



Cisco Plug-in for OpenFlow Configuration Guide for Catalyst 3850 and 3650 Series Switches

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Preface

- [Document Conventions](#), page iii
- [Related Documentation](#), page v
- [Obtaining Documentation and Submitting a Service Request](#), page vi

Document Conventions

This document uses the following conventions:

Convention	Description
^ or Ctrl	Both the ^ symbol and Ctrl represent the Control (Ctrl) key on a keyboard. For example, the key combination ^D or Ctrl-D means that you hold down the Control key while you press the D key. (Keys are indicated in capital letters but are not case sensitive.)
bold font	Commands and keywords and user-entered text appear in bold font .
<i>Italic font</i>	Document titles, new or emphasized terms, and arguments for which you supply values are in <i>italic font</i> .
Courier font	Terminal sessions and information the system displays appear in <i>courier font</i> .
Bold Courier font	Bold Courier font indicates text that the user must enter.
[x]	Elements in square brackets are optional.
...	An ellipsis (three consecutive nonbolded periods without spaces) after a syntax element indicates that the element can be repeated.
	A vertical line, called a pipe, indicates a choice within a set of keywords or arguments.
[x y]	Optional alternative keywords are grouped in brackets and separated by vertical bars.

Convention	Description
{x y}	Required alternative keywords are grouped in braces and separated by vertical bars.
[x {y z}]	Nested set of square brackets or braces indicate optional or required choices within optional or required elements. Braces and a vertical bar within square brackets indicate a required choice within an optional element.
string	A nonquoted set of characters. Do not use quotation marks around the string or the string will include the quotation marks.
<>	Nonprinting characters such as passwords are in angle brackets.
[]	Default responses to system prompts are in square brackets.
!, #	An exclamation point (!) or a pound sign (#) at the beginning of a line of code indicates a comment line.

Reader Alert Conventions

This document may use the following conventions for reader alerts:



Note

Means *reader take note*. Notes contain helpful suggestions or references to material not covered in the manual.



Tip

Means *the following information will help you solve a problem*.



Caution

Means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.



Timesaver

Means *the described action saves time*. You can save time by performing the action described in the paragraph.



Warning

IMPORTANT SAFETY INSTRUCTIONS

This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. Use the statement number provided at the end of each warning to locate its translation in the translated safety warnings that accompanied this device. Statement 1071

SAVE THESE INSTRUCTIONS

Related Documentation

Release Notes

**Note**

Before installing or upgrading, refer to the switch release notes.

- Catalyst 3850 release notes:
<http://www.cisco.com/c/en/us/support/switches/catalyst-3850-series-switches/products-release-notes-list.html>
- Catalyst 3650 release notes:
<http://www.cisco.com/c/en/us/support/switches/catalyst-3650-series-switches/products-release-notes-list.html>

Software Documentation

Software documents for the Catalyst 3850 series switches is available at the following URLs:

- Software Configuration Guides
<http://www.cisco.com/c/en/us/support/switches/catalyst-3850-series-switches/products-installation-and-configuration-guides-list.html>
- Software Command References
<http://www.cisco.com/c/en/us/support/switches/catalyst-3850-series-switches/products-command-reference-list.html>

Software documents for the Catalyst 3650 series switches is available at the following URLs:

- Software Configuration Guides
<http://www.cisco.com/c/en/us/support/switches/catalyst-3650-series-switches/products-installation-and-configuration-guides-list.html>
- Software Command References
<http://www.cisco.com/c/en/us/support/switches/catalyst-3650-series-switches/products-command-reference-list.html>

Hardware Documentation

Installation guides and notes for the Catalyst 3850 series switches including specifications and relevant safety information are available at the following URLs:

- International agency compliance, safety, and statutory information
http://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst3850/hardware/regulatory/compliance/cat3850_rcsi.html
- Hardware Installation Guide
http://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst3850/hardware/installation/guide/b_c3850_hig.html

Installation guides and notes for the Catalyst 3650 series switches including specifications and relevant safety information are available at the following URLs:

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- Hardware Installation Guide

http://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst3650/hardware/installation/guide/Cat3650hig_book.html

Other References

- Cisco SFP and SFP+ modules documentation, including compatibility matrixes, located at: <http://www.cisco.com/c/en/us/support/interfaces-modules/transceiver-modules/tsd-products-support-series-home.html>
- Cisco Validated Designs documents, located at: <http://www.cisco.com/go/designzone>
- Error Message Decoder, located at: <http://tools.cisco.com/search/results/en/us/get>

Obtaining Documentation and Submitting a Service Request

For information on obtaining documentation, submitting a service request, and gathering additional information, see the monthly *What's New in Cisco Product Documentation*, which also lists all new and revised Cisco technical documentation, at:

<http://www.cisco.com/c/en/us/td/docs/general/whatsnew/whatsnew.html>

Subscribe to the *What's New in Cisco Product Documentation* as a Really Simple Syndication (RSS) feed and set content to be delivered directly to your desktop using a reader application. The RSS feeds are a free service and Cisco currently supports RSS version 2.0.



