External Connectivity in Cisco Modeling Labs

Basic Node Access

For simple network topology simulations, access to simulated nodes can be conducted through the Cisco Modeling Labs server's management interface , Ethernet0. This is useful for simulation scenarios that do not require connection to external devices, and leverages the Cisco Modeling Labs server's management interface for communications with the virtual devices. No Flat or SNAT interfaces are configured or referenced, and no option is specified within the project's **Properties** > **Topology** > **Management Network** setting. In this minimal configuration, connections to the virtual nodes instances are facilitated through the Cisco Modeling Labs's client Server management option.

Telnet via Cisco Modeling Labs Client Console

The Cisco Modeling Labs client provides an integral access method to running node simulations. In the **Simulation** perspective, highlight an ACTIVE node within the **Simulations** view and performing a right-click operation expands a session start menu. Positioning the cursor over Telnet triggers a popup menu from which

the Console, Monitor, or Management ports may be selected. Alternatively, highlighting a node on the canvas and performing a right-click will present the same set of options, as shown.

Figure 1: Start a Telnet Session
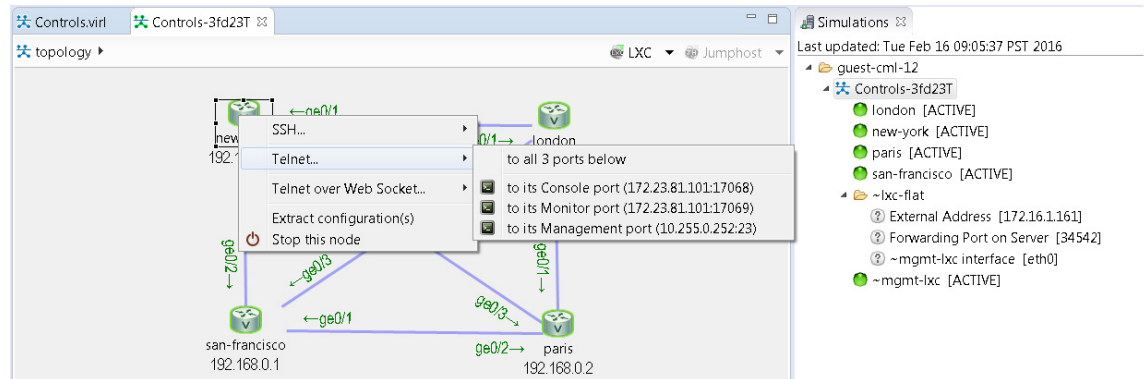
Within the Cisco Modeling Labs client's console, a Telnet session through this node's console port is started.

SSH via Cisco Modeling Labs Client Console

Using the same scenario as for Telnet, an SSH session may be used. In the pop-up menu, a SSH session may be selected. Positioning the cursor over SSH triggers a popup menu from which the Management port may be selected. Alternatively, highlighting a node on the canvas and performing a right-click will present the same set of options, as shown.

Figure 2: Start a SSH Session
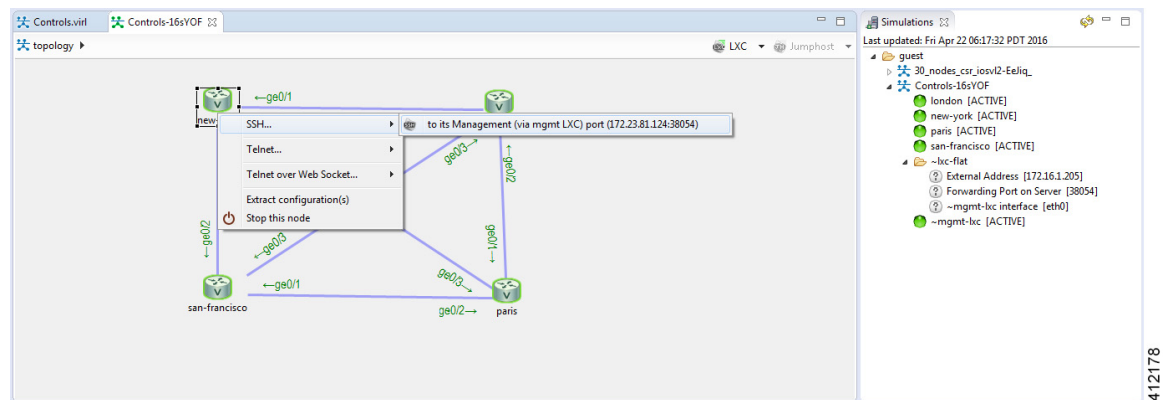
A secure shell session is then launched to an internal jumphost (a lightweight Linux-based virtual machine running within the simulation) from which a Telnet session is started to the highlighted node's Management interface. The **IP_Addr:Port_ID** combination is the same for each of the nodes within the running simulation, and represents the JumpHost as an intermediate session proxy. The Cisco Modeling Labs client will initiate

the connection via the Cisco Modeling Labs management interface (Eth0) to the intermediate jumphost, and then facilitate the subsequent Telnet connection to the targeted node in a single operation.

Figure 3: SSH Session via JumpHost
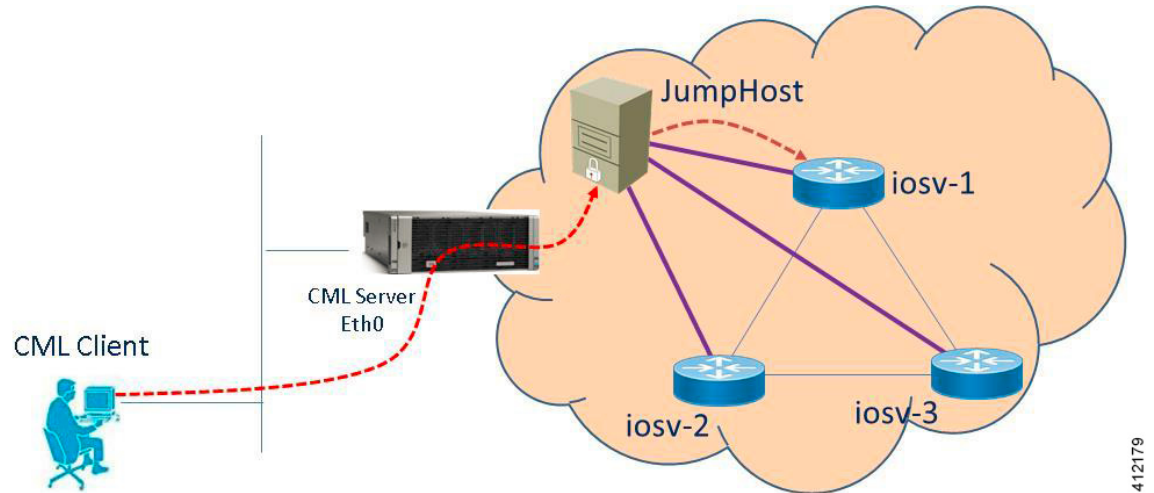
Access via User Workspace Management Interface

Another option is to access the nodes in a running simulation through the **User Workspace Management** interface via a web browser. After entering log in credentials, click the **My Simulations** option to view a list of running simulations. Select the applicable simulation to view a list of nodes comprising the running

simulation. To access a node, click one of the ports icons, representing Serial-0, Serial-1, or the Management port, associated with the desired node. As shown, a corresponding session is started for the selected node.

Figure 4: Using the User Workspace Management Interface for Node Access

External Connectivity to a Node

Depending on how the Cisco Modeling Labs environment has been set up by the system administrator, you may have several ways to externally connect to the nodes in a running simulation.

1 Bypass the Cisco Modeling Labs client and connect directly to nodes via Out of Band Management IP access using FLAT

   If enabled by the system administrator, when designing your virtual network, you can specify that you want all nodes to be configured on a reserved management network. All management interfaces are connected to a shared management network segment known as FLAT. This set up will allow you to bypass the Cisco Modeling Labs client and connect directly via Telnet to the nodes.

2 Connecting to external devices using FLAT Inband access

   When enabled, you can configure your virtual topologies to connect and pass data-plane and control-plane packets to one or more external devices such as routers or traffic generators during a simulation. Since FLAT is a Layer-2 solution, the IP addresses in your topology are reachable externally. The **L2 External FLAT** tool in the Cisco Modeling Labs client GUI is used to enable this option.

Note   Your simulation continues to be driven through the Cisco Modeling Labs client GUI by communicating with the Cisco Modeling Labs server at its IP address that is bound to the relevant management port.

3 Connecting to external devices using SNAT Inband access

As an alternative to Inband access using FLAT, you can set up the Static NAT (SNAT) approach. SNAT is a Layer-3 solution that leverages the use of an internal SNAT router to hide the IP addresses in your topology. This router, internal to the Cisco Modeling Labs server, translates IP addresses inbound and outbound which means that the addressing schemes used on the virtual topology are not propagated outside the virtual network.

When configured, an internal and an external address are assigned to the SNAT-assigned interface on the nodes. For example, configuring 10.11.12.1 as the internal address, and mapping it to 172.16.2.51 externally. Traffic sent to 172.16.2.51 will be translated to the correct internal address and presented to the appropriate node.

The **L3 External SNAT** tool in the Cisco Modeling Labs client GUI is used to enable this option.

Note Your simulation continues to be driven through the Cisco Modeling Labs client by communicating with the Cisco Modeling Labs server at its IP address that is bound to the relevant management port.

Node Access via an External Terminal Client

There are situations when an external terminal client may be preferred over the Cisco Modeling Labs client for accessing the nodes' console. Factors may just be familiarity, or to capture and save session commands and respective responses to configuration changes.

Standard Telnet Sessions

By using the same socket combination used by the Cisco Modeling Labs client initiated sessions, a Telnet session may be launched from a Telnet client residing on the Cisco Modeling Labs client workstation, or another workstation. Using the Cisco Modeling Labs client, hovering the cursor over Telnet triggers a popup menu from which either the Console or Monitor ports may be noted. A Telnet session is directed to the Cisco Modeling Labs management IP address using the assigned port to the serial console port.

Note The TCP port is a transient value generated upon spinning up the virtual node. If the party accessing the nodes does not have a Cisco Modeling Labs project login account, the project owner/administrator will need to provide the node access socket details.

SSH Sessions

If using an external terminal emulator, an SSH session directed to the JumpHost socket will open a terminal session on the JumpHost. After entering user credentials (same as those for the Cisco Modeling Labs server), the logged in user will then manually initiate a Telnet session to the desired node using its management interface.

# Out-of-Band Management Sessions via the Flat Interface

The Cisco Modeling Labs client is not required to access nodes within a running project simulation. When configured, the out-of-band (OOB) management network interface for the running nodes may be accessible by external (physical) devices. A variety of methods employ a Layer-2 connection through the Ethernet1

interface, designated as Flat. This can be useful when you want to grant access to nodes within a running project to users without Cisco Modeling Labs credentials.

The available options are:

- **Use Telnet to bypass the Cisco Modeling Labs Client:** You can configure a shared OOB management interface on each of the topology's nodes. You can do this by selecting **Shared Flat Network** as the **Management Network** option for the topology under **Properties** > **Topology**.

