



Open SDN Controller Applications

The following topics describe the five applications that Open SDN Controller provides to facilitate the day-to-day administration of your network:

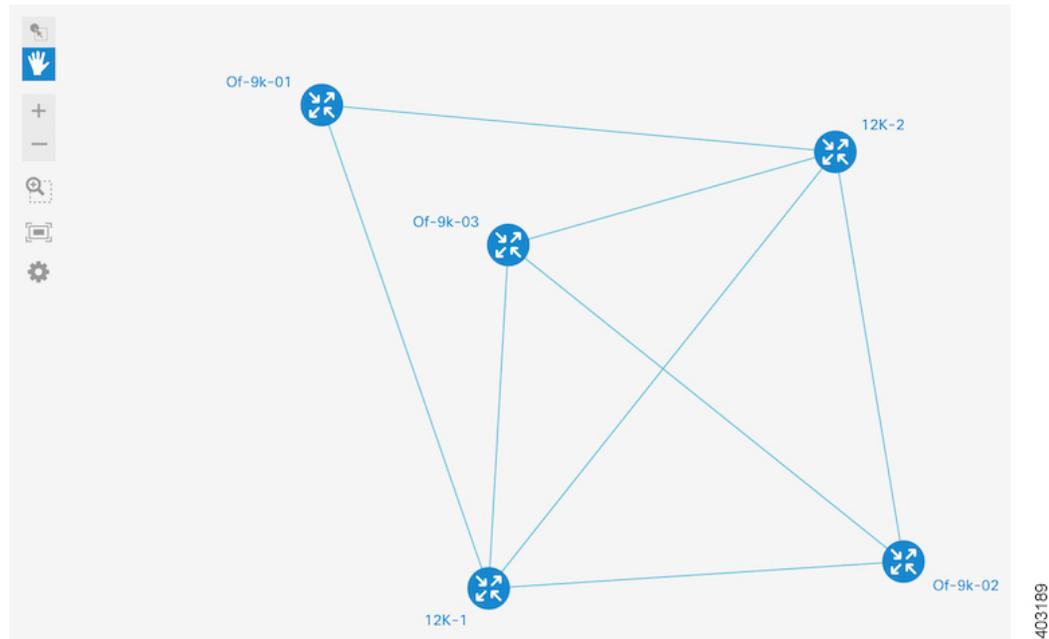
- [BGPLS Manager, page 1](#)
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BGPLS Manager

Border Gateway Protocol (BGP) allows you to set up an interdomain routing system that automatically guarantees the loop-free exchange of routing information between autonomous systems. The primary function of a BGP system is to exchange network reachability information with other BGP systems, including information about the list of autonomous system paths. BGP can also be used to exchange other types of network information. For example, BGP Link-State (a BGP extension) enables a router running a link-state routing protocol (such as IS-IS) to communicate the link-state database in a BGP session up to the controller.

From the BGPLS Manager, you can view a topology that maps to the nodes or devices in your network running a link-state routing protocol. You can also view address and interface information for each device, as well as the status of device links.

Figure 1: BGPLS Manager



Note that BGP-enabled devices cannot be added to the topology within BGPLS Manager. To add devices, complete the following procedure described in the [Adding BGP Devices](#) topic.

BGPLS Manager Workflow

The following procedure describes a typical workflow you would employ for the BGPLS Manager.



Note

Before you proceed, ensure that BGP-LS has been configured properly on both the controller and a BGP-LS speaker in the network. For more information, see the [Setting Up BGP-LS and PCEP](#) section in the Open SDN Controller installation guide.

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- Step 1** Open the BGPLS Manager by selecting **BGPLS Manager** from the Applications pane. A topology appears in the content pane, displaying the BGP-enabled devices in your network and the links that connect them. In this example, say you want to focus on the device that resides in your San Francisco site and view its BGP information.
- Step 2** From the BGPLS Manager toolbar, click **Select**.
Note For a description of the BGPLS Manager toolbar, see [Application Toolbar](#).
- Step 3** Click the icon for the San Francisco device.

A popup window opens, displaying basic BGP information for the device such as its IP address and any networks it is set to announce.

Note To quickly determine a device's neighbor devices, place your cursor over that device's icon in the topology. The icons for any non-neighbor devices are dimmed.

Step 4 Click the links connected to the device to view traffic information and identify any links with higher than normal traffic, which could indicate that a problem exists.

Note See [Creating LSPs](#) for a description of how to create links between devices.

Inventory Manager

From the Inventory Manager, you can view summary information for both the devices that Open SDN Controller manages and the interfaces that are configured on those devices. Note the following:

- You are only able to edit or delete NETCONF devices from the Inventory Manager. For a description of how to add devices, see [Mounting NETCONF Devices to the Controller](#).
- Any non-operational NETCONF devices will be indicated by red text.
- After a login username and password have been set on a NETCONF device, you can then change these values directly from the Inventory Manager.

Figure 2: Inventory Manager Application



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Inventory Manager Workflow

The following procedure describes a typical workflow you would employ for the Inventory Manager.

Step 1 Open the Inventory Manager by selecting **Inventory Manager** from the Applications pane. When you first open the Inventory Manager, you see a listing of every managed device in your system, as well as information such as its node ID, serial number, and interface count.

Note If you only want to view information for a specific device, enter its name in the Search field.

Step 2 Manage the devices in your system:

- To add a device, see [Adding a Device](#).
- To edit the settings for a device, see [Editing a Device](#).
- To delete a device, see [Deleting a Device](#).

Step 3 View information for the interfaces configured on a device:

- a) Open the Interface Details for *node-ID* page by either clicking anywhere in that device's table row or clicking its interface count value.
This page lists the name, port number, and MAC address for every interface configured on that device.
- b) Open the Interface Statistics for *node-ID* page by clicking **Statistics**.
This page provides data transfer statistics such as the number of packets dropped, transmission errors, and collisions.
- c) Investigate any interfaces that have higher than normal error numbers.

Note If no devices are connected to the controller, you should still see *controller-config* listed in the first row of the Inventory Manager table. If this entry is not visible, this indicates that the controller inventory APIs are not functioning properly. To confirm this, open the browser developer console. After the page refreshes, you should see either an HTTP 404 or 500 error for API `controller/restconf/operational/opendaylight-inventory:nodes`.

