High Availability Configuration Guide, Cisco IOS XE Gibraltar 16.12.x (Catalyst 9600 Switches)

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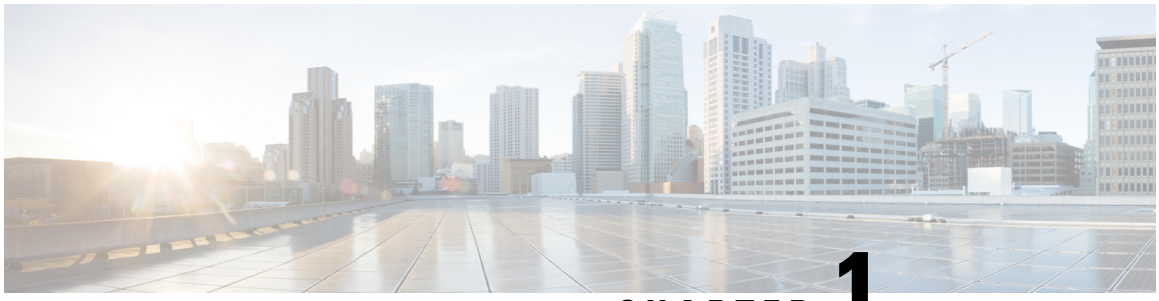


CHAPTER 1

Configuring Nonstop Forwarding with Stateful Switchover

Prerequisites for Cisco Nonstop Forwarding with Stateful Switchover

- Cisco nonstop forwarding (NSF) must be configured on a networking device that has been configured for stateful Switchover (SSO).
- Border Gateway Protocol (BGP) support in NSF requires that neighbor networking devices be NSF-aware; that is, devices must have the graceful restart capability and advertise that capability in their OPEN message during session establishment. If an NSF-capable device discovers that a particular BGP neighbor does not have graceful restart capability, it does not establish an NSF-capable session with that neighbor. All other neighbors that have graceful restart capability continue to have NSF-capable sessions with this NSF-capable networking device.
- Open Shortest Path First (OSPF) support in NSF requires that all neighbor networking devices be NSF-aware. If an NSF-capable device discovers that it has non-NSF-aware neighbors on a particular network segment, it disables NSF capabilities for that segment. Other network segments composed entirely of NSF-capable or NSF-aware devices continue to provide NSF capabilities.

Restrictions for Cisco Nonstop Forwarding with Stateful Switchover

The following are restrictions for configuring NSF with SSO:

- For NSF operation, you must have SSO configured on the device.
- All Layer 3 neighboring devices must be an NSF helper or NSF-capable to support graceful restart capability.
- For IETF, all neighboring devices must be running an NSF-aware software image.
- The Hot Standby Routing Protocol (HSRP) is not supported with NSF SSO.
- An NSF-aware device cannot support two NSF-capable peers performing an NSF restart operation at the same time. However, both neighbors can reestablish peering sessions after the NSF restart operation is complete.
- For SSO operation, ensure that both active and standby devices run the same version of the Cisco IOS XE image. If the active and standby devices are operating different images, SSO failover might cause an outage.
- If the sensitive timer is set in milliseconds during SSO for Fast UniDirectional Link Detection (UDLD) and Bidirectional Forwarding Detection (BFD) protocols, the port could be disabled and is displayed as err-disabled state.

Information About Cisco Nonstop Forwarding with Stateful Switchover

Overview of Cisco Nonstop Forwarding with Stateful Switchover

Cisco NSF works with the SSO feature. The device supports fault resistance by allowing a standby supervisor module to take over if the active supervisor module becomes unavailable. NSF works with SSO to minimize the amount of time a network is unavailable.

Usually, when a networking device restarts, all routing peers of that device detect that the device went down and then came back up. This transition results in what is called a routing flap, which could spread across multiple routing domains. Routing flaps caused by routing restarts create routing instabilities, which are detrimental to the overall network performance. Cisco NSF helps to suppress routing flaps in SSO-enabled devices, thus reducing network instability.

Cisco NSF with SSO allows for the forwarding of data packets to continue along known routes while the routing protocol information is being restored following a switchover. With NSF/SSO, peer networking devices do not experience routing flaps. Data traffic is forwarded through intelligent line cards or dual forwarding processors (FPs) while the standby router processor (RP) assumes control from the failed active RP during a switchover. NSF with SSO operation provides the ability of line cards and FPs to remain active through a switchover and to be kept current with the Forwarding Information Base (FIB) on the active RP.

NSF provides the following benefits:

- Improved network availability—NSF continues forwarding network traffic and application state information so that user session information is maintained after a switchover.
- Overall network stability—Network stability can be improved with the reduction in the number of route flaps that are created when devices in the network fail, and lose their routing tables.
- Neighboring devices do not detect a link flap—Because interfaces remain active during a switchover, neighboring devices do not detect a link flap (the link does not go down and come back up).
- Prevents routing flaps—Because SSO continues forwarding network traffic during a switchover, routing flaps are avoided.
- Maintains user sessions established prior to the switchover.
- When the active supervisor module is down, the standby supervisor module takes the active role

SSO Operation

When a standby supervisor module runs in SSO mode, it starts up in a fully-initialized state and synchronizes with the persistent configuration and the running configuration on the active supervisor module. It subsequently maintains the state of the protocols, and all changes in hardware and software states for features that support SSO are kept in synchronization. Consequently, it offers minimum interruption to Layer 2 sessions in a redundant active supervisor module configuration.

If the active supervisor module fails, the standby supervisor module becomes the active supervisor module. This new active supervisor module uses existing Layer 2 switching information to continue forwarding traffic. Layer 3 forwarding is delayed until routing tables are repopulated in the newly active supervisor module.

Cisco Nonstop Forwarding Operation

NSF always runs with SSO, and provides redundancy for Layer 3 traffic. NSF is supported by BGP, Enhanced Interior Gateway Routing Protocol (EIGRP), and OSPF routing protocols and also by Cisco Express Forwarding for forwarding. These routing protocols have been enhanced with NSF-capability and awareness, which means that devices running these protocols can detect a switchover and take necessary actions to continue forwarding network traffic and to recover route information from peer devices.

Each protocol depends on Cisco Express Forwarding to continue forwarding packets during switchover while routing protocols rebuild the Routing Information Base (RIB) tables. After the convergence of routing protocols, Cisco Express Forwarding updates the FIB table and removes stale route entries. Cisco Express Forwarding then updates the hardware with the new FIB information.

If the active supervisor module is configured (with the **graceful-restart** command) for BGP, OSPF, or EIGRP routing protocols, routing updates are automatically sent during the active supervisor module election.

NSF has two primary components:

- NSF-aware: A networking device is NSF-aware if it is running NSF-compatible software. If neighboring devices detect that an NSF device can still forward packets when an active supervisor module election happens, this capability is referred to as NSF-awareness. Enhancements to the Layer 3 routing protocols (BGP, OSPF, and EIGRP) are designed to prevent route-flapping so that the Cisco Express Forwarding routing table does not time out or the NSF device does not drop routes. An NSF-aware device helps to send routing protocol information to the neighboring NSF device. NSF-awareness is enabled by default for EIGRP-stub, EIGRP, and OSPF protocols. NSF-awareness is disabled by default for BGP.

- NSF-capability: A device is NSF-capable if it is configured to support NSF; it rebuilds routing information from NSF-aware or NSF-capable neighbors. NSF works with SSO to minimize the amount of time that a Layer 3 network is unavailable following an active device election by continuing to forward IP packets. Reconvergence of Layer 3 routing protocols (BGP, OSPFv2, and EIGRP) is transparent to the user and happens automatically in the background. Routing protocols recover routing information from neighbor devices and rebuild the Cisco Express Forwarding table.

Cisco Express Forwarding

A key element of NSF is packet forwarding. In a Cisco networking device, packet forwarding is provided by Cisco Express Forwarding. Cisco Express Forwarding maintains the Forwarding Information Base (FIB), and uses the FIB information that is current at the time of a switchover to continue forwarding packets during a switchover, to reduce traffic interruption during the switchover.

During normal NSF operation, Cisco Express Forwarding on the active supervisor module synchronizes its current FIB and adjacency databases with the FIB and adjacency databases on the standby supervisor module. Upon switchover, the standby supervisor module initially has FIB and adjacency databases that are mirror images of those that were current on the active supervisor module. Cisco Express Forwarding keeps the forwarding engine on the standby supervisor module current with changes that are sent to it by Cisco Express Forwarding on the active supervisor module. The forwarding engine can continue forwarding after a switchover as soon as the interfaces and a data path are available.

As the routing protocols start to repopulate the RIB on a prefix-by-prefix basis, the updates cause prefix-by-prefix updates to Cisco Express Forwarding, which it uses to update the FIB and adjacency databases. Existing and new entries receive the new version (“epoch”) number, indicating that they have been refreshed. The forwarding information is updated on the forwarding engine during convergence. The device signals when the RIB has converged. The software removes all FIB and adjacency entries that have an epoch older than the current switchover epoch. The FIB now represents the newest routing protocol forwarding information.

Routing Protocols

Routing protocols run only on the active RP, and receive routing updates from neighbor devices. Routing protocols do not run on the standby RP. Following a switchover, routing protocols request that the NSF-aware neighbor devices send state information to help rebuild routing tables. Alternately, the Intermediate System-to-Intermediate System (IS-IS) protocol can be configured to synchronize state information from the active to the standby RP to help rebuild the routing table on the NSF-capable device in environments where neighbor devices are not NSF-aware.

