	String (Either ingress or egress)	ingress	The direction in which metering rule is applied, either ingress or egress.
metering_label_id	uuid-str	N/A	The metering label ID to associate with this metering rule.
excluded	Boolean	False	Specify whether the remote_ip_prefix will be excluded or not from traffic counters of the metering label (for example, to not count the traffic of a specific IP address of a range).

Attribute name	Type	Default Value	Description
remote_ip_prefix	String (CIDR)	N/A	Indicates remote IP prefix to be associated with this metering rule.

Basic L3 metering operations

Only administrators can manage the L3 metering labels and rules.

This table shows example **neutron** commands that enable you to complete basic L3 metering operations:

Table 7.23. Basic L3 operations

Operation	Command
Creates a metering label.	`$ neutron meter-label-create LABEL1 --description "DESCRIPTION_LABEL1"`
Lists metering labels.	`$ neutron meter-label-list`
Shows information for a specified label.	`$ neutron meter-label-show LABEL_UUID` `$ neutron meter-label-show LABEL1`
Deletes a metering label.	`$ neutron meter-label-delete LABEL_UUID` `$ neutron meter-label-delete LABEL1`

Creates a metering rule.	`$ neutron meter-label-rule-create LABEL_UUID CIDR --direction DIRECTION --excluded`
	
	For example:
	
	`$ neutron meter-label-rule-create label1 10.0.0.0/24 --direction ingress`
	`$ neutron meter-label-rule-create label1 20.0.0.0/24 --excluded`

Lists metering all label rules.	`$ neutron meter-label-rule-list`
Shows information for a specified label rule.	`$ neutron meter-label-rule-show RULE_UUID`
Deletes a metering label rule.	`$ neutron meter-label-rule-delete RULE_UUID`

Firewall-as-a-Service

FIXME

VPN-as-a-service

FIXME

Service chaining

FIXME

8. Troubleshoot OpenStack Networking

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These sections provide additional troubleshooting information for OpenStack Networking (neutron). For nova-network troubleshooting information, see the *OpenStack Operations Guide*.

Visualize OpenStack Networking service traffic in the cloud

http://docs.openstack.org

Troubleshoot network namespace issues

Linux network namespaces are a kernel feature the networking service uses to support multiple isolated layer-2 networks with overlapping IP address ranges. The support may be disabled, but it is on by default. If it is enabled in your environment, your network nodes will run their dhcp-agents and l3-agents in isolated namespaces. Network interfaces and traffic on those interfaces will not be visible in the default namespace.

To see whether you are using namespaces, run `ip netns`:

```
# ip netns
qdhcp-e521f9d0-a1bd-4ff4-bc81-78a60dd88fe5
qdhcp-a4d00c60-f005-400e-a24c-1bf8b8308f98
qdhcp-fe178706-9942-4600-9224-b2ae7c61db71
qdhcp-0a1d0a27-cffa-4de3-92c5-9d3fd3f2e74d
qrouter-8a4ce760-ab55-4f2f-8ec5-a2e858ce0d39
```

L3-agent router namespaces are named `qrouter-<router_uuid>`, and dhcp-agent name spaces are named `qdhcp-<net_uuid>`. This output shows a network node with four networks running dhcp-agents, one of which is also running an l3-agent router. It's important to know which network you need to be working in. A list of existing networks and their UUIDs can be obtained by running `neutron net-list` with administrative credentials.

Once you've determined which namespace you need to work in, you can use any of the debugging tools mention earlier by prefixing the command with `ip netns exec <namespace>`. For example, to see what network interfaces exist in the first qdhcp namespace returned above, do this:

```
# ip netns exec qdhcp-e521f9d0-a1bd-4ff4-bc81-78a60dd88fe5 ip a
10: tape6256f7d-31: <BROADCAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state
 UNKNOWN
    link/ether fa:16:3e:aa:f7:a1 brd ff:ff:ff:ff:ff:ff
    inet 10.0.1.100/24 brd 10.0.1.255 scope global tape6256f7d-31
    inet 169.254.169.254/16 brd 169.254.255.255 scope global tape6256f7d-31
    inet6 fe80::f816:3eff:feaa:f7a1/64 scope link
       valid_lft forever preferred_lft forever
28: lo: <LOOPBACK,UP,LOWER_UP> mtu 16436 qdisc noqueue state UNKNOWN
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
```