Adding a Device

Step 1 With the Inventory Manager already open, click the Config Nodes tab.

Step 2 Click **Add Device** to open the Add Device dialog box.

Step 3 Specify the following information for the new device:

- Node ID
- IP address
- Port number
- Username and passphrase required to log into the device

Take care when you specify a device's node ID, IP address, and port number because you will not be able to change these settings once the device has been added.

Step 4 Click **Save**.
The device should now be listed in the Config Nodes table.

Editing a Device

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- Step 1** Select either the Operational Nodes or Config Nodes tab and locate the device you want to edit.
 - Step 2** From the Actions column, click the device's Edit icon.
 - Step 3** Make the necessary changes to the username and passphrase required to log into that device and then click **Save**.
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Deleting a Device

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- Step 1** Select either the Operational Nodes or Config Nodes tab and locate the device you want to delete.
 - Step 2** From the Actions column, click the device's Delete icon.
 - Step 3** Click **Delete** to confirm the deletion of that device.
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Model Explorer

YANG is a data modeling language that models NETCONF configuration data, state data, remote procedure calls (RPCs), and notifications. Open SDN Controller uses YANG models to structure this data hierarchically into modules and submodules and render REST APIs at runtime in the Model Explorer. From here, you can access your network's configuration and state data via REST API methods such as GET and PUT.

To open the Model Explorer, select **Model Explorer** from the Applications pane.

Before you use the Model Explorer, we recommend that you view the documentation available for the REST APIs that Open SDN Controller supports to better understand their syntax and usage. See [Viewing RESTCONF API Documentation](#) for more information.

Viewing RESTCONF API Documentation

Open SDN Controller supports a number of RESTCONF APIs. To access documentation that provides usage information for these APIs:

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- Step 1** From the Help menu, select **API Documentation**.
A browser page opens, displaying all of the APIs that the controller supports.
 - Note** By default, the Controller Resources tab is selected when you first access the API documentation. If you want to view information for the APIs supported by a mounted NETCONF-enabled device, click the Mounted Resources tab.

- Step 2** Locate the API you want to view usage information for and click **Expand Operations**. All of the HTTP methods that the API supports are displayed.
- Step 3** To view usage information for a particular method, click its corresponding button (see the following screenshot for an example).

Figure 3: RESTCONF API Documentation Page

The screenshot shows the Cisco Open SDN Controller RESTCONF API Documentation page. At the top, there are two tabs: "Controller Resources" and "Mounted Resources". Below the tabs, it says "Below are the list of APIs supported by the Controller." There is a table listing several APIs: IF-MIB(2000-06-14), XSQL(2014-06-26), aaa-authn-model(2014-10-29), and bgp-rib(2013-09-25). Each row has buttons for "Show/Hide", "List Operations", "Expand Operations", and "Raw". The "bgp-rib(2013-09-25)" row is highlighted in green, and its details are expanded. The details include the HTTP method "POST" and path "/config/". There are sections for "Implementation Notes", "Response Class", and "Model Schema". The "Implementation Notes" section contains text about the Routing Information Base concept. The "Response Class" section lists "Model" and "Model Schema". The "Model Schema" section shows a JSON schema for the POST method: `(config)bgp-rib_modulePOST { application-rib (array((config)application-rib), optional), bgp-rib (object((config)bgp-rib), optional)`.

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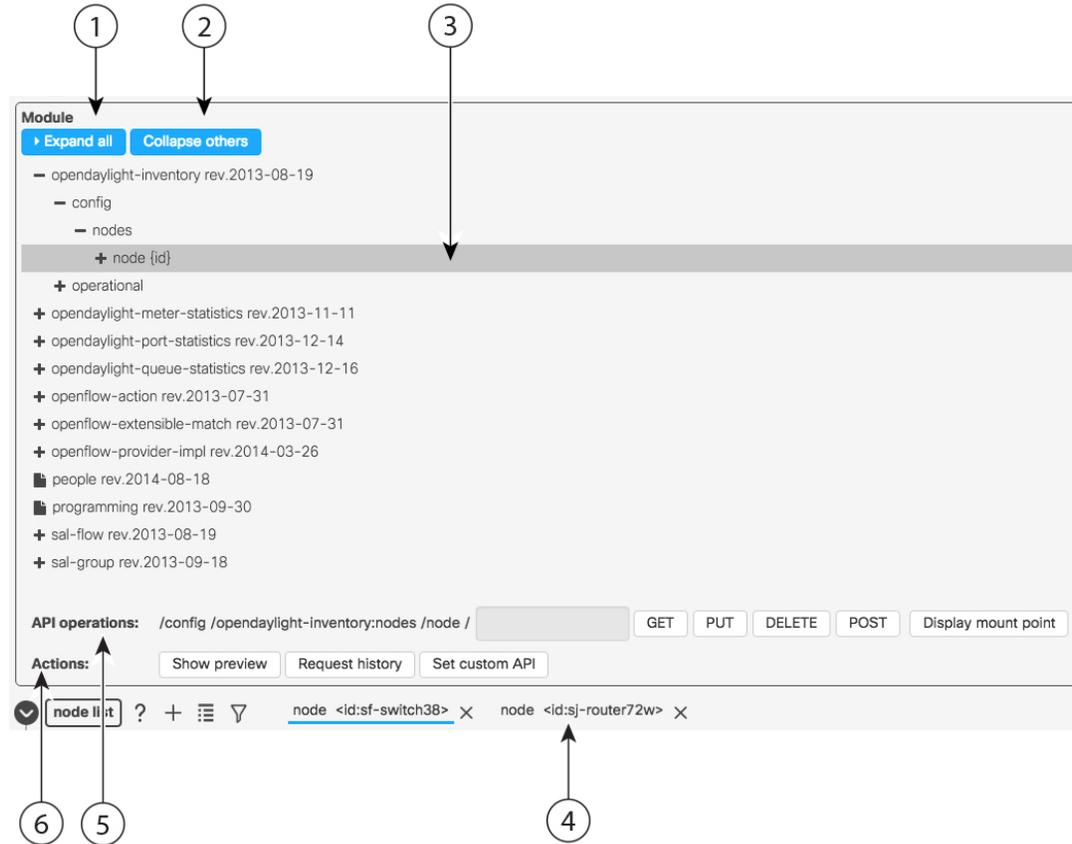
- Step 4** (Optional) Test a HTTP method to see what is returned based on the values you specify:
- 1 If applicable, set the response and parameter content types you want to use.
 - 2 If applicable, enter the parameter values you want to use.
 - 3 Click **Try it out!**

The browser page updates, displaying the corresponding URL for the test request as well as the resulting response, code, and headers.