Note For NSF operation, routing protocols depend on Cisco Express Forwarding to continue forwarding packets while routing protocols rebuild the routing information.

BGP Operation

When a NSF-capable device begins a BGP session with a BGP peer, it sends an OPEN message to the peer. Included in the message is a declaration that the NSF-capable device has “graceful restart capability.” Graceful restart is the mechanism by which BGP routing peers avoid a routing flap following a switchover. If the BGP peer has this capability, it is aware that the device sending the message is NSF-capable. Both the NSF-capable device and its BGP peer(s) need to exchange the Graceful Restart Capability in their OPEN messages, at the

time of session establishment. If both peers do not exchange the Graceful Restart Capability, the session is not graceful restart capable.

If the BGP session is lost during the RP switchover, the NSF-aware BGP peer marks all routes associated with the NSF-capable device as stale; however, it continues to use these routes to make forwarding decisions for a set period of time. This functionality means that no packets are lost while the newly active RP is waiting for convergence of the routing information with the BGP peers.

After an RP switchover occurs, the NSF-capable device reestablishes the session with the BGP peer. In establishing the new session, it sends a new graceful restart message that identifies the NSF-capable device as having restarted.

At this point, the routing information is exchanged between two BGP peers. Once this exchange is complete, the NSF-capable device uses the routing information to update the RIB and the FIB with the new forwarding information. The NSF-aware device uses the network information to remove stale routes from its BGP table. Following that, the BGP protocol is fully converged.

If a BGP peer does not support the graceful restart capability, it will ignore the graceful-restart capability in an OPEN message; but will establish a BGP session with the NSF-capable device. This function allows interoperability with non-NSF-aware BGP peers (and without NSF functionality), but the BGP session with non-NSF-aware BGP peers will not be graceful restart capable.

Note BGP support in NSF requires that neighbor networking devices be NSF-aware; that is, devices must have the Graceful Restart Capability and advertise that capability in their OPEN message during session establishment. If an NSF-capable device discovers that a particular BGP neighbor does not have Graceful Restart Capability, it will not establish an NSF-capable session with that neighbor. All other neighbors that have Graceful Restart Capability will continue to have NSF-capable sessions with this NSF-capable networking device.

EIGRP Operation

Enhanced Interior Gateway Routing Protocol (EIGRP) NSF capabilities are exchanged by EIGRP peers in hello packets. The NSF-capable device notifies its neighbors that an NSF restart operation has started by setting the restart (RS) bit in a hello packet. When an NSF-aware device receives notification from an NSF-capable neighbor that an NSF-restart operation is in progress, the NSF-capable and NSF-aware devices immediately exchange their topology tables. The NSF-aware device sends an end-of-table update packet when the transmission of its topology table is complete. The NSF-aware device then performs the following actions to assist the NSF-capable device:

- The EIGRP hello hold timer is expired to reduce the time interval set for hello packet generation and transmission. This allows the NSF-aware device to reply to the NSF-capable device more quickly reducing the amount of time required for the NSF-capable device to rediscover neighbors and rebuild the topology table.
- The route-hold timer is started. This timer is used to set the period of time that the NSF-aware device will hold known routes for the NSF-capable neighbor. This timer is configured with the **timers graceful-restart purge-time** command. The default time period is 240 seconds.
- In the peer list, the NSF-aware device notes that the NSF-capable neighbor is restarting, maintains adjacency, and holds known routes for the NSF-capable neighbor until the neighbor signals that it is ready for the NSF-aware device to send its topology table, or the route-hold timer expires. If the route-hold timer expires on the NSF-aware device, the NSF-aware device discards held routes and treats the NSF-capable device as a new device joining the network and reestablishes adjacency accordingly.

- The NSF-aware device continues to send queries to the NSF-capable device which is still in the process of converging after a switchover, effectively extending the time before a stuck-in-active condition can occur.

When the switchover operation is complete, the NSF-capable device notifies its neighbors that it has reconverged and has received all of their topology tables by sending an end-of-table update packet to assisting devices. The NSF-capable device then returns to normal operation. The NSF-aware device will look for alternate paths (go active) for any routes that are not refreshed by the NSF-capable (restarting device). The NSF-aware device will then return to normal operation. If all paths are refreshed by the NSF-capable device, the NSF-aware device will immediately return to normal operation.

Note NSF-aware devices are completely compatible with non-NSF aware or -capable neighbors in an EIGRP network. A non-NSF aware neighbor will ignore NSF capabilities and reset adjacencies and otherwise maintain the peering sessions normally.

OSPF Operation

When an OSPF NSF-capable device performs a supervisor engine switchover, it must perform the following tasks in order to resynchronize its link state database with its OSPF neighbors:

- Relearn the available OSPF neighbors on the network without causing a reset of the neighbor relationship.
- Reacquire the contents of the link state database for the network.

As quickly as possible after a supervisor engine switchover, the NSF-capable device sends an OSPF NSF signal to neighboring NSF-aware devices. Neighbor networking devices recognize this signal as an indicator that the neighbor relationship with this device should not be reset. As the NSF-capable device receives signals from other devices on the network, it can begin to rebuild its neighbor list.

After neighbor relationships are reestablished, the NSF-capable device begins to resynchronize its database with all of its NSF-aware neighbors. At this point, the routing information is exchanged between the OSPF neighbors. Once this exchange is complete, the NSF-capable device uses the routing information to remove stale routes, update the RIB, and update the FIB with the new forwarding information. The OSPF protocols are then fully converged.

Note OSPF support in NSF requires that all neighbor networking devices be NSF-aware. If an NSF-capable device discovers that it has non-NSF -aware neighbors on a particular network segment, it disables NSF capabilities for that segment. Other network segments composed entirely of NSF-capable or NSF-aware devices continue to provide NSF capabilities.

How to Configure Cisco Nonstop Forwarding with Stateful Switchover

Configuring Stateful Switchover

You must configure SSO in order to use NSF with any supported protocol.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show redundancy states** **Example:** `Device# show redundancy states`	Displays the operating redundancy mode.
Step 3	**redundancy** **Example:** `Device(config)# redundancy`	Enters redundancy configuration mode.
Step 4	**mode sso** **Example:** `Device(config-red)# mode sso`	Configures stateful switchover. • When this command is entered, the standby supervisor module is reloaded and begins to work in SSO mode.
Step 5	**end** **Example:** `Device(config-red)# end`	Exits redundancy configuration mode and returns to privileged EXEC mode.
Step 6	**show redundancy states** **Example:** `Device# show redundancy states`	Displays the operating redundancy mode.
Step 7	**debug redundancy status** **Example:** `Device# debug redundancy status`	Enables the debugging of redundancy status events.

Verifying Cisco Express Forwarding with Cisco Nonstop Forwarding

Procedure

show cef state

Displays the state of Cisco Express Forwarding on a networking device.

Example:

```
Device# show cef state

CEF Status:
RP instance
common CEF enabled
IPv4 CEF Status:
CEF enabled/running
dCEF enabled/running
CEF switching enabled/running
universal per-destination load sharing algorithm, id DEA83012
IPv6 CEF Status:
CEF disabled/not running
dCEF disabled/not running
universal per-destination load sharing algorithm, id DEA83012
RRP state:
I am standby RRP: no
RF Peer Presence: yes
RF PeerComm reached: yes
RF Progression blocked: never
Redundancy mode: rpr(1)
CEF NSF sync: disabled/not running
CEF ISSU Status:
FIBHWIDB broker
No slots are ISSU capable.
FIBIDB broker
No slots are ISSU capable.
FIBHWIDB Subblock broker
No slots are ISSU capable.
FIBIDB Subblock broker
No slots are ISSU capable.
Adjacency update
No slots are ISSU capable.
IPv4 table broker
No slots are ISSU capable.
CEF push
No slots are ISSU capable.
```

Configuration Examples for Cisco Nonstop Forwarding with Stateful Switchover

Example: Configuring Stateful Switchover

This example shows how to configure the system for SSO and displays the redundancy state:

```
Device(config)# redundancy
Device(config-red)# mode sso
Device(config-red)# end
Device#
```

The following is sample output from the **show redundancy states** command:

```
show redundancy states
 my state = 13 -ACTIVE
 peer state = 8 -STANDBY HOT
 Mode = Duplex
 Unit = Primary
 Unit ID = 5
 Redundancy Mode (Operational) = sso
 Redundancy Mode (Configured) = sso
 Split Mode = Disabled
 Manual Swact = Enabled
 Communications = Up
 client count = 29
 client_notification_TMR = 30000 milliseconds
 keep_alive TMR = 9000 milliseconds
 keep_alive count = 1
 keep_alive threshold = 18
 RF debug mask = 0x0
```

Additional References for Nonstop Forwarding with Stateful Switchover

Related Documents

Related Topic	Document Title
For complete syntax and usage information for the commands used in this chapter.	See the *High Availability* section of the *Command Reference (Catalyst 9600 Series Switches)*

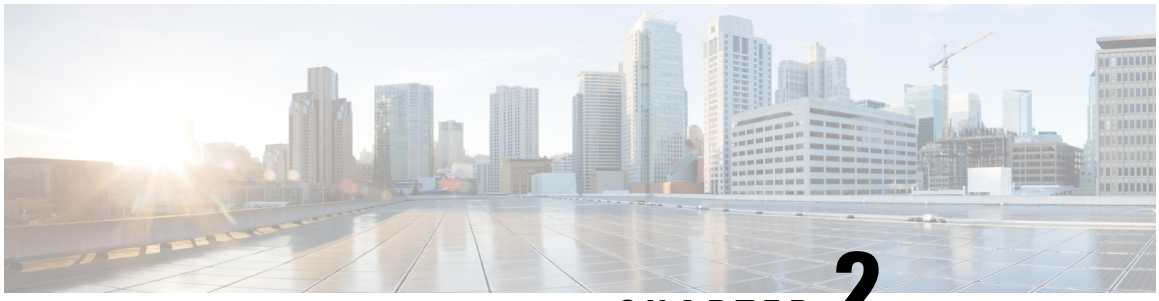
Feature History and Information for Cisco Nonstop Forwarding with Stateful Switchover

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use the Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required

Table 1: Feature Information for Nonstop Forwarding with Stateful Switchover

Feature Name	Release	Feature Information
Nonstop Forwarding with Stateful Switchover	Cisco IOS XE Gibraltar 16.11.1	This feature was introduced. Cisco NSF works with the SSO feature. NSF works with SSO to minimize the amount of time a network is unavailable to users following a switchover. The main objective of NSF SSO is to continue forwarding IP packets following a Route Processor (RP) switchover.



