Cisco Modeling Labs OpenStack Clusters

Cisco Modeling Labs OpenStack Clusters Overview

Cisco Modeling Labs uses OpenStack's clustering capability to allow you to run simulations across multiple servers, with a single point of control. The system supports up to five servers operating within a cluster. Cisco Modeling Labs on OpenStack Clusters is available for local installation on Vmware ESXi only. No special licenses are required in order to operate a Cisco Modeling Labs Cluster. The maximum number of Cisco VMs that you can run will be subject to:

- The Cisco Modeling Labs license key (node count) that applies
- The hardware resources that you have available within the set of computers

Note Cluster installation and operation have only been tested on VMware ESXi and on the Cisco UCS C-series systems. Installation issues may be encountered when using other types of hardware.

An OpenStack cluster is minimally comprised of one controller and one compute node. Currently, Cisco Modeling Labs clusters can be scaled to a maximum of one controller and four compute nodes.

Cisco Modeling Labs OpenStack Cluster Terminology

The terminology used for Cisco Modeling Labs OpenStack clusters is described in the following table.

Table 1: Cisco Modeling Labs OpenStack Cluster Terminology

Term	Description
Controller	The primary Cisco Modeling Labs node that includes a complete installation of the Cisco Modeling Labs server software, including full compute, storage, and network functionality and all of the node and container images.
Compute Node	A node that includes a partial installation of the Cisco Modeling Labs server software that enables it to provide additional compute and networking resources for use by a Cisco Modeling Labs simulation.
Cluster	A collection of nodes operating in concert. At a minimum, a cluster can be composed of one controller and one compute node.
Cisco Modeling Labs Server Image	A standard Cisco Modeling Labs installation source (OVA or ISO) that contains the full complement of Cisco Modeling Labs software.
Cisco Modeling Labs Compute Image	A Cisco Modeling Labs installation source (OVA or ISO) that contains only the Cisco Modeling Labs software necessary to provide compute and networking services.

Important When using Cisco Modeling Labs Clusters, the IP address used to reach the User Workspace Management interface and by the Cisco Modeling Labs client will be that of the Controller.

Cisco Modeling Labs OpenStack Clusters Installation Requirements

This section details the hardware and software requirements for successfully deploying a Cisco Modeling Labs cluster.

Attention The following instructions were developed for use with Cisco UCS C-series servers running vSphere ESXi. You may encounter installation issues and need to adapt them to suit other environments.

Cluster-Member Resources

To successfully deploy a Cisco Modeling Labs OpenStack Cluster, ensure that the following minimum requirements are met:

- Each node must have at least 16GB RAM and 4 CPU or vCPU cores.
- Each node must support and expose Intel VT-x/EPT extensions.

Note When using virtual machines, each must be configured to support nested virtualization. This is the default for Cisco Modeling Labs OVA-based installations.

- Controllers must have at least 250GB of disk or virtual disk space available.
- Compute nodes must have at least 250GB of disk or virtual disk space available.
- Each node must have five physical or virtual network interfaces.

Software Requirements

The following minimum requirements for Cisco Modeling Labs software must be met when deploying Cisco Modeling Labs OpenStack Clusters:

Node Type	Cisco Modeling Labs Software Release
Controller	CML 1.3 (Build 1.3.286.04)
Compute Node	CML 1.3 (Build 1.3.286.04)

Network Time Protocol (NTP)

Every ESXi-node and cluster-member must be configured to properly synchronize with a valid NTP clock source.

