

# Network OS Layer 2 Switching Configuration Guide

Supporting Network OS v5.0.0



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# Preface

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## Document conventions

The document conventions describe text formatting conventions, command syntax conventions, and important notice formats used in Brocade technical documentation.

### Text formatting conventions

Text formatting conventions such as boldface, italic, or Courier font may be used in the flow of the text to highlight specific words or phrases.

Format	Description
<b>bold text</b>	Identifies command names Identifies keywords and operands Identifies the names of user-manipulated GUI elements
<i>italic text</i>	Identifies text to enter at the GUI Identifies emphasis Identifies variables and modifiers Identifies paths and Internet addresses
Courier font	Identifies document titles Identifies CLI output Identifies command syntax examples

### Command syntax conventions

Bold and italic text identify command syntax components. Delimiters and operators define groupings of parameters and their logical relationships.

Convention	Description
<b>bold text</b>	Identifies command names, keywords, and command options.
<i>italic text</i>	Identifies a variable.
value	In Fibre Channel products, a fixed value provided as input to a command option is printed in plain text, for example, <b>--show</b> WWN.
[ ]	Syntax components displayed within square brackets are optional.
{ x   y   z }	Default responses to system prompts are enclosed in square brackets. A choice of required parameters is enclosed in curly brackets separated by vertical bars. You must select one of the options.

Convention	Description
x   y	In Fibre Channel products, square brackets may be used instead for this purpose.
< >	A vertical bar separates mutually exclusive elements.
< >	Nonprinting characters, for example, passwords, are enclosed in angle brackets.
...	Repeat the previous element, for example, <i>member[member...]</i> .
\	Indicates a "soft" line break in command examples. If a backslash separates two lines of a command input, enter the entire command at the prompt without the backslash.

## Notes, cautions, and warnings

Notes, cautions, and warning statements may be used in this document. They are listed in the order of increasing severity of potential hazards.

### NOTE

A Note provides a tip, guidance, or advice, emphasizes important information, or provides a reference to related information.

### ATTENTION

An Attention statement indicates a stronger note, for example, to alert you when traffic might be interrupted or the device might reboot.



### CAUTION

A Caution statement alerts you to situations that can be potentially hazardous to you or cause damage to hardware, firmware, software, or data.



### DANGER

*A Danger statement indicates conditions or situations that can be potentially lethal or extremely hazardous to you. Safety labels are also attached directly to products to warn of these conditions or situations.*

## Brocade resources

Visit the Brocade website to locate related documentation for your product and additional Brocade resources.

You can download additional publications supporting your product at [www.brocade.com](http://www.brocade.com). Select the Brocade Products tab to locate your product, then click the Brocade product name or image to open the individual product page. The user manuals are available in the resources module at the bottom of the page under the Documentation category.

To get up-to-the-minute information on Brocade products and resources, go to [MyBrocade](http://MyBrocade). You can register at no cost to obtain a user ID and password.

Release notes are available on [MyBrocade](http://MyBrocade) under Product Downloads.

White papers, online demonstrations, and data sheets are available through the [Brocade website](http://Brocade website).

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As a Brocade customer, you can contact Brocade Technical Support 24x7 online, by telephone, or by e-mail. Brocade OEM customers contact their OEM/Solutions provider.

## Brocade customers

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If you have purchased Brocade product support directly from Brocade, use one of the following methods to contact the Brocade Technical Assistance Center 24x7.

Online	Telephone	E-mail
<p>Preferred method of contact for non-urgent issues:</p> <ul style="list-style-type: none"> <li>• <a href="#">My Cases</a> through MyBrocade</li> <li>• <a href="#">Software downloads</a> and licensing tools</li> <li>• <a href="#">Knowledge Base</a></li> </ul>	<p>Required for Sev 1-Critical and Sev 2-High issues:</p> <ul style="list-style-type: none"> <li>• Continental US: 1-800-752-8061</li> <li>• Europe, Middle East, Africa, and Asia Pacific: +800-AT FIBREE (+800 28 34 27 33)</li> <li>• For areas unable to access toll free number: +1-408-333-6061</li> <li>• <a href="#">Toll-free numbers</a> are available in many countries.</li> </ul>	<p><a href="mailto:support@brocade.com">support@brocade.com</a></p> <p>Please include:</p> <ul style="list-style-type: none"> <li>• Problem summary</li> <li>• Serial number</li> <li>• Installation details</li> <li>• Environment description</li> </ul>

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- Brocade provides backline support for issues that cannot be resolved by the OEM/Solution Provider.
- Brocade Supplemental Support augments your existing OEM support contract, providing direct access to Brocade expertise. For more information, contact Brocade or your OEM.
- For questions regarding service levels and response times, contact your OEM/Solution Provider.

## Document feedback

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Quality is our first concern at Brocade and we have made every effort to ensure the accuracy and completeness of this document. However, if you find an error or an omission, or you think that a topic needs further development, we want to hear from you. You can provide feedback in two ways:

- Through the online feedback form in the HTML documents posted on [www.brocade.com](http://www.brocade.com).
- By sending your feedback to [documentation@brocade.com](mailto:documentation@brocade.com).

Provide the publication title, part number, and as much detail as possible, including the topic heading and page number if applicable, as well as your suggestions for improvement.



# About this document

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## Supported hardware and software

In those instances in which procedures or parts of procedures documented here apply to some switches but not to others, this guide identifies exactly which switches are supported and which are not.

Although many different software and hardware configurations are tested and supported by Brocade Communications Systems, Inc. for Network OS 5.0.0, documenting all possible configurations and scenarios is beyond the scope of this document.

The following hardware platforms are supported by this release of Network OS:

- Brocade VDX 2740 embedded switch
- Brocade VDX 6740
  - Brocade VDX 6740-48
  - Brocade VDX 6740-64
- Brocade VDX 6740T
  - Brocade VDX 6740T-48
  - Brocade VDX 6740T-64
  - Brocade VDX 6740T-1G
- Brocade VDX 8770
  - Brocade VDX 8770-4
  - Brocade VDX 8770-8

To obtain information about an OS version other than Network OS v5.0.0, refer to the documentation specific to that OS version.

## Using the Network OS CLI

For complete instructions and support using the Network OS v5.0.0 command line interface (CLI), refer to the Network OS Command Reference.

## What's new in this document

This document supports Network OSv5.0.0. The major new features in this release that are covered in this document include the following:

- VXLAN overlay gateway for Layer 2 extension
- Conversational MAC learning (CML)
- FlexPort
- sFlow for VXLAN

What's new in this document

For complete information, refer to the *Network OS Release Notes*.



# Administering Edge-Loop Detection

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## Edge-loop detection overview

Edge-loop detection (ELD) detects and disables Layer 2 loops that would cause broadcast storms. Typically, these loops are caused by misconfigurations.

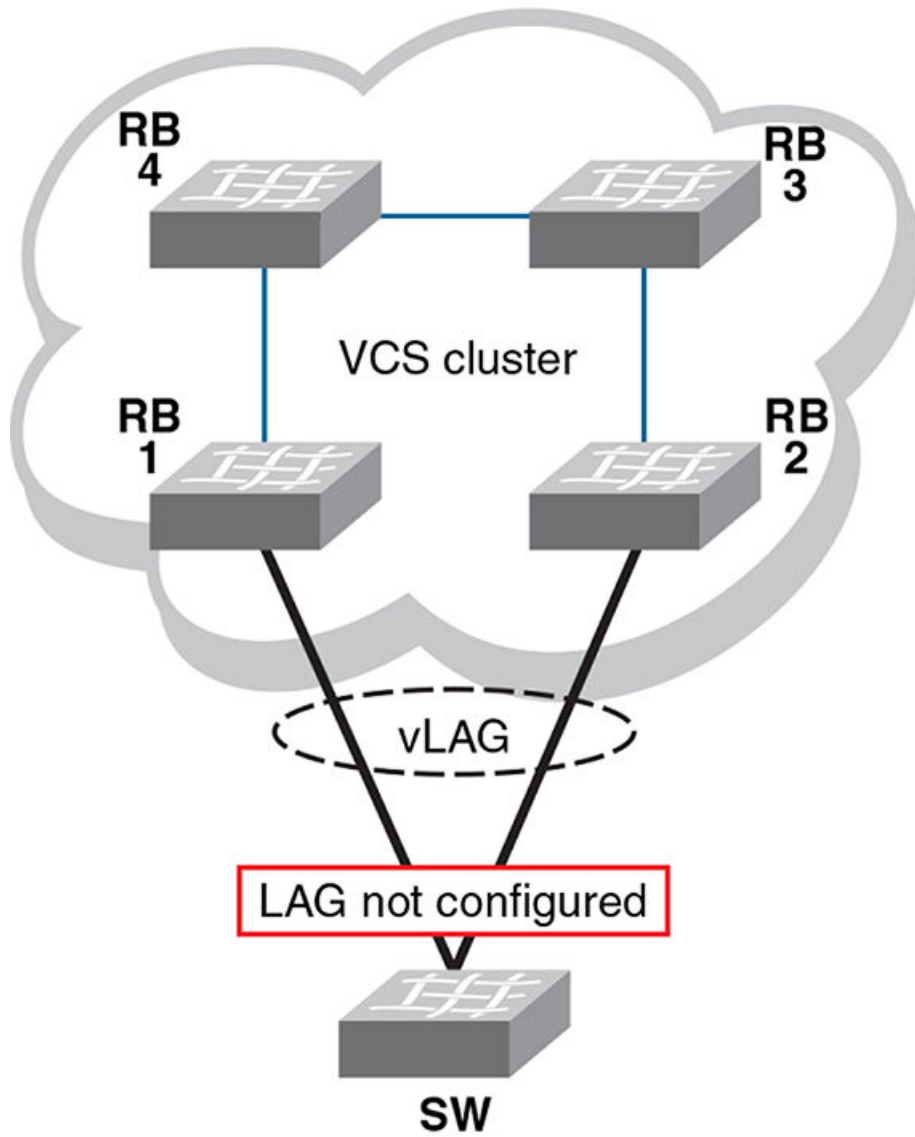
ELD is configured and enabled on Brocade VCS Fabric clusters. Any topology that includes one or more Brocade VCS Fabric clusters use ELD to detect Layer 2 loops and prevent broadcast storms. Standalone switches can be included in such a cluster, but loop detection takes place on the Brocade VCS Fabric cluster, and not on the standalone switch. You cannot use ELD in a network consisting of standalone switches only.

Specifically, ELD can be used to prevent broadcast storms caused by Layer 2 loops in the following topologies:

- A Brocade VCS Fabric cluster connects to a standalone switch.
- A Brocade VCS Fabric cluster connects to a multiple node network.
- A Brocade VCS Fabric cluster connects to other Brocade VCS Fabric clusters.

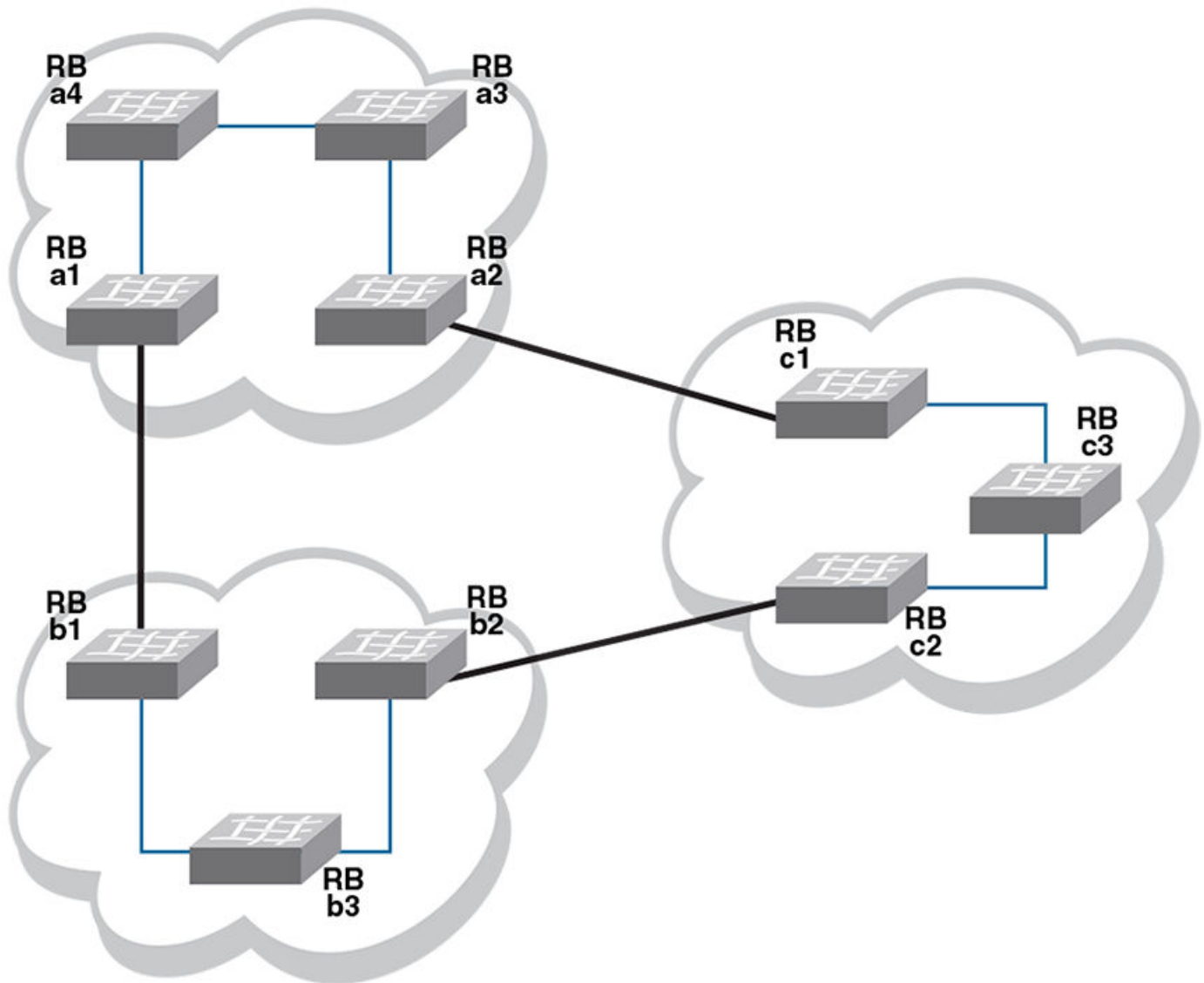
The following figure shows an example of a misconfiguration between a Brocade VCS Fabric cluster and a standalone switch that could cause a Layer 2 loop. In this case, a VLAG is configured on the edge devices of the Brocade VCS Fabric cluster for the two ISLs that connect the Brocade VCS Fabric cluster to the standalone switch. In this case, a LAG has not been created on the standalone switch at the other end of the ISLs. ELD detects and breaks this potential Layer 2 loop.

FIGURE 1 Missing LAG causes loop



The following figure shows another example for which ELD could be used to detect and break a Layer 2 loop. In this case, multiple Brocade VCS Fabric clusters are interconnected in a manner that creates a Layer 2 loop.

FIGURE 2 Interconnected Brocade VCS Fabric clusters cause loop



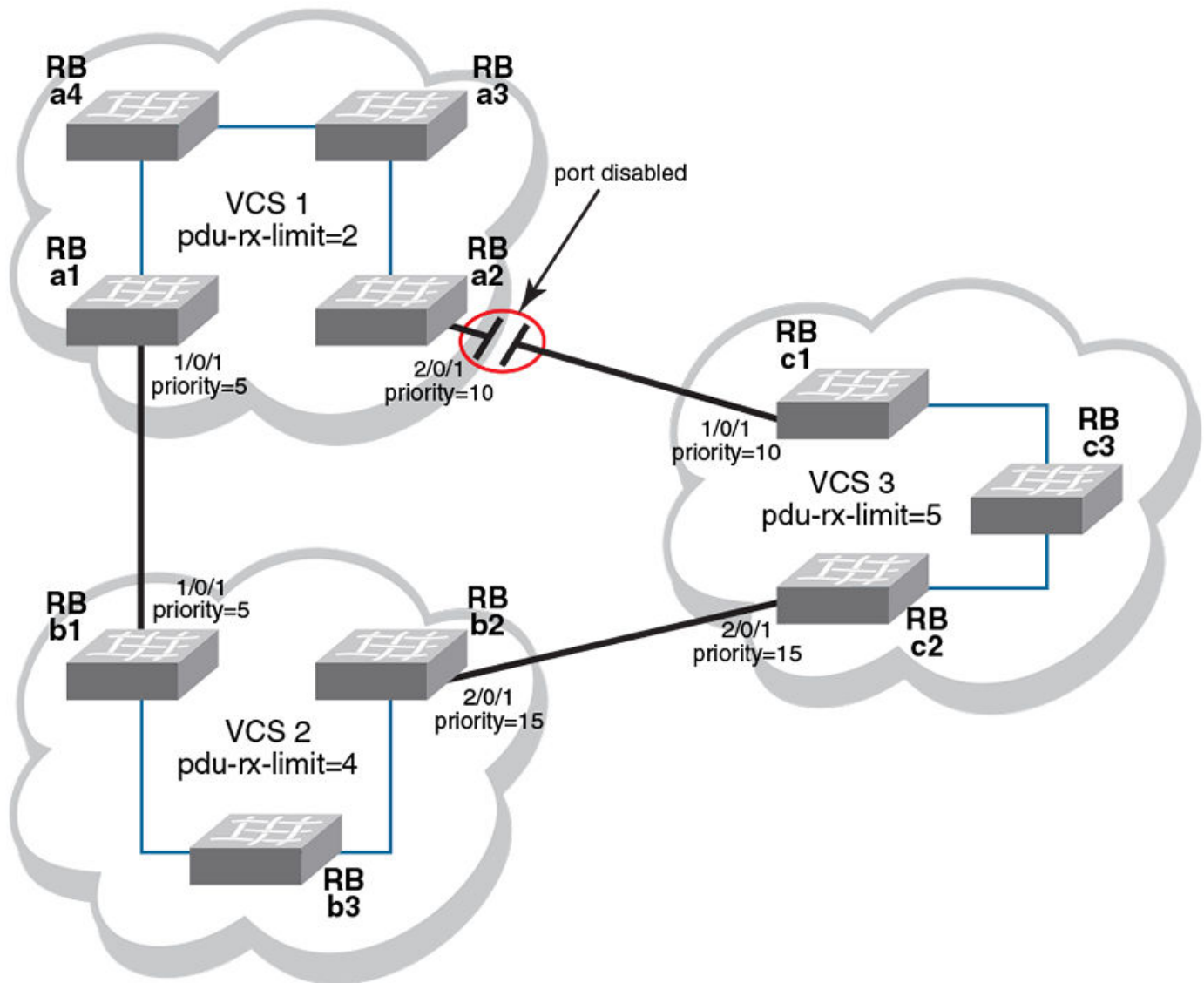
## How ELD detects loops

ELD works by multicasting Protocol Data Unit (PDU) packets on edge ports. A device recognizes a loop when it receives a PDU that it initiated. Once the device recognizes that a Layer 2 loop exists, it can take action to disable a port and break the Layer 2 loop.

To minimize the number of disabled ports, ELD assigns a priority to each port and a unique receive limit (pdu-rx-limit) to each Brocade VCS Fabric cluster. The port priority determines whether the sending or receiving edge port of the cluster is disabled. The pdu-rx-limit determines on which Brocade VCS Fabric the action takes place. Without these configured values, it is possible that a Layer 2 loop could be detected in multiple clusters at the same time. As a result, multiple ports would be disabled, stopping traffic among the Brocade VCS Fabric clusters.

The following figure shows the same interconnections as the previous figure under [Edge-loop detection overview](#) on page 17, but with ELD enabled on each edge port, and with port priorities and receive limits assigned.

FIGURE 3 Interconnected Brocade VCS Fabric clusters with ELD enabled



With all ELD enabled edge ports sending PDUs at the same rate, VCS1 reaches its pdu-rx-limit first. Port 2/0/1 has a lower priority (higher priority number) than port 1/0/1, and is therefore selected to be disabled. If both ports have the same priority, the port with the higher port-ID is disabled.

If the port being shut down by ELD is part of a LAG, all member ports of the LAG are also shut down. If the port being shut down is part of a vLAG, all member ports of the vLAG on that RBridge are also shut down.

Once ELD disables a port, normal operation is for the port to remain disabled until any misconfiguration is repaired. Once the repair is finished, the port can be re-enabled manually.

#### NOTE

When ELD disables a port, the port is operationally down, but administratively still up. If a port is disabled by STP or some other Layer 2 protocol, ELD does not process PDUs for that port.

## Configuring edge-loop detection

Edge-loop detection requires configuration at the global level and at the interface level. For global level configuration, you need to set the number of PDUs that the Brocade VCS Fabric cluster receives on any port before determining that a loop exists. This value is the **pdu-rx-limit**. You must also set the interval between sending PDUs by using the **hello-interval** command. The combination of **pdu-rx-limit** and **hello-interval** determines the time it takes for ELD to detect and break a Layer 2 loop.

At the interface level, you must enable ELD on each port you want it to run on and set the port priority. You should also specify a VLAN on which ELD is enabled.

Enter the **pdu-rx-limit** command to set the limit to a different number on each Brocade VCS Fabric cluster so that only one Brocade VCS Fabric cluster disables a port. Set this value in the increment of two to prevent race conditions which might disable ports on two Brocade VCS Fabric clusters that are incrementally only one apart.

Enter the **hello-interval** command to set the interval between PDUs. This interval must be set to the same value on all Brocade VCS Fabric clusters for which ELD is configured, otherwise the results of edge-loop detection become unpredictable.

Optionally, enter the **mac refresh** command to flush MAC addresses at a specified interval (in seconds) on either the entire cluster or on the partner port to remove any MAC inconsistencies in your system. If two interfaces are present in a Layer 2 loop, each interface learns the same set of MAC addresses. When ELD detects the Layer 2 loop, it puts the participating interface into an operationally down state. Consequently, MAC addresses learned on that interface get flushed. However, the same MAC addresses are present at the interface at the other end of the already detected loop, thereby creating this MAC inconsistency.

Optionally, enter the **shutdown-time** command to configure ports to be re-enabled after a specified period of time (range 10 minutes to 24 hours). A typical use for this feature is in environments in which reconfiguration is common, such as in a typical lab environment. Typical use is to allow the default value of zero, which does not allow ports to be re-enabled automatically.

### NOTE

Any change to **shutdown-time** only takes effect for the ports that are disabled by ELD after the configuration change. Any ports that were already disabled by ELD before the **shutdown-time** change continues to follow the old **shutdown-time** value. These ports start to follow the new shutdown time after the currently running timer expires and ELD still detects the loop and shuts down the port again.

For each interface on which ELD runs, enter the **edge-loop detection** command to enable ELD. You must also enter the **edge-loop-detection port-priority** command to specify the ELD port priority.

## Setting global ELD parameters for a Brocade VCS Fabric cluster

Perform this procedure on every Brocade VCS Fabric cluster where you configure ELD.

The values in this example configure the Brocade VCS Fabric cluster to detect and break loops on receipt of 5 PDUs. Because the PDU interval is set to 2000 ms (2 seconds), any loop breaks after 10 seconds. The selected port will remain disabled for 24 hours, after which it is automatically re-enabled.

1. Log in to any switch in a Brocade VCS Fabric cluster.
2. In global configuration mode, enter the **protocol edge-loop-detection** command to enter edge-loop detection configuration mode.

```
switch(config)# protocol edge-loop-detection
```

3. Enter the **pdu-rx-limit** *number* command to set the number of PDUs that will be received before breaking the Layer 2 loop. The *number* variable must be a value in the range 1 through 5. The default value is 1.

```
switch(config-eld)# pdu-rx-limit 5
```

4. Enter the **hello-interval** *number* command to set the interval between PDUs. The *number* variable has a unit of 1 millisecond (ms). It must be in the range from 100 ms to 5000 ms. The default value is 1000 ms.

```
switch(config-eld)# hello-interval 2000
```

5. Enter the **mac-refresh** *number* command to flush MAC addresses at a specified interval (in seconds) on either the entire cluster or on the partner port to remove any MAC inconsistencies in your system.

The *number* variable must be in the range 60 through 300 (seconds). You must also specify either **all** or *port*, depending on whether you want to flush the entire cluster or only the partner port.

```
switch(config-eld)# mac refresh 100 all
```

6. Enter the **shutdown-time** *number* command to set the number of minutes after which the shutdown port is re-enabled. The *number* variable must be in the range 10 through 1440 (10 minutes through 24 hours). The default value is 0, indicating that the port is not automatically re-enabled.

```
switch(config-eld)# shutdown-time 1440
```

## Setting interface parameters on a port

Perform this procedure for every port you want to be monitored by ELD.

1. Log in to any switch in a Brocade VCS Fabric cluster.
2. In global configuration mode, enter the **interface** command to select the *rbridge-id/slot/port* for which you want to enable edge-loop detection.
3. In interface configuration mode, enter the **edge-loop-detection vlan** command to specify the VLAN you want ELD to monitor on this port.

If you do not specify a VLAN, the command fails.

4. Enter the **edge-loop-detection port-priority** command to specify the ELD port priority of the specified port for the selected VLAN. However, enabling switching is not mandatory for assigning a port-priority.

### NOTE

The priority range of values is from 0 through 255. A port with priority 0 means that shutdown for this port is disabled. The default value port priority is 128

## Setting the ELD port priority on two port/VLAN pairs

This example sets the ELD port priority on two port/VLAN pairs: port 1/0/7 VLAN 10 and port 4/0/6 VLAN 10.

If both these ports are detected in the same loop, ELD shuts down port 4/0/6 when the pdu-rx-limit for the Brocade VCS Fabric cluster is reached. Port 4/0/6 is chosen for shut down because it has been assigned the lower priority (higher number) than port 1/0/7.

```
switch(config)# interface TenGigabitEthernet 1/0/7
switch(conf-if-te-1/0/7)# edge-loop-detection vlan 10
switch(conf-if-te-1/0/7)# edge-loop-detection port-priority 5
switch(conf-if-te-1/0/7)# top
switch(config)# interface TenGigabitEthernet 4/0/6
switch(conf-if-te-1/0/7)# edge-loop-detection vlan 10
switch(conf-if-te-1/0/7)# edge-loop-detection port-priority 7
```

## Troubleshooting edge-loop detection

Use the edge-loop detection commands to view and correct misconfigurations

1. Log in to any switch in a Brocade VCS Fabric cluster.
2. In the global configuration mode, enter the **show edge-loop-detection** command to display edge-loop detection statistics for the Brocade VCS Fabric cluster.

The command output shows ports disabled by ELD.

3. Correct any misconfigurations detected in step 2.
4. Perform one of the following operations in global configuration mode:
  - To re-enable a single port disabled by ELD:
    1. Enter the **shutdown** command on the port.
    2. Enter the **no shutdown** command on the port.

### NOTE

If an edge-port becomes an ISL port because a remote port's VCS ID was changed, a port that was already shut down by ELD must be cycled with the **shutdown** and **no shutdown** commands to be detected as an ISL port.

- To re-enable all ports disabled by ELD, enter **clear edge-loop-detection**.





# Configuring AMPP

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## AMPP overview

Server virtualization infrastructure associates a server-side Virtual Ethernet Bridge (VEB) port-profile with each Ethernet MAC address used by a virtual machine (VM) to access the network through a VEB port. The Brocade Auto Migrating Port Profile (AMPP) feature provides advanced controls for maintaining and migrating these port-profile associations when a VM migrates across physical servers.

If the VM is migrated from one physical server to another, the VEB's port-profile migrates with it, providing automated port-profile migration of the server's VEB ports that are associated with the VM.

For environments where the server's virtualization infrastructure provides sufficient controls, automated port-profile migration approaches are fine. An example of such an environment is a high performance cluster that uses a Layer 2 network that is isolated from external networks through firewalls and security appliances.

However, there is a gap between the access and Quality of Service (QoS) controls supported in external Layer 2 switches and the server virtualization infrastructure. External Layer 2 switches have more advanced controls compared to server VEB implementations.

Some environments prefer the more advanced controls provided by external network switches. An example of such an environment is a multi-tier data center that has several types of applications, each with differing advanced network controls, running over the same Layer 2 network. In this type of environment, the network administrator often prefers the use of advanced access controls available in external switches.

Layer 2 networks do not provide a mechanism for automatically migrating switch access and traffic controls associated with an end-point device when that device migrates from one switch to another. The migration may be physical, such as an operating system image (such as an application, middleware, operating system, and associated state) that is running BareMetal OS on one system and is migrated to another system. The migration may be also be virtual, such as an operating system image that is running over Hypervisor VMware on one system and is migrated to run over Hypervisor VMware on another system.

## AMPP over vLAG

Virtual Link Aggregation Group (vLAG) is the name for Brocade proprietary LAG in which the links to the Brocade VCS Fabric can be connected to one or more physical switches or servers. For redundancy and greater bandwidth, vLAG is a vital component of Brocade VCS Fabric technology. AMPP is supported on vLAG and standard LAG in a manner similar to physical port.

FCoE capability on all port-profiled interfaces can be activated using the `fcoe-port` configuration in the default port-profile (refer to [Configuring FCoE profiles](#) on page 31). This configuration enforces FCoE capability only on physical interfaces, not on the port-channel LAG. Member links of the LAG must be explicitly configured for FCoE capability.

For complete information on vLAG, refer to [Link Aggregation Control Protocol](#) on page 153.

The *italic* text in the following example highlights the vLAG information in the port profile:

```
switch# show port-profile status

Port-Profile      PPID      Activated   Associated MAC   Interface
auto-dvPortGroup  1         Yes        None             None
auto-dvPortGroup2 2         Yes        None             None
auto-dvPortGroup3 3         Yes        None             None
auto-dvPortGroup_4_0 4         Yes        0050.567e.98b0  None
```

auto-dvPortGroup_vlag	5	Yes	0050.5678.eaed	None
auto-for_iscsi	6	Yes	0050.5673.85f9	None
			0050.5673.fc6d	None
			0050.5674.f772	None
			0050.5675.d6e0	Te 234/0/54
			0050.567a.4288	None
auto-VM_Network	9	Yes	000c.2915.4bdc	None
			0050.56a0.000d	None
			0050.56a0.000e	None
			0050.56a0.000f	None
			0050.56a0.0010	Po 53
			0050.56a0.0011	Po 53
			0050.56a0.0012	Po 53
			0050.56a0.0013	None
			0050.56a0.0025	None
			0050.56a0.0026	None
			0050.56a0.0027	None
			0050.56a0.0028	None
			0050.56a0.0029	Po 53
			0050.56a0.002a	Po 53
			0050.56a0.002b	Po 53
			0050.56a0.002c	None
			0050.56a0.002d	None
			0050.56a0.002e	None
			0050.56a0.002f	None
			0050.56b3.0001	Po 53
			0050.56b3.0002	Po 53
			0050.56b3.0004	Po 53
			0050.56b3.0005	None
auto-VM_kernel	10	Yes	0050.5671.4d06	None
			0050.5672.862f	Po 53
			0050.5678.37ea	None
			0050.567a.ddc3	None
auto-VM_NW_1G	11	Yes	0050.56b3.0000	None
			0050.56b3.0003	Po 82
			0050.56b3.0007	None
			0050.56b3.0008	Po 82
			0050.56b3.0009	Po 82
auto-VMkernel	12	Yes	0050.567a.fdcf	Po 82
			0050.567c.c2e3	None
auto-VMkernel_VS	13	Yes	0050.567d.16b9	None
			0050.567e.e25b	None
auto-Management+Network	14	Yes	5cf3.fc4d.ca88	None
auto-Virtual+Machine+Network	15	Yes	000c.2941.27e2	None
			000c.2980.335d	None

```

switch# show port-profile int all
Interface      Port-Profile
Gi 234/0/1     None
Gi 234/0/13    None
Gi 234/0/25    None
Gi 234/0/26    None
Te 234/0/54    auto-for_iscsi
Po 82          auto-VM_NW_1G
               auto-VMkernel
Po 53          auto-VM_Network
               auto-VM_kernel

```

## AMPP and Switched Port Analyzer

Switched Port Analyzer (SPAN), or Port Mirroring, selects network traffic for analysis by a network analyzer. If you are interested in listening or snooping on traffic that passes through a particular port, Port Mirroring is necessary to artificially copy the packets to a port connected to the analyzer. However, SPAN and the Auto Migrating Port Profile (AMPP) port-profile-port configuration are mutually exclusive. All of the Layer 2 configuration for SPAN is mutually exclusive with regard to the **port-profile-port** command for AMPP.