CHAPTER 2

Configuring ISSU

Prerequisites for Performing ISSU

The following prerequisites apply for performing ISSU:

- The active supervisor module must have access to the new IOS XE image or pre-load it into flash.
- The device must be running in install mode.
- Non-Stop Forwarding (NSF) must be enabled.

Information About ISSU

ISSU is a process that upgrades an image to another image on a device while the network continues to forward packets. ISSU helps network administrators avoid a network outage when performing a software upgrade. The images are upgraded in install mode wherein each package is upgraded individually.

ISSU supports upgrade and rollback of software.

ISSU Upgrade

The following steps describe the process that is followed in performing ISSU:

1. Copy the new image to the standby and active supervisor modules.
2. Unzip the files and copy packages to both the active and standby supervisor modules.
3. Install the packages on the standby supervisor module.
4. Restart the standby supervisor module.

The standby supervisor module is now upgraded to the new software.

5. Install the packages on the active supervisor module.
6. Restart the active supervisor module and switchover the standby to new active supervisor module. After the switchover, the new standby supervisor module will be up with the new software. The new software image is already installed on the new active supervisor module, hence ISSU is completed.

ISSU Upgrade: 3-Step Work Flow

This workflow involves three steps—add, activate, and commit. After activation, all switches are upgraded to new software version except that the software is not committed automatically but must be performed manually via the **install commit** command. The advantage of this approach is the system can be rolled back to a previous software version. The system automatically rolls back if the rollback timer is not stopped using the **install abort-timer-stop** or the **install commit** command. If the rollback timer is stopped, the new software version could be run on the device for any duration and then rolled back to the previous version.

ISSU Upgrade: 1-Step Work Flow

This workflow involves only one step and helps in optimization. You cannot roll back as the upgrade is committed automatically.

For more information about ISSU release support and recommended releases, see Technical References → In-Service Software Upgrade (ISSU).

Restrictions and Guidelines for Performing ISSU

- Upgrading hardware and software simultaneously is not supported. Only one upgrade operation can be performed at a time.
- We recommend that upgrades are performed during a maintenance window.
- Do not perform any configuration changes while the ISSU process is being performed.
- Downgrade with ISSU is not supported.
- If synchronization between the active and standby supervisor modules fail during an ISSU, the system reboots five consecutive times within an interval of 25 minutes before switching to ROMMON mode. When this switchover happens, change the standby supervisor from manual boot mode to auto boot mode.

Upgrade Software Using 1-Step WorkFlow

Before you begin

- The device must be booted in the install mode.
- There must be two supervisor modules in the system. Both the supervisor modules must be running the same image.

Procedure

	Command or Action	Purpose
Step 1	enable **Example:** `Switch> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**install add file** { **ftp:** | **tftp:** | **flash:** | **disk:** ***.bin** } **activate issu commit**	Automates the sequence of all upgrade procedures that include downloading the images to both the switches and expanding into packages, and upgrading each switch as per the procedure. **Note** This command throws an error if the switch is booted with a bundle image.

Upgrade Software Using 3-Step WorkFlow

Before you begin

- The device must be booted in the install mode.
- There must be two supervisor modules in the system. Both the supervisor modules must be running the same image.

Procedure

	Command or Action	Purpose
Step 1	enable **Example:** `Switch> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**install add file** { **ftp:** | **tftp:** | **flash:** | **disk:** ***.bin** } **Example:** `Switch# install add file ftp:file.bin`	This command downloads the image into the bootflash and expands it on both the supervisor modules.
Step 3	**install activate issu** **Example:** `Switch# install activate issu`	On executing this command, the following sequence of events occurs: **a.** A rollback timer is started. If the rollback timer expires, the system rolls back to the same state before the start of the ISSU. The rollback timer can be stopped by using the **install abort-timer stop** command. ISSU

	Command or Action	Purpose
		can be rolled back using **install abort issu** command. **b.** The standby supervisor module is provisioned with the new software and it reloads with the new software version. Next, the active supervisor module is provisioned with the new software and it reloads. The standby supervisor module with the new image now becomes the active supervisor module and the old active supervisor module becomes the standby. **c.** At the end of this procedure, both the supervisor modules run with the new software image.
Step 4	**install commit** **Example:** `Switch# install commit`	The **commit** command performs the necessary clean up, enables the new software as permanent (removing the older version of the software) and stops the rollback timer. Any reboot after the commit will boot with new software. **Note** There is no rollback when this command is used.

Monitoring ISSU

To verify ISSU on StackWise Virtual, use the following **show** commands:

Command	Description
show issu clients	Displays a list of the current ISSU clients--that is, the network applications and protocols supported by ISSU.
show issu message types	Displays the formats, versions, and size of ISSU messages supported by a particular client.
show issu negotiated	Displays results of a negotiation that occurred concerning message versions or client capabilities.
show issu sessions	Displays detailed information about a particular ISSU client, including whether the client status is compatible for the impending software upgrade.
show issu comp-matrix	Displays information regarding the ISSU compatibility matrix.

Command	Description
show issu entities	Displays information about entities within one or more ISSU clients.
show issu state [detail]	Displays the current ISSU state.

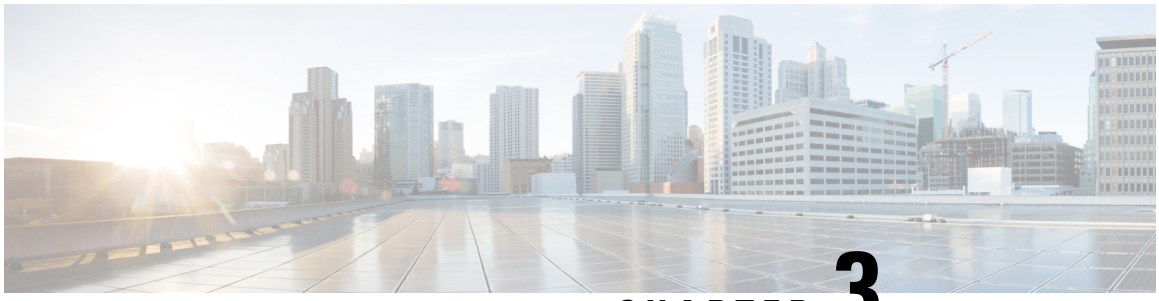
Feature History for ISSU

This table provides release and related information for the features explained in this module.

These features are available in all the releases subsequent to the one they were introduced in, unless noted otherwise.

Release	Feature	Feature Information
Cisco IOS XE Gibraltar 16.12.1	ISSU and ISSU on Cisco StackWise Virtual switches	This feature was introduced. ISSU is a process that upgrades an image to another image on a device while the network continues to forward packets. ISSU helps network administrators avoid a network outage when performing a software upgrade. ISSU is supported in install mode. You can perform ISSU in a set-up where Cisco StackWise Virtual is configured and also in a set-up where Cisco StackWise Virtual is not configured.

Use the Cisco Feature Navigator to find information about platform and software image support. To access Cisco Feature Navigator, go to https://cfnng.cisco.com/.



CHAPTER 3

Configuring Cisco StackWise Virtual

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for Cisco StackWise Virtual

- Both switches in the Cisco StackWise Virtual pair must be directly connected to each other.
- Both switches in the Cisco StackWise Virtual pair must be of the same switch model.
- Both switches in the Cisco StackWise Virtual pair must be running the same license level.
- Both switches in the Cisco StackWise Virtual pair must be running the same software version.
- Both switches in the Cisco StackWise Virtual pair must be running the same SDM template.
- All the ports used for configuring a StackWise Virtual Link (SVL) must share the same speed. For example, you cannot configure a 10G or a 40G port to form an SVL, simultaneously. Furthermore, all

ports used for configuring SVL must be either from the same line card or across line cards within the same chassis.