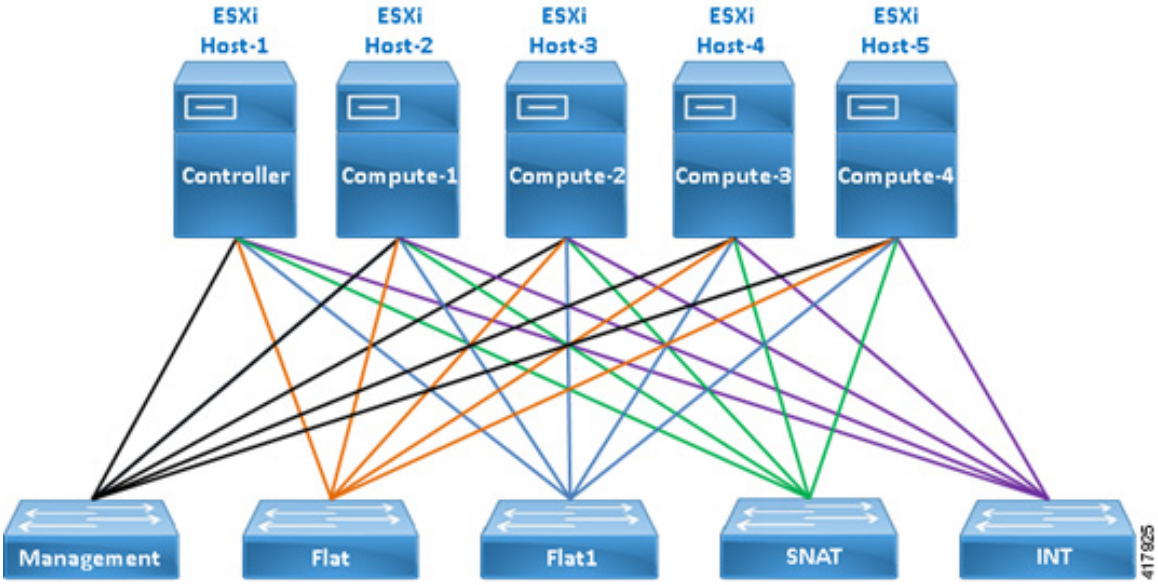
Note If you are in a lab or other environment where special requirements apply to the use of NTP, work with your network administrators to ensure that NTP is properly and successfully configured.

Networking

The Cisco Modeling Labs networks are named **Management**, **Flat**, **Flat1**, **SNAT**, and **INT**. These are used for management, Layer-2 and Layer-3 connectivity, and cluster control-plane functions, respectively.

Each of the five required interfaces on a cluster member are connected to these networks in order, as shown.

Figure 1: Interface Mapping



vSphere ESXi Interface Mapping

In vSphere ESXi deployments, multiple port-groups should be used to provide seamless, isolated connectivity for each of the Cisco Modeling Labs networks.

The following table details the vNIC to port-group connections to use:

Interface	LAN Switch or VLAN/Port Group
eth0	Management (default VM Network)
eth1	Flat
eth2	Flat1
eth3	SNAT
eth4	INT

Note The default vSphere ESXi port-group used for the Management network is VM Network but any port-group may be used. Update as required to conform to site-specific configurations.

Important The Flat, Flat1 and SNAT port-groups must be configured for **Promiscuous-Mode** in order to allow inbound communications to virtual nodes running within simulations. Refer to the vSphere Client installation section for detailed steps.

As cluster-members are deployed across multiple vSphere ESXi hosts, care must be taken to ensure that seamless connectivity is maintained for each Cisco Modeling Labs network. This can be done in one of two ways:

- Using a vSphere Distributed Virtual Switch (DVS). For further information, refer to VMware documentation for details on DVS configuration.
- Using physical network connections between network interfaces on each host that are associated with the Cisco Modeling Labs networks and port-groups.

Important The INT (eth4) interface is used for OpenStack's intra-cluster communications between the participating nodes. Communications between virtual nodes running on different cluster nodes leverage VXLAN exchanges across this interface. As such, the adjacent access switch handling the eth4 uplinks must be enabled for jumbo frame support. The physical access switch must also be multicast enabled by configuring an igmp snooping querier, or by deploying a PIM router to manage igmp messaging.

Interface Addressing

The default interface addressing convention for Cisco Modeling Labs on OpenStack Clusters is detailed below. The addresses for the Management, Flat, Flat1, and SNAT networks can and should be adjusted to suit your exact deployment requirements when necessary.