Navigating the Model Explorer GUI

The following table describes the components that make up the Model Explorer GUI.

Figure 4: Model Explorer GUI Components



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Callout	Component	Description
1	Expand all button	Click to expand all of the APIs listed in the Module area and view their elements.
2	Collapse others button	Click to minimize all of the APIs listed in the Module area except for the API that is currently selected and expanded.
3	Module area	Lists every REST API that the controller supports. To work with a particular API, locate it in the list (expanding elements, as needed) and then select the API.
4	API Settings area	Displays the settings configured for the selected API or API operation. From here, you can also add list elements and configure filters.

Callout	Component	Description
5	API Operations field	Lists the corresponding URL for the selected API. Inputs can be filled with data. This field also provides buttons that allow you to execute the operations supported by that API.
6	Actions field	Provides three buttons: <ul style="list-style-type: none"> • Show preview: Click to preview the API path and payload that will be used in an operation you want to execute. • Request history: Click to view all of the API method operations that have been executed on the controller. See Viewing Request History for more information. • Set Custom API: Click to open the custom API popup window and modify the settings configured for an API. See Modifying API Settings Directly for more information.

Model Explorer Workflow

The following procedure describes a typical workflow you would employ for the Model Explorer.

Step 1

With the Model Explorer open, select an API from the Module area.

What you can do from here depends on whether you selected a config API, an operational API, or an API operation:

- If you selected either a config API or an API operation, the API Settings area updates to display the settings configured for that API or operation. You can then proceed to make the necessary additions or changes. Proceed to Step 2.
- If you selected an operational API, you can view its settings in the API Settings area by clicking **GET** in the API operations field. You will not be able to make any setting changes, so you can either stop here or select another API to work with.

Step 2

Update the settings for the selected API or operation, as needed.

Note the following:

- When you place your cursor over a particular field, a tooltip that indicates the type of value you need to enter (such as a text string or 32-bit unsigned integer) appears.
- Open SDN Controller will indicate any settings you entered incorrectly with an exclamation mark. Place your cursor over the exclamation mark to view a tooltip that describes the error.
- When navigating through an API or operation's elements, click the chevron icons that precede them to expand and collapse the elements.
- For some APIs and operations, you will need to enter path information in the API operations field. Ensure that the information you enter corresponds to the information displayed in the API Settings area.

- Step 3** Add list elements to the selected API or operation.
See [Adding List Elements](#) for more information.
- Step 4** Apply filters to the selected API or operation.
See [Managing Filters](#) for more information.
- Step 5** (Optional) Click **Show preview** to view the corresponding API path and payload for the operation you want to execute. This feature is useful when you want to copy and paste this information into another application, such as OpenFlow Manager.
- Step 6** Execute the appropriate POST, PUT, or DELETE operation.
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Adding List Elements

When you view a config API's or operational API's settings, you may see lists that you can modify in the API Settings area. To add elements to a list, complete the following procedure. In this example, we will add two nodes to the opendaylight-inventory API and configure a few settings for each node.

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- Step 1** From the Module area, select the opendaylight-inventory API.
- Step 2** Expand its config and nodes elements and then select the node {id} element. The node list is now displayed in the API Settings area.
- Step 3** Add two nodes to the node list:
- Click the node list's add list item icon twice.
2 nodes should now be displayed beside the node list.
 - Enter the following settings for each node:
(node 1)
 - id: **sf-switch38**
 - software: **ios-xr 5.1.2**
 - serial-number: **h18si8****(node 2)**
 - id: **sj-router72w**
 - software: **nx-os 6.0(2)U3(1)**
 - serial-number: **z99173**
-

List Element Operations

The following table describes the operations that are available when you are working with lists in the Model Explorer.

Table 1: Available List Element Operations

Icon	Description
	Click to view a description of an element.
	Click to add a new list element.
	Click to view all of the elements that belong to a list.
	Click to open the filter popup window. See Managing Filters for more information.
	Click to view additional list elements so you can select them. Only three elements are displayed in API Settings area at any given time.
	Click to delete a list element.

Managing Filters

The Model Explorer allows you to apply filters to the information it maintains. The following topics describe how to make use of this functionality.

Adding a Filter

Building on the previous example, we will set up a filter for the 2 nodes we added.

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- Step 1** Click the node list's filter icon to open the filter popup window. By default, a blank filter is displayed after you first open the filter popup window. You cannot delete it because at least one filter must be displayed in the filter popup window at any given time. In this example, say you only want to view devices that run Cisco NX-OS software.
- Step 2** In the software field, enter **nx-os** and then click **Ok**. Notice that both nodes are still displayed. This is because = is set as the logical operator (by default), which instructs the Model Explorer to return results that match the value you entered exactly.
- Step 3** Reopen the filter popup window and set the software field's logical operator to **contains**. Only node sj-router72w should be displayed now. Note the following:

- When multiple filters are configured in the filter popup window, you can switch between them by clicking the appropriate filter button.
 - Whenever you click **Ok**, all activated filters will be applied to the selected API or API operation.
 - When a filter is configured for a lower-level list, the filter is stored and available to any elements you add to that list, even if you select a different parent object.
 - The logical operators that are available for you to choose from will depend on the type of value you need to enter for a particular field.
 - When specifying a range for integer values, enter the first and last values in the provided fields.
 - To use wildcards:
 - 1 Set the logical operator to **regEXp** (regular expression).
 - 2 Enter **[a-z]** for letters and **[0-9]** for numbers.
 - For certain elements, you can configure filter settings by selecting the appropriate checkbox in either the API Settings or filter popup window.
-

Activating and Deactivating a Filter

Step 1 Click a list's filter icon to open the filter popup window.