Restrictions for Cisco StackWise Virtual

- Cisco StackWise Virtual can be configured only on the same supervisor module slot on both the chassis as asymmetric supervisor module slots between the chassis is not supported. For example, if you have inserted the supervisor module in slot 3 in chassis 1, then chassis 2 should also have the supervisor module in slot 3.
- Cisco StackWise Virtual configuration commands will be recognised only on a switch running Network Advantage license. The configuration commands will not be recognised on a Network Essentials license.
- Only Cisco Transceiver Modules are supported.
- When deploying Cisco StackWise Virtual, ensure that VLAN ID 4094 is not used anywhere on the network. All inter-chassis system control communication between stack members is carried over the reserved VLAN ID 4094 from the global range.
- Dual-Active Detection (DAD) and SVL configuration must be performed manually and the devices should be rebooted for the configuration changes to take effect.
- In a Cisco StackWise Virtual solution, QSA along with 10G interfaces can be used as data ports and SVL or DAD links.
- In a Cisco StackWise Virtual solution, QSA along with 1G interfaces can be used as data ports and DAD links. SVL links are not supported on 1G interfaces.
- The interface VLAN MAC address that is assigned by default, can be overridden using the **mac-address** command. If this command is configured on a single SVI or router port that requires Layer 3 injected packets, all other SVIs or routed ports on the device also must be configured with the same first four most significant bytes (4MSB) of the MAC address. For example, if you set the MAC address of any SVI to xxxx.yyyy.zzzz, set the MAC address of all other SVIs to start with xxxx.yyyy. If Layer 3 injected packets are not used, this restriction does not apply.

Note This applies to all Layer 3 ports, SVIs, and routed ports. This does not apply to GigabitEthernet0/0 port.

- Secure StackWise Virtual is supported only on two node front-side stacking.
- Do not configure Secure Stackwise Virtual and Federal Information Processing Standards (FIPS) at the same time as they are mutually exclusive features that cannot co-exist.

  Configuring both at the same time is redundant as Secure StackWise Virtual is FIPS 140-2 compliant. Secure StackWise Virtual will encrypt control packets as well. Therefore, enabling FIPS is not required.
- Only 128-bit authorization key is supported.
- Secure StackWise Virtual is not supported on DAD Links.

Information About Cisco StackWise Virtual

Overview of Cisco StackWise Virtual

Cisco StackWise Virtual is a network system virtualization technology that pairs two directly connected switches into one virtual switch. The switches in a Cisco StackWise Virtual solution increase operational efficiency by using single control and management plane, scale system bandwidth with distributed forwarding plane, and help in building resilient networks using the recommended network design. Cisco StackWise Virtual allows two directly connected physical switches to operate as a single logical virtual switch using an Ethernet connection.

Cisco StackWise Virtual Topology

A typical network design consists of core, distribution, and access layers. The default mode of a switch is standalone. When two redundant switches are deployed in the distribution layer, the following network challenges arise:

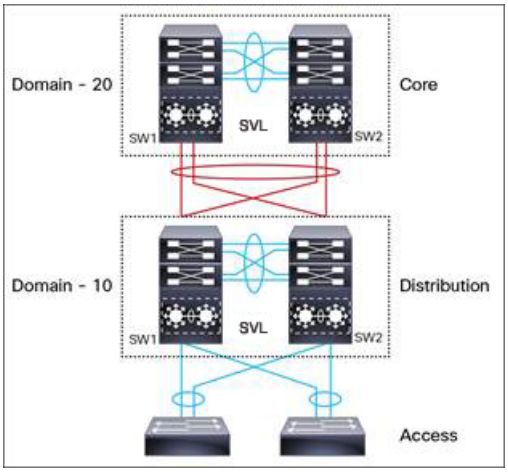
- If VLAN IDs are reused between access layers then, it will introduce a spanning tree loop that will impact the overall performance of the network.
- Spanning tree protocols and configuration are required to protect Layer 2 network against spanning tree protocol loop, and root and bridge protocol data unit management.
- Additional protocols such as first hop redundancy protocol are required to virtualize the IP gateway function. This should align with STP root priorities for each VLAN.
- The Protocol independent multicast designated router (PIM DR) configuration should be fine-tuned to selectively build a multicast forwarding topology on a VLAN.
- The standalone distribution layer system provides protocol-driven remote failure and detection, which results in slower convergence time. Fine-tune FHRP and PIM timers for rapid fault detection and recovery process.

We recommend Cisco StackWise Virtual model for aggregation layers and collapsed aggregation and core layers. The stack can be formed over a 40G or 100G links to ensure that the distribution or the aggregation switches can be deployed over a large distance.

Note Ensure that the cables and/or transceivers on all the SVL and DAD links are not disturbed during SVL bring up.

Note that STP keeps one of the ports connected to the distribution switches blocked on the access switches. As a result of this, an active link failure causes STP convergence and the network suffers from traffic loss, flooding, and a possible transient loop in the network. On the other hand, if the switches are logically merged into one switch, all the access switches might form an EtherChannel bundle with distribution switches, and a link failure within an EtherChannel would not have any impact as long as at least one member within the EtherChannel is active.

Figure 1: Typical Network Design using Cisco StackWise Virtual



Etherchannel in StackWise Virtual is capable of implementing Multi-chassis EtherChannel (MEC) across the stack members. When access layer and aggregation layer are collapsed into a single StackWise Virtual system, MEC across the different access layer domain members and across distribution and access layer switches will not be supported. MEC is designed to forward the traffic over the local link irrespective of the hash result.

Since the control plane, management plane, and data plane are integrated, the system behaves as a single switch.

The virtualization of multiple physical switches into a single logical switch is from a control and management plane perspective only. Because of the control plane being common, it may look like a single logical entity to peer switches. The data plane of the switches is distributed. Each switch is capable of forwarding over its local interfaces without involving other members. However, when a packet coming into a switch has to be forwarded over a different member's port, the forwarding context of the packet is carried over to the destination switch after ingress processing is performed in the ingress switch. Egress processing is done only in the egress switch. This provides a uniform data plane behavior to the entire switch irrespective whether of the destination port is in a local switch or in a remote switch. However, the common control plane ensures that all the switches have equivalent data plane entry for each forwarding entity.

An election mechanism elects one of the switches to be Cisco StackWise Virtual active and the other switch to be Cisco StackWise Virtual standby in terms of Control Plane functions. The active switch is responsible for all the management, bridging and routing protocols, and software data path. The standby switch is in hot standby state ready to take over the role of active, if the active switch fails over.

The following are the components of the Cisco StackWise Virtual solution:

- Stack members
- SVL: 10G, 25G, 40G or 100G Ethernet connections. SVL is established using the 10G, 25G, 40G or 100G interfaces depending on the switch models. However, a combination of two different speeds is not supported.

SVL is the link that connects the switches over Ethernet. Typically, Cisco StackWise Virtual consists of multiple 100G, 25G, 40G or 10G physical links. It carries all the control and data traffic between the switching units. You can configure SVL on a supported port. When a switch is powered up and the hardware is initialized, it looks for a configured SVL before the initialization of the control plane.

The Link Management Protocol (LMP) is activated on each link of the SVL as soon as the links are established. LMP ensure the integrity of the links and monitors and maintains the health of the links. The redundancy role

of each switch is resolved by the StackWise Discovery Protocol (SDP). It ensures that the hardware and software versions are compatible to form the SVL and determines which switch becomes active or standby from a control plane perspective.

Cisco StackWise Virtual Header (SVH) is 64-byte frame header that is prepended over all control, data, and management plane traffic that traverse over each SVL between the two stack members of the Cisco StackWise Virtual domain. The SVH-encapsulated traffic operates at OSI Layer 2 and can be recognized and processed only by Cisco StackWise Virtual-enabled switches. SVL interfaces are non-bridgeable and non-routeable, and allows non-routeable traffic over L2 or L3 network.

Cisco StackWise Virtual Redundancy

Cisco StackWise Virtual operates stateful switchover (SSO) between the active and standby switches. The following are the ways in which Cisco StackWise Virtual's redundancy model differs from that of the standalone mode:

- The Cisco StackWise Virtual active and standby switches are hosted in separate switches and use a StackWise Virtual link to exchange information.
- The active switch controls both the switches of Cisco StackWise Virtual. The active switch runs the Layer 2 and Layer 3 control protocols and manages the switching modules of both the switches.
- The Cisco StackWise Virtual active and standby switches perform data traffic forwarding.

Note If the Cisco StackWise Virtual active switch fails, the standby switch initiates a switchover and assumes the Cisco StackWise Virtual active switch role.

SSO Redundancy

A StackWise Virtual system operates with SSO redundancy if it meets the following requirements:

- Both the switches must be running the same software version, unless they are in the process of software upgrade.
- SVL-related configuration in the two switches must match.
- License type must be same on both the switch models.
- Both the switch models must be in the same StackWise Virtual domain.

With SSO redundancy, the StackWise Virtual standby switch is always ready to assume control if a fault occurs on the StackWise Virtual active switch. Configuration, forwarding, and state information are synchronized from the StackWise Virtual active switch to the redundant switch at startup, and whenever changes to the StackWise Virtual active switch configuration occur. If a switchover occurs, traffic disruption is minimized.

If StackWise Virtual does not meet the requirements for SSO redundancy, it will be incapable of establishing a relationship with the peer switch. StackWise Virtual runs stateful switchover (SSO) between the StackWise Virtual active and standby switches. The StackWise Virtual determines the role of each switch during initialization.

The CPU in the StackWise Virtual standby switch runs in hot standby state. StackWise Virtual uses SVL to synchronize configuration data from the StackWise Virtual active switch to the StackWise Virtual standby switch. Also, protocols and features that support high availability synchronize their events and state information to the StackWise Virtual standby switch.

Nonstop Forwarding

While implementing Nonstop Forwarding (NSF) technology in systems using SSO redundancy mode, network disruptions are minimized for campus users and applications. High availability is provided even when the control-plane processing stack-member switch is reset. During a failure of the underlying Layer 3, NSF-capable protocols perform graceful network topology resynchronization. The preset forwarding information on the redundant stack-member switch remains intact; this switch continues to forward the data in the network. This service availability significantly lowers the mean time to repair (MTTR) and increases the mean time between failure (MTBF) to achieve a high level of network availability.