Interface	Controller	Compute-1	Compute-2	Compute-3	Compute-4
eth0	DHCP or Static	DHCP or Static	DHCP or Static	DHCP or Static	DHCP or Static
eth1	172.16.1.254	172.16.1.241	172.16.1.242	172.16.1.243	172.16.1.244
eth2	172.16.2.254	172.16.2.241	172.16.2.242	172.16.2.243	172.16.2.244
eth3	172.16.3.254	172.16.3.241	172.16.3.242	172.16.3.243	172.16.3.244
eth4	172.16.10.250	172.16.10.241	172.16.10.242	172.16.10.243	172.16.10.244

Caution Do not change the subnet used for the INT network. This must remain on the 172.16.10.0/24 subnet, and the Controller must be assigned 172.16.10.250 on interface eth4.
If you are installing a Cisco Modeling Labs OpenStack Cluster alongside an existing standalone Cisco Modeling Labs deployment, you must ensure that they remain isolated using distinct switches, VLANs, or port-groups. Otherwise, conflicts will occur on one or more of the Controller interfaces.

Controller Deployment

This section details the process involved in controller deployment.

Install Controller Software

The Controller in a Cisco Modeling Labs OpenStack Cluster is adapted from a Cisco Modeling Labs standalone node. As such, complete the installation steps as described in the Cisco Modeling Labs Corporate Edition System Administrator Installation Guide appropriate to your target environment.

Note Do not proceed until you have fully installed, configured, licensed, and verified your Cisco Modeling Labs node using the installation process for your environment.

Configuring the Controller

The first series of steps inform the new Cisco Modeling Labs standalone node that it will be operating in a cluster:

Step 1 Login to the controller at the IP address recorded during the installation process using username **virl** and password **VIRL**.

```
ssh virl@<controller-ip-address>
```

Step 2 Make a copy of the Cisco Modeling Labs configuration file, settings.ini.

```
sudo cp /etc/settings.ini /etc/settings.ini.orig
```

Step 3 Open the settings.ini file using the nano editor.

```
sudo nano /etc/settings.ini
```

Step 4 Locate the configuration element **virl_cluster: FALSE** and update its value to **TRUE**.

Step 5 Identify how many compute nodes from 1 to 4 will be present in the cluster and locate the configuration element for the first compute node: **compute1_active: FALSE** and change its value to **TRUE**.

Step 6 Repeat for each additional compute node to be included in the cluster, from 2 to 4.

Step 7 Save and apply the configuration changes by entering **Control-X**, **Y** and then **Enter** to save the file and exit.

Step 8 Apply the changes and update the controller's Salt configuration using the following commands:

```
vinstall vinstall
vinstall salt
sudo salt-call state.sls common.salt-master.cluster
sudo salt-call state.sls virl.hostname.cluster
vinstall salt
```

Step 9 Login to the User Workspace Management interface and navigate to the controller's ip address: http://<controller-ip-address>:19400.

Step 10 Login using username uwmadmin and password password.

Step 11 Select **CML Server** > **System Configuration** from the menu. The System Configuration page includes tabs for each of the enabled compute nodes.

Step 12 For each compute node in your cluster, select the appropriate tab and adjust its configuration to match your environment.

Note The Cluster Configuration and Defaults section below includes a description of each cluster configuration element and the default values associated with each of the four possible compute nodes.

Step 13 Once you have made all of the necessary changes made, choose **Apply Changes** to save your changes.

Step 14 You must now restart the controller in order to finalize the configuration and services.

```
sudo reboot now
```

Compute Node Deployment

Compute nodes are installed using specialized OVAs or ISOs named `compute.n.n.n.ova` or `compute.n.n.n.iso`, respectively. Refer to your license confirmation email for information on how to download these installation sources.

Install Compute Node Software

The installation of a compute node starts as an abbreviated version of a standalone installation.

1. Download the compute node OVAs 1 through 4, depending on the number you wish to deploy.
2. Deploy each of the OVAs to your vCenter/ESXi environment.

Important It is critical that the CML cluster controller and compute-nodes share common port-groups for each of the five network interfaces. These are typically VM Network, Flat, Flat1, SNAT, and INT.