Cisco Plug-in for OpenFlow

- [Prerequisites for Cisco Plug-in for OpenFlow, page 1](#)
- [Restrictions for Cisco Plug-in for OpenFlow, page 2](#)
- [Information About Cisco Plug-In for Open Flow, page 3](#)
- [How to Configure Cisco Plug-In for Open Flow, page 11](#)
- [Configuration Examples for Cisco Plug-In for OpenFlow , page 26](#)
- [Additional Information for Cisco Plug-In for OpenFlow, page 27](#)

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 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

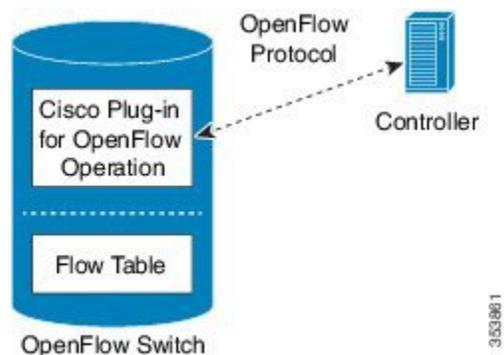
OpenFlow Switch Specification Version 1.0.1 (Wire Protocol 0x01), referred to as OpenFlow 1.0, and OpenFlow Switch Specification Version 1.3.0 (Wire Protocol 0x04), referred to as OpenFlow 1.3, are based on the concept of an Ethernet switch with an internal flow table and standardized interface to allow 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. Note 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. 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"> • Controller to switch: <ul style="list-style-type: none"> • Handshake • Switch Configuration • Modify State (Port Modification message is not supported) • Read State • Packet-Out • Barrier • Asynchronous messages: <ul style="list-style-type: none"> • Packet-In • Flow Removed • Port Status • Error • Symmetric messages: <ul style="list-style-type: none"> • Hello • Echo Request • Echo Reply • Vendor
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"> • The flow can have only one output action. • Some action combinations which are not supported may be rejected at flow programming time. • The flow should not have an output-to-controller action in combination with other rewrite actions.
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 default-miss 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. The logical switch supports only table 1.

Feature	Notes
Forwarding Table	

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

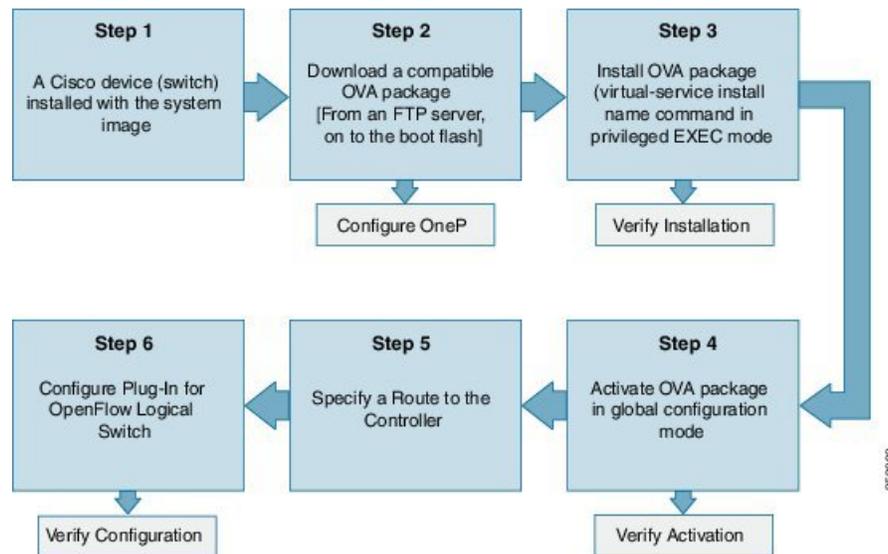
Feature	Notes			
	<ul style="list-style-type: none"> • Modify L4 destination port • Decrement TTL 			
Number of flows	Flow type	TCAM entries for each flow	Scale (c3850)	Scale (c3650)
	L2 with EtherType	1	1000	500
	L3	2	500	250
	L2 without EtherType	5	200	100
Configuration of VLANs for each port of the 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
Step 1	enable Example: Switch> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Switch# configure terminal	Enters the global configuration mode.
Step 3	interface <i>type number</i> Example: Switch(config)# interface GigabitEthernet1/0/1	Enters the physical interface. The interface used here should not be an Cisco Plug-in for OpenFlow ports.
Step 4	no switchport Example: Switch(config-if)# no switchport	Configures a specified interface as a Layer 3 interface and deletes any interface configuration specific to Layer 2.
Step 5	ip address <i>ip-address mask</i> Example: Switch(config-if)# ip-address 10.0.1.4 255.255.255.0	Configures an IP address for a specified interface.

	Command or Action	Purpose
Step 6	exit Example: Switch(config-if)# exit	Exits interface configuration mode and enters global configuration mode.
Step 7	ip route 0.0.0.0 0.0.0.0 next-hop Example: Switch(config)# ip route 0.0.0.0 0.0.0.0 10.0.1.6	Configures a default route for packet addresses not listed in the routing table. Packets are directed to a controller.
Step 8	exit Example: Switch(config)# exit	Exits global configuration mode and enters privileged EXEC mode.
Step 9	copy running-config startup-config Example: Switch# copy running-config startup-config	(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
Step 1	enable Example: Switch> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Switch# configure terminal	Enters the global configuration mode.
Step 3	interface <i>type number</i> Example: Switch(config)# interface GigabitEthernet0/0	Enters the management interface. The interface used here should not be an Cisco Plug-in for OpenFlow ports.
Step 4	ip address <i>ip-address mask</i> Example: Switch(config-if)# ip-address 10.0.1.4 255.255.255.0	Configures an IP address for the specified interface.
Step 5	exit Example: Switch(config-if)# exit	Exits interface configuration mode and enters global configuration mode.
Step 6	ip route vrf <i>vrf-name</i> 0.0.0.0 0.0.0.0 <i>next-hop</i> Example: Switch(config)# ip route vrf mgmtVrf 0.0.0.0 0.0.0.0 10.0.1.6	Configures an IP address for the specified interface.
Step 7	exit Example: Switch(config)# exit	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

	Command or Action	Purpose
Step 1	enable Example: Switch> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Switch# configure terminal	Enters the global configuration mode.
Step 3	onep Example: Switch(config)# onep	Enters OneP configuration mode.
Step 4	end Example: Switch(config-onep)# end	Returns to privileged EXEC mode.
Step 5	copy running-config startup-config Example: Switch# copy running-config startup-config	(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
Step 1	enable Example: Switch> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Switch# configure terminal	Enters the global configuration mode.
Step 3	openflow Example: Switch(config)# openflow	Enters Cisco Plug-in for OpenFlow mode.
Step 4	switch <i>logical-switch-id</i> Example: Switch(config-ofta-switch)# switch 1	Specifies an ID for a logical switch that is used for OpenFlow switching and enters logical switch configuration mode. The only logical switch ID supported is 1.