Step 2 Do one of the following:

- To activate or deactivate an individual filter, click its filter icon to toggle between the two states.
- To deactivate all of the filters that are currently configured, click **Deactivate all** and then click **Ok**.

Step 3 Verify that the filters you have configured are in the correct state by placing your cursor over the list's filter icon and viewing the resulting popup.
A full icon indicates that the filter is activated, whereas an empty icon indicates that the filter is deactivated.

Deleting a Filter

Step 1 Click a list's filter icon to open the filter popup window.

Step 2 Do one of the following:

- To delete an individual filter, click its Remove filter icon and then click **Ok**.
- To delete all of the filters that are currently configured, click **Remove all**.

- Step 3** Place your cursor over the list's filter icon to verify that the appropriate filter was deleted. The resulting popup should reflect the changes you made. If you removed all of the filters, the list's filter icon should be empty.

Viewing Request History

The Request history popup window maintains a record of every REST API method operation that has been executed in Open SDN Controller and provides summary information for each operation. The following table describes this window and its components.

Figure 5: Request History Popup Window Components



Callout	Component	Description
1	Method column	Indicates the REST API method used for an operation.
2	History tab	Displays the REST API method operations that have been executed on the controller since the last time the Request history popup window's data was cleared.
3	URL column	Indicates the REST API URL used for an operation.
4	Collection tab	Displays the REST API method operations that have been saved by a user for future use.
5	Status column	Indicates whether an operation was executed successfully and whether data was sent or received during the operation.

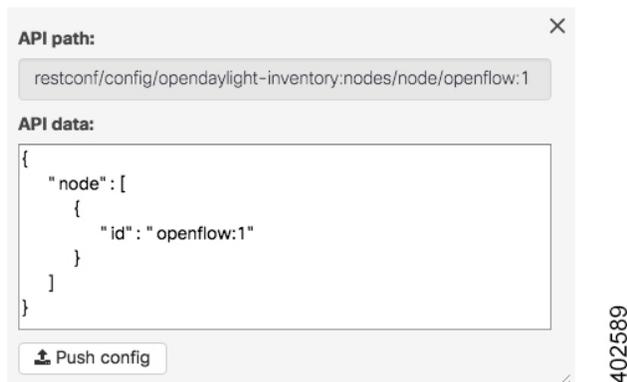
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Callout	Component	Description
6	Action column	Allows you to perform one of the following actions on an operation: <ul style="list-style-type: none"> • Click to add the operation to the Collection tab. • Click to populate the operation with data. • Click to execute the operation. • Click to delete the operation's entry.
7	clear history data button	Deletes every REST API method operation that is currently listed in the Request history popup window.

Modifying API Settings Directly

When you want to update the settings configured for an API, you would normally do so from the Model Explorer's API Settings area. You also have the option of updating an API's settings directly in the custom API popup window. In the following example, we will configure an API's root node.

Figure 6: Custom API Popup Window



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- Step 1** From the Actions field, click **Set custom API** to open the custom API popup window.
- Step 2** In the API path field, enter the path for the API you want to modify.
In this example, set the API path to `restconf/config/opendaylight-inventory:nodes/node/openflow:1`.
- Step 3** In the API data area, enter the setting changes you want to make.
In this example, enter the following text: `{"node": [{"id": "openflow:1"}]}`
- Step 4** Click **Push config**.
-

OpenFlow Manager

The OpenFlow protocol is based on the concept of an Ethernet switch, with an internal flow-table and standardized interface to allow traffic flows on a switch to be added or removed. The OpenFlow protocol defines the communications channel between the OpenFlow agent and the OpenFlow controller. In an OpenFlow network, the OpenFlow Agent exists on the switch and the OpenFlow controller exists on a server, which is external to the switch. Any network management is either part of the controller or accomplished through the controller.

Open SDN Controller relies on the OpenFlow 1.3 plugin to implement OpenFlow support and provide functionality such as connection creation, session management, state management, and error handling. The plugin, which is installed when you install the controller, allows you to manage the OpenFlow-enabled devices in your network via the OpenFlow Manager. The following components make up this application and are described in more detail in this section:

- [Basic View Tab](#)
- [Flow Management Tab](#)
- [Statistics Tab](#)
- [Hosts Tab](#)
- [Settings Tab](#)

To open the OpenFlow Manager, select **OpenFlow Manager** from the Applications pane.

Figure 7: OpenFlow Manager Application



Basic View Tab

By default, the Basic View tab is displayed after you open the OpenFlow Manager. The topology provided here maps the OpenFlow-enabled devices in your network and the hosts that are connected to them.

To display hosts, do the following:

- 1 Ensure that the L2switch feature is enabled on the controller.
- 2 If you are using Mininet, discover hosts by running the **pingall** command from Mininet. Otherwise, proceed to Step 3.
- 3 With the Basic View tab open, click the **Show host devices** check box.

After selecting a device in the topology, you can manage the flows configured on that device and view the corresponding statistics.



Note

To quickly determine a device's neighbor devices, place your cursor over that device's icon in the topology. The icons for any non-neighboring devices are dimmed.

See the following topics for more information:

- For information about adding devices to the topology, see [Adding OpenFlow-Enabled Devices](#).
- For information about configuring secure connections between the controller and devices, see [Enabling TLS Support](#).
- For a description of the OpenFlow Manager toolbar, see [Application Toolbar](#).

Adding OpenFlow-Enabled Devices

Devices cannot be added to the topology within OpenFlow Manager. To add a device, refer to the Open SDN Controller installation guide and complete the procedure specific to the type of device you are adding:

- To add a Cisco ASR 9000 Series router, see [Configuring OpenFlow Support on a Cisco ASR 9000 Series Router](#).
- To add a Cisco Nexus 3000 Series switch, see [Configuring OpenFlow Support on a Cisco Nexus 3000 Series Switch](#).