3. Boot the newly deployed compute-node OVA.

Validate Compute Node Operations

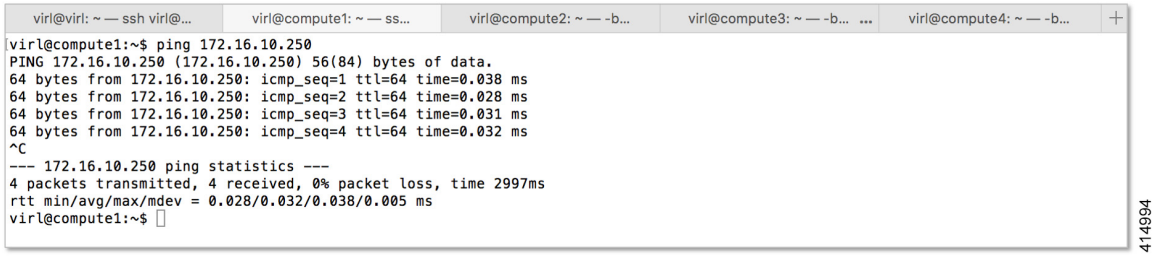
Once the compute node has rebooted, continue by validating connectivity to the controller and enabling the Cisco Modeling Labs compute node software using the following steps:

Step 1 Login to the compute node at the IP address recorded during installation using username virl and password VIRL.

```
ssh virl@<compute-node-ip-address>
```

Step 2 Ensure that connectivity to the controller exists by issuing the ping command.

```
ping 172.16.10.250
```



Note Connectivity to the controller must be confirmed. Explore and resolve any issues before proceeding.

Cluster Validation

Once the controller and each compute node has been deployed, you should validate that the cluster is properly configured and operational. To do this, complete the following steps:

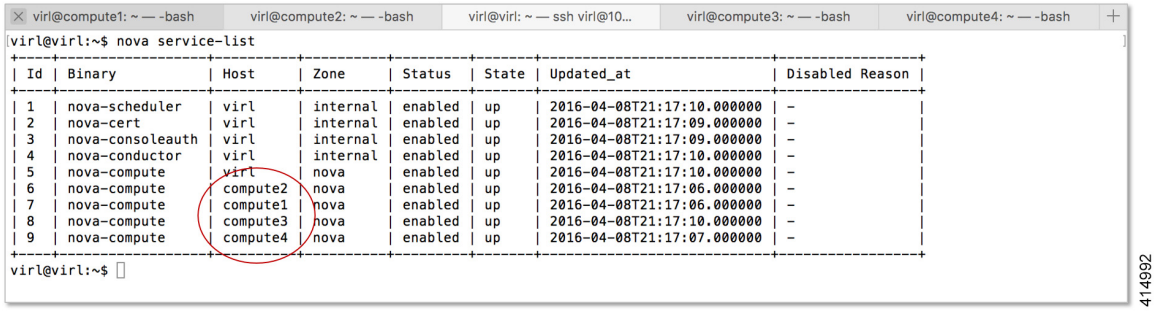
Step 1 Login to the controller at the IP address recorded during installation using username virl and password VIRL.

```
ssh virl@<compute-node-ip-address>
```

Step 2 Verify that each compute node is registered with OpenStack Nova.

```
nova service-list
```

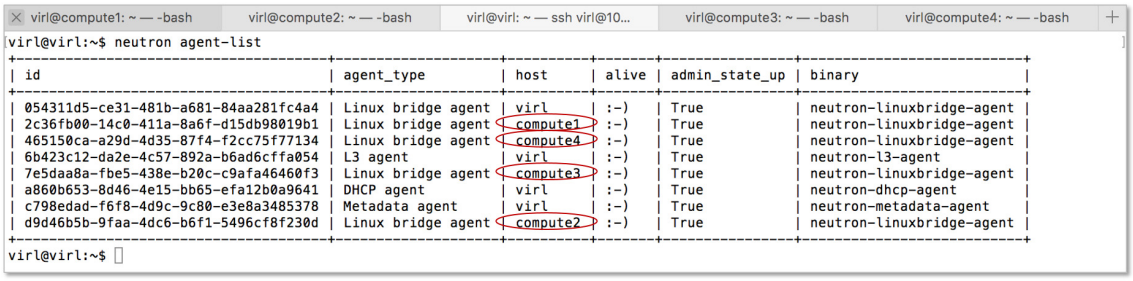
In the following example, there are five nova-compute services registered; one on the controller and another for each compute node that has been deployed.