	Command or Action	Purpose
Step 5	<p>pipeline <i>pipeline-id</i></p> <p>Example: Switch(config-ofa-switch)# pipeline 1</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>of-port interface <i>interface-name</i></p> <p>Example: Switch(config-ofa-switch)# of-port interface GigabitEthernet1/0/23</p> <p>Example: Switch(config-ofa-switch)# of-port interface TenGigabitEthernet1/1/2</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"> • 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. • The interface must be designated for the Cisco Plug-in for OpenFlow logical switch only. • The onep application openflow exclusive 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 onep application openflow exclusive configuration. To remove an interface as a port of Cisco Plug-in for OpenFlow, use the no form of this command. <p>Repeat this step to configure additional interfaces.</p>
Step 7	<p>protocol-version <i>version-info</i></p> <p>Example: Switch(config-ofa-switch)# protocol-version negotiate</p>	<p>Configures the protocol version. Supported values are:</p> <ul style="list-style-type: none"> • 1.0—Configures device to connect to 1.0 controllers only. • 1.3—Configures device to connect to 1.3 controllers only. • negotiate—Negotiates the protocol version with the controller. Device uses 1.3 for negotiation. <p>The default value is negotiate.</p>
Step 8	<p>controller ipv4 <i>ip-address</i> [port <i>tcp-port</i>] [vrf <i>vrf-name</i>] security { none tls }</p> <p>Example: Controller in default VRF: Switch(config-ofa-switch)# controller ipv4 5.0.32.10 security none</p> <p>Controller in management VRF: Switch(config-ofa-switch)# controller ipv4 5.0.32.10 vrf mgmtVrf security none</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"> • Repeat this step if you need to configure additional controllers. You can configure up to eight controllers. • If TLS is used in this step, configure TLS trustpoints in the next step. • You can use the clear openflow switch 1 controller all 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. <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.
Step 9	default-miss <i>action-for-unmatched-flows</i> Example: Switch(config-ofa-switch) # default-miss continue-controller	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"> • continue-drop • continue-controller • drop • controller The default action for both tables or pipeline 1 is drop . This can be overridden by this configuration or the controller.
Step 10	datapath-id <i>datapath-id</i> Example: Switch(config-ofa-switch) # datapath-id 0x222	Configures a unique datapath ID for the switch. This step is mandatory for a logical switch configuration. Enter a 64-bit hexadecimal value.
Step 11	tls trust-point local <i>local-trust-point</i> remote <i>remote-trust-point</i>	(Optional) Specifies the local and remote TLS trustpoints to be used for the controller connection. For more information about configuring trustpoints, see chapter PKI Trustpool Management in the <i>Public Key Infrastructure Configuration Guide</i> .
Step 12	logging flow-mod	(Optional) Enables logging of flow changes, including addition, deletion, and modification of flows. Logging of flow changes is a CPU intensive activity and should not be enabled for a large number of flows. Logging of flow changes is disabled by default. Flow changes are logged in syslog and can be viewed using the show logging command.
Step 13	probe-interval <i>probe-interval</i> Example: Switch(config-ofa-switch) # probe-interval 7	(Optional) Configures the interval (in seconds) at which the controller is probed. 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. The default value is 5 seconds; the range is from 5 to 65535 seconds.
Step 14	rate-limit packet_in <i>controllet-packet-rate</i> burst <i>maximum-packets-to-controller</i>	(Optional) 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>Example: Switch(config-ofta-switch)# rate-limit packet_in 300 burst 50</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>
Step 15	<p>max-backoff <i>backoff-timer</i></p> <p>Example: Switch(config-ofta-switch)# max-backoff 8</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>
Step 16	<p>statistics collection-interval <i>interval</i></p> <p>Example: Switch(config-ofta-switch)# statistics collection-interval 0</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"> • The default interval value is 7 seconds. • The minimum interval is 7 seconds; the maximum is 82 seconds. • You can also specify a value of 0, this disables statistics collection. • Flows with an idle timeout value less than $2 * interval$ are rejected. <p>Configured interval value is displayed in the output of the show openflow switch 1 command.</p>
Step 17	<p>end</p> <p>Example: Switch(config-ofta-switch)# end</p>	
Step 18	<p>copy running-config startup-config</p> <p>Example: Switch# copy running-config startup-config</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, on page 41](#)

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	Cisco IOS Master Command List, All Releases

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.	http://www.cisco.com/cisco/web/support/index.html



Virtual Services Container

- [Prerequisites for a Virtual Services Container, page 29](#)
- [Information about Virtual Services Container, page 30](#)
- [How to Configure a Virtual Services Container, page 30](#)
- [Configuration Examples for Virtual Services Container Installation , page 38](#)
- [Upgrading a Virtual Services Container, page 39](#)
- [Additional References for the Virtual Services Container, page 39](#)

Prerequisites for a Virtual Services Container

- A Cisco device installed with an operating system release that supports virtual services and has the needed system infrastructure required for specific applications like 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](#)



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 3650 Series Switches](#)

- An open virtual application (OVA) package that is compatible with the device operating system has been 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.
- Enough memory is available for the installation and deployment of the application. The container and its applications require 256 MB.

Information about Virtual Services Container

Virtual Services Containers and Applications

A virtual services container is a virtualized environment on a device. It is also referred to as a virtual machine (VM), virtual service, or container.

You can install an application within a virtual services container. The application runs in the virtual services container of the operating system of a device. The application is delivered as an open virtual application (OVA), which is a tar file with a .ova extension. The OVA package is installed and enabled on a device through the device CLI.

Cisco Plug-In for OpenFlow is an example of an application that can be deployed within a virtual services container.