Flow Management Tab

From this tab, you can perform the following flow management tasks:

- Determine the number of flows associated with each OpenFlow-enabled device in your network.
- View a listing of all the flows that are currently configured.
- Set the deployment mode for a particular device.
- Add, modify, and activate filters to refine the information displayed in the Flows table.
- Add, modify, delete, and reload flows.

Flow Management Tab Workflow

The following procedure describes a typical workflow you would employ for this tab.

-
- Step 1** With the OpenFlow Manager already open, click the Flow Management tab.
- Step 2** View the Flow Summary table at the top of the tab, which lists the number of flows (both configured and pending) associated with each OpenFlow-enabled device.
- Note** You can filter the information provided in this table by entering a device or device type value in the corresponding filter field.
- Step 3** Set the deployment mode for the devices listed in the Flow Summary table by clicking the appropriate icon:
- For Proactive mode, click the P icon.
 - For Reactive mode, click the R icon.
 - For Integrated mode, click the I icon.

For a description of these modes, see [Flow Deployment Modes](#).

- Step 4** Scroll to the middle of the tab and manage the filters you want to apply to the Flows table. See [Adding a Filter](#), [Modifying a Filter](#), and [Deleting a Filter](#) for more information.
- Step 5** Scroll to the bottom of the tab and manage the flows configured on the controller. See [Adding a Flow](#), [Modifying a Flow](#), and [Deleting a Flow](#) for more information.
-

Adding a Filter

To apply a simple filter to the Flows table, enter a value in the filter field that corresponds to a particular column in the Flows table. If you want to create a more robust filter, complete the following procedure.

-
- Step 1** From the Filters table toolbar, click the Filter Management icon.
- Step 2** Configure the filter you want to add:
- In the Filter name field, enter a name for the filter you are creating.
 - From the Device drop-down list, select the device you want to base the filter on.
 - From the General Properties, Match, and Actions lists, select the parameters you want to base the filter on by clicking the appropriate slider buttons.
 - For each parameter you select, enter the value that flows listed in the Flows table should contain.
- Step 3** Do one of the following:
- If you want to create an additional filter, click the Create new empty filter icon at the top of the tab and go back to Step 2.
 - If you do not want to create an additional filter, proceed to Step 4.
- Step 4** Click **Save and Exit**.
- Step 5** In the Filters table, confirm that the filter you just created is listed and its check box is selected.
-

Activating a Filter

Any filters that have been configured will only be applied to the Flows table if they are active.

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- Step 1** View the heading for the Filters table:
- If the heading reads `Filters inactive`, proceed to Step 2.
 - If the heading reads `Filters active`, skip ahead to Step 3.

- Step 2** From the Filters table toolbar, click the Activate/Deactivate filters icon.
- Step 3** Confirm that the check box for every filter you want to apply to the Flows table is selected.
-

Modifying a Filter

- Step 1** From the Filters table toolbar, click the Filter Management icon.
- Step 2** If multiple filters are currently configured, select the filter you want to modify.
- Step 3** Make any necessary changes and then click **Save and exit**.
-

Deleting a Filter

There are two ways to delete a filter:

(From the Filters table)

Locate the filter in the table and click the corresponding Delete icon.

(From the Filters creation/modification tab)

- 1 From the Filters table toolbar, click the Filter Management icon.
- 2 At the top of the tab, locate the filter you want to delete and click its Delete icon.

Adding a Flow

- Step 1** From the Flows toolbar, click the Flow Management icon.
- Step 2** Configure the settings for the flow you want to add:
- a) From the device drop-down list, select the source device.
 - b) From the General Properties, Match, and Actions lists, select the parameters you want to define by clicking the appropriate slider buttons.
Note The Table, ID, and Priority parameters are mandatory and cannot be removed from a flow.
 - c) Specify the appropriate value for each parameter you selected.
- Step 3** Do one of the following:
- If you want to create an additional flow, click the Create new empty flow icon at the top of the tab and go back to Step 2.
 - If you do not want to create an additional flow, proceed to Step 4.

- Step 4** (Optional) Click **Show Preview** to view the actual code that will be sent to the controller when you submit your request.
- Step 5** Click **Send Request**.
If you have configured multiple flows, click **Send All** instead.
- Step 6** Click the Reload flows icon to update the Flows table.
The flow you created should now be listed here.
-

Modifying a Flow

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- Step 1** From the Flows table, select the check box for the flow you want to modify.
- Step 2** Do one of the following:
- Click the Flow Management icon.
 - From the Actions column, click the Edit icon.
- Step 3** Make any necessary changes and then click **Send Request**.
Note Only the fields you can update will be editable.
- Step 4** From the Flows toolbar, click the Reload Flows icon.
-

Deleting a Flow

There are three ways to delete a flow:

(From the Flows table)

To delete an individual flow:

- 1 Click its Delete icon in the Actions column.
- 2 Click **OK** to confirm deletion in the popup window.

To delete multiple flows:

- 1 Select the check box for every flow you want to delete.
- 2 From the Flows toolbar, click the Delete icon.
- 3 Click **OK** to confirm deletion in the popup window.

(From the Flows creation/modification tab)

- 1 From the Flows toolbar, click the Flow Management icon.
- 2 At the top of the tab, locate the flow you want to delete and click its Delete icon.

Note the following:

- When you delete a flow that resides in the controller's configuration, it is deleted from the Flows table immediately.
- When you delete a flow that resides on a device, that flow will continue to be displayed in the Flows table until it is removed from the corresponding device.

Statistics Tab

The Statistics tab provides statistics for both the flows configured in your network and the corresponding device ports.

Statistics Tab Workflow

Complete the following procedure to access these statistics.