Multichassis EtherChannels

Multichassis EtherChannel (MEC) is an EtherChannel bundled with physical ports having common characteristics such as speed and duplex, that are distributed across each Cisco StackWise Virtual system. A Cisco StackWise Virtual MEC can connect to any network element that supports EtherChannel (such as a host, server, router, or switch). Cisco StackWise Virtual supports up to 128 MECs deployed in Layer 2 or Layer 3 modes.

EtherChannel 127 and 128 are reserved for SVL connections. Hence, the maximum available MEC count is 126.

In a Cisco StackWise Virtual system, an MEC is an EtherChannel with additional capability. A multichassis EtherChannel link reduces the amount of traffic that requires transmission across the SVL by populating the index port only with the ports local to the physical switch. This allows the switch to give precedence to the local ports of the multichassis EtherChannel link over those on the remote switch.

Each MEC can optionally be configured to support either Cisco PAgP, IEEE LACP, or Static ON mode. We recommend that you implement EtherChannel using Cisco PAgP or LACP with a compatible neighbor. If a remotely connected neighbor such as Cisco Wireless LAN Controller (WLC) does not support this link-bundling protocol, then a Static ON mode can be deployed. These protocols run only on the Cisco StackWise Virtual active switch.

An MEC can support up to eight physical links that can be distributed in any proportion between the Cisco StackWise Virtual active switch and the Cisco StackWise Virtual standby switch. We recommend that you distribute the MEC ports across both switches evenly.

MEC Minimum Latency Load Balancing

The StackWise Virtual environment is designed such that data forwarding always remains within the switch. The Virtual Stack always tries to forward traffic on the locally available links. This is true for both Layer 2 and Layer3 links. The primary motivation for local forwarding is to avoid unnecessarily sending data traffic over the SVL and thus reduce the latency (extra hop over the SVL) and congestion.The bidirectional traffic is load-shared between the two StackWise Virtual members. However, for each StackWise Virtual member, ingress and egress traffic forwarding is based on locally-attached links that are part of MEC. This local forwarding is a key concept in understanding convergence and fault conditions in a StackWise Virtual enabled campus network.

The active and standby switches support local forwarding that will individually perform the desired lookups and forward the traffic on local links to uplink neighbors. If the destination is a remote switch in the StackWise

Virtual domain, ingress processing is performed on the ingress switch and then traffic is forwarded over the SVL to the egress switch where only egress processing is performed.

MEC Failure Scenarios

The following sections describe issues that may arise and the resulting impact:

Single MEC Link Failure

If a link within a MEC fails (and other links in the MEC are still operational), the MEC redistributes the load among the operational links, as in a regular port.

All MEC Links to the Cisco StackWise Virtual Active Switch Fail

If all the links to the Cisco StackWise Virtual active switch fail, a MEC becomes a regular EtherChannel with operational links to the Cisco StackWise Virtual standby switch.

Data traffic that terminates on the Cisco StackWise Virtual active switch reaches the MEC by crossing the SVL to the Cisco StackWise Virtual standby switch. Control protocols continue to run in the Cisco StackWise Virtual active switch. Protocol messages reach the MEC by crossing the SVL.

All MEC Links Fail

If all the links in an MEC fail, the logical interface for the EtherChannel is set to Unavailable. Layer 2 control protocols perform the same corrective action as for a link-down event on a regular EtherChannel.

On adjacent switches, routing protocols and the Spanning Tree Protocol (STP) perform the same corrective action as for a regular EtherChannel.

Cisco StackWise Virtual Standby Switch Failure

If the Cisco StackWise Virtual standby switch fails, a MEC becomes a regular EtherChannel with operational links on the Cisco StackWise Virtual active switch. Connected peer switches detect the link failures, and adjust their load-balancing algorithms to use only the links to the StackWise Virtual active switch.

Cisco StackWise Virtual Active Switch Failure

Cisco StackWise Virtual active switch failure results in a stateful switchover (SSO). After the switchover, a MEC is operational on the new Cisco StackWise Virtual active switch. Connected peer switches detect the link failures (to the failed switch), and adjust their load-balancing algorithms to use only the links to the new Cisco StackWise Virtual active switch.

Cisco StackWise Virtual Packet Handling

In Cisco StackWise Virtual, the Cisco StackWise Virtual active switch runs the Layer 2 and Layer 3 protocols and features and manages the ports on both the switches. Cisco StackWise Virtual uses SVL to communicate system and protocol information between the peer switches and to carry data traffic between the two switches.

The following sections describe packet handling in Cisco StackWise Virtual.

Traffic on StackWise Virtual link

SVL carries data traffic and in-band control traffic between two switches. All the frames that are forwarded over the SVL are encapsulated with a special StackWise Virtual Header (SVH). The SVH adds an overhead

of 64 bytes for control and data traffic, which provides information for Cisco StackWise Virtual to forward the packet on the peer switch.

An SVL transports control messages between two switches. Messages include protocol messages that are processed by the Cisco StackWise Virtual active switch, but received or transmitted by interfaces on the Cisco StackWise Virtual standby switch. Control traffic also includes module programming between the Cisco StackWise Virtual active switch and the switching modules on the Cisco StackWise Virtual standby switch.

Cisco StackWise Virtual transmits data traffic over an SVL under the following circumstances:

- Layer 2 traffic flooded over a VLAN (even for dual-homed links).
- Packets processed by software on the Cisco StackWise Virtual active switch where the ingress interface is on the Cisco StackWise Virtual standby switch.
- The packet destination is on the peer switch, as described in the following examples:
  - Traffic within a VLAN where the known destination interface is on the peer switch.
  - Traffic that is replicated for a multicast group and the multicast receivers are on the peer switch.
  - The known unicast destination MAC address is on the peer switch.
  - The packet is a MAC notification frame destined for a port on the peer switch.

An SVL also transports system data, such as NetFlow export data and SNMP data, from the Cisco StackWise Virtual standby switch to the Cisco StackWise Virtual active switch.

Traffic on the SVL is load balanced with the same global hashing algorithms available for EtherChannels (the default algorithm is source-destination IP and Port).

Layer 2 Protocols

The Cisco StackWise Virtual active switch runs the Layer 2 protocols (such as STP and VTP) for the switching modules on both the switches. Protocol messages that are received on the standby switch ports must traverse SVLs to reach the active switch where they are processed. Similarly, protocol messages that are transmitted from the standby switch ports originate on the active switch, and traverse the SVLs to reach the standby ports.

All the Layer 2 protocols in Cisco StackWise Virtual work similarly in standalone mode. The following sections describe the difference in behavior for some protocols in Cisco StackWise Virtual.

Spanning Tree Protocol

The Cisco StackWise Virtual active switch runs the STP. The Cisco StackWise Virtual standby switch redirects the STP BPDUs across an SVL to the StackWise Virtual active switch.

The STP bridge ID is commonly derived from the switch MAC address. To ensure that the bridge ID does not change after a switchover, Cisco StackWise Virtual continues to use the original switch MAC address for the STP Bridge ID.

EtherChannel Control Protocols

Link Aggregation Control Protocol (LACP) and Port Aggregation Protocol (PAgP) packets contain a device identifier. Cisco StackWise Virtual defines a common device identifier for both the switches. Use either PAgP or LACP on Multi EtherChannels instead of mode ON, even if all the three modes are supported.

Note A new PAgP enhancement has been defined for assisting with dual-active scenario detection.

Switched Port Analyzer

Switched Port Analyzer (SPAN) on SVL and fast hello DAD link ports is not supported. These ports can be neither a SPAN source, nor a SPAN destination. Cisco StackWise Virtual supports all the SPAN features for non-SVL interfaces. The number of SPAN sessions that are available on Cisco StackWise Virtual matches that on a single switch running in standalone mode.

Private VLANs

Private VLANs on StackWise Virtual work the same way as in standalone mode. The only exception is that the native VLAN on isolated trunk ports must be configured explicitly.

Apart from STP, EtherChannel Control Protocols, SPAN, and private VLANs, the Dynamic Trunking Protocol (DTP), Cisco Discovery Protocol (CDP), VLAN Trunk Protocol (VTP), and Unidirectional Link Detection Protocol (UDLD) are the additional Layer 2 control-plane protocols that run over the SVL connections.

Layer 3 Protocols

The Cisco StackWise Virtual active switch runs the Layer 3 protocols and features for the StackWise Virtual. All the Layer 3 protocol packets are sent to and processed by the Cisco StackWise Virtual active switch. Both the member switches perform hardware forwarding for ingress traffic on their interfaces. When software forwarding is required, packets are sent to the Cisco StackWise Virtual active switch for processing.

The same router MAC address assigned by the Cisco StackWise Virtual active switch is used for all the Layer 3 interfaces on both the Cisco StackWise Virtual member switches. After a switchover, the original router MAC address is still used. The router MAC address is chosen based on chassis-mac and is preserved after switchover by default.

The following sections describe the Layer 3 protocols for Cisco StackWise Virtual.

IPv4 Unicast

The CPU on the Cisco StackWise Virtual active switch runs the IPv4 routing protocols and performs any required software forwarding. All the routing protocol packets received on the Cisco StackWise Virtual standby switch are redirected to the Cisco StackWise Virtual active switch across the SVL. The Cisco StackWise Virtual active switch generates all the routing protocol packets to be sent out over ports on either of the Cisco StackWise Virtual member switches.

