



# Cisco Plug-in for OpenFlow

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## Prerequisites for Cisco Plug-in for OpenFlow

- A Cisco device and its corresponding operating system that supports the installation of Cisco Plug-in for OpenFlow.



**Note**

Refer to the corresponding release notes for information about which operating system release supports the features and necessary infrastructure.

- Release notes for [Cisco Catalyst 3850 Series Switches](#)
- Release notes for [Cisco Catalyst 3650 Series Switches](#)

- An open virtual application (OVA) package that is compatible with the device operating system and downloaded from an FTP server connected to the device. The OVA package is available for download in the same location as your system image (.bin) file.
- A controller installed on a connected server.

**Table 1: Controller Support**

| OpenFlow Version | Supported Controllers  |
|------------------|--|
| OpenFlow 1.0     | Extensible Network Controller (XNC) 1.0, POX, Cisco Open SDN Controller, or Ixia controllers . |

| OpenFlow Version | Supported Controllers                            |
|------------------|--|
| OpenFlow 1.3     | Ixia, Cisco Open SDN Controller, or OpenDaylight |

- The required disk storage available on the device for installation and deployment of Cisco Plug-in for OpenFlow. The recommended disk space is 360 MB.
- 2048 TCAM entries are available before you enable OpenFlow.

## Restrictions for Cisco Plug-in for OpenFlow

- Cisco Plug-in for OpenFlow supports only a subset of OpenFlow 1.3 functions. For more information, see the *Cisco Plug-in for OpenFlow Feature Support* section.
- You cannot configure more than one Cisco Plug-in for OpenFlow logical switch. The logical switch ID has a value of 1.
- OpenFlow hybrid model (ships-in-the-night) is supported. VLANs configured for Cisco Plug-in for OpenFlow logical switch ports should not overlap with regular device interfaces.
- Cisco Plug-in for OpenFlow logical switch ports must not be configured in a mode other than trunk port.
- You cannot configure a bridge domain, Virtual LANs, virtual routing and forwarding (VRF) or port-channel interfaces on a Cisco Plug-in for OpenFlow logical switch. You can only configure physical interfaces.
- You cannot make additional configurations to an interface configured as a port of Cisco Plug-in for OpenFlow Logical Switch without removing the configuration as a port of Cisco Plug-in for OpenFlow Logical Switch.
- High availability is not supported. On switchover, all flows are deleted resulting in traffic loss. When the standby RP becomes active, the flows are relearned from the controller and reprogrammed. Until then, traffic loss is experienced.
- Cisco IOS In-Service Software Upgrade (ISSU) is not supported for Cisco Plug-in for OpenFlow.
- MIBs and XMLs are not supported.
- You must not add or remove an interface as a port of a Cisco Plug-in for OpenFlow if the Cisco Plug-in for OpenFlow is inactive or not running.
- Cisco Catalyst 3850 switch supports 1000 L2 flows with EtherType, 200 L2 flows without EtherType, and 500 L3 flows.
- Cisco Catalyst 3650 switch supports 500 L2 flows with EtherType, 100 L2 flows without EtherType type, and 250 L3 flows.
- A maximum of 48 ports can be assigned for Openflow operation.
- In general, the maximum sustained flow programming rate from the controller should not exceed 50 (added or deleted) flows per second. For flows that have more than 1 match criteria (more than input port + 1 match), the sustained controller programming rate should not exceed 40 flows per second.

- The maximum burst flow programming rate from the controller should not exceed 1000 flows, spaced by 30-second time intervals. A minimum of 30-second time interval should be maintained between addition or deletion of flows.
- The rate of PACKET\_IN messages sent to the controller should be rate-limited to 300 packets per second, using configuration.

## Information About Cisco Plug-In for Open Flow

### About OpenFlow

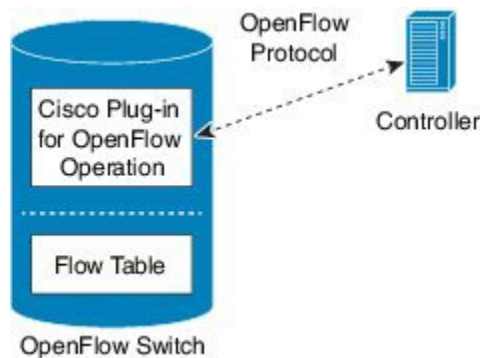
OpenFlow Switch Specification Version 1.0.1 (Wire Protocol 0x01), referred to as OpenFlow 1.0, and OpenFlow Switch Specification Version 1.3.0 (Wire Protocol 0x04), referred to as OpenFlow 1.3, are based on the concept of an Ethernet switch with an internal flow table and standardized interface to allow traffic flows on a device to be added or removed. OpenFlow 1.3 defines the communication channel between Cisco Plug-in for OpenFlow and controllers.

Cisco supports a subset of OpenFlow 1.0 and OpenFlow 1.3 functions.

A controller can be Extensible Network Controller (XNC) 1.0, or any controller compliant with OpenFlow 1.3.

The following figure gives an overview of the OpenFlow network:

**Figure 1: OpenFlow Overview**



Related concepts include:

#### Related Topics

[Cisco Plug-in for OpenFlow Feature Support](#), on page 4

[Cisco Plug-in for OpenFlow and Virtual Services Container](#), on page 4

[OpenFlow Workflow](#), on page 11

### Cisco Plug-in for OpenFlow Operation

Cisco Plug-in for OpenFlow creates OpenFlow-based connections to controllers for a Cisco Plug-in for OpenFlow logical switch. The Cisco Plug-in for OpenFlow creates databases for the following:

- A configured logical switch—Contains all the information needed to connect to a controller.
- OpenFlow-enabled interfaces—Contains the list of OpenFlow-enabled interfaces associated with a logical switch.
- Flows—Contains the list of flows on a logical switch and for the interface that is programmed into forwarded traffic.