Some of the files that can be found in an OVA file are the following:

- Virtual machine definition file, in libvirt XML format, with Cisco extensions.
- Manifest file, listing the contents of a distribution. It contains the hash information for each file in the OVA package.
- Certificate file containing the signature of a manifest file. This file is used in validating the integrity of an OVA package.
- Version file, used to check compatibility with the virtualization infrastructure.

Related Topics

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

[Installing and Activating an Application in a Virtual Services Container, on page 30](#)

How to Configure a Virtual Services Container

Installing and Activating an Application in a Virtual Services Container

This task copies an open virtual application (OVA) package from an FTP file location, installs the application in a virtual services container, provisions the application, and activates it.

SUMMARY STEPS

1. **enable**
2. **copy** *from://source-directory-url destination-directory-url*
3. **virtual-service install name** *virtual-services-name* **package file**
4. **configure terminal**
5. **virtual-service** *virtual-services-name*
6. **activate**
7. **end**
8. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example:</p> <pre>Switch> enable</pre>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<p>copy <i>from://source-directory-url destination-directory-url</i></p> <p>Example:</p> <pre>Switch# copy tftp://myserver.com/downloads/ofa-1.1.64144n-cat3000-SSA-k9.ova flash: ofa-1.1.64144n-cat3000-SSA-k9.ova</pre>	<p>Downloads the new OVA package to the device for upgrade. Possible values are:</p> <ul style="list-style-type: none"> • flash: • tftp: <p>Ensure you have configured the ip tftp source-interface <i>mgmt_interface</i> for the tftp to be usable.</p>
Step 3	<p>virtual-service install name <i>virtual-services-name</i> package file</p> <p>Example:</p> <pre>Switch# virtual-service install name openflow_agent package flash: ofa-1.1.64144n-cat3000-SSA-k9.ova</pre>	<p>Installs an OVA package from the specified location onto a device. Ensure that the ova file is located in the root directory of the storage device</p> <p>The <i>virtual-services-name</i> defined here should be used in all occurrences of this argument in this document.</p>
Step 4	<p>configure terminal</p> <p>Example:</p> <pre>Switch# configure terminal</pre>	Enters the global configuration mode.

	Command or Action	Purpose
Step 5	virtual-service <i>virtual-services-name</i> Example: Switch(config)# virtual-service openflow_agent	Configures a virtual services container and enters virtual services configuration mode. Observe these guidelines: <ul style="list-style-type: none"> • Use the <i>virtual-services-name</i> defined during installation of the application. • Ensure that installation is complete before proceeding to the next step using the show virtual-service list command.
Step 6	activate Example: Switch(config-virt-serv)# activate	Activates the installed virtual services container.
Step 7	end Example: Switch(config-virt-serv)# end	Exits virtual services configuration mode and enters privileged EXEC mode.
Step 8	copy running-config startup-config Example: Switch# copy running-config startup-config	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

What to Do Next

You can now begin using your application.

Related Topics

[Verifying Installation of Virtual Services Container Applications](#), on page 33

[Configuration Examples for Virtual Services Container Installation](#), on page 38

Verifying Installation of Virtual Services Container Applications

SUMMARY STEPS

1. **show virtual-service [global]**
2. **show virtual-service detail [name *virtual-services-name*]**
3. **show virtual-service list**
4. **show virtual-service storage pool list**
5. **show virtual-service storage volume list**
6. **show virtual-service version name *virtual-services-name* installed**
7. **show virtual-service tech-support**
8. **show virtual-service redundancy state**
9. **show virtual-service utilization name *virtual-services-name***
10. **show virtual-service utilization statistics CPU**

DETAILED STEPS

Step 1 **show virtual-service [global]**

This command displays available memory, disk space, and CPU allocated for applications.

Example:

```
Switch# show virtual-service
```

Virtual Service Global State and Virtualization Limits:

```
Infrastructure version : 1.5
Total virtual services installed : 1
Total virtual services activated : 1
```

```
Machine types supported : LXC
Machine types disabled : KVM
```

```
Maximum VCPUs per virtual service : 1
Resource virtualization limits:
```

Name	Quota	Committed	Available
system CPU (%)	6	1	5
memory (MB)	256	256	0
flash (MB)	256	219	37

Step 2 **show virtual-service detail [name *virtual-services-name*]**

This command displays a list of resources committed to a specified application, including attached devices.

Example:

```
Switch# show virtual-service detail name openflow_agent
```

```
Virtual service openflow_agent detail
State : Activated
```

```

Package information
  Name           : ofa-1.1.64148n-cat3000-SSA-k9.ova
  Path           :
flash:/virtual-instance/OVA/openflow_agent/ofa-1.1.64148n-cat3000-SSA-k9.ova
Application
  Name           : CiscoPluginForOpenFlow
  Installed version : 1.1.64148n
  Description    : Cisco Plug-in for OpenFlow
Signing
  Key type      : Cisco key
  Method       : SHA-512
Licensing
  Name         : Not Available
  Version      : Not Available

Resource reservation
  Disk        : 135 MB
  Memory     : 256 MB
  CPU        : 1% system CPU

Attached devices
  Type          Name          Alias
-----
Disk           _rootfs
Disk           /mnt/ofa
Disk           /cisco/...
Serial/shell
Serial/aux
Serial/Syslog          serial2
Serial/Trace          serial3
Watchdog

```

Step 3 **show virtual-service list**

This command displays an overview of resources utilized by the applications.

Example:

```
Switch# show virtual-service list
```

Virtual Service List:

Name	Status	Package Name
openflow_agent	Activated	ofa-1.1.64148n-cat3000-SSA-k9.ova

Step 4 **show virtual-service storage pool list**

This command displays an overview of storage locations (pools) used for virtual service containers.