Hardware forwarding is distributed across both members on Cisco StackWise Virtual. The CPU on the Cisco StackWise Virtual active switch sends Forwarding Information Base (FIB) updates to the Cisco StackWise Virtual standby switch, which in turn installs all the routes and adjacencies into hardware.

Packets intended for a local adjacency (reachable by local ports) are forwarded locally on the ingress switch. Packets intended for a remote adjacency (reachable by remote ports) must traverse the SVL.

The CPU on the Cisco StackWise Virtual active switch performs all software forwarding and feature processing (such as fragmentation and Time to Live exceed functions). If a switchover occurs, software forwarding is disrupted until the new Cisco StackWise Virtual active switch obtains the latest Cisco Express Forwarding and other forwarding information.

In virtual switch mode, the requirements to support non-stop forwarding (NSF) match those in the standalone redundant mode of operation.

From a routing peer perspective, Multi-Chassis EtherChannels (MEC) remain operational during a switchover, that is, only the links to the failed switch are down, but the routing adjacencies remain valid.

Cisco StackWise Virtual achieves Layer 3 load balancing over all the paths in the Forwarding Information Base entries, be it local or remote.

IPv6

Cisco StackWise Virtual supports IPv6 unicast and multicast because it is present in the standalone system.

IPv4 Multicast

The IPv4 multicast protocols run on the Cisco StackWise Virtual active switch. Internet Group Management Protocol (IGMP) and Protocol Independent Multicast (PIM) protocol packets received on the Cisco StackWise Virtual standby switch are transmitted across an SVL to the StackWise Virtual active switch. The latter generates IGMP and PIM protocol packets to be sent over ports on either of the Cisco StackWise Virtual members.

The Cisco StackWise Virtual active switch synchronizes the Multicast Forwarding Information Base (MFIB) state to the Cisco StackWise Virtual standby switch. On both the member switches, all the multicast routes are loaded in the hardware, with replica expansion table (RET) entries programmed for only local, outgoing interfaces. Both the member switches are capable of performing hardware forwarding.

Note To avoid multicast route changes as a result of a switchover, we recommend that all the links carrying multicast traffic be configured as MEC rather than Equal Cost Multipath (ECMP).

For packets traversing an SVL, all Layer 3 multicast replications occur on the egress switch. If there are multiple receivers on the egress switch, only one packet is replicated and forwarded over the SVL, and then replicated to all the local egress ports.

Software Features

Software features run only on the Cisco StackWise Virtual active switch. Incoming packets to the Cisco StackWise Virtual standby switch that require software processing are sent across an SVL to the Cisco StackWise Virtual active switch.

Dual-Active Detection

If the standby switch detects a complete loss of the SVL, it assumes the active switch has failed and will take over as the active switch. However, if the original Cisco StackWise Virtual active switch is still operational, both the switches will now be Cisco StackWise Virtual active switches. This situation is called a dual-active scenario. This scenario can have adverse effects on network stability because both the switches use the same IP addresses, SSH keys, and STP bridge IDs. Cisco StackWise Virtual detects a dual-active scenario and takes recovery action. DAD link is the dedicated link used to mitigate this.

If the last available SVL fails, the Cisco StackWise Virtual standby switch cannot determine the state of the Cisco StackWise Virtual active switch. To ensure network uptime without delay, the Cisco StackWise Virtual standby switch then assumes the Cisco StackWise Virtual active role. The original Cisco StackWise Virtual

active switch enters recovery mode and brings down all its interfaces, except the SVL and the management interfaces.

Dual-Active-Detection Link with Fast Hello

To use the dual-active fast hello packet detection method, you must provision a direct ethernet connection between the two Cisco StackWise Virtual switches. You can dedicate up to four links for this purpose.

The two switches start with exchanging dual-active hello messages containing information about the initial switch states. If all SVLs fail and a dual-active scenario occurs, each switch will trigger an exchange of the dual-active hello messages which allows it to recognize that there is a dual-active scenario from the peer's messages.

This initiates recovery actions as described in the Recovery Actions, on page 28 section. If a switch does not receive an expected dual-active fast hello message from the peer before the timer expires, the switch assumes that the link is no longer capable of dual-active detection.

Note Do not use the same port for StackWise Virtual Link and dual-active detection link.

Dual-Active Detection with enhanced PAgP

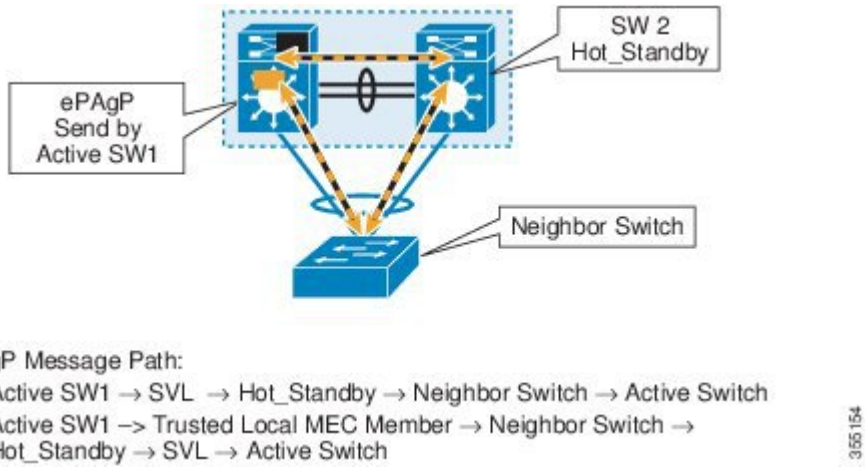
Port aggregation protocol (PAgP) is a Cisco proprietary protocol used for managing EtherChannels. If a StackWise Virtual MEC terminates on a Cisco switch, you can run PAgP protocol on the MEC. If PAgP is running on the MECs between the StackWise Virtual switch and an upstream or downstream switch, the StackWise Virtual can use PAgP to detect a dual-active scenario. The MEC must have at least one port on each switch of the StackWise Virtual setup.

Enhanced PAgP is an extension of the PAgP protocol. In virtual switch mode, ePAgP messages include a new type length value (TLV) which contains the ID of the StackWise Virtual active switch. Only switches in virtual switch mode send the new TLV.

When the StackWise Virtual standby switch detects SVL failure, it initiates SSO and becomes StackWise Virtual active. Subsequent ePAgP messages sent to the connected switch from the newly StackWise Virtual active switch contain the new StackWise Virtual active ID. The connected switch sends ePAgP messages with the new StackWise Virtual active ID to both StackWise Virtual switches.

If the formerly StackWise Virtual active switch is still operational, it detects the dual-active scenario because the StackWise Virtual active ID in the ePAgP messages changes.

Figure 2: Dual-active-detection with ePAgP



Note To avoid PAgP flaps and to ensure that dual-active detection functions as expected, the stack MAC persistent wait timer must be configured as indefinite using the command **stack-mac persistent timer 0 .**

Recovery Actions

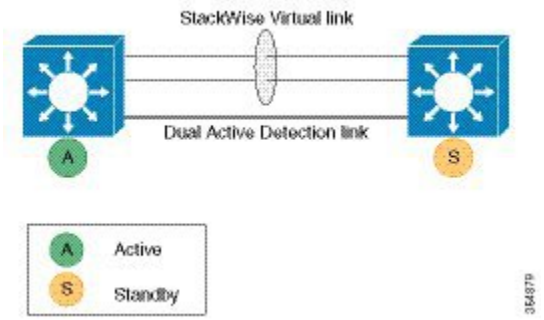
A Cisco StackWise Virtual active switch that detects a dual-active condition shuts down all of its non-SVL or non-DAD interfaces to remove itself from the network. The switch then waits in recovery mode until the SVLs recover. You should physically repair the SVL failure and the switch automatically reloads and restores itself as the standby switch. To enable the switch to remain in recovery mode after restoring the SVL links, see Disabling Recovery Reload, on page 36 section.

Implementing Cisco StackWise Virtual

The two-node solution of Cisco StackWise Virtual is normally deployed at the aggregation layer. Two switches are connected over an SVL.

Cisco StackWise Virtual combines the two switches into a single logical switch with a large number of ports, offering a single point of management. One of the member switches is the active and works as the control and management plane, while the other one is the standby. The virtualization of multiple physical switches into a single logical switch is only from a control and management perspective. Because of the control plane being common, it may look like a single logical entity to peer switches. The data plane of the switches are converged, that is, the forwarding context of a switch might be passed to the other member switch for further processing when traffic is forwarded across the switches. However, the common control plane ensures that all the switches have equivalent data plane entry for each forwarding entity.

Figure 3: Two-Node Solution



An election mechanism that determines which switch is Cisco StackWise Virtual active and which one is a control plane standby, is available. The active switch is responsible for management, bridging and routing protocols, and software data path. These are centralized on the active switch supervisor of the Cisco StackWise Virtual active switch.

How to Configure Cisco StackWise Virtual

Configuring Cisco StackWise Virtual Settings

To enable StackWise Virtual, perform the following procedure on both the switches:

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device>enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**switch***switch-number***renumber***new switch -number* **Example:** `Device#switch 1 renumber 2`	(Optional) Reassigns the switch number. The default switch number will be 1. The valid values for the new switch number are 1 and 2.
Step 3	**switch***switch-number***priority***priority-number* **Example:** `Device#switch 1 priority 5`	(Optional) Assigns the priority number. The default priority number is 1. The highest priority number is 15.

