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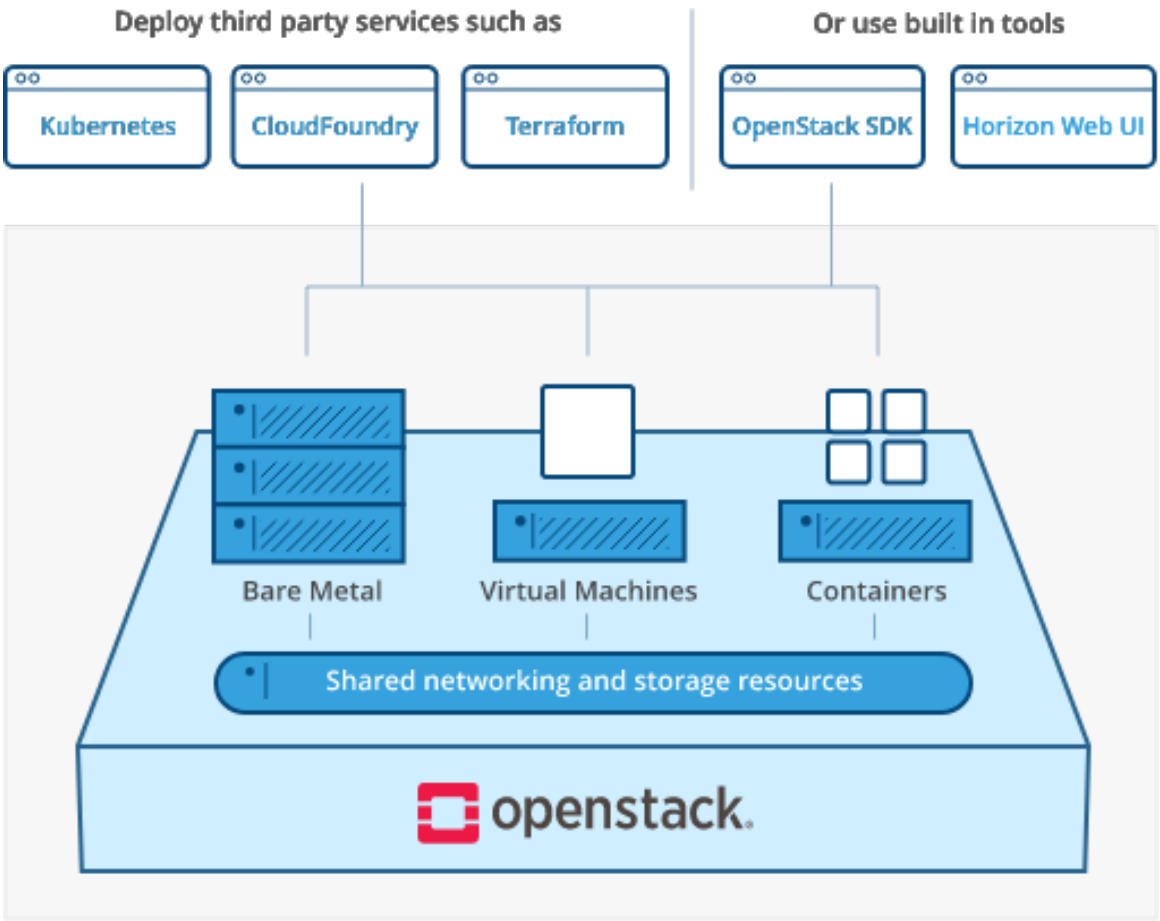
Topic: Implementation of Private Cloud using OpenStack

- **Exploring OpenStack Middleware**

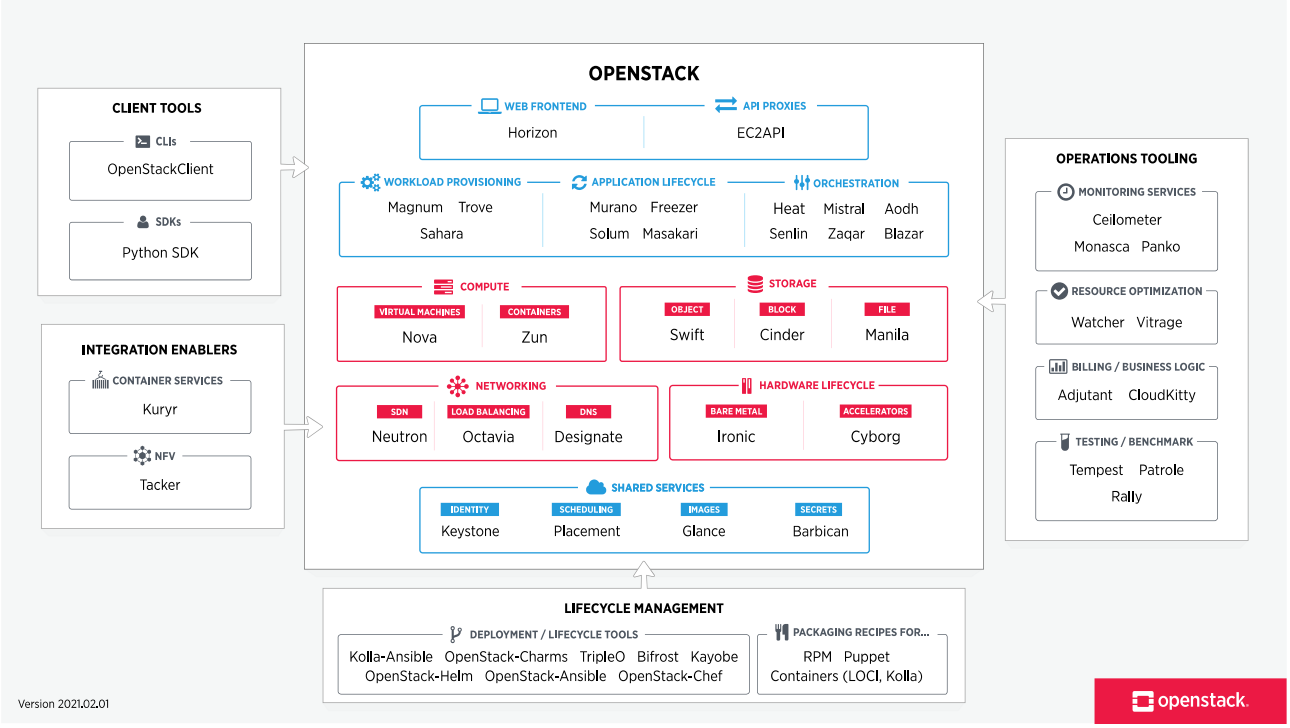
OpenStack is an open source cloud computing platform that is used by organizations to manage and control large scale deployments of virtual machines, such as in a cloud computing or virtual private server environment. OpenStack is a popular choice for organizations because it is scalable, reliable, and provides a high degree of control over the underlying infrastructure.

- **Components of OpenStack**

Beyond standard infrastructure-as-a-service functionality, additional components provide orchestration, fault & service management, and other services to ensure high availability of user applications.



OpenStack is broken up into services to allow you to plug and play components depending on your needs. The OpenStack map below shows common services and how they fit together.



some of the more common OpenStack services do.

Object Storage: OpenStack Object Storage (Swift) is a highly scalable, distributed object storage system.

Compute: OpenStack Compute (Nova) is a cloud computing fabric controller, which manages the allocation of compute resources.

Networking: OpenStack Networking (Neutron) is a system for managing networks and IP addresses.

Dashboard: The OpenStack Dashboard (Horizon) is a web-based interface for managing OpenStack resources.

Identity: OpenStack Identity (Keystone) is a system for managing user accounts and access control.

Image: OpenStack Image (Glance) is a service for storing and retrieving virtual machine images.

Block Storage: OpenStack Block Storage (Cinder) is a service for managing block storage devices.

Telemetry: OpenStack Telemetry (Ceilometer) is a service for collecting and storing metering data.

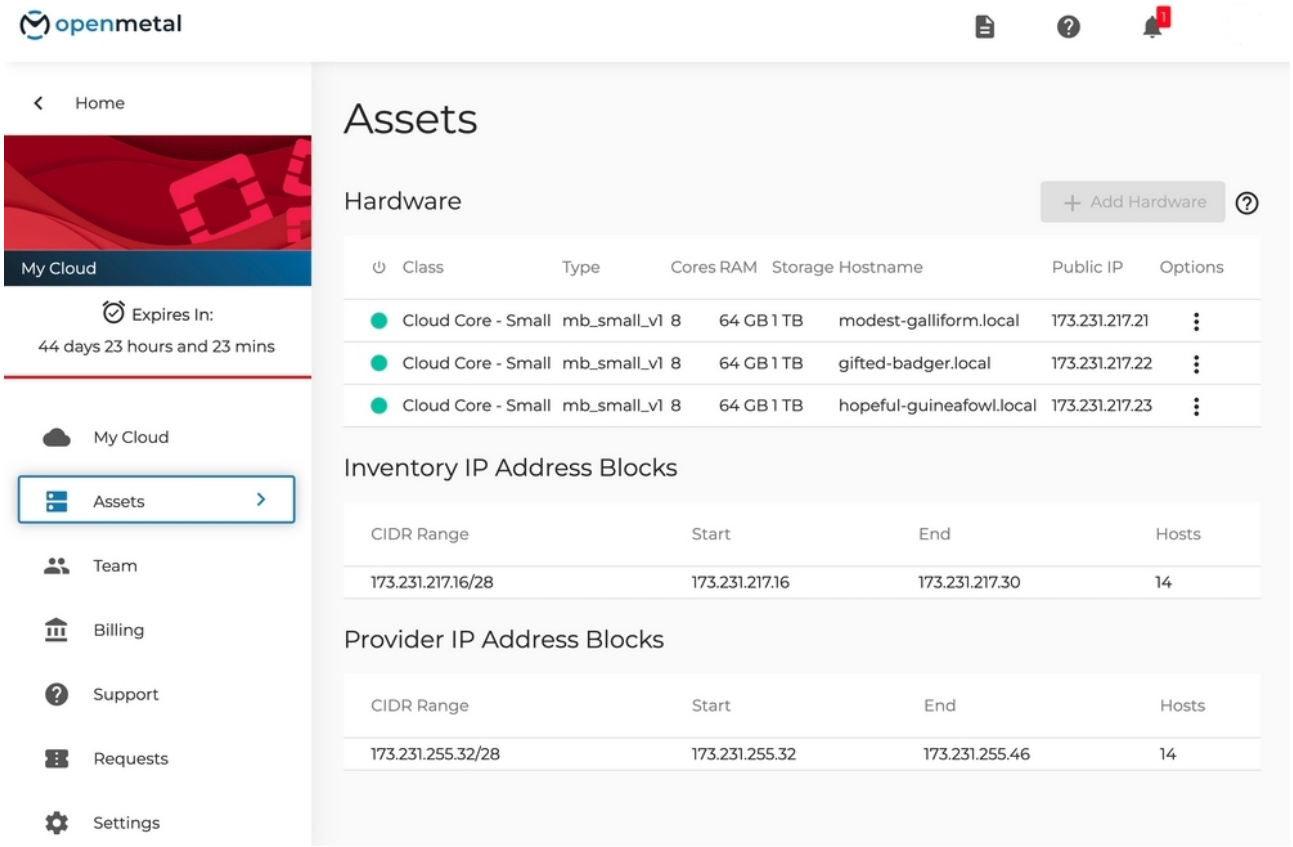
Orchestration: OpenStack Orchestration (Heat) is a service for orchestration and cloud formation.