-
- Step 1** Select **OpenFlow Manager** from the Applications pane. The Basic View tab is open, by default.
- Step 2** Do one of the following:
- To view statistics for one or multiple devices, click **Select** from the OpenFlow Manager toolbar and proceed to Step 3.
 - To view statistics for all of the OpenFlow-enabled devices in your network, click the Statistics tab and skip ahead to Step 5.
- Step 3** Select the device(s) you want to view statistics for.
The page updates, displaying the following buttons:
- Port Stats
 - Flow Stats
 - Flow Table Stats
 - Aggregate Flow Stats
 - Queue Stats
 - Group Stats
 - Meter Stats
 - Meter Features Stats
- Step 4** Click the button that corresponds to the statistics you want to view and skip ahead to Step 7.
- Step 5** From the Statistics drop-down list, select whether you want to view flow (table) or port statistics. If you select the Table Statistics option, proceed to Step 6. Otherwise, skip ahead to Step 7.
- Step 6** From the Type drop-down list, select one of the following options:
- Flow Stats

- Flow Table Stats
- Aggregate Flow Stats
- Queue Stats
- Group Stats
- Meter Stats
- Meter Features Stats

Step 7 Below the statistics table, specify the number of table rows and objects you want to view and then click **Refresh Data**.

Hosts Tab

The Hosts tab provides summary information for the OpenFlow-enabled host devices that Open SDN Controller manages. From here, you can quickly determine things like a host device's ID, attachment point status, and HTS IP address. To specify how many host devices are listed in the Hosts table, select the appropriate value below the table.

Settings Tab

You can configure two settings in the Settings tab: the refresh interval for OpenFlow device statistics and the flow instantiation mode OpenFlow Manager should use.

Step 1 With the OpenFlow Manager already open, click the Settings tab.

Step 2 Configure the following settings:

- Statistics timer-Specifies how often OpenFlow device statistics are refreshed, in seconds.
- Deployment mode-Indicates the flow instantiation mode configured for OpenFlow Manager. There are three modes to choose from:
 - **Proactive**
 - **Reactive**
 - **Integrated**

For more information on these three modes, see [Flow Deployment Modes](#).

Step 3 Click **Confirm settings** to save your changes to the controller.

Flow Deployment Modes

In the Settings tab, you can specify OpenFlow Manager to use one of three modes when instantiating flows: Reactive Mode, Proactive Mode, or Integrated Mode.

Note the following:

- After you install either the odl-l2switch-switch or odl-openflowplugin-apps feature, the deployment-mode-manager feature is available for use. The functionality provided by this feature depends on which of the two previously mentioned features are installed.
- In the description of each mode, an asterisk indicates that an action is performed only when the odl-l2switch-switch feature is installed.
- Say you have a scenario where either the odl-l2switch-switch or odl-openflowplugin-apps feature is installed and the deployment mode on certain devices has been changed from the default. After you install the other feature, connected devices are updated with the correct flows based on the deployment mode that was set for each device prior to installation.
- Reactive mode is the initial default deployment mode that is automatically applied to all connected devices. To set either Proactive or Integrated mode as the default, update the flow deployment mode configuration file:
 - 1 Navigate to the directory in which the configuration file resides:
cd etc/opendaylight/karaf/
 - 2 Open 42-deployment-mode-manager.xml in a text editor.
 - 3 Locate the following line and replace REACTIVE with the mode you want to configure:

```
<default-deployment-mode>REACTIVE</default-deployment-mode>
```


When specifying a mode, use all uppercase letters.
 - 4 Save your changes.
- To set a different deployment mode on a particular device, locate the device's entry in the Flow Summary table (in the Flow Management tab) and click the appropriate icon.
- When you change the default deployment mode, that mode is automatically applied only to newly connected devices from that point on. The deployment mode that's already set for devices that connected previously is unchanged.

Reactive Mode

When this mode is selected, OpenFlow Manager forwards a flow's unmatched packets (packets that don't match any entries in a flow table) to the controller, allowing the controller to decide what to do with them. This decision is then stored as a flow entry in the relevant flow table, allowing any packets received for that flow in the future to be processed without controller intervention.

OpenFlow Manager carries out the following actions when Reactive Mode is selected:

- 1 Punts all packets to the controller.
- 2 *Punts incoming ARP packets to the controller.
- 3 *Floods ARP packets.

Proactive Mode

When this mode is selected, OpenFlow Manager pushes all known flows to the network elements that handle forwarding before any traffic is received. Since the flows and their corresponding instructions have already been defined, the controller doesn't need to step in and decide what to do with any unmatched packets (unless that is what you have instructed the controller to do).

OpenFlow Manager carries out the following actions when Proactive Mode is selected:

- 1 Punts LLDP packets to the controller.
- 2 Drops remaining packets.
- 3 *Punts incoming ARP packets to the controller.
- 4 *Floods ARP packets.

Integrated Mode

This mode is essentially a hybrid of Reactive and Proactive Mode, instructing the controller to figure out what to do with packets that don't match any of the flows that have been defined.

OpenFlow Manager carries out the following actions when Integrated Mode is selected:

- 1 Punts LLDP packets to the controller.
- 2 Forces NORMAL routing.
- 3 *Punts incoming ARP packets to the controller.

Determining the Current Deployment Mode

When you need to determine the deployment mode that is currently set for either the controller or a particular device, you can do so by making one of the following POST requests.

Note the following:

- Before every RESTCONF request you make, you must first generate a security token. See [Making RESTCONF Requests](#) for more information.
- You can also determine the deployment mode that is currently set for the controller by viewing OpenFlow Manager's Settings tab.

For the Controller

(URL)

`https://token:$token@<controller-IP-address>/controller/restconf/operations/deployment-mode:get-deployment-mode`

For a Device

(URL)

`https://token:$token@<controller-IP-address>/controller/restconf/operations/node-deployment-mode:get-node-deployment-mode`

(Payload)

```
<input xmlns="urn:opendaylight:params:xml:ns:yang:controller:node-deployment-mode">
  <node
```

```
xmlns:inv="urn:opendaylight:inventory"/>inv:nodes/inv:node[inv:id="<OpenFlow-device-ID>"]</node>
</input>
```

Setting the Deployment Mode Manually

Although you can set the deployment mode for the controller and devices from OpenFlow Manager, you also have the option of doing so manually. To do so, make one of the following POST requests, replacing *<deployment-mode>* and *<OpenFlow-device-ID>* with the correct value in the request's payload.



Note

Before every RESTCONF request you make, you must first generate a security token. See [Making RESTCONF Requests](#) for more information.