Figure 5: Shared Flat Network Option
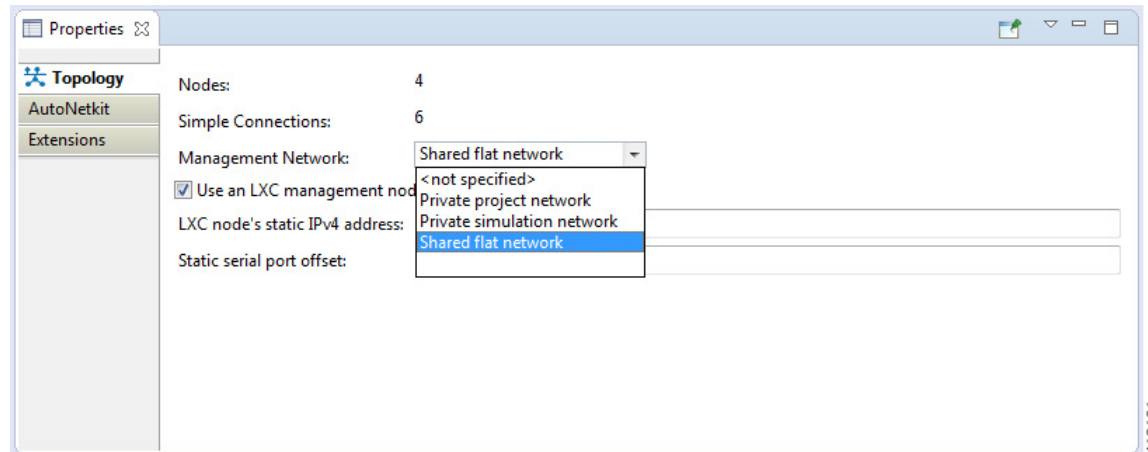
Selecting the **Shared Flat Network** option enables OOB external network access to all devices within the topology. This management network option assigns an IP address from the Flat network pool to each of the node's designated OOB Management interface (GigabitEthernet0/0), and presents that network to the Cisco Modeling Labs' Flat interface (Eth1).

> **Note** All running projects configured with **Shared Flat Network** as the Management Network will have their constituent nodes exposed to the Flat network interface with an IP address assigned from the provisioned Flat subnet range. As such, project users are able to access operating nodes beyond those associated with their specific project.

For management stations directly attached to this network, a node is accessed by initiating a standard Telnet session to the OOB management interface assigned during the topology start-up process. The Cisco Modeling Labs client, via the **Simulations** perspective or the User Workspace Management interface may be used to find out the IP addresses assigned to the OOB management interface for each of the running nodes.

• **Use SSH via Jumphost:** You can use SSH to access a node's OOB management interface via the Flat Ethernet1 interface, where the session is directed to the project-level Jumphost.

Figure 6: Using an SSH JumpHost in a Simulation
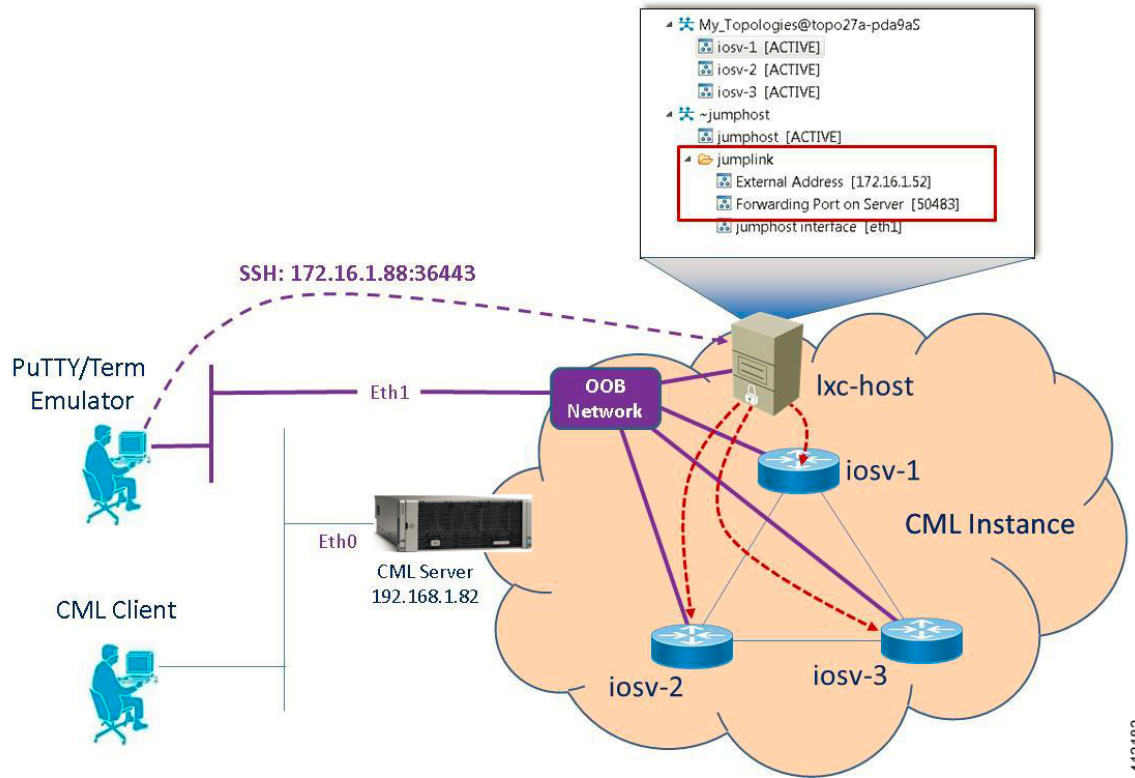
Accessing the simulated nodes via SSH using an external terminal emulator will require a two-step process. The jumphost represents a minimal Linux-container that terminates the SSH sessions. After entering user credentials, the logged in user may then manually initiate a Telnet session to the desired node using its management interface, provided that remote access has been enabled in the devices' configurations. A jumphost implemented at the Project level will have accessibility to any simulation running within the user's project space. Implementing an LXC management node creates a jumphost within the simulation. The following figure shows where enabling a node with the **Use an LXC**

Management Node option when defining the topology's properties results in an ~lxc-flat object being launched within the simulation.

Figure 7: Using an LXC Flat JumpHost in a Simulation
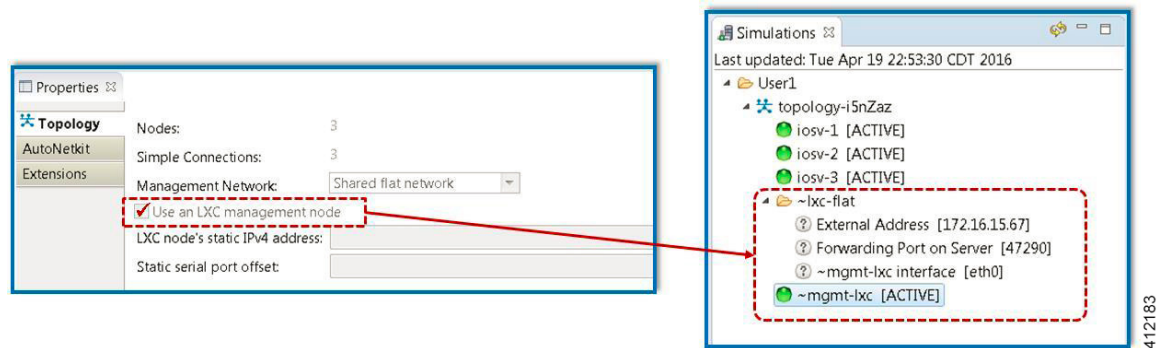
- **Use Private Management Networks:** When the simulation's Management Network is set as **Shared Flat Network**, all nodes within the topology are assigned an IP address from the pool provisioned for the Flat network interface (Eth1) and are accessible to any user attached to the Eth1 interface. To provide additional isolation from other users, the topology may be optioned with an internal OOB management network. When set for private management, the simulation-nodes' OOB interfaces are assigned, by default, addresses from the 10.255.0.0/24 range.

  A private OOB management network may be established at the project-level with multiple simulations within a common project or per simulation. When a private OOB management network is implemented, access to the simulation's virtual nodes is limited to the Cisco Modeling Labs client, or via SSH to the jumphost when external terminals are used.

Set Up a FLAT Network for Out of Band (OOB) Management Access

By using an out-of-band (OOB) network connection to the Cisco Modeling Labs simulation, you can connect an external application to the Management port of any router node in the simulated network. All management ports will have an IP address on the OOB network, which is a separate network from the other interface IP addresses.

☞

Important The IP address range assigned to FLAT must be a routable IP address. In addition, these IP addresses must be defined in the settings.ini file. When done, the administrator must run the Upgrade or Rehost option so that the changes take affect. Note too that running the Rehost option will affect other users on the server.

Before You Begin

- Ensure that you have installed a third-party application for Telnet connections, such as PuTTY.

• Ensure that FLAT connectivity has been enabled by the system administrator.

Step 1   Log in to the Cisco Modeling Labs client.

Step 2   Verify you have connectivity to the Cisco Modeling Labs server.

Step 3   Open the **Design** perspective, if it is not already open.

Step 4   Open an existing topology or create your network topology. See Create a Topology for information on how to do this.

Step 5   Configure the OOB management network.

    a) Click on the **Topology Editor** canvas.

    b) Choose **Properties > Topology**.

    c) Locate **Management Network** and select **Shared flat network** from the drop-down list.
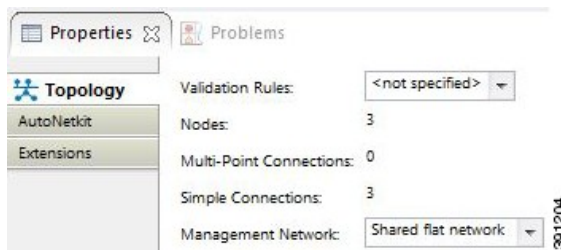
The **Shared flat network** option is what enables the OOB connectivity.

Step 6   From the toolbar, click the **Build Initial Configurations** tool.

    Note   For the purpose of this task, you may retain the default settings.

Step 7   After the build phase is completed, initiate the simulation by clicking the **Launch Simulation** tool in the toolbar, and then change to the **Simulation** perspective.

Step 8   (Optional) Enter the **ping** command on the PC to confirm that the management port on a running node can be reached.

    a) In the Cisco Modeling Labs client simulation, select a node and display the IP address for its management port. In this example, the IP address for the node management port is 172.16.1.51.
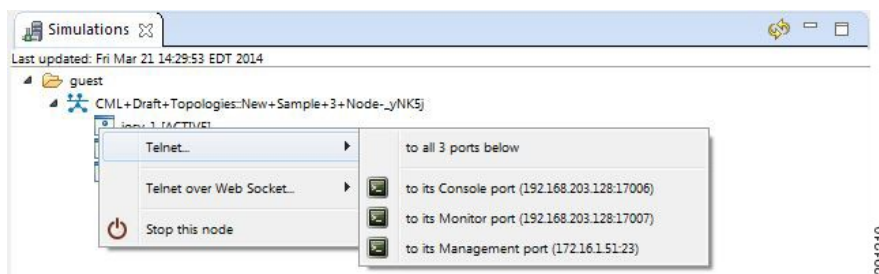
    b) In the PC command window, enter the **ping** command to target the node management port identified in Step 8a.