## OpenFlow Controller Operation

OpenFlow controller (referred to as controller) controls the switch and inserts flows with a subset of OpenFlow 1.3 and 1.0 match and action criteria through Cisco Plug-in for OpenFlow logical switch. Cisco Plug-in for OpenFlow rejects all OpenFlow messages with any other action.

## Cisco Plug-in for OpenFlow and Virtual Services Container

Cisco Plug-in for OpenFlow runs in an operating-system-level virtual service container on the device. The Cisco Plug-in for OpenFlow virtual service container is delivered in an open virtual application (OVA) file package (.ova). The OVA package is installed and enabled on the device through the CLI.

## Cisco Plug-in for OpenFlow Feature Support

The following is a subset of OpenFlow 1.3 and OpenFlow 1.0 functions that are supported by Cisco Plug-in for OpenFlow.

| Feature   | Notes   |
|---|---|
| The OpenFlow hybrid (ships-in-night) model is supported.                                | OpenFlow-hybrid models where traffic can flow between Cisco Plug-in for OpenFlow ports and regular interfaces (integrated) are not supported. Both types of ports can transmit and receive packets.<br><br><b>Note</b> VLANs must be configured such that the VLANs on the Cisco Plug-in for OpenFlow do not overlap with those on the regular device interfaces. |
| Configuration of physical interfaces as Cisco Plug-in for OpenFlow logical switch ports | Bridge domain, Virtual LANs and Virtual Routing and Forwarding (VRF), and port-channel interfaces are not supported.<br><br>Only L2 interfaces can be Cisco Plug-in for OpenFlow logical switch ports.  |

| Feature                          | Notes  |
|----------------------------------|--|
| Supported OpenFlow message types | <ul style="list-style-type: none"><li>• Controller to switch:<ul style="list-style-type: none"><li>• Handshake</li><li>• Switch Configuration</li><li>• Modify State (Port Modification message is not supported)</li><li>• Read State</li><li>• Packet-Out</li><li>• Barrier</li></ul></li><li>• Asynchronous messages:<ul style="list-style-type: none"><li>• Packet-In</li><li>• Flow Removed</li><li>• Port Status</li><li>• Error</li></ul></li><li>• Symmetric messages:<ul style="list-style-type: none"><li>• Hello</li><li>• Echo Request</li><li>• Echo Reply</li><li>• Vendor</li></ul></li></ul> |
| Connection to controllers        | <p>You can connect up to eight controllers.</p> <p>Connection to the controller through a management interface or a switched virtual interface (SVI) is supported.</p> <p>Connection via TCP and TLS is supported.</p>   |

| Feature                     | Notes   |
|-----------------------------|---|
| Multiple actions            | <p>If multiple actions are associated with a flow, they are processed in the order specified. The output action should be the last action in the action list. Any action after the output action is not supported, and can cause the flow to fail and return an error to the controller.</p> <p>Flows defined on the controller must follow the these guidelines:</p> <ul style="list-style-type: none"> <li>• The flow can have only one output action.</li> <li>• Some action combinations which are not supported may be rejected at flow programming time.</li> <li>• The flow should not have an output-to-controller action in combination with other rewrite actions.</li> </ul> |
| Supported OpenFlow counters | <p>Per Table—Active entries, packet lookups, and packet matches.</p> <p>Per Flow—Received Packets, Received bytes, Duration (seconds), Duration (milliseconds).</p> <p>Per Port—Received or transmitted packets, and bytes.</p> <p>Per Controller— Flow addition, modification, deletion, error messages, echo requests or replies, barrier requests or replies, connection attempts, successful connections, packet in or packet out.</p>  |
| Default forwarding rule     | <p>All packets that cannot be matched to programmed flows are dropped by default. You can configure sending unmatched packets to the controller. You can modify the default action taken on unmatched packets either using the <b>default-miss</b> command or by the controller.</p>  |
| Idle timeout                | <p>A minimum Idle timeout of 14 seconds is supported for 700 flows and 48 ports.</p> <p>The statistics collection interval influences the minimum idle timeout. When the interval is set to 7 seconds, the timeout is a minimum of 14 seconds. 700 flows are supported with the 14-second idle timeout.</p> <p>When using an idle timeout of less than 25 seconds, the number of L3 flows should be limited to 700.</p>   |

## Supported Match and Actions and Pipelines

| Feature  | Notes   |
|--|---|
| Pipelines for Cisco Plugin for OpenFlow Logical Switch | Pipelines are mandatory for logical switch. The logical switch supports only pipeline 1.<br>The logical switch supports only table 1. |

| Feature          | Notes |
|------------------|-------|
| Forwarding Table |       |



| Feature | Notes   |
|---------|---|
|         | <p>Match Criteria:</p> <ul style="list-style-type: none"> <li>• Input Port</li> <li>• Ethernet type</li> <li>• Source Mac Address</li> <li>• Dest Mac Address</li> <li>• VLAN priority</li> <li>• VLAN ID</li> <li>• IP TOS (DSCP bits)</li> <li>• IP Protocol (except for lower 8 bits of ARP code)</li> <li>• IPv4 Source Address</li> <li>• IPv4 Destination Address</li> <li>• Layer 4 Source Port</li> <li>• Layer 4 Destination Port</li> <li>• IPv6 Source Address</li> <li>• IPv6 Destination Address</li> </ul> <p>Action Criteria:</p> <ul style="list-style-type: none"> <li>• Forward: Controller</li> <li>• Forward: Port</li> <li>• Forward: Drop</li> <li>• Forward: to Queue</li> <li>• Forward: Controller + Port</li> <li>• Set VLAN ID</li> <li>• New VLAN ID</li> <li>• Replace VLAN ID</li> <li>• Set VLAN Priority</li> <li>• Strip VLAN Header</li> <li>• Modify Source MAC</li> <li>• Modify Destination MAC</li> <li>• Modify IPv4 Source Address</li> <li>• Modify IPv4 Destination Address</li> <li>• Modify IPv4 TOS bits</li> <li>• Modify L4 source port</li> </ul> |