From this you see that the DHCP server on that network is using the tape6256f7d-31 device and has an IP address of 10.0.1.100. Seeing the address 169.254.169.254, you can also see that the dhcp-agent is running a metadata-proxy service. Any of the commands mentioned previously in this chapter can be run in the same way. It is also possible to run a shell, such as `bash`, and have an interactive session within the namespace. In the latter case, exiting the shell returns you to the top-level default namespace.

Troubleshoot Open vSwitch

Open vSwitch as used in the previous OpenStack Networking Service examples is a full-featured multilayer virtual switch licensed under the open source Apache 2.0 license. Full documentation can be found at the project's website. In practice, given the preceding configuration, the most common issues are being sure that the required bridges (`br-int`, `br-tun`, `br-ex`, etc.) exist and have the proper ports connected to them.

The Open vSwitch driver should and usually does manage this automatically, but it is useful to know how to do this by hand with the `ovs-vsctl` command. This command has many more subcommands than we will use here; see the man page or use `ovs-vsctl --help` for the full listing.

To list the bridges on a system, use `ovs-vsctl list-br`. This example shows a compute node that has an internal bridge and a tunnel bridge. VLAN networks are trunked through the `eth1` network interface:

```
# ovs-vsctl list-br
br-int
br-tun
eth1-br
```

Working from the physical interface inwards, we can see the chain of ports and bridges. First, the bridge `eth1-br`, which contains the physical network interface `eth1` and the virtual interface `phy-eth1-br`:

```
# ovs-vsctl list-ports eth1-br
eth1
phy-eth1-br
```

Next, the internal bridge, `br-int`, contains `int-eth1-br`, which pairs with `phy-eth1-br` to connect to the physical network shown in the previous bridge, `patch-tun`, which is

used to connect to the GRE tunnel bridge and the TAP devices that connect to the instances currently running on the system:

```
# ovs-vsctl list-ports br-int
int-eth1-br
patch-tun
tap2d782834-d1
tap690466bc-92
tap8a864970-2d
```

The tunnel bridge, `br-tun`, contains the `patch-int` interface and `gre-<N>` interfaces for each peer it connects to via GRE, one for each compute and network node in your cluster:

```
# ovs-vsctl list-ports br-tun
patch-int
gre-1
.
.
.
gre-<N>
```

If any of these links is missing or incorrect, it suggests a configuration error. Bridges can be added with `ovs-vsctl add-br`, and ports can be added to bridges with `ovs-vsctl add-port`. While running these by hand can be useful debugging, it is imperative that manual changes that you intend to keep be reflected back into your configuration files.

Debug DNS issues

If you are able to use SSH to log into an instance, but it takes a very long time (on the order of a minute) to get a prompt, then you might have a DNS issue. The reason a DNS issue can cause this problem is that the SSH server does a reverse DNS lookup on the IP address that you are connecting from. If DNS lookup isn't working on your instances, then you must wait for the DNS reverse lookup timeout to occur for the SSH login process to complete.

When debugging DNS issues, start by making sure that the host where the dnsmasq process for that instance runs is able to correctly resolve. If the host cannot resolve, then the instances won't be able to either.

A quick way to check whether DNS is working is to resolve a hostname inside your instance by using the `host` command. If DNS is working, you should see:

```
$ host openstack.org
openstack.org has address 174.143.194.225
openstack.org mail is handled by 10 mx1.emailsrvr.com.
openstack.org mail is handled by 20 mx2.emailsrvr.com.
```

If you're running the Cirros image, it doesn't have the "host" program installed, in which case you can use ping to try to access a machine by hostname to see whether it resolves. If DNS is working, the first line of ping would be:

```
$ ping openstack.org
PING openstack.org (174.143.194.225): 56 data bytes
```