## AMPP scalability

The following table describes the Auto Migrating Port Profile (AMPP) scalability values supported by Network OS 5.0.0.

**TABLE 1** AMPP scalability values

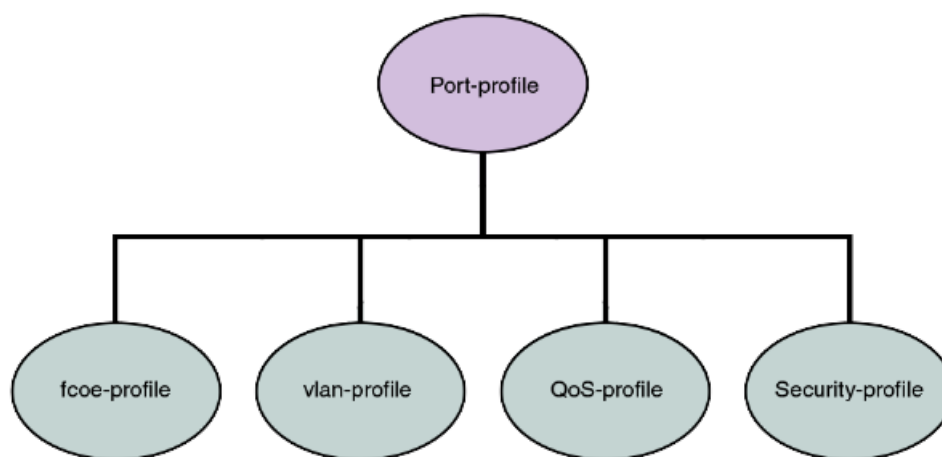
Metric	Logical chassis mode	Fabric cluster mode
Number of profiles	1000	1000
Number of VLANs in port-profiles	2000	2000
QoS profile	1 cee-map 1 mutation-map	1 cee-map 1 cos-mutation-map
Number of ACLs in security profiles	1 ingress MAC ACL 1 egress MAC ACL 1 ingress IPv4 ACL 1 egress IPv4 ACL 1 ingress IPv6 ACL 1 egress IPv6 ACL	1 ingress MAC ACL 1 egress MAC ACL 1 ingress IPv4 ACL 1 egress IPv4 ACL 1 ingress IPv6 ACL 1 egress IPv6 ACL
Number of MAC associations	8000	8000

The MAC and VLAN scaling numbers in the previous table are based on mac-association and vlan-profile scaling without any ACL configuration. In addition, AMPP is subject to the maximum number of vLAGs and LAGs supported on the switch, which is 1000 in this case.

## AMPP port-profiles

As shown in the following figure, the default port-profile contains the entire configuration needed for a VM to get access to the LAN and SAN.

**FIGURE 4** Port-profile contents



In addition, all the combinations can be mixed up with some security rules grouped under a security-profile.

**NOTE**

A port-profile does not contain some of the interface level configurations, such as LLDP, SPAN, LAG, and so on.

A port-profile operates as a self-contained configuration container. In other words, if a port-profile is applied on a completely new switch without any configuration, it is capable of configuring the interface's local configuration and starting to carry traffic. Any changes to the policies are immediately applied to the data plane.

Security profiles are applied to the ACLs based on the profile or PolicyID. Therefore, multiple security profiles can be applied to the same profiled port.

**NOTE**

The fcoe-profile is only available on the default profile. User-defined port-profiles do not have access to the fcoe-profile. However, editing of the port-profile is not allowed once the port-profile is activated. Activation of the port-profile is mandatory when it is applied to a port. Refer to [Configuring FCoE profiles](#) on page 31 for additional details.

### Life of a port-profile

A port-profile during creation will go through multiple states. The states of a port-profile are as follows:

- **Created** —This state specifies that a port-profile is created or modified, but may not be complete.
- **Activated** —This state specifies that a port-profile is activated and is available for MAC->port-profile association. If the port-profile created is not complete then the activation fails; you must resolve any conflicts or dependencies and reactivate the port-profile.
- **Associated** —This state specifies that one or more MAC addresses have been associated to this port-profile within the fabric.
- **Applied** —This state indicates that the port-profile is applied on the profiled port where the associated MAC address appeared. In the absence of any signaling protocol, the system snoops the packet to detect if the associated MAC address has appeared on the profiled port. Configuration of two different port-profiles can co-exist on a profiled port, but if there is a conflict then the application of the later port-profile fails.

The following table describes the AMPP events and the applicable failure behaviors.

**TABLE 2** AMPP behavior and failure descriptions

AMPP event	Applicable behavior and failures
Create port-profile	<ul style="list-style-type: none"> <li>• If the port-profile does not exist, then it is created. If it exists, then it is available for modification (if it is not yet activated).</li> </ul>
Activate port-profile	<ul style="list-style-type: none"> <li>• If the port-profile configuration is not complete, activation fails. Unless the port-profile is activated, it is not applied on any port-profile-port.</li> <li>• If all the dependency validations succeed, the port-profile is in the ACTIVE state and is ready for association.</li> <li>• A vlan-profile is mandatory for all port-profiles.</li> </ul>
De-activate port-profile	<ul style="list-style-type: none"> <li>• This event removes the applied port-profile configuration from all the profiled-ports.</li> <li>• De-activation is allowed even if there are MAC addresses associated with the port-profile.</li> </ul>
Modify port-profile	<ul style="list-style-type: none"> <li>• Port-profile can be edited only in the pre-activation stage.</li> <li>• The port-profile is set to the INACTIVE state if any conflicting attributes are configured, or some dependent configuration is not completed.</li> <li>• Port-profile state is set as INACTIVE and any attempt to associate the port-profile to a MAC address may not be allowed.</li> </ul>
Associate MAC addresses to a port-profile	<ul style="list-style-type: none"> <li>• If the MAC is already associated with a port-profile, the port-profile to MAC association fails.</li> <li>• Otherwise, if the port-profile to MAC association succeeds, when the same MAC is learned on any of the ports, the port-profile which has the MAC association is applied to the port.</li> </ul>

TABLE 2 AMPP behavior and failure descriptions (continued)

AMPP event	Applicable behavior and failures
De-associate MAC addresses from a port-profile	<ul style="list-style-type: none"> <li>If mapping exists, all the policies configured for a specific MAC address are removed from that port or switch.</li> </ul>
Deleting a port-profile	<ul style="list-style-type: none"> <li>An IN USE error is generated if the port-profile is in an activated state. AMPP forces you to deactivate the profile before deleting.</li> <li>If the port-profile is in an inactive state, then deletion of profile removes all the MAC associations as well.</li> </ul>
Modifying port-profile content when in an associated state	<ul style="list-style-type: none"> <li>An IN USE error is generated if the port-profile is already activated.</li> </ul>
Moving the VM MAC and notifying the fabric	<ul style="list-style-type: none"> <li>All policies associated to the port-profile ID are mapped on the MAC address and applied to the new port in the fabric.</li> </ul>
Unused port-profile	<ul style="list-style-type: none"> <li>You must manually remove the port-profile to MAC associations.</li> </ul>

## Configuring AMPP profiles

The following sections cover configuring, deleting, and monitoring various AMPP-related profiles.

### Configuring a new port-profile

To support VM MAC address learning, the default port-profile is employed. The default profile is different from the other user-defined AMPP profiles:

- The **allow non-profiled-macs** command only functions with the default port-profile. Refer to the *Network OS Command Reference*.
- The **restrict-flooding** command only functions with the default port-profile. Refer to the *Network OS Command Reference*.
- The port-profile ID (ppid) of the profile cannot be changed.
- The VLAN sub-profile cannot be modified.
- The QoS sub-profile and security-profile cannot be added.
- The default port-profile cannot be activated.

Brocade recommends that you create a new port-profile to accommodate your requirements. To configure a new port-profile, perform the following steps in privileged EXEC mode.

1. Configure the physical interface, LAG, or vLAG as a port-profile port.

```
switch(if-te-2/0/1)# port-profile-port
```

2. Create and configure a new port-profile name.

```
switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
switch(config)# port-profile vml-port-profile
switch(config-port-profile-vml-port-profile)# vlan-profile
switch(config-pp-vlan)# switchport
switch(config-pp-vlan)# switchport mode trunk
switch(config-pp-vlan)# switchport trunk native-vlan 300
switch(config-pp-vlan)# switchport trunk allowed vlan add 300
```

3. Exit VLAN profile configuration mode.

```
switch(config-pp-vlan)# exit
```

4. Activate the profile.

```
switch(config)# port-profile vml-port-profile activate
```

5. Associate the profile to the MAC address for each host.

```
switch(config)# port-profile vml-port-profile static 0050.56bf.0001
switch(config)# port-profile vml-port-profile static 0050.56bf.0002
switch(config)# port-profile vml-port-profile static 0050.56bf.0003
switch(config)# port-profile vml-port-profile static 0050.56bf.0004
switch(config)# port-profile vml-port-profile static 0050.56bf.0005
```

## Configuring VLAN profiles

The VLAN profile defines the VLAN membership of the overall port-profile, which includes both the tagged and untagged VLANs.

### NOTE

Private VLAN port mode commands are not available for AMPP VLAN profiles.

To configure the VLAN profile, perform the following steps in global configuration mode.

1. AMPP profiles cannot be modified while active. De-activate the port-profile before modifying the VLAN profile.

```
switch(config)# no port-profile vml-port-profile activate
```

2. Enter VLAN profile configuration mode.

```
switch(config)# port-profile vml-port-profile
switch(config-port-profile-vml-port-profile)# vlan-profile
```

3. Use the **switchport** command to change the mode to Layer 2 and set the switching characteristics to the defaults.

```
switch(config-pp-vlan)# switchport
```

4. Access the VLAN profile mode for the correct VLAN.

```
switch(config-pp-vlan)# switchport access vlan 200
```

5. Enter trunk configuration mode.

```
switch(config-pp-vlan)# switchport mode trunk
```

6. Configure the trunk mode for the allowed VLAN IDs.

```
switch(config-pp-vlan)# switchport trunk allowed vlan add 10, 20, 30-40
```

7. Configure the trunk mode to be a native VLAN.

```
switch(config-pp-vlan)# switchport trunk native-vlan 300
```

8. Exit VLAN profile configuration mode.

```
switch(config-pp-vlan)# exit
```

9. Activate the profile.

```
switch(config)# port-profile vml-port-profile activate
```

10. Associate the profile to the MAC address for each host.

```
switch(config)# port-profile vml-port-profile static 0050.56bf.0001
switch(config)# port-profile vml-port-profile static 0050.56bf.0002
switch(config)# port-profile vml-port-profile static 0050.56bf.0003
switch(config)# port-profile vml-port-profile static 0050.56bf.0004
switch(config)# port-profile vml-port-profile static 0050.56bf.0005
```

## Configuring FCoE profiles

Only the FCoE profile of the default profile can be modified. The FCoE profile can only be part of the default profile. When it is part of the default profile, FCoE is enabled globally and all the profiled ports automatically become FCoE ports.

In the absence of the FCoE profile in the default AMPP profile, you can configure FCoE on a per-interface basis, based on the profiled ports. Refer to [Configuring FCoE Interfaces](#) on page 37 for details.

To globally configure the FCoE profile, perform the following steps in global configuration mode.

1. Enter port-profile configuration mode.

```
switch(config)# port-profile default
```

2. Enter FCoE-profile configuration mode.

```
switch(config-port-profile-default)# fcoe-profile
```

3. Activate the FCoE port profile.

An FCoE map cannot be applied on interfaces that already have a CEE map applied to it.

```
switch(config-fcoe-profile)# fcoeport default
```

## Configuring QoS profiles

QoS profiles define the following values:

- Incoming 802.1p priority is set to internal queue priority. If the port is in QoS untrusted mode, all incoming priorities will be mapped to default best effort priority.
- Incoming priority is set to outgoing priority.
- Mapping of incoming priorities is set to strict or WRR traffic classes.
- Enabling of flow control on a strict or a WRR traffic class.

The QoS profile has two flavors: CEE QoS and Ethernet QoS. The QoS profile may contain either CEE QoS or Ethernet QoS. Server side ports typically are carrying converged traffic.

To configure the QoS profile, perform the following steps in global configuration mode.

1. AMPP profiles cannot be modified while active. Deactivate the port-profile before modifying the VLAN profile.

```
switch(config)# no port-profile vml-port-profile activate
```

2. Enter QoS profile mode.

```
switch(config)# port-profile vml-port-profile
switch(config-port-profile-vml-port-profile)# qos-profile
switch(config-qos-profile)#
```

3. Apply the CEE map.

```
switch(config-qos-profile)# cee default
```

4. Set the default CoS value.

```
switch(config-qos-profile)# qos cos 7
```

5. Set the QoS trust attribute for CoS

```
switch(config-qos-profile)# qos trust cos
```

6. Apply a map to the profile. You can do either of the following:

- Apply the existing CoS-to-CoS mutation map.

```
switch(config-qos-profile)# qos cos-mutation vml-cos2cos-map
```

- Apply the existing CoS-to-Traffic-Class map.

```
switch(config-qos-profile)# qos cos-traffic-class vml-cos2traffic-map
```

7. Enable pause generation. You can do either of the following:

- Without PFC.

```
switch(config-qos-profile)# qos flowcontrol tx on rx on
```

- With PFC for each CoS.

```
switch(config-qos-profile)# qos flowcontrol pfc 1 tx on rx on
switch(config-qos-profile)# qos flowcontrol pfc 2 tx on rx on
```

8. Exit QoS profile mode.

```
switch(config-qos-profile)# exit
```

9. Activate the profile.

```
switch(config)# port-profile vml-port-profile activate
```

10. Associate the profile to the MAC address for each host.

```
switch(config)# port-profile vml-port-profile static 0050.56bf.0001
switch(config)# port-profile vml-port-profile static 0050.56bf.0002
switch(config)# port-profile vml-port-profile static 0050.56bf.0003
switch(config)# port-profile vml-port-profile static 0050.56bf.0004
switch(config)# port-profile vml-port-profile static 0050.56bf.0005
```

## Configuring security profiles

A security profile defines all the security rules needed for the server port. A typical security profile contains attributes for MAC-based and IP-based standard and extended ACLs. Security profiles are applied to the ACLs based on the profile or PolicyID. Therefore, multiple security profiles can be applied to the same profiled port.

To configure the security profile, perform the following steps in global configuration mode.

1. AMPP profiles cannot be modified while active. Deactivate the port-profile before modifying the security profile.

```
switch(config)# no port-profile vml-port-profile activate
```



2. Enter security profile configuration mode.

```
switch(config)# port-profile vml-port-profile
switch(config-pp)# security-profile
switch(config-pp-security)#
```

3. Modify the ACL security attributes. Refer to the *Network OS Security Guide* for details on modifying ACLs.
4. Apply the ACL to the security profile.

```
switch(config-pp-security)# mac access-group vml-acl in
```

5. Exit security profile configuration mode.

```
switch(config-pp-security)# exit
```

6. Activate the profile.

```
switch(config)# port-profile vml-port-profile activate
```

7. Associate the profile to the MAC address for each host.

```
switch(config)# port-profile vml-port-profile static 0050.56bf.0001
switch(config)# port-profile vml-port-profile static 0050.56bf.0002
switch(config)# port-profile vml-port-profile static 0050.56bf.0003
switch(config)# port-profile vml-port-profile static 0050.56bf.0004
switch(config)# port-profile vml-port-profile static 0050.56bf.0005
```

## Creating a port-profile-port

To create a port-profile-port, perform the following steps in global configuration mode.

1. Activate the interface configuration mode for the interface you wish to modify.

The following example activates the mode for the 10-gigabit Ethernet interface in slot 0/port 0.

```
switch(config)# interface tengigabitethernet 1/0/1
```

2. Configure port-profile-port on the physical interface.

```
switch(conf-int-te-1/0/1)# port-profile-port
```

## Deleting a port-profile-port

To delete a port-profile-port, perform the following steps in global configuration mode.

1. Activate the interface configuration mode for the interface you wish to modify.

The following example activates the mode for the 10-gigabit Ethernet interface in slot 0/port 0.

```
switch(config)# interface tengigabitethernet 1/0/1
```

2. Unconfigure port-profile-port on the physical interface.

```
switch(conf-int-te-1/0/1)# no port-profile-port
switch(conf-int-te-1/0/1)# no shutdown
```

## Deleting a port-profile

To delete a port-profile, perform the following steps in privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
```

2. Deactivate the port-profile.

```
switch(config)# no port-profile vml-port-profile activate
```

3. Use the **no** form of the **port-profile** command to delete the custom profile.

You cannot delete the default port-profile.

```
switch(config)# no port-profile vml-port-profile
```

## Deleting a sub-profile

To delete a sub-profile, perform the following steps in privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
```

2. Deactivate the port-profile.

```
switch(config)# no port-profile vml-port-profile activate
```

3. Enter port-profile mode.

```
switch(conf-vml-port-profile)# port-profile vml-port-profile
```

4. Use the following to delete sub-profiles.

- To delete a VLAN sub-profile:

```
switch(conf-vml-port-profile)# no vlan-profile
```

- To delete a security sub-profile:

```
switch(conf-vml-port-profile)# no security-profile
```

- To delete a FCoE sub-profile under default profile:

```
switch(conf-pp-default)# no fcoe-profile
```

- To delete a QoS sub-profile:

```
switch(conf-vml-port-profile)# no qos-profile
```

## Monitoring AMPP profiles

To monitor the AMPP profiles, perform the following steps in privileged EXEC mode.

1. Use the **show** command to display the current MAC details.

```
switch# show mac-address-table port-profile
Legend: Untagged(U), Tagged (T), Not Forwardable(NF) and Conflict(C)
VlanId  Mac-address      Type      State      Port-Profile  Ports
1       0050.5679.5351   Dynamic   Active     Profiled(U)   Te 111/0/10
1       0050.567b.7030   Dynamic   Active     Profiled(U)   Te 111/0/12
1       005a.8402.0000   Dynamic   Active     Profiled(T)   Te 111/0/24
1       005a.8402.0001   Dynamic   Active     Profiled(NF)  Te 111/0/24
1       005a.8402.0002   Dynamic   Active     Not Profiled  Te 111/0/24
1       005a.8402.0003   Dynamic   Active     Not Profiled  Te 111/0/24
1       005a.8402.0004   Dynamic   Active     Not Profiled  Te 111/0/24
1       005a.8402.0005   Dynamic   Active     Profiled(NF)  Te 111/0/24
1       005a.8402.0006   Dynamic   Active     Not Profiled  Te 111/0/24
1       005a.8402.0007   Dynamic   Active     Profiled(T)   Te 111/0/24
1       005b.8402.0001   Dynamic   Active     Profiled(T)   Te 111/0/24
1       005c.8402.0001   Dynamic   Active     Profiled(T)   Te 111/0/24
100     005a.8402.0000   Dynamic   Active     Profiled      Te 111/0/24
100     005a.8402.0001   Dynamic   Active     Profiled(NF)  Te 111/0/24
100     005a.8402.0003   Dynamic   Active     Not Profiled  Te 111/0/24
100     005a.8402.0005   Dynamic   Active     Profiled(NF)  Te 111/0/24
100     005a.8402.0007   Dynamic   Active     Profiled      Te 111/0/24
Total MAC addresses : 17
```

2. Use the **show running-config** command to display all the available port-profile configurations.

```
switch# show running-config port-profile
port-profile default
vlan-profile
switchport
switchport mode trunk
switchport trunk allowed vlan all
switchport trunk native-vlan 1
!
fcoe-profile
fcoeport default
!
!
port-profile pp1
vlan-profile
switchport
switchport mode access
switchport access vlan 1
!
qos-profile
!
!
port-profile pp1 activate
port-profile pp1 static 1000.0000.0001
```

- Use the **show port-profile** command to display the current port-profile configuration.

```
switch# show port-profile
port-profile default
ppid 0
vlan-profile
switchport
switchport mode trunk
switchport trunk allowed vlan all
port-profile vm_kernel
ppid 1
vlan-profile
switchport
switchport mode access
switchport access vlan 1
```

- Use the **show port-profile status** command to display the current status of all AMPP profiles.

```
switch# show port-profile status applied
Port-Profile      PPID  Activated  Associated MAC  Interface
auto-for_iscsi    6     Yes        0050.5675.d6e0  Te 9/0/54
auto-VM_Network   9     Yes        0050.56b3.0001  Te 9/0/53
                  0050.56b3.0002  Te 9/0/53
                  0050.56b3.0004  Te 9/0/53
                  0050.56b3.0014  Te 9/0/53

switch# show port-profile status activated
Port-Profile      PPID  Activated  Associated MAC  Interface
auto-dvPortGroup  1     Yes        None            None
auto-dvPortGroup2 2     Yes        None            None
auto-dvPortGroup3 3     Yes        None            None
auto-dvPortGroup_4_0 4     Yes        0050.567e.98b0  None
auto-dvPortGroup_vlag 5     Yes        0050.5678.eaed  None
auto-for_iscsi     6     Yes        0050.5673.85f9  None

switch# show port-profile status associated
Port-Profile      PPID  Activated  Associated MAC  Interface
auto-dvPortGroup_4_0 4     Yes        0050.567e.98b0  None
auto-dvPortGroup_vlag 5     Yes        0050.5678.eaed  None
auto-for_iscsi     6     Yes        0050.5673.85f9  None
```

- Use **show port-profile interface all** to display profile and applied interface information.

```
switch# show port-profile interface all
Port-profile      Interface
auto-VM_Network   Te 9/0/53
auto-for_iscsi     Te 9/0/54
```

# Configuring FCoE Interfaces

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- FCoE interface configuration..... 50
- Troubleshooting FCoE interfaces..... 53

## FCoE overview

Fibre Channel over Ethernet (FCoE) enables you to transport FC protocols and frames over Data Center Bridging (DCB) networks. DCB is an enhanced Ethernet network that enables the convergence of various applications in data centers (LAN, SAN, and HPC) onto a single interconnect technology.

FCoE provides a method of encapsulating the Fibre Channel (FC) traffic over a physical Ethernet link. FCoE frames use a unique EtherType [FCoE uses 0x8906 and FCoE Initialization Protocol (FIP) uses 0x8914] that enables FCoE SAN traffic and legacy LAN Ethernet traffic to be carried on the same link. FC frames are encapsulated in an Ethernet frame and sent from one FCoE-aware device across an Ethernet network to a second FCoE-aware device. The FCoE-aware devices may be FCoE end nodes (ENodes) such as servers, storage arrays, or tape drives on one end and FCoE Forwarders on the other end. FCoE Forwarders (FCFs) are switches providing SAN fabric services and may also provide FCoE-to-FC bridging.

The motivation behind using DCB networks as a transport mechanism for FC arises from the desire to simplify host protocol stacks and consolidate network interfaces in data center environments. FC standards allow for building highly reliable, high-performance fabrics for shared storage, and these characteristics are what DCB brings to data centers. Therefore, it is logical to consider transporting FC protocols over a reliable DCB network in such a way that it is completely transparent to the applications. The underlying DCB fabric is highly reliable and high performing, the same as the FC SAN.

In FCoE, ENodes discover FCFs and initialize the FCoE connection through the FCoE Initialization Protocol (FIP). FIP has a separate EtherType from FCoE. FIP includes a discovery phase in which ENodes discover VLANs supporting FCoE, solicit FCFs on those VLANs, and FCFs respond to the solicitations with advertisements of their own. At this point, the ENodes know enough about the FCFs to log in to them. The virtual link establishment and fabric login (FLOGI/FDISC) for VN-to-VF port connections is also part of FIP.

Network OS supports the following:

- 100-Gbps blades
- 40-Gbps breakout Inter-Switch Links (ISLs)
- Changes to the way in which the number of FCoE interfaces are created, through the **foe-enodes** command
- FCoE troubleshooting commands

## FCoE terminology

The following table lists and describes the FCoE terminology used in this document.

**TABLE 3** FCoE terminology

Term	Description
FCoE	Fibre Channel over Ethernet
DCB	Data Center Bridging
VN_Port	FCoE equivalent of an FC N_Port
VF_Port	FCoE equivalent of an FC F_Port

**TABLE 3** FCoE terminology (continued)

Term	Description
ENode	An FCoE device that supports FCoE VN_Ports (servers and target devices)

## End-to-end FCoE

The Brocade VCS Fabric is a convergence-ready fabric. This means it is capable of providing lossless service and other features expected of a CEE-capable network. This includes support for multi-hop FCoE, where an FCoE initiator can communicate with an FCoE target that is a number of hops away.

### FCoE operations

Each switch in the Brocade VCS Fabric cluster acts as a fully functional FCoE Forwarder (FCF). All Fibre Channel (FC) services required to support a Virtual Network (VN) must run on every Brocade VCS Fabric cluster switch, and each switch in the fabric acts as if it were a separate domain in an FC SAN.

For all practical purposes, a Brocade VCS Fabric operates similarly to an FC fabric because all the FCoE initiators and targets are connected to the Brocade VCS Fabric. Each switch in the cluster gets a domain ID, and once the fabric forms, all the FC services (such as Name Server, Login Controller, Domain Controller) are available on each individual cluster switch.

Network OS 4.0.0 and later supports FCR/LSAN zoning. A combination of 2000 FCoE devices and 1000 FC routed devices (for a total maximum of 3000 devices) is the fabric limit. Because open zoning floods all the State Change Notifications (SCNs) to every device, it should be used only when the fabric has 300 total devices or fewer. Fabrics with higher device counts should have user-defined zoning configurations, with a maximum of 255 devices per zone.

FCoE traffic forwarding across the fabric follows the same equal-cost multi-path (ECMP) routing rules as does LAN traffic forwarding.

### FCoE end-to-end forwarding

FCoE frame forwarding between two FCoE devices attached to the Brocade VCS Fabric works similarly to Layer 3 IP routing. The end-node talks to the default gateway's MAC address and the Layer 2 headers are modified hop-by-hop until the frame reaches its final destination. Forwarding decisions are based on the contents of the IP header in the case of IP routing, and the IP header is untouched along the path. FCoE forwarding works the same way.

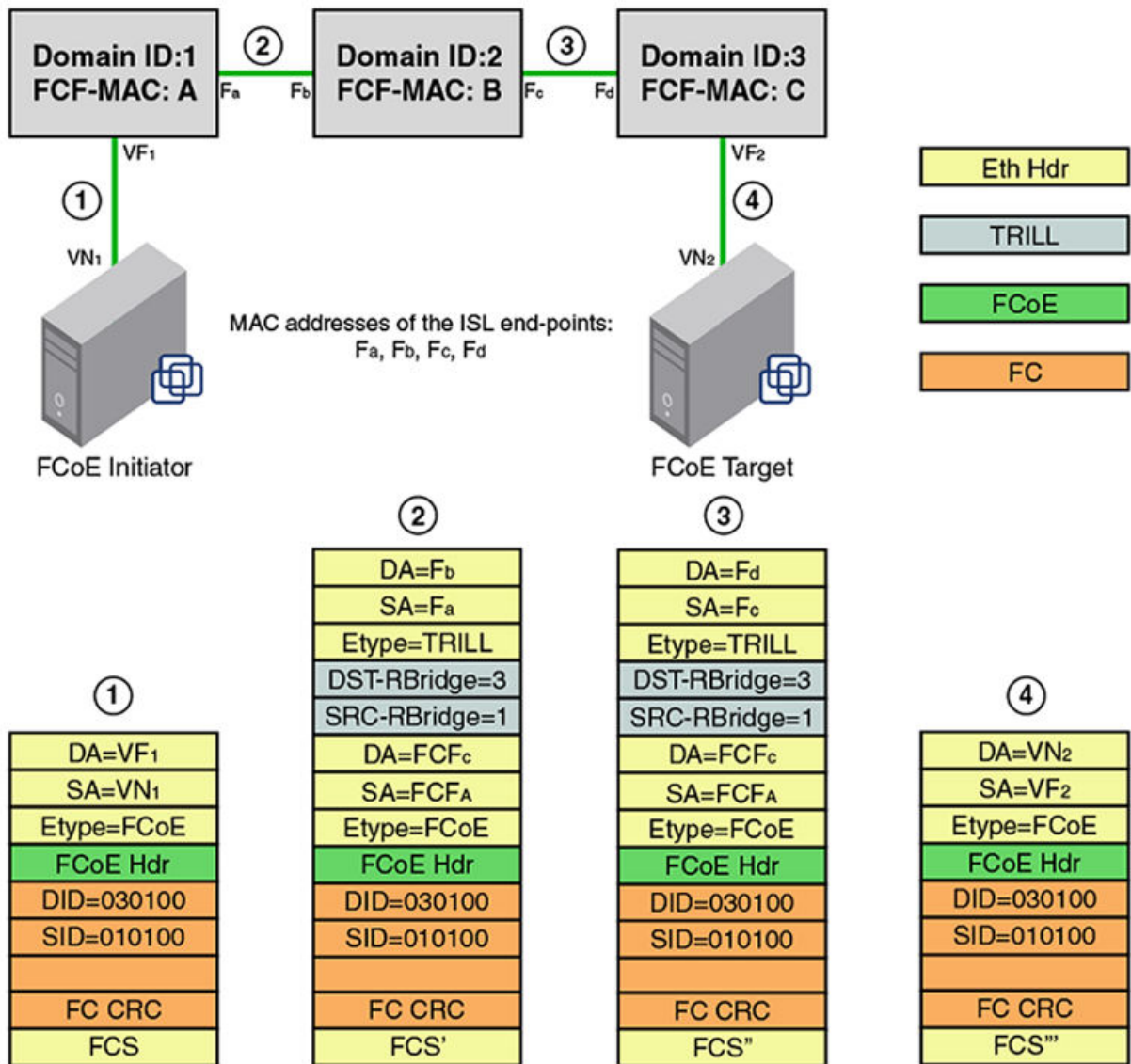
The following figure illustrates this process. Assume that VN1 (an FCoE initiator) is trying to access VN2 (an FCoE target).

1. VN1 and VN2 discover VF1 and VF2 through FIP Discovery Protocol and perform a Fabric Login (FLOGI) to their respective VF ports. That is, VN1 performs an FIP FLOGI to VF1 and VN2 performs a FIP FLOGI to VF2. This works like IP in that all communication between the end-station and the network happens to the router's MAC address at Layer 2. This means VN1 is always communicating with VF1 at Layer 2.
2. In a Brocade VCS Fabric implementation, all FC services are available on every cluster unit. This means there is Fibre Channel Network Switch (FCNS) available on both FCF1 and FCF2. The FCNS service functions identically as it does in an FC SAN. As a result, VN1 discovers VN2.

3. VN1 attempts an N\_Port Login (PLOGI) to VN2, with the frame information shown at point 1 in the following figure. The Layer 2 header contains VF1 as the destination MAC address. The Layer 3 header (in this case, the FC header) contains the actual DID and SID of the initiator and the target respectively.