For the Controller

(URL)

`https://token:$token@<controller-IP-address>/controller/restconf/operations/deployment-mode:set-deployment-mode`

(Payload)

```
<input xmlns="urn:opendaylight:params:xml:ns:yang:controller:deployment-mode">
  <deployment-mode><deployment-mode></deployment-mode>
</input>
```

For a Device

(URL)

`https://token:$token@<controller-IP-address>/controller/restconf/operations/node-deployment-mode:set-node-deployment-mode`

(Payload)

```
<input xmlns="urn:opendaylight:params:xml:ns:yang:controller:node-deployment-mode">
  <node
    xmlns:inv="urn:opendaylight:inventory"/>inv:nodes/inv:node[inv:id="<OpenFlow-device-ID>"]</node>
    <deployment-mode><deployment-mode></deployment-mode>
</input>
```

PCEP Manager

Path Computation Element Communication Protocol (PCEP) is a TCP-based protocol that defines a set of messages and objects used to manage PCEP sessions and to request and send paths for multi-domain traffic engineering Label Switched Paths (LSPs). From the PCEP Manager, you can create LSPs between the BGP-enabled devices in your network. To open this application, select **PCEP Manager** from the Applications pane.

Note the following:

- The BGPLS Manager and PCEP Manager display the same topology. To add devices to this topology, complete the procedure described in the [Adding BGP Devices](#).
- The list of configured LSPs that is displayed after you click the Establish LSP icon is not updated in real time. It is refreshed only after a change has been made (such as adding or deleting an LSP).
- For a description of the PCEP Manager toolbar, see [Application Toolbar](#).

Before You Get Started

Keep the following information in mind before you use the PCEP Manager.

Requirements

The PCEP Manager assumes that:

- All the BGP-LS/PCEP-enabled routers in your network have a hostname.
- The BGP-Router-ID, MPLS-TE ID, and PCC value configured for each router is the same IP address.
- All router IDs must be reachable from the Open SDN Controller host and vice versa. Specifically, the routers must be able to reply to the controller via a static, default, or dynamic route. **One** of the following must also be true:
 - The controller has a static route to each router loopback address.
 - The controller uses dynamic routing.
 - The controller uses a default route to a node that can reach the router's loopbacks.

Caveats

- The Terminal feature (accessed by right-clicking a device) has been disabled in this release.
- Multipoint links have not been tested.
- A maximum of 50 routers are displayed on the topology at any given time.

Troubleshooting

Problem: No nodes are displayed on the topology.

Solution:

- 1 Make a GET request, using the following URL—
`https://token.$token@<controller-IP-address>/controller/restconf/operational/network-topology:network-topology/topology/example-linkstate-topology`
- 2 In the topology section of the resulting output, find every instance of *router-id* and note the IP address of the corresponding device.

Every device listed here should be displayed in the topology. If any devices are not displayed, this indicates that they were not configured properly.



Note

For a description of how to make RESTCONF requests in Open SDN Controller, see [Making RESTCONF Requests](#).

Problem: When two nodes are selected in the Auto Path tab, a list of the available paths between those nodes is not displayed.

Solution:

- 1 Check that a PCEP topology is available.
- 2 If so, check that the loopback IDs for the two nodes are reachable from the controller.
- 3 If so, verify that the PCE ID and BGP router ID values are the same.

Creating LSPs

You can create three types of LSPs in PCEP Manager: path-based, hop-based, and manual. Complete the procedure for the LSP type you want to create.



Note

To quickly determine a device's neighbor devices, place your cursor over that device's icon in the topology. The icons for any non-neighboring devices are dimmed.