Step 9   (Optional) In the Cisco Modeling Labs client simulation, connect to a console port on a node and confirm the management network IP address exists. Enter the **show ip interface brief** command to display the IP addresses. For this example, use the IP address 172.16.1.51.

Step 10   Launch and configure a terminal emulator for a Telnet connection to the node management port. In this example, the PuTTY application is used.

a)   Launch the PuTTY application.

b)   In the **PuTTY Configuration window**, enter the IP address for a Telnet connection to the management port. In this example, the IP address for the node management port is 172.16.1.51.
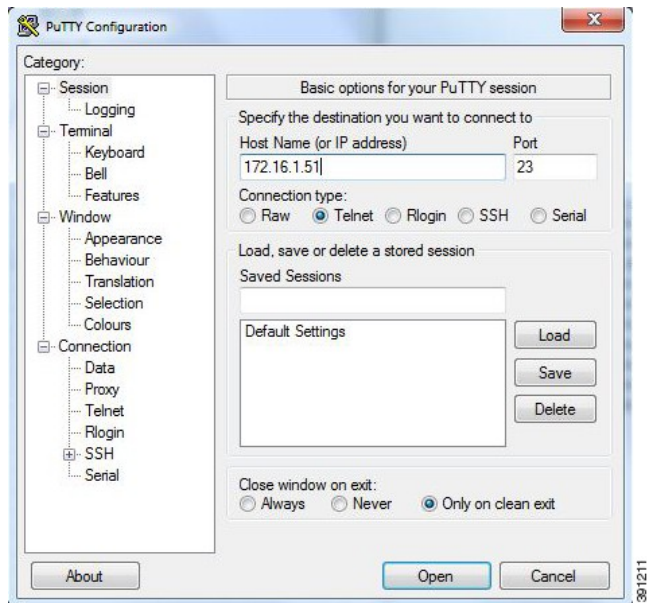
c) When successful, a Telnet window opens and the router console information is displayed.
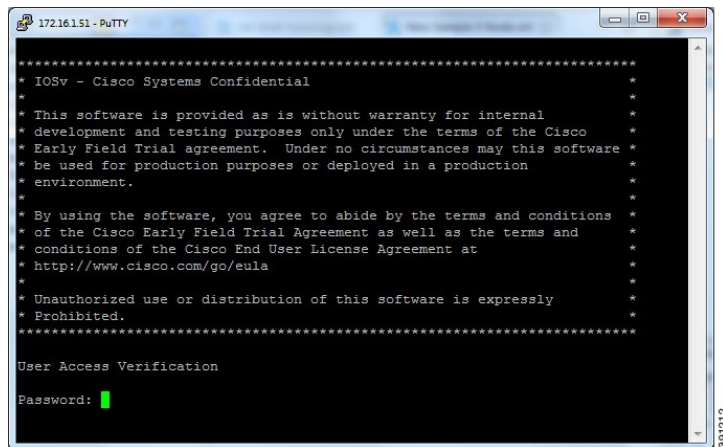
Add an Additional FLAT Network to a Simulation

The following procedure describes how to configure a second FLAT network to your simulation. A FLAT network uses Layer 2 connectivity, in which the IP address information about your virtual network can be viewed externally.

Step 1   With your topology open on the canvas, click the **L2 External (FLAT)** icon to add another FLAT network to your topology, as shown.

Figure 8: Add an Additional FLAT Network
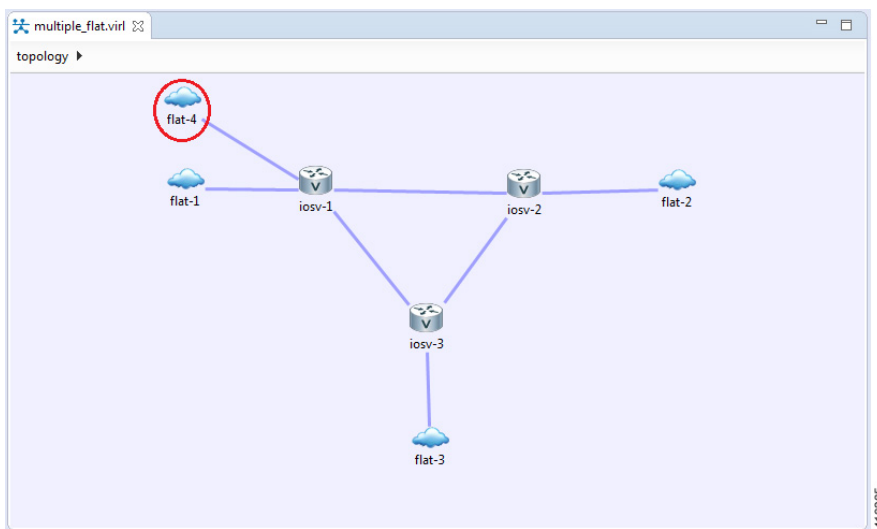
Step 2   Click the FLAT network just added, and in the **Extensions** tab in the **Properties** view, click the **Add new extension** icon.
The **Edit extension** dialog box is displayed.

Step 3   Add the following details for the new extension and click **OK**.

- **Key: host_network**

- **Value: flat1**

　　　　• **Type: String**

Figure 9: Edit Extension Dialog Box
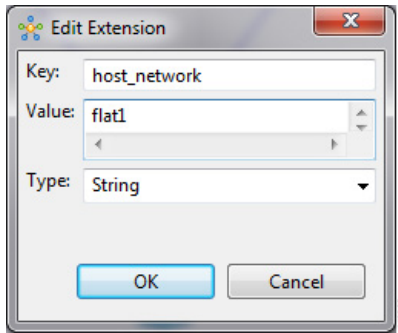
Note　　You must add this new extension for the second FLAT network, as a second interface is not permitted in the same subnet. This FLAT network is in the **flat1** subnet.

Step 4　　From the toolbar, click the **Build Initial Configurations** tool.

　　　　Note　　For the purpose of this task, you may retain the default settings.

During the simulation phase, the system automatically assigns an IP address to the node interface that is connected to the FLAT cloud.

Step 5　　After the build phase is completed, start the simulation by clicking the **Launch Simulation** tool in the toolbar, and then change to the **Simulation** perspective.

The IP addresses assigned to each of the interfaces in the FLAT network and connected to each node, are displayed in the **Simulations** view. These IP addresses are automatically applied to the nodes when they become active.

Figure 10: Flat1 Subnet
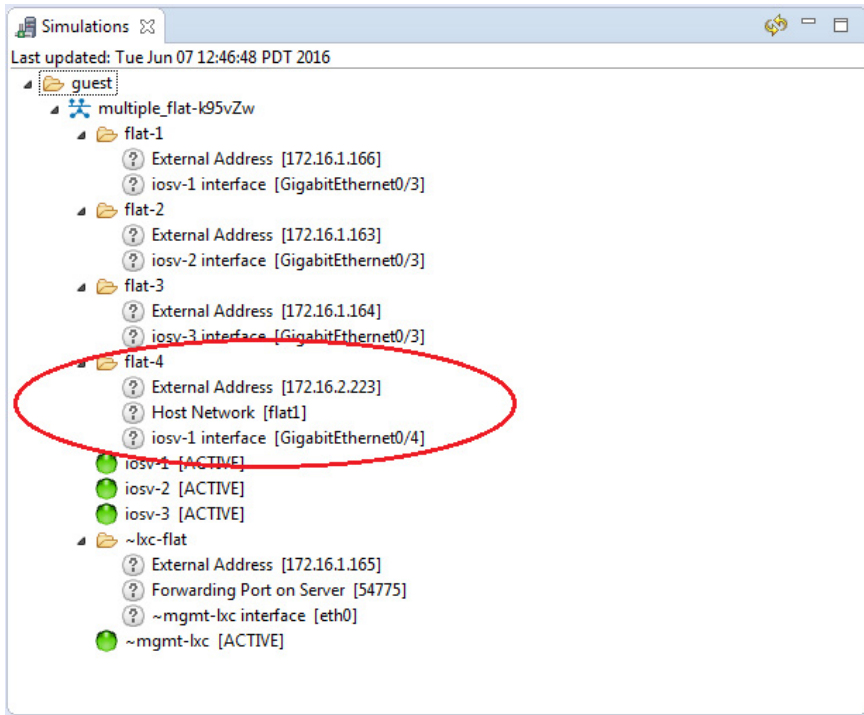
Step 6   Regarding the node that has two FLAT network connections, when its state has changed to **[ACTIVE]**, log in to said node.

Step 7   Enter the command `show ip interface bri` to view all interfaces available to the node.

Figure 11: Viewing the FLAT Networks

```
Console    Terminal View iosv-1 multiple_flat-k95vZw (Management (via mgmt LXC))

iosv-1 (Management (via mgmt LXC)) - multiple_flat-k95vZw
* Supplemental End User License Restrictions            *
*                                                       *
* This IOSv software is provided AS-IS without warranty of any kind.  *
* Under no circumstances may this software be used separate from  *
* the Cisco Modeling Labs Software that this software was provided  *
*  with, or deployed or used as part of a production environment.  *
*                                                       *
* By using the software, you agree to abide by the terms and  *
* conditions of the Cisco End User License Agreement at  *
* http://www.cisco.com/go/eula.                         *
*                                                       *
* Unauthorized use or distribution of this software is expressly  *
* prohibited.                                           *
***********************************************************

iosv-1#show ip interface bri
Interface              IP-Address      OK? Method Status           Protoco
l
GigabitEthernet0/0     10.255.0.27     YES NVRAM  up               up

GigabitEthernet0/1     10.0.0.1        YES NVRAM  up               up

GigabitEthernet0/2     10.0.0.5        YES NVRAM  up               up

GigabitEthernet0/3     172.16.1.166    YES NVRAM  up               up

GigabitEthernet0/4     172.16.2.223    YES NVRAM  up               up

Loopback0              192.168.0.1     YES NVRAM  up               up

iosv-1#
```

You can see that the node has a connection into each of the external FLAT connectivity networks, 172.16.1.196 and 172.16.2.53.

In-Band Management Sessions via a Flat Interface

Managing nodes via the Cisco Modeling Labs client or using terminal emulator sessions via OOB management interfaces work well when the access is exclusively used for management plane interactions. When external connectivity will be used for both management-plane and data-plane traffic exchanges with external devices, an In-Band management solution may be warranted. As shown in the following figure, the Flat (Eth1) interface

is associated with an interface on the new-york node, to which an IP address from the Flat-interface address pool is assigned.