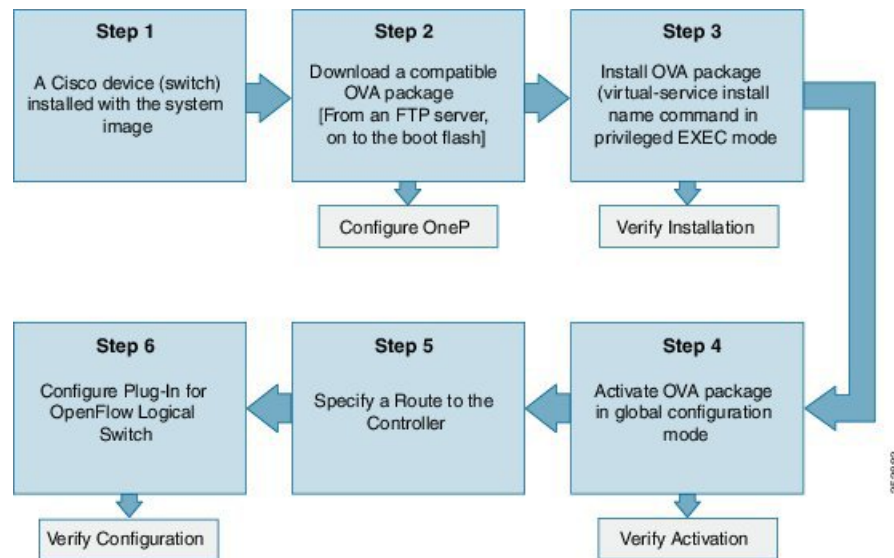
| Feature   | Notes   |                                   |                      |                      |
|---|---|-----------------------------------|----------------------|----------------------|
|   | <ul style="list-style-type: none"> <li>• Modify L4 destination port</li> <li>• Decrement TTL</li> </ul> |                                   |                      |                      |
| Number of flows   | <b>Flow type</b>  | <b>TCAM entries for each flow</b> | <b>Scale (c3850)</b> | <b>Scale (c3650)</b> |
|   | L2 with EtherType   | 1                                 | 1000                 | 500                  |
|   | L3  | 2                                 | 500                  | 250                  |
|   | L2 without EtherType  | 5                                 | 200                  | 100                  |
| Configuration of VLANs for each port of the Cisco Plug-in for OpenFlow logical switch | VLAN range is from 1 to 4094.   |                                   |                      |                      |

# How to Configure Cisco Plug-In for Open Flow

## OpenFlow Workflow

The following figure describes the overall process of installing and activating the Cisco Plug-In for Open Flow.

**Figure 2: OpenFlow WorkFlow**



## Specifying a Route to a Controller

The following tasks are used to specify a route from the device to a controller. This can be done using a physical interface (Front Panel) or a management interface.

### Related Topics

[Specifying a Route to a Controller Using a Physical Interface, on page 12](#)

[Specifying a Route to a Controller Using a Management Interface, on page 13](#)

## Specifying a Route to a Controller Using a Physical Interface

### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **no switchport**
5. **ip address** *ip-address mask*
6. **exit**
7. **ip route** *0.0.0.0 0.0.0.0 next-hop*
8. **exit**
9. **copy running-config startup-config**

### DETAILED STEPS

|               | Command or Action   | Purpose  |
|---------------|---|--|
| <b>Step 1</b> | <b>enable</b><br><br><b>Example:</b><br>Switch> <b>enable</b>   | Enables privileged EXEC mode. Enter your password if prompted.   |
| <b>Step 2</b> | <b>configure terminal</b><br><br><b>Example:</b><br>Switch# <b>configure terminal</b>   | Enters the global configuration mode.  |
| <b>Step 3</b> | <b>interface</b> <i>type number</i><br><br><b>Example:</b><br>Switch(config)# <b>interface</b><br><b>GigabitEthernet1/0/1</b>                   | Enters the physical interface. The interface used here should not be an Cisco Plug-in for OpenFlow ports.            |
| <b>Step 4</b> | <b>no switchport</b><br><br><b>Example:</b><br>Switch(config-if)# <b>no switchport</b>  | Configures a specified interface as a Layer 3 interface and deletes any interface configuration specific to Layer 2. |
| <b>Step 5</b> | <b>ip address</b> <i>ip-address mask</i><br><br><b>Example:</b><br>Switch(config-if)# <b>ip-address</b> <b>10.0.1.4</b><br><b>255.255.255.0</b> | Configures an IP address for a specified interface.  |

|        | Command or Action   | Purpose  |
|--------|---|--|
| Step 6 | <b>exit</b><br><br><b>Example:</b><br>Switch(config-if)# <b>exit</b>  | Exits interface configuration mode and enters global configuration mode.   |
| Step 7 | <b>ip route 0.0.0.0 0.0.0.0 next-hop</b><br><br><b>Example:</b><br>Switch(config)# <b>ip route 0.0.0.0 0.0.0.0 10.0.1.6</b> | Configures a default route for packet addresses not listed in the routing table. Packets are directed to a controller. |
| Step 8 | <b>exit</b><br><br><b>Example:</b><br>Switch(config)# <b>exit</b>   | Exits global configuration mode and enters privileged EXEC mode.   |
| Step 9 | <b>copy running-config startup-config</b><br><br><b>Example:</b><br>Switch# <b>copy running-config startup-config</b>       | (Optional) Saves your entries in the configuration file.   |

### What to Do Next

Configure interfaces for the Cisco Plug-in for OpenFlow logical switch.