Step 3 Verify that each compute node is registered with OpenStack Neutron.

```
neutron agent-list
```

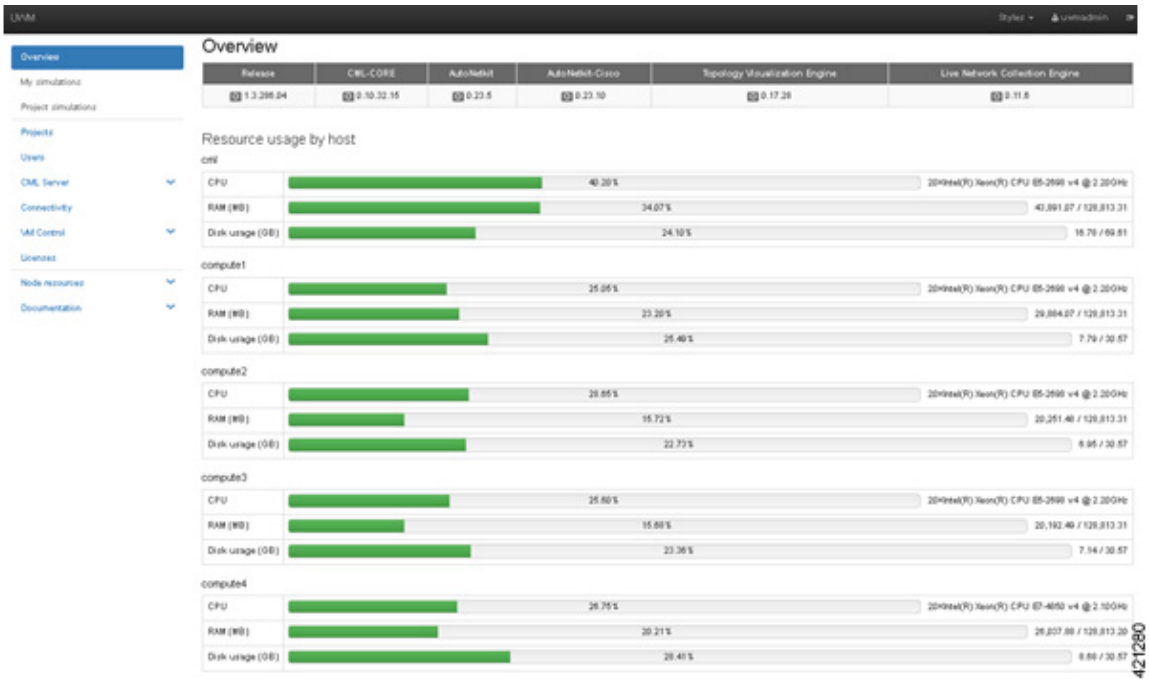
In the following example, there are five Linux bridge agents registered; one on the controller and another for each compute node that has been deployed.



At this point your Cisco Modeling Labs OpenStack Cluster should be fully operational and you should be able to start a Cisco Modeling Labs simulation and observe all of the nodes become **Active**.

The following figure shows an overview of the compute nodes in the User Workspace Management interface, when validation has completed.