In this example, because VN1 is connected to the FCF with a Domain ID of 1, its PID is 010100. Similarly, because VN2 is connected to FCF3, its FC address is 030100.

FIGURE 5 FCoE end-to-end header process



4. When FCF-A receives the frame on VF1, it performs a Layer 3 lookup. It looks up the DID in the FC header and determines that the frame is destined to a non-local domain. FCF-A decodes the next hop needed to reach the destination domain of 3, based on Fabric Shortest Path First (FSPF). It is at this point that it does something different than a normal IP router.

5. FCF-A now knows that it needs to reach FCF-C. Each FCF in the Brocade VCS Fabric is assigned an FCF MAC address. FCF-A constructs the Layer 2 header based on this information. So, the original MAC header is now transformed as follows: the DA is changed from VF1 to FCF-C and the SA is changed from VN1 to FCF-A. This occurs at point 2 in the previous figure.
6. The frame gets a Transparent Interconnection of Lots of Links (TRILL) header and traverses across the fabric to reach FCF-C. The TRILL header indicates that the source is RBridge 1 and the destination is RBridge 3. This occurs at point 2 in the previous figure.
7. The outer MAC header is a link level header that gets the frame from FCF-A to FCF-B. FCF-B receives the frame. FCF-B scans the TRILL header, decodes the destination RBridge ID in the frame, and forwards the frame. FCF-B only modifies the Layer 2 header. It neither looks up nor modifies anything in the FC header or the inner MAC header. This occurs at point 3 in the previous figure.
8. FCF-C receives the frame. FCF-C scans the TRILL header and decodes the destination RBridge ID. FCF-C promotes the frame to Layer 3 lookup, because the FCF-C is the DA in the inner MAC header. FCF-C then scans the FC header and does something similar to an area route lookup in FC SAN. This lookup yields the MAC address of VN2 and the VF interface (in this case, VF2) information that it needs to use to forward the frame to VN2. This occurs at point 4 in the previous figure.
9. VN2 receives the PLOGI. The PLOGI response from VN2 traverses back to VN1 in similar fashion.

**NOTE**

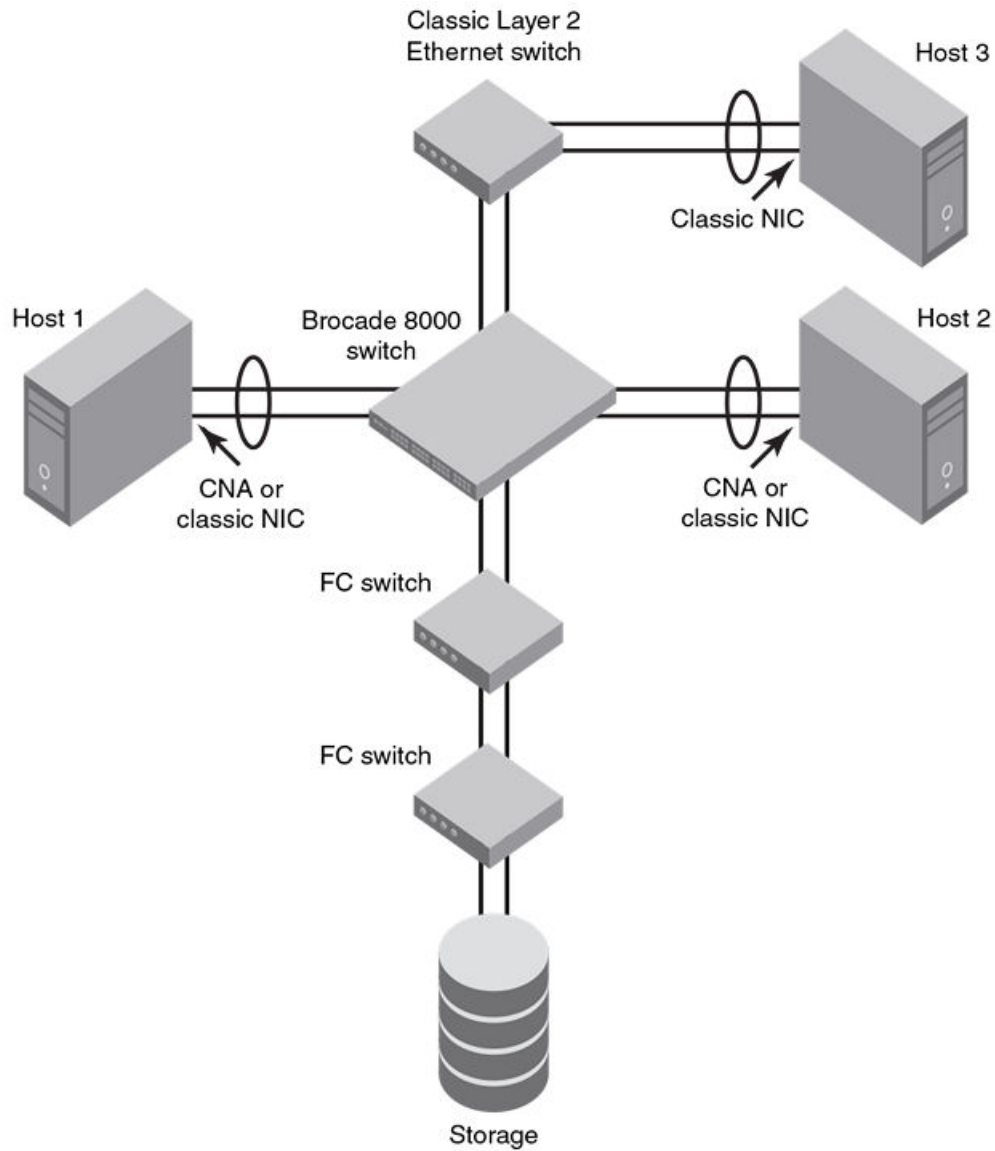
It is assumed that both VN1 and VN2 are configured to be in the same FCoE VLAN, and FCoE forwarding is enabled on this VLAN in the Brocade VCS Fabric. Network OS v4.0.0 and later supports only one FCoE VLAN for all FCoE devices connected to the fabric.

## FCoE and Layer 2 Ethernet

The Brocade VDX hardware contains DCB ports that support FCoE forwarding. The DCB ports are also backwards-compatible and support classic Layer 2 Ethernet networks (as shown in the following figure). In Layer 2 Ethernet operation, a host with a Converged Network Adapter (CNA) can be directly attached to a DCB port on the Brocade VDX hardware. Another host with a classic 10-gigabit Ethernet network interface card (NIC) can be either directly attached to a DCB port, or attached to a classic Layer 2 Ethernet network that is attached to the Brocade VDX hardware.



FIGURE 6 Multiple switch fabric configuration



### Layer 2 forwarding

Layer 2 Ethernet frames are forwarded on the DCB ports. 802.1Q VLAN support is used to tag incoming frames to specific VLANs, and 802.3ac VLAN tagging support is used to accept VLAN tagged frames from external devices.

Network OS uses the following 802.1D bridging protocols between Layer 2 switches and to maintain a loop-free network environment:

- Spanning Tree Protocol (STP)
- Rapid Spanning Tree Protocol (RSTP)
- Multiple Spanning Tree Protocol (MSTP)
- Per-VLAN Spanning Tree (PVST+)
- Rapid Per-VLAN Spanning Tree (RPVST+)

For detailed information on configuring these protocols, refer to [Configuring STP-Type Protocols](#) on page 121.

The Brocade VDX hardware handles Ethernet frames as follows:

- When the destination MAC address is not in the lookup table, the frame is flooded on all ports in the same VLAN, except the ingress port.
- When the destination MAC address is present in the lookup table, the frame is switched only to the correct egress port.
- When the destination MAC address is present in the lookup table, and the egress port is the same as the ingress port, the frame is dropped.
- If the Ethernet Frame Check Sequence (FCS) is incorrect, because the switch is in cut-through mode, a correctly formatted Ethernet frame is sent out with an incorrect FCS.
- If the Ethernet frame is too short, the frame is discarded and the error counter is incremented.
- If the Ethernet frame is too long, the frame is truncated and the error counter is incremented. The truncated frame is sent out with an incorrect FCS.
- Frames sent to a broadcast destination MAC address are flooded on all ports in the same VLAN, except the ingress port.
- When MAC address entries in the lookup table time out, they are removed. In this event, frame forwarding changes from unicast to flood.
- An existing MAC address entry in the lookup table is discarded when a device is moved to a new location. When a device is moved, the ingress frame from the new port causes the old lookup table entry to be discarded and the new entry to be inserted into the lookup table. Frame forwarding remains unicast to the new port.
- When the lookup table is full, new entries replace the oldest MAC addresses after the oldest MAC addresses reach a certain age and time out. MAC addresses that still have traffic running are not timed out.
- If the port is receiving jumbo frame packets and the port is not configured with the required MTU size to support jumbo frames, then the port discards those frames and increments the over-sized packet error counter.
- If the port is receiving valid multicast frames and the port is **not** part of a VLAN that is enabled for IGMP snooping, then the frames are treated as broadcast frames.
- If the port is receiving multicast frames with a destination MAC address (multicast MAC address) and destination IP address (multicast IP address) belonging to different group addresses or not pointing to the same group, the frames are silently discarded by the port.

#### NOTE

New entries start replacing older entries when the lookup table reaches 90 percent of its 32Kb capacity.

## 802.1Q VLAN tagging

The Layer 2 switch always tags an incoming frame with an 802.1Q VLAN ID. If the incoming frame is untagged, then a tag is added according to the port configuration. A port can classify untagged traffic to a single VLAN or to multiple VLANs. If the incoming frame is already tagged, then the port will either forward or discard the frame according to allowed VLAN rules in the port configuration.

These are three examples of 802.1Q VLAN tagging:

- If the DCB port is configured to tag incoming frames with a single VLAN ID, then incoming frames that are untagged are tagged with the VLAN ID.
- If the DCB port is configured to tag incoming frames with multiple VLAN IDs, then incoming frames that are untagged are tagged with the correct VLAN ID based on the port setting.
- If the DCB port is configured to accept externally tagged frames, then incoming frames that are tagged with a VLAN ID are passed through unchanged.

**NOTE**

Only a single switch-wide VLAN is capable of forwarding FCoE traffic.

For detailed information on configuring VLANs, refer to [Configuring 802.1Q VLANs](#) on page 57.

### *Support for Virtual Fabrics*

Network OS provides a Virtual Fabrics feature that supports multitenancy by extending the standard (802.1Q) VLAN ID space from 4096 through 8191, enabling the use of classified VLANs. Following an upgrade to Network OS 4.1, the system operates in native VLAN mode until the Virtual Fabrics feature is enabled. In this release, FCoE VLANs are limited to the 802.1Q range of 1 through 4096. FCoE frames are now able to accommodate 802.1AD S-TAGs (service provider tags) and C-TAGs (customer tags) for future support. A C-TAG used to classify an FCoE frame is the same as the VLAN ID and is system wide.

**NOTE**

Currently, FCoE VLANs can be only 802.1Q VLANs. They cannot be classified or used as C-TAGs for other VLAN classification. All tenant FCoE traffic rides on the same default FCoE VLAN (1002) as in the previous Network OS releases.

For details of the Virtual Fabrics feature, refer to [Configuring Virtual Fabrics](#) on page 81.

### *Incoming frame classification*

The Brocade VDX hardware is capable of classifying incoming Ethernet frames based on the following criteria:

- Port number
- Protocol
- MAC address

The classified frames can be tagged with a VLAN ID or with 802.1p Ethernet priority. The 802.1p Ethernet priority tagging is done using the Layer 2 Class of Service (CoS). The 802.1p Ethernet priority is used to tag frames in a VLAN with a Layer 2 CoS to prioritize traffic in the VLAN. The Brocade VDX hardware also accepts frames that have been tagged by an external device.

Frame classification options are as follows:

- VLAN ID and Layer 2 CoS by physical port number — With this option, the port is set to classify incoming frames to a preset VLAN ID and the Layer 2 CoS on a physical port on the Brocade VDX hardware.
- VLAN ID and Layer 2 CoS by LAG virtual port number — With this option, the port is set to classify incoming frames to a preset VLAN ID and Layer 2 CoS on a Link Aggregation Group (LAG) virtual port.
- Layer 2 CoS mutation — With this option, the port is set to change the Layer 2 CoS setting by enabling the QoS mutation feature.
- Layer 2 CoS trust — With this option, the port is set to accept the Layer 2 CoS of incoming frames by enabling the QoS trust feature.

For detailed information on configuring QoS, refer to [Configuring QoS](#) on page 181.

### *Congestion control and queuing*

The Brocade VDX hardware supports several congestion control and queuing strategies. As an output queue approaches congestion, Random Early Detection (RED) is used to selectively and proactively drop frames to maintain maximum link utilization. Incoming frames are classified into priority queues based on the Layer 2 CoS setting of the incoming frame, or the possible rewriting of the Layer 2 CoS field based on the settings of the DCB port or VLAN.

The Brocade VDX hardware supports a combination of two scheduling strategies to queue frames to the egress ports: Priority queuing, which is also referred to as strict priority, and Deficit Weighted Round Robin (DWRR) queuing.

The scheduling algorithms work on the eight traffic classes as specified in 802.1Qaz Enhanced Transmission Selection (ETS).

Queuing features are described as follows:

- RED — RED increases link utilization. When multiple inbound TCP traffic streams are switched to the same outbound port, and some traffic streams send small frames while other traffic streams send large frames, link utilization will not be able to reach 100 percent. When RED is enabled, link utilization approaches 100 percent.
- Classification — Setting user priority.
  - Inbound frames — Inbound frames are tagged with the user priority set for the inbound port. The tag is visible when examining the frames on the outbound port. By default, all frames are tagged to priority zero.
  - Externally tagged Layer 2 frames — When the port is set to accept externally tagged Layer 2 frames, the user priority is set to the Layer 2 CoS of the inbound frames.
- Queuing
  - Input queuing — Input queuing optimizes the traffic flow in the following way. A DCB port has inbound traffic that is tagged with several priority values, and traffic from different priority settings is switched to different outbound ports. Some outbound ports are already congested with background traffic while others are uncongested. With input queuing, the traffic rate of the traffic streams switched to uncongested ports should remain high.
  - Output queuing — Output queuing optimizes the traffic flow in the following way. Several ports carry inbound traffic with different priority settings. Traffic from all ports is switched to the same outbound port. If the inbound ports have different traffic rates, some outbound priority groups will be congested while others can remain uncongested. With output queuing, the traffic rate of the traffic streams that are uncongested should remain high.
  - Multicast rate limit — A typical multicast rate limiting example is where several ports carry multicast inbound traffic that is tagged with several priority values. Traffic with different priority settings is switched to different outbound ports. The multicast rate limit is set so that the total multicast traffic rate on output ports is less than the specified set rate limit. Multicast rate-limiting commands are not supported on the Brocade VDX 6740 or VDX 8770. On the latter platforms, use BUM storm control instead.
  - Multicast input queuing — A typical multicast input queuing example is where several ports carry multicast inbound traffic that is tagged with several priority values. Traffic with different priority settings is switched to different outbound ports. Some outbound ports are already congested with background traffic while others are uncongested. The traffic rate of the traffic streams switched to the uncongested ports should remain high. All outbound ports should carry some multicast frames from all inbound ports. This enables multicast traffic distribution relative to the set threshold values.
  - Multicast output queuing — A typical multicast output queuing example is where several ports carry multicast inbound traffic. Each port has a different priority setting. Traffic from all ports is switched to the same outbound port. If the inbound ports have varying traffic rates, some outbound priority groups will be congested while others remain uncongested. The traffic rate of the traffic streams that are uncongested remains high. The outbound ports should carry some multicast frames from all the inbound ports.
- Scheduling — A typical example of scheduling policy (using Strict Priority 0 and Strict Priority 1 modes) is where ports 0 through 7 carry inbound traffic, each port has a unique priority level, port 0 has priority 0, port 1 has priority 1, and so on. All traffic is switched to the same outbound port. In Strict Priority 0 mode, all ports have DWRR scheduling; therefore, the frames per second (FPS) on all ports should correspond to the DWRR settings. In Strict Priority 1 mode, priority 7 traffic uses Strict Priority; therefore, priority 7 can achieve a higher FPS. Frames from input ports with the same priority level should be scheduled in a round robin manner to the output port.

When setting the scheduling policy, each priority group that is using DWRR scheduling can be set to use a percentage of the total bandwidth by setting the PG\_Percentage parameter.

For detailed information on configuring QoS, refer to [Configuring QoS](#) on page 181.

## Access control

Access Control Lists (ACLs) are used for Layer 2 switching security. Standard ACLs inspect the source address for the inbound ports. Extended ACLs provide filtering by source and destination addresses and protocol. ACLs can be applied to the DCB ports or to VLANs.

ACLs function as follows:

- A standard Ethernet ACL configured on a physical port is used to permit or deny frames based on the source MAC address. The default is to permit all frames.
- An extended Ethernet ACL configured on a physical port is used to permit or deny frames based on the source MAC address, destination MAC address, and EtherType. The default is to permit all frames.
- A standard Ethernet ACL configured on a LAG virtual port is used to permit or deny frames based on the source MAC address. The default is to permit all frames. LAG ACLs apply to all ports in the LAG.
- An extended Ethernet ACL configured on a LAG virtual port is used to permit or deny frames based on the source MAC address, destination MAC address, and EtherType. The default is to permit all frames. LAG ACLs apply to all ports in the LAG.
- A standard Ethernet ACL configured on a VLAN is used to permit or deny frames based on the source MAC address. The default is to permit all frames. VLAN ACLs apply to the Switched Virtual Interface (SVI) for the VLAN.
- An extended Ethernet ACL configured on a VLAN is used to permit or deny frames based on the source MAC address, destination MAC address, and EtherType. The default is to permit all frames. VLAN ACLs apply to the Switched Virtual Interface (SVI) for the VLAN.

For detailed information on configuring ACLs, refer to the "Configuring and Managing ACLs" section of the *Network OS Security Configuration Guide*.

## Trunking

### NOTE

The term "trunking" in an Ethernet network refers to the use of multiple network links (ports) in parallel to increase the link speed beyond the limits of any one single link or port, and to increase the redundancy for higher availability.

802.1ab Link Layer Discovery Protocol (LLDP) is used to detect links to connected switches or hosts. Trunks can then be configured between an adjacent switch or host and the Brocade VDX hardware.

The Data Center Bridging Capability Exchange Protocol (DCBX) extension is used to identify a DCB-capable port on an adjacent switch or host. For detailed information on configuring LLDP and DCBX, refer to [Configuring LLDP](#) on page 167.

The 802.3ad Link Aggregation Control Protocol (LACP) is used to combine multiple links to create a trunk with the combined bandwidth of all the individual links. For detailed information on configuring LACP, refer to [Configuring Link Aggregation](#) on page 153.

### NOTE

Brocade software supports a maximum of 24 LAG interfaces.

## Flow control

802.3x Ethernet pause and Ethernet Priority-based Flow Control (PFC) are used to prevent dropped frames by slowing traffic at the source end of a link. When a port on a switch or host is not ready to receive more traffic from the source, perhaps due to congestion, it sends pause frames to the source to pause the traffic flow. When the congestion has been cleared, it stops requesting the source to pause traffic flow, and traffic resumes without any frame drop.

### NOTE

Ethernet pause differs from PFC in that the former is applied to all traffic streams irrespective of their COS values, whereas the latter is always applied to a specific COS or priority value.

When Ethernet pause is enabled, pause frames are sent to the traffic source. Similarly, when PFC is enabled, there is no frame drop; pause frames are sent to the source switch.

For detailed information on configuring Ethernet pause and PFC, refer to [Configuring QoS](#) on page 196.

## Support for 40-Gbps ISLs on breakout ports

40 Gigabit per second ISLs are supported, including on breakout ports.

## FCoE Initialization Protocol

The FCoE Initialization Protocol (FIP) discovers and establishes virtual links between FCoE-capable entities connected to an Ethernet cloud through a dedicated EtherType (0x8914) in the Ethernet frame.

### FIP discovery

#### NOTE

ANSI INCITS 462-2010 Fibre Channel - Backbone - 5 (FC-BB-5) / 13-May-2010 is supported.

The Brocade VDX hardware FIP discovery phase operates as follows:

- The Brocade VDX hardware uses the FCoE Initialization Protocol (FIP). ENodes discover VLANs supporting FCoE, FCFs, and then initialize the FCoE connection through the FIP.
- VF\_Port configuration — An FCoE port accepts ENode requests when it is configured as a VF\_Port and enabled. An FCoE port does not accept ENode requests when disabled.
- Solicited advertisements — A typical scenario is where a Brocade VDX hardware receives a FIP solicitation from an ENode. Replies to the original FIP solicitation are sent to the MAC address embedded in the original FIP solicitation. After being accepted, the ENode is added to the VN\_Port table.
- VLAN 1 — The Brocade VDX hardware should not forward FIP frames on VLAN 1 because it is reserved for management traffic only.
- A fabric-provided MAC address is supported.

#### NOTE

In the fabric-provided MAC address format, VN\_Port MAC addresses are based on a 48-bit fabric-supplied value. The first three bytes of this value are referred to as the FCMAP. The next three bytes are the FC ID, which is assigned by the switch when the ENode logs in to the switch.

### FIP login

FIP login operates as follows:

- ENodes can log in to the Brocade VDX hardware using FIP, Fabric login (FLOGI) or fabric discovery (FDISC).
- Brocade VDX hardware in the fabric maintains the MAC address, World Wide Name (WWN), and PID mappings per login. Each ENode port should have a unique MAC address and WWN.
- FIP FLOGI — The Brocade VDX hardware accepts the FIP FLOGI from the ENode. The FIP FLOGI acceptance (ACC) is sent to the ENode if the ENode MAC address or WWN matches the VN\_Port table on the Brocade VDX hardware. The FIP FLOGI request is rejected if the ENode MAC address or WWN does not match. The ENode login is added to the VN\_Port table. Fabric Provided MAC Addressing (FPMA) is supported.

- FIP FDISC — The Brocade VDX hardware accepts FIP FDISC from the ENode. FIP FDISC acceptance (ACC) is sent to the ENode if the ENode MAC address or WWN matches the VN\_Port table on the Brocade VDX hardware. The FIP FDISC request is rejected if the ENode MAC address or WWN does not match. The ENode login is added to the VN\_Port table. FPMA is supported.
- Maximum logins per VF\_Port (logical FCoE port) — The Brocade VDX hardware supports a maximum of 64 logins. The VF\_Port rejects further logins after the maximum is reached.
- Maximum logins per switch — The Brocade VDX hardware accepts a maximum of 1000 logins per switch.
- Maximum logins per VCS cluster — 3000.

## FIP logout

FIP logout operates as follows:

- ENodes and VN\_Ports can log out from the Brocade VDX hardware using FIP. The Brocade VDX hardware in the fabric updates the MAC address, WWN, and PID mappings upon logout. The Brocade VDX hardware also handles scenarios of implicit logout where the ENode has left the fabric without explicitly logging out.
- FIP logout (LOGO) — The Brocade VDX hardware accepts a FIP LOGO from the ENode. The FIP LOGO acceptance (ACC) should be sent to the ENode if the ENode MAC address and the VN\_Port MAC address matches the VN\_Port table data on the switch. The LOGO is ignored (not rejected) if the ENode MAC address does not match. The ENode logout is updated in the VN\_Port table.
- Implicit logout — With the ENode directly connected to a DCB port, if the port that the ENode is attached to goes offline, the Brocade VDX hardware implicitly logs out that ENode. ENode logout is updated in the VN\_Port table. The Brocade VDX hardware sends an FIP Clear Virtual Links (CVL) to the ENode.

The FIP Virtual Link Maintenance protocols provide a mechanism to detect reachability loss to an ENode or any VN\_Port instantiated on that ENode. This is accomplished by the periodic transmission of FIP Keep-Alive (FKA) messages from the ENode.

If FKA timeouts are enabled on the switch, all VN\_Ports associated with an ENode will be implicitly logged out in the event of an ENode FKA timeout.

If FKA timeouts are enabled on the switch, the VN\_Port will be implicitly logged out in the event of a VN\_Port FKA timeout.

## Name server operation

The Brocade VDX hardware name server function operates as follows:

- ENode login and logout to and from the Brocade VDX hardware updates the name server in the FC fabric. The Brocade VDX hardware maintains the MAC address to WWN and PID mappings.
- ENode login and logout — When an ENode login occurs through any means (FIP FLOGI, FIP FDISC, FCoE FLOGI, or FCoE FDISC), an entry is added to the name server. When an ENode logout occurs through any means (FIP LOGO, FCoE LOGO, or implicit logout), the entry is removed from the name server.
- ENode data — The Brocade VDX hardware maintains a VN\_Port table. The table tracks the ENode MAC address, FIP login parameters for each login from the same ENode, and WWN and PID mappings on the FC side. You can display the VN\_Port table with the **show fcoe login** command.

## Registered State Change Notification

The Brocade VDX hardware Registered State Change Notification (RSCN) function operates as follows:

- RSCN events generated in the FC fabric are forwarded to the ENodes. RSCN events generated on the FCoE side are forwarded to the FC devices. DCB is not aware of RSCN events.
- Device RSCN — An RSCN is generated to all registered and affected members when an ENode either logs in or logs out of an FCF through any means. An RSCN is generated when an FC N\_Port device either logs in or logs out of the FC fabric.

### NOTE

When transmitting an RSCN, zoning rules still apply for FCoE devices as the devices are treated as regular FC N\_Ports.

- VF\_Port RSCN — An RSCN is generated to all registered members when a VF\_Port goes online or offline, causing ENode or FC devices to be added or removed.
- Domain RSCN — An RSCN is generated to all registered and affected members when an FC switch port goes online or offline, causing ENode or FC devices to be added or removed. An RSCN is generated when two FC switches merge or segment, causing ENode or FC devices to be added or removed. When FC switches merge or segment, an RSCN is propagated to ENodes.
- Zoning RSCN — An RSCN is generated to all registered and affected members when a zoning exchange occurs in the FC fabric.

## Local ENode configuration

Prior to the current release, the configuration of the number of FCoE interfaces to be created per switch was done through a **max-enodes** attribute in the FCoE default fabric map. This was a global configuration, and the same number of Virtual Fabric ports was configured on all the switches in the VCS cluster in logical chassis cluster mode.

Beginning with the current release, the number of interfaces to be created is configured per switch by means of the **fcoe-enodes** command, executed in RBridge ID configuration mode. This is known as the local ENode configuration model. The number of ENodes that can be configured ranges from 0 through 1000, with a default of 64.

An FCoE license is required to enable FCoE interfaces. If this license is not present, no FCoE interfaces are created. To upgrade from the previous release, the user executes the **enode-config** command with the keyword of **local** (the default). The user can choose the **global** keyword to maintain the previous configuration model. In this case, the user cannot modify **fcoe-enodes** in an RBridge context or **max-enodes** in a global context. The global keyword is provided only to support a downgrade from the current release to the previous release.

## FCoE queuing

The QoS configuration controls the FCoE traffic distribution.

### NOTE

Changing these settings requires changes on both the Brocade VDX hardware and the Converged Network Adapter (CNA); therefore, the link must be taken offline and put back online after a change is made.

Traffic scheduler configuration changes affect FCoE traffic distribution as follows:

- Changing the priority group for a port causes the FCoE traffic distribution to be updated. The priority group and bandwidth are updated.
- Changing the priority table for a port causes the FCoE traffic distribution to be updated. The CoS-to-priority group mapping is updated.
- Changing the class map for a port causes the FCoE traffic distribution to be updated.
- Changing the policy map for a port causes FCoE traffic distribution to be updated.



- Changing the DCB map for a port causes the FCoE traffic distribution to be updated.
- The FCMAP-to-VLAN mapping determines the FCoE VLAN allowed for the FCoE session. Modifying this mapping causes the existing sessions to terminate.

#### NOTE

Only one FCoE VLAN is supported in Network OS 4.0.0 and later releases.

## FCoE upgrade and downgrade considerations

If an FCoE license is not present, FCoE interfaces are not created and the value of **fcoe-enodes** is 0. When the license is installed, interfaces are created and the value of **fcoe-enodes** is set to the default of 64 if the user does not change that value by means of the **fcoe-enodes** command. If the FCoE license is removed, a reboot is required; the number of FCoE interfaces is set to 0 and all FCoE interfaces are deleted.

Upgrades and downgrades are supported only to or from an adjacent release, respectively.

The following additional issues for upgrades and downgrades apply:

### Upgrades

- The value of **enodes-config** is set by default to **local** in the fabric map.
- On nodes with an FCoE license:
  - The default value of 64 is set for **fcoe-enodes** in the RBridge ID context of the running configuration.
  - If a node has more than 64 static or dynamic bindings, the value of **fcoe-enodes** is reduced to as many bindings as are present, and the value is updated in the running configuration.
  - Extra FCoE interfaces (the difference between the value of **max-enodes** and that of **fcoe-enodes**) are deleted.
  - In logical chassis cluster mode, the value of "Total-FCoE-Enodes" in the fabric map is set to the total number of FCoE interfaces created in the cluster. In fabric cluster mode, that value is set to the number of FCoE interfaces created on the respective RBridge.
- On nodes without an FCoE license:
  - The value of **fcoe-enodes** is set to 0 in the RBridge ID context of the running configuration.
  - All FCoE interfaces are deleted.

### Downgrades

- If the value of **fcoe-enodes** is set to **local**, a downgrade to the previous release (Network OS 4.0.0) is not allowed.
- The user must ensure that the value of **max-enodes** is at least 256.
- The user must change the value of **enodes-config** to **global** before downgrading. The value set by **fcoe-enode** on all RBridges in the cluster is set to the maximum of all **fcoe-enodes** values in the cluster and that value is applied to all nodes. The extra required interfaces (**max-enodes** minus **fcoe-enodes**) are created on appropriate nodes in the cluster.
- Following the downgrade, the value of **max-enodes** in Network OS 4.0.0 is the same as the value set by **fcoe-enodes** in Network OS 4.1.0.

#### NOTE

For the complete syntax and examples of the **fcoe-enodes** and **enodes-config** commands, refer to the *Network OS Command Reference*.

## FCoE interface configuration

FCoE maps are used to configure FCoE properties on interfaces. An FCoE map is a placeholder for an FCoE VLAN and a CEE map. You assign FCoE maps on to physical interfaces using the **fcoeport** command. Once the FCoE map is assigned onto an interface:

- The corresponding FCoE VLAN 1002 is applied to the interface.
- The corresponding CEE map is applied to the interface.
- The FCoE/FIP VLAN classifiers are applied to the interface.

In short, the interface becomes capable of carrying FCoE traffic. The FCoE map can be applied on an interface only if the FCoE map is complete in all aspects. That is, it should have an FCoE VLAN and a CEE map associated with it.

### NOTE

Brocade does not support non-FCoE traffic over the FCoE VLAN. The FCoE VLAN should not carry any mixed traffic.

Only a single FCoE map is allowed, which is created automatically with the name "default." You are not able to delete or rename this map. By default, the FCoE VLAN associated to the FCoE map is FCoE VLAN (1002) and the CEE map associated is the default CEE map (also called "default").

## Assigning an FCoE map onto an interface

The FCoE map cannot be edited if it is associated with any interfaces.

The FCoE map can be applied, irrespective of whether or not the interface is in "switchport" mode. However, the FCoE map cannot be applied on an interface if the same interface already has a CEE map assigned to it.

To assign the FCoE map onto an interface, perform the following steps in global configuration mode.