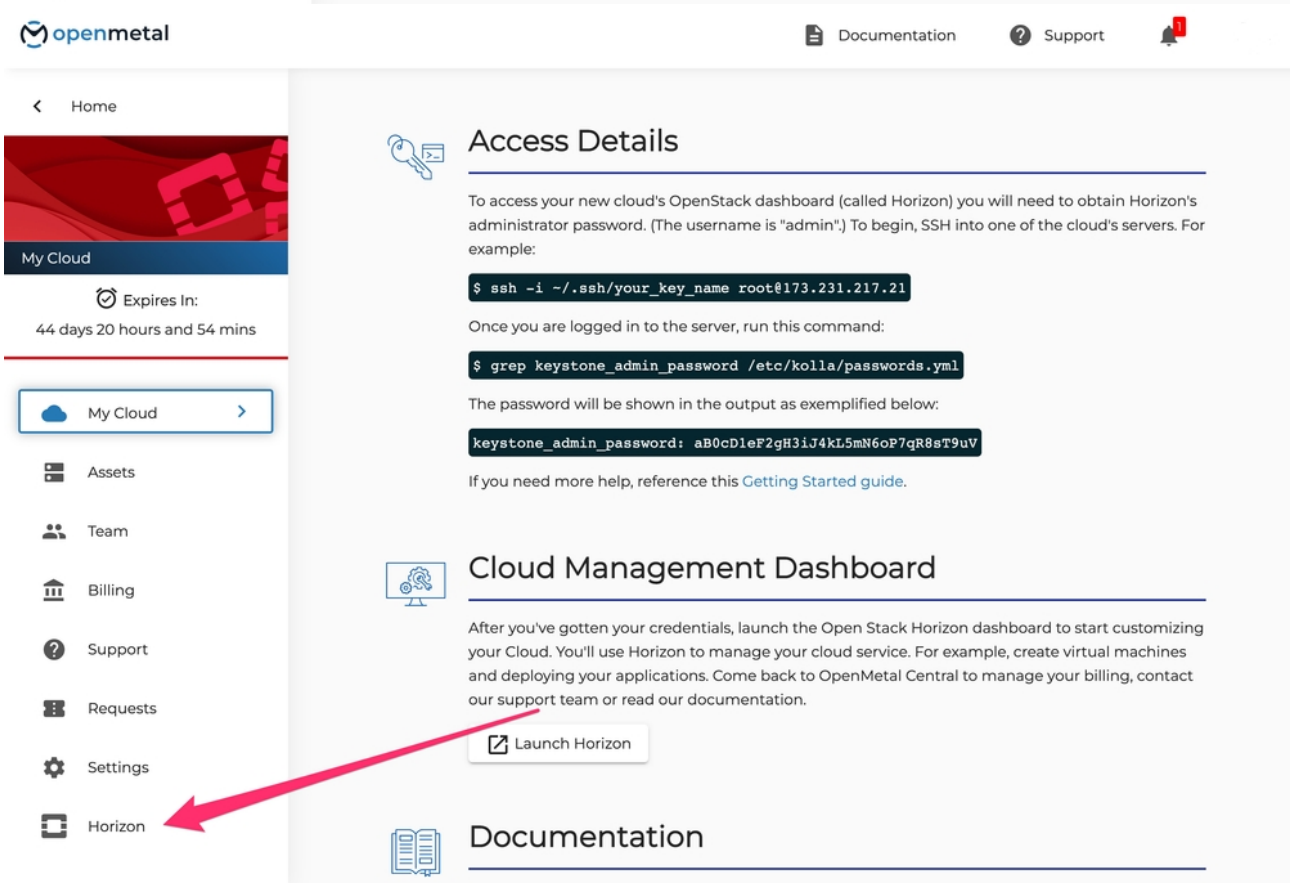
Bare Metal: OpenStack Bare Metal (Ironic) is a service for provisioning and managing bare metal servers.

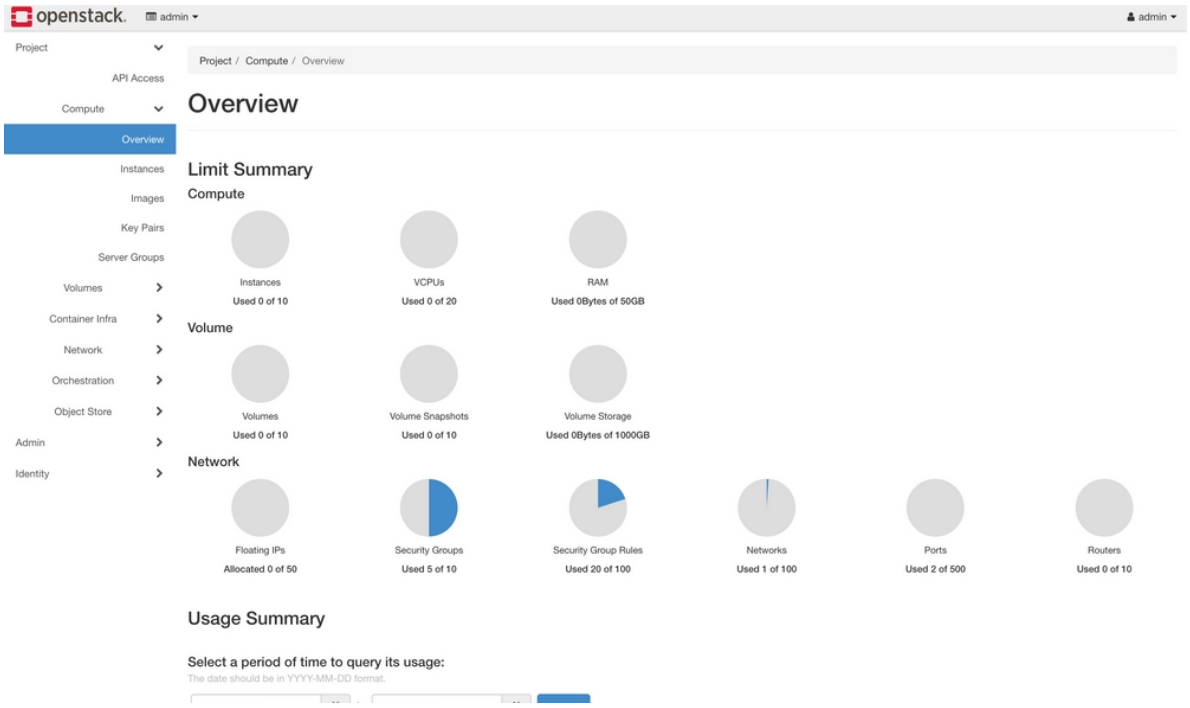
Data Processing: OpenStack Data Processing (Sahara) is a service for provisioning and managing Hadoop and Spark clusters.

- **Installation and Configuration of OpenStack Middleware on Virtual Machines using Oracle VirtualBox/ VMware Workstation. (Screen Shots) Creating Virtual Machine Instance in Dashboard**