Example:

```
Switch# show virtual-service storage pool list
```

Virtual-Service storage pool list

Name	Pool Type	Path
------	-----------	------

```
-----
virt_strg_pool_fl      Directory    /flash/virt_strg_pool_fl
```

Step 5**show virtual-service storage volume list**

This command displays an overview of storage volume information for virtual service containers.

Example:

```
Switch# show virtual-service storage volume list
```

```
Virtual-Service storage volume list
```

```
Name                               Capacity    In Use    Virtual-Service
-----
_rootfs.openflow_agent             130 MB     Yes       openflow_agent
```

Step 6**show virtual-service version name *virtual-services-name* installed**

This command displays the version of an installed application.

Example:

```
Switch# show virtual-service version name openflow_agent installed
```

```
Virtual service openflow_agent installed version:
```

```
  Name : CiscoPluginForOpenFlow
  Version : 1.1.64148n
```

Step 7**show virtual-service tech-support**

Displays all relevant container-based information.

Step 8**show virtual-service redundancy state****Example:**

```
Switch# show virtual-service redundancy state
```

```
Virtual Service Redundancy State:
```

```
Switch No.      Role          Configure sync status    OVA sync status
-----
1               Active        N/A                       N/A
```

Displays state of virtual-services.

Step 9**show virtual-service utilization name *virtual-services-name*****Example:**

```
Switch# show virtual-service utilization name openflow_agent
```

```
Virtual-Service Utilization:
```

```
CPU Utilization:
```

```
  CPU Time: 0 % (30 second average)
  CPU State: R : Running
```

```
Memory Utilization:
```

```
  Memory Allocation: 262144 Kb
  Memory Used:      9308 Kb
```

```

Storage Utilization:
Name: _rootfs, Alias: _rootfs
  RD Bytes:      0          WR Bytes:      0
  RD Requests:  0          WR Requests:  0
  Errors:        0
  Capacity(1K blocks): 128908  Used(1K blocks): 82304
  Available(1K blocks): 39948  Usage: 68 %
Name: cisco, Alias: cisco
  RD Bytes:      0          WR Bytes:      0
  RD Requests:  0          WR Requests:  0
  Errors:        0
  Capacity(1K blocks): 2712192  Used(1K blocks): 337908
  Available(1K blocks): 2374284  Usage: 13 %
Name: /mnt/ofa, Alias: /mnt/ofa
  RD Bytes:      0          WR Bytes:      0
  RD Requests:  0          WR Requests:  0
  Errors:        0
  Capacity(1K blocks): 4955     Used(1K blocks): 35
  Available(1K blocks): 4664    Usage: 1 %
Name: /cisco/core, Alias: /cisco/core
  RD Bytes:      0          WR Bytes:      0
  RD Requests:  0          WR Requests:  0
  Errors:        0
  Capacity(1K blocks): 248895   Used(1K blocks): 201014
  Available(1K blocks): 35031   Usage: 86 %
Name: /tmp1, Alias: /tmp1
  RD Bytes:      0          WR Bytes:      0
  RD Requests:  0          WR Requests:  0
  Errors:        0
  Capacity(1K blocks): 2712192  Used(1K blocks): 337908
  Available(1K blocks): 2374284  Usage: 13 %
Name: /cisco123, Alias: /cisco123
  RD Bytes:      0          WR Bytes:      0
  RD Requests:  0          WR Requests:  0
  Errors:        0
  Capacity(1K blocks): 1800824  Used(1K blocks): 42020
  Available(1K blocks): 1758804  Usage: 3 %

```

Displays virtual-services utilization information.

Step 10 **show virtual-service utilization statistics CPU**
Displays virtual service CPU utilization statistics.

Related Topics

[Troubleshooting: Installing Applications in a Virtual Services Container, on page 42](#)

[Troubleshooting: Activating Applications in a Virtual Services Container, on page 45](#)

Deactivating and Uninstalling an Application from a Virtual Services Container

(Optional) Perform this task to uninstall and deactivate an application from within a virtual services container.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **virtual-service** *virtual-services-name*
4. **no activate**
5. **no virtual-service** *virtual-services-name*
6. **end**
7. **virtual-service uninstall name** *virtual-services-name*
8. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Switch> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Switch# configure terminal	Enters the global configuration mode.
Step 3	virtual-service <i>virtual-services-name</i> Example: Switch(config)# virtual-service openflow_agent	Enters virtual services configuration mode to configure a specified application. <ul style="list-style-type: none"> • Use the <i>virtual-services-name</i> defined during installation of the application.
Step 4	no activate Example: Switch(config-virt-serv)# no activate	Disables the application.
Step 5	no virtual-service <i>virtual-services-name</i> Example: Switch(config)# no virtual-service openflow_agent	Unprovisions the application. <ul style="list-style-type: none"> • Use the <i>virtual-services-name</i> defined during installation of the application. • This command is optional for all devices running Cisco IOS-XE.

	Command or Action	Purpose
Step 6	end Example: Switch(config-virt-serv) # end	Exits virtual services configuration mode and enters privileged EXEC mode.
Step 7	virtual-service uninstall name <i>virtual-services-name</i> Example: Switch# virtual-service uninstall name openflow_agent	Uninstalls the application. <ul style="list-style-type: none"> • Use the <i>virtual-services-name</i> defined during installation of the application. • Run this command only after receiving a successful deactivation response from the device.
Step 8	copy running-config startup-config Example: Switch# copy running-config startup-config	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

Related Topics

[Collecting Troubleshooting Information, on page 41](#)

Configuration Examples for Virtual Services Container Installation

Example: Cisco Plug-In for OpenFlow Virtual Services Container Installation

```
Switch# enable
Switch# copy tftp://myserver.com/downloads/ofa-1.1.64148n-cat3000-SSA-k9.ova flash:
ofa-1.1.64148n-cat3000-SSA-k9.ova
Switch# virtual-service install name openflow_agent package
flash:/ofa-1.1.64148n-cat3000-SSA-k9.ova
Switch# configure terminal
Switch(config)# virtual-service openflow_agent
Switch(config-virt-serv)# activate
Switch(config-virt-serv)# end
Switch# copy running-config startup-config
```

Example: Verifying Cisco Plug-In for OpenFlow Virtual Services Container Installation

```
Switch# show virtual-service list
```

Virtual Service List:

Name	Status	Package Name
openflow_agent	Activated	
ofa-1.1.64148n-cat3000-SSA-k9.ova		

Upgrading a Virtual Services Container

The **virtual-service upgrade** command is not supported. Follow the instructions in the previous sections to deactivate, uninstall, then install and activate the new OVA.