1. Activate the interface configuration mode for the interface you wish to modify.

The following example activates the mode for the 10-gigabit Ethernet interface in slot 0/port 1.

```
switch(config)# interface tengigabitethernet 1/0/1
switch(conf-if-te-0/1)#
```

2. Apply the current FCoE profile map to the interface by using the **fcoeport** command.

```
switch(conf-if-te-1/0/1)# fcoeport default
```

3. Return to the privileged EXEC mode by using the **end** command.

```
switch(conf-if-te-1/0/1)# end
switch#
```

4. Confirm the changes to the interface by using the **show running-config** command.

```
switch# show running-config interface tengigabitethernet 1/0/1

interface TenGigabitEthernet 1/0/1
 fcoeport default
 no shutdown
```

- Use the **show fcoe fabric-map default** command to confirm the current status of the FCoE map.

```
switch# show fcoe fabric-map default
=====
Fabric-Map  VLAN      VFID    Pri   FCMAP      FKA      Timeout
=====
default     1002[D]  128[D]  3[D]  0xefc00[D] 8000[D]  Enabled[D]
Total number of Fabric Maps = 1
```

- Repeat this procedure for any additional interfaces.

## Assigning an FCoE map onto a LAG member

The **fcoeport default** command is used under interface subtype configuration mode to provision a port to be an FCoE port. This puts the port in Layer 2 mode, but only for FCoE VLANs. In Network OS 4.0.0 and later, the **fcoeport default** command is supported for LAG member ports where FCoE provisioning is applied to individual 10-gigabit Ethernet ports.

You must apply the **fcoeport default** command on the LAG member interface. Once this command is applied, and if the member port of the LAG is CEE-capable, it carries FCoE traffic only.

To assign the FCoE map onto a LAG member, perform the following steps in global configuration mode.

- Activate the interface configuration mode for the interface you wish to modify.

The following example activates the mode for a 10-gigabit Ethernet interface.

```
switch(config)# interface tengigabitethernet 3/0/19
switch(conf-if-te-3/0/19)#
```

- Activate the channel-group mode.

```
switch(conf-if-te-3/0/19)# channel-group 10 mode active type standard
```

- Set the LACP timeout to long.

```
switch(conf-if-te-3/0/19)# lacp timeout long
```

- Apply the current FCoE profile map to the interface by using the **fcoeport** command.

```
switch(conf-if-te-3/0/19)# fcoeport default
```

- Return to privileged EXEC mode by using the **end** command.

```
switch(conf-if-te-3/0/19)# end
```

- Confirm the changes to the interface with the **show running-config** command.

```
switch# show running-config interface tengigabitethernet 3/0/19
interface TenGigabitEthernet 3/0/19
  fabric isl enable
  fabric trunk enable
  channel-group 10 mode active type standard
  lacp timeout long
  fcoeport default
  no shutdown
```

- Use the **show fcoe interface brief** command to confirm the current status of the FCoE logins.

```
switch# show fcoe interface brief
```

- Repeat this procedure for any additional interfaces.

## Configuring FCoE over LAG

Network OS 4.0.0 and later supports FCoE over LAGs. These are LAGs between the FCoE Forwarder (FCF) and a DCB capable switch. The entire LAG is provisioned for FCoE, so that all member ports are used for FCoE traffic. FCoE traffic is broadcast on all the member links of the LAG.

### NOTE

FCoE over LAG supports standard LAGs only. vLAGs are not supported.

Additionally, Network OS 4.0.0 and later supports multiple logins per port. This feature allows multiple ENodes to login to a single 10-gigabit Ethernet port or a LAG.

### Guidelines and restrictions for configuring FCoE over LAG

Follow these configuration guidelines and restrictions when configuring FCoE over LAG:

1. The intermediate switches may or may not be an FSB. However, FSB is recommended for security.
2. All ACLs and FCoE forwarding entries will continue to be on the FCF's ingress ports.
3. It is assumed that the intermediate switch works in "Willing" mode towards the FCF in the DCBX exchange, and accepts the configuration from the FCF and propagates it downstream.
4. The CEE/DCBX configuration is expected to be identical on both FCF and the intermediate switch.
5. Irrespective of item 3 or item 4, the PFC/No-drop behavior from the FCF perspective will be guaranteed only on the links between the FCF and first hop switch. There is no provision in the standard to guarantee this requirement on all paths leading to the Enode.
6. FSBs may or may not be able to forward the FCoE LLS TLV to the Enodes. Hence this TLV may not be present in the LLDP packets sent to the Enodes. The FCF continues to send this TLV in its LLDP packets destined to the intermediate switch.

### Configuring FCoE provisioning on LAGs

The existing **fcoeport default** command is extended to the LAG interfaces to support the new feature, as shown in the following example.

```
switch# configure
Entering configuration mode terminal

switch(config)# interface port-channel 10

switch(config-Port-channel-10)# fcoeport default

switch(config-Port-channel-10)#
```

This provisions all the member ports of port-channel 10 for FCoE.

### Configuring logical FCoE ports

When the switch boots, a pool of 64 FCoE ports is created. These ports are not bound to any physical ports. The bindings are created when an FLOGI is received on the switch. Any free port that is available from the pool is selected and bound to the physical port where the FLOGI is received. The default number of logical ports is 64, and the range of valid values is from 0 through 1000. The following lists the total number of FCoE ports available per platform.

**TABLE 4** Number of FCoE ports per platform

Platform	Number of FCoE ports
Brocade VDX 6740	1000

**TABLE 4** Number of FCoE ports per platform (continued)

Platform	Number of FCoE ports
Brocade VDX 6740T	1000
Brocade VDX 6740T-1G	1000
Brocade VDX 8770-4	1000
Brocade VDX 8770-8	1000

When the FCoE logical port is automatically bound to a 10-gigabit Ethernet LAG port, it is referred to as dynamic binding. This binding is valid only until the FLOGI session is valid. The binding is automatically removed when CNA logs out. If you want to create a persistent binding between the logical FCoE port and an interface that can be used for static binding (FortyGigabitEthernet, HundredGigabitEthernet, Port-channel, TenGigabitEthernet, mac-address), use the **bind** command. This is stored in the configuration and retained across reboots.

**NOTE**

Only one type of binding can be used for each physical port, so the 10-gigabit or LAG binding configurations will overwrite each other.

To create additional logical FCoE ports, perform the following steps in RBridge ID configuration mode.

1. Enter FCoE configuration mode on an RBridge.

```
switch(config-rbridge-id-1)# fcoe
```

2. Enter fabric-map configuration mode.

```
switch(config-rbridge-fcoe)# fabric-map default
```

3. Enter the **fcoe-enodes** command to set the maximum number of logins allowed on the switch.

```
switch(config-rbridge-fcoe-fabric-map)# fcoe-enodes 384
```

To bind the logical FCoE ports to a physical port, perform the following steps

4. Exit FCoE configuration mode.

```
switch(config)# exit
```

5. Enter interface configuration mode.

```
switch(config)# interface fcoe 1/1/55
```

6. Bind the logical port to the physical port.

```
switch(conf-if-te-1/1/55)# bind tengigabitethernet 1/0/1
```

## Troubleshooting FCoE interfaces

The following commands can be used to troubleshoot FCoE interfaces.

**TABLE 5** FCoE troubleshooting commands

Command	Description
<b>show fcoe fabric-map</b>	Displays VLAN and fabric-map state, among other items
<b>show vlan brief</b>	Displays VLANs that are configured, provisioned, and unprovisioned, among other items

For details and example output, refer to the *Network OS Command Reference*.

# Configuring FlexPort

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## FlexPort overview

The FlexPort feature allows up to 32 ports to transmit data as either 10G Ethernet or Fibre Channel, and to be changed from one type to the other without requiring a reboot. These ports are grouped together as connector groups.

Connector groups share common speed and protocol type properties. The settings allow any port within each connector group to operate as either:

- An Ethernet port running at 1Gbps, 10Gbps or 40Gbps speed with 16Gbps Fibre Channel speed.
- A Fibre Channel port running at 2Gbps, 4Gbps, 8Gbps, or 16Gbps speeds, or a combination of 2Gbps, 4Gbps or 8Gbps Fibre Channel speeds with Ethernet speeds supported.
- The Ethernet ports must be running any supported 8 Gbps or 16 Gbps Brocade FC transceivers.

The default setting is for Ethernet, and ports that do not support the Fibre Channel protocol are not allowed to have their connector group setting changed from the default setting.

Speed combinations allowed per connector-group are:

- **LowMixed** - 2/4/8G Fibre Channel, and Ethernet speeds (default)
- **HighMixed** - 16G Fibre Channel, and Ethernet speeds
- **FibreChannel** - 2/4/8/16G Fibre Channel (Only if all eight ports are already set as Fibre Channel type)

For the currently supported platforms, the connector-group numbers range from 1 through 6. They are related directly to the ports as numbered on each platform. The connector-group numbers that are allowed to be changed and their associated port numbers are shown in the table below. For example, on a Brocade VDX 2740, ports 43 through 50 belong to connector group 1. Not every connector group is supported on a switch.

### NOTE

Changing connector-group speed may be disruptive for certain ports within the group, depending on their configuration and the new connector-group to be used.

**TABLE 6** FlexPort supported hardware

Platform	Port number range	Connector group
Brocade VDX 2740	43-50	1
	51-56 (6 ports only)	2
Brocade VDX 6740	1-8	1
	17-24	3
	33-40	5
	41-48	6

# Configuring FlexPort

The FlexPort feature allows up to 32 ports to transmit either Ethernet or Fibre Channel. This feature is only supported by Network OS v5.0.0 or later.

The FlexPort feature is set to Ethernet by default. You should only need to perform this task to switch to Fibre Channel, or back to Ethernet.

1. Enter hardware configuration mode.

```
switch(config)#hardware
switch(config-hw)#
```

2. Enter FlexPort configuration mode for the switch. This command configures FlexPort 5 on Rbridge-ID 1. Flexport 5 is part of connector group 1 on the Brocade VDX 6740.

```
switch(config-hw)# flexport 1/0/5
switch(conf-hw-flex-1/0/5)#
```

3. Set the FlexPort type to Fibre Channel.

```
switch(conf-hw-flex-1/0/5)# type FibreChannel
```

4. Optionally, you may adjust the speed for the connector group. For example, if you want the connector group 1 to function at 16Gbps speed:

```
switch(conf-hw-flex-1/0/5)# connector-group 1/0/1
switch(config-connector-group-1/0/1)# speed HighMixed
```

5. Repeat these steps for additional switches as needed.
6. Confirm the FlexPort configuration with the **show running-config hardware flexport** command.

```
switch# show running-config hardware flexport
Hardware
 flexport 1/0/1
   type FibreChannel
!
Hardware
 flexport 1/0/5
   type FibreChannel
!
connector-group 1/0/1
 speed HighMixed
!
```



# Configuring 802.1Q VLANs

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## 802.1Q VLAN overview

### NOTE

This chapter addresses the use of standard Virtual LANs (VLANs) as defined by IEEE 802.1Q. Those VLANs have VLAN IDs that range from 1 through 4096. To support multitenancy by means of classified VLANs, the ID range has been extended through 8191. For details on this feature, refer to [Configuring Virtual Fabrics](#) on page 81.

IEEE 802.1Q VLANs provide the capability to overlay the physical network with multiple virtual networks. VLANs allow you to isolate network traffic between virtual networks and reduce the size of administrative and broadcast domains.

A VLAN contains end stations that have a common set of requirements that are independent of physical location. You can group end stations in a VLAN even if they are not physically located in the same LAN segment. VLANs are typically associated with IP subnetworks and all the end stations in a particular IP subnet belong to the same VLAN. Traffic between VLANs must be routed. VLAN membership is configurable on a per-interface basis.

The VLAN used for carrying FCoE traffic needs to be explicitly designated as the FCoE VLAN. FCoE VLANs are configured through the Network OS CLI (refer to [Configuring an interface port as a Layer 2 switch port](#) on page 61 for details).

### NOTE

Currently only one VLAN can be configured as the FCoE VLAN at a time.

## Ingress VLAN filtering

A frame arriving at Brocade VDX hardware is either associated with a specific port or with a VLAN, based on whether the frame is tagged or untagged. The association rules are as follows:

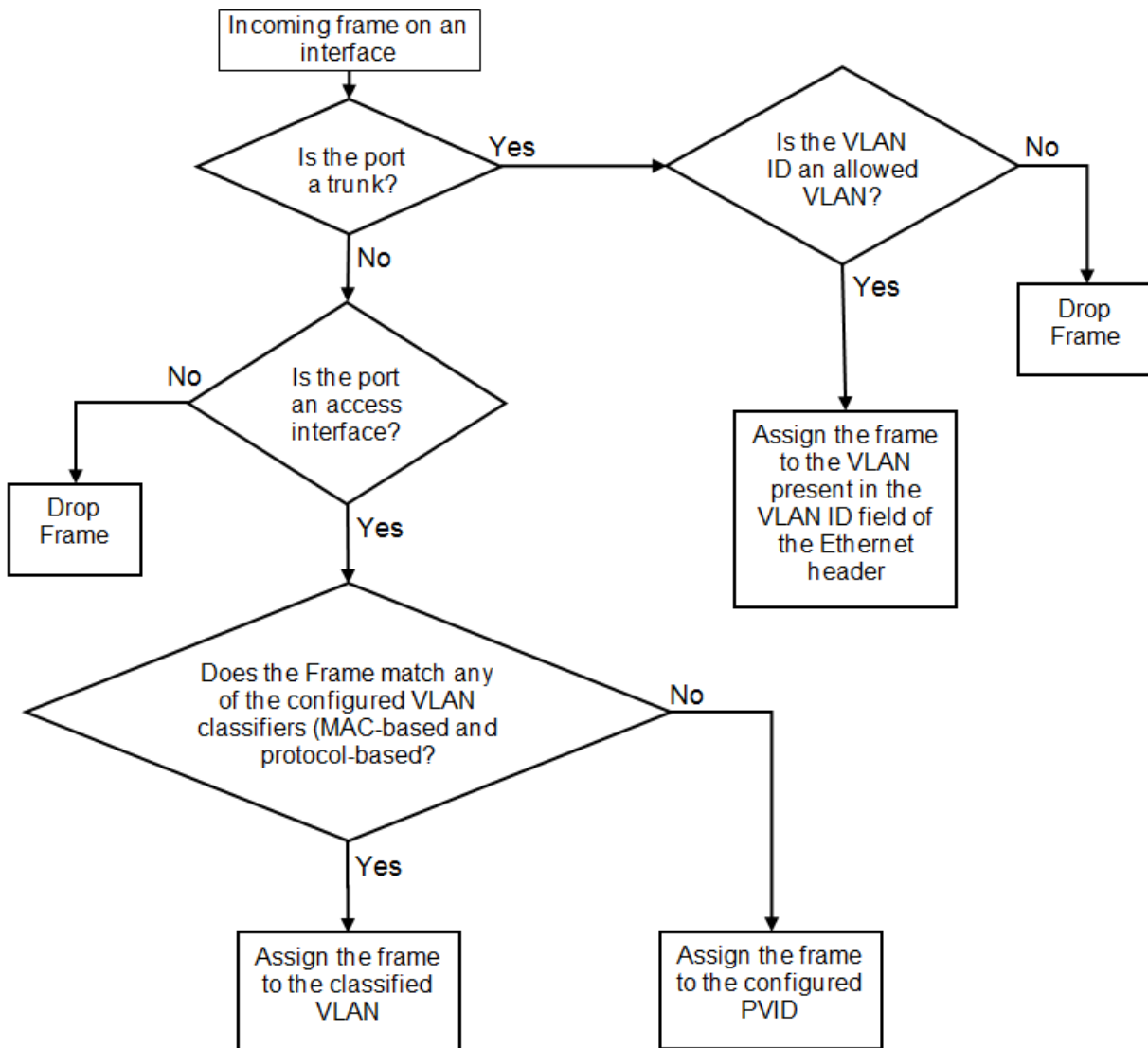
- Admit tagged frames only — The port the frame came in on is assigned to a single VLAN or to multiple VLANs depending on the VLAN ID in the frame's VLAN tag. This is called trunk mode.
- Admit untagged frames only — These frames are assigned the port VLAN ID (PVID) assigned to the port the frame came in on. This is called access mode.
- Admit VLAN tagged and untagged frames — All tagged and untagged frames are processed as follows:
  - All untagged frames are classified into native VLANs.
  - If the tengigabitethernet interface port is configured as an fcoeport and is in access mode, untagged Layer 2 or priority-tagged frames are forwarded by the egress port as untagged frames, unless you enable priority-tagging on the tengigabitethernet interface. By default, priority-tagging is disabled.
  - Any tagged frames coming with a VLAN tag equal to the configured native VLAN are processed.
  - For ingress and egress, non-native VLAN tagged frames are processed according to the allowed VLAN user specifications. This is called trunk mode.

**NOTE**

Ingress VLAN filtering is enabled by default on all Layer 2 interfaces. This ensures that VLANs are filtered on the incoming port (depending on the user configuration).

The following illustrates the frame-processing logic for an incoming frame.

**FIGURE 7** Ingress VLAN filtering



There are important facts you should know about Ingress VLAN filtering:

- Ingress VLAN filtering is based on port VLAN membership.
- Port VLAN membership is configured through the Network OS CLI.
- Dynamic VLAN registration is not supported.
- The Brocade VDX hardware does VLAN filtering at both the ingress and egress ports.
- The VLAN filtering behavior on logical Layer 2 interfaces such as LAG interfaces is the same as on port interfaces.

- The VLAN filtering database (FDB) determines the forwarding of an incoming frame.

Additionally, there are important facts you should know about the VLAN FDB:

- The VLAN FDB contains information that helps determine the forwarding of an arriving frame based on MAC address and VLAN ID data. The FDB contains both statically configured data and dynamic data that is learned by the switch.
- The dynamic updating of FDB entries using learning is supported (if the port state permits).
- Dynamic FDB entries are not created for multicast group addresses.
- Dynamic FDB entries are aged out based on the aging time configured per Brocade VDX hardware. The aging time is between 60 and 1000000 seconds. The default is 300 seconds.
- You can add static MAC address entries specifying a VLAN ID. Static entries are not aged out.
- A static FDB entry overwrites an existing dynamically learned FDB entry and disables learning of the entry going forward.

#### NOTE

For more information on frame handling for Brocade VDX hardware, refer to [FCoE and Layer 2 Ethernet](#) on page 40.

## VLAN configuration guidelines and restrictions

Follow these guidelines and restrictions when configuring VLANs:

- On all Brocade VDX switches, VLAN 1002 is reserved for FCoE VLAN functionality.
- On Brocade VDX 8770 switches: 1 through 4086 for 802.1Q VLANs (VLAN IDs 4087 through 4095 are reserved on these switches), and 4096 through 8191 for service or transport VFs in a Virtual Fabrics context.
- On all other Brocade VDX switches: 1 through 3962 for 802.1Q VLANs (VLAN IDs 3963 through 4095 are reserved on these switches), and 4096 through 8191 for service or transport VFs in a Virtual Fabrics context.
- In an active topology, MAC addresses can be learned, per VLAN, using Independent VLAN Learning (IVL) only.
- A MAC address ACL always overrides a static MAC address entry. In this case, the MAC address is the forwarding address and the forwarding entry can be overwritten by the ACL.
- The Brocade DCB switch supports Ethernet DIX frames and 802.2 LLC SNAP encapsulated frames only.
- You must configure the same native VLAN on both ends of an 802.1q trunk link. Failure to do so can cause bridging loops and VLAN leaks.
- All switches in a fabric cluster or logical chassis cluster must be configured with the same VLAN number.

# Configuring and managing 802.1Q VLANs

## Understanding the default VLAN configuration

The following table summarizes the default VLAN configuration. Consider this when making configuration changes.

**TABLE 7** Default VLAN configuration

Parameter	Default setting
Default VLAN	VLAN 1
Interface VLAN assignment	All interfaces assigned to VLAN 1
VLAN state	Active
MTU size	2500 bytes

**NOTE**

Enter the **copy running-config startup-config** command to save your configuration changes.

## Configuring interfaces to support VLANs

This section details the various tasks required to configure and manage VLAN traffic.

### Enabling and disabling an interface port

**NOTE**

DCB interfaces are enabled by default in Brocade VCS Fabric mode.

**NOTE**

DCB interfaces do not support auto-negotiation of Ethernet link speeds. The DCB interfaces support 10-gigabit Ethernet and 1-gigabit Ethernet.

To enable and disable an interface port, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter the **interface** command to specify the interface port.

```
switch(config)# interface tengigabitethernet 1/0/1
```

### Configuring the MTU on an interface port

**NOTE**

The entire fabric acts like a single switch. Therefore, MTU is applicable only on the edge-ports, and not on ISL.

To configure the maximum transmission unit (MTU) on an interface port, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter the **interface** command to specify the interface port.

```
switch(config)# interface tengigabitethernet 1/0/1
```

3. Enter the **mtu** command to specify the MTU value on the interface port.

```
switch(conf-if-te-0/1)# mtu 4200
```

### Creating a VLAN

On Brocade VDX hardware, VLANs are treated as interfaces from a configuration point of view.

By default all the DCB ports are assigned to VLAN 1 (VLAN ID equals 1). The *vlan\_ID* value can be 1 through 3963. VLAN IDs 3964 through 4090 are internally-reserved VLAN IDs. However, the **reserved-vlan** command can modify this range. VLANs above 4090 are not configurable. Refer to the *Network OS Command Reference* for more information.

**NOTE**

For the Brocade VDX 67XX switches, the default reserved space is 128 VLANs, and is equal to sum of the number of maximum allowed port channels and the number of interfaces. Presently, VLANs from 3960 through 4090 are reserved. For the Brocade VDX 8770 switches, the default reserved VLAN space is 4. VLANs 4087 through 4090 are reserved.

To create a VLAN interface, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter the **interface vlan** command to assign the VLAN interface number.

```
switch(config)# interface vlan 1010
```

### Enabling STP on a VLAN

Once all of the interface ports have been configured for a VLAN, you can enable Spanning Tree Protocol (STP) for all members of the VLAN with a single command. Whichever protocol is currently selected is used by the VLAN. Only one type of STP can be active at a time.

A physical interface port can be a member of multiple VLANs. For example, a physical port can be a member of VLAN 1015 and VLAN 55 simultaneously. In addition, VLAN 1015 can have STP enabled and VLAN 55 can have STP disabled simultaneously.

To enable STP for a VLAN, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter the **protocol spanning tree** command to select the type of STP for the VLAN.

```
switch(config)# protocol spanning tree mstp
```

3. Enter the **interface** command to select the VLAN interface number.

```
switch(config)# interface vlan 1015
```

4. Enter the **no spanning-tree shutdown** command to enable spanning tree on VLAN 1015.

```
switch(conf-if-vl-1015)# no spanning-tree shutdown
```

### Disabling STP on a VLAN

Once all of the interface ports have been configured for a VLAN, you can disable STP for all members of the VLAN with a single command.

To disable STP for a VLAN, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.
2. Enter the **interface** command to select the VLAN interface number.

```
switch(config)# interface vlan 55
```

3. Enter the **spanning-tree shutdown** command to disable STP on VLAN 55.

```
switch(conf-if-vl-55)# spanning-tree shutdown
```

### Configuring an interface port as a Layer 2 switch port

To configure the interface as a Layer 2 switch port, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.
2. Enter the **interface** command to specify the interface port.

```
switch(config)# interface tengigabitethernet 1/0/1
```

3. Enter the **switchport** command to configure the interface as a Layer 2 switch port.
4. Enter the **do show** command to confirm the status of the DCB interface.

```
switch(conf-if-te-1/0/1)# do show interface tengigabitethernet 1/0/1
```

5. Enter the **do show** command to confirm the status of the DCB interface running configuration.

```
switch(conf-if-te-1/0/1)# do show running-config interface tengigabitethernet 1/0/1
```

### Configuring an interface port as an access interface

Each DCB interface port supports admission policies based on whether the frames are untagged or tagged. Access mode admits only untagged and priority-tagged frames.

To configure the interface as an access interface, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter the **interface** command to specify the interface port.

```
switch(config)# interface tengigabitethernet 1/0/1
```

3. Enter the **switchport** command to make the interface a Layer 2 switch port.

```
switch(conf-if-te-0/1)# switchport
```

4. Configure the interface as an access interface.

```
switch(conf-if-te-0/1)# switchport mode access
```

5. Enter the **switchport** command again to configure the DCB interface as a VLAN.

```
switch(conf-if-te-0/1)# switchport access vlan 20
```

### Configuring an interface port as a trunk interface

Each DCB interface port supports admission policies based on whether the frames are untagged or tagged. Trunk mode admits only VLAN-tagged frames.

To configure the interface as a trunk interface, run the following steps in privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter the **interface** command to specify the interface port.

```
switch(config)# interface tengigabitethernet 1/0/19
```

3. Enter the **switchport** command to place the DCB interface into trunk mode.

```
switch(conf-if-te-1/0/19)# switchport mode trunk
```

4. Specify whether all, one, or none of the VLAN interfaces are allowed to transmit and receive through the DCB interface. Enter the one of the following commands as is appropriate for your needs.

### Allowing only one VLAN to transmit or receive through the DCB interface

This example allows VLAN 30 to transmit or receive through the DCB interface.

```
switch(conf-if-te-1/0/19)# switchport trunk allowed vlan add 30
```

### Allowing all VLANs to transmit or receive through the DCB interface

This example allows all VLANs to transmit or receive through the DCB interface.

```
switch(conf-if-te-1/0/19)# switchport trunk allowed vlan all
```

### Excluding a VLAN from the DCB interface

This example allows all except VLAN 11 to transmit or receive through the DCB interface.

```
switch(conf-if-te-1/0/19)# switchport trunk allowed vlan except 11
```

### Blocking all VLANs from the DCB interface

This example allows none of the VLANs to transmit or receive through the DCB interface.

```
switch(conf-if-te-1/0/19)# switchport trunk allowed vlan none
```

### Disabling a VLAN on a trunk interface

To disable a VLAN on a trunk interface, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8 in VCS mode. The prompt for these ports is in the format: switch(config-if-gi-22/0/1)#.

```
switch(config)# interface tengigabitethernet 0/10
```

3. Enter the **switchport** command to place the DCB interface into trunk mode.

```
switch(conf-if-te-0/10)# switchport mode trunk none
```

4. Enter the **switchport** command again to remove the VLAN ranges from the trunk port.

```
switch(conf-if-te-0/10)# switchport trunk allowed vlan remove 30
```

## Configuring protocol-based VLAN classifier rules

You can configure VLAN classifier rules to define specific rules for classifying frames to selected VLANs based on protocol and MAC addresses. Sets of rules can be grouped into VLAN classifier groups (refer to [Deleting a VLAN classifier rule](#) on page 64).

VLAN classifier rules (1 through 256) are a set of configurable rules that reside in one of these categories:

- 802.1Q protocol-based classifier rules
- Source MAC address-based classifier rules
- Encapsulated Ethernet classifier rules

**NOTE**

Multiple VLAN classifier rules can be applied per interface, provided that the resulting VLAN IDs are unique for the different rules.

802.1Q protocol-based VLANs apply only to untagged frames, or frames with priority tagging.

With both Ethernet-II and 802.2 SNAP encapsulated frames, the following protocol types are supported:

- Ethernet hexadecimal (0x0000 through 0xffff)
- Address Resolution Protocol (ARP)
- Fibre Channel over Ethernet (FCoE)
- FCoE Initialization Protocol (FIP)
- IP version 6 (IPv6)

**NOTE**

For complete information on all available VLAN classifier rule options, refer to the *Network OS Command Reference*.

### Configuring a VLAN classifier rule

To configure a ARP protocol-based VLAN classifier rule, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter the **vlan classifier rule** command to configure a protocol-based VLAN classifier rule.

```
switch(config)# vlan classifier rule 1 proto ARP encap ethv2
```

**NOTE**

Refer to the *Network OS Command Reference* for complete information on all the protocols available for the **vlan classifier rule** command.

### Configuring MAC address-based VLAN classifier rules

To configure a MAC address-based VLAN classifier rule, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Enter the **vlan classifier rule** command to configure a MAC address-based VLAN classifier rule.

```
switch(config)# vlan classifier rule 5 mac 0008.744c.7fid
```

### Deleting a VLAN classifier rule

VLAN classifier groups (1 through 16) can contain any number of VLAN classifier rules.

To configure a VLAN classifier group and remove a VLAN classifier rule, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Specify a VLAN classifier group and delete a rule.

```
switch(config)# vlan classifier group 1 delete rule 1
```



## Creating a VLAN classifier group and adding rules

VLAN classifier groups (1 through 16) can contain any number of VLAN classifier rules.

To configure a VLAN classifier group and add a VLAN classifier rule, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Create a VLAN classifier group and add a rule.

```
switch(config)# vlan classifier group 1 add rule 1
```

## Activating a VLAN classifier group with an interface port

To associate a VLAN classifier group with an interface port, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8 in VCS mode. The prompt for these ports is in the format: switch(config-if-gi-22/0/1)#.

```
switch(config)# interface tengigabitethernet 0/10
```

3. Enter the **vlan classifier** command to activate and associate it with a VLAN interface (group 1 and VLAN 2 are used in this example).

```
switch(conf-if-te-0/10)# vlan classifier activate group 1 vlan 2
```

### NOTE

This example assumes that VLAN 2 was already created.

## Displaying VLAN information

### NOTE

The **show vlan brief** command displays the VLAN as inactive if there are no member ports associated to that VLAN, or if the ports associated are in an admin down state.

To display VLAN information, perform the following steps from privileged EXEC mode.

1. Enter the **show interface** command to display the configuration and status of the specified interface.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8 in VCS mode. The prompt for these ports is in the format: switch(config-if-gi-22/0/1)#.

```
switch# show interface tengigabitethernet 0/10 port-channel 10 switchport
```

2. Enter the **show vlan** command to display the specified VLAN information. For example, this syntax displays the status of VLAN 20 for all interfaces, including static and dynamic:

```
switch# show vlan 20
```

## Configuring the MAC address table and conversational MAC learning

Each DCB port has a MAC address table. The MAC address table stores a number of unicast and multicast address entries without flooding any frames. Brocade VDX hardware has a configurable aging timer. If a MAC address remains inactive for a specified number of seconds, it is removed from the address table. For detailed information on how the switch handles MAC addresses in a Layer 2 Ethernet environment, refer to [FCoE and Layer 2 Ethernet](#) on page 40.

In addition, support is now provided for conversational MAC learning (CML).

### Conversational MAC learning

Layer 2 switches use forwarding tables to direct traffic to specific ports, based on the VLAN number and destination MAC address of the frame. When there is no entry corresponding to the destination MAC address in the incoming VLAN, the frame is sent to all forwarding ports within the respective VLAN, which causes flooding. MAC address learning is an essential Layer 2 feature whereby the source MAC addresses of each received packet is stored so that future packets destined for that address can be forwarded only to the bridge interface on which the address is located.

Prior to Network OS v5.0.0, each node in the VCS Fabric stores in its hardware table the Layer 2 addresses of all end stations that are learned, without consideration for actual conversations. This poses a considerable unnecessary burden on system memory. Beginning with Network OS v5.0.0, the global **mac-address-table** command has been enhanced with a **conversational** keyword, allowing the user to enable conversational MAC (address) learning, or CML, globally on a switch.

### Specifying or disabling the aging time for MAC addresses

You can set the length of time that a dynamic entry remains in the MAC address table after the entry is used or updated. Static address entries are never aged or removed from the table. You can also disable the aging time. The default is 300 seconds.

#### NOTE

To disable the aging time for MAC addresses, enter an aging time value of 0.