Figure 12: In-Band Management Connections
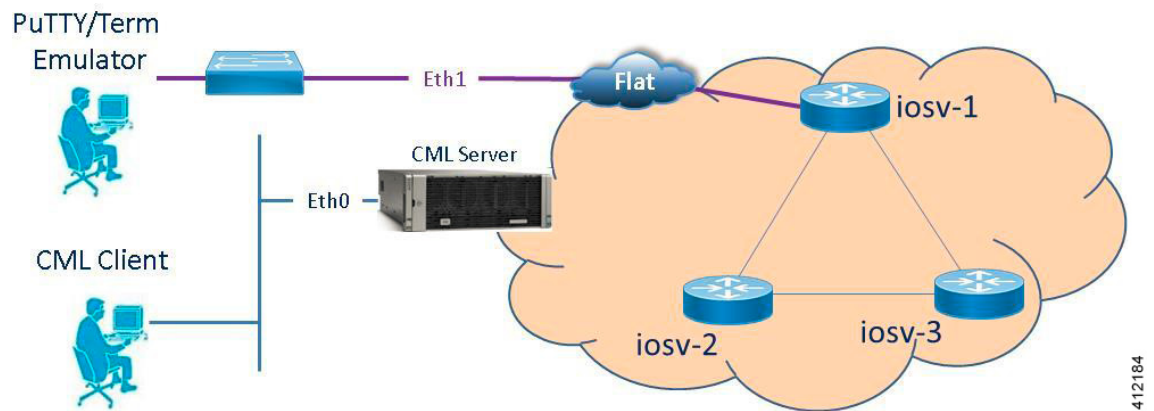
Within the Cisco Modeling Labs client's **Design** perspective, an L2 External (FLAT) object is placed on the canvas and a link connection is drawn between the resultant flat-1 icon and a node, as shown.

Figure 13: Enabling Bridged Connections to External Devices
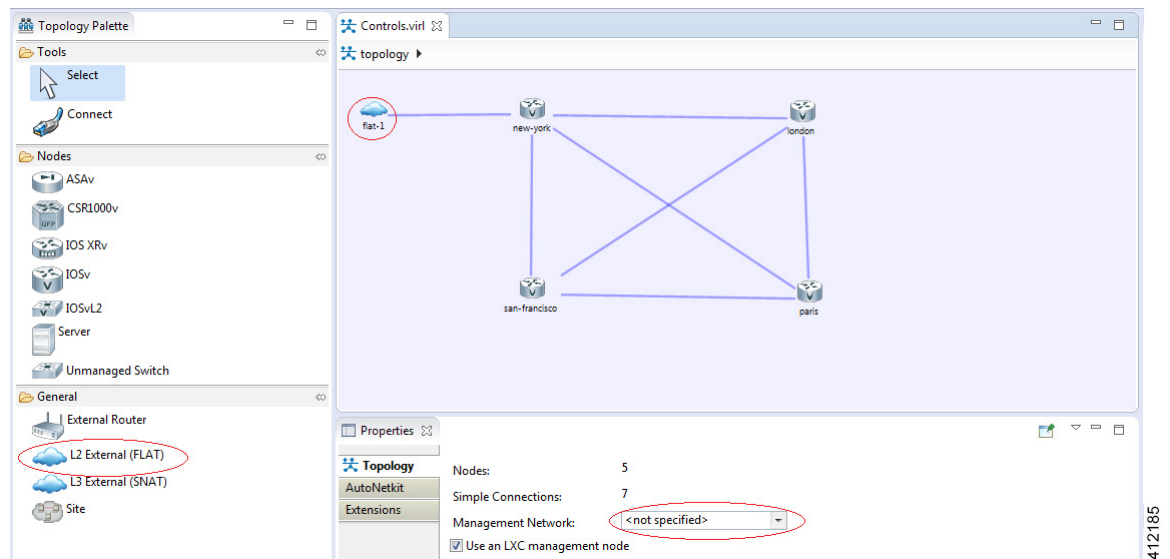
Using the L2 External (FLAT) object precludes the simultaneous use of the Out-of-Band management option. The Management Network option within **Properties** > **Topology** is not defined (<not specified>) as shown above.

During the topology's launch phase, an IP address from the range provisioned for the Flat (Eth1) interface (by default, 172.16.1.0/24) is assigned to the associated interface on new-york. The externally attached terminal or management device is then manually configured with an unused IP address within this scope. An alternative option is to enable DHCP services on the node as to offer an IP address to the attached workstation.

Note   In multiuser deployments, consideration must be given to DHCP scope and exclusion ranges applied to nodes within simulation environments and to coordinate the assignment ranges being facilitated by the Cisco Modeling Labs server during topology build/launch phases. Otherwise, multiple agents assigning addresses from overlapping pools might result in duplicate address assignments.

Set Up a FLAT Network for Inband Access

Managing nodes via the Cisco Modeling Labs client or using terminal emulator sessions via OOB management interfaces work well when the access is exclusively used for management plane interactions. When external connectivity is used for both management-plane and data-plane traffic exchanges with external devices, an In-Band management solution may be required.

The following procedure describes how to connect your virtual network topology to physical devices that are external to the Cisco Modeling Labs server environment. In this procedure, you will be configuring a FLAT network. A FLAT network uses Layer-2 connectivity in which the IP address information about your virtual network can be viewed externally.

Important   The IP address range assigned to FLAT must be a routable IP address. In addition, these IP addresses must be defined in the settings.ini. When done, the administrator must run the Upgrade or Rehost option so that the changes take affect. Note too that running the Rehost option will affect other users on the server.

Before You Begin

- Ensure that the system administrator has configured the Cisco Modeling Labs server to allow FLAT connections.

- Ensure that you obtain the IP address of the default gateway from the system administrator.

- Ensure that you have the IP address of the external device to which the nodes will connect.

Note   We recommend that you first draw your intended design, and then label the devices with the appropriate IP addresses.

Step 1   Log in to the Cisco Modeling Labs client.

Step 2   Verify you have connectivity to the Cisco Modeling Labs server.

Step 3   Open the **Design** perspective, if it is not already open.

Step 4   Open an existing topology or create your network topology. See Create a Topology for information on how to do this.

Step 5   Click on the canvas to open the **Topology** tab in the **Properties** view and ensure that **Management Network** displays **<not specified>**.

Step 6   From the **Palette** view, under **General**, click the **L2 External FLAT** tool, and then click the canvas to add one FLAT cloud network icon to each corresponding node icon on the canvas.

Step 7   From the **Palette** view, under **Tools**, click the **Connect** tool and connect the **L2 External FLAT** to the desired nodes.

Note L2 External FLAT connections can only be assigned to one interface on one node.

Step 8 From the toolbar, click the **Build Initial Configurations** tool.

Note For the purpose of this task, you may retain the default settings.

The system automatically assigns an IP address to the node interface that is connected to the FLAT cloud during the **Simulation** phase, not the **Build** phase.

Step 9 After the build phase is completed, start the simulation by clicking the **Launch Simulation** tool in the toolbar, and then change to the **Simulation** perspective.

Step 10 Log in to the node that is connected to the FLAT network when its state has changed to ACTIVE.

Step 11 View the IP address assigned to the FLAT network and determine if it is on the same subnet as the gateway IP address provided by your system administrator. The L2 external address for each node can be viewed from the **Simulations** view or from each individual node.

- If yes, continue to Step 12.

- If no, advise your system administrator and request the correct gateway IP address.

Step 12 If the external device is on a different subnet, define a default gateway or a broadcast domain that points to the IP address of the gateway that the system administrator supplies.

Prior to completing this step, if you do a **show route**, you will see that no default gateway is defined in the node. This is the default set up. This step allows you to inform the node what path to take in order to reach the external environment via the gateway. An alternative to defining a gateway or static route, with IOSv devices, is to enable DHCP on the interface used for external connectivity.

Note Not all virtual images support DHCP. Check the supported features for the virtual images to determine which ones do support DHCP.

Step 13 Test the connection by pinging from the node to the external (physical) device. If required, turn on **debug ip icmp** or use the **tracert** command to see the progress through the network.

Note You must repeat steps 10-13 for each node that is connected to the FLAT network.

If the ping does not work, confirm with your system administrator that the Cisco Modeling Labs server is configured to support FLAT connectivity and that the gateway IP address you have been provided is correct.

If these items are correct, ping to each of the key devices in the path to determine where the failure occurs and notify your system administrator of the failure source if it is outside your Cisco Modeling Labs environment.

Interconnect Topologies in Physical Labs via a Flat Interface

A Flat interface may also be used to interconnect a group of physical lab devices to nodes running within a simulation.

By default, the node's interface associated with the Flat object is assigned an IP address from the range provisioned to the Cisco Modeling Labs' Ethernet1 interface during server installation. This is allotted when the node is spun up by OpenStack when the simulation is launched. Once fully active, the assigned interface address may be adjusted to meet the addressing requirements of the external environment (or the external device's interface is configured with an appropriate address to interact with the node.) After confirming Layer-2

connectivity between the physical/virtual nodes, implement the necessary (static or dynamic) routing in both physical and virtual lab environments to complete the integration.

Access Multiple Nodes via a Flat Interface

The **L2 External (FLAT)** object may be assigned to only one interface on one node. When topology scenarios demand Layer-2 connections to multiple nodes, additional L2 External (FLAT) objects may be used on the canvas with the associated link relationship to the associated node.

*Figure 14: Multiple Flat Network Associations*

When a simulation is launched, an IP address from the Flat (Ethernet1) external address pool is assigned to the respective node interfaces connected to the external icon. While the example functionally matches that of the OOB_Management configuration, it differs in that the interfaces reserved for OOB (GigabitEthernet0/0) are not used. Instead, the next available infrastructure interface is selected for use (or manually allocated).

Connect Multiple Networks across a Single Flat Interface

Multiple Layer-3 networks may be interconnected between physical and virtual nodes using a single flat interface. This is facilitated by the use of the Cisco IOSvL2 node within the simulation, with the external facing interface configured as an 802.1Q trunk. The corresponding trunk configurations are applied to the

attached physical device's interface, as shown. Each Layer-3 network is represented as a VLAN traversing this Layer-2 trunk.