## Specifying a Route to a Controller Using a Management Interface

### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip address** *ip-address mask*
5. **exit**
6. **ip route vrf** *vrf-name* **0.0.0.0 0.0.0.0 next-hop**
7. **exit**

## DETAILED STEPS

|               | Command or Action  | Purpose   |
|---------------|--|---|
| <b>Step 1</b> | <b>enable</b><br><br><b>Example:</b><br>Switch> <b>enable</b>  | Enables privileged EXEC mode. Enter your password if prompted.  |
| <b>Step 2</b> | <b>configure terminal</b><br><br><b>Example:</b><br>Switch# <b>configure terminal</b>  | Enters the global configuration mode.   |
| <b>Step 3</b> | <b>interface</b> <i>type number</i><br><br><b>Example:</b><br>Switch(config)# <b>interface</b> GigabitEthernet0/0  | Enters the management interface. The interface used here should not be an Cisco Plug-in for OpenFlow ports. |
| <b>Step 4</b> | <b>ip address</b> <i>ip-address mask</i><br><br><b>Example:</b><br>Switch(config-if)# <b>ip-address</b> 10.0.1.4<br>255.255.255.0                              | Configures an IP address for the specified interface.   |
| <b>Step 5</b> | <b>exit</b><br><br><b>Example:</b><br>Switch(config-if)# <b>exit</b>   | Exits interface configuration mode and enters global configuration mode.                                    |
| <b>Step 6</b> | <b>ip route vrf</b> <i>vrf-name 0.0.0.0 0.0.0.0 next-hop</i><br><br><b>Example:</b><br>Switch(config)# <b>ip route vrf</b> mgmtVrf 0.0.0.0<br>0.0.0.0 10.0.1.6 | Configures an IP address for the specified interface.   |
| <b>Step 7</b> | <b>exit</b><br><br><b>Example:</b><br>Switch(config)# <b>exit</b>  | Exits global configuration mode and enters privileged EXEC mode.  |

**What to Do Next**

Configure interfaces for the Cisco Plug-in for OpenFlow logical switch.

**Configuring OneP**

To enable the internal OneP infrastructure required to support the OpenFlow Plug-in, perform this task

**SUMMARY STEPS**

1. **enable**
2. **configure terminal**
3. **onep**
4. **end**
5. **copy running-config startup-config**

**DETAILED STEPS**

|               | <b>Command or Action</b>  | <b>Purpose</b>   |
|---------------|---|--|
| <b>Step 1</b> | <b>enable</b><br><br><b>Example:</b><br>Switch> <b>enable</b>   | Enables privileged EXEC mode. Enter your password if prompted. |
| <b>Step 2</b> | <b>configure terminal</b><br><br><b>Example:</b><br>Switch# <b>configure terminal</b>                                 | Enters the global configuration mode.                          |
| <b>Step 3</b> | <b>onep</b><br><br><b>Example:</b><br>Switch(config)# <b>onep</b>   | Enters OneP configuration mode.                                |
| <b>Step 4</b> | <b>end</b><br><br><b>Example:</b><br>Switch(config-onep)# <b>end</b>  | Returns to privileged EXEC mode.                               |
| <b>Step 5</b> | <b>copy running-config startup-config</b><br><br><b>Example:</b><br>Switch# <b>copy running-config startup-config</b> | (Optional) Saves your entries in the configuration file.       |

**Configuring a Cisco Plug-in for OpenFlow Logical Switch**

To configure a Cisco Plug-in for OpenFlow logical switch and the IP address of a controller, perform this task:

## SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **openflow**
4. **switch** *logical-switch-id*
5. **pipeline** *pipeline-id*
6. **of-port interface** *interface-name*
7. **protocol-version** *version-info*
8. **controller ipv4** *ip-address* [ **port** *tcp-port* ][ **vrf** *vrf-name* ] **security** { **none** | **tls** }
9. **default-miss** *action-for-unmatched-flows*
10. **datapath-id** *datapath-id*
11. (Optional) **tls trust-point local** *local-trust-point* **remote** *remote-trust-point*
12. (Optional) **logging flow-mod**
13. (Optional) **probe-interval** *probe-interval*
14. (Optional) **rate-limit packet\_in** *controllet-packet-rate* **burst** *maximum-packets-to-controller*
15. (Optional) **max-backoff** *backoff-timer*
16. **statistics collection-interval** *interval*
17. **end**
18. **copy running-config startup-config**

## DETAILED STEPS

|               | Command or Action  | Purpose  |
|---------------|--|--|
| <b>Step 1</b> | <b>enable</b><br><br><b>Example:</b><br>Switch> <b>enable</b>  | Enables privileged EXEC mode. Enter your password if prompted.   |
| <b>Step 2</b> | <b>configure terminal</b><br><br><b>Example:</b><br>Switch# <b>configure terminal</b>                                  | Enters the global configuration mode.  |
| <b>Step 3</b> | <b>openflow</b><br><br><b>Example:</b><br>Switch(config)# <b>openflow</b>  | Enters Cisco Plug-in for OpenFlow mode.  |
| <b>Step 4</b> | <b>switch</b> <i>logical-switch-id</i><br><br><b>Example:</b><br>Switch(config-ofta-switch)# <b>switch</b><br><b>1</b> | Specifies an ID for a logical switch that is used for OpenFlow switching and enters logical switch configuration mode.<br><br>The only logical switch ID supported is 1. |