To specify an aging time or disable the aging time for MAC addresses, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.
2. Enter the appropriate command based on whether you want to specify an aging time or disable the aging time for MAC addresses:

```
switch(config)# mac-address-table aging-time 600
```

### Adding static addresses to the MAC address table

To add a static address to the MAC address table, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.
2. Add the static address 0011.2222.3333 to the MAC address table with a packet received on VLAN 100:

```
switch(config)# mac-address-table static 0011.2222.3333 forward tengigabitethernet 1/0/1 vlan 100
```

### Disabling dynamic MAC learning

You can disable dynamic MAC address learning on a switch, and enable CML, by means of the **mac-address-table learning-mode conversational** command.

**NOTE**

The ability to disable source MAC address learning on a per-port, per-VLAN basis constrains traffic flooding to only the ports that are part of a VLAN. Disabling traditional dynamic MAC learning prevents the MAC address table from being saturated. For example, when a device is being attacked by many packets with different source MAC address, the updating of the MAC address table is significantly impaired.

Do the following in global configuration mode to disable dynamic MAC learning and enable CML globally on an RBridge.

```
switch(config)# mac-address-table learning-mode conversational
```

Do the following to revert to legacy dynamic MAC learning mode.

```
switch(config)# no mac-address-table learning-mode
```

Do the following to configure the destination MAC address aging interval to 60 seconds.

```
switch(config)# mac-address-table aging-time conversational 60
```

Do the following to revert to the default aging interval of 300 seconds.

```
switch(config)# no mac-address-table aging-time conversational
```

### *Disabling source MAC learning on an interface*

You can disable legacy dynamic MAC address learning on one or more VLANs on an interface. (CML is disabled by default.) VLANs range from 1 through 4090 for 802.1Q VLANs, and from 4096 through 8191 for VLANs in a Virtual Fabrics context.

To add a VLAN and range of VLANs to a switchport trunk:

```
switch(conf-if-te-4/0/5)# switchport trunk allowed vlan add 2000,3000-3500
```

To add the above VLANs to the MAC-learning-disabled list:

```
switch(conf-if-te-4/0/5)# mac-learning disable vlan add 2000,3000-3500
```

To remove a VLAN from the list:

```
switch(conf-if-te-4/0/5)# mac-learning disable vlan remove 2000
```

To disable MAC learning for all VLANs on the interface:

```
switch(conf-if-te-4/0/5)# no mac-learning disable
```

To disable MAC learning for all VLANs on the interface:

```
switch(conf-if-te-4/0/5)# no mac-learning disable
```

To disable MAC learning for VLANs 2000, 3000, and 3001 on the interface:

```
switch(conf-if-te-4/0/5)# mac-learning disable vlan 2000, 3000, 3001
```

To view the status of the VLANs, use the **show interface switchport** command, as in the following example:

```
switch# show interface tengigabitethernet 4/0/5 switchport

Interface name           : TenGigabitEthernet 4/0/5
Switchport mode         : trunk
Fcoepoint enabled       : no
Ingress filter           : enable
Acceptable frame types  : vlan-tagged only
Native Vlan              : 1
Active Vlans             : 1-2,4,7-10
Inactive Vlans          : -
MAC learn disable Vlans : 2000,3000,3001
```

## Private VLANs

A private VLAN (PVLAN) domain is built with at least one pair of VLAN IDs; one (and only one) primary VLAN ID plus one or more secondary VLAN IDs. A primary VLAN is the unique and common VLAN identifier of the whole private VLAN domain and of all its VLAN ID pairs. Secondary VLANs can be configured as one of two types: either isolated VLANs or community VLANs. Only one isolated VLAN can be part of one PVLAN domain.

An isolated VLAN is a secondary VLAN whose distinctive characteristic is that all hosts connected to its ports are isolated at Layer 2. A community VLAN is a secondary VLAN that is associated to a group of ports that connect to a designated community of end devices with mutual trust relationships.

A PVLAN is often used to isolate networks from security attacks, or to simplify IP address assignments.

Within the private VLAN, ports can be assigned port types. A port can be assigned to only one kind of port type at a time. The types of ports available for private VLANs are described in the following table.

**TABLE 8** Private VLAN terms and definitions

Term	Description
Isolated port	An isolated port cannot talk to any other port in the private VLAN domain except for promiscuous ports and traffic ports. If a customer device needs to have access only to a gateway router, then it should be attached to an isolated port.
Community port	A community port is part of a group of ports that have Layer 2 communications with one another, and can also talk to any promiscuous port. For example, if you have two devices that you want to be isolated from other devices, but still be able to communicate between themselves, then community ports should be used. You cannot configure multiple community VLANs on a single port.
Promiscuous port	A promiscuous port can talk to all other types of ports. A promiscuous port can talk to isolated ports as well as community ports. Layer 3 gateways, DHCP servers, and other trusted devices that need to communicate with the customer endpoints are typically connected using promiscuous ports.
Trunk port	A trunk port connects two switches and carries two or more VLANs.
Promiscuous trunk port	A promiscuous trunk port carries multiple primary and normal VLANs. Packets are received and transmitted with primary or regular VLAN tags. Otherwise, the port operates as a promiscuous port.
Secondary VLAN	A VLAN used to implement PVLANS. Secondary VLANs are associated with a primary VLAN, and carry traffic from hosts to other allowed hosts or routers.
Community VLAN	A secondary VLAN that carries upstream traffic from the community ports to the promiscuous port gateways, and to other host ports in the same community. Multiple community VLANs are permitted in a PVLAN.
Primary VLAN	A PVLAN has only one primary VLAN. Every port in a PVLAN is a member of the primary VLAN. The primary VLAN carries unidirectional traffic downstream from the promiscuous ports to the isolated and community ports and to other promiscuous ports.

## PVLAN configuration guidelines and restrictions

Follow these guidelines and restrictions when configuring VLANs:

- VE configuration is not supported on a primary VLAN.
- IGMP is not supported on private VLANs; however you can create an IGMP configuration. The configuration succeeds but the hardware is not programmed.
- For private VLANs, egress ACLs on the primary VLAN are applied only for the traffic that ingresses and egresses from the primary VLAN, and not for the traffic that gets translated from the secondary VLAN to the primary VLAN.
- For private VLANs, egress ACLs on the primary VLAN are also applied to the traffic that gets translated to the secondary VLAN.
- STP is not supported on private VLAN host ports.

## Associating the primary and secondary VLANs

This procedure configures the PVLAN and associates the secondary VLAN with the primary VLAN.

1. Configure the VLAN interface.

```
switch(config)# interface vlan 10
```

2. Configure the VLAN as a primary PVLAN.

```
switch(conf-if-vl-10)# private-vlan primary
```

3. Create multiple community VLANs, for use in Step 5.

```
switch(config)# interface vlan 100
switch(conf-if-vl-100)# private-vlan community
```

4. Configure the secondary VLAN (isolated).

```
switch(config)# interface vlan 200
switch(conf-if-vl-200)# private-vlan isolated
```

5. Associate the multiple community VLANs and the isolated VLAN.

```
switch(config)# interface vlan 10
switch(conf-if-vl-10)# private-vlan association add 100 200
```

6. Exit VLAN configuration mode.

```
switch(conf-if-vl-10)# exit
```

## Configuring an interface as a PVLAN promiscuous port

This procedure configures an interface as the PVLAN promiscuous port.

1. Specify the interface.

```
switch(config)# interface tengigabitethernet 0/1
```

2. Mark the interface as switch port

```
switch(conf-if-te-0/1)#switchport
```

3. Configure the interface as a PVLAN promiscuous port (untagged).

```
switch(conf-if-te-0/1)# switchport mode private-vlan promiscuous
```

4. Configure the interface as a PVLAN promiscuous port (tagged).

```
switch(conf-if-te-0/1)# switchport mode private-vlan trunk promiscuous
```

5. Associate the interface with a PVLAN.

```
switch(conf-if-te-0/1)# switchport private-vlan mapping add 10 100,200
```

6. Configure a normal VLAN on the PVLAN promiscuous port.

```
switch(conf-if-te-0/1)# switchport trunk allowed vlan add 500
```

## Configuring an interface as a PVLAN host port

This procedure configures an interface as the PVLAN host port.

1. Specify the interface.

```
switch(config)#interface tengigabitethernet 1/0/1
```

2. Mark the interface as a switch port.

```
switch(conf-if-te-1/0/1)# switchport
```

3. Configure the interface as a PVLAN host port that is tagged.

```
switch(conf-if-te-1/0/1)# switchport mode private-vlan trunk host
```

4. Alternatively, configure the interface as a PVLAN host port that is untagged.

```
switch(conf-if-te-1/0/1)# switchport mode private-vlan host
```

5. Associate the interface with a PVLAN.

```
switch(conf-if-te-1/0/1)# switchport private-vlan host-association 10 100
```

## Configuring an interface as a PVLAN trunk port

This procedure configures an interface as a PVLAN trunk port.

1. Specify the interface.

```
switch(config)# interface tengigabitethernet 0/1
```

2. Mark the interface as switch port.

```
switch(conf-if-te-0/1)# switchport
```

3. Configure the interface as a PVLAN trunk port.

Do not complete this step if the host is a plain, untagged server.

```
switch(conf-if-te-0/1)# switchport mode private-vlan trunk
```

4. Configure the association between primary VLANs and secondary VLANs and the PVLAN trunk port with a PVLAN.

```
switch(conf-if-te-0/1)# switchport private-vlan association trunk 10 100
```

#### NOTE

Multiple PVLAN pairs can be specified by means of the **switchport private-vlan association trunk** command, so that a PVLAN trunk port can carry multiple secondary VLANs. If an association is specified for the existing primary VLAN, the existing association is replaced. If there is no trunk association, any packets received on secondary VLANs are dropped.

5. Configure a normal VLAN on the PVLAN trunk port.

```
switch(conf-if-te-0/1)# switchport private-vlan trunk allowed vlan 400
```

6. Configure a VLAN to which untagged packets (as in IEEE 802.1Q tagging) are assigned on a PVLAN trunk port. If there is no native VLAN configured, all untagged packets are dropped. If the native VLAN is a secondary VLAN and the port does not have the association for the secondary VLAN, the untagged packets are dropped.

```
switch(conf-if-te-0/1)# switchport private-vlan trunk native vlan 600
```

## Displaying PVLAN information

To display private VLAN information, use the **show vlan private-vlan** command to see the private VLAN types (for example, "private," "isolated," and "community").





# Configuring VXLAN Overlay Gateways for NSX Controller Deployments

---

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## Introduction to VXLAN overlay gateways with NSX Controller

Virtual Extensible LAN (VXLAN) is an overlay network that extends Layer 2 domains over Layer 3 networks. The overlay network supports elastic compute architectures, enabling network engineers to scale a cloud computing environment while logically isolating cloud applications and tenants.

VXLAN extends the virtual LAN (VLAN) address space by adding a 24-bit segment ID and increasing the number of available VLAN IDs to 16 million, in a Virtual Fabrics context. The VXLAN segment ID in each frame differentiates individual logical networks, allowing millions of isolated Layer 2 VXLAN networks to coexist on a common Layer 3 infrastructure. As with VLANs, only virtual machines (VMs) within the same logical network can communicate with each other.

VXLAN creates large-scale, isolated virtual Layer 2 networks for virtualized and multi-tenant environments by encapsulating frames in VXLAN packets. Frame encapsulation is performed by means of a VXLAN Network Identifier (VNI) tunnel endpoint (VTEP), which originates or terminates VXLAN tunnels.

Because not all devices and servers are capable of sending or receiving VXLAN traffic, a VXLAN overlay gateway allows communication between the VXLAN-aware world and the non-VXLAN-aware world. In the non-VXLAN-aware world, a broadcast domain represented by a VLAN typically comprises the virtual cluster switch and other switches and devices behind the switch.

In the initial phase, the VXLAN-aware world consists of virtual networks that are managed by a third-party system known as the VMware NSX Controller. The NSX Controller is a highly available distributed system that manages, or orchestrates, all network components and connections in a virtual network. The VXLAN overlay gateway must communicate with the NSX Controller to create tunnels with VXLAN-aware end devices. The NSX Controller function can comprise a cluster of controllers. The orchestrator function resides most commonly at top of rack (ToR); however, it can also be deployed as an aggregator.

With Network OS v5.0.0, MAC, IPv4, and IPv6 ingress ACLs are supported, as well as sFlow configurations.

### NOTE

Note the following conditions for this feature:

- VXLAN overlay gateways are supported only on the Brocade VDX 6740, 6740T, and 6740T-1G.
- VXLAN gateways must be in logical chassis cluster mode. This allows the virtual cluster switch to present itself as a single device to the NSX Controller, in conjunction with a VMware Hypervisor.

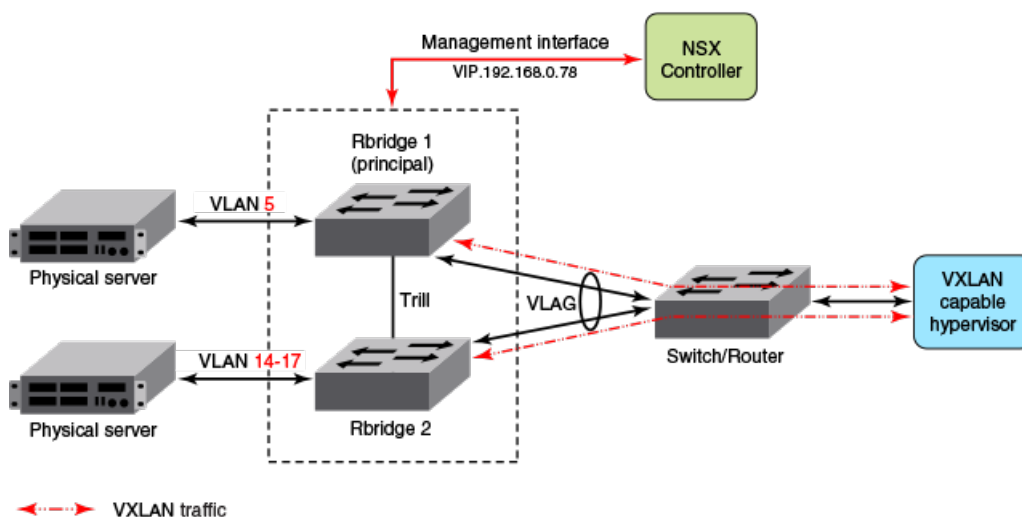
# Configuring a VXLAN overlay gateway for NSX Controller deployments

Before you configure the VXLAN overlay gateway, complete the configuration steps in [Configuring VRRP-E for NSX Controller deployments](#) on page 75. The prerequisite steps demonstrate how to configure the Rbridges as part of a Virtual Router Redundancy Protocol - Extended (VRRP-E) group, which is a requirement for a VXLAN overlay gateway. Also, you must configure the identical virtual Ethernet (VE) and VRRP-E group on all the Rbridges for the VXLAN overlay gateway.

## High-level communication in a VXLAN environment with an NSX Controller

The following illustration provides a basic view of the interaction of components in a VXLAN environment that uses an NSX Controller.

FIGURE 8 High-level communication for VXLAN overlay gateway with NSX Controller



VXLAN overlay gateways must be part of a two-node virtual switching cluster. In the example topology, Rbridge 1 and Rbridge 2 make up the two-node cluster. These two Rbridges combine to form the VXLAN overlay gateway.

The current principal switch of the VXLAN overlay gateway always communicates with the NSX Controller. This communication occurs over what is known as the management interface (depicted by the red line in the illustration).

## Coordination of activities in NSX Controller deployments

Be sure to coordinate your activities with the administrators of the virtual network and NSX Controller to help ensure a successful setup. This includes providing the NSX administrator with an inventory of switches, ports, and VLANs in your cluster.

The NSX administrator creates the virtual network, assigns a VXLAN Network Identifier (VNI) to this network, and selects the ports that are to be attached to this virtual network. If ports on the virtual cluster switch are selected, the NSX Controller pushes network information to the switch. This information includes VNI, VLAN-to-VNI bindings for each port, and MAC-VNI-VTEP mappings for each of the MAC addresses in the virtual network. The NSX Controller is not aware of MAC addresses in the Layer 2 network behind the switch at this time.

## Configuring VRRP-E for NSX Controller deployments

The steps that follow show an example VRRP-Extended (VRRP-E) group configuration for the Rbridges shown in [Figure 8](#) on page 74. Perform all the following steps on the principal switch (Rbridge 1).

### NOTE

When the VTEP is using the VRRP-E address of a VE interface on a VLAN, then for all Layer 2 interfaces that carry that VLAN, incoming packets on that VLAN can lead to tunnel termination. Tunnel termination can also occur for incoming packets on any other VLAN if all the VE interfaces run VRRP-E (active-active) with the same VRID and same virtual MAC address.

1. Enter global configuration mode:

```
switch# config
```

2. Enter RBridge ID configuration mode for the first RBridge in the logical chassis cluster (this example uses Rbridge ID 1, as in the example topology).

```
switch(config)# rbridge-id 1
```

3. Enable VRRP-E for this RBridge.

```
switch(config-rbridge-id-1)# protocol vrrp-extended
```

4. Enter the **interface ve** command to configure a virtual Ethernet (VE) interface for RBridge 1 (for example, 10) that corresponds to an already created VLAN, and enter the IP address and mask for the interface (for example, 10.60.60.3/24):

```
switch(config-ve-10)# ip address 10.60.60.3/24
```

5. Enter the **no shutdown** command to enable the interface.

```
switch(config-ve-10)# no shutdown
```

6. Enter the **vrrp-extended-group** command for the group ID (100 in this example) of the VRRP-E group.

```
switch(config-ve-10)# vrrp-extended-group 100
```

7. Assign a virtual MAC address by entering the **virtual-mac** command.

```
switch(config-vrrp-extended-group-100)# virtual-mac 02e0.5200.00xx
```

8. Enter a virtual IP address of the VRRP-E group, as in the following example.

```
switch(config-vrrp-extended-group-100)# virtual-ip 10.10.10.230
```

9. Enable short-path forwarding on the virtual router.

```
switch(config-vrrp-extended-group-100)# short-path-forwarding
```

10. Exit this configuration mode and enter global configuration mode.

```
switch(config-vrrp-extended-group-100)# end
switch# configure
```

11. Enter RBridge ID configuration mode for the other RBridge in your logical chassis cluster (Rbridge 2 in the example topology).

```
switch(config)# rbridge-id 2
```

12. Enable VRRP-E for this RBridge.

```
switch(config-rbridge-id-2)# protocol vrrp-extended
```

13. Enter the **interface ve** command to configure the same VE interface as for RBridge 1.

```
switch(config-rbridge-id-2)# interface ve 10
```

14. Enter the IP address and mask for RBridge 2 for this VE interface (for example, 10.60.60.4/24).

```
switch(config-Ve-10)# ip address 10.10.10.4/24
```

15. Enter the **no shutdown** command to enable the interface.

```
switch(config-Ve-10)# no shutdown
```

16. Enter the **vrrp-extended-group** command with the group ID of the VRRP-E group used on the other RBridge.

```
switch(config-Ve-10)# vrrp-extended-group 100
```

17. Enter the **virtual-mac** command and assign the virtual MAC address used on RBridge 1.

```
switch(config-vrrp-extended-group-100)# virtual-mac 02e0.5200.00xx
```

18. Enter a virtual IP address for the VRRP-E group, as in the following example.

```
switch(config-vrrp-extended-group-100)# virtual-ip 10.10.10.230
```

19. Enable short-path forwarding on the virtual router.

```
switch(config-vrrp-extended-group-100)# short-path-forwarding
```

## Configuring a loopback interface VTEP for NSX Controller deployments

As an alternative to the VRRP-E method, you can configure a loopback interface to serve as a VTEP.

Do the following to configure a loopback interface as a VTEP.

### NOTE

You must manually configure distinct router IDs, by means of the **ip router-id** command, for use by routing protocols.

1. Enter VXLAN overlay gateway configuration mode.

```
switch(config)# overlay-gateway gateway1
```

2. Use the **ip interface** command to specify a loopback interface.

```
switch(config-overlay-gw-gateway1)# ip interface loopback 25
```

### NOTE

When a VXLAN gateway is active (as configured by means of the **activate** command in VXLAN overlay gateway configuration mode), the loopback interface cannot be deleted. You must first use the **no activate** command.

## Configuring the VXLAN gateway for NSX Controller deployments

The following steps detail how to configure a VXLAN overlay gateway and point it to the NSX Controller. This procedure references [Figure 8](#) on page 74.

Perform all the following steps on the principal switch (Rbridge 1 in the example topology).

**NOTE**

A tunnel will not be created if there is no active VM on the Hypervisor. If the tunnel is not created, check the VM connectivity on the Hypervisor.

1. The following substeps create a VXLAN Network Identifier (VNI) tunnel endpoint (VTEP).
  - a) Enter global configuration mode, then enter the **overlay-gateway name type nsx** command.

**NOTE**

The **type nsx** keywords are required to specify that this deployment uses an NSX Controller. The name "gateway1" is only an example; this can be a name of your choice.

```
switch# config
switch(config)# overlay-gateway gateway1
```

- b) Enter the **attach rbridge-id** command to attach existing RBridge IDs to this VXLAN gateway instance. You can specify a range of RBridge IDs up to a maximum of four.

```
switch(config-overlay-gw-gateway1)# attach rbridge-id add 1-2
```

- c) Enter the **ip interface ve veid vrrp-extended-group group-ID** command to set the IP address of the VXLAN overlay gateway, as shown in the following example.

```
switch(config-overlay-gw-gateway1)# ip interface ve 10 vrrp-extended-group
100
```

The command accepts the VE interface ID and VRRP-E group ID, then sets the VXLAN overlay gateway's IP address as identical to the already configured VRRP-E virtual IP address. Tunnels that form use this IP address as the source IP address for outgoing packets.

- d) Enter the **attach vlan vlan\_id** command to export the desired VLANs (these are VLANs that can be mapped to VXLAN domains), as shown in the following example.

```
switch(config-overlay-gw-gateway1)# attach vlan 5,14-17
```

All the MAC addresses that the VXLAN overlay gateway learns on these VLANs are shared with the NSX Controller. When a MAC address ages out in VCS, the MAC address is removed from the NSX Controller.

**NOTE**

There is also an option to list specific MAC addresses. In this case, other MAC addresses that are learned for the VLAN are not shared with the NSX Controller. For more information, refer to the **attach vlan** command in the *Network OS Command Reference*.

- e) Optional: (Optional) You can enter the **enable statistics direction** command to enable statistics collection for tunnels you specify, as shown in the following example.

```
switch(config-overlay-gw-gateway1)# enable statistics direction both vlan
add 14-17
```

This example command enables statistics collection for tunnels in both directions (transmitting and receiving) for the specified VLANs.

- f) Optional: If you have created a SPAN destination outside of the VXLAN overlay gateway (as a monitor session), you can enter the **monitor session** command to monitor session traffic, as shown in the following examples.

```
switch(config-overlay-gw-gateway1)# monitor session 1 direction both
remote-endpoint 1.2.3.4 vlan add 41-43
```

```
switch(config-overlay-gw-gateway1)# monitor session 1 direction both
remote-endpoint any vlan add 41-43
```

- g) Enter the **activate** command to activate this gateway instance.

```
switch(config-overlay-gw-gateway1)# activate
```

This enables all tunnels associated with this gateway. VXLAN tunnels are not user configurable.

- h) Return to privileged EXEC mode.

```
switch(config-overlay-gw-gateway1)# end
switch(config)# end
switch#
```

2. Generate the security certificate for the VXLAN overlay gateway by entering the **nsx-controller client-cert generate** command.

#### NOTE

Certificate generation is a one-time-only action.

```
switch# nsx-controller client-cert generate
```

3. In privileged EXEC mode, display the certificate by entering the **show nsx-controller client-cert** command, then provide the certificate to the NSX administrator.
4. The following substeps configure the management interface (depicted by the red line in [Figure 8](#) on page 74), which allows communication between the VXLAN gateway and the NSX Controller:
- a) Enter global configuration mode.

```
switch# config
```

- b) Enter the **vcs virtual ip address** command and assign an IP address and mask.

```
switch(config)# vcs virtual ip address
192.168.0.78/24
```

- c) Enter the **nsx-controller name** command to specify a name for a new NSX Controller connection profile:

```
switch(config)# nsx-controller profile1
```

- d) Enter the **ip address** command to set the IP address of the controller, the port, and connection-method settings for an NSX Controller connection profile as shown in this example.

```
switch(config-nsx-controller-profile1)# ip address 10.21.83.188
```

- e) Optional: You can change the reconnect interval between the NSX Controller and the VCS Fabric in case the connection is lost. The default is 10 seconds, meaning that a reconnection is attempted every 10 seconds. To change this interval to 40 seconds, for example, use the **reconnect-interval** command:

```
switch(config-nsx-controller-profile1)# reconnect-interval 40
```

- f) Finally, enter the **activate** command to activate the NSX Controller profile.

```
switch(config-nsx-controller-profile1)# activate
```

This command initiates the connection between the NSX Controller and the VCS Fabric.

## Additional commands for VXLAN configuration

For complete information on the those commands as well as other VXLAN overlay-gateway commands and commands related to the NSX Controller, refer to the *Network OS Command Reference*.

Some additional supporting commands are listed in the following table:

**TABLE 9** Additional commands for VXLAN configuration

Command	Description
<b>clear overlay-gateway</b>	Clears counters for the specified gateway.
<b>enable statistics</b>	Enables statistics for tunnels.
<b>sflow remote-endpoint</b>	Applies an sFlow profile for a VXLAN overlay gateway and sets the remote endpoints for tunnel interfaces.
<b>show nsx controller</b>	Displays connection status of the NSX Controller. Includes an option to display the gateway certificate that is needed for NSX "transport node" configuration.
<b>show overlay-gateway</b>	Displays status and statistics for the VXLAN overlay-gateway instance.
<b>show tunnel</b>	Displays tunnel statistics.





# Configuring Virtual Fabrics

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- [Configuring and managing Virtual Fabrics.....](#) 101

## Virtual Fabrics overview

The Virtual Fabrics feature delivers Layer 2 Multitenancy solutions that provide support for overlapping VLANs, VLAN scaling, and transparent VLAN services by providing both traditional VLAN service and a transport service. These services are offered by provisioning a Virtual Fabric (VF) in the data center. A VF operates like a regular 802.1Q VLAN, but has a 24-bit address space that allows the number of networks to scale beyond the standard 4K (4096) limit. The transport service is provided by configuring a transport VF, whereas traditional Layer 2/Layer 3 VLAN service is provided by configuring a service VF.

The Virtual Fabrics feature is deployed in data centers where logical switch partitioning and server virtualization require a large number of customer VLAN domains that must be isolated from each other in the data plane. On the hardware platforms that support this feature, the Brocade VDX 8770 series and the Brocade VDX 6740 series running Network OS release 4.1.0 or later, the VLAN ID range is extended from the standard 802.1Q limit of 4095, to extend through 8191 on both a local RBridge and in a single VCS Fabric.

Data center virtualization, such as that provided by VMware vCenters, challenges network design in a variety of areas. Large numbers of networks can be required to support the virtualization of server hosts and multiple-tenant virtual machines (VMs), with Ports on Demand (POD) for the virtual data center (vDC) leading to POD configurations replicated at different ports. Such virtualization topologies are inherently largely independent of physical networks, with VM network configurations decoupled from the addressing and configurations of physical networks. The underlying Layer 2/Layer 3 infrastructure is an extension of a VMware virtual switch, or vSwitch, requiring address mapping at the boundary between the physical and virtual networks. In addition, the requirement for VM mobility makes it necessary to support the migration of VMs across the Virtual Cluster Switching (VCS) data center or across geographically separated sites, independently of the connectivity of the underlying infrastructure.

When a fabric is VF-enabled, existing VLAN configurations can apply to any VLAN. When a fabric is not VF-enabled, VLAN classification is not supported, and VLAN configurations are 802.1Q VLANs with VLAN IDs 1 through 4095.

A Virtual Fabric is just like a regular 802.1Q VLAN, but with a 24-bit address space that has the potential to support up to approximately 16 million VLANs to be provisioned in the fabric. This VF VLAN address space is common to regular 802.1Q VLANs and classified VLANs. VLAN IDs from 1 through 4095 identify a conventional 802.1Q VLAN. VLAN IDs greater than or equal to 4096, up through 8191, identify VFs that need frame classification. A VF VLAN ID is unique within a local VCS Fabric, but may not be unique across multiple VCS Fabrics.

### NOTE

A service VF is defined on the basis of the encapsulation classification of the ingress frame, with frames classified at the edge port according to the 802.1Q VLAN ID or MAC address. For the same service VF, the 802.1Q classification rule at each interface is a link-local configuration; the rule may be different at each interface.

A service VF thus represents a virtualized, normalized VLAN domain, where different link-protocol VLAN identifiers (port number, MAC address, and customer VLAN ID, or C-VID) are mapped to the same VLAN. In other words, VMs on the same service VF belong to the same forwarding domain, even though the attachment interfaces use different classification rules. When a VM moves among these interfaces, the Layer 2 forwarding domain does not change.

Extending a service VF among VCS data centers makes it possible to migrate VMs across those data centers.

## Virtual Fabrics features

The following VLAN switch-port configurations are supported:

- Regular 802.1Q configuration (VLAN IDs 1 through 4095, with the exception of reserved VLANs)
- VLAN classification by means of a 802.1Q tag at the trunk port
- VLAN classification by means of a source MAC address at the access port

The following standard VLAN features remain supported by the service VF feature:

- Private VLANs (PVLANS)
- Layer 3 virtual Ethernet (VE) interfaces
- VLAN classifiers
- IGMP snooping
- VLAN ACLs
- Automatic Migration of Port Profiles (AMPP)
- RSPAN
- xSTP

In addition, support is now provided for transport service VFs, enabling a provisioning model in which a specific group of 802.1Q VLANs at an interface is classified into a common forwarding domain.

The maximum number of VLANs supported in this release, 802.1Q and classified, is as follows:

- There is fabric-wide support for 8K VF instances. The number of VFs supported on a local switch is platform-dependent.
- In a pure transport service deployment, port-based transport VFs are supported on every edge port, with up to 2048 VLANs (both 802.1Q and classified) across all ports.

For additional scalability details, refer to [Virtual Fabrics performance considerations](#) on page 85.

For example topologies and detailed discussion, refer to [Virtual Fabrics configuration overview](#) on page 84.

### NOTE

Beginning with Network OS release 5.0.0, support is added for conversational MAC learning (CML) on classified VLANs as well as on 802.1Q VLANs. For an overview and applicable configuration examples, refer to [Conversational MAC learning](#) on page 66.

## Virtual Fabrics considerations and limitations

### *FGL limitations*

Support is provided for pre-IETF standard Fine-Grained Labeling (FGLs) on ISLs. IETF defines the Ethertype for inner and outer labels as 0x893B. The outer and inner Ethernets on ISLs are set to 0x893B and 0x8100, respectively.

### *FCoE VLAN limitations*

FCoE VLANs can be only 802.1Q VLANs. All tenant FCoE traffic rides on the same default FCoE VLAN, 1002. This is the same as in previous releases. An FCoE VLAN can be used as a classification tag on a port if it is not configured as an FCoE port.

## STP support

The correct configuration of xSTP is the responsibility of the user. Much as the user must ensure that VLAN configurations and VLAN instance mappings are consistent on all switch ports, so also the user must understand whether a specific protocol, whether RSTP, MSTP, or PVST, is applicable to the underlying physical topology when 802.1Q VLANs and VFs coexist in the fabric.

## Brocade VDX 6740 series limitations

The Brocade VDX 6740 series platforms do not support full port-based C-TAG translation. Whenever there is a translation conflict among the ports because the same C-TAG is used for different VLANs, the conflict cannot be resolved without incurring severe internal VLAN ID (IVID) scalability constraints. Optimal scalability is possible only when overlapping C-TAG classification occurs across port groups.