If the instance fails to resolve the hostname, you have a DNS problem. For example:

```
$ ping openstack.org
ping: bad address 'openstack.org'
```

In an OpenStack cloud, the dnsmasq process acts as the DNS server for the instances in addition to acting as the DHCP server. A misbehaving dnsmasq process may be the source of DNS-related issues inside the instance. As mentioned in the previous section, the simplest way to rule out a misbehaving dnsmasq process is to kill all the dnsmasq processes on the machine and restart `nova-network`. However, be aware that this command affects everyone running instances on this node, including tenants that have not seen the issue. As a last resort, as root:

```
# killall dnsmasq
# restart nova-network
```

After the dnsmasq processes start again, check whether DNS is working.

If restarting the dnsmasq process doesn't fix the issue, you might need to use `tcpdump` to look at the packets to trace where the failure is. The DNS server listens on UDP port 53. You should see the DNS request on the bridge (such as, br100) of your compute node. Let's say you start listening with `tcpdump` on the compute node:

```
# tcpdump -i br100 -n -v udp port 53
tcpdump: listening on br100, link-type EN10MB (Ethernet), capture size 65535
bytes
```

Then, if you use SSH to log into your instance and try `ping openstack.org`, you should see something like:

```
16:36:18.807518 IP (tos 0x0, ttl 64, id 56057, offset 0, flags [DF],
proto UDP (17), length 59)
 192.168.100.4.54244 > 192.168.100.1.53: 2+ A? openstack.org. (31)
16:36:18.808285 IP (tos 0x0, ttl 64, id 0, offset 0, flags [DF],
proto UDP (17), length 75)
 192.168.100.1.53 > 192.168.100.4.54244: 2 1/0/0 openstack.org. A
 174.143.194.225 (47)
```

Appendix A. 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 openSUSE 13.1 and SUSE Linux Enterprise Server 11 SP3*
- *Installation Guide for Red Hat Enterprise Linux 7, CentOS 7, and Fedora 20*
- *Installation Guide for Ubuntu 14.04*

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

- *Architecture Design Guide*
- *Cloud Administrator Guide*
- *Configuration Reference*
- *Operations Guide*
- *High Availability Guide*
- *Security Guide*

- *Virtual Machine Image Guide*

The following books explain how to use the OpenStack dashboard and command-line clients:

- *API Quick Start*
- *End User Guide*
- *Admin User Guide*
- *Command-Line Interface Reference*

The following documentation provides reference and guidance information for the OpenStack APIs:

- OpenStack API Complete Reference (HTML)
- API Complete Reference (PDF)
- *OpenStack Block Storage Service API v2 Reference*
- *OpenStack Compute API v2 and Extensions Reference*
- *OpenStack Identity Service API v2.0 Reference*
- *OpenStack Image Service API v2 Reference*
- *OpenStack Networking API v2.0 Reference*
- *OpenStack Object Storage API v1 Reference*

The *Training Guides* offer software training for cloud administration and management.

ask.openstack.org

During the set up or testing of OpenStack, you might have questions about how a specific task is completed or be in a situation where a feature does not work correctly. Use the ask.openstack.org site to ask questions and get answers. When you visit the http://ask.openstack.org site, scan the recently asked questions to see whether your question has already been answered. If not, ask a new question. Be sure to give a clear, concise summary in the title and provide as much detail as possible in the description. Paste in your command output or stack traces, links to screen shots, and any other information which might be useful.

OpenStack mailing lists

A great way to get answers and insights is to post your question or problematic scenario to the OpenStack mailing list. You can learn from and help others who might have similar issues. To subscribe or view the archives, go to http://lists.openstack.org/cgi-bin/mailman/listinfo/openstack. You might be interested in the other mailing lists for specific projects or development, which you can find on the wiki. A description of all mailing lists is available at http://wiki.openstack.org/MailingLists.

The OpenStack wiki

The OpenStack wiki contains a broad range of topics but some of the information can be difficult to find or is a few pages deep. Fortunately, the wiki search feature enables you to search by title or content. If you search for specific information, such as about networking or nova, you can find a large amount of relevant material. More is being added all the time, so be sure to check back often. You can find the search box in the upper-right corner of any OpenStack wiki page.