|        | Command or Action  | Purpose  |
|--------|--|--|
| Step 5 | <p><b>pipeline</b> <i>pipeline-id</i></p> <p><b>Example:</b><br/>Switch(config-ofa-switch)# <b>pipeline 1</b></p>  | <p>Configures a pipeline .</p> <p>This step is mandatory for a logical switch configuration. The only pipeline ID supported is 1.</p>  |
| Step 6 | <p><b>of-port interface</b> <i>interface-name</i></p> <p><b>Example:</b><br/>Switch(config-ofa-switch)# <b>of-port interface GigabitEthernet1/0/23</b></p> <p><b>Example:</b><br/>Switch(config-ofa-switch)# <b>of-port interface TenGigabitEthernet1/1/2</b></p>  | <p>Configures an Ethernet interface as a port of a Cisco Plug-in for OpenFlow logical switch. Observe these guidelines:</p> <ul style="list-style-type: none"> <li>• Do not abbreviate the interface type. Ensure that the interface type is spelled out completely and is as shown in the examples. If the keyword is abbreviated, the interface is not configured.</li> <li>• The interface must be designated for the Cisco Plug-in for OpenFlow logical switch only.</li> <li>• The <b>onep application openflow exclusive</b> configuration is added to an interface when an interface is configured as a port of Cisco Plug-in for OpenFlow. To add or remove an interface as a port of Cisco Plug-in for OpenFlow, ensure that the Cisco Plug-in for OpenFlow is activated and running to ensure the proper automatic addition and removal of the <b>onep application openflow exclusive</b> configuration. To remove an interface as a port of Cisco Plug-in for OpenFlow, use the no form of this command.</li> </ul> <p>Repeat this step to configure additional interfaces.</p> |
| Step 7 | <p><b>protocol-version</b> <i>version-info</i></p> <p><b>Example:</b><br/>Switch(config-ofa-switch)# <b>protocol-version negotiate</b></p>   | <p>Configures the protocol version. Supported values are:</p> <ul style="list-style-type: none"> <li>• <b>1.0</b>—Configures device to connect to 1.0 controllers only.</li> <li>• <b>1.3</b>—Configures device to connect to 1.3 controllers only.</li> <li>• <b>negotiate</b>—Negotiates the protocol version with the controller. Device uses 1.3 for negotiation.</li> </ul> <p>The default value is <b>negotiate</b>.</p>   |
| Step 8 | <p><b>controller ipv4</b> <i>ip-address</i> [ <b>port</b> <i>tcp-port</i> ] [ <b>vrf</b> <i>vrf-name</i> ] <b>security</b> { <b>none</b>   <b>tls</b> }</p> <p><b>Example:</b><br/>Controller in default VRF:<br/>Switch(config-ofa-switch)# <b>controller ipv4 5.0.32.10 security none</b></p> <p>Controller in management VRF:<br/>Switch(config-ofa-switch)# <b>controller ipv4 5.0.32.10 vrf mgmtVrf security none</b></p> | <p>Specifies the IPv4 address, port number used by the controller to connect to the logical switch and the VRF of the controller. Observe these guidelines:</p> <ul style="list-style-type: none"> <li>• Repeat this step if you need to configure additional controllers. You can configure up to eight controllers.</li> <li>• If TLS is used in this step, configure TLS trustpoints in the next step.</li> <li>• You can use the <b>clear openflow switch 1 controller all</b> command to clear controller connections. This command can reset a connection after Transport Layer Security (TLS) certificates and keys are updated. This is not required for TCP connections.</li> </ul> <p>If unspecified, the default VRF is used; Controllers use TCP port 6653 by default.</p>   |

|                | Command or Action  | Purpose   |
|----------------|--|---|
|                |  | A connection to a controller is initiated by the logical switch.  |
| <b>Step 9</b>  | <b>default-miss</b> <i>action-for-unmatched-flows</i><br><br><b>Example:</b><br>Switch(config-ofa-switch) #<br><b>default-miss continue-controller</b> | Configures the action to be taken for packets that do not match any of the flow defined. Supported values are: <ul style="list-style-type: none"> <li>• <b>continue-drop</b></li> <li>• <b>continue-controller</b></li> <li>• <b>drop</b></li> <li>• <b>controller</b></li> </ul> The default action for both tables or pipeline 1 is <b>drop</b> . This can be overridden by this configuration or the controller.   |
| <b>Step 10</b> | <b>datapath-id</b> <i>datapath-id</i><br><br><b>Example:</b><br>Switch(config-ofa-switch) #<br><b>datapath-id 0x222</b>                                | Configures a unique datapath ID for the switch.<br><br>This step is mandatory for a logical switch configuration. Enter a 64-bit hexadecimal value.   |
| <b>Step 11</b> | <b>tls trust-point local</b> <i>local-trust-point</i><br><b>remote</b> <i>remote-trust-point</i>   | (Optional)<br>Specifies the local and remote TLS trustpoints to be used for the controller connection.<br><br>For more information about configuring trustpoints, see chapter <a href="#">PKI Trustpool Management</a> in the <i>Public Key Infrastructure Configuration Guide</i> .  |
| <b>Step 12</b> | <b>logging flow-mod</b>  | (Optional)<br>Enables logging of flow changes, including addition, deletion, and modification of flows.<br><br>Logging of flow changes is a CPU intensive activity and should not be enabled for a large number of flows.<br><br>Logging of flow changes is disabled by default.<br><br>Flow changes are logged in syslog and can be viewed using the <b>show logging</b> command.  |
| <b>Step 13</b> | <b>probe-interval</b> <i>probe-interval</i><br><br><b>Example:</b><br>Switch(config-ofa-switch) #<br><b>probe-interval 7</b>                           | (Optional)<br>Configures the interval (in seconds) at which the controller is probed.<br><br>After the configured interval of time passes, if the switch has not received any messages from the controller, the switch sends an echo request (echo_request) to the controller. It should normally receive an echo reply (echo_reply). If no message is seen for the duration of another probe interval, the switch presumes that the controller is down and disconnects the controller connection. The switch tries to reconnect periodically.<br><br>The default value is 5 seconds; the range is from 5 to 65535 seconds. |
| <b>Step 14</b> | <b>rate-limit packet_in</b><br><i>controllet-packet-rate</i> <b>burst</b><br><i>maximum-packets-to-controller</i>                                      | (Optional)<br>Configures the maximum packet rate sent to the controller and the maximum packets burst sent to the controller in a second.   |