Figure 15: Extending VLANs across Cisco Modeling Labs' Flat (Eth1) Interface
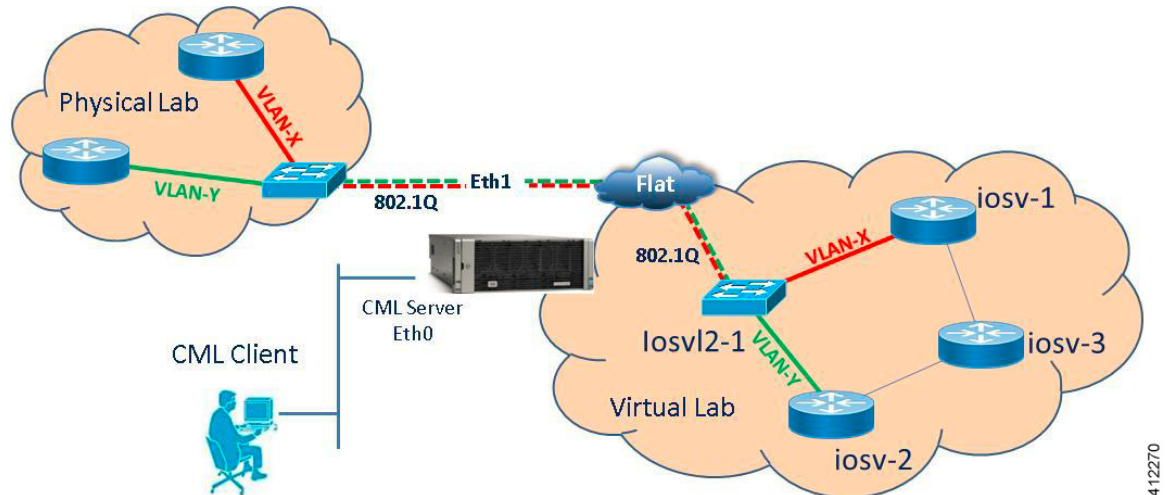
Note that the AutoNetkit process may not completely provision this application, and manual configurations may be necessary to enable the external connection as a trunked interface. Special consideration may be required for Cisco Modeling Labs deployments on top of ESXi when extending VLANs between an IOSvL2 node and an external device. Whether deployed with distinct ESXi vSwitches and dedicated pNICs or a common vSwitch with a shared/trunked pNIC, the ESXi Port Groups associated with the Flat interface must be set to carry 802.1Q tagged frames. Using the vSphere client (or vCenter management station) to access the ESXi server, the host's **Networking** > **Configuration** page is accessed. Edit the Port Group properties of the Flat interface to pass All (4095) VLAN IDs, as shown. If the Flat1 interface is to be used in a similar manner, it should also be enabled to carry all VLAN IDs.

*Figure 16: Setting the ESXi Port Group to Support VLANs*
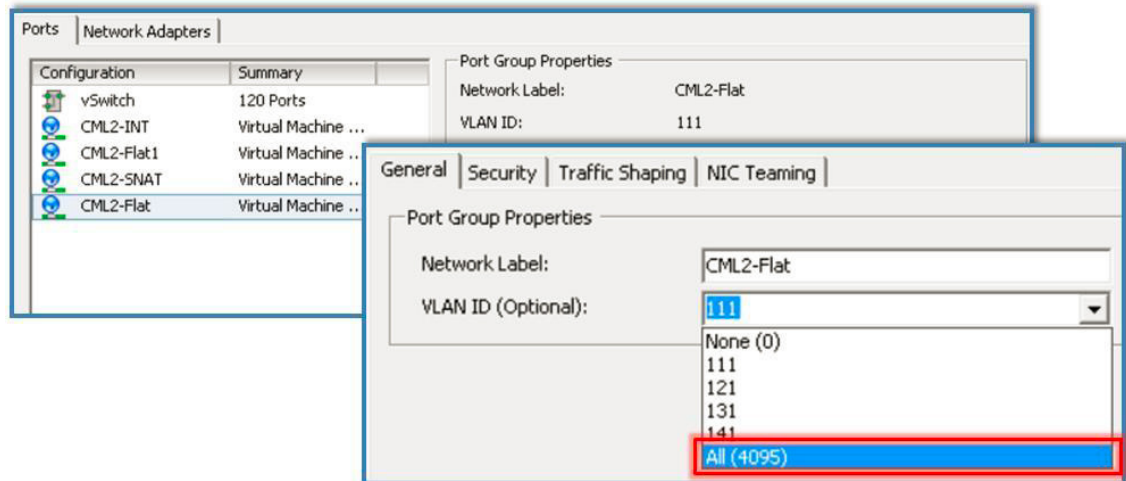
Note   The upstream (physical) switch interface should not have the BPDU_Guard feature enabled on the associated interface(s) as to prevent any BPDUs originating from virtual nodes from triggering an interface-shutdown.

Employ Multiple Flat Interfaces

There are simulation scenarios that may necessitate multiple Layer-2 connections to external devices, as shown.

Figure 17: Employing Multiple Flat Interfaces to External Devices
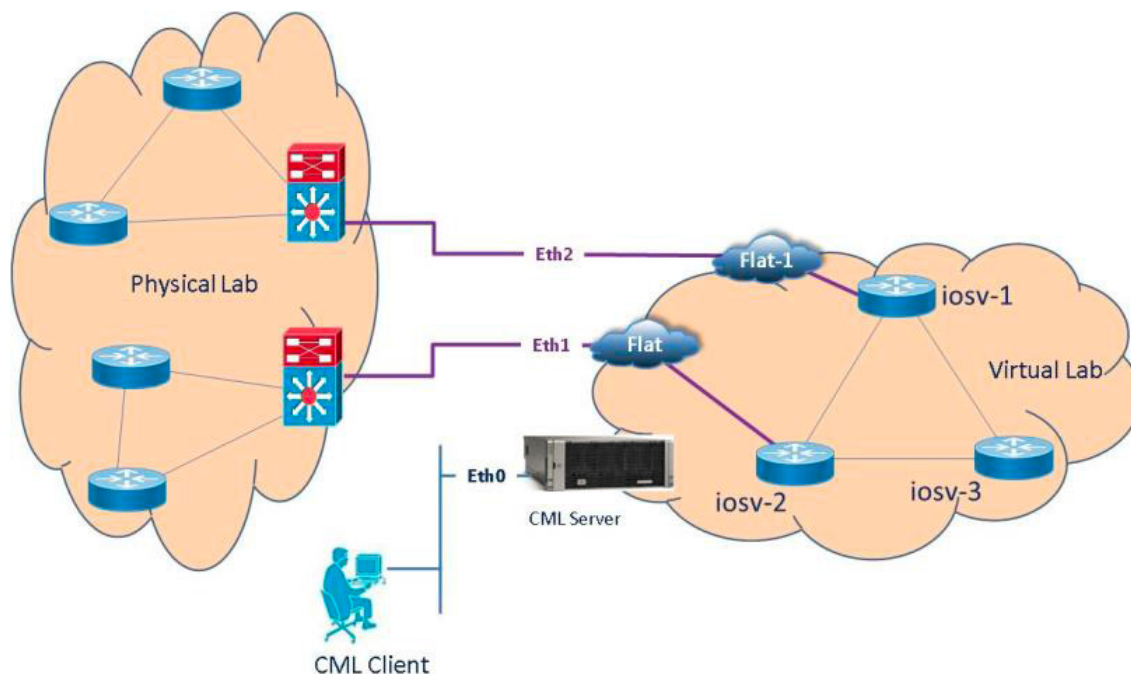

Applications that necessitate multiple flat network interfaces may include:

- Traffic generated by an external source that crosses the virtualized network to another external destination device.

- Integrating multiple, physical lab topologies (representing access-networks) to a simulated core topology.

- Interconnecting multiple virtual lab scenarios or external virtual machines to a simulated core topology.

- Scaling Cisco Modeling Labs topology sizes by interconnecting multiple Cisco Modeling Labs instances across separate servers.

The Cisco Modeling Labs server offers a second bridged interface to enable such test designs. Adding L2 External (FLAT) objects will, by default, be associated to the Flat (Eth1) interface. This default allocation may be manually overridden by editing the object's properties as to use the server's Flat1 (Eth2) interface.

This change is done by selecting the **L2 External (FLAT)** icon on the canvas. Within the **Properties** view, choose the **Extensions** tab and click **Add** [+], as shown.

*Figure 18: Editing L2_External(FLAT) Object Properties*
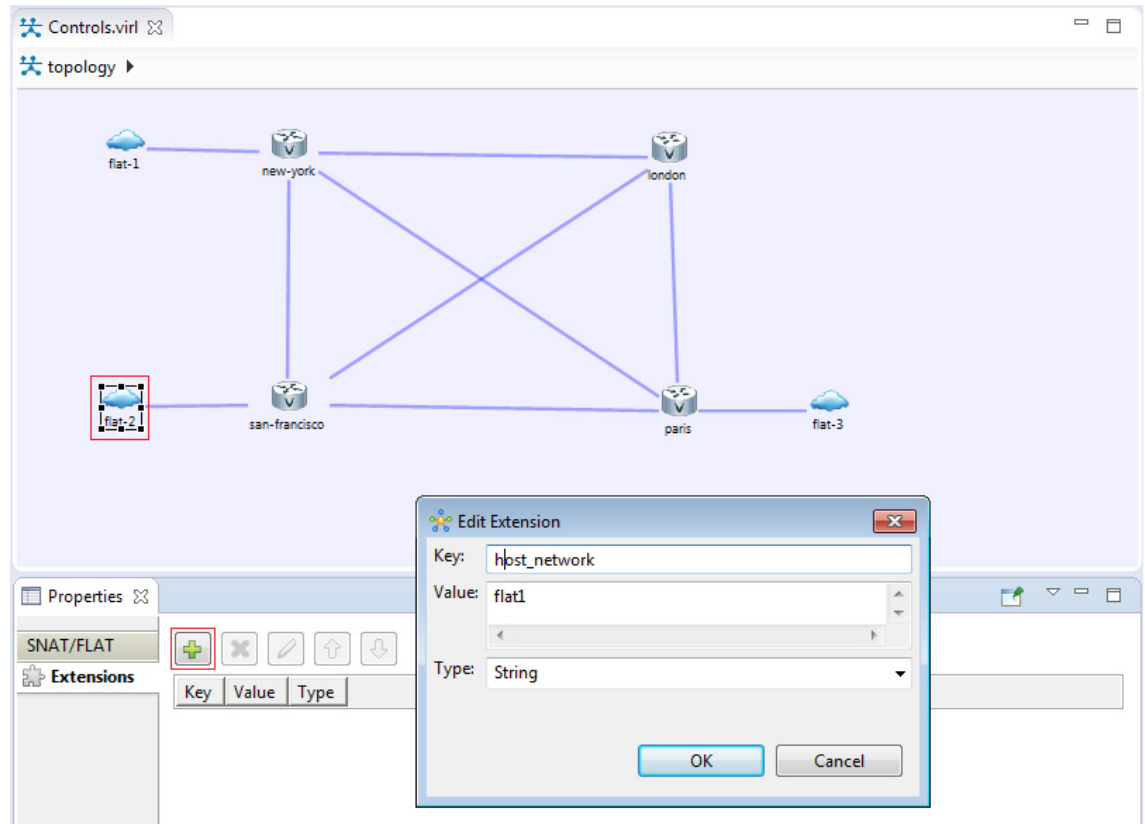
Within the **Edit Extension** dialog box, add the following details for the new extension, and click **OK**.

- Key: host_network
- Value: flat1
- Type: String

When the simulation is launched, an IP address from the Flat1 external address pool is assigned to the respective node interface connected to the L2 External (FLAT) icon. The Simulations view shows the flat-1 and flat-2 objects and their attributes.