Additional References for the Virtual Services Container

Related Documents

Related Topic	Document Title
Cisco commands	Cisco IOS Master Command List, All Releases

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.	http://www.cisco.com/cisco/web/support/index.html



APPENDIX **A**

Troubleshooting

- [Collecting Troubleshooting Information, page 41](#)
- [Troubleshooting: Installing Applications in a Virtual Services Container, page 42](#)
- [Troubleshooting: Activating Applications in a Virtual Services Container, page 45](#)
- [Troubleshooting: Uninstalling Applications in a Virtual Services Container, page 46](#)
- [Troubleshooting: Deactivating Applications in a Virtual Services Container, page 47](#)

Collecting Troubleshooting Information

Information collected using the commands listed below can be sent to Cisco Technical Support for troubleshooting purposes.

SUMMARY STEPS

1. `show system sysmgr service name vman`
2. `show mgmt-infra trace message vman_trace`
3. `virtual-service move name virtual-services-name [core | log] to destination-url`
4. `show mgmt-infra trace settings vman_trace`
5. `set trace control vman_trace buffer-size buffer-size`
6. `set trace control vman_trace clear [location active]`
7. `set trace vman_trace level {debug | default | err | info | warning} [location active]`

DETAILED STEPS

	Command or Action	Purpose
Step 1	<code>show system sysmgr service name vman</code> Example: Switch# <code>show system sysmgr service name vman</code> Service "virtManager" ("vman", 40):	This command shows the health of the virtualization manager (VMAN) process.

	Command or Action	Purpose
	<pre> UUID = 702, PID = 6482, no SAP State: SRV_STATE_STARTED (entered at tim e Thu Nov 19 18:27:01 2015). Restart count: 1 Time of last restart: Thu Nov 19 18:27:01 2015. The service never crashed since the last reboot. Tag = N/A Plugin ID: 0 </pre>	
Step 2	show mgmt-infra trace message vman_trace	This command contains information logged by the VMAN process.
Step 3	virtual-service move name <i>virtual-services-name</i> [core log] to <i>destination-url</i> Example: Switch# virtual-service move name openflow_agent core to flash:	Moves application log or core files to a specified destination location. This command can be used when the application running in the container has an issue (but the container is running as expected).
Step 4	show mgmt-infra trace settings vman_trace Example: Switch# show mgmt-infra trace settings vman_trace One shot Trace Settings: Buffer Name: vman_trace Default Size: 262144 Current Size: 262144 Traces Dropped due to internal error: Yes Total Entries Written: 4653 One shot mode: No One shot and full: No Disabled: False	This command displays trace settings of a trace buffer.
Step 5	set trace control vman_trace buffer-size <i>buffer-size</i>	This command sets the trace buffer size.
Step 6	set trace control vman_trace clear [location active]	This command clears the trace buffer.
Step 7	set trace vman_trace level {debug default err info warning} [location active]	This command sets the trace level.

Troubleshooting: Installing Applications in a Virtual Services Container

This topic describes the possible reasons why installation of an application in a virtual services container may not have been successful, and the corresponding solutions.

Problem Installation of an application in a virtual services container is not successful.

Possible Cause Installation of the application may still be ongoing.

Solution Check the installation status, by using the **show virtual-service list** command. The following sample output shows an application that has status `Installed`.

```
Switch# show virtual-service list
Virtual Service List:
```

Name	Status	Package Name
openflow_agent	Installed	ofa-1.1.64142n-cat3000-SSA-k9.ova

Possible Cause An application with the same name has already been installed.

Solution Ensure that an application with the same name has not already been installed, by using the **show virtual-service list** command. You can verify this by referencing the Name field.

Possible Cause The target media has not been installed.

Solution Target media for the switch — flash. Ensure that the target media is installed, by using the **show version** command.

```
Switch# show version
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
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2015 by Cisco Systems, Inc.
Compiled Thu 12-Nov-15 05:27 by gereddy
```

```
Cisco IOS-XE software, Copyright (c) 2005-2015 by cisco Systems, Inc.
All rights reserved. Certain components of Cisco IOS-XE software are
licensed under the GNU General Public License ("GPL") Version 2.0. The
software code licensed under GPL Version 2.0 is free software that comes
with ABSOLUTELY NO WARRANTY. You can redistribute and/or modify such
GPL code under the terms of GPL Version 2.0.
(http://www.gnu.org/licenses/gpl-2.0.html) For more details, see the
documentation or "License Notice" file accompanying the IOS-XE software,
or the applicable URL provided on the flyer accompanying the IOS-XE
software.
```

```
ROM: IOS-XE ROMMON
BOOTLDR: CAT3K_CAA Boot Loader (CAT3K_CAA-HBOOT-M) Version 1.2, RELEASE SOFTWARE (P)

ott-of-c3k-118 uptime is 36 minutes
Uptime for this control processor is 38 minutes
System returned to ROM by Power Failure
System image file is "flash:cat3k_caa-universalk9.SSA.03.07.03.E3.369.152-3.3.69.E3.bin"
Last reload reason: Power Failure
```

```
This product contains cryptographic features and is subject to United
States and local country laws governing import, export, transfer and
use. Delivery of Cisco cryptographic products does not imply
third-party authority to import, export, distribute or use encryption.
Importers, exporters, distributors and users are responsible for
compliance with U.S. and local country laws. By using this product you
agree to comply with applicable laws and regulations. If you are unable
to comply with U.S. and local laws, return this product immediately.
```

A summary of U.S. laws governing Cisco cryptographic products may be found at:
<http://www.cisco.com/wvl/export/crypto/tool/stqrg.html>

If you require further assistance please contact us by sending email to
 export@cisco.com.