The Launchpad Bugs area

The OpenStack community values your set up and testing efforts and wants your feedback. To log a bug, you must sign up for a Launchpad account at https://launchpad.net/+login. You can view existing bugs and report bugs in the Launchpad Bugs area. Use the search feature to determine whether the bug has already been reported or already been fixed. If it still seems like your bug is unreported, fill out a bug report.

Some tips:

- Give a clear, concise summary.
- Provide as much detail as possible in the description. Paste in your command output or stack traces, links to screen shots, and any other information which might be useful.
- Be sure to include the software and package versions that you are using, especially if you are using a development branch, such as, `"Juno release" vs git commit bc79c3ecc55929bac585d04a03475b72e06a3208`.
- Any deployment-specific information is helpful, such as whether you are using Ubuntu 14.04 or are performing a multi-node installation.

The following Launchpad Bugs areas are available:

- Bugs: OpenStack Block Storage (cinder)
- Bugs: OpenStack Compute (nova)
- Bugs: OpenStack Dashboard (horizon)
- Bugs: OpenStack Identity (keystone)
- Bugs: OpenStack Image Service (glance)
- Bugs: OpenStack Networking (neutron)
- Bugs: OpenStack Object Storage (swift)
- Bugs: Bare Metal (ironic)
- Bugs: Data Processing Service (sahara)
- Bugs: Database Service (trove)

- Bugs: Orchestration (heat)
- Bugs: Telemetry (ceilometer)
- Bugs: Queue Service (marconi)
- Bugs: OpenStack API Documentation (developer.openstack.org)
- Bugs: OpenStack Documentation (docs.openstack.org)

The OpenStack IRC channel

The OpenStack community lives in the #openstack IRC channel on the Freenode network. You can hang out, ask questions, or get immediate feedback for urgent and pressing issues. To install an IRC client or use a browser-based client, go to http://webchat.freenode.net/. You can also use Colloquy (Mac OS X, http://colloquy.info/), mIRC (Windows, http://www.mirc.com/), or XChat (Linux). When you are in the IRC channel and want to share code or command output, the generally accepted method is to use a Paste Bin. The OpenStack project has one at http://paste.openstack.org. Just paste your longer amounts of text or logs in the web form and you get a URL that you can paste into the channel. The OpenStack IRC channel is `#openstack` on `irc.freenode.net`. You can find a list of all OpenStack IRC channels at https://wiki.openstack.org/wiki/IRC.

Documentation feedback

To provide feedback on documentation, join and use the `<openstack-docs@lists.openstack.org>` mailing list at OpenStack Documentation Mailing List, or report a bug.

OpenStack distribution packages

The following Linux distributions provide community-supported packages for OpenStack:

- **Debian:** http://wiki.debian.org/OpenStack
- **CentOS, Fedora, and Red Hat Enterprise Linux:** http://openstack.redhat.com/
- **openSUSE and SUSE Linux Enterprise Server:** http://en.opensuse.org/Portal:OpenStack
- **Ubuntu:** https://wiki.ubuntu.com/ServerTeam/CloudArchive

Glossary

API
: Application programming interface.

Block Storage
: The OpenStack core project that enables management of volumes, volume snapshots, and volume types. The project name of Block Storage is cinder.

Compute
: The OpenStack core project that provides compute services. The project name of Compute service is nova.

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.

distributed virtual router (DVR)
: Mechanism for highly-available multi-host routing when using OpenStack Networking (neutron).

firewall
: Used to restrict communications between hosts and/or nodes, implemented in Compute using iptables, arptables, ip6tables, and etables.

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.

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.

network
: A virtual network that provides connectivity between entities. For example, a collection of virtual ports that share network connectivity. In Networking terminology, a network is always a layer-2 network.

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.

Orchestration
: An integrated project that orchestrates multiple cloud applications for OpenStack. The project name of Orchestration is heat.

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.

router
: A physical or virtual network device that passes network traffic between different networks.

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.

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.