|                | Command or Action   | Purpose   |
|----------------|---|---|
|                | <p><b>Example:</b><br/>Switch(config-ofta-switch)#<br/><b>rate-limit packet_in 300 burst 50</b></p>   | <p>The default value is zero, that is, an indefinite packet rate and packet burst is permitted.</p> <p>This rate limit is for Cisco Plug-in for OpenFlow. It is not related to the rate limit of the device (data plane) configured by COPP.</p>  |
| <b>Step 15</b> | <p><b>max-backoff</b> <i>backoff-timer</i></p> <p><b>Example:</b><br/>Switch(config-ofta-switch)#<br/><b>max-backoff 8</b></p>                                  | <p>(Optional)</p> <p>Configures the duration (in seconds) for which the device must wait before attempting to initiate a connection with the controller.</p> <p>The device initially tries to initiate connection frequently, as the number of unsuccessful attempts increases, the device tries less frequently, that is, the waiting period between attempts also increases. The backoff timer configures the maximum period that the device waits in-between each retry.</p> <p>The default value is 8 seconds; the range is from 1 to 65535 seconds.</p>  |
| <b>Step 16</b> | <p><b>statistics collection-interval</b> <i>interval</i></p> <p><b>Example:</b><br/>Switch(config-ofta-switch)#<br/><b>statistics collection-interval 0</b></p> | <p>Configures the statistics collection interval (in seconds) for all configured flows of Cisco Plug-in for OpenFlow. Observe these guidelines:</p> <ul style="list-style-type: none"> <li>• The default interval value is 7 seconds.</li> <li>• The minimum interval is 7 seconds; the maximum is 82 seconds.</li> <li>• You can also specify a value of 0, this disables statistics collection.</li> <li>• Flows with an idle timeout value less than <math>2 * interval</math> are rejected.</li> </ul> <p>Configured interval value is displayed in the output of the show openflow switch 1 command.</p> |
| <b>Step 17</b> | <p><b>end</b></p> <p><b>Example:</b><br/>Switch(config-ofta-switch)# <b>end</b></p>   |   |
| <b>Step 18</b> | <p><b>copy running-config startup-config</b></p> <p><b>Example:</b><br/>Switch# <b>copy running-config startup-config</b></p>                                   | <p>(Optional) Saves your entries in the configuration file.</p>   |

### What to Do Next

Verify Cisco Plug-in for OpenFlow.

### Related Topics

[Verifying Cisco Plug-in for OpenFlow, on page 20](#)

[Configuration Examples for Cisco Plug-In for OpenFlow , on page 26](#)

# Verifying Cisco Plug-in for OpenFlow

## SUMMARY STEPS

1. **show openflow copyright**
2. **show openflow switch *switch-id***
3. **show openflow switch *switch-id* controllers [ stats ]**
4. **show openflow switch *switch* ports**
5. **show openflow *switch-id* flows [ configured | controller | default | fixed | pending | pending-del ] [ brief | summary]**
6. **show openflow switch *switch-id* stats**
7. **show interfaces *type number* counter**
8. **show running-config | section openflow**
9. **show openflow hardware capabilities**

## DETAILED STEPS

### Step 1 **show openflow copyright**

Displays copyright information related to Cisco Plug-in for OpenFlow.

#### Example:

```
Switch# show openflow copyright
openflow-ott-of-c3k-118-3920
Cisco Plug-in for OpenFlow
TAC support: http://www.cisco.com/tac
Copyright (c) 2013-2015 by Cisco Systems, Inc. All rights reserved.
The copyrights to certain works contained in this software are
owned by other third parties and used and distributed under
license. Certain components of this software are licensed under
the GNU General Public License (GPL) version 2.0, the GNU
Lesser General Public License (LGPL) Version 2.1, or or the GNU
Library General Public License (LGPL) Version 2. A copy of each
such license is available at
http://www.opensource.org/licenses/gpl-2.0.php and
http://www.opensource.org/licenses/lgpl-2.1.php and
http://www.gnu.org/licenses/old-licenses/lgpl-2.0.txt
```

### Step 2 **show openflow switch *switch-id***

Displays information related to Cisco Plug-in for OpenFlow logical switch.

#### Example:

```
Switch# show openflow switch 1
openflow-ott-of-c3k-118-3920
Logical Switch Context
  Id: 1
  Switch type: Forwarding
  Pipeline id: 1
  Data plane: secure
  Table-Miss default: continue-controller
```

```

Configured protocol version: Negotiate
Config state: no-shutdown
Working state: enabled
Rate limit (packet per second): 300
Burst limit: 50
Max backoff (sec): 8
Probe interval (sec): 7
TLS local trustpoint name: not configured
TLS remote trustpoint name: not configured
Logging flow changes: Disabled
Stats collect interval (sec): 0
Stats collect Max flows: 0
Stats collect period (sec): disabled
Minimum flow idle timeout (sec): disabled
OFA Description:
  Manufacturer: Cisco Systems, Inc.
  Hardware: WS-C3650-24TS V01
  Software: Cisco IOS Software, IOS-XE Software, Catalyst L3 Switch Software
(CAT3K_CAA-UNIVERSALK9-M), Version 03.07.03.E3.369 EARLY DEPLOYMENT PROD BUILD
ENGINEERING NOVA_WEEKLY BUILD, synced to FLO_DSGS7_BENI_MR2_SYNC| of_agent
1.1.64148n
  Serial Num: FDO1909E0XX
  DP Description: ott-of-c3k-118:sw1
OF Features:
  DPID:00000000000000222
  Number of tables:1
  Number of buffers:256
  Capabilities: FLOW_STATS TABLE_STATS PORT_STATS
Controllers:
  5.0.32.10:6233, Protocol: TCP, VRF: default
Interfaces:
GigabitEthernet1/0/1
GigabitEthernet1/0/3

```

**Step 3** **show openflow switch *switch-id* controllers [ stats ]**

Displays information related to the connection status between an Cisco Plug-in for OpenFlow logical switch and connected controllers.