Figure 2: Overview of Compute Nodes in the User Workspace Management Interface

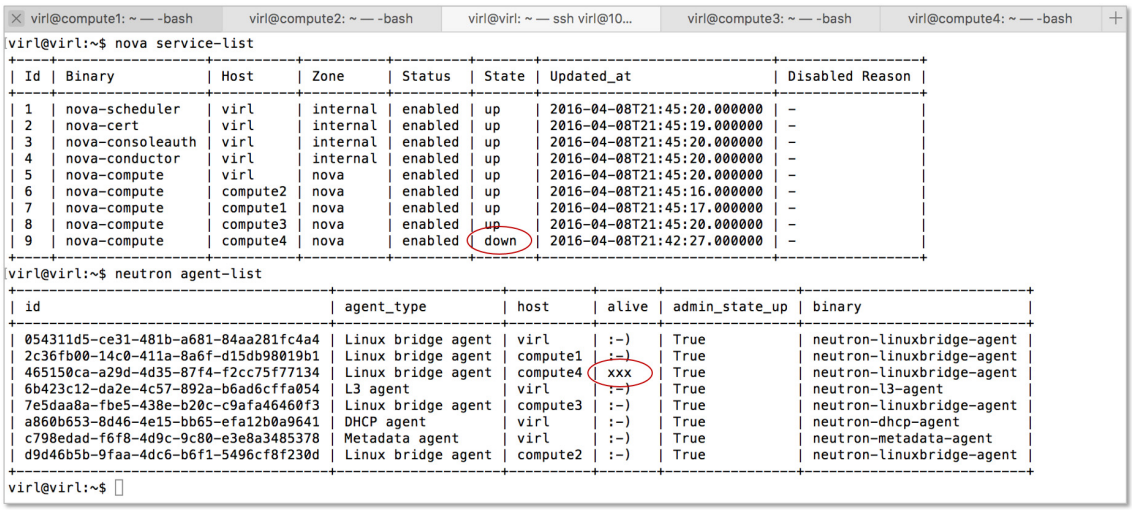


Cluster Troubleshooting

In situations where communication is lost between the controller and a compute node, or if a compute node becomes inoperable, you can determine the state of each compute node from the controller using the `nova service-list` and `neutron agent-list` commands.

For example, in the following image communication has been lost with compute4. Note that Nova shows the node in the state **down**, and Neutron shows the agent as **xxx** (dead state):

Figure 3: `nova service-list` and `neutron agent list` Commands Executed



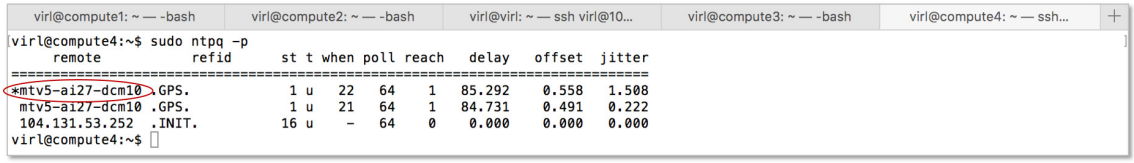
In such circumstances, correct operation may be restored by restarting the affected node.

If restarting the compute node does not restore proper operation, you may also want to check that the node is associated with a valid NTP clock source, using the following command:

```
sudo ntpq -p
```

Valid peer associations are indicated by a * alongside the clock-source name, as shown:

Figure 4:



Cluster Maintenance

Add Additional Compute Nodes

To add additional compute nodes to an existing Cisco Modeling Labs cluster, complete the following steps:

Step 1 Login to the controller at the IP address recorded during installation using username virl and password VIRL.

Step 2 Edit the `/etc/settings.ini` file and set the configuration element for the new compute node to True.

Step 3 Apply the changes and update the controller's cluster configuration.

```
vinstall salt
```

Step 4 Complete the instructions described in Compute Node Deployment for the new compute node.

Step 5 Complete the instructions described in Cluster Validation to ensure that the new compute node is properly deployed.

Cluster Configuration and Defaults

The following configuration elements defined in the /etc/settings.ini file or via the User Workspace Management interface are used to define Cisco Modeling Labs OpenStack Cluster configurations.

Table 2: Cluster Configuration Elements

Parameter	Default	Description	
computeN_active	False	Specifies the absence or presence of the compute node N in the cluster.	Set to True for each available compute node (1 through 4).
computeN_nodename	computeN	Specifies the hostname associated with the compute node.	This field must match the node name defined on the compute node.
computeN_public_port	eth0	Specifies the name of the port used to reach the Internet on the compute node.	This field must match exactly the public port name and format specified on the compute node.
computeN_using_dhcp_on_the_public_port	True	Specifies the addressing method used for the public port on the compute node.	Set to False if using Static IP addressing.