	Command or Action	Purpose
Step 4	**configure terminal** **Example:** `Device#configure terminal`	Enters global configuration mode.
Step 5	**stackwise-virtual** **Example:** `Device(config)#stackwise-virtual`	Enables Cisco StackWise Virtual and enters stackwise-virtual submode.
Step 6	**domain** *id* **Example:** `Device(config-stackwise-virtual)#domain 2`	(Optional) Specifies the Cisco StackWise Virtual domain ID. The domain ID range is from 1 to 255. The default value is one.
Step 7	**end** **Example:** `Device(config-stackwise-virtual)#end`	Returns to privileged EXEC mode.
Step 8	**show stackwise-virtual** **Example:** `Device#show stackwise-virtual`	
Step 9	**write memory** **Example:** `Device#write memory`	Saves the running-configuration which resides in the system RAM and updates the ROMmon variables. If you do not save the changes, the changes will no longer be part of the startup configuration when the switch reloads. Note that the configurations for **stackwise-virtual** and **domain** are saved to the running-configuration and the startup-configuration after the reload.
Step 10	**reload** **Example:** `Device#reload`	Restarts the switch and forms the stack.

Configuring Cisco StackWise Virtual Link

Note Depending on the switch model, SVL is supported on all 100G, 40G, 25G and 10G interfaces of the Cisco Catalyst 9600 Series High Performance switches. However, a combination of different interface speeds is not supported.

To configure a switch port as an SVL port, perform the following procedure on both the switches:

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device>enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device#configure terminal`	Enters global configuration mode.
Step 3	**interface** {**HundredGigE** | **FortyGigabitEthernet** | **TwentyFiveGigE**} <*interface*> **Example:** `Device(config)#interface FortyGigabitEthernet1/0/5`	Enters ethernet interface configuration mode.
Step 4	**stackwise-virtual link** *link value* **Example:** `Device(config-if)#stackwise-virtual link 1`	Associates the interface with configured SVL.
Step 5	**end** **Example:** `Device(config-if)#end`	Returns to privileged EXEC mode.
Step 6	**write memory** **Example:** `Device#write memory`	Saves the running-configuration which resides in the system RAM and updates the ROMmon variables. If you do not save the changes, the changes will no longer be part of the startup configuration when the switch reloads. Note that the configuration for **stackwise-virtual link** *link value* is saved only in the running-configuration and not the startup-configuration.
Step 7	**reload** **Example:** `Device#reload`	Restarts the switch. **Note** When converting a Cisco Catalyst 9600 Series switch from standalone mode to SVL mode for the first time, one of the switches boots up or resets, for resolving the switch number conflict

	Command or Action	Purpose

		and sets the SWITCH_NUMBER environment variable to 2. The following message appears on the console prompt indicating this:
		`Waiting for remote chassis to join`
		`##################################################`
		`Chassis number is 2`
		`All chassis in the stack have been discovered. Accelerating discovery`
		
		`Chassis is reloading, reason: Configured Switch num conflicts with peer, Changing local switch number to 2 and reloading to take effect`

Configuring Secure StackWise Virtual

Before you begin

Note Ensure that the devices are in a standalone mode.

Disable FIPS mode using the **no fips authorization-key** command before configuring the Secure StackWise Virtual authorization key.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device#configure terminal`	Enters global configuration mode.
Step 3	**secure-stackwise-virtual authorization-key <128-bits>** **Example:** `Device(config)#secure-stackwise-virtual authorization-key <128-bits>`	Configures the Secure StackWise Virtual authorization key.
Step 4	**reload** **Example:**	Restarts the switch and the configuration of Secure StackWise Virtual takes effect.

	Command or Action	Purpose
	`Device#reload`	

Configuring StackWise Virtual Fast Hello Dual-Active-Detection Link

To configure StackWise Virtual Fast Hello DAD link, perform the following procedure. This procedure is optional.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device>enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device#configure terminal`	Enters global configuration mode.
Step 3	**interface** {**HundredGigE** | **FortyGigabitEthernet** | **TwentyFiveGigE**} *<interface>* **Example:** `Device(config)#interface FortyGigabitEthernet1/0/20`	Enters ethernet interface configuration mode.
Step 4	**stackwise-virtual dual-active-detection** **Example:** `Device(config-if)#stackwise-virtual dual-active-detection`	Associates the interface with StackWise Virtual dual-active-detection. **Note** This command will not be visible on the device after the configuration, but will continue to function.
Step 5	**end** **Example:** `Device(config-if)#end`	Returns to privileged EXEC mode.
Step 6	**write memory** **Example:** `Device#write memory`	Saves the running-configuration which resides in the system RAM and updates the ROMmon variables. If you do not save the changes, the changes will no longer be part of the startup configuration when the switch reloads. Note that the configuration for **stackwise-virtual**

	Command or Action	Purpose
		dual-active-detection is saved only in the running-configuration and not the startup-configuration.
Step 7	**reload** **Example:** `Device#reload`	Restarts the switch and configuration takes effect.

Enabling ePAgP Dual-Active-Detection

To enable ePAgP dual-active-detection on a switch port, perform the following procedure on both the switches. This procedure is optional.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device>enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device#configure terminal`	Enters global configuration mode.
Step 3	**interface** { **HundredGigabitEthernet** | **FortyGigabitEthernet** | **TwentyFiveGigE** } *<interface>* **Example:** `Device(config)#interface FortyGigabitEthernet 1/0/5`	Enters the interface configuration mode.
Step 4	**channel-group** *group_ID* **mode desirable** **Example:** `Device(config-if)#channel-group 1 mode desirable`	Enables PAgP MEC with channel-group id in the range of 1 to for 10 GigabitEthernet interfaces.
Step 5	**exit** **Example:** `Device(config-if)#exit`	Exits interface configuration.
Step 6	**interface port-channel** *channel-group-id* **Example:**	Selects a port channel interface to configure.

	Command or Action	Purpose
	`Device(config)#interface port-channel 1`	
Step 7	**shutdown** **Example:** `Device(config-if)#shutdown`	Shuts down an interface.
Step 8	**exit** **Example:** `Device(config-if)#exit`	Exits interface configuration.
Step 9	**stackwise-virtual** **Example:** `Device(config)#stackwise-virtual`	Enters the StackWise Virtual configuration mode.
Step 10	**dual-active detection pagp** **Example:** `Device(config-stackwise-virtual)#dual-active detection pagp`	Enables pagp dual-active detection. This is enabled by default.
Step 11	**dual-active detection pagp trust channel-group** *channel-group id* **Example:** `Device(config-stackwise-virtual)#dual-active detection pagp trust channel-group 1`	Enables dual-active detection trust mode on channel-group with the configured ID.
Step 12	**exit** **Example:** `Device(config-stackwise-virtual)#exit`	Exits the StackWise-Virtual configuration mode.
Step 13	**interface port-channel** *portchannel* **Example:** `Device(config)#interface port-channel 1`	Configured port-channel on the switch.
Step 14	**no shutdown** **Example:** `Device(config-if)#no shutdown`	Enables the configured port-channel on the switch.
Step 15	**end** **Example:** `Device(config-if)#end`	Exits interface configuration.
Step 16	**write memory** **Example:**	Saves the running-configuration which resides in the system RAM and updates the ROMmon variables. If you do not save the changes, the

	Command or Action	Purpose
	`Device#write memory`	changes will no longer be part of the startup configuration when the switch reloads. Note that the configuration for **dual-active detection pagp trust channel-group** *channel-group id* is saved to the running-configuration and the startup-configuration after the reload.
Step 17	**reload** **Example:** `Device#reload`	Restarts the switch and configuration takes effect.

Disabling Recovery Reload

After recovering from StackWise Virtual link failure, the switch in recovery mode performs a recovery action by automatically reloading the switch . This is the default behaviour in the event of a link failure. In order to retain a switch in recovery mode and prevent the switch from reloading automatically, you must perform the following steps.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device>enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device#configure terminal`	Enters global configuration mode.
Step 3	**stackwise-virtual** **Example:** `Device(config)#stackwise-virtual`	Enables Cisco StackWise Virtual and enters stackwise-virtual mode.
Step 4	**dual-active recovery-reload-disable** **Example:** `Device(config-stackwise-virtual)#dual-active recovery-reload-disable`	Disables automatic recovery reload of the switch. Disables automatic reload of the switch in recovery mode. Note that the configuration for **dual-active recovery-reload-disable** is saved only in the

	Command or Action	Purpose
		running-configuration and not the startup-configuration.
Step 5	**end** **Example:** `Device(config-stackwise-virtual)#end`	Returns to privileged EXEC mode.

Disabling Cisco StackWise Virtual

To disable Cisco StackWise Virtual on a switch, perform the following procedure:

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device>enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device#configure terminal`	Enters global configuration mode.
Step 3	**interface** {**HundredGigE** | **FortyGigabitEthernet** | **TwentyFiveGigE**} <*interface*> **Example:** `Device(config)#interface FortyGigabitEthernet 1/0/10`	Enters ethernet interface configuration mode.
Step 4	**no stackwise-virtual dual-active-detection** **Example:** `Device(config-if)#no stackwise-virtual dual-active-detection`	Dissociates the interface from StackWise Virtual DAD.
Step 5	Repeat step 3 **Example:** `Device(config)#interface FortyGigabitEthernet 1/0/5`	Enters the interface configuration mode.
Step 6	**no stackwise-virtual link** *link* **Example:**	Dissociates the interface from SVL.