**Example:**

```

Switch# show openflow switch 1 controllers stats
openflow-ott-of-c3k-118-3920
Logical Switch Id: 1
Total Controllers: 1
  Controller: 1
    address                : tcp:5.0.32.10:6233
    connection attempts    : 2
    successful connection attempts : 1
    flow adds               : 0
    flow mods               : 0
    flow deletes           : 0
    flow removals          : 0
    flow errors             : 0
    flow unencodable errors : 0
    total errors            : 0
    echo requests          : rx: 0, tx: 0
    echo reply              : rx: 0, tx: 0
    flow stats              : rx: 0, tx: 0
    barrier                 : rx: 1, tx: 1
    packet-in/packet-out   : rx: 0, tx: 16

```

```
Switch# show openflow switch 1 controllers
openflow-ott-of-c3k-118-3920
Logical Switch Id: 1
Total Controllers: 1
Controller: 1
  5.0.32.10:6233
  Protocol: tcp
  VRF: default
  Connected: Yes
  Role: Master
  Negotiated Protocol Version: OpenFlow 1.0
  Last Alive Ping: 11/17/2015 01:35:51
  last_error:Connection timed out
  state:ACTIVE
  sec_since_connect:16
  sec_since_disconnect:17
```

**Step 4****show openflow switch *switch* ports**

Displays the mapping between physical device interfaces and ports of an Cisco Plug-in for OpenFlow logical switch.

**Example:**

```
Switch# show openflow switch 1 ports
openflow-ott-of-c3k-118-3920
Logical Switch Id: 1
Port Interface Name Config-State Link-State Features
5097 Gi1/0/3 PORT_UP LINK_UP 1GB-FD
5098 Gi1/0/1 PORT_UP LINK_UP 1GB-FD
```

**Step 5****show openflow *switch-id* flows [ configured | controller | default | fixed | pending | pending-del ] [ brief | summary ]**

Displays flows defined for the device by controllers.

**Example:**

```
Switch# show openflow switch 1 flows
openflow-ott-of-c3k-118-3920
Logical Switch Id: 1
Total flows: 3

Flow: 1
Match: in_port=5098
Actions: CONTROLLER:65535
Priority: 32768
Table: 0
Cookie: 0x0
Duration: 21.477s
Number of packets: 0
Number of bytes: 0

Flow: 2
Match: in_port=5097
Actions: output:5098
Priority: 32768
Table: 0
Cookie: 0x0
Duration: 7.834s
Number of packets: 0
Number of bytes: 0

Flow: 3
```

```

Match:          any
Actions:        CONTROLLER:0
Priority:        0
Table:          0
Cookie:         0x0
Duration:       299.759s
Number of packets: 0
Number of bytes: 0

```

**Example:**

```

Switch# show openflow switch 1 flows configured
openflow-ott-of-c3k-118-3920
Logical Switch Id: 1
Total flows: 1

```

```

Flow: 1
Match:          any
Actions:        CONTROLLER:0
Priority:        0
Table:          0
Cookie:         0x0
Duration:       370.903s
Number of packets: 0
Number of bytes: 0

```

**Example:**

```

Switch# show openflow switch 1 flows controller
openflow-ott-of-c3k-118-3920
Logical Switch Id: 1
Total flows: 2

```

```

Flow: 1
Match:          in_port=5098
Actions:        CONTROLLER:65535
Priority:        32768
Table:          0
Cookie:         0x0
Duration:       124.211s
Number of packets: 0
Number of bytes: 0

```

```

Flow: 2
Match:          in_port=5097
Actions:        output:5098
Priority:        32768
Table:          0
Cookie:         0x0
Duration:       110.568s
Number of packets: 0
Number of bytes: 0

```

**Step 6** **show openflow switch *switch-id* stats**

Displays send and receive statistics for each port defined for a Cisco Plug-in for OpenFlow logical switch.

**Example:**

```

Switch# show openflow switch 1 stats
openflow-ott-of-c3k-118-3920
Logical Switch Id: 1

```

```

Total ports: 2
  Port 5098: rx pkts=38, bytes=4810, drop=0, errs=0,
            tx pkts=195, bytes=12652, drop=0, errs=0,
  Port 5097: rx pkts=0, bytes=0, drop=0, errs=0,
            tx pkts=195, bytes=12652, drop=0, errs=0,
Total tables: 1
  Table 0: Openflow SIN
  Wildcards = 0x00000
  Max entries = 1000
  Active entries = 2
  Number of lookups = 0
  Number of matches = 0

```

**Step 7** **show interfaces type number counter**

Displays send and receive statistics for the specified port defined for an Cisco Plug-in for OpenFlow logical switch.

**Example:**

```

Switch# show interfaces gigabitethernet 1/0/1 counters
Port          InOctets    InUcastPkts  InMcastPkts  InBcastPkts
Gi1/0/1       4810        0            24           14

Port          OutOctets    OutUcastPkts  OutMcastPkts  OutBcastPkts
Gi1/0/1       13292       102          103           0

```

**Step 8** **show running-config | section openflow**

Displays configurations made for Cisco Plug-in for OpenFlow.

**Example:**

```

Switch# show running-config | section ^openflow
openflow
  switch 1
    pipeline 1
      controller ipv4 5.0.32.10 port 6233 security none
      of-port interface GigabitEthernet1/0/1
      of-port interface GigabitEthernet1/0/3
      default-miss continue-controller
      probe-interval 7
      statistics collection-interval 0
      rate-limit packet in 300 burst 50
      datapath-id 0x222

```

**Step 9** **show openflow hardware capabilities**

Displays Cisco Plug-in for OpenFlow configurations.