In a pure service VF deployment, these platforms support up to 4096 802.1Q VLANs and 2048 classified VLANs, assuming that each VLAN configured on a single port constitutes a single conflict.

In a pure transport VF deployment, these platforms support port-based transport VFs on every edge port, and a total of 2048 combined 802.1Q and classified VLANs, assuming that each VLAN is configured on a single port.

## VCS extension through VXLAN

Network OS 5.0.0 and later supports the use of VFs by means of VXLAN Layer 2 extension, to extend a VCS fabric to another VCS fabric.

## High Availability considerations

In-Service Software Upgrade (ISSU) and High Availability (HA) are supported for this feature on the Brocade VDX 8770 series, but not on the Brocade 6740 series.

# Virtual Fabrics upgrade and downgrade considerations

The following Virtual Fabric upgrade and downgrade considerations need to be kept in mind.

## Virtual Fabrics backward compatibility

In Network OS release 4.1.0, the Virtual Fabrics feature is capable of support both regular 802.1Q and VF configurations. R Bridges that upgrade to Network OS 4.1.0 will continue to support 802.1Q configurations that exist in the fabric.

## Virtual Fabrics forward compatibility

The Virtual Fabrics feature is supported on Brocade VDX 6740 series, and VDX 8770 series platforms beginning with Network OS 4.1.0. However, whether VF configuration is permitted on these platforms is a global fabric-wide decision, and is not a platform-based decision. VF configuration is permitted only when a fabric consists of VF-capable R Bridges running in logical chassis cluster mode.

In earlier releases, every 802.1Q VLAN had to be configured on every R Bridge. This configuration had to be applied to every R Bridge, even when that R Bridge serves as a transit and did not terminate the VLAN. This is because the R Bridge only forwarded frames on an Inter-Switch Link (ISL) that were associated with a configured VLAN. Beginning with Network OS 4.1.0, this restriction does not apply. In logical chassis cluster mode, VLAN configurations are automatically distributed to all nodes; the user does not have to configure VLANs on transit R Bridges. A transit R Bridge can always forward VLAN frames that arrive on an ISL. If the frame exists in the fabric, it must have been allowed to enter the fabric at the edge. In fabric cluster mode, Network OS 4.0.0 configuration rules still apply; the user must configure VLANs on every R Bridge.

## Virtual Fabrics operations

This section summarizes the fundamental behavior of Virtual Fabrics.

### *Enabling and disabling a Virtual Fabric*

Virtual Fabrics can be enabled only in logical chassis cluster mode. In a VF-incapable fabric, ISL encapsulation is based on C-TAGs. In a VF-enabled fabric, ISL encapsulation is based on Fine-Grain Labels (FGLs), using both C-TAGs and S-TAGs. The VF is enabled only when the user issues the **vcs virtual-fabric enable** command. This enables the transition from one encapsulation type to another without disrupting existing traffic.

#### Enabling VFs

To ensure that there is no data disruption, the ISL encapsulation transition must be coordinated at the fabric level without toggling the link state. When the fabric is in a VF-capable state, the user executes the fabric-wide **vcs virtual-fabric enable** command to enable this transition. The command is distributed to all R Bridges in the fabric and is executed in multiple stages across nodes.

#### NOTE

If the fabric state is VF-incapable, the **vcs virtual-fabric enable** command will not succeed.

#### Disabling VFs

To disable VFs in the fabric, the user must first remove all VF configurations in the fabric before issuing the **no vcs virtual-fabric enable** command. This command is distributed to all R Bridges in the fabric. Each R Bridge reverses the stage execution from what was done to enable the VF. When ISL encapsulation returns to being C-TAG based, the fabric is in a VF-capable state.

#### NOTE

Prior to issuing the **no vcs virtual-fabric enable** command, the user must ensure that all new commands and enhanced commands that reference VFs (VFs with IDs greater than 4095) in the fabric are removed from the running configuration. Otherwise, the command will be rejected.

### *Joining a switch to the fabric*

If VFs are disabled in the startup configuration, the R Bridge will not be able to join a VF-enabled fabric upon reboot. Although the R Bridge may form ISLs with a neighbor R Bridge at the link level, the R Bridge will be segmented from the VF-enabled cluster because of a capability mismatch.

In order for the R Bridge to join a VF-enabled cluster, the procedures described in the "Upgrading and downgrading firmware with Virtual Fabrics" task must apply to the segmented R Bridge. At the end of the procedures, the segmented R Bridge will also be in the VF-enabled state. All segmented ISLs on the R Bridge are automatically toggled so that it can rejoin the fabric.

### *Default Virtual Fabrics state*

A switch after a **netinstall** is VF-incapable in the default configuration. It will fail to join a VF-enabled cluster when it reboots.

The default VF state in the startup configuration is changed when the **copy default-config startup-config** command is executed. The resulting state is the same as the current VF state of the fabric.

## Virtual Fabrics configuration overview

This section addresses a variety of Virtual Fabrics architecture scenarios and configuration issues related to service VFs.

## Virtual Fabrics performance considerations

VLAN configurations, whether for 802.1Q or classified VLANs, are VCS Fabric global configurations that are distributed to all R Bridges in the fabric. If there are 100K VLANs in the data center, this implies that as R Bridge will receive all those configuration, even though the R Bridge could support a maximum of 8K (8192) VLANs. The processing of VLAN configurations for classified VLANs that are not actually provisioned in the R Bridge introduces performance overhead. The impact of this will be manifest in configuration playback during system boot up and will result in a longer time for the fabric to reach a ready state to forward data.

## Feature scalability

The scalability numbers of VLAN features remains same as in the previous release. The following lists VF resource numbers for the Brocade VDX 8770 series and VDX 6740 series.

**TABLE 10** VF resource numbers for Brocade VDX 8770 and VDX 6740 series

Resources	VDX 8770 series	VDX 6740 series
802.1Q VLANs per switch	8192	4096
VFs per switch	8192	2000
VFs per fabric	8192	8192
MAC-based classifications per switch	8192	256
Service VF with overlapping C-TAG (best case)	8192	2000
Service VF with overlapping C-TAG (worst case)	8192	64
AMPP port profiles	1000	1000
Transport VFs (best case)	1000	1000
Transport VFs (worst case)	1000	178

## Maximum number of VLANs

The target number of VLANs supported is 8K at a local R Bridge. These may be traditional 802.1Q VLANs or service VFs. Below are some factors that determine the actual number of VLAN IDs that are configurable on a local R Bridge constrained by the availability of ASIC resources to support internal VLAN IDs (IVIDs).

### AMPP port-profile provisioning

When a port becomes a profile-port, IVIDs are allocated internally for VLANs that are defined in a port-profile domain associated with the interface or VLANs that are defined in the port-profiles associated with the interface. These resources are consumed before the VLANs are provisioned, underutilizing the IVID resources if a VM does not appear on these VLANs. The overbooked IVIDs will not be available for VLANs configured by the **switchport** command.

### Number of VE interfaces

The **interface ve** command creates a VE interface on a specified VLAN on a specified R Bridge. Because the VLAN flood domain must extend within the VCS Fabric by means of ISLs for routing purposes, an IVID must be allocated for the VLAN even though the VLAN is not configured on any local R Bridge switch ports, imposing a scalability issue. Each VE interface consumes an IVID from the resource pool. The total number of interfaces (without switch ports) and VLANs that are provisioned cannot exceed 8192 on the VDX 8770 series and VDX 6740 series.

### Number of VLAN ACLs

A VLAN ACL requires an IVID allocation for the target VLAN. If the target VLAN is configured on the local switch port, the ACL can be applied on the IVID for this VLAN. However, on the switch where the VLAN is transiting (that is, it is not configured on any switch port), an IVID must still be allocated for the ACL entry. The maximum number of VLANs that can be configured on the switch is determined by the maximum number of IVIDs minus the number of transit VLAN ACLs that are configured on the switch.

### Brocade VDX 6740 series limitations

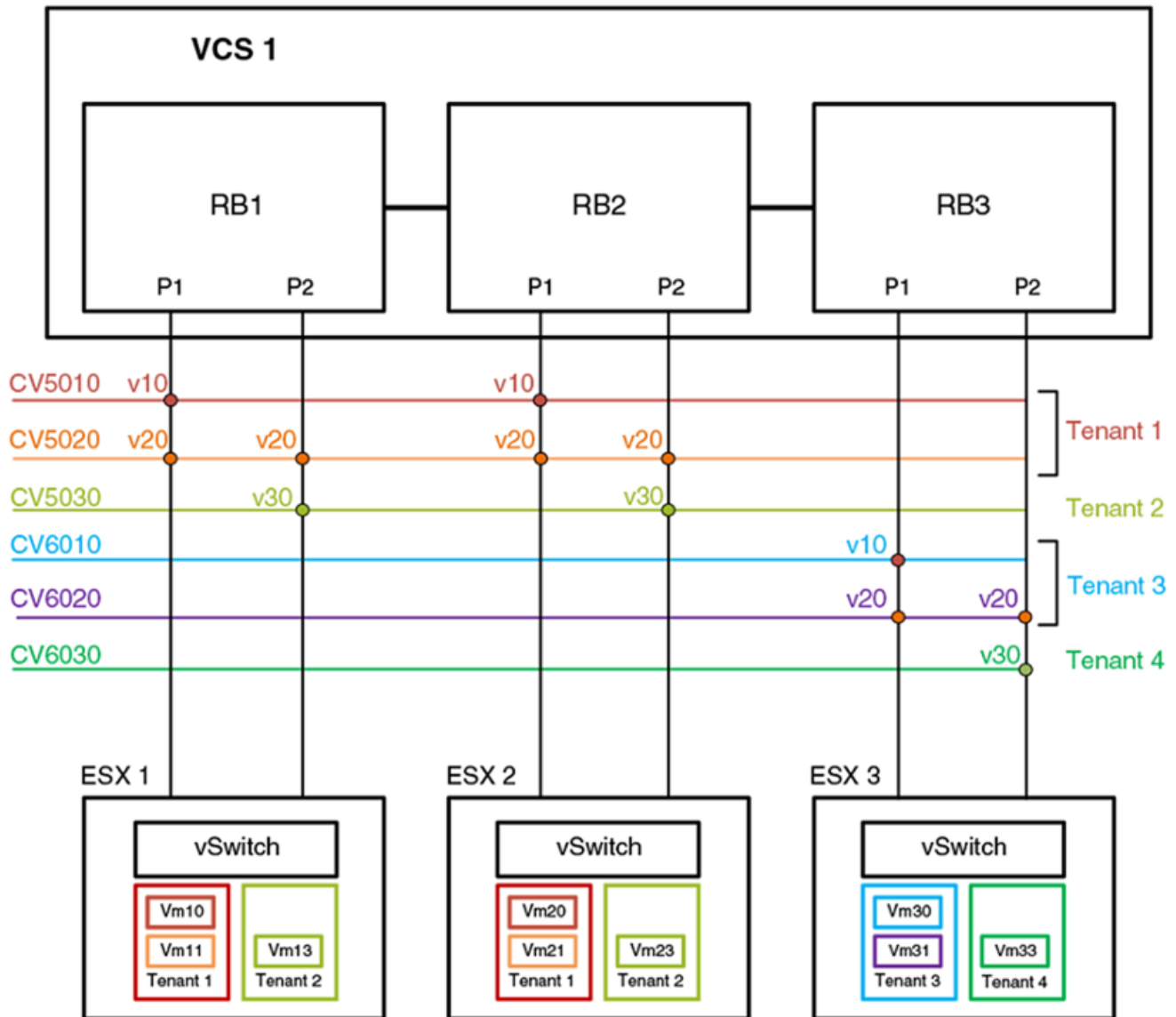
The Brocade VDX 6740 series RBridge supports a total of 6096 (4096 + 2000) VLANs, 4096 of which must be 802.1Q VLANs. The other 2000 VLANs can be configured as service VFs, assuming that the VLAN is configured on a single port. This limitation comes from the VPN table size on this platform.

### VLAN virtualization

When a cloud computing provider provisions a virtual datacenter by replicating server-rack ports on demand (PODs) across server ports, different tenant domains exist but with overlapping 802.1Q VLANs at the server ports. The tenant domains are isolated by mapping the 802.1Q VLAN at each interface into a different VLAN forwarding domain. This capability allows the switch to support more than the 4K VLANs permitted by the 802.1Q address space.

In the example VMware topology shown in the following figure, the data center has three PODs, provided by RBridges RB1, RB2, and RB3. All three PODs (VMware ESXi hypervisors 1 through 3) have an identical pre-installed configuration. Each POD supports two tenants. The first tenant can have two applications running on VFs 10 and 20. The other tenant has only one application, running on VF 30. Here, four tenant applications are provisioned. Tenant 1 and 2 applications run on ESX1 and ESX2. Tenant 3 and 4 applications run on ESX3.

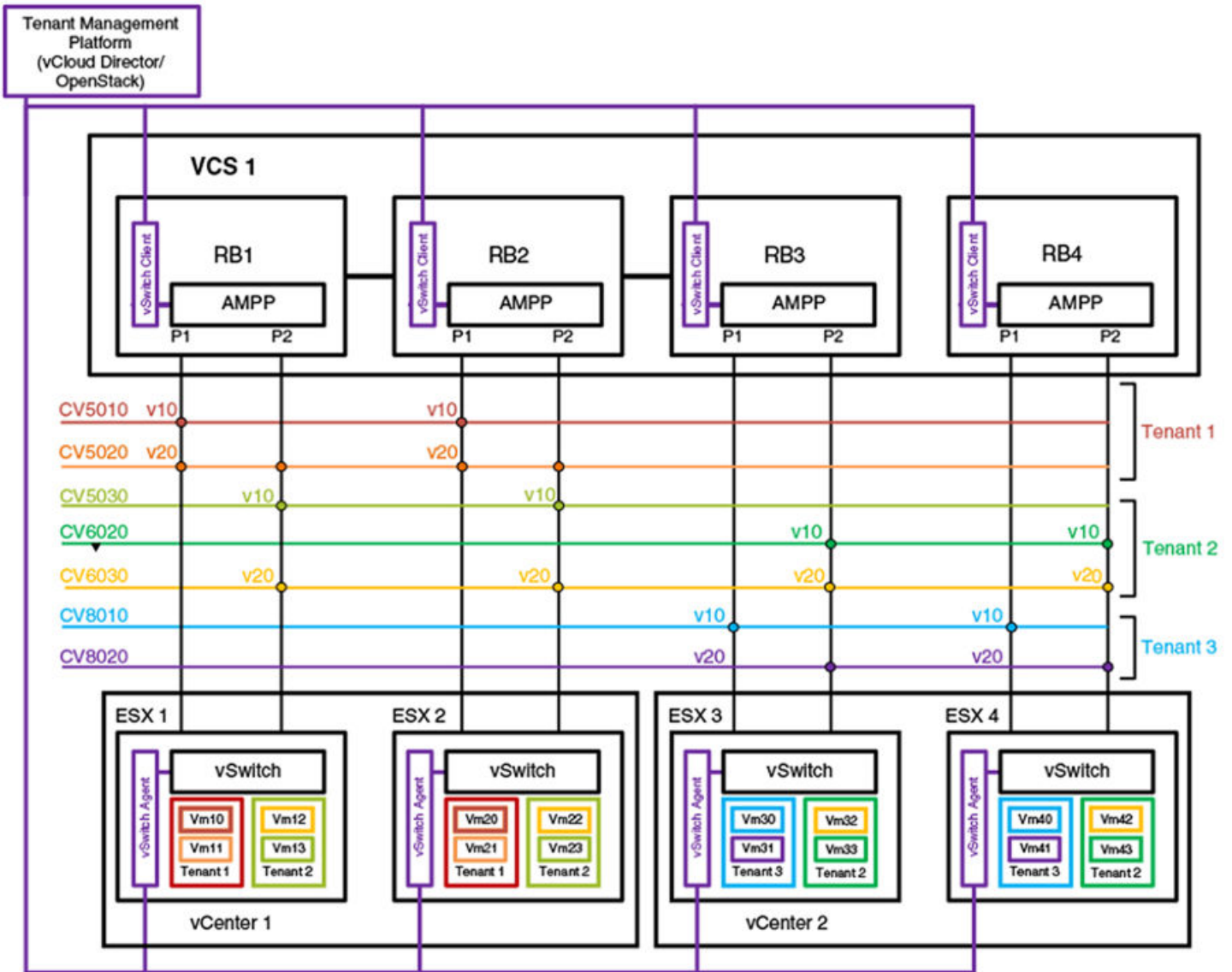
FIGURE 9 VLAN virtualization



### Virtual data center deployment

The following figure illustrates an example VDC infrastructure that supports a VMware deployment.

FIGURE 10 VDC infrastructure



In a VMware-based cloud provider network, a VCS Fabric is connected to multiple vCenters, where each data center manages its own set of tenant networks. VMware vCloud/OpenStack is responsible for orchestrating tenant VLAN configuration through the vCenter agent integrated into a VCS RBridge and its ESXi servers. Each data center connects to the VCS Fabric by means of dedicated edge ports. The ability of the VCS Fabric to support 802.1Q VLAN virtualization allows each data center to support more than 4000 tenant VLANs. ESXi servers may use the same 802.1Q VLAN to represent different tenant VLANs at the edge port, or have them belong to a single VLAN domain. A vCenter agent running at an RBridge achieves VLAN virtualization by collating information obtained from the ESXi servers and the vCenter database. AMPP port profiles with service VF classifications are configured on the respective server ports.

The topology in the figure shows two vCenters. vCenter1 is connected to VCS RBridges1 and2. Because the VCS Fabric supports VLAN virtualization, the vCenter can assign two tenant networks, CV5010 and CV5030, that use the same 802.1Q VLAN (VLAN 10) on the ESXi server. Similarly, in vCenter2, three tenant VLANs –CV5030, CV6020, and CV8010– are configured, each representing a unique VLAN domain, but all using the same customer classification, C-TAG 10. If a VM application needs to run across applications,



then the same service VF can be configured on both vCenters; this is illustrated by CV6030, which is configured at all RBridges and uses the same C-TAG (C-TAG 20).

The service VF configuration at each edge port can be done as part of an AMPP configuration or automatically through vCenter orchestration. (Refer to VMware documentation for details of the vCenter Orchestrator.)

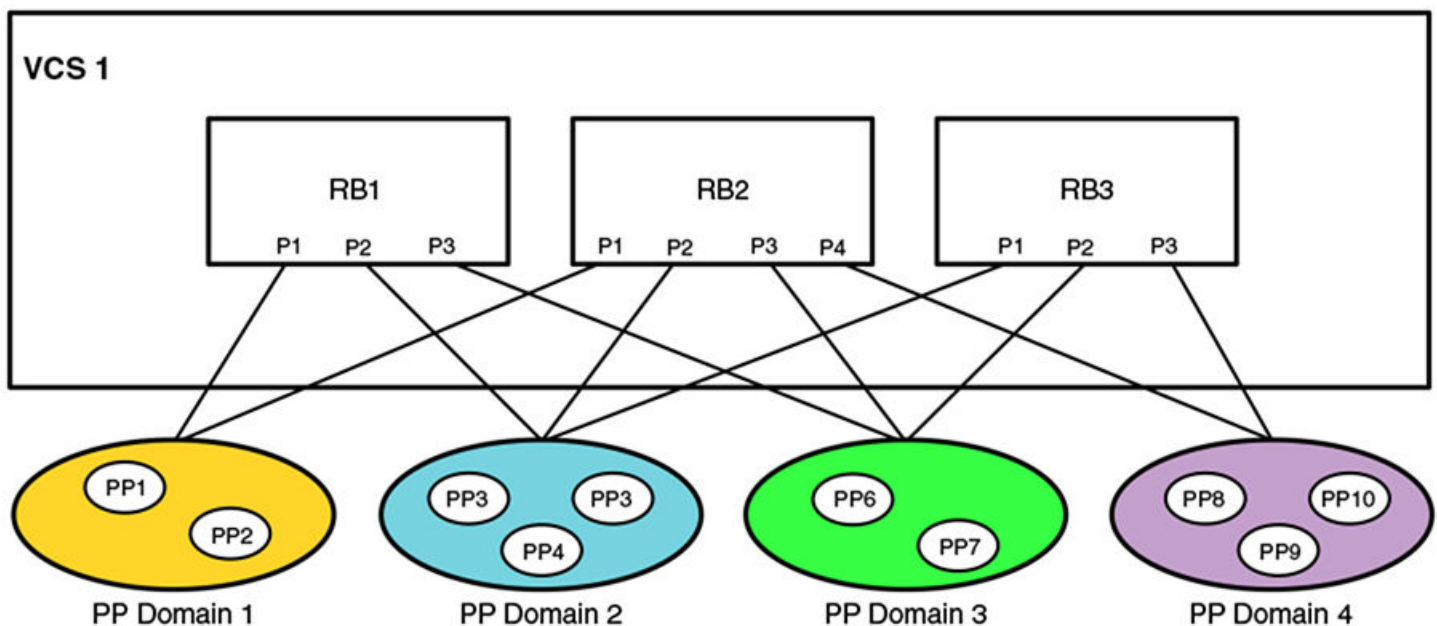
### AMPP provisioning with service VFs

When the Automatic Migration of Port Profiles (AMPP) feature is used in Network OS 4.1.0 and later, a VCS Fabric is partitioned into port-profile (PP) domains. A PP domain is a set of port-profiles whose service VF ID cannot have conflicting C-TAG or MAC classifications. A port-profile domain supports a maximum of 4096 service VFs. The scope of VM mobility is defined by the set of interfaces onto which the port-profile domain is applied.

### Port-profile domain topology

The following illustrates an example VCS Fabric that serves four port-profile domains across three RBridges.

FIGURE 11 Port-profile domains



### Port-profile configuration rules

The VLAN classifications in a port-profile domain follow these rules:

1. Each profiled-port is associated with a port-profile domain. Different profiled-ports (on the same RBridge) may belong to different domains.
2. The same port-profile may be associated with multiple domains.
  - a. This allows a service VF that is defined in one domain to extend into another domain.
  - b. The VM MAC address must be unique within a domain.

3. The service VF classification rules within a domain are as follows:
  - a. MAC-based classification is allowed only on an access port.
  - b. C-TAG classification is allowed only on a trunk port
  - c. Service VF classification cannot overlap across port-profiles in the same port-profile domain.
  - d. Classification can overlap across PP domains.
4. The following example configurations are allowed for classification across all port-profiles in the same domain:
  - a. **switchport trunk allow vlan add 5000 ctag 10**
  - b. **switchport trunk allow vlan add 6000 ctag 20**
  - c. **switchport trunk allow vlan add 7000 ctag 30**
5. The following example configurations are allowed for MAC-based classification on an access port:
  - a. **switchport access vlan 8001**
  - b. **switchport access vlan 8002 mac 2.2.2**
  - c. **switchport access vlan 8002 mac 3.3.3**
6. The following example configurations are disallowed across all profiles in the same port-profile domain.
  - a. Overlapping VF VLANs
    - **switchport trunk allow vlan add 8000 ctag 80**
    - **switchport trunk allow vlan add 8000 ctag 800**
  - b. Overlapping C-TAG:
    - **switchport trunk allow vlan add 5000 ctag 10**
    - **switchport trunk allow vlan add 6000 ctag 10**
  - c. Overlapping MAC address across all profiles in the same domain:
    - **switchport access vlan 8002 mac 2.2.2**
    - **switchport access vlan 8003 mac 2.2.2**
  - d. Conflicting access and trunk service VF configurations:
    - **switchport access vlan 8000 mac 2.2.2**
    - **switchport trunk vlan add 8000 ctag 20**
7. The following configuration can be present on only one port-profile domain; it cannot coexist with other C-TAG-based classifications in that domain:
  - a. **switchport trunk allow vlan all**
  - b. When a port becomes a profiled-port, all service VFs in that domain are provisioned on this port.

### Port-profile backward compatibility

The AMPP port-profile-domain-based provisioning model is different from that in prior releases in two respects:

- The default port-profile configuration is not the same. The **switchport trunk allow vlan all** command that was present in prior releases has been removed. Other related configurations remain the same.
- A user-defined port-profile-domain has been introduced to support VM mobility. A port-profile must be explicitly associated with a profile domain.

In order to maintain legacy AMPP behavior when service VFs are disabled as a result of an upgrade, the following occurs:

- After upgrade, a new port-profile named UpgradedVlanProfile is auto-created. This profile has the single VLAN profile that contains the statement "switch port trunk allow vlan all". This is the configuration that is present in the pre-Network OS 4.1.1 default port-profile to resolve the provisioning differences before the service VFs are enabled.
- After upgrade, a default port-profile domain is created. This default domain contains all the existing user-created port-profiles and vCenter-created auto-profiles prior to the upgrade, in addition to the UpgradedVlanProfile.

The following rules apply to the UpgradedVlanProfile and the default port-profile domain while the switch is in the VF-disabled state after the upgrade.

- The user cannot edit the UpgradedVlanProfile.
- The newly created user port-profile or vCenter auto-profile is automatically added to the default port-profile domain.
- The deleted user or auto port-profile is automatically deleted from the default port-profile domain.
- The **show running-config** command or the **show port-profile domain** command shows the port-profiles in the default-profile-domain.
- The user is not allowed to edit the default port-profile domain.

The following rules apply after service VFs are enabled in the fabric.

- The user can edit the UpgradedVlanProfile just like any other port-profile.
- The newly created port-profile is not automatically added to the default domain. It can only be explicitly added to or removed from the default profile-domain.
- vCenter-managed auto-profiles continue to be added to or deleted automatically from the default port-profile domain.

#### NOTE

In Network OS 4.1.1 and later, the vCenter auto-profile does not support service VF classification.

- The **show running-config** command or the **show port-profile domain** command shows the port-profiles in the port-profile domain.
- The user is allowed to edit the default port-profile domain.
- The user is not allowed to delete the default port-profile-domain.

The following table compares the results of a **show running-config** command before and after an upgrade from Network OS 4.0.0 to Network OS 4.1.1 and later.

**TABLE 11** Configuration status before and after upgrade

Network OS 4.0.0	Network OS 4.1.1 and later
<pre>port-profile default allow non-profiled-macs vlan-profile switchport switchport mode trunk switchport trunk allowed vlan all switchport trunk native-vlan 1 ! fcoe-profile fcoeport default ! restrict-flooding ! port-profile ppl vlan-profile switchport</pre>	<pre>port-profile default allow non-profiled-macs vlan-profile switchport switchport mode trunk switchport trunk native-vlan 1 ! fcoe-profile fcoeport default ! restrict-flooding ! ! port-profile ppl vlan-profile switchport</pre>

**TABLE 11** Configuration status before and after upgrade (continued)

Network OS 4.0.0	Network OS 4.1.1 and later
<pre> switchport mode trunk switchport trunk allowed vlan add 11 ! ! port-profile pp2 vlan-profile switchport switchport mode trunk switchport trunk allowed vlan add 12 ! ! </pre>	<pre> switchport mode trunk switchport trunk allowed vlan add 11 ! ! port-profile pp2 vlan-profile switchport switchport mode trunk ! ! port-profile UpgradedVlanProfile vlan-profile switchport switchport mode trunk switchport trunk allowed vlan all ! port-profile-domain default port-profile pp1 port-profile pp2 port-profile UpgradedVlanProfile ! </pre>

### Association of port-profile-domains with an interface

The **port-profile-port** command allows a user to associate a port-profile-domain (default or nondefault) with an interface. The result is that all VLANs specified therein are configured onto the port.

When the **domain** keyword is not used, the default port-profile-domain is associated with an interface, as in the following example.

```

switch(config)# int te 2/0/1
switch(config-int-te-2/0/1)# port-profile-port

```

### STP with service VFs

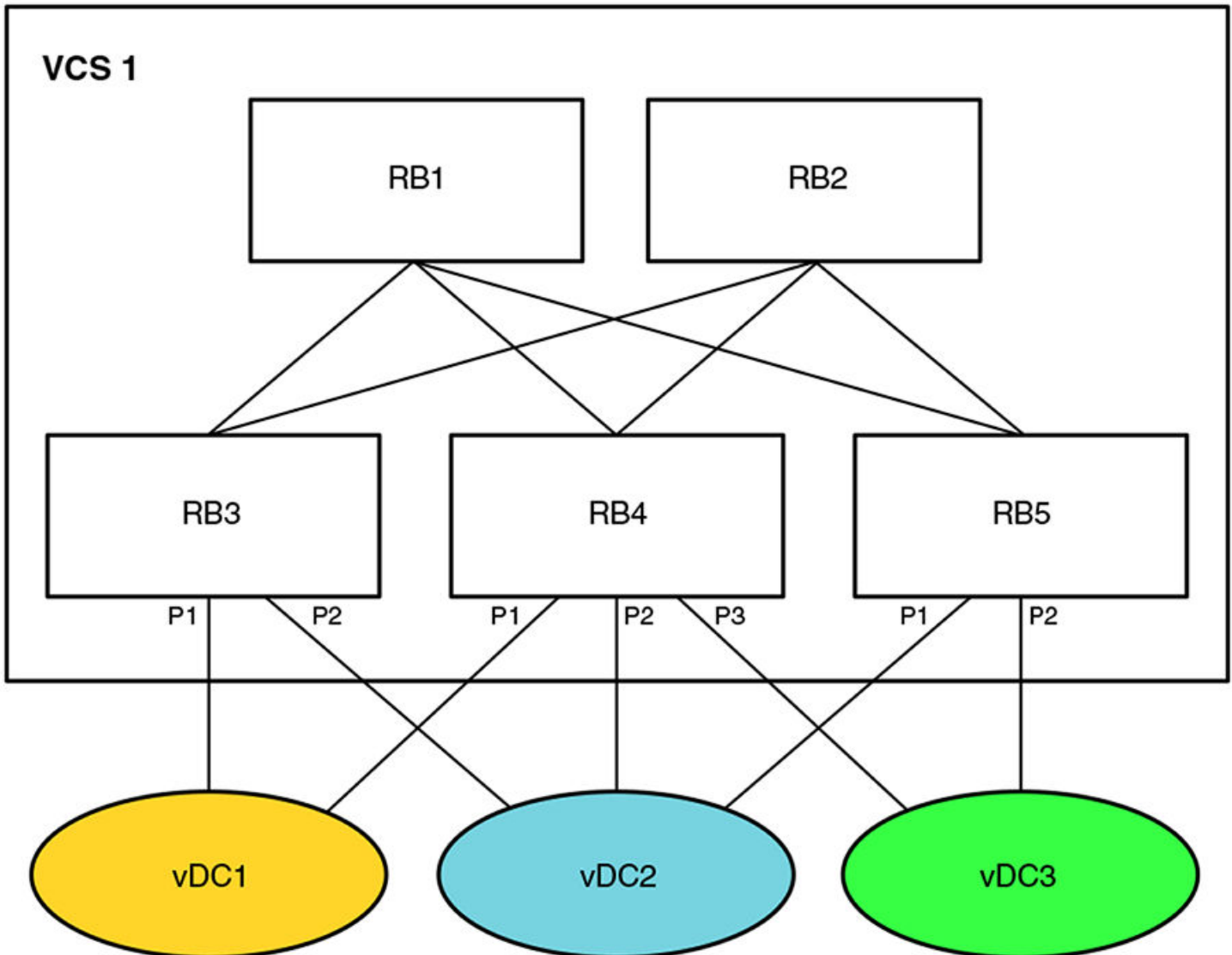
Spanning Tree Protocol (xSTP) is configured on a switch port as in previous releases. However, the user is responsible for configuring xSTP correctly. The user must ensure that VLAN configurations and VLAN-to-instance mappings are consistent across switch ports, and must understand whether RSTP or MSTP are applicable when 802.1Q VLANs and overlapping service VF classifications coexist in the fabric.