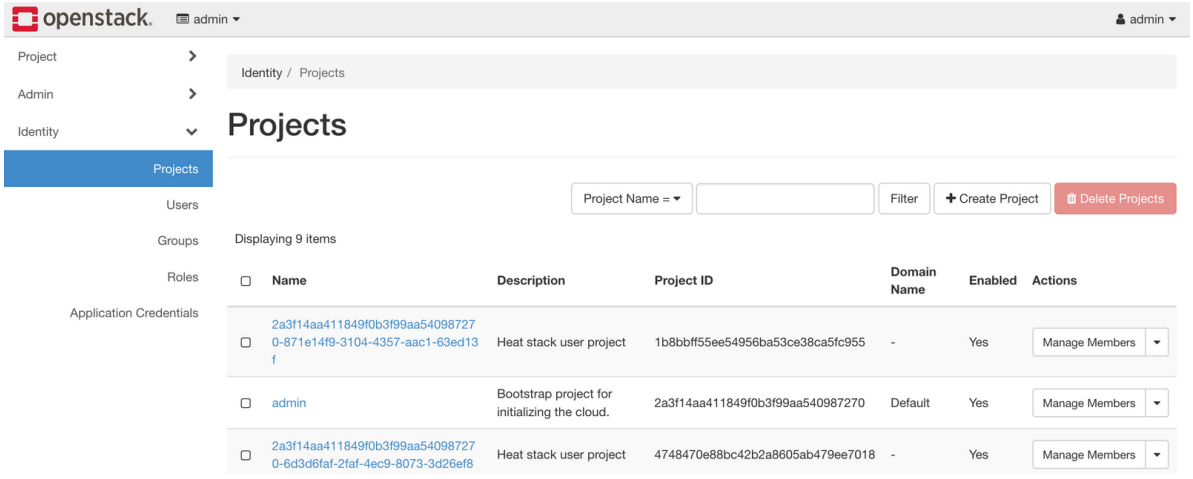
Setting Up OpenStack on OpenMetal

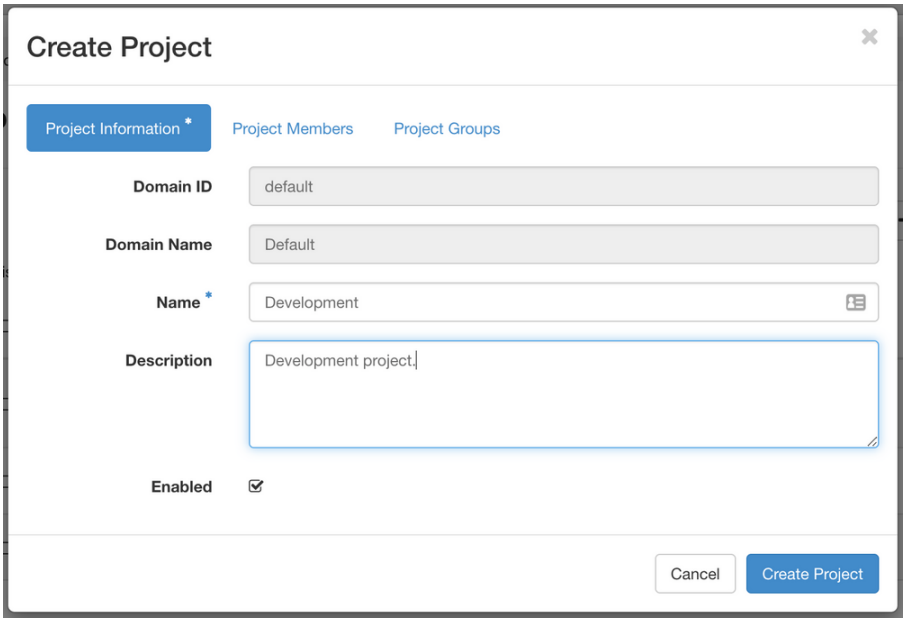


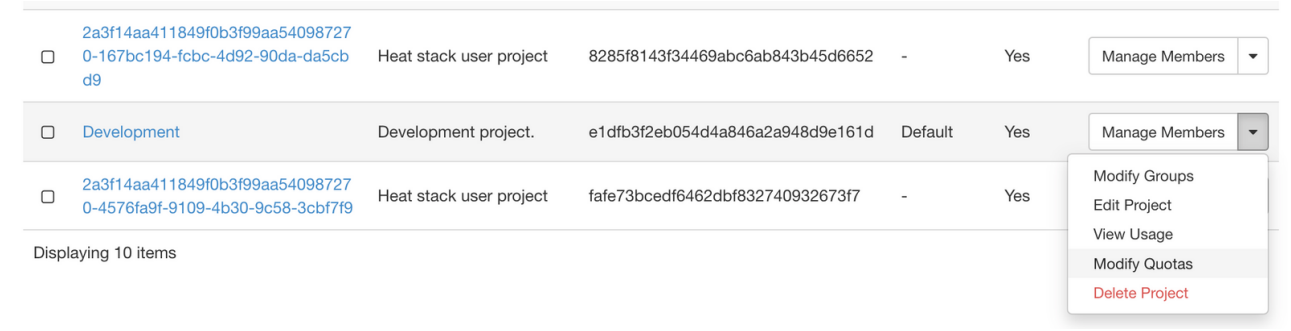


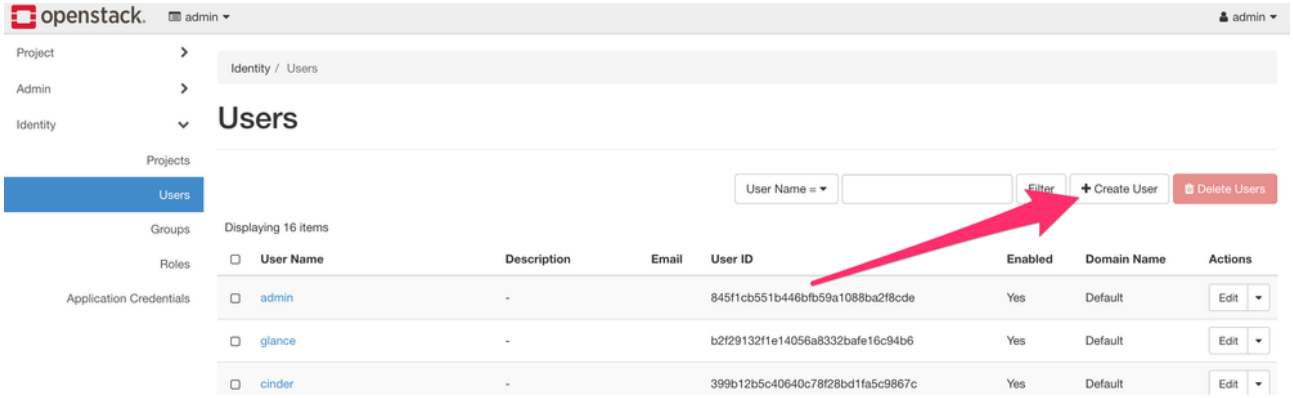


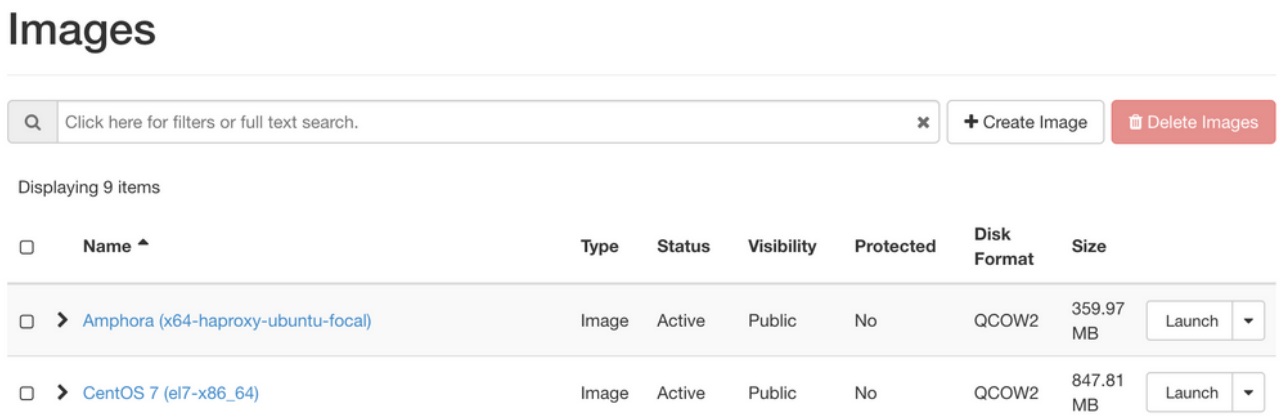
Create a Project in OpenStack Horizon

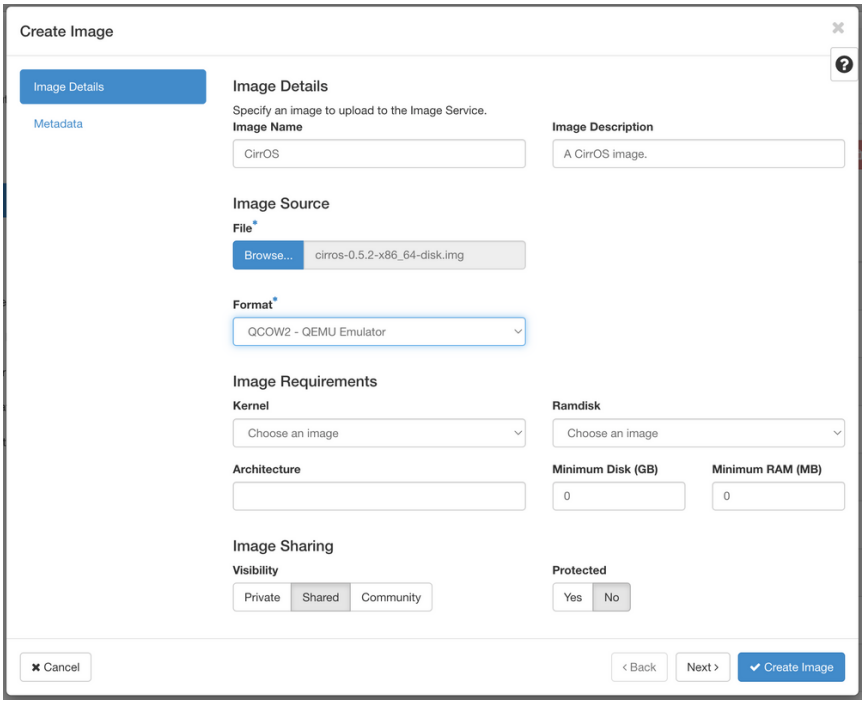


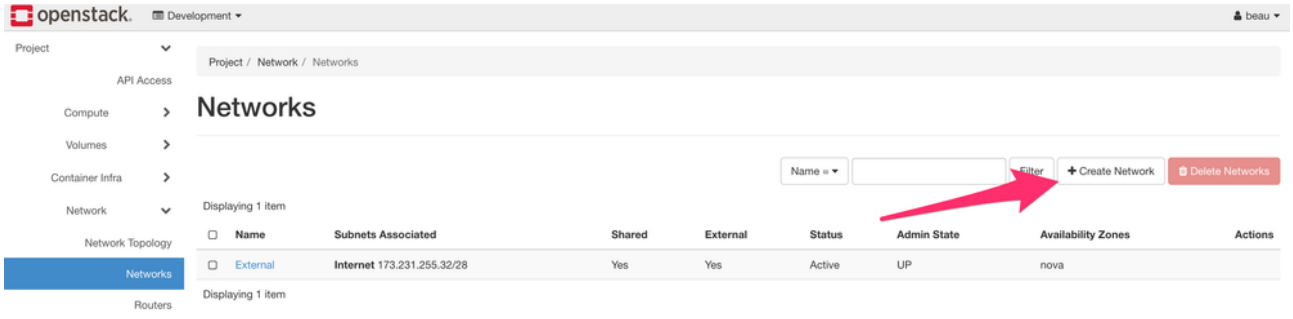


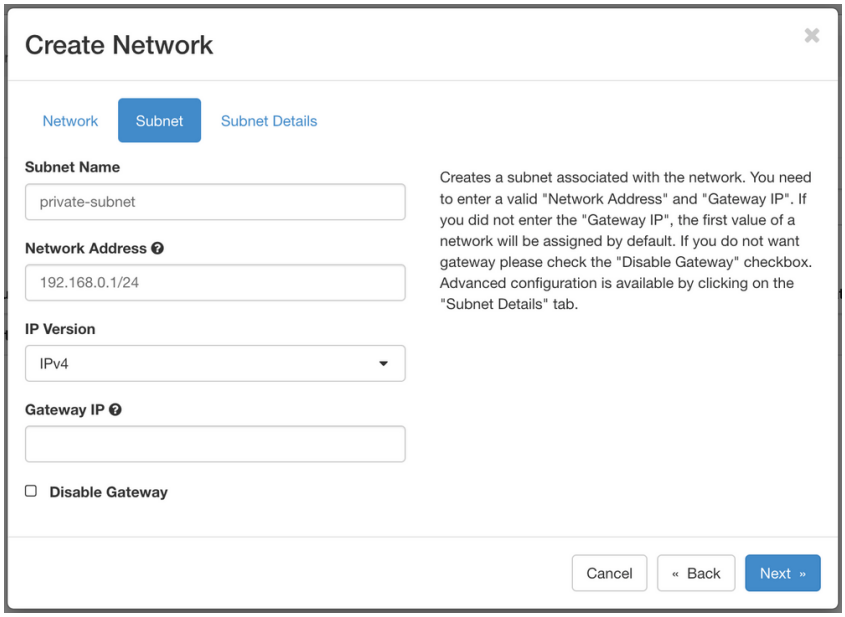

2a3f14aa411849f0b3f99aa540987270-167bc194-fcbc-4d92-90da-da5cbd9
Heat stack user project
8285f8143f34469abc6ab843b45d6652
-
Yes
Manage Members
Development
Development project.
e1dfb3f2eb054d4a846a2a948d9e161d
Default
Yes
Manage Members
2a3f14aa411849f0b3f99aa540987270-4576fa9f-9109-4b30-9c58-3cbf7f9
Heat stack user project
fafe73bcedf6462dbf832740932673f7
-
Yes
Displaying 10 items
Modify Groups
Edit Project
View Usage
Modify Quotas
Delete Project