**Example:**

```

Switch# show openflow hardware capabilities
openflow-ott-of-c3k-118-3920

Max Flow Batch Size: 250

Statistics Max Polling Rate (flows/sec): 1024

Max Interfaces: 1000

Aggregated Statistics: YES

```



Pipeline ID: 1

Pipeline Max Flows: 1000

Pipeline Default Statistics Collect Interval: 7

Flow table ID: 0

Max Flow Batch Size: 250

Max Flows: 1000

Bind Subintfs: FALSE

Primary Table: TRUE

Table Programmable: TRUE

Miss Programmable: TRUE

Number of goto tables: 0

goto table id:

Stats collection time for full table (sec): 1

| Match Capabilities            | Match Types |
|-------------------------------|-------------|
| -----                         | -----       |
| ethernet mac destination      | optional    |
| ethernet mac source           | optional    |
| ethernet type                 | optional    |
| VLAN ID                       | optional    |
| VLAN priority code point      | optional    |
| IP DSCP                       | optional    |
| IP protocol                   | optional    |
| IPv4 source address           | lengthmask  |
| IPv4 destination address      | lengthmask  |
| ipv6 source addresss          | lengthmask  |
| ipv6 destination address      | lengthmask  |
| source port                   | optional    |
| destination port              | optional    |
| icmpv4 type                   | optional    |
| icmpv4 code                   | optional    |
| icmpv6 type                   | optional    |
| icmpv6 code                   | optional    |
| in port (virtual or physical) | optional    |

| Actions                             | Count | Limit | Order |
|-------------------------------------|-------|-------|-------|
| specified interface                 | 1     |       | 100   |
| controller                          | 1     |       | 100   |
| divert a copy of pkt to application | 1     |       | 100   |
| set eth source mac                  | 1     |       | 10    |
| set eth destination mac             | 1     |       | 10    |
| set vlan id                         | 1     |       | 10    |
| set vlan priority (cos)             | 1     |       | 10    |
| set IPv4 source address             | 1     |       | 10    |
| set IPv4 destination address        | 1     |       | 10    |
| set IP dscp                         | 1     |       | 10    |
| set TCP source port                 | 1     |       | 10    |
| set TCP destination port            | 1     |       | 10    |
| set UDP source port                 | 1     |       | 10    |
| set UDP destination port            | 1     |       | 10    |
| set qos group                       | 1     |       | 10    |
| pop vlan tag                        | 1     |       | 10    |
| drop packet                         | 1     |       | 100   |

| Miss actions | Count | Limit | Order |
|--------------|-------|-------|-------|
| controller   | 1     | 100   |       |
| drop packet  | 1     | 100   |       |

## Related Topics

[Collecting Troubleshooting Information](#)

# Configuration Examples for Cisco Plug-In for OpenFlow

## Example: Specifying a Route to a Controller Using a Physical Interface

```
Switch> enable
Switch# configure terminal
Switch(config)# interface GigabitEthernet1/0/1
Switch(config-if)# no switchport
Switch(config-if)# ip address 10.0.1.4 255.255.255.0
Switch(config-if)# exit
Switch(config)# ip route 0.0.0.0 0.0.0.0 10.0.1.6
Switch# copy running-config startup-config
Switch(config)# exit
```

## Example: Specifying a Route to a Controller Using a Management Interface

```
Device> enable
Switch# configure terminal
Switch(config)# interface GigabitEthernet0/0
Switch(config-if)# no switchport
Switch(config-if)# ip address 10.0.1.4 255.255.255.0
Switch(config-if)# exit
Switch(config)# ip route vrf mgmtVrf 0.0.0.0 0.0.0.0 10.0.1.6
Switch# copy running-config startup-config
Switch(config)# exit
```

## Example: Cisco Plug-In for OpenFlow Logical Switch Configuration (Default VRF)

```
Switch> enable
Switch# configure terminal
Switch(config)# onep
Switch(config-onep)# exit

Switch(config)# openflow
Switch(config-ofa)# switch 1
```

```
! Specifies the pipeline that enables the IP Forwarding Table.
Switch(config-ofa-switch)# pipeline 1
Switch(config-ofa-switch)# tls trust-point local local-trustpoint-name remote
remote-trustpoint-name
Switch(config-ofa-switch)# max-backoff 5
Switch(config-ofa-switch)# probe-interval 5
Switch(config-ofa-switch)# rate-limit packet-in 300 burst 50
Switch(config-ofa-switch)# controller ipv4 10.0.1.6 port 6323 security none
Switch(config-ofa-switch)# datapath-id 0x222
```

```
! Adding an interface to the Cisco Plug-In for OpenFlow logical switch.
```

```
Switch(config-ofa-switch)# of-port interface GigabitEthernet1/0/23
Switch(config-ofa-switch)#end
Switch# copy running-config startup-config
```

### Example: Configuring a Cisco Plug-In for OpenFlow Logical Switch (Management VRF)

```
Switch> enable
Switch# configure terminal
Switch(config)# onep
Switch(config-onep)# exit

Switch(config)# openflow
Switch(config-ofa)# switch 1
Switch(config-ofa-switch)# pipeline 1

! Specifying a controller that is part of a VRF.
Switch(config-ofa-switch)# controller ipv4 10.0.1.6 port 6323 vrf mgmtVrf security none

! Adding an interface to the Cisco Plug-In for OpenFlow logical switch.
Switch(config-ofa-switch)# of-port interface GigabitEthernet1/0/23
Switch(config-ofa-switch)# end
Switch# copy running-config startup-config
```

## Additional Information for Cisco Plug-In for OpenFlow

### Related Documents

| Related Topic  | Document Title  |
|----------------|---|
| Cisco commands | <a href="#">Cisco IOS Master Command List, All Releases</a> |

### Standards and RFCs

| Standard/RFC | Title  |
|--------------|--|
| OpenFlow 1.3 | <i>OpenFlow Switch Specification Version 1.3.0 (Wire Protocol 0x04).</i> |
| OpenFlow 1.0 | <i>OpenFlow Switch Specification Version 1.0.1 (Wire Protocol 0x01).</i> |

**Technical Assistance**

| Description  | Link  |
|--|---|
| The Cisco Support and Documentation website provides online resources to download documentation and tools. Use these resources to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password. | <a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a> |