	Command or Action	Purpose
	`Device(config-if)#no stackwise-virtual link 1`	
Step 7	**exit** **Example:** `Device(config-if)#exit`	Exits interface configuration.
Step 8	**no stackwise-virtual** **Example:** `Device(config)#no stackwise-virtual`	Disables StackWise Virtual configuration.
Step 9	**exit** **Example:** `Device(config)#exit`	Exits the global configuration mode.
Step 10	**write memory** **Example:** `Device#write memory`	Saves the running configuration.
Step 11	**reload** **Example:** `Device#reload`	Restarts the switch and the configuration takes effect.

Disabling Secure StackWise Virtual

To disable Secure StackWise Virtual, perform the following procedure:

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device#configure terminal`	Enters global configuration mode.
Step 3	**secure-stackwise-virtual zeroize sha1-key** **Example:** `Device(config)#secure-stackwise-virtual zeroize sha1-key`	Zeroization of the Secure StackWise Virtual SHA-1 key from the device by deleting the IOS image and configuration files.

	Command or Action	Purpose
Step 4	**reload** **Example:** `Device#reload`	Restarts the device and disables Secure StackWise Virtual. **Note** You must reboot the device.
Step 5	**nosecure-stackwise-virtualauthorization-key** **Example:** `Device#no secure-stackwise-virtual authorization-key`	Removes the authorization key without zeroizing it. **Note** You must reload the device for the authorization key to be removed.

Configuration Examples for StackWise Virtual

This section provides the following configuration examples:

- Example: Configuring StackWise Virtual Link, on page 39
- Example: Displaying StackWise Virtual Link Information, on page 40

Example: Configuring StackWise Virtual Link

The following is a sample configuration for configuring SVL on a switch.

```
On Switch 1:
Device>enable
Device#configure terminal
Device(config)#interface FortyGigabitEthernet1/0/5
Device(config-if)#stackwise-virtual link 1
WARNING: All the extraneous configurations will be removed for FortyGigabitEthernet1/1/1
on reboot
INFO: Upon reboot, the config will be part of running config but not part of start up config.
Device(config-if)#end
Device#write memory
Device#reload

On Switch 2:
Device>enable
Device#configure terminal
Device(config)#interface FortyGigabitEthernet1/0/5
Device(config-if)#stackwise-virtual link 1
WARNING: All the extraneous configurations will be removed for FortyGigabitEthernet1/1/1
on reboot
INFO: Upon reboot, the config will be part of running config but not part of start up config.
Device(config-if)#end
Device#write memory
Device#reload
```

Example: Configuring Secure StackWise Virtual

The following is a sample configuration for configuring Secure StackWise Virtual.

```
Device (config)# secure-stackwise-virtual authorization-key <128-bits>
```

Example: Displaying Secure StackWise Virtual Authorization Key and Status

The following is an example displaying the Secure StackWise Virtual authorization key.

```
Device# show secure-stackwise-virtual authorization-key
Secure-stackwise-virtual: Stored key (16) : 12345678901234567890123456789012
```

The following is an example displaying the Secure StackWise Virtual authorization key status.

```
Device# show secure-stackwise-virtual status
Switch is running in SECURE-SVL mode
```

Example: Disabling Secure StackWise Virtual

The following is an example of Secure StackWise Virtual authorization key zeroization.

```
Device(config)# secure-stackwise-virtual zeroize sha1-key
**Critical Warning** - This command is irreversible
and will zeroize the Secure-SVL-VPK by Deleting
the IOS image and config files, please use extreme
caution and confirm with Yes on each of three
iterations to complete. The system will reboot
after the command executes successfully
Do you want to proceed ?? (yes/[no]):
```

Example: Configuring StackWise Virtual Fast Hello Dual-Active-Detection Link

The following is a sample configuration for configuring a StackWise Virtual Fast Hello dual-active-detection link on a Switch 1 and Switch 2. You cannot configure StackWise Virtual Fast Hello dual-active-detection links on ports that are already configured as StackWise Virtual link ports.

```
On Switch 1:
Device>enable
Device#configure terminal
Device(config)#interface FortyGigabitEthernet1/0/3
Device(config-if)#stackwise-virtual dual-active-detection
Please reload the switch for Stackwise Virtual configuration to take effect
Upon reboot, the config will be part of running config but not part of start up config.
Device(config-if)#exit
On Switch 2:
Device(config)#interface FortyGigabitEthernet1/0/3
Device(config-if)#stackwise-virtual dual-active-detection
Please reload the switch for Stackwise Virtual configuration to take effect
Upon reboot, the config will be part of running config but not part of start up config.
Device(config-if)#end
On both the switches:
Device#write memory
Device#reload
```

Example: Displaying StackWise Virtual Link Information

Sample output of show stackwise-virtual link command

In this example, the output is displayed from a switch where SVL is configured.

```
Device#show stackwise-virtual link
Stackwise Virtual Link(SVL) Information:
----------------------------------------
Flags:
------
Link Status
-----------
U-Up D-Down
Protocol Status
---------------
S-Suspended P-Pending E-Error T-Timeout R-Ready
-----------------------------------------------
Switch       SVL      Ports                          Link-Status        Protocol-Status
------       ---      -----                          -----------        ---------------
1            1        FortyGigabitEthernet1/1/0/5          U                  R

2            1        FortyGigabitEthernet2/1/0/5          U                  R
```

By default in standalone mode, the switches are identified as Switch 1 unless explicitly changed to some other switch number. During the conversion to StackWise Virtual, the switch numbers are changed automatically to reflect two switches in a StackWise Virtual domain.

In Cisco Catalyst 9600 Series Switches, the interface numbering will be in 4 tuple format after reload and the switch conversion to Cisco StackWise Virtual

Example: Displaying StackWise Virtual Dual-Active-Detection Link Information

Sample output of show stackwise-virtual dual-active-detection command

StackWise Virtual DAD links configuration:

```
Device#show stackwise-virtual dual-active-detection
Recovery Reload for switch 1: Enabled
Recovery Reload for switch 2: Enabled

Dual-Active-Detection Configuration:
------------------------------------
Switch   Dad port                        Status
------   ------------                    ---------
1        FortyGigabitEthernet1/1/0/3       up
2        FortyGigabitEthernet2/1/0/3       up
```

StackWise Virtual DAD links configuration after configuring the **dual-active recovery-reload-disable** command:

```
Device#show stackwise-virtual dual-active-detection
Recovery Reload for switch 1: Enabled
Recovery Reload for switch 2: Enabled

Dual-Active-Detection Configuration:
------------------------------------
Switch      Dad port                     Status
------      ------------                 ---------
1           FortyGigabitEthernet1/1/0/3    up
2           FortyGigabitEthernet2/1/0/3    up
```

Sample output of show stackwise-virtual dual-active-detection epagp command

StackWise Virtual DAD ePAgP information:

```
Device#show stackwise-virtual dual-active-detection pagp
Pagp dual-active detection enabled: Yes
In dual-active recovery mode: No
Recovery Reload for switch 1: Enabled
Recovery Reload for switch 2: Enabled

Channel group 11
                  Dual-Active           Partner              Partner         Partner
Port              Detect Capable        Name                 Port            Version
Fo1/1/0/17          Yes                   SwitchA              Hu2/0/1           1.1
Fo2/1/0/21          Yes                   SwitchA              Hu1/0/4           1.1
```

Partner Name and **Partner Port** fields in the output represent the name and the ports of the peer switch to which the PagP port-channel is connected through MEC.

Verifying Cisco StackWise Virtual Configuration

To verify your StackWise Virtual configuration, use the following **show** commands:

show stackwise-virtual switch *number <1-2>*	Displays information of a particular switch in the stack.
show stackwise-virtual link	Displays StackWise Virtual link information.
show secure-stackwise-virtual authorization-key	Displays the installed Secure StackWise Virtual authorization key.
show secure-stackwise-virtual status	Displays the Secure StackWise Virtual status.
show secure-stackwise-virtual interface	Displays the Secure StackWise Virtual interface statistics.
show stackwise-virtual bandwidth	Displays the bandwidth available for the Cisco StackWise Virtual.
show stackwise-virtual neighbors	Displays the Cisco StackWise Virtual neighbors.
show stackwise-virtual dual-active-detection	Displays StackWise Virtual dual-active-detection information.
show stackwise-virtual dual-active-detection pagp	Displays ePAgP dual-active-detection information.
Switch ½ renumber ½	(Optional)Assigns a new switch number. The default number is 1.

Additional References for StackWise Virtual

Related Documents

Related Topic	Document Title
For complete syntax and usage information for the commands used in this chapter.	High Availability Command Reference for Catalyst 9600 Switches

Feature History for Cisco StackWise Virtual

This table provides release and related information for features explained in this module.

These features are available on all releases subsequent to the one they were introduced in, unless noted otherwise.

Release	Feature	Feature Information
Cisco IOS XE Gibraltar 16.12.1	Cisco StackWise Virtual	Cisco StackWise Virtual is a network system virtualization technology that pairs two switches into one virtual switch to simplify operational efficiency with a single control and management plane Also supported in the introductory release, are the following features: • BGP EVPN VXLAN on switches with Cisco StackWise Virtual: Support for the *BGP EVPN VXLAN* feature on switches with Cisco StackWise Virtual configured. • Secure StackWise Virtual: Secure StackWise Virtual support was introduced for two node front-side stacking. Secure StackWise Virtual is FIPS 140-2 compliant and encrypts control packets as well. • Recovery Reload: Support for disabling DAD recovery reload. Enter the **dual-active recovery-reload-disable** command in stackwise virtual mode (config-stackwise-virtual).

Use the Cisco Feature Navigator to find information about platform and software image support. To access Cisco Feature Navigator, go to https://cfnng.cisco.com/.