License Level: Ipservices
 License Type: Permanent
 Next reload license Level: Ipservices

cisco WS-C3650-24TS (MIPS) processor with 4194304K bytes of physical memory.
 Processor board ID FDO1909E0XX
 1 Virtual Ethernet interface
 56 Gigabit Ethernet interfaces
 2048K bytes of non-volatile configuration memory.
 4194304K bytes of physical memory.
 257008K bytes of Crash Files at crashinfo:.
 1550272K bytes of Flash at flash:.
 0K bytes of Dummy USB Flash at usbflash0:.
 0K bytes of at webui:.

Base Ethernet MAC Address : 84:b8:02:55:82:00
 Motherboard Assembly Number : 73-15127-05
 Motherboard Serial Number : FDO19091CMW
 Model Revision Number : D0
 Motherboard Revision Number : A0
 Model Number : WS-C3650-24TS
 System Serial Number : FDO1909E0XX

Switch Ports	Model	SW Version	SW Image	Mode
* 1 28	WS-C3650-24TS	03.07.03.E3.369	cat3k_caa-universalk9	BUNDLE

Configuration register is 0x102

Possible Cause There is insufficient space to install an application.

Solution Check the amount of space that is available, by using the **dir** command.

Switch# **dir flash:**
 Directory of flash:/

16168	-rw-	2097152	Nov 17 2015 19:50:45 +00:00	nvrाम_config
16185	-rw-	88145920	Nov 17 2015 06:33:32 +00:00	ofa-1.1.64144n-cat3000-SSA-k9.ova
16169	-rw-	88145920	Nov 16 2015 20:04:16 +00:00	ofa-1.1.64148n-cat3000-SSA-k9.ova
16190	-rw-	17134	Oct 20 2015 20:21:25 +00:00	eci_config.out
16184	-rw-	58202	Oct 9 2015 01:24:55 +00:00	vman_ofa.log.6568.20151009012455
16201	-rw-	10188	Oct 28 2015 20:28:12 +00:00	iosdMemLeaks.txt
16191	-rw-	345	Oct 20 2015 20:21:25 +00:00	eci_show.out
16199	-rw-	954	Nov 17 2015 20:25:24 +00:00	virtual-instance.conf
24245	-rw-	53754776	Oct 9 2015 14:06:37 +00:00	cat3k_caa-infra.SSA.0.DEV-0.pkg
16167	-rw-	556	Oct 14 2015 02:41:30 +00:00	vlan.dat
16174	drwx	4096	Nov 17 2015 19:49:57 +00:00	dc_profile_dir
16176	drwx	4096	Jul 27 2015 20:03:59 +00:00	wnweb_store
24244	-rw-	5661364	Oct 9 2015 14:06:48 +00:00	cat3k_caa-drivers.SSA.0.DEV-0.pkg
16193	-rw-	356	Oct 20 2015 20:21:25 +00:00	eci_debug.out
16171	drwx	4096	Jul 27 2015 20:43:41 +00:00	onep
16186	drwx	4096	Nov 17 2015 20:00:23 +00:00	temp_amd
80801	drwx	4096	Nov 2 2015 14:22:41 +00:00	tracelogs
16192	-rw-	11792	Oct 20 2015 20:21:25 +00:00	eci_show_content.out
16194	-rw-	9543	Oct 20 2015 20:21:25 +00:00	eci_debug_content.out
16195	-rw-	356	Oct 20 2015 20:21:25 +00:00	eci_clear.out
16196	-rw-	1752	Oct 20 2015 20:21:25 +00:00	eci_clear_content.out
24246	-rw-	46494884	Oct 9 2015 14:06:41 +00:00	cat3k_caa-iosd-universalk9.SSA.0.DEV-0.pkg
24247	-rw-	30839508	Oct 9 2015 14:06:38 +00:00	cat3k_caa-platform.SSA.0.DEV-0.pkg
24248	-rw-	126614208	Oct 9 2015 14:06:48 +00:00	cat3k_caa-wcm.SSA.0.DEV-0.pkg
16212	-rw-	478495	Oct 28 2015 20:36:55 +00:00	iosdProcMemDetail.txt
16175	-rw-	328263356	Nov 16 2015 15:35:23 +00:00	

```
cat3k_caa-universalk9.SSA.03.07.03.E3.369.152-3.3.69.E3.bin
```

Possible Cause Disk quota for container is insufficient.

Solution Ensure that sufficient disk quota is allotted to the virtual services container, by using the **show virtual-service global** command.

```
Switch# show virtual-service global
Virtual Service Global State and Virtualization Limits:

Infrastructure version : 1.5
Total virtual services installed : 1
Total virtual services activated : 1

Machine types supported   : LXC
Machine types disabled   : KVM

Maximum VCPUs per virtual service : 1
Resource virtualization limits:
Name                       Quota      Committed   Available
-----
system CPU (%)             6          1           5
memory (MB)                256       256         0
flash (MB)                 256       219         37
```

Possible Cause An invalid OVA package has been used for installation (Invalid package/Parsing error/Invalid machine specification error).

Solution Ensure that the OVA package copied to the device matches in size with the OVA package on the FTP server. Refer to the release for details or Contact Cisco Technical Support to ensure that the OVA file provided is compatible with the device operating system and not corrupted.

Possible Cause The virtual services container does not install properly due to unknown reasons.

Solution Uninstall the virtual services container. If the problem persists, collect general troubleshooting information and contact Cisco Technical Support.