*Figure 19: Displaying Properties of Running Flat Interfaces*
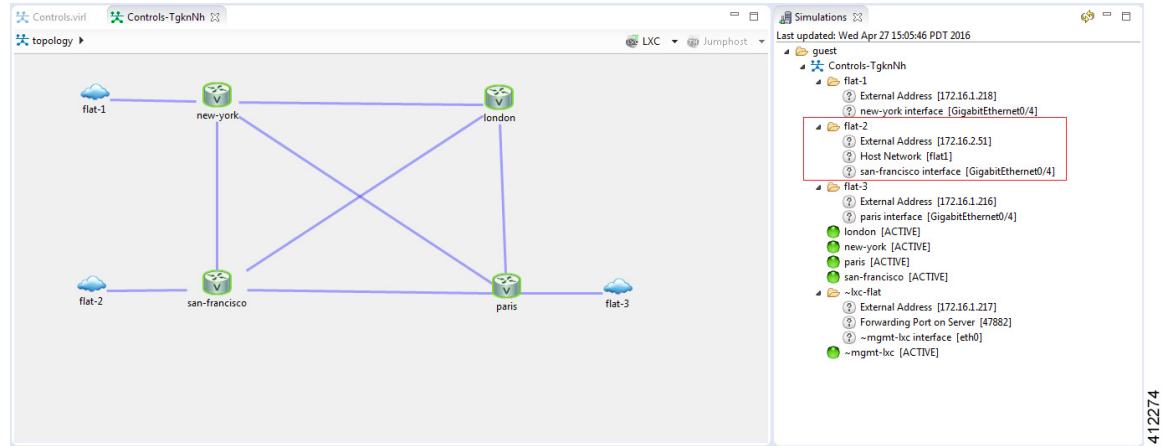
Examination of the flat-2 object shows its association to the flat1 Host Network, and the respective iosv-1 interface (GigabitEthernet0/3) assigned an IP address from the Flat1 address pool (172.16.2.0/24 in the example). As additional L2 External (FLAT) objects are added to the canvas, they may remain associated with the default flat interface or edited as described to be associated with the flat1 interface.

Employ OOB Management with External Devices

When the Shared flat network is selected as the Management Network for OOB_Management, the Flat (Eth1) interface is associated with the GigabitEthernet0/0 interfaces for each of the nodes in the topology simulation.

If external devices are also to be integrated using a flat interconnection, the Flat1 (Eth2) and associated IP address range must be used, as shown.

Figure 20: Using OOB Management with Flat-interconnect External Devices
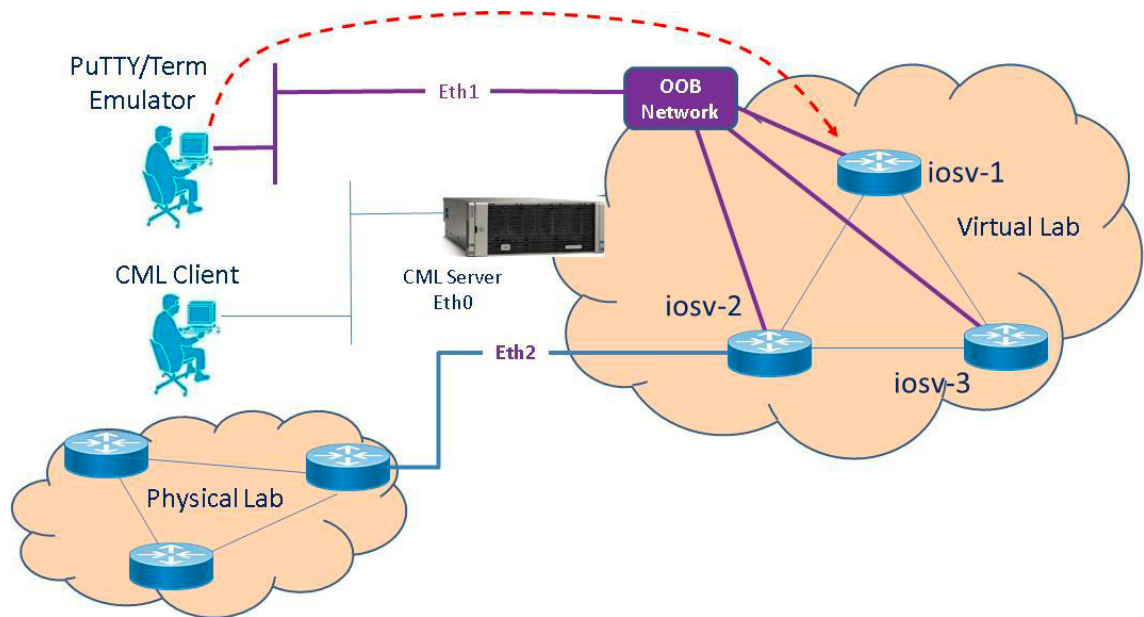
When the L2 External (FLAT) object is inserted into the topology, its properties must be edited as described in the previous section.


Important   In these scenarios, if the L2 External (FLAT) object is not edited to use the Flat1 interface, the Cisco Modeling Labs client's Build process will fail, reporting overlapping use of the Flat interface.

Interconnect External Devices via a SNAT Interface

The Static Network Address Translation (SNAT) interface enables communications between running nodes and external devices using Layer-3 services via an internal (OpenStack) virtual router. Using the L3_External (SNAT) object, the simulated virtual networks and details are hidden behind a Static NAT address block. The Cisco Modeling Labs server does a static IP address translation, translating the private address range allocated

to the SNAT 'inside' network into the IP network configured for the SNAT 'outside' network. By default, Cisco Modeling Labs uses an internal gateway function that acts as a SNAT router, as shown.

Figure 21: Using the SNAT Interface
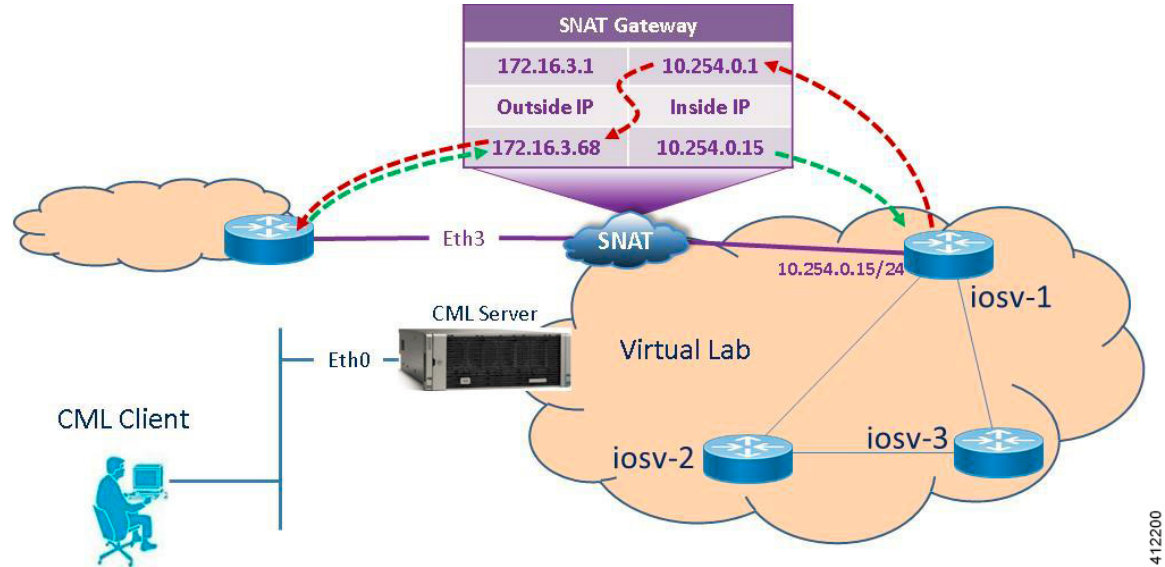
| | Important | The IP address range assigned to SNAT must be a routable IP address. In addition, these IP addresses must be defined in the settings.ini file. When done, you must run the Upgrade or Rehost option so that the changes take affect. |

When a simulation starts up, IP addresses from the internal infrastructure pool are assigned to their respective node interfaces by OpenStack's Neutron services. Those interfaces are then mapped to their corresponding external address, also assigned by Neutron services. These internal to external IP mappings are maintained within the Neutron SNAT-Gateway.

In the following example, the new-york GE 0/4 interface has two IP addresses. The addresses on the 172.16.3.0 subnet are reachable from the external devices and will be translated to the internal addresses which are on the 10.254.0.1 network.

Figure 22: SNAT Functionality
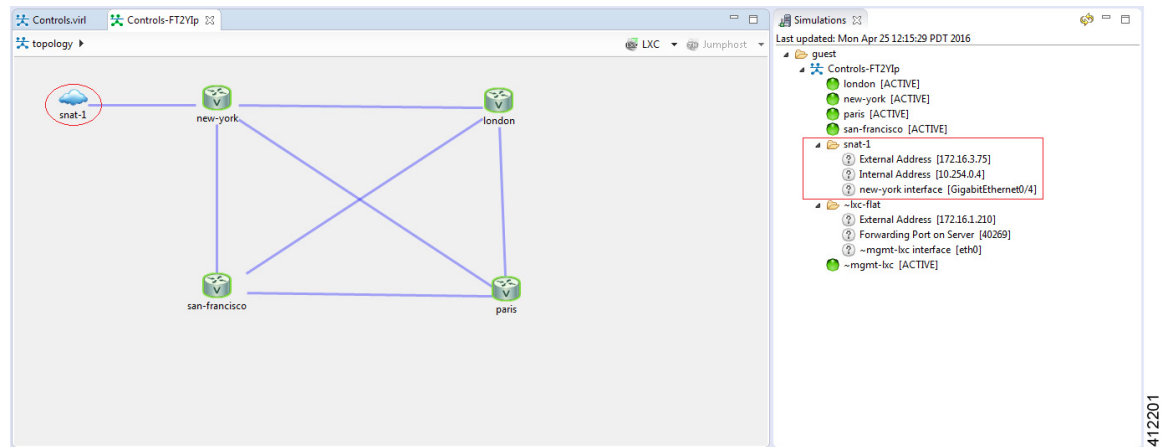
Looking at the snat-1 object shows the internal and external addresses assigned to the SNAT gateway function associated with the GigabitEthernet0/1 interface within the new-york node during the spin-up of the project simulation. Manual configuration of the associated nodes is now required to enable traffic to traverse the SNAT gateway, where static routing statements must be added to the simulated device "attached" to the snat-1 object.

By accessing the **User Workplace Management** interface, you can determine the additional details required to set up the static routing. After logging in, access the external connections list by selecting the **Connectivity** option. Within the **L3 Snat IP Address Allocations** section, the appropriate SNAT gateway addresses are listed, as shown.

Figure 23: Determine the SNAT Gateway Addresses
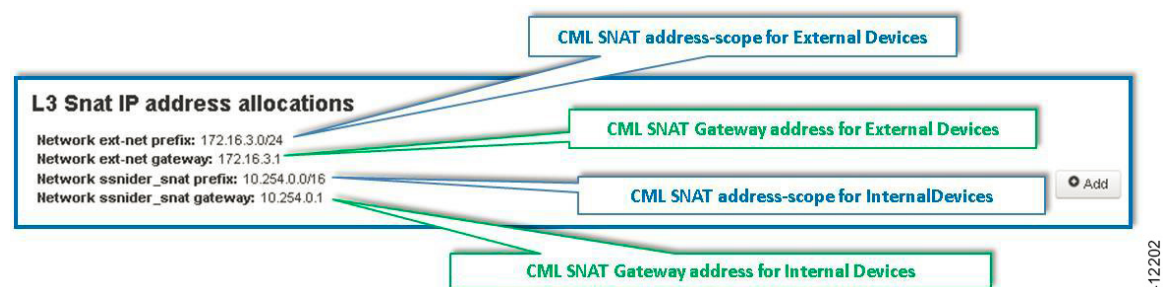
✎ **Note**   The IP addresses shown above are default values that may be adjusted during the Cisco Modeling Labs server installation process. Viewing the Connectivity information in the **User Workplace Management** interface ensures that the correct details are employed. If the **User Workplace Management** interface is not available, the necessary details must be provided by the system administrator.