A VCS Fabric supports only a single STP domain of any protocol flavor that sends untagged BPDUs (for example, RSTP/MSTP). This domain should contain only switch ports that have identical VLAN configurations, whether 802.1Q or service VF. This is necessary for STP to operate correctly across the fabric. All other switch ports that do not participate in this domain must have STP disabled.

### STP-with-service-VFs topology

The following illustrates an example VCS Fabric that is connected to three vDCs. There must not be any external physical connectivity among the vDCs.

FIGURE 12 STP-with-service-VFs topology



### STP-with-service-VFs configuration rules

It is the user's responsibility to determine which vDC should participate in RSTP. The following behavior and rules apply:

- RSTP
  - RSTP is VLAN-unaware. Service VF configurations are allowed in each vDC.
  - A single RSTP topology is formed by the VCS Fabric (which appears as a single logical switch) and all attached vDCs.
  - A topology change in one vDC affects the topology of other vDCs.
  - Data loops between the VCS Fabric and individual vDCs are detected by this RSTP topology.
- MSTP
  - The VCS Fabric and the attached vDCs belong to the same MSTP region.
  - VLAN-to-instance mapping must be the same in the VCS Fabric and for each vDC.
  - An MSTP instance topology is formed by the VCS Fabric (which appears as a single logical switch) and all attached vDCs.

- Service VF configuration is allowed. Service VFs (VLAN IDs greater than 4095) are not assigned to any instance and are always in a forwarding state.
- A topology change in one MSTP instance for a vDC affects the topology of the same instance in other vDCs.
- Data loops between the VCS Fabric and individual vDCs are detected by each MSTP topology.

## STP participation

The default state for all VLANs (802.1Q or service VFs) is "no spanning-tree shutdown."

For RSTP, there is one RSTP instance in the VCS fabric; the protocol is still VLAN-unaware. This RSTP instance consists of switch ports that have identical VLAN configurations. The VLAN configuration may consist of 802.1Q VLANs or classified VLANs. The STP port state applies to all VLANs (802.1Q and classified) on a port. For switch ports that cannot participate in the same RSTP instance, it is the user's responsibility to shut down spanning tree on these ports. This is the case where ports have overlapping C-TAG classifications and these C-TAGs represent different service VFs.

For MSTP, the VCS Fabric is a single MSTP region. The VLAN-to-instance mapping is applicable only to 802.1Q VLANs. The MSTP VLAN digest calculation is based on 802.1Q VLANs alone. The MSTP state is applied on a port-instance basis (as in previous releases). For switch ports that cannot participate in the same MSTP instance, it is the user's responsibility to shut down spanning tree on these ports. This is the case where ports have overlapping C-TAG classifications.

Service VFs can participate only in MST instance 0 and cannot be assigned to another MST instance. When a service VF is shut down, it is assigned to an internal instance (instance 255) that is always in the forwarding state. The default state for all 802.1Q VLAN and service VFs is "no spanning-tree shutdown."

For PVST, the STP instance is on a per-service-VF basis. PVST can be enabled only on a service VF that has a classification tag. The classification tag identifies the default 802.1Q VLAN in the attached network and is carried in the PVST BPDU; it is also used to form the root RBridge ID. The service VF must have the same C-TAG classification and a nonconflicting classification with other VFs on all RBridge interfaces. This is to ensure the uniqueness of the root RBridge ID for each PVST instance. Consequently, note the following conditions:

- PVST cannot be enabled on a service VF with a VLAN ID greater than 4095 on an access port.
- PVST cannot be enabled on a trunk-mode native VLAN that has no C-TAG classification.

For edge-loop detection (ELD), the protocol instance is on a per-service-VF basis. The user can use the CLI to enable ELD for any service VF on a switch port. Because an ELD configuration applies on a port, the classification for that service VF must exist before the ELD configuration can be accepted.

## STP tunneling

BPDU tunneling can be controlled on a per-port basis by means of the existing **bpdu-drop** command. In a multitenancy environment, where a VCS Fabric could be connected to multiple STP-enabled networks, the fabric should tunnel only one instance of the STP BPDU. It is the user's responsibility to enable tunneling on ports that belong to the same STP instance. Other switch ports should have tunneling disabled.

Currently, the **bpdu drop** command controls BPDU forwarding only on the ingress port; the forwarding decision must be applied on the egress port as well. Nontagged BPDUs are tunneled on VCS control VLAN 4095. At the egress RBridge, switch ports that have BPDU tunnels disabled should be removed from the flood membership of the VLAN. For tagged BPDUs (as in PVST), a BPDU is tunneled on its own service-VF flood domain.

## PVLANS with service VFs

Private VLAN (PVLAN) configurations apply to service VFs. A service VF can be a primary or a secondary VLAN. However, before an association between the primary and secondary VLAN can be made at the trunk port, the classification of a PVLAN that is a service VF must have been configured. Based on the PVLAN type, the classification is done at the respective promiscuous or host port. That is, the classification of a primary VLAN is done at a promiscuous port, that of a community VLAN at a community port, and that of an isolated VLAN at an isolated port.

The service VF classification is required only if a port operates in trunk mode. An access port does not require classification rules. The validation that is done for the service VF corresponds to the port type.

## IP over service VFs

Layer 3 configurations are applicable to service VFs as well. The **interface ve** command for virtual Ethernet (VE) interfaces also applies to service VFs, and all commands under the **interface ve** submode are supported.

Each VE interface is mapped to a service VF, and all such interfaces share the router's MAC address.

A VE interface can be assigned to a VRF instance. Layer 3 runs per-VRF OSPF instances to exchange routes between R Bridges in a given VRF instance.

## Transport VFs

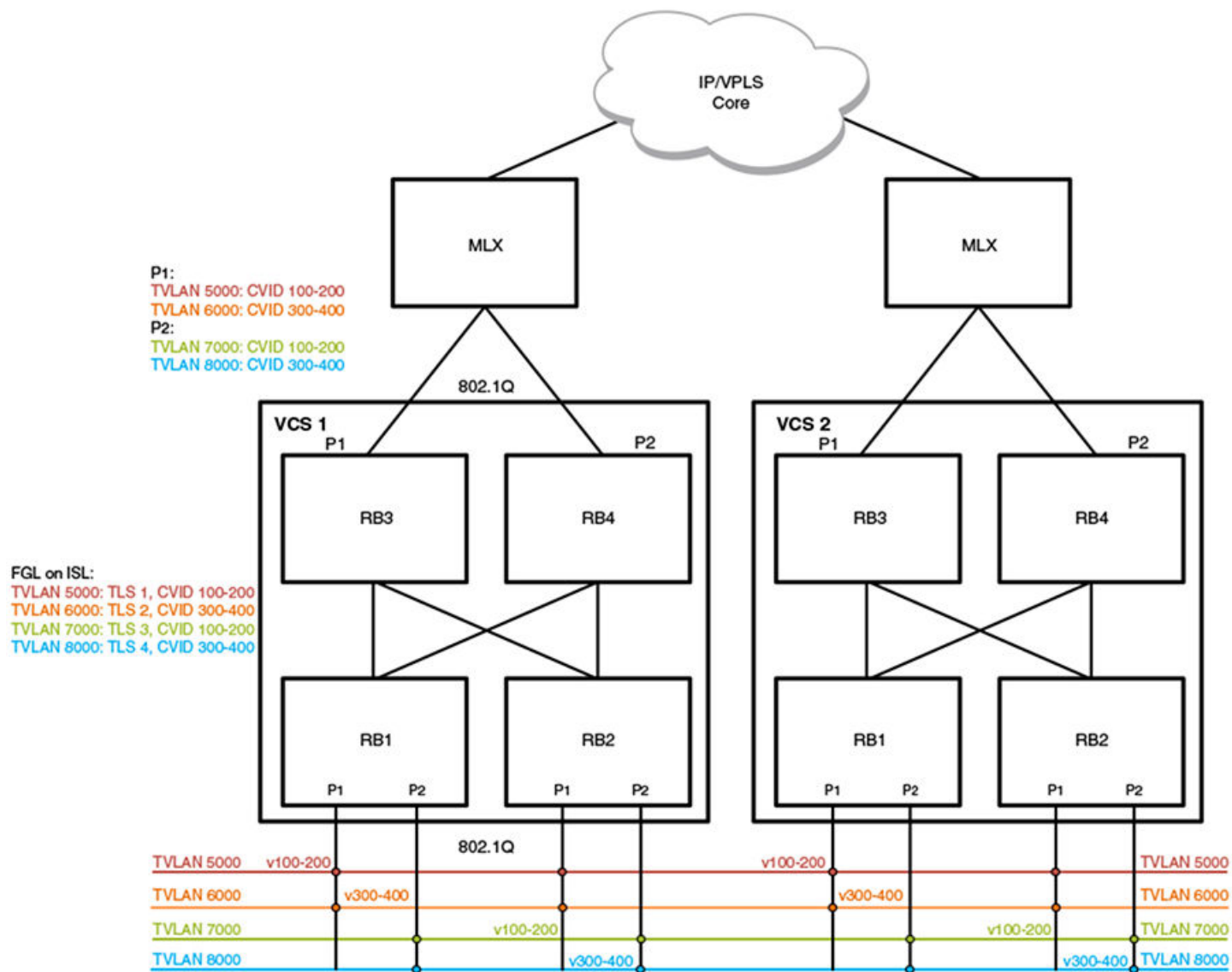
Transport service enables a cloud provider to offer service applicability on a VLAN group level, rather than at a per-individual tenant VLAN level.

The cloud-based service provider needs to provide different service-level agreements (SLAs) to support tenant needs and changes. Transport VFs enable the provider to offer services applicability on a VLAN group level, rather than at a per-individual tenant VLAN level, where the VLAN group represents a specific tenant application. Accordingly, the service offered can be associated only with a single transparent VLAN that collectively represents all the VLANs in the group that participate in supporting a given application. With transport VFs, all VLANs that support the application share the same Layer 2 forwarding domain (individual VLAN isolation is not maintained), and all end stations that participate in a given application or transport VF instance must use unique MAC addresses.

## Transport VF topology

The following figure shows four transport VF instances on the respective transparent VLANs (TVLANs) 5000, 6000, 7000 and 8000. Each transport VF carries 101 VLANs in that application. Across the transport VFs, overlapping service VFs among tenants can be supported. The transport VFs can also be extended to another VCS Fabric over a VPLS network.

FIGURE 13 Transport service



The transport VFs that can extend outside of the VCS Fabric are numbered up through 4095, bound by the 802.1Q interface. Because the extension port cannot support QinQ encapsulation, transport VFs that have overlapping C-TAGs cannot be configured on the same port. In the initial release of this feature, no Layer 2 or Layer 3 configuration is supported.

Transport VFs are created by configuring a transparent VLAN that is classified by a set of VLANs at a trunk interface. The operational model is similar to the implementation of SVL (shared VLAN learning). The forwarding behavior is that all service VFs in the transport VF instance are mapped to the transparent LAN forwarding domain (individual VLAN isolation is not maintained), and all end stations participating in the transport VF must have unique MAC addresses.



## Transport VF classification rules

The following Transport Layer Security classification rules apply:

- Transport VFs can be configured only on a trunk port, by means of the **transport-service** *tsid* command in VLAN configuration mode.
- The maximum number of transport VFs that can be configured in this release is 1000.
- Both service and transport VFs can coexist on the same port. A C-TAG is assigned exclusively to a service or transport VF.
- Multiple transport VFs can be configured on the same port.
- Control traffic is classified and handled as follows:
  - Untagged control traffic is not subject to transport VF classification rules. It is handled according to the respective protocol configuration (that is, trapped, dropped, forwarded).
  - Tagged control traffic received on a transport VF is forwarded on the transport VF domain as is data traffic. (PVST cannot be established on a transport VF and is always in the shutdown state.)
  - Tagged control traffic received on a service VF is governed by its respective protocol configuration.
- Transport VF classification can be based on any of the following:
  - A C-TAG range
  - The native VLAN
  - Default traffic (any nonmatching data traffic)
- A vXLAN VNI cannot be mapped to a transport VF.
- Layer 2/Layer 3 configurations are not supported on a transport VF. This means that AMPP/xSTP/PVLAN/RSPAN/ACL/VE configurations are not allowed on a transparent VLAN.

## Additional transport VF classification issues

The following table summarizes the classification rules that are applicable to some special VLANs and native VLANs.

**TABLE 12** Additional transport VF classification rules

C-TAG	VF classification	Transport VF C-TAG range	Transport VF default VLAN	Notes
Default VLAN 1	No	No	Yes	VLAN 1 cannot be used as a VF classification C-TAG in regular trunk mode. However, it can be used as a VF classification C-TAG in no-default-native-VLAN trunk mode.
Native VLAN	Yes	Yes	Yes	The transport VF default VLAN excludes matching any existing VLAN classification on the port. Because a native VLAN exists as the implicit classification on a trunk port, it is not classified into the default transport VF.
FCoE VLAN (1002)	Yes	Yes	Yes	An FCoE VLAN defined in the FCoE fabric-map configuration can be used as a classification C-TAG if the port is not configured as an FCoE port.
Reserved VLAN	Yes	Yes	Yes	Each platform has a certain VLAN range that is reserved for internal operations. A VLAN in this range can be used as a service or transport C-TAG if the VLAN ID is not internally configured on an edge port. (VLAN 4095 is an internal VLAN and cannot be used.)

## Service and transport VF classification with native VLANs

This section addresses two ways to classify service and transport VFs with native VLANs: a default native VLAN mode, and a nondefault native VLAN mode.

### Default-native-VLAN trunk mode

When a port is configured in normal trunk mode, a default native VLAN exists. Consequently, the native VLAN complies with the existing native VLAN configuration and forwarding behavior in this mode. The normal behavior for the existing native VLAN is as follows:

- Default native VLAN 1 exists when the port first enters this mode.
- The default native VLAN always exists (either as VLAN 1 or any 802.1Q VLAN ID) and cannot be deleted.
- A tagged native VLAN is always forwarded and cannot be discarded, unless it is blocked by STP.
- Egress tagging behavior depends on acceptable ingress frame types:
  - Tagged egress is enabled only if the acceptable ingress frame type is tagged only.
  - Untagged egress is enabled only if the acceptable ingress frame type includes untagged frames.
  - Egress tagging cannot preserve ingress frame encapsulation.

The following commands are applicable to native VLANs (802.1Q VLANs or service VFs):

- **[no] switchport trunk native vlan vid [ctag ctag]**
- **[no] dot1q tag native** (global configuration mode)
- **[no] switchport trunk tag native-vlan** (interface subtype configuration mode)

The first command is used to define a native 802.1Q VLAN or a native service or transport VF. The last two commands are used to control the ingress acceptable frame and egress tagged behavior. The 802.1Q native VLAN classifications and the role of the respective commands are summarized in the following table.

**TABLE 13** 802.1Q native VLAN classifications

Ingress allowed frame type	Egress tagging: Untagged only	Egress tagging: Tagged only	CLI commands
None	N/A	N/A	None (tagged 802.1Q native VLAN is always forwarded)
Untagged only	No	N/A	None (tagged 802.1Q native VLAN is always forwarded)
Tagged only	N/A	Yes	<b>switchport trunk native vlan vid,</b> <b>switchport trunk tag native-vlan,</b> AND <b>dot1q tag native</b>
Untagged and tagged	Yes	No	<b>switchport trunk native vlan vid,</b> <b>no switchport trunk tag native-vlan,</b> OR <b>no dot1q tag native</b>

The service VF classification rules are similar to those for native VLAN classification, but with the following exceptions:

- VLAN 1 cannot be used as a classification CTAG.
- Ingress and egress tagging behavior is controlled by the interface-level configuration, not by the global configuration.

The following summarizes the native service VF (VLAN ID > 4095) classifications that can or cannot be supported with the respective commands.

**TABLE 14** Service VF native VLAN classifications

Ingress allowed frame type	Egress tagging: Untagged only	Egress tagging: Tagged only	CLI
None	N/A	N/A	None (tagged native VLAN is always forwarded)
Untagged only	No	N/A	<b>switchport trunk native vlan vid,</b> <b>no switchport trunk tag native-vlan</b>
Tagged only	N/A	Yes	<b>switchport trunk native vlan vid ctag cvid,</b> <b>switchport trunk tag native-vlan</b>
Untagged and tagged	Yes	No	<b>switchport trunk native vlan vid ctag cvid,</b> <b>no switchport trunk tag native-vlan</b>

The following illustrates configurations that are valid or invalid in regular trunk mode.

```
(config)# int te 5/0/1
(config-if-te-5/0/1)# switchport mode trunk
(config-if-te-5/0/1)# switchport trunk native-vlan-untagged 6000
ERROR: invalid command
# VLAN 1 cannot be used as a classification tag
(config-if-te-5/0/1)# switchport trunk native-vlan 6000 ctag 1
ERROR: default vlan 1 cannot be classified to a virtual fabric
# CTAG not used elsewhere can be used
(config-if-te-5/0/1)# switchport trunk native-vlan 6000 ctag 2
# Service VF classification without C-TAG is permitted if ingress frame type allows untagged packet
# at that interface. Global mode tagging control does not apply to a service VF.
(config-if-te-5/0/1)# switchport trunk native-vlan 7000
ERROR: interface is not configured to accept untagged packet
(config-if-te-5/0/1)# no switchport trunk tag native-vlan
(config-if-te-5/0/1)# switchport trunk native-vlan 7000
```

### No-default-native-VLAN trunk mode

Another set of native VLAN classifications for service and transport VFs is available in trunk mode without the implicit creation of a default VLAN. The purpose of this trunk mode is to provide flexibility that is not available in default VLAN trunk mode and do the following:

- Provide a raw Layer 2 switchport with no VLAN configuration.
- Allow native VLAN configuration when it is needed.
- Allow the mapping of a native VLAN to a service or transport VF.
- Allow the independent specification of ingress acceptable frame type and egress tagging options.

This trunk mode differs from the default-VLAN trunk mode in the following ways:

- Default VLAN 1 is not implicitly created in this mode.
- Native VLAN commands that are applicable in default-VLAN trunk mode are not supported in this mode.
- Native VLAN commands that are applicable in this mode are not supported in default-VLAN trunk mode.

Because of the different mode behaviors, the user must be aware of the following:

- A port in default-VLAN trunk mode cannot use the new classifications. For example, an AMPP profile port operates in default-VLAN trunk mode and therefore the new classifications are not supported in this case.
- When a port is configured in this mode there is no assumption that VLAN 1 exists. The default VLAN 1 must be configured explicitly. For example, PVST VLAN 1 is not enabled on an interface unless that VLAN is configured explicitly.

The following commands are used to support different native VLAN configurations:

- **switchport mode trunk-no-default-native**

- **[no] switchport trunk native-vlan-untagged vid**
- **[no] switchport native-vlan-xtagged vid [ctag cvid] egress [tagged | untagged | any]**

The service and transport VF native VLAN classifications and the role of the respective commands are summarized in the following table.

**TABLE 15** Service and transport VF native VLAN classifications

Ingress allowed frame type	Egress tagging: Untagged only	Egress tagging: Tagged only	CLI commands
None	N/A	N/A	<b>switchport mode trunk-no-default-native</b>
Untagged only	Yes	N/A	<b>switchport trunk native-vlan-untagged vid</b>
Tagged only	N/A	Yes	Use regular VLAN classification: <b>switchport trunk allow vlan add vid [ctag cvid]</b>
Untagged and tagged	Yes	Yes	<b>switchport trunk native-vlan-xtagged vid [ctag cvid] [ctag cvid] egress [untagged   tagged   any]</b>

The following configuration rules apply in no-default-native-VLAN trunk mode.

Rules for the **switchport trunk-no-default-native** command:

- There is no automatic native VLAN configuration.
  - VLAN 1 is not created automatically when the port is configured in this mode.
  - VLAN 1 is not a default VLAN. It is just another C-TAG that is available for classification.
  - The user can explicitly create VLAN 1 to achieve a default-VLAN trunk mode configuration, by using the **switchport trunk allow vlan add vid** command.
- An untagged or unclassified frame is discarded by default.
- All switchport configurations except the following native VLAN commands in default-VLAN trunk mode continue to be supported:
  - **switchport trunk tag native-vlan**
  - **switchport trunk native vlan vlan\_id**
  - **dot1q tag native-vlan** (a global command that does not apply to a port)
- All service and transport VF configurations that are available in default-VLAN trunk mode continue to be supported. An 802.1Q native VLAN can be classified to a service or transport VF with the new commands.

Rules for the **[no] switchport native-vlan-untagged vid** command are as follows:

- This command accepts untagged packets only and allows egress untagged packets. The VLAN ID can be a regular 802.1Q VLAN ID or a service or transport VF.
- The **no** form of this command removes the native VLAN classification, and untagged frames are dropped.

Rules for the **[no] switchport native-vlan-xtagged vid [ctag cvid] egress [tagged | untagged | any]** command are as follows:

- This command accepts untagged or tagged 802.1Q VLANs and service and transport VFs and specifies egress tagging behavior. If a VLAN is an 802.1Q VLAN or a service VF, the supported egress tagging behavior is untagged or tagged. If a VLAN is a transport VF, the **egress** option must be **any**, to indicate that the ingress frame encapsulation must be preserved.
- The **no** form of this command removes the native VLAN classification. Untagged frames and the associated tagged 802.1Q VLAN are dropped.

The following illustrates configuration in no-default-native-VLAN trunk mode.

```
switch(config)# int vlan 5000
switch(config)# int vlan 6000
switch(config-Vlan-6000)# transport-service 60
switch(config)# int vlan 7000
switch(config-Vlan-7000)# transport-service 70
```

In the new mode, the default behavior is to drop all packets.

```
(config)# int te 1/0/1
(config-if-te-1/0/1)# switchport mode trunk-no-default-native
```

VLAN configuration similar to that of regular trunk mode can be achieved explicitly after VLAN 1 is configured as a tagged VLAN.

```
switch(config-if-te-1/0/1)# switchport trunk allow vlan add 1
```

The following creates native VLAN 10. All service and transport VFs can continue to coexist on the same port.

```
switch(config-if-te-1/0/1)# switchport trunk native-vlan-untagged 10
switch(config-if-te-1/0/1)# switchport trunk allow vlan 6000 ctag 100-200
switch(config-if-te-1/0/1)# switchport trunk default-vlan 7000
```

The following accepts ingress tagged or untagged frames, but egress frames must be tagged only. This is not allowed in default-VLAN trunk mode.

```
switch(config-if-te-1/0/1)# switchport trunk native-vlan-xtagged 10 egress tagged
```

The following classifies a tagged native VLAN to service VF 5000.

```
switch(config-if-te-1/0/1)# switchport trunk native-vlan-xtagged 5000 ctag 10 egress tagged
```

The following classifies VLAN 10 to transport VF 6000. Because this native VLAN is a transport VF, the option for **egress** is **any**.

```
switch(config-if-te-1/0/1)# switchport trunk native-vlan-xtagged 6000 ctag 10 egress any
switch(config-if-te-1/0/1)# switchport trunk allow vlan 6000 ctag 100-200
```

The following configurations are valid or invalid in no-default-native-VLAN mode.

```
switch(config)# int te 5/0/1
switch(config-if-te-5/0/1)# switchport mode trunk-no-default-native
switch(config-if-te-5/0/1)# switchport trunk tag-native
ERROR: Port mode not set to trunk
switch(config-if-te-5/0/1)# switchport trunk native vlan 2
ERROR: Port mode not set to trunk
# C-TAG classification to service or transport VF mapping is still 1 to 1.
# Rejected as duplicate classification even when same CTAG-to-VF mapping is given.
switch(config-if-te-5/0/1)# switchport trunk native-vlan-xtagged 6000 ctag 10 egress any
switch(config-if-te-5/0/1)# switchport trunk allow vlan add 6000 ctag 10-20
ERROR: ctag already used in other classification
switch(config-if-te-5/0/1)# switchport trunk allow vlan 7000 ctag 10
ERROR: ctag already used in other classification
```

## Configuring and managing Virtual Fabrics

The fabric must be in logical chassis cluster mode for the configuration and management of the Virtual Fabrics feature. Whenever changes are made, they are saved automatically. Ensure that the fabric is in logical chassis cluster mode before attempting to configure or manage this feature.

Refer also to [Virtual Fabrics overview](#) on page 81.

## Configuring a service VF instance

Configuring a service VF instance consists of enabling VF configuration in the fabric, and then configuring a service VF instance that is greater than 4095. The initial release of this feature supports up through 8192 VLANs, with 8191 being the largest number that can be assigned.

The **vcs virtual-fabric enable** command, issued in global configuration mode, expands the VLAN ID address space beyond the 802.1Q limit in the fabric, allowing VLANs with IDs greater than 4095 to be supported, up through 8191. The command, which is accepted only if the state of the fabric is capable of supporting VLAN virtualization, does not disrupt existing 802.1Q data traffic in the fabric.

### Enabling service VF configuration

In global configuration mode, issue the **vcs virtual-fabric enable** command:

```
switch(config)# vcs virtual-fabric enable
```

#### NOTE

Use the **no** form of this command to disable service VF configuration.

### Creating a service VF instance

In global configuration mode, use the **interface vlan *vlan\_id*** command, where *vlan\_id* is a number greater than 4095, through 8191, and is not a reserved VLAN.

```
switch(config)# interface vlan 5000
```

#### NOTE

Use **no interface vlan *vlan\_id*** to delete a service VF.

## Configuring a transport VF instance

The following example command sequence illustrates the configuration of three transport VF instances.

```
switch(config)# interface vlan 6001
switch(config-Vlan-6001)# transport-service 1
switch(config)# interface vlan 6002
switch(config-Vlan-6002)# transport-service 2
switch(config)# interface vlan 6003
switch(config-Vlan-6003)# transport-service 3
```

## Configuring VF classification to a trunk interface

The following example command sequence illustrates the configuration of VF classification to a trunk interface.

```
switch(config)# interface TenGigabitEthernet 1/0/1
switch(conf-if-te-1/0/1)# switchport
switch(conf-if-te-1/0/1)# switchport mode trunk
switch(conf-if-te-1/0/1)# switchport trunk allowed vlan add 5000 ctag 100
switch(conf-if-te-1/0/1)# switchport trunk allowed vlan add 5001 ctag 101
```

## Configuring transport VF classification to a trunk interface

The following example command sequence illustrates the configuration of VF classification to a trunk interface.

```
switch(config)# interface TenGigabitEthernet 1/0/1
switch(config-if-te-1/0/1)# switchport
switch(config-if-te-1/0/1)# switchport mode trunk
switch(config-if-te-1/0/1)# switchport trunk allowed vlan add 6000 ctag 600-610
```

## Creating a default VLAN with a transport VF to a trunk interface

The following example command sequence illustrates the configuration of a default VLAN with a transport VF to a trunk interface.

```
switch(config)# interface TenGigabitEthernet 1/0/1
switch(config-if-te-1/0/1)# switchport
switch(config-if-te-1/0/1)# switchport mode trunk
switch(config-if-te-1/0/1)# switchport trunk default-vlan 7000
```

## Configuring a native VLAN in regular VLAN trunk mode

The following examples illustrate the configuration of a native VLAN in regular VLAN trunk mode, where the default native VLAN 1 exists.

The following native VLAN commands are supported in this trunk mode:

- **switchport trunk tag native-vlan**
- **switchport trunk native-vlan**

1. Create native VLAN 10.

### NOTE

VLAN 1 is the default VLAN in this mode.

```
switch(config)# interface te 2/1/1
switch(config-if-te-2/1/1)# switchport mode trunk
switch(config-if-te-2/1/1)# switchport trunk native-vlan 10
```

2. Configure untagged native VLAN (service VF) 5000 and transport VLAN (transport VF) 6000, and make VLAN 7000 the default VLAN.

```
switch(config)# interface te 2/1/1
switch(config-if-te-2/1/1)# switchport mode trunk
switch(config-if-te-2/1/1)# no switchport trunk tag native
switch(config-if-te-2/1/1)# switchport trunk native-vlan 5000
switch(config-if-te-2/1/1)# switchport trunk allow vlan add 6000 ctag 100-200
switch(config-if-te-2/1/1)# switchport trunk default-vlan 7000
```

3. Configure transport VLAN 6000 to accept the C-TAG range 100 through 200, as well as tagged or untagged native VLAN traffic.

```
switch(config)# interface te 2/1/1
switch(config-if-te-2/1/1)# switchport mode trunk
switch(config-if-te-2/1/1)# no switchport trunk tag native
switch(config-if-te-2/1/1)# switchport trunk native-vlan 6000 ctag 10
switch(config-if-te-2/1/1)# switchport trunk allow vlan add 6000 ctag 100-200
```

## Configuring a native VLAN in no-default-native-VLAN trunk mode

The following examples illustrate the configuration of a native VLAN in a trunk mode where the native VLAN does not exist. The native VLAN must be explicitly created in this mode.

The following native VLAN commands are supported in this mode:

- **switchport trunk native-vlan-untagged**
- **switchport trunk native-vlan-xtagged**

1. Configure a trunk port without a default native VLAN, then explicitly configure the native VLAN.

```
switch(config)# interface te 2/1/1
switch(config-if-te-2/1/1)# switchport mode trunk-no-default-native
switch(config-if-te-2/1/1)# switchport trunk native-vlan-xtagged 10 egress tagged
```

2. In no-default-native-VLAN trunk mode, configure untagged native VLAN 5000 and transport VLAN 6000, and make VLAN 7000 the default VLAN.

```
switch(config)# interface te 2/1/1
switch(config-if-te-2/1/1)# switchport mode trunk-no-default-native
switch(config-if-te-2/1/1)# switchport trunk native-vlan-untagged 5000
switch(config-if-te-2/1/1)# switchport trunk allow vlan add 6000 ctag 100-200
switch(config-if-te-2/1/1)# switchport trunk default-vlan 7000
```

3. In no-default-native-VLAN trunk mode, configure transport VLAN 6000 to accept C-TAG range 100 through 200 as well as tagged or untagged native VLAN traffic..

```
switch(config)# interface te 2/1/1
switch(config-if-te-2/1/1)# switchport mode trunk-no-default-native
switch(config-if-te-2/1/1)# switchport trunk native-vlan-xtagged 6000 ctag 10 egress any
switch(config-if-te-2/1/1)# switchport trunk allow vlan add 6000 ctag 100-200
```

## Configuring additional Layer 2 service VF features

This section addresses additional features that are available on trunk ports once a Virtual Fabric is established.

### Configuring private service VFs

The following examples illustrate the configuration of a variety of private VLANs (PVLANS) as service VFs and their association on access and trunk ports.

Refer also to [PVLANS with service VFs](#) on page 95.

### Configuring service VFs and defining and associating PVLANS

1. In global configuration mode, use the **interface vlan *vlan\_id*** command to create VLAN instances that are greater than 4095, through 8191.

```
switch(config)# interface vlan 5000
switch(config)# interface vlan 6000
switch(config)# interface vlan 7000
```



- In VLAN configuration mode, use the **private-vlan** command to create the three types of PVLAN.

```
switch(config)# interface vlan 5000
switch(conf-vlan-5000)# private-vlan primary
switch(config)# interface vlan 6000
switch(conf-vlan-6000)# private-vlan isolated
switch(config)# interface vlan 7000
switch(conf-vlan-7000)# private-vlan community
```

- Using the **private-vlan association** command, associate the secondary PVLANs with the primary PVLAN.

```
switch(config)# interface vlan 5000
switch(conf-vlan-5000)# private-vlan association add 6000
switch(conf-vlan-5000)# private-vlan association add 7000
```

## Configuring physical interfaces

- Create classification rules for the primary and secondary VLAN at the respective primary and host ports.