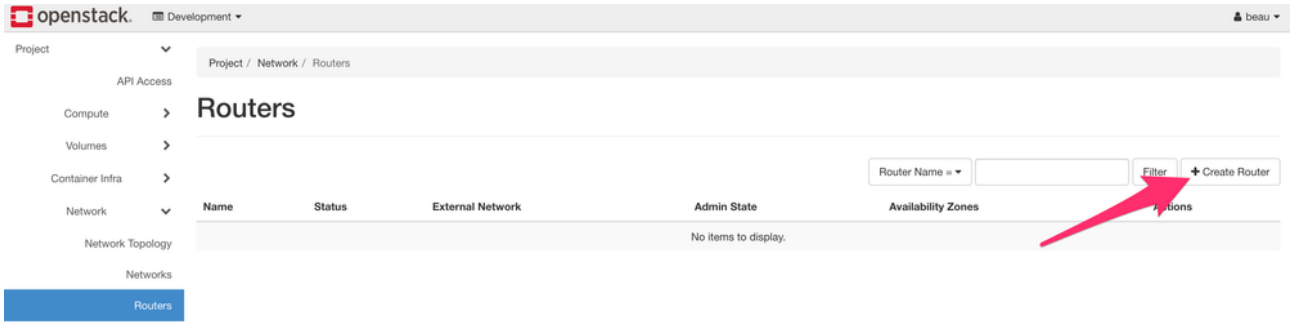

openstack.
admin
admin
Project
Admin
Identity
Projects
Users
Groups
Roles
Application Credentials
Identity / Users
Users
User Name =
Filter
+ Create User
Delete Users
Displaying 16 items
User Name
Description
Email
User ID
Enabled
Domain Name
Actions
admin
845f1cb551b446bfb59a1088ba2f8cde
Yes
Default
Edit
glance
b2f29132f1e14056a8332bafe16c94b6
Yes
Default
Edit
cinder
399b12b5c40640c78f28bd1fa5c9867c
Yes
Default
Edit

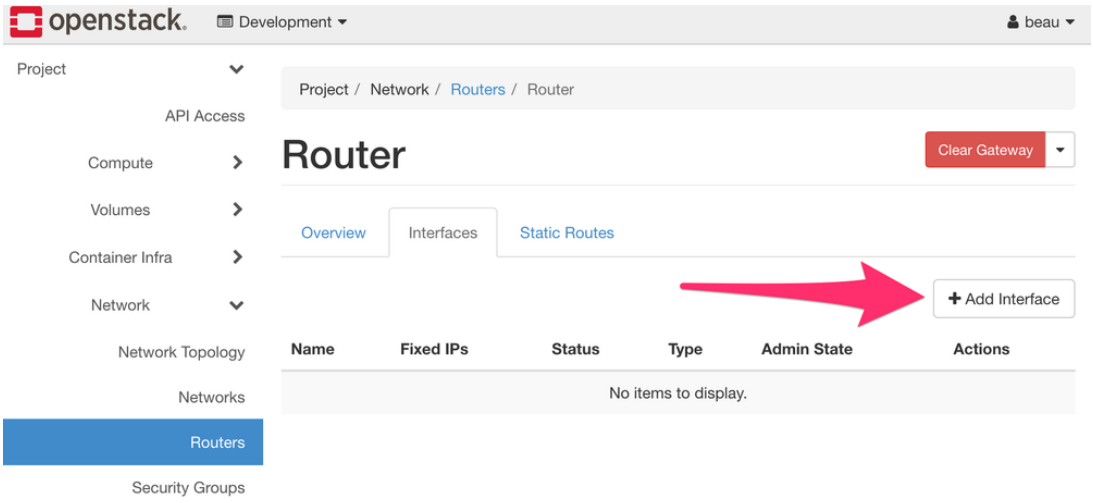

Images
Click here for filters or full text search.
+ Create Image
Delete Images
Displaying 9 items
Name
Type
Status
Visibility
Protected
Disk Format
Size
Amphora (x64-haproxy-ubuntu-focal)
Image
Active
Public
No
QCOW2
359.97 MB
Launch
CentOS 7 (el7-x86_64)
Image
Active
Public
No
QCOW2
847.81 MB
Launch

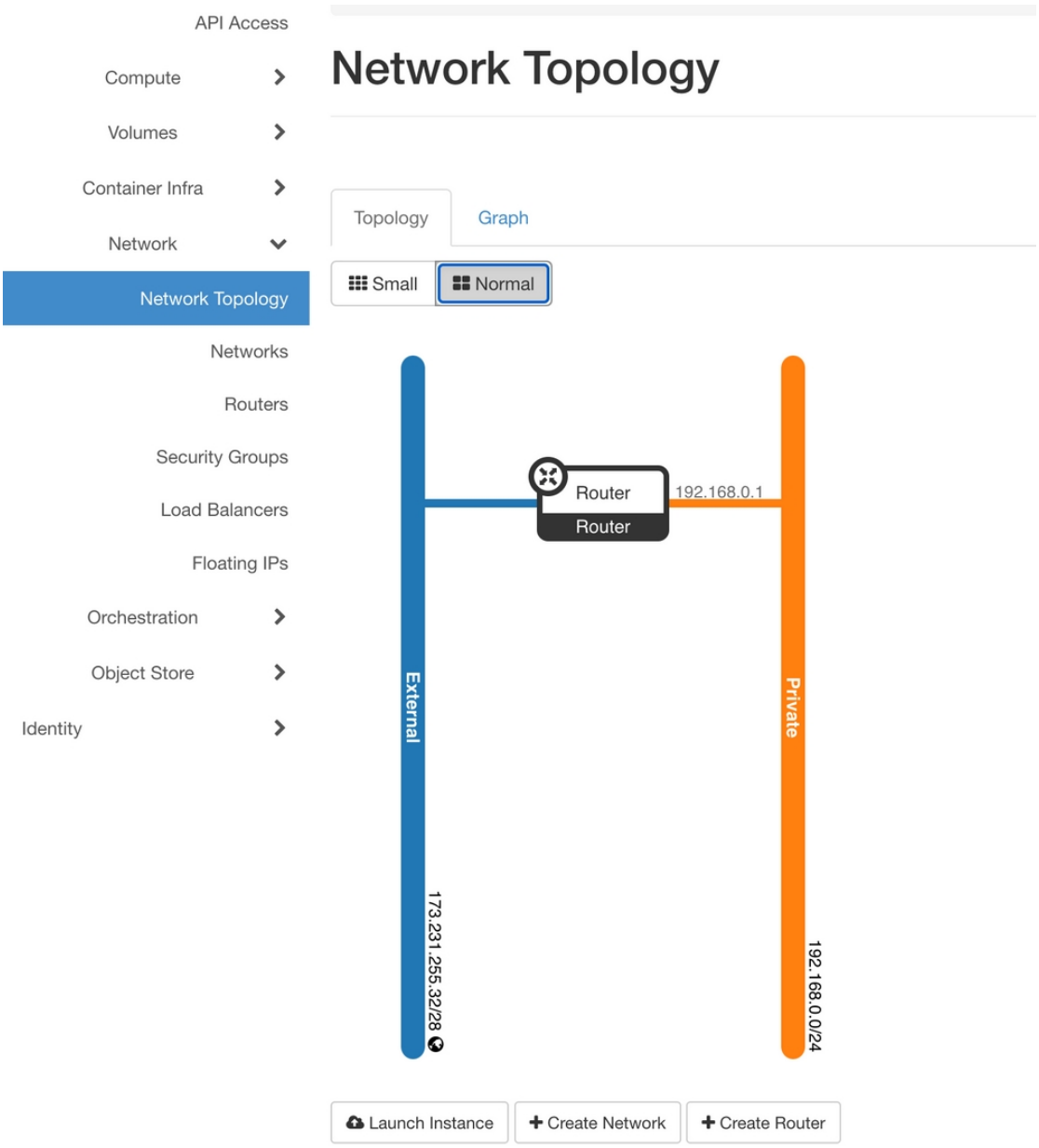

Create Image
Image Details
Metadata
Image Details
Specify an image to upload to the Image Service.
Image Name
CirrOS
Image Description
A CirrOS image.
Image Source
File*
Browse...
cirros-0.5.2-x86_64-disk.img
Format*
QCOW2 - QEMU Emulator
Image Requirements
Kernel
Choose an image
Ramdisk
Choose an image
Architecture
Minimum Disk (GB)
0
Minimum RAM (MB)
0
Image Sharing
Visibility
Private
Shared
Community
Protected
Yes
No
Cancel
Back
Next
Create Image

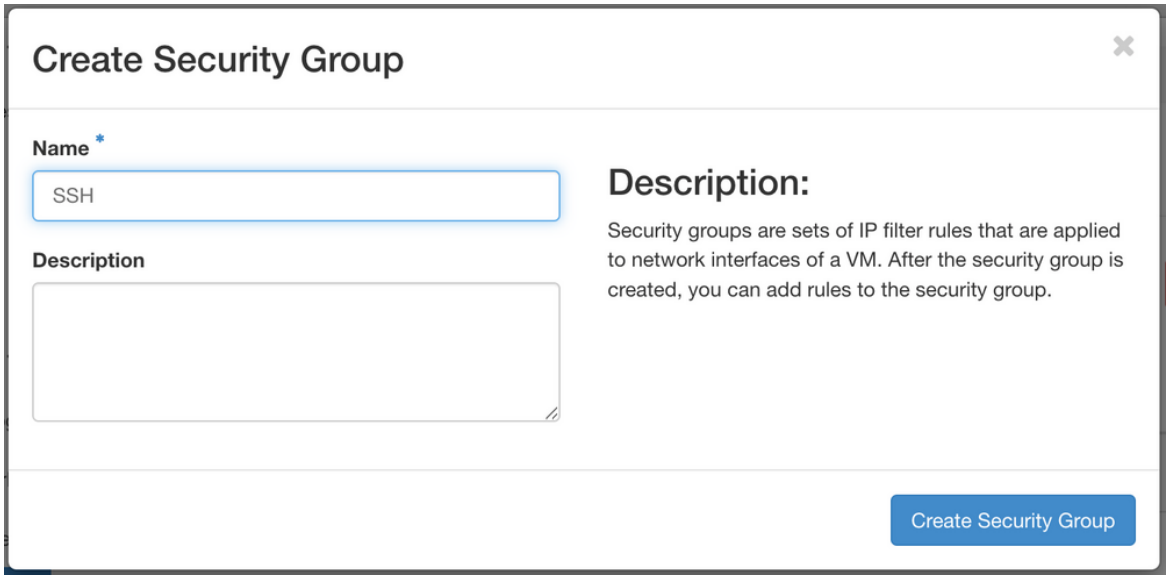

openstack.
Development
beau
Project
API Access
Compute
Volumes
Container Infra
Network
Network Topology
Networks
Routers
Project / Network / Networks
Networks
Name =
Filter
+ Create Network
Delete Networks
Displaying 1 item
Name
Subnets Associated
Shared
External
Status
Admin State
Availability Zones
Actions
External
Internet 173.231.255.32/28
Yes
Yes
Active
UP
nova
Displaying 1 item