The appropriate static routes must be configured to route externally destined traffic to the inside gateway's IP address. This may be done manually by logging into the running node associated with the SNAT object, and adding the appropriate static or default routing statement(s).

Alternatively, you can use AutoNetkit to insert the static route statements. This is done in the Cisco Modeling Labs client in the **Design** perspective, before the simulation is launched. With the node directly connected to the SNAT node selected, enter the static route statements under **Properties** > **AutoNetkit** > **Custom Configuration** > **Global**, as shown.
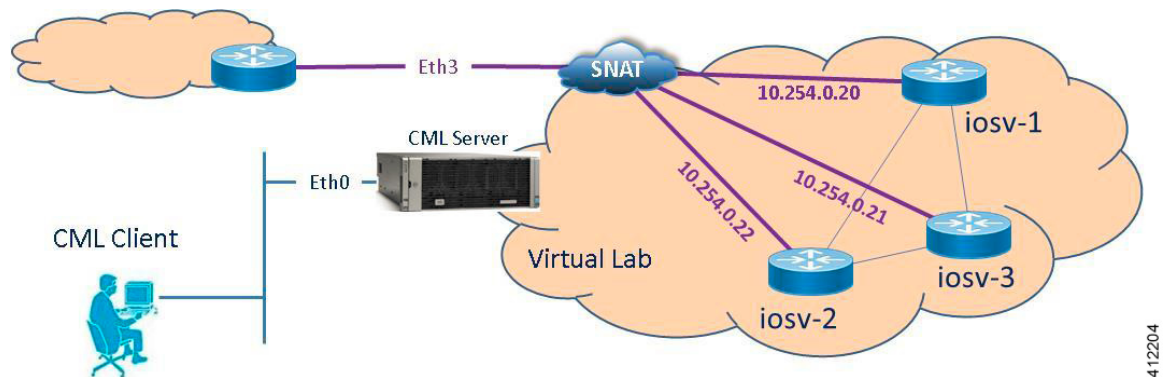
Figure 24: Use AutoNetkit to Set the SNAT Gateway Route

Access Multiple Devices via a SNAT Interface

Multiple L3_External (SNAT) objects may be placed on the canvas in the Cisco Modeling Labs client with links drawn to their respective virtual nodes as shown.

Figure 25: Using the SNAT Interface

When a simulation starts up, OpenStack-Neutron services within Cisco Modeling Labs provisions internal and external IP assignments and maintains these mappings on a 1:1 basis within the SNAT gateway, as shown.

Figure 26: Multiple SNAT Connections
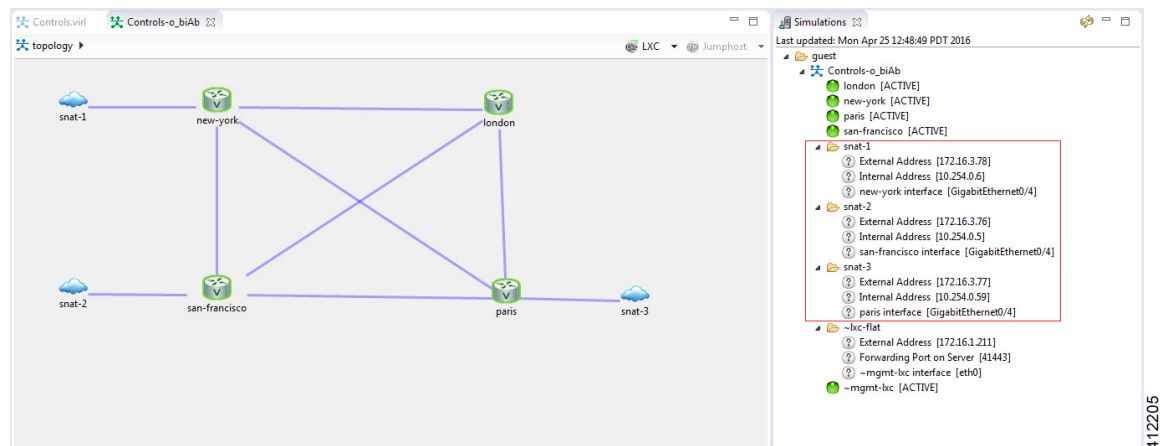
The SNAT-attached nodes will require appropriated static routing commands applied to their running configurations. As with the single SNAT connection, these may be inserted via console sessions with each of the nodes after launching. This will also require configuration extraction prior to shutting down the simulation if the topology is expected to be run again.

Note   The node to snat-n links shown above do not represent Layer-3 links to distinct external devices.

The more efficient method is to use AutoNetkit to apply the statements to the startup configuration file via the build process. By selecting each of the affected nodes on the canvas, the Custom Configuration may be simultaneously added to all of the nodes with SNAT connectors, as shown.

Figure 27: Applying Static Routes to Multiple SNAT-attached Nodes
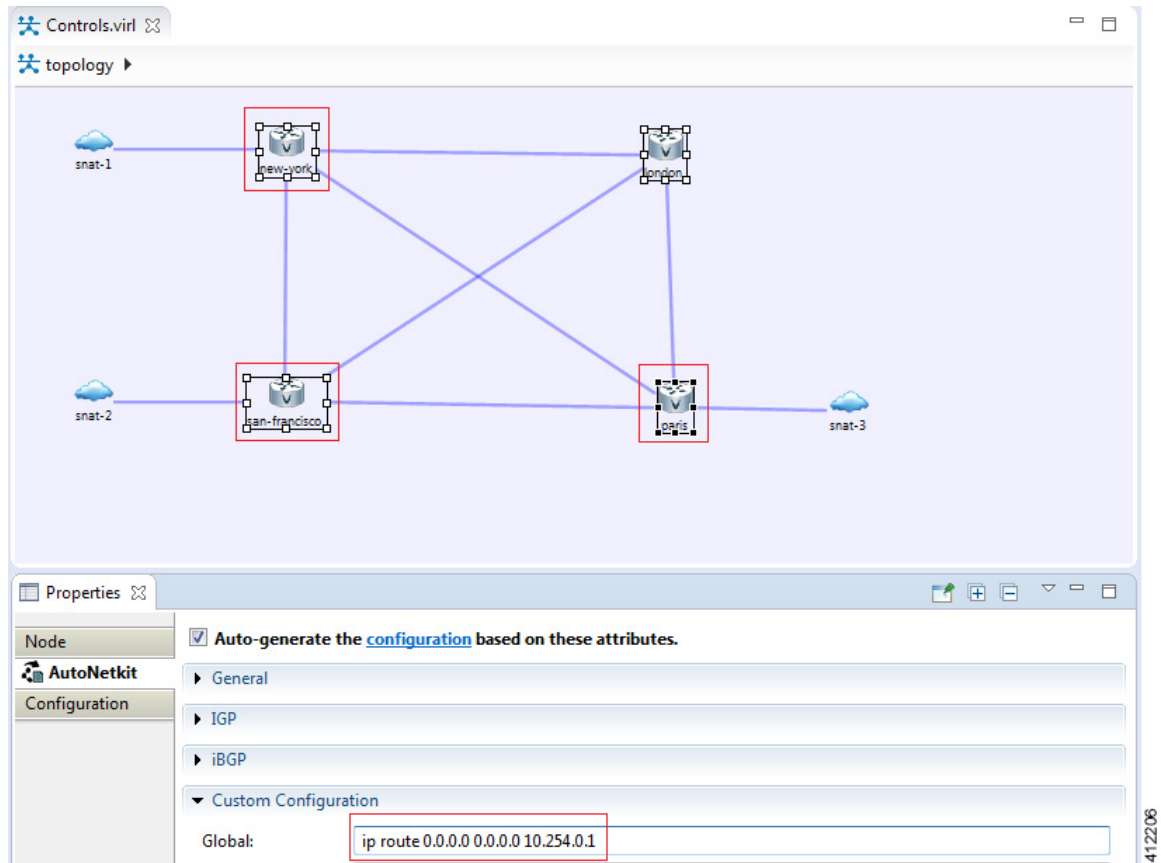
Set Up a SNAT Network for Inband Access

To set up a SNAT Network for inband access, complete the following steps:

Before You Begin

- Ensure that the system administrator has configured the Cisco Modeling Labs server to allow SNAT connections.

- Ensure that the system administrator provides you with the internal and external IP addresses of the SNAT router.

- Ensure that you have the IP address to the default gateway.

• Ensure that you have the IP address of the external device to which the nodes will connect.

Step 1 Log in to the Cisco Modeling Labs client.

Step 2 Verify you have connectivity to the Cisco Modeling Labs server.

Step 3 Open the **Design** perspective, if it is not already open.

Step 4 Open an existing topology or create your network topology. See Create a Topology for information on how to do this.

Step 5 Click on the canvas to open the **Topology** tab in the **Properties** view and ensure that **Management Network** displays **<not specified>**.

Step 6 From the **Palette** view, under **General**, click the **L3 External SNAT** tool, and then click the canvas to add one SNAT cloud network icon to each corresponding node icon on the canvas.

Step 7 From the **Palette** view, under **Tools**, click the **Connect** tool and connect the **L3 External SNAT** to the desired nodes.

> **Note** L3 External SNAT connections can only be assigned to one interface on one node.

Step 8 From the toolbar, click the **Build Initial Configurations** tool.

> **Note** For the purpose of this task, you may retain the default settings.

The system automatically assigns the internal and external IP addresses to the node interface that is connected to the SNAT cloud during the **Simulation** phase, not the **Build** phase. Therefore, no assigned addresses are visible at this point.

Step 9 After the build phase is completed, start the simulation by clicking the **Launch Simulation** tool in the toolbar, and then change to the **Simulation** perspective.

Step 10 Log in to the node that is connected to the SNAT network when the status of the device has changed to ACTIVE.

Step 11 Create a static route or define a default gateway for the external connection IP addresses that point to the SNAT router's internal IP address. For example, if the external connections are part of the subnet 172.16.2.0/24, and the SNAT router's internal IP address is 10.11.11.1, then the route statement would be:
ip route 172.16.2.0 255.255.255.0 10.11.11.1

An alternative to defining a gateway or static route, with IOSv devices, is to enable DHCP on the interface used for external connectivity.

> **Note** Not all virtual images support DHCP. Check the supported features for the virtual images to determine which ones do support DHCP.

Step 12 Test the connection by pinging from the node to the external (physical) device. If required, turn on **debug ip icmp** or use the **tracert** command to see the connectivity between the end points.