Path-Based LSPs

Figure 8: Path-Based LSP Creation Page

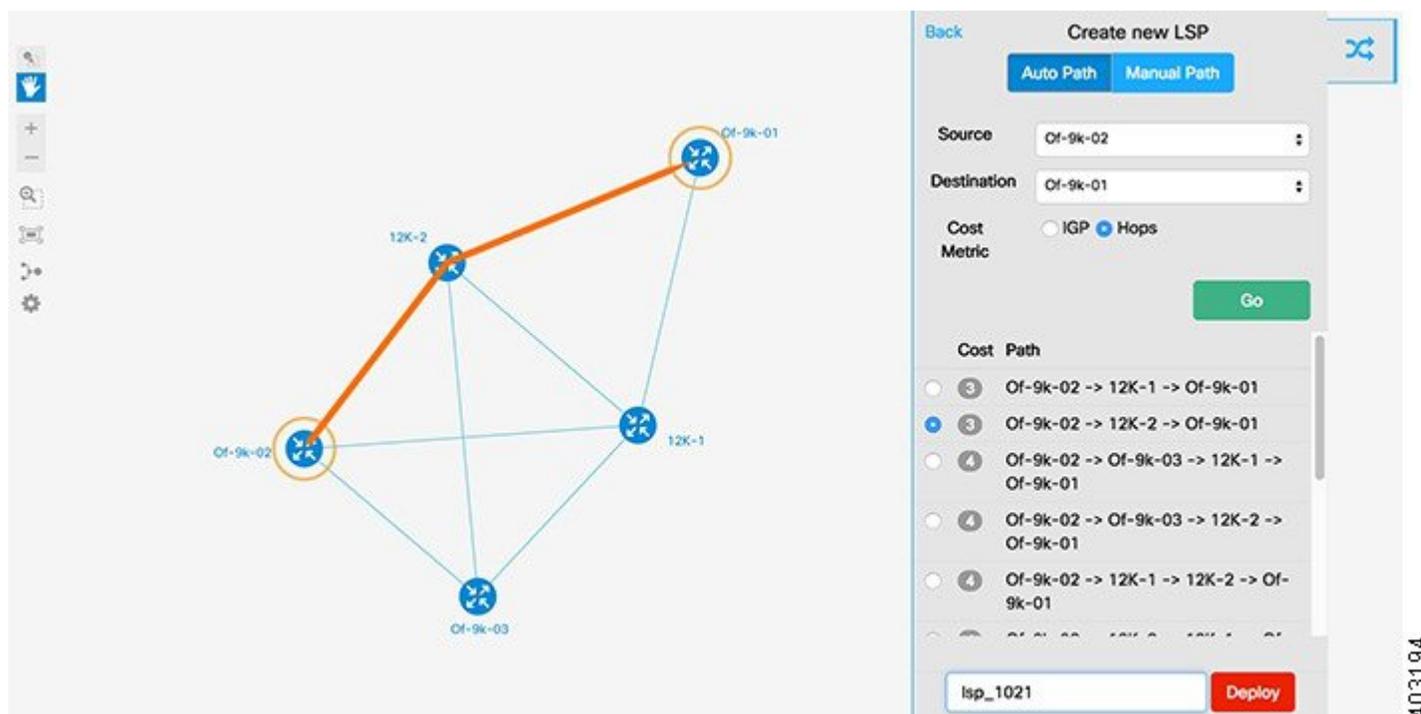
403196

- Step 1** From the upper right-hand corner of the content pane, click the Establish LSP icon. A listing of the LSPs that are currently active is displayed.

- Step 2** Click **Create New LSP**.
By default, the Auto Path tab and IGP radio button are already selected.
- Step 3** Select the source and destination device and then click **Go**.
A listing of the available paths between the two devices is displayed, sorted by IGP metric order.
- Step 4** Select the path you want to use.
- Step 5** In the LSP Name field, enter a name for the new LSP and then click **Deploy**.

Hop-Based LSPs

Figure 9: Hop-Based LSP Creation Page

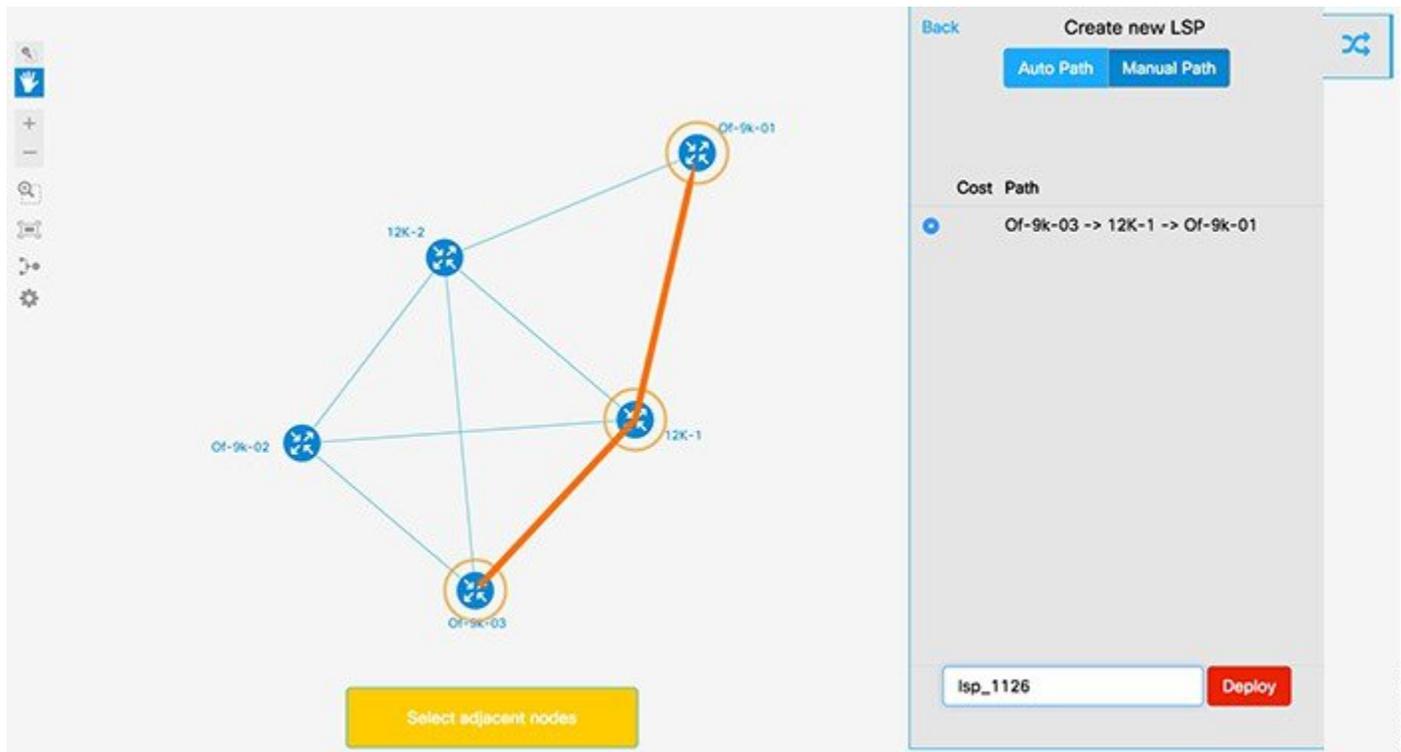


- Step 1** From the upper right-hand corner of the content pane, click the Establish LSP icon.
A listing of the LSPs that are currently active is displayed.
- Step 2** Click **Create New LSP**.
By default, the Auto Path tab and IGP radio button are already selected.
- Step 3** Specify the source and destination device.
- Step 4** Select the Hops radio button and then click **Go**.
A listing of the available paths between the two devices is displayed, along with the cost associated with those paths.

- Step 5** Select the path you want to use.
- Step 6** In the LSP Name field, enter a name for the new LSP and then click **Deploy**.

Manual LSPs

Figure 10: Manual LSP Creation Page



- Step 1** From the upper right-hand corner of the content pane, click the Establish LSP icon. A listing of the LSPs that are currently active is displayed.
- Step 2** Click **Create New LSP**. By default, the Auto Path tab is already selected.
- Step 3** Select the Manual Path tab.
- Step 4** From the topology, select the source device, adjacent devices, and then the destination device.
- Step 5** In the LSP Name field, enter a name for the new LSP and then click **Deploy**.

Deleting LSPs

-
- Step 1** From the upper right-hand corner of the content pane, click the Establish LSP icon. A listing of the LSPs that are currently active is displayed.
- Step 2** Select the LSP you want to delete and then click **Delete LSP**.
-