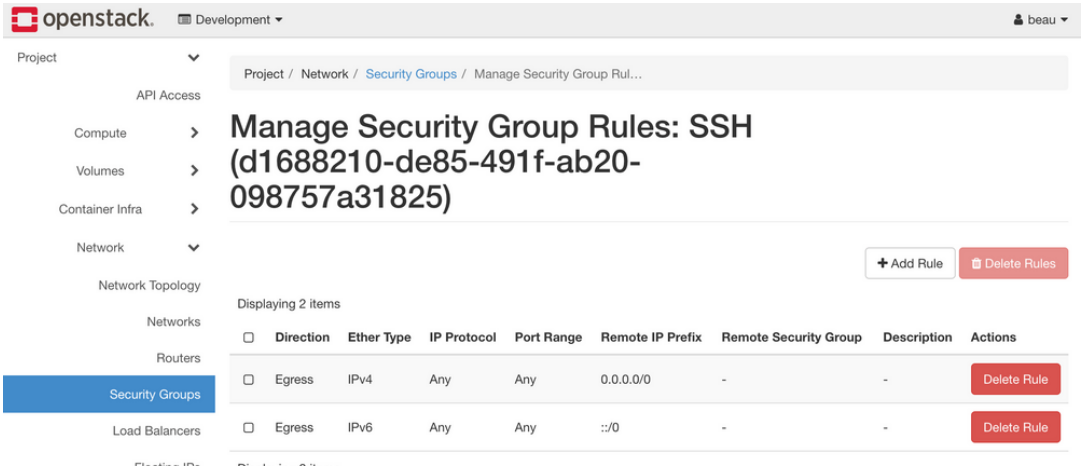

Create Network
Network
Subnet
Subnet Details
Subnet Name
private-subnet
Network Address
192.168.0.1/24
IP Version
IPv4
Gateway IP
Disable Gateway
Creates a subnet associated with the network. You need to enter a valid "Network Address" and "Gateway IP". If you did not enter the "Gateway IP", the first value of a network will be assigned by default. If you do not want gateway please check the "Disable Gateway" checkbox. Advanced configuration is available by clicking on the "Subnet Details" tab.
Cancel
« Back
Next »

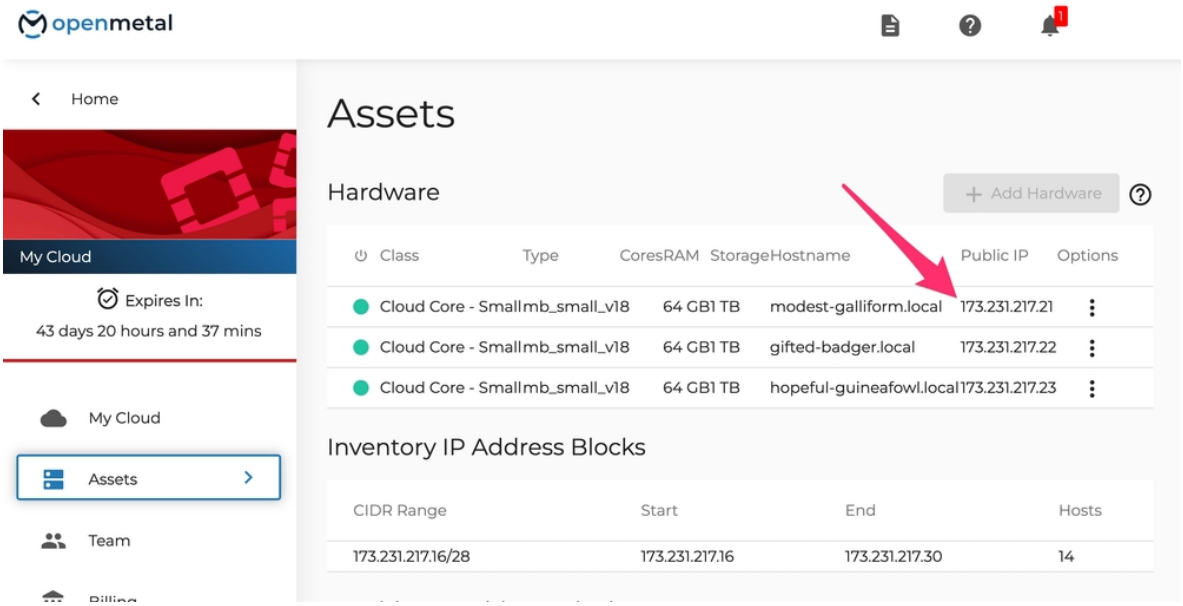

openstack.
Development
beau
Project
API Access
Compute
Volumes
Container Infra
Network
Network Topology
Networks
Routers
Project / Network / Routers
Routers
Router Name =
Filter
+ Create Router
Name
Status
External Network
Admin State
Availability Zones
Actions
No items to display.

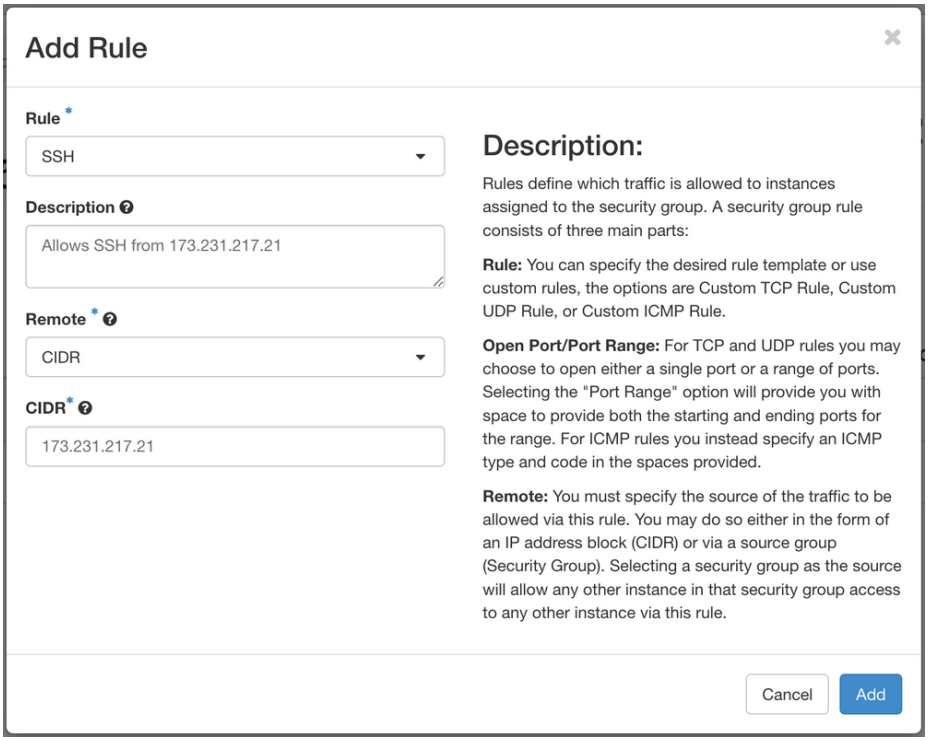

openstack.
Development
beau
Project
API Access
Compute
Volumes
Container Infra
Network
Network Topology
Networks
Routers
Security Groups
Project / Network / Routers / Router
Router
Clear Gateway
Overview
Interfaces
Static Routes
+ Add Interface
Name
Fixed IPs
Status
Type
Admin State
Actions
No items to display.

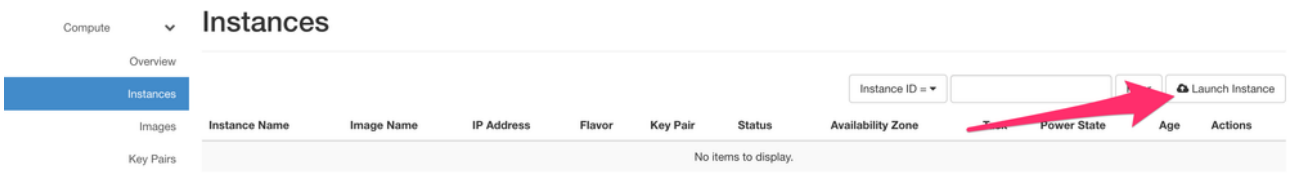

API Access
Compute
Volumes
Container Infra
Network
Network Topology
Networks
Routers
Security Groups
Load Balancers
Floating IPs
Orchestration
Object Store
Identity
Network Topology
Topology
Graph
Small
Normal
Router
Router
192.168.0.1
External
Private
173.231.255.32/28
192.168.0.0/24
Launch Instance
+ Create Network
+ Create Router

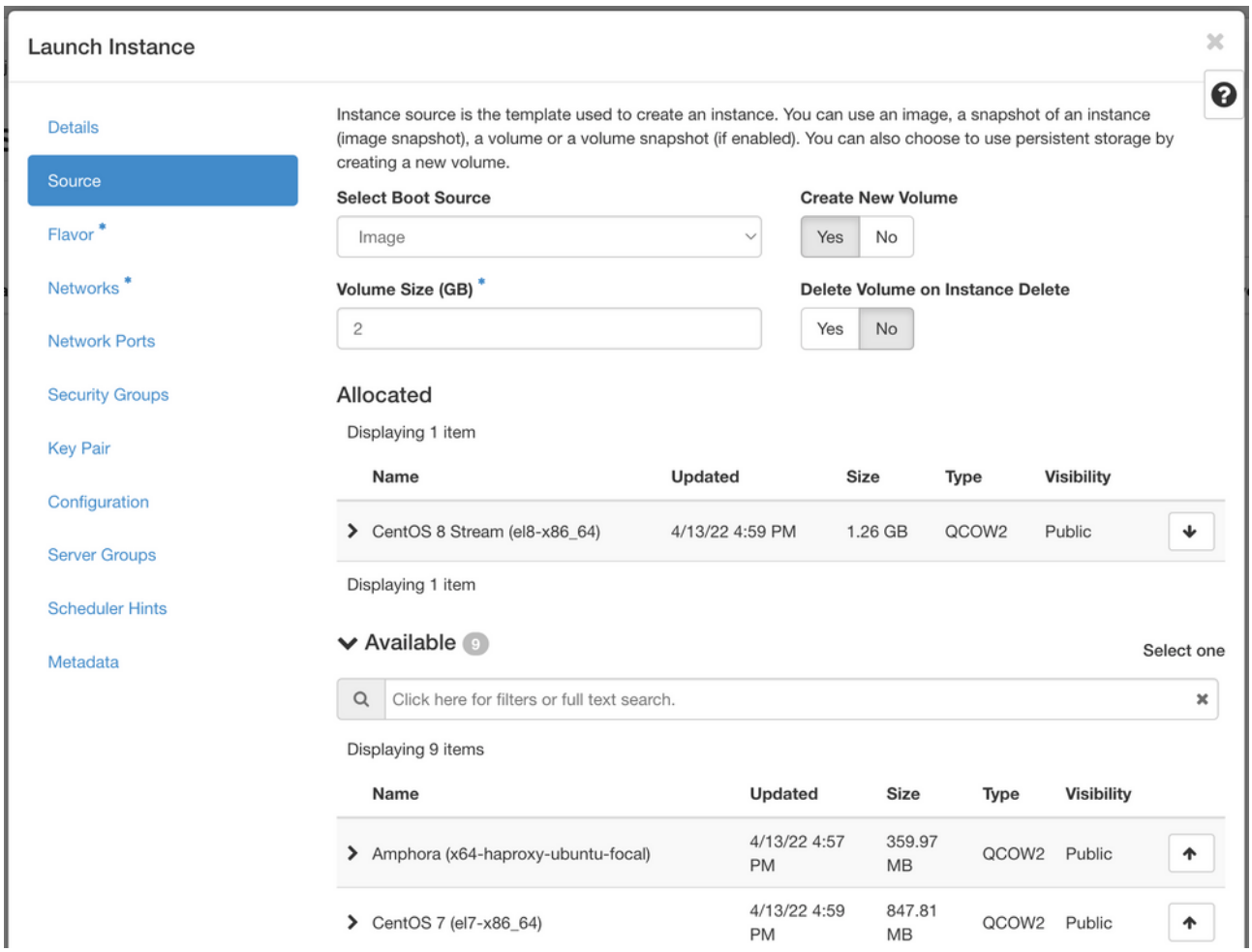

Create Security Group
Name *
SSH
Description
Description:
Security groups are sets of IP filter rules that are applied to network interfaces of a VM. After the security group is created, you can add rules to the security group.
Create Security Group