If the ping does not work, confirm with your system administrator that the Cisco Modeling Labs server is configured to support SNAT connectivity and that the gateway IP address you have been provided is correct.

If these items are correct, ping to each of the key devices in the path to determine where the failure occurs and notify your system administrator of the failure source if it is outside your Cisco Modeling Labs environment.

Use Case Scenarios

Within many different sectors, for example, education and technical training, Cisco Modeling Labs may be used to facilitate virtual labs to support hands-on practice in conjunction with lesson plans. Cisco Modeling Lab's multi-user features can be configured to support multiple projects, containing several similarly defined simulations representing a lab exercise. There are a variety of methods to enable student access to virtualized lab environments, for example:

• Using Flat for OOB_Management of Simulations

• Using SNAT for OOB_Management of Simulations

•

These methods are discussed in the next sections.

Using Flat for OOB_Management of Simulations

In this use case, each course is represented as a Cisco Modeling Labs project containing a sequential series of pre-defined topology designs representing the lab exercises associated with the lesson plan. Each of these topologies is spun up as a group of lab instances with one for each student. To assure isolated access to each virtual lab-pod, the simulations are launched with the Private_Simulation OOB_Management Network, which uses a simulation-level jump-host employed as a lab-network gateway.

Note
For each lab-pod, the virtualized devices within the simulations must be enabled for Telnet logins before students can access them via the Jumphosts. The appropriate **users**, **passwords**, and **line vty** commands may be implemented as part of the AutoNetKit custom configurations, by manually modifying the configurations prior to launching the simulations, or implemented after spinning up the virtual nodes (preferably using an automated script.)

This basic layout is summarized in the following figure, which illustrates two subsets of students accessing virtualized lab resources associated with two different courses. Two distinct Projects are shown **Course-A** and **Course-B**, each independently managed by their respective course instructor. Within each project, a set of similarly designed and configured simulations are spun-up as student lab resources. Because each simulation is completely isolated from the other simulations within the project, they may be exact copies of each other

(the exception being the external IP address assigned to the jumphost, which is assigned when the simulation starts.)

Figure 28: Using Flat Connections for Student Lab Access
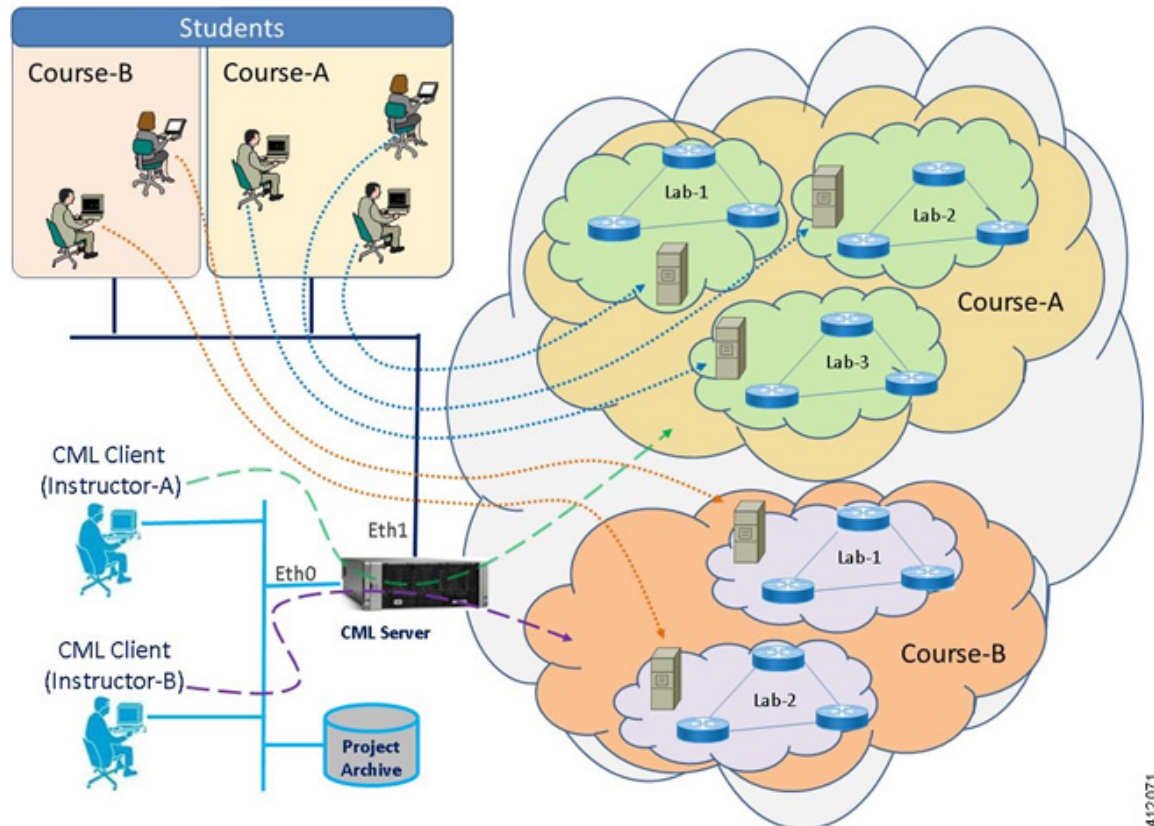
Students access their respective lab-pods using SSH sessions to the jumphost address assigned by the instructor. Upon successful login, they may access the virtual nodes within their topology and perform the hands-on exercise associated with the lesson. Using the Cisco Modeling Labs client, the instructor is able to access any of the labs within the project to provide assistance and perform course-specific administration of the lab exercises.
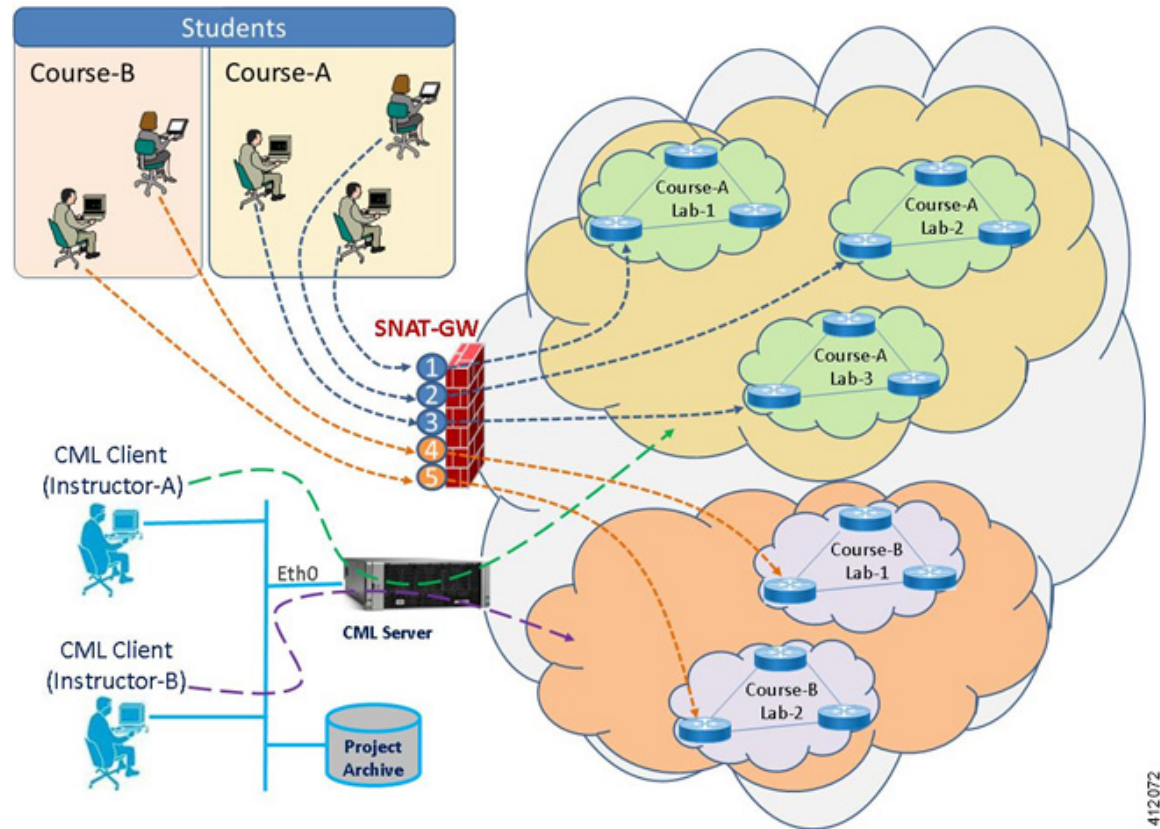
Note   This scenario only depicts the student/instructor access to the lab environment. There are additional considerations with respect to simulation startup/teardown, remote access (e.g. front-end VPN gateway or router), access scheduling, activity retention/restoral, and lab resets.

Using SNAT for OOB_Management of Simulations

A Layer-3 based method may be used to access the same course lab scenario. In this use case, the SNAT interface provides access to a single node within each simulation. A significant advantage of this approach is that it preserves the other Flat interfaces for other external communications considerations (for example, connections to physical devices and interconnecting student simulations as part of a progression lab design.) Each simulation is set for Private_Simulation management network as to ensure the desired isolation between

the simulated topologies. Users gain access to the simulation via the public IP address associated with their assigned topology environment, which is translated to the internal IP address of the head-end node. Once logged in, Telnet sessions may be launched to the other simulation's nodes, as shown in the following figure.

Figure 29: Using SNAT Connections for Student Lab Access

Since the SNAT based approach only establishes an in-band management connection to the head-end node, the base topology design must have sufficient configurations applied as to enable in-band Telnet sessions to the other virtual nodes within the simulation. This includes the initial interface configurations, as well as the appropriate **users**, **passwords**, and **line vty** commands.

As in the previous example, this scenario only depicts the student/instructor access to the lab environment. There are additional considerations with respect to simulation startup/teardown, remote access (e.g. front-end VPN gateway or router), access scheduling, activity retention/restoral, and lab resets.

Similar to the Flat-interface based method, the Cisco Modeling Labs client is used by the instructor to access any of the labs within the project to provide assistance, as well as to perform course-specific administration of the lab exercises.

Using the Cisco Modeling Labs Client

Leveraging external communications interfaces for student access of virtual labs is useful for the novice learner or when there is a desire to use more tightly scripted learning labs. It allows the hands-on lab elements to be limited to the curricula requirements without introducing the features of the Cisco Modeling Labs' client interface. For more intermediate and advanced networking learners, the Cisco Modeling Labs client may be the appropriate means to access Cisco Modeling Labs services. Student use of the Cisco Modeling Labs client

enables self-administration of lab scenarios, and enables a self-directed discovery and learning style. When allowing student use of the Cisco Modeling Labs client, considerations include (but not limited to):

- Remote access options and associated firewall settings

- Setting appropriate resource quotas

- Configuring an expiration account access

- Corresponding access rights to any NAS/shared storage for reusable .virl files

- Access to any external communications interfaces and attached devices