The classification must be done before the primary-to-secondary VLAN associations are specified. In following example, the same C-TAG is used to classify the primary and secondary VLANs.

Interface te 1/0/1 is a primary trunk port.

```
switch(config)# interface te 1/0/1
switch(conf-if-te-1/0/1)# switchport mode private-vlan trunk promiscuous
switch(conf-if-te-1/0/1)# switchport trunk allow vlan add 5000 ctag 10
```

Interface te 1/0/2 is an isolated trunk port.

```
switch(config)# interface te 1/0/2
switch(conf-if-te-1/0/2)# switchport mode private-vlan trunk host
switch(conf-if-te-1/0/2)# switchport trunk allow vlan add 6000 ctag 10
```

Interface te 0/3 is a community trunk port.

```
switch(config)# interface te 1/0/3
switch(conf-if-te-1/0/3)# switchport mode private-vlan trunk host
switch(conf-if-te-1/0/3)# switchport trunk allow vlan add 7000 ctag 10
```

- Configure the PVLAN association on the promiscuous trunk port.

```
switch(config)# interface te 1/0/1
switch(conf-if-te-1/0/1)# switchport mode private-vlan trunk promiscuous
switch(conf-if-te-1/0/1)# switchport trunk allowed vlan add 400
switch(conf-if-te-1/0/1)# switchport trunk allowed vlan add 5000 ctag 10
switch(conf-if-te-1/0/1)# switchport private-vlan mapping 5000 add 6000
switch(conf-if-te-1/0/1)# switchport private-vlan mapping 5000 add 7000
```

- Configure the PVLAN association on the promiscuous access port.

```
switch(config)# interface te 1/1/1
switch(conf-if-te-1/1/1)# switchport mode private-vlan promiscuous
switch(conf-if-te-1/1/1)# switchport private-vlan mapping 5000 add 6000
switch(conf-if-te-1/1/1)# switchport private-vlan mapping 5000 add 7000
```

- Configure the isolated PVLAN on the trunk port.

```
switch(config)# interface te 1/0/2
switch(conf-if-te-1/0/2)# switchport mode private-vlan trunk host
switch(conf-if-te-1/0/2)# switchport private-vlan host-association 5000 6000
```

- Configure the isolated PVLAN on the access port.

```
switch(config)# interface te 1/1/2
switch(config-if-te-1/1/2)# switchport mode private-vlan host
switch(config-if-te-1/1/2)# switchport private-vlan host-association 5000 6000
```

- Configure the community PVLAN on the trunk port.

```
switch(config)# interface te 1/0/3
switch(config-if-te-1/0/3)# switchport mode private-vlan trunk host
switch(config-if-te-1/0/3)# switchport trunk allowed vlan add 7000 ctag 10
switch(config-if-te-1/0/3)# switchport private-vlan host-association 5000 7000
```

- Configure the community PVLAN on the access port.

```
switch(config)# interface te 1/1/3
switch(config-if-te-1/1/3)# switchport mode private-vlan host
switch(config-if-te-1/1/3)# switchport mode private-vlan host 5000 7000
```

- Configure the PVLAN trunk port.

```
switch(config)# interface te 1/4/1
switch(config-if-te-1/4/1)# switchport private-vlan trunk allowed vlan add 5000 ctag 10
switch(config-if-te-1/4/1)# switchport private-vlan trunk allowed vlan add 6000 ctag 20
switch(config-if-te-1/4/1)# switchport private-vlan trunk allowed vlan add 7000 ctag 30
switch(config-if-te-1/4/1)# switchport mode private-vlan trunk
```

The trunk port can have both PVLAN and regular VF configurations. The following configures PVLAN VFs.

```
switch(config-if-te-1/4/1)# switchport trunk allowed vlan add 5000 ctag 10
switch(config-if-te-1/4/1)# switchport trunk allowed vlan add 6000 ctag 10
switch(config-if-te-1/4/1)# switchport trunk allowed vlan add 6000 ctag 10
switch(config-if-te-1/4/1)# switchport private-vlan association trunk 5000 6000
switch(config-if-te-1/4/1)# switchport private-vlan association trunk 5000 7000
```

The following configures non-PVLAN VFs.

```
switch(config-if-te-1/4/1)# switchport private-vlan trunk allowed vlan add 400
switch(config-if-te-1/4/1)# switchport private-vlan trunk allowed vlan add 5000 ctag 100
```

## Understanding PVLAN configuration failures

The following example conditions, with error messages, that determine the success or failure of a PVLAN configuration.

- If a PVLAN is a service VF and the classification does not exist for this port, the PVLAN association executed on this interface will fail. This following commands fail because there is no classification rule for primary service VF 5000.

```
switch(config)# interface te 1/0/1
switch(config-if-te-1/0/1)# switchport mode private-vlan trunk promiscuous
switch(config-if-te-1/0/1)# switchport private-vlan mapping 5000 add 200
%%ERROR: Primary Vlan should have a ctag associated with it on this port.
switch(config)# interface te 1/0/2
switch(config-if-te-1/0/2)# switchport mode private-vlan trunk host
switch(config-if-te-1/0/2)# switchport private-vlan host-association 100 add 6000
%%ERROR: Secondary Vlan should have a ctag associated with it on this port.
```

- The following command succeeds because the primary port is an access port.

```
switch(config-if-te-1/1/1)# switchport mode private-vlan promiscuous
switch(config-if-te-1/1/1)# switchport private-vlan mapping 5000 add 6000
```

- The following command succeeds because the secondary port is an access port.

```
switch(conf-if-te-1/1/2)# switchport mode private-vlan host
switch(conf-if-te-1/1/2)# switchport private-vlan host-association 5000 add 6000
```

## Configuring MAC groups

You can assign individual MAC addresses or a group of MAC addresses to a service VF at an access port.

### Creating a MAC group instance and assigning MAC addresses

1. In global configuration mode, create a MAC group instance to define the MAC addresses of end stations, by using the **mac-group** *mac-group-id* command.

The value of *mac-group-id* ranges from 1 through 500.

```
switch(config)# mac-group 1
```

2. In MAC group configuration mode, use the **mac** *mac\_address* command to add a MAC address in hexadecimal notation.

#### NOTE

Ranging is not allowed. Leading zeros can be omitted.

```
switch(config-mac-group 1)# mac 0002.0002.0002
```

### Deleting a MAC group or MAC address

1. This command deletes a MAC group.

```
switch(config)# no mac-group 1
```

2. This command deletes a MAC address from a MAC group.

#### NOTE

Only one MAC address can be deleted at a time.

```
switch(config)# mac-group 1
switch(config-mac-group 1)# no mac 0004.0004.0004
```

### Configuring an interface for service VF MAC address access

The following illustrates various options and errors that can occur in configuring an interface for service VF MAC address access.

1. In interface configuration mode, set switchport mode to access and change the default VLAN to a service VF.

#### NOTE

The default VLAN must be unique. It must not be the same as that used for another MAC classification.

```
switch(config)# int te 2/0/1
switch(config-if-te-2/0/1)# switchport access vlan 5000
```

2. Classify the access VLAN by means of a MAC address.

```
switch(config-if-te-2/0/1)# switchport access vlan 6000 mac 0002.0002.0002
```

- Classify another access VLAN on the same interface by means of a MAC address.

```
switch(config-if-te-2/0/1)# switchport access vlan 7000 mac 0004.0004.0004
```

**NOTE**

Frames that do not match 0002.0002.0002 or 0004.0004.0004 are classified into service VF 5000.

- Create a MAC group to be used to classify a VLAN.

```
switch(config)# mac-group 1
switch(config-mac-group 1)# mac 0002.0002.0002
switch(config-mac-group 1)# mac 0005.0005.0005
switch(config-mac-group 1)# mac 0008.0008.0008
```

- Configure another service VF on the same interface by means of a MAC group.

```
switch(config-if-te-2/0/1)# switchport access vlan 7000 mac-group 1
Error: mac address is already used in another classification
```

**NOTE**

The MAC address cannot be used in another service VF classification.

- Configure another interface with a third service VF and classify the VLANs by MAC group and MAC address, respectively.

```
switch(config-if-te-3/0/1)# switchport mode access
switch(config-if-te-3/0/1)# switchport access vlan 7000 mac-group 1
switch(config-if-te-3/0/1)# switchport access vlan 8000 0008.0008.0008
switch(config-if-te-3/0/1)# %Error: Mac-address/Mac-group is overlapping with another Mac-address/
Mac-group configuration on the same port.
```

**NOTE**

The MAC address cannot be used in another service VF classification.

## Configuring Layer 3 service VF features

Refer to [IP over service VFs](#) on page 95.

Layer 3 configurations are applicable to service VFs, by means of existing **interface ve** commands. Each virtual Ethernet (VE) interface is mapped to a service VF, and all VE interfaces share the router's MAC address. A VE interface can be assigned to a VRF instance, with per-VRF OSPF instances exchanging routes between R Bridges in that VRF instance. Virtual Router Redundancy Protocol (VRRP) provides high availability.

Do the following to configure Layer 3 service VF features.

- Create a service VF and add it to the trunk port with a C-TAG.

```
switch(config)# interface vlan 5000
switch(config)# interface te 3/1/1
switch(config-if-te-3/1/1)# switchport
switch(config-if-te-3/1/1)# switchport mode trunk
switch(config-if-te-3/1/1)# switchport trunk allowed vlan add 5000 ctag 50
```

- Enable VRF and VRRP on an R Bridge.

```
switch(config)# rbridge-id 3
switch(config-rbridge-id-3)# protocol vrrp
```

3. Create a VRF instance and set OSPF routing parameters.

**NOTE**

BGP is also supported in the appropriate context.

```
switch(config)# ip vrf VRF_CUST1
```

- a) Use the **rd** (Route Distinguisher) command to assign an administrative number.

```
switch(config-vrf-CUST1)# rd 10.1.1.1:1
```

- b) Set the OSPF address family to IPv4.

```
switch(config-vrf-CUST1)# address-family ipv4
switch(config-vrf-CUST1)# exit
```

- c) Return to config mode.

```
switch(config-vrf-CUST1)# exit
```

4. Create the VE interface on the service VF and configure VRF forwarding and VRRP.

- a) Configure forwarding for a VRF instance.

```
switch(config-ve-5000)# ip vrf forwarding VRF_CUST1
```

- b) In RBridge ID configuration mode, create a virtual Ethernet interface, and assign the service VF and IP address. Be sure to enable the interface.

```
switch(config)# rbridge-id 3
switch(config-rbridge-id-3)# interface ve 5000
switch(config-ve-5000)# ip address 10.1.1.1/24
switch(config-ve-5000)# no shutdown
```

- c) Create a VRRP group and assign a virtual IP address.

```
switch(config-ve-5000)# vrrp-group 22
switch(config-vrrp-group-22)# virtual-ip 10.1.1.1
```

## Configuring Layer 2 extension over Layer 3 with Virtual Fabrics

In the current release, the VLAN-based broadcast domain is extended over a Layer 3 network without the need for an orchestrator. The extension function commonly resides at the aggregation layer, either embodied in the aggregation node itself, or hanging as a service off the aggregation node in a one-arm topology. This feature resides in the network spine, with up to four R Bridges participating. Tunnels are provided through router ports and switch ports.

In addition, the user can collect statistics on tunnel and gateway traffic, through the range of attached VLANs. Both transmit and receive traffic can be monitored for a single tunnel and range of VLANs, or all tunnels and a range of VLANs. Support is also provided for similar sFlow monitoring.

### Supported and unsupported features

The following new features are supported:

- Layer 3 forwarding for extended Layer 2 segments, for connections local to the fabric or through a tunnel
- Extension as part of the main fabric or through a "1-arm" topology in which VLAN and VXLAN traffic occupies the same path through connected subnets

- Ability to use VLANs, service VFs, and transport VFs for extension, in a flexible deployment model
- Nondefault VRFs
- Fully meshed tunnels between fabrics, with BUM through headend replication
- Multicast (without multicast traffic optimization)
- Split horizon in the data plane for loop avoidance
- MAC address learning on tunnels
- Layer 2 fault domain isolation across fabrics
- Layer 3 protocol isolation controls (off by default)
- MAC, IPv4, and IPv6 ingress ACLs
- sFlow configurations

The following features are not supported:

- VXLAN-to-VLAN routing, and vice versa
- VNI translation (because of a single VNI domain)
- Exposing of ARPs behind the physical network as a unicast map
- VXLAN transit
- BUM optimization (including ARP-related optimization)
- Loop-detection protocols over tunnels. There is no support for STP or tunneling STP BPDUs. (The user is responsible for avoiding loops over any interfaces.)
- Keepalives on tunnels
- TRILL with VXLAN
- Tunnels as a SPAN destination
- vLAG of tunnels to the same remote VTEP
- PACL on tunnels (VACL is supported)
- Tunnels as profile-ports. (However, a VLAN that spans a tunnel can have a profiled physical port, as in the previous release.)
- Router port IP addresses or VE IP addresses used as VTEP addresses
- Fabric cluster mode

Note the following considerations with respect to ACLs, SPAN, sFlow, and statistics, as these features share the ternary content-addressable memory (TCAM) tables for the corresponding features of nontunnel traffic:

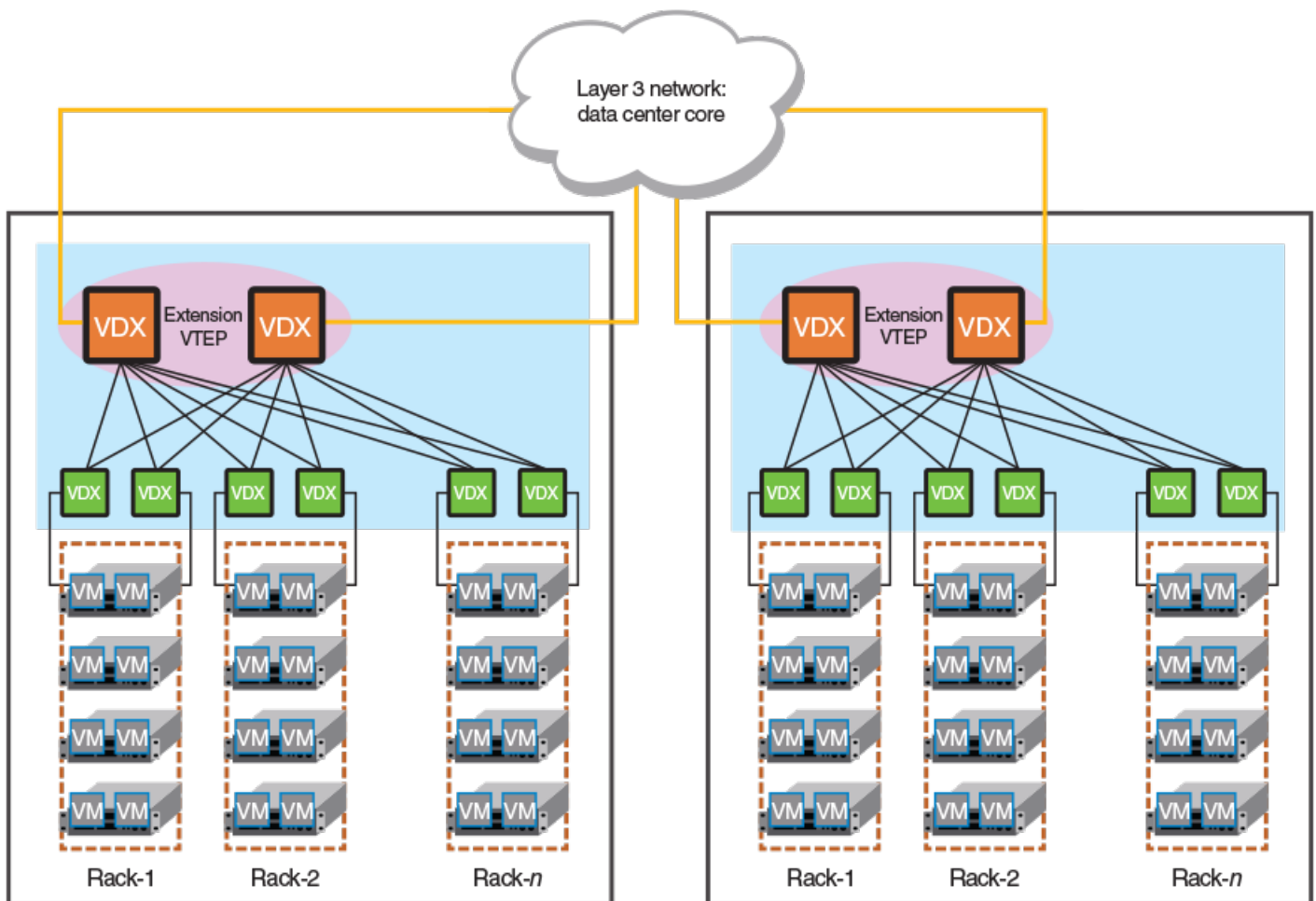
- Ingress statistics and sFlow both need a counting ability. Consequently, if both functions are enabled and a particular traffic type satisfies both classifiers, then statistics alone takes effect and sFlow does not.
- Ingress SPAN and sFlow both use the same resources. Consequently, if both functions are enabled and a particular traffic type satisfies both classifiers, then sFlow takes effect and SPAN does not.
- Ingress statistics and ACLs both use the same resources. Consequently, if both functions are enabled and a particular traffic type satisfies both classifiers, then ACLs take effect and statistics does not.
- The scaling limits of the above features are constrained by the profiles applied on the system.

## High-level topologies

The following illustrates an example high-level topology for Layer 2 extension at the aggregation layer only. Note the following restrictions for this topology:

- If a vLAG is deployed, the number of aggregation VDX devices supporting extension is limited to the size of the vLAG with respect to R Bridges and the number of R Bridges in a VRRP group. (This restriction does not apply if router ports are used.)
- A static route must be configured on the upstream device, or VRRP must use the First Hop Redundancy Protocol (FHRP) gateway.

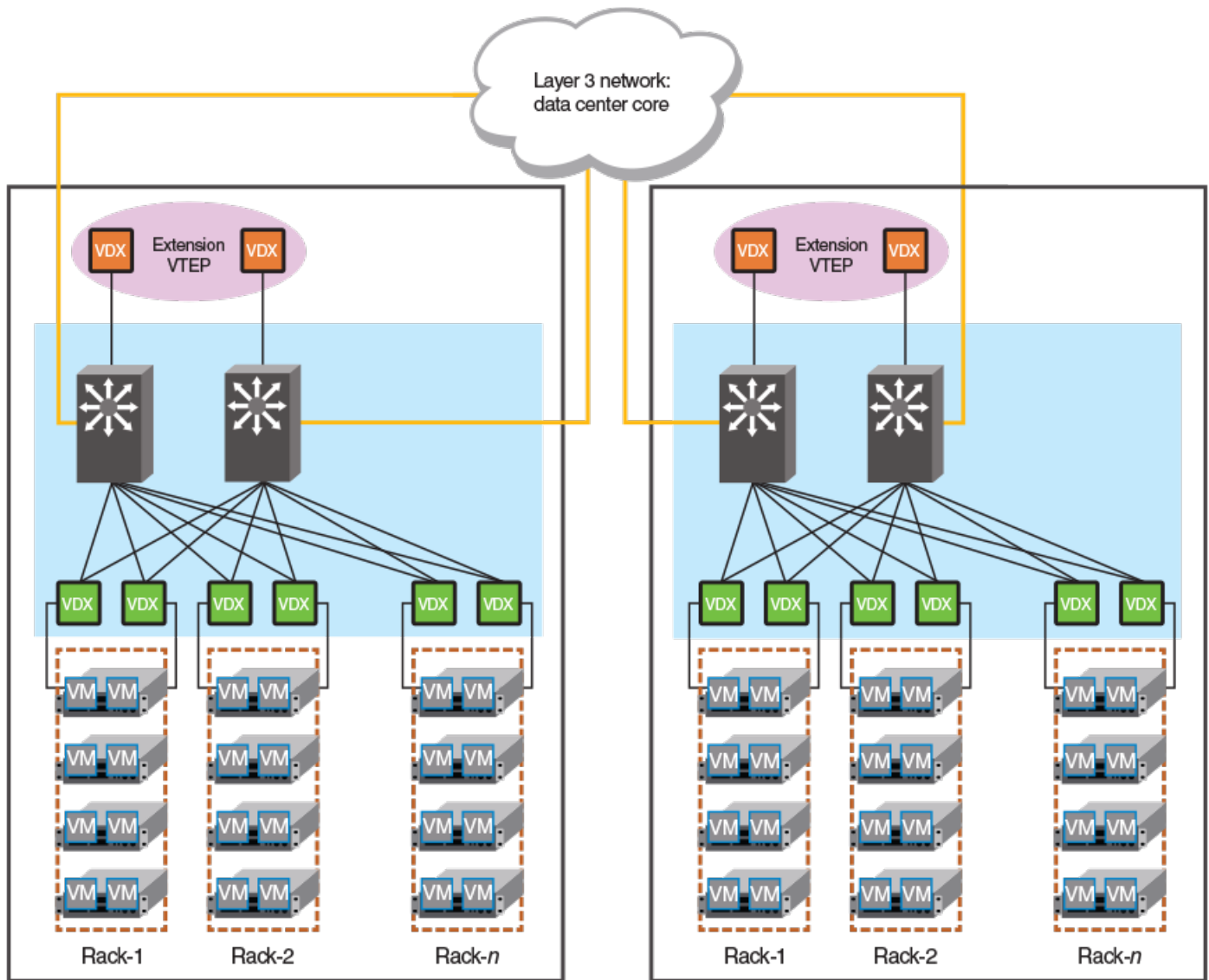
FIGURE 14 Layer 2 extension at the aggregation layer only



The following illustrates an example high-level topology that uses VXLAN virtual network interface (VNI) tunnel endpoints (VTEPs) in separate fabrics with a one-arm VDX deployment. Note the following restrictions for this topology:

- The fabric must be extended through an 802.1Q port.
- Only vLAG connectivity is supported. Router ports are not supported to the aggregation device.

FIGURE 15 Layer 2 extension with VTEPs in separate fabrics (one arm)



### VXLAN overlay gateway for Layer 2 extension: summary of steps

This overview summarizes the basic steps that are required to extend a Layer 2 VLAN-based broadcast domain over a Layer 3 network, without the use of an orchestrator such as the NSX Controller.

The basic provisioning and configuration steps can be summarized as follows:

1. Ensure that the network administrator has created a broadcast domain on the physical side. This domain consists of 802.1Q VLANs, as well as the service and transport VFs available in a Virtual Fabrics context.
2. Create a VXLAN tunnel endpoint (VTEP) container with a "type" qualifier that specifies the use of the VTEP for Layer 2 extension.



**NOTE**

If you are configuring a loopback interface to serve as a VTEP, you must manually configure distinct router IDs, by means of the **ip router-id** command, for use by routing protocols.

3. Create containers for the remote sites. These containers will have the IP addresses of the site. This leads to the automatic creation of VTEP tunnels to the remote sites. The tunnels refer to VTEP as the source endpoint, and to the IP addresses of the remote site as the destination endpoint. (Multiple addresses, corresponding to a LAG of tunnels, are not supported in this release.)

**NOTE**

A full mesh of tunnels must be created.

4. A VLAN-to-VNI map is created for the VTEP. This provides a global mapping across all sites for the VTEP. The map can be created automatically, where VLAN-to-VNI mapping is autogenerated, or the user can specify each map explicitly.
5. In the site container, extend the required VLANs (including service and transport VFs) that must be extended to a given remote site.

## Configuring the VXLAN overlay gateway for Layer 2 extension

The network administrator must first configure a broadcast domain.

This task configures the nondefault mode of configuration for a VXLAN overlay gateway.

1. In VXLAN overlay gateway configuration mode, set the type of gateway to support Layer 2 extension.

```
switch(config)# overlay-gateway gateway1
switch(config-overlay-gw-gateway1)# type layer2-extension
```

2. **Using automatic VLAN-to-VNI mapping:** You can optionally use the **map vlan vni auto** command to configure VLAN-to-VNI mappings automatically if they have not been configured manually.

```
switch(config-overlay-gw-gateway1)# map vlan vni auto
```

3. **Using explicit VLAN-to-VNI mapping:** The following configures VLAN-to-VNI mappings manually.

```
switch(config-overlay-gw-gateway1)# map 10,20-22 vni 5000-5002,6000
```

**NOTE**

Automatic and explicit mappings are mutually exclusive. Also, the VLANs used in the **extend vlan** configuration must be a subset of the VLANs used in the **map vlan** configuration. In other words, a VLAN must have a VNI mapping for it to be extended across sites.

4. Configure the site, which includes providing a site name and entering VXLAN overlay gateway site configuration mode, providing an IPv4 address for the VNI tunnel endpoint (VTEP) in that mode, extending VLANs, and enabling the tunnels administratively.

- a) Enter a site name and enter VXLAN overlay gateway site configuration mode.

```
switch(config-overlay-gw-gateway1)# site mysitel
switch(config-overlay-gw-gateway1-mysitel)#
```

- b) Configure an IPv4 address for the tunnel endpoints.

```
switch(config-overlay-gw-gateway1-mysitel)# ip address 10.10.10.1
```

**NOTE**

Only one IPv4 address is allowed.

- c) Extend the VLANs.

```
switch(config-overlay-gw-gateway1-mysitel)# extend vlan add 10,20-22
```

- d) Enable the tunnels administratively.

```
switch(config-overlay-gw-gateway1-mysitel)# no shutdown
```

5. The following substeps attach the RBridge IDs to the VXLAN gateway instance, set the IP address of the gateway, and activate the instance.

- a) Enter the **attach rbridge-id** command to attach existing RBridge IDs to this VXLAN gateway instance. You can specify a range of RBridge IDs up to a maximum of four.

```
switch(config-overlay-gw-gateway1)# attach rbridge-id add 1-2
```

- b) Enter the **ip interface ve veid vrrp-extended-group group-ID** command to set the IP address of the VXLAN overlay gateway, as shown in the following example.

```
switch(config-overlay-gw-gateway1)# ip interface ve 10 vrrp-extended-group
100
```

The command accepts the VE interface ID and VRRP-E group ID, then sets the VXLAN overlay gateway's IP address as identical to the already configured VRRP-E virtual IP address. Tunnels that form use this IP address as the source IP address for outgoing packets.

- c) Enter the **activate** command to activate this gateway instance.

```
switch(config-overlay-gw-gateway1)# activate
```

This enables all tunnels associated with this gateway. VXLAN tunnels are not user configurable.

- d) Return to privileged EXEC mode.

```
switch(config-overlay-gw-gateway1)# end
switch(config)# end
switch#
```

### Additional commands for VXLAN extension

Some additional supporting commands, for both configuration and management, are listed in the following tables. For complete information, refer to the *Network OS Command Reference*.

**TABLE 16** Additional configuration commands for VXLAN extension

Command	Description
<b>ip access-group in</b>	Applies rules specified in a MAC ACL to traffic on an interface, for the ingress direction.
<b>ip interface loopback</b>	Sets the IP address of the VXLAN overlay gateway instance for a loopback interface.
<b>ipv6 access-group in</b>	Applies or removes an ingress ACL from an IPv6 interface.
<b>mac access-group in</b>	Applies or removes an ingress Layer 2 ACL from an interface.
<b>ip access-list</b>	Configures the ingress ACL on the VTEP.
<b>sflow remote-endpoint</b>	Applies an sFlow profile for a VXLAN overlay gateway and sets the remote endpoints for tunnel interfaces.

**TABLE 17** Additional management commands for VXLAN extension

Command	Description
<b>clear counters access-list overlay-gateway in</b>	Clears the IP counter statistics on interfaces on the switch for the specified overlay gateway in the inbound direction.
<b>clear overlay-gateway</b>	Clears counters for the specified gateway.
<b>enable statistics direction</b>	Enables the collection of per-VLAN statistics for VXLAN overlay gateway tunnels.
<b>monitor session</b>	Enables switched port analyzer (SPAN) on one or all tunnels of a VXLAN overlay gateway.
<b>show access-list</b>	Displays the status of all ACLs bound to a particular interface.
<b>show access-list overlay-gateway in</b>	Displays the status of all ingress ACLs bound to a particular interface for the specified overlay gateway.
<b>show overlay-gateway</b>	Displays status and statistics for the VXLAN overlay-gateway instance.
<b>show statistics access-list overlay-gateway in</b>	Displays the statistics of an access-list status, or the statistical information on the specified ingress ACL bound to an interface for the specified overlay gateway.
<b>show tunnel</b>	Displays tunnel statistics.

## Troubleshooting VXLAN Layer 2 extension configurations

This section provides examples of a variety of **show** commands that can be used to troubleshoot VXLAN Layer 2 extension configurations. In general, do the following to confirm the proper operation of the configuration:

- Confirm that the overlay gateway is up, with a valid VTEP IP address on all RBridges.
- Confirm that the tunnel interface is a member of the VLAN.
- Confirm that the administrative and operational states of the tunnels are up on all RBridges.
- Confirm that there is one multicast-replicator enabled RBridge for every extension tunnel.
- Confirm that only one BUM forwarder is enabled for the next hop for every extension tunnel.
- Confirm that all sites are configured so that the tunnels form a full mesh, and that there are no VLAN extension inconsistencies across sites.
- Confirm the MAC addresses.

## Confirming the status of the VXLAN Layer 2 extension overlay gateway

### NOTE

In the following examples, items to look for and confirm are highlighted in **bold**.

Confirm the IP address, loopback ID, and administrative state, by using the **show overlay-gateway** command:

```
sw0(config-overlay-gw-gw121)# do show overlay-gateway

Overlay Gateway "gw121", ID 1, rbridge-ids 1
Type Layer2-Extension, Tunnel mode VXLAN
IP address 10.2.2.1 ( Loopback 100 ), Vrf default-vrf
Admin state up
Number of tunnels 0
Packet count: RX 0           TX 0
Byte count  : RX (NA)       TX 0
```

### NOTE

Ensure that there are no "Unknown" entries.

## Confirming that the tunnel interface is a member of the VLAN

Confirm the tunnel and VNIs, by using the **show vlan brief** command:

```
switch# show vlan brief

Total Number of VLANs configured   : 14
Total Number of VLANs provisioned  : 14
Total Number of VLANs unprovisioned : 0
VLAN  Name      State      Ports      Classification
(F)-FCoE      (u)-Untagged
(R)-RSPAN     (c)-Converged
(T)-TRANSPARENT (t)-Tagged
=====
1      default  ACTIVE    Po 333 (t)
                                           Po 444 (t)
1002 (F) VLAN1002 INACTIVE (no member port)
5000  VLAN5000 INACTIVE (member port down) Tu 61441 (t)   vni 15000
6000  VLAN6000 INACTIVE (member port down) Tu 61441 (t)   vni 16000
                                           Tu 61442 (t)   vni 16000
6001  VLAN6001 INACTIVE (member port down) Tu 61441 (t)   vni 16001
                                           Tu 61442 (t)   vni 16001
6002  VLAN6002 INACTIVE (member port down) Tu 61441 (t)   vni 16002
                                           Tu 61442 (t)   vni 16002
```

## Confirming the status of the VTEP and tunnel

Confirm the administrative and operational state, by using the **show tunnel brief rbridge-id** command for the relevant RBridges:

```
switch# show tunnel brief rbridge-id 10

Tunnel 61441, mode VXLAN, rbridge-ids 10
Admin state UP, Oper state UP
Source IP 10.2.2.1, Vrf default-vrf
Destination IP 10.1.1.1
```

```
switch# show tunnel brief rbridge-id 40

Tunnel 61441, mode VXLAN, rbridge-ids 