Related Topics

[Collecting Troubleshooting Information, on page 41](#)

Troubleshooting: Activating Applications in a Virtual Services Container

This topic describes the possible reasons why the activation of an application in a virtual services container may not have been successful, and the corresponding solutions.

Problem Activation of an application in a virtual services container is not successful.

Possible Cause Activation of the application may still be ongoing.

Solution Check the activation status of the application, by using the **show virtual-service list** command. The following sample output shows an application that status `Activated`.

```
Switch# show virtual-service list
```

Virtual Service List:

Name	Status	Package Name
openflow_agent	Activated	ofa-1.1.64148n-cat3000-SSA-k9.ova

Possible Cause The virtual services container does not have sufficient resources for activation of the application.

Solution Check if the device has sufficient resources for virtualization, including—memory, disk space, and CPU utilization. You can display the resource requirement for virtualization, by using the **show virtual-service** command.

Switch# **show virtual-service**

Virtual Service Global State and Virtualization Limits:

Infrastructure version : 1.5
 Total virtual services installed : 1
 Total virtual services activated : 1

Machine types supported : LXC
 Machine types disabled : KVM

Maximum VCPUs per virtual service : 1
 Resource virtualization limits:

Name	Quota	Committed	Available
system CPU (%)	6	1	5
memory (MB)	256	256	0

Possible Cause The application does not activate properly due to unknown reasons.

Solution Deactivate and uninstall the application. If the problem persists, collect general troubleshooting information and contact Cisco Technical Support.

Related Topics

[Collecting Troubleshooting Information, on page 41](#)

Troubleshooting: Uninstalling Applications in a Virtual Services Container

This topic describes the possible reasons why you may not have been successful with the process of uninstalling an application in a virtual services container, and the corresponding solutions.

Problem Uninstallation of an application from the virtual services container is not successful.

Possible Cause The application being uninstalled is not completely deactivated.

Solution Check the activation status of the application, by using the **show virtual-service list** command. The following sample output shows an application in the `Deactivated` status, and can be uninstalled.

Switch# **show virtual-service list**

Virtual Service List:

```

Name                Status                Package Name
-----
openflow_agent      Deactivated           ofa-1.1.64148n-cat3000-SSA-k9.ova

ott-of-c3k-118#delete flash:virtual-instance.conf
ott-of-c3k-118#reload
    
```

Possible Cause The application does not uninstall due to unknown reasons.

Solution As a last resort, delete the `virtual-instance.conf`, by using the `delete` command, and then reload the device.

```

Switch# delete bootflash:virtual-instance.conf
Switch# reload
    
```

If the problem persists, collect general troubleshooting information and contact Cisco Technical Support.

Troubleshooting: Deactivating Applications in a Virtual Services Container

This topic describes the possible reasons why you may not have been successful with the process of deactivating an application in a virtual services container, and the corresponding solutions.

Problem Deactivation of an application is not successful.

Possible Cause The application being deactivated is not activated.

Solution Check the activation status of the application, by using the `show virtual-service list` command. The following sample output shows an application that is in the `Activated` state, and can be deactivated.

```

Switch# show virtual-service list

Virtual Service List:

Name                Status                Package Name
-----
openflow_agent      Activated             ofa-1.1.64148n-cat3000-SSA-k9.ova
    
```

Possible Cause Deactivation takes a long time (5 minutes).

Solution Check if application directories are in use. Ensure that there are no shells open in the application file system directories on the device.

Possible Cause The application does not deactivate gracefully due to unknown reasons.

Solution As a last resort, uninstall the application (if you have not already done this) and delete the `virtual-instance.conf` configuration file, by entering the `delete` command, and then reload the device. This step deletes all applications installed in the virtual services container.

```

Switch# delete flash:virtual-instance.conf
Switch# reload
    
```

Solution If the problem persists, collect general troubleshooting information and contact Cisco Technical support.



INDEX

C

- cisco plug-in for openflow [1](#)
 - configuring [1](#)
- Cisco Plug-In for OpenFlow [1, 2, 3, 4, 7, 11, 15, 20, 26](#)
 - about [3](#)
 - about, controller operation [4](#)
 - about, OpenFlow operation [4](#)
 - configuring, for an OpenFlow logical switch [15](#)
 - examples [26](#)
 - feature support [4](#)
 - match, actions, and pipelines [7](#)
 - prerequisites [1](#)
 - restrictions [2](#)
 - specifying a route to a controller [11](#)
 - verifying configuration [20](#)
 - workflow [11](#)
- cisco plug-in for OpenFlow and virtual service container [4](#)
- configured logical switch [4](#)
- configuring physical interfaces as logical switch ports [4](#)
- configuring virtual services container [38](#)
 - example [38](#)
- connection to controllers [5](#)

D

- default forwarding rule [6](#)

F

- flows [4](#)

I

- idle timeout [6](#)

M

- multiple actions for a flow [6](#)

O

- OneP [14](#)
 - configuring [14](#)
- OpenFlow 1.0 [3](#)
- OpenFlow 1.3 [3, 4](#)
- OpenFlow counters [6](#)
- OpenFlow hybrid [4](#)
- OpenFlow message types [5](#)
- OpenFlow-enabled interfaces [4](#)
- OVA [4](#)

R

- recommended disk space [2](#)
- reference information [27, 39](#)

S

- specifying a route to a controller [12, 13](#)
 - using a management interface [13](#)
 - using a physical interface [12](#)

T

- TCAM entries [2](#)
- troubleshooting [41, 42, 45, 46, 47](#)
 - application activation [45](#)
 - application deactivation [47](#)
 - application installation [42](#)
 - collecting information for [41](#)
 - uninstalling [46](#)

V

- virtual services container [29](#)
 - configuring [29](#)
- Virtual Services Container [29, 30](#)
 - and an application [30](#)
 - installing and activating an application [30](#)
 - prerequisites [29](#)

W

- wire protocol [3](#)

X

- XNC [3](#)