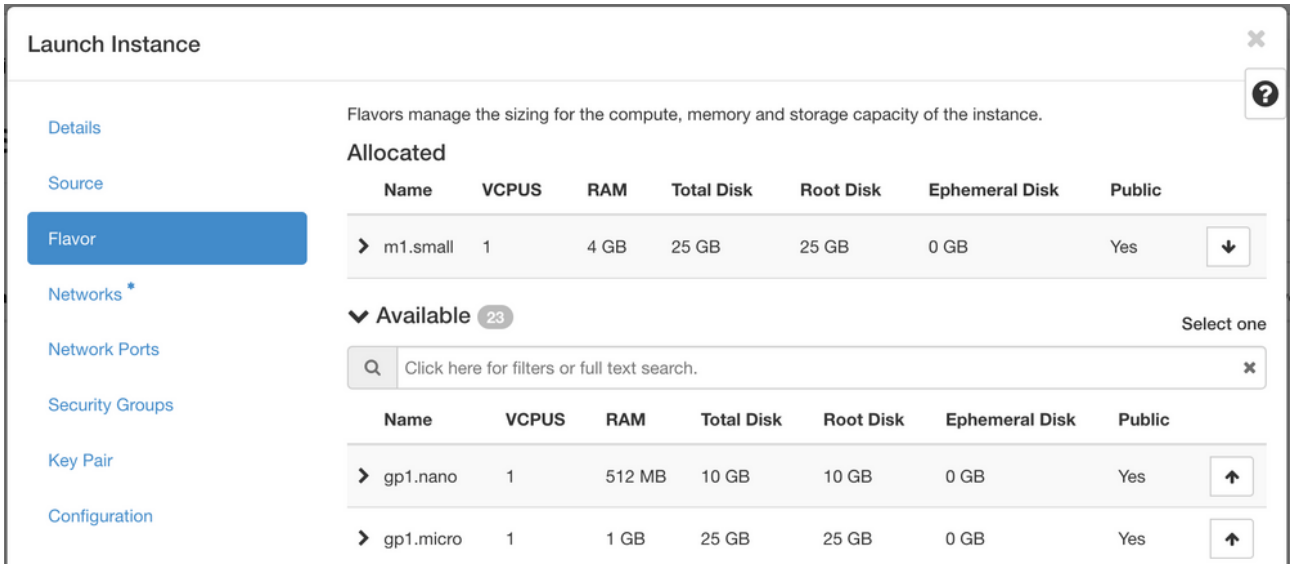

openstack
Development
beau
Project
API Access
Compute
Volumes
Container Infra
Network
Network Topology
Networks
Routers
Security Groups
Load Balancers
Project / Network / Security Groups / Manage Security Group Rul...
Manage Security Group Rules: SSH (d1688210-de85-491f-ab20-098757a31825)
+ Add Rule
Delete Rules
Displaying 2 items
Direction
Ether Type
IP Protocol
Port Range
Remote IP Prefix
Remote Security Group
Description
Actions
Egress
IPv4
Any
Any
0.0.0.0/0
-
-
Delete Rule
Egress
IPv6
Any
Any
::/0
-
-
Delete Rule

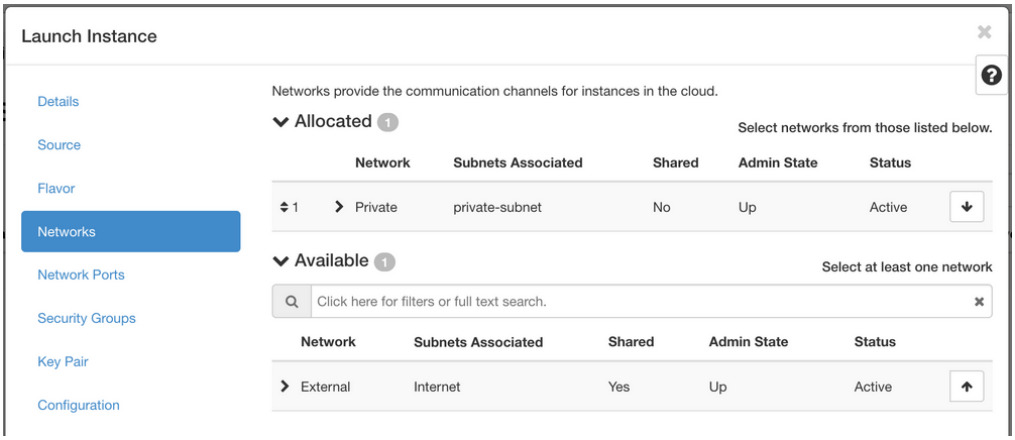

openmetal
Home
My Cloud
Expires In:
43 days 20 hours and 37 mins
My Cloud
Assets
Team
Assets
Hardware
+ Add Hardware
Class
Type
Cores
RAM
Storage
Hostname
Public IP
Options
Cloud Core - Small
mb_small_v18
64 GB
1 TB
modest-galliform.local
173.231.217.21
Cloud Core - Small
mb_small_v18
64 GB
1 TB
gifted-badger.local
173.231.217.22
Cloud Core - Small
mb_small_v18
64 GB
1 TB
hopeful-guineafowl.local
173.231.217.23
Inventory IP Address Blocks
CIDR Range
Start
End
Hosts
173.231.217.16/28
173.231.217.16
173.231.217.30
14

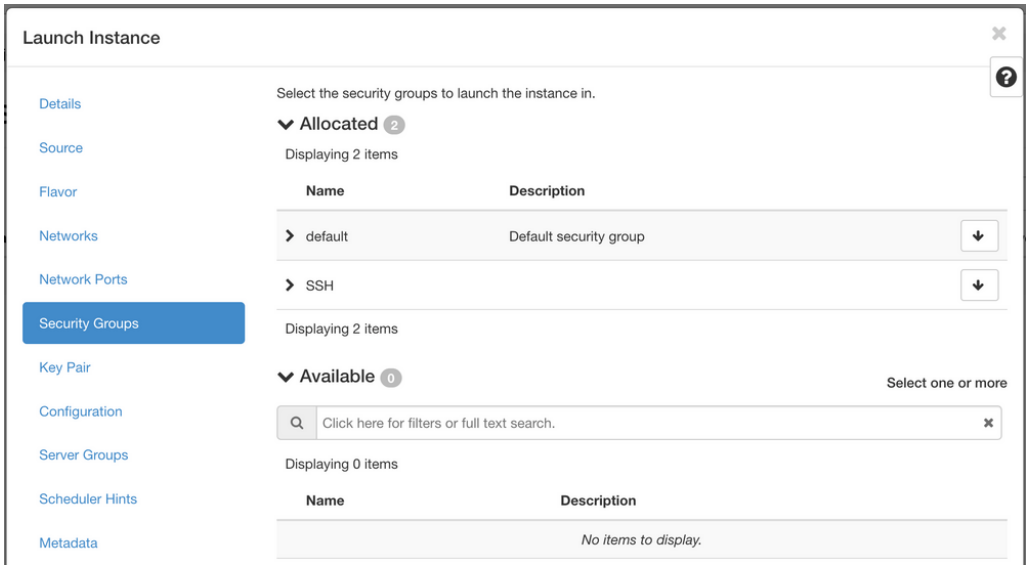

Add Rule
Rule *
SSH
Description
Allows SSH from 173.231.217.21
Remote *
CIDR
CIDR*
173.231.217.21
Description:
Rules define which traffic is allowed to instances assigned to the security group. A security group rule consists of three main parts:
Rule: You can specify the desired rule template or use custom rules, the options are Custom TCP Rule, Custom UDP Rule, or Custom ICMP Rule.
Open Port/Port Range: For TCP and UDP rules you may choose to open either a single port or a range of ports. Selecting the "Port Range" option will provide you with space to provide both the starting and ending ports for the range. For ICMP rules you instead specify an ICMP type and code in the spaces provided.
Remote: You must specify the source of the traffic to be allowed via this rule. You may do so either in the form of an IP address block (CIDR) or via a source group (Security Group). Selecting a security group as the source will allow any other instance in that security group access to any other instance via this rule.
Cancel
Add

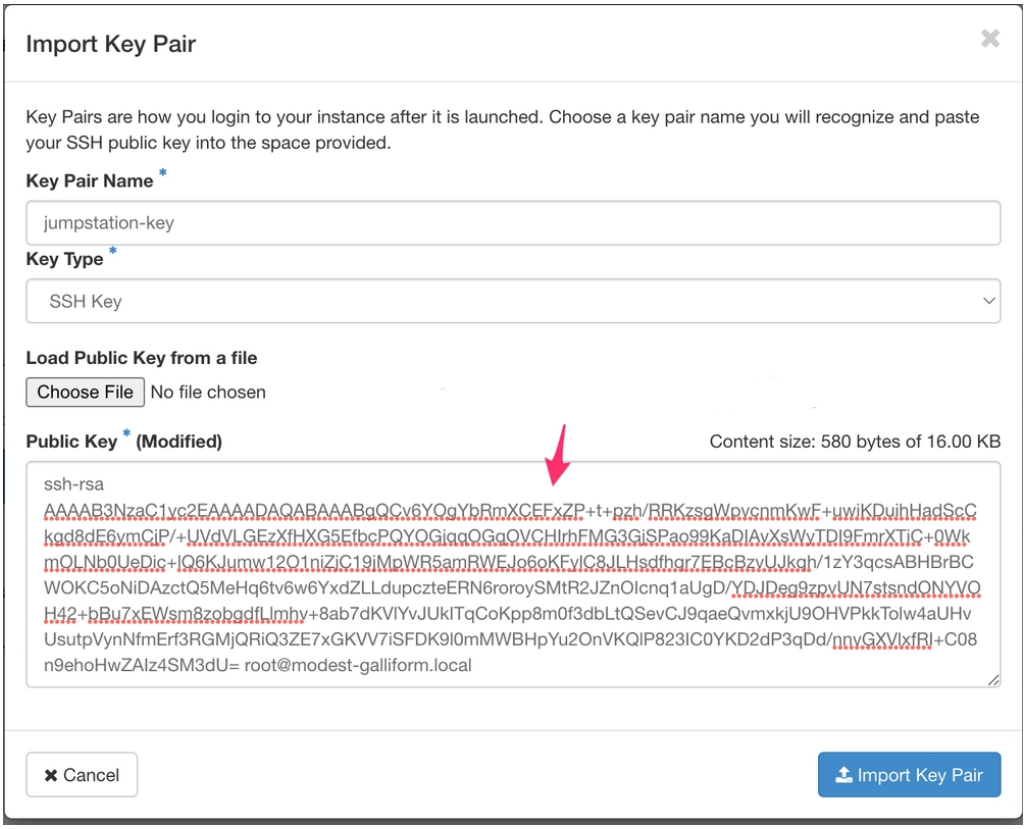

Compute
Overview
Instances
Images
Key Pairs
Instances
Instance ID =
Launch Instance
Instance Name
Image Name
IP Address
Flavor
Key Pair
Status
Availability Zone
Power State
Age
Actions
No items to display.