Parameter	Default	Description	
computeN_static_ip	10.10.10.10	The Static IP address assigned to the public port.	Not used if DHCP is enabled. Review and modify to match deployment requirements.
computeN_public_netmask	255.255.255.0	The network mask assigned to the public port.	Not used if DHCP is enabled. Review and modify to match deployment requirements.
computeN_public_gateway	10.10.10.1	The IP address of the default gateway assigned to the public port.	Not used if DHCP is enabled. Review and modify to match deployment requirements.
computeN_first_nameserver	8.8.8.8	The IP address of the first name-server assigned to the public port.	Not used if DHCP is enabled. Review and modify to match deployment requirements.
computeN_second_nameserver	8.8.4.4	The IP address of the second name-server assigned to the public port.	Not used if DHCP is enabled. Review and modify to match deployment requirements.
computeN_l2_port	eth1	The name of the first layer-2 network port (Flat) on the compute node.	This field must match exactly the name and format specified on the compute node.
computeN_l2_address	172.16.1.24N	The IP address assigned to the first layer-2 network port (Flat) on the compute node.	This field must match exactly the IP address specified on the compute node. N must match the node name / position in the cluster.
computeN_l2_port2	eth2	The name of the second layer-2 network port (Flat1) on the compute node.	This field must match exactly the name and format specified on the compute node.
computeN_l2_address2	172.16.2.24N	The IP address assigned to the second layer-2 network port (Flat1) on the compute node.	This field must match exactly the IP address specified on the compute node. N must match the node name / position in the cluster.

Parameter	Default	Description	
computeN_l3_port	eth3	The name of the layer-3 network port (SNAT) on the compute node.	This field must match exactly the name and format specified on the compute node.
computeN_l3_address	172.16.3.24N	The IP address assigned to layer-3 network port (SNAT) on the compute node.	This field must match exactly the IP address specified on the compute node. N must match the node name / position in the cluster.
computeN_internalnet_ip	172.16.10.24N	The IP address assigned to internal / cluster network interface (eth4).	This field must match exactly the IP address specified on the compute node. N must match the node name / position in the cluster.

The default configuration elements for each compute node in a Cisco Modeling Labs OpenStack Cluster are as follows:

Table 3: Default Cluster Configuration Elements

Parameter	Compute Node 1	Compute Node 2	Compute Node 3	Compute Node 4
computeN_active	False	False	False	False
computeN_nodename	compute1	compute2	compute3	compute4
computeN_public_port	eth0	eth0	eth0	eth0
computeN_using_dhcp_on_the_public_port	True	True	True	True
computeN_static_ip	10.10.10.10	10.10.10.10	10.10.10.10	10.10.10.10
computeN_public_netmask	255.255.255.0	255.255.255.0	255.255.255.0	255.255.255.0
computeN_public_gateway	10.10.10.1	10.10.10.1	10.10.10.1	10.10.10.1
computeN_first_nameserver	8.8.8.8	8.8.8.8	8.8.8.8	8.8.8.8
computeN_second_nameserver	8.8.4.4	8.8.4.4	8.8.4.4	8.8.4.4
computeN_l2_port	eth1	eth1	eth1	eth1

Parameter	Compute Node 1	Compute Node 2	Compute Node 3	Compute Node 4
computeN_l2_address	172.16.1.241	172.16.1.242	172.16.1.243	172.16.1.244
computeN_l2_port2	eth2	eth2	eth2	eth2
computeN_l2_address2	172.16.2.241	172.16.2.242	172.16.2.243	172.16.2.244
computeN_l3_port	eth3	eth3	eth3	eth3
computeN_l3_address	172.16.3.241	172.16.3.242	172.16.3.243	172.16.3.244
computeN_internalnet_port	eth4	eth4	eth4	eth4
computeN_internalnet_ip	172.16.10.241	172.16.10.242	172.16.10.243	172.16.10.244