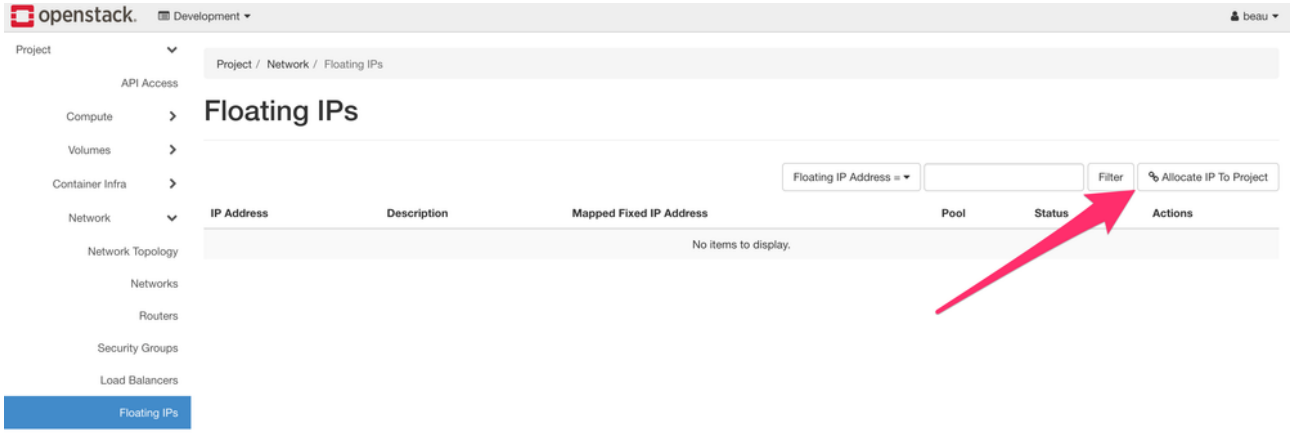

Launch Instance
Details
Source
Flavor *
Networks *
Network Ports
Security Groups
Key Pair
Configuration
Server Groups
Scheduler Hints
Metadata
Instance source is the template used to create an instance. You can use an image, a snapshot of an instance (image snapshot), a volume or a volume snapshot (if enabled). You can also choose to use persistent storage by creating a new volume.
Select Boot Source
Image
Create New Volume
Yes
No
Volume Size (GB) *
2
Delete Volume on Instance Delete
Yes
No
Allocated
Displaying 1 item
Name
Updated
Size
Type
Visibility
CentOS 8 Stream (el8-x86_64)
4/13/22 4:59 PM
1.26 GB
QCOW2
Public
Displaying 1 item
Available 9
Select one
Click here for filters or full text search.
Displaying 9 items
Name
Updated
Size
Type
Visibility
Amphora (x64-haproxy-ubuntu-focal)
4/13/22 4:57 PM
359.97 MB
QCOW2
Public
CentOS 7 (el7-x86_64)
4/13/22 4:59 PM
847.81 MB
QCOW2
Public


Launch Instance
Details
Source
Flavor
Networks *
Network Ports
Security Groups
Key Pair
Configuration
Flavors manage the sizing for the compute, memory and storage capacity of the instance.
Allocated
Name
VCPUS
RAM
Total Disk
Root Disk
Ephemeral Disk
Public
m1.small
1
4 GB
25 GB
25 GB
0 GB
Yes
Available 23
Select one
Click here for filters or full text search.
Name
VCPUS
RAM
Total Disk
Root Disk
Ephemeral Disk
Public
gp1.nano
1
512 MB
10 GB
10 GB
0 GB
Yes
gp1.micro
1
1 GB
25 GB
25 GB
0 GB
Yes


Launch Instance
Details
Source
Flavor
Networks
Network Ports
Security Groups
Key Pair
Configuration
Networks provide the communication channels for instances in the cloud.
Allocated 1
Select networks from those listed below.
Network
Subnets Associated
Shared
Admin State
Status
1
Private
private-subnet
No
Up
Active
Available 1
Select at least one network
Click here for filters or full text search.
Network
Subnets Associated
Shared
Admin State
Status
External
Internet
Yes
Up
Active


Launch Instance
Details
Source
Flavor
Networks
Network Ports
Security Groups
Key Pair
Configuration
Server Groups
Scheduler Hints
Metadata
Select the security groups to launch the instance in.
Allocated 2
Displaying 2 items
Name
Description
default
Default security group
SSH
Displaying 2 items
Available 0
Select one or more
Click here for filters or full text search.
Displaying 0 items
Name
Description
No items to display.


Import Key Pair
Key Pairs are how you login to your instance after it is launched. Choose a key pair name you will recognize and paste your SSH public key into the space provided.
Key Pair Name *
jumpstation-key
Key Type *
SSH Key
Load Public Key from a file
Choose File
No file chosen
Public Key * (Modified)
Content size: 580 bytes of 16.00 KB
ssh-rsa
AAAAB3NzaC1yc2EAAAADAQABAAABgQCv6YOgYbRmXCEFxZP+t+pzh/RRKzsgWpvcnmKwF+uwiKDuihHadScC
kqd8dE6vmCiP/+UVdVLGEzXfHXG5EfbcPQYOGiqqOGqOVCHlrhFMG3GiSPao99KaDIAvXsWvTDI9FmrXTiC+0Wk
mOLNb0UeDic+lQ6KJumw12O1niZiC19iMpWR5amRWEJo6oKFvlC8JLHsdfhqr7EBcBzvUJkqh/1zY3qcsABHBrBC
WOKC5oNiDAzctQ5MeHq6tv6w6YxdZLLdupczteERN6roroySMtR2JZnOIcnq1aUgD/YDJDeg9zpvUN7stsndQNYVO
H42+bBu7xEWsm8zobgdfLlmhy+8ab7dKVlYvJUkITqCoKpp8m0f3dbLtQSevCJ9qaeQvmxkjU9OHVPkkTolw4aUHv
UsutpVynNfmErf3RGMjQRiQ3ZE7xGKVV7iSFDK9l0mMWBHpYu2OnVKQlP823IC0YKD2dP3qDd/nnvGXVlxfRl+C08
n9ehoHwZAlz4SM3dU= root@modest-galliform.local
Cancel
Import Key Pair

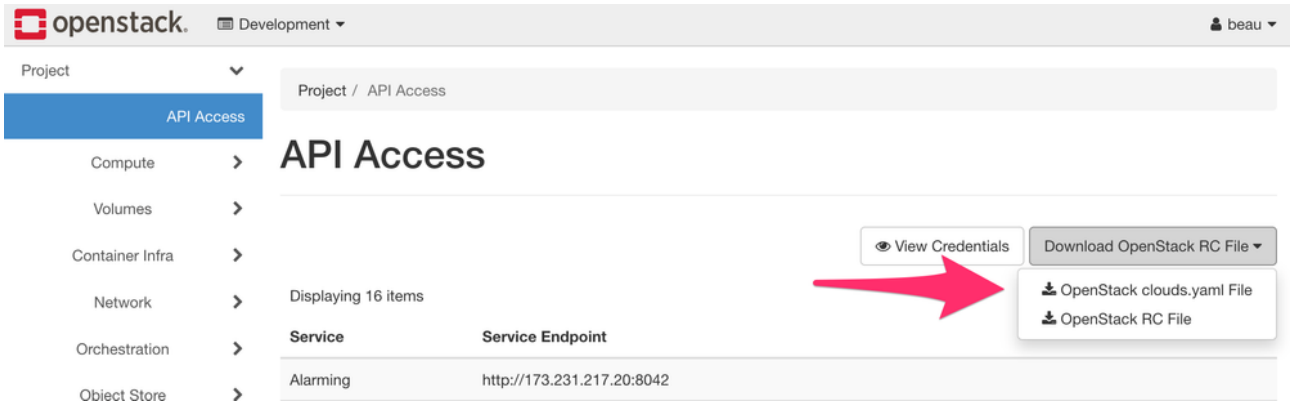


Displaying 1 item

	IP Address	Description	Mapped Fixed IP Address	Pool	Status	Actions
☐	173.231.255.40		-	External	Down	Associate

Displaying 1 item

- **Exploring OpenStack APIs.**



https://docs.openstack.org/api-quick-start/

OpenStack API Documentation

Use the OpenStack APIs to launch server instances, create images, assign metadata to instances and images, create storage containers and objects, and complete other actions in your OpenStack cloud.

Note

The links below are grouped according to the API status that reflects the state of the endpoint on the service.

- 'Current' indicates a stable version that is up-to-date, recent, and might receive future versions. This endpoint should be prioritized over all others.
- 'Supported' is a stable version that is available on the server. However, it is not likely the most recent available and might not be updated or might be deprecated at some time in the future.
- 'Deprecated' is a stable version that is still available but is being deprecated and might be removed in the future.
- 'Experimental' is not a stable version. This version is under development or contains features that are otherwise subject to change.

For more information about API status values and version information, see Version Discovery.

The notation '(microversions)' next to the link to an API reference indicates that the API follows a pattern established by the Compute service to enable small, documented changes to the API on a resource-by-resource basis.

Current API versions

Acceleration API v2

Admin Logic API

Application Catalog API v1

Application Container Service API (microversions)

Backup API v1

Bare Metal API v1 (microversions)

Block Storage API v3 (microversions)

> **Note**
>
> The Block Storage API v3 is functionally identical to the Block Storage API v2. Subsequent API v3 microversions, such as v3.1, differ from API v2.

Clustering API v1

Compute API (microversions)

Container Infrastructure Management API (microversions)

Data Processing v1.1

Data Protection Orchestration v1

Database Service API v1.0

Domain Name Server (DNS) API v2

EC2 API Service

Function Engine

Identity API v3

Identity API v3 extensions

Image service API v2

Key Manager API v1

Load Balancer API v2

Messaging API v2

Networking API v2.0

NFV Orchestration API v1.0

Object Storage API v1

Orchestration API v1

Placement API (microversions)

Resource Optimization API v1

Search API v1

Shared File Systems API v2 (microversions)

> **Note**
>
> The Shared File Systems API v1 is functionally identical to the Shared File Systems API v2. Subsequent API v2 microversions, such as v2.1, differ from API v1.

Supported API versions

Deprecated API versions

Block Storage API v2

> **Note**
>
> The Block Storage API v3 is functionally identical to the Block Storage API v2. Subsequent API v3 microversions, such as v3.1, differ from API v2.

Identity API v2.0 extensions

API quick-start examples

With the TryStack OpenStack installation, these services work together in the background of the installation, and many of these examples work on TryStack.

After you authenticate through Identity, you can use the other OpenStack APIs to create and manage resources in your OpenStack cloud. You can launch instances from images and assign metadata to instances through the Compute API or the **openstack** command-line client.

To begin sending API requests, use one of the following methods:

- **cURL**

  A command-line tool that lets you send HTTP requests and receive responses. See the section called OpenStack APIs.

- **OpenStack command-line client**

  The OpenStack project provides a command-line client that enables you to access APIs through easy-to-use commands. See the section called OpenStack command-line clients.

- **REST clients**

  Both Mozilla and Google provide browser-based graphical interfaces for REST. For Firefox, see RESTClient. For Chrome, see rest-client.

- **OpenStack Python Software Development Kit (SDK)**

  Use this SDK to write Python automation scripts that create and manage resources in your OpenStack cloud. The SDK implements Python bindings to the OpenStack API, which enables you to perform automation tasks in Python by making calls on Python objects rather than making REST calls directly. All OpenStack command-line tools are implemented by using the Python SDK. See OpenStack Python SDK in the *OpenStack End User Guide*.

- OpenStack APIs
  - Authentication and API request workflow
  - Authenticate
  - Send API requests
  - OpenStack command-line clients

Sample api example

Clustering API

Show All

Concepts

The Senlin API supports a "major versions" expressed in request URLs and "microversions" which can be sent in HTTP header **`OpenStack-API-Version`**.

When the specified **`OpenStack-API-Version`** is not supported by the API service, a 406 (NotAcceptable) exception will be raised. Note that this applies to all API requests documented in this guide.

GET / — **List Major Versions** — detail

GET /`{version}`/ — **Show Details of an API Version** — detail

Shows build information for a Senlin deployment.

GET /v1/build-info — **Show build information** — detail

Lists all profile types and shows details for a profile type.

GET /v1/profile-types — **List profile types** — detail

GET /v1/profile-types/`{profile_type}` — **Show profile type details** — detail

GET /v1/profile-types/`{profile_type}`/ops — **List profile type operations** — detail

Lists all profiles and creates, shows information for, updates, and deletes a profile.

GET /v1/profiles — **List profiles** — detail

POST /v1/profiles — **Create profile** — detail

GET /v1/profiles/`{profile_id}` — **Show profile details** — detail

PATCH /v1/profiles/`{profile_id}` — **Update profile** — detail

DELETE /v1/profiles/`{profile_id}` — **Delete profile** — detail

POST /v1/profiles/validate — **Validate profile** — detail

Lists all policy types and shows details for a policy type.

GET /v1/policy-types — **List policy types** — detail

GET /v1/policy-types/`{policy_type}` — **Show policy type details** — detail

Lists all policies and creates, shows information for, updates, and deletes a policy.

GET /v1/policies — **List policies** — detail

POST /v1/policies — **Create policy** — detail

GET /v1/policies/`{policy_id}` — **Show policy details** — detail

PATCH /v1/policies/`{policy_id}` — **Update policy** — detail

DELETE /v1/policies/`{policy_id}` — **Delete policy** — detail

POST /v1/policies/validate — detail

Lists all clusters and creates, shows information for, updates, deletes, and triggers an action on a cluster.

GET	/v1/clusters **List clusters**	detail
POST	/v1/clusters **Create cluster**	detail
GET	/v1/clusters/ `{cluster_id}` **Show cluster details**	detail
PATCH	/v1/clusters/ `{cluster_id}` **Update cluster**	detail
DELETE	/v1/clusters/ `{cluster_id}` **Delete cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Resize a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Scale-in a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Scale-out a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Add nodes to a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Remove nodes from a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Replace nodes in a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Attach a Policy to a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Scale-in a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Scale-out a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Add nodes to a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Remove nodes from a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Replace nodes in a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Attach a Policy to a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Detach a Policy from a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Update a Policy on a Cluster**	detail
GET	/v1/clusters/ `{cluster_id}` /attrs/ `{path}` **Collect Attributes Across a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Check a Cluster's Health Status**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Recover a Cluster to a Healthy Status**	detail
POST	/v1/clusters/ `{cluster_id}` /ops **Perform an Operation on a Cluster**	detail
POST	/v1/clusters/ `{cluster_id}` /actions **Complete Lifecycle on a Cluster action**	detail

Lists all cluster policies and shows information for a cluster policy.

GET	/v1/clusters/ `{cluster_id}` /policies **List all cluster policies**	detail
GET	/v1/clusters/ `{cluster_id}` /policies/ `{policy_id}` **Show cluster_policy details**	detail

Lists all nodes, and creates, shows information for, updates, deletes a node.

GET	/v1/nodes **List nodes**	detail
POST	/v1/nodes **Create node**	detail
POST	/v1/nodes/adopt **Adopt node**	detail
POST	/v1/nodes/adopt-preview **Adopt node (preview)**	detail
GET	/v1/nodes/ `{node_id}` **Show node details**	detail
PATCH	/v1/nodes/ `{node_id}` **Update node**	detail
DELETE	/v1/nodes/ `{node_id}` **Delete node**	detail
POST	/v1/nodes/ `{node_id}` /actions **Check a Node's Health**	detail
POST	/v1/nodes/ `{node_id}` /actions **Recover a Node to Healthy Status**	detail
POST	/v1/nodes/ `{node_id}` /ops **Perform an Operation on a Node**	detail

Lists all receivers and creates, shows information for, and deletes a receiver.

GET	/v1/receivers **List receivers**	detail
POST	/v1/receivers **Create receiver**	detail
GET	/v1/receivers/ `{receiver_id}` **Show receiver details**	detail
PATCH	/v1/receivers/ `{receiver_id}` **Update receiver**	detail
DELETE	/v1/receivers/ `{receiver_id}` **Delete receiver**	detail
POST	/v1/receivers/ `{receiver_id}` /notify **Notify receiver**	detail

Lists all events and shows information for an event.

GET	/v1/events **List events**	detail
GET	/v1/events/ `{event_id}` **Shows event details**	detail

Triggers an action represented by a webhook. For API microversion less than 1.10, optional params in the query are sent as inputs to be used by the targeted action. For API microversion equal or greater than 1.10, any key-value pairs in the request body are sent as inputs to be used by the targeted action.

POST	/v1/webhooks/ `{webhook_id}` /trigger **Trigger webhook action**	detail

- **Comparative study between OpenStack and AWS/GCE**

OpenStack vs. AWS - Overview
AWS, Amazon Web Services is the on-demand cloud computing framework. It includes numerous cloud services across the cloud models, such as Platform as a Services, PaaS, etc. The framework uses a pay-as-you-go pricing model to offer reasonable prices to the end-users.

Openstack, on the other hand, is an open-source platform to create and use cloud services with the necessary customizations as per the requirements. The end-users can access and operate it through APIs and web dashboards.

AWS vs. OpenStack - Security
The frequency of security attacks and issues over the cloud is increasing with every passing day. It is essential to have supreme access control over the cloud to avoid any security violations. AWS offers better security compared to OpenStack as the latter may not provide the necessary array of services. In AWS, the launch of an instance immediately maps it with a separate security group, thereby promoting the overall privacy and security levels.

Multi-factor authentication is one security technique to ensure only authentic users access the servers, system, and data. Identity management for better security is made possible with Keystone in OpenStack and IAM in AWS. These determine the identity functions in these cloud technologies and provide integration with external providers, such as the LAPD. These are some of the essential services in these platforms, and both AWS and OpenStack score equally well in identity management.

AWS vs. OpenStack - Storage
It is essential to have two categories of storage in cloud computing, viz. block and object storage. The former is necessary to assign values to the virtual server to enhance the respective capacities. It also plays a vital role in the data and server backups. Object storage primarily deals with the media files, such as videos, images, etc. AWS has S3 and Cinder as its object and blocks storage, respectively. OpenStack has Swift as the object storage and EBS as the block storage.
AWS vs. OpenStack - Networking
Server connectivity is essential to maintain the flow of information exchange and communications. In AWS, multiple networking options and channels are available. For example, Amazon ELB is

known for effective load balancing. Similarly, Amazon VPC, Virtual Private Cloud, establishes a secure connection with the corporate servers. OpenStack has LBaaS, Load Balancer as a Service for automatic network connection and addressing. Flat networks VLANs make it possible to set up and configure the IP addresses and networks manually.

AWS vs. OpenStack - Monitoring
Continuous and constant monitoring is significant to understand the overall resource utilization over the cloud. AWS uses CloudWatch and OpenStack uses Ceilometer for these tasks. OpenStack has the edge over AWS in this area as Ceilometer provides effective control over the logistics. CloudWatch, on the other hand, is specifically available only for AWS.

AWS vs. OpenStack - Computation
Running an application on a virtual server shall come easy with these cloud technology options. AWS uses EC2 to add scalability to the virtual networks. It also offers scalable and flexible data analytics through EMR Hadoop. OpenStack is primarily available for IaaS (Infrastructure as a Service) cloud and provides horizontal scalability. It can quickly scale up or scale down on the hardware without any particular specifications.

OpenStack Use Cases
OpenStack can easily leverage the existing hardware to come up with a private cloud. This makes it suitable for corporate profitability and also ensures better resilience. OpenStack is preferable in scenarios where cost is the major constraint. The open-source nature can cut down the costs while offering ease of building an in-house cloud solution. Cases wherein the team requires developing or setting up its private cloud, and its maintenance should prefer OpenStack.

Amazon Web Services (AWS) Use Cases
AWS can be extremely useful for start-ups and small firms with its flexible and scalable options. Amazon has a considerable workforce ensuring better customer service and support options in data management, analytics, backup, etc.

- **Lessons Learned during Public Cloud Setup.**

  Learnt core understanding of what OpenStack is and the basics of setting up and administering OpenStack. Also understood some commonly used OpenStack services. And learnt how to setup Public Cloud Setup

- **Conclusion**

  Got have a basic understanding of OpenStack and some of the things you can do with it. Under stood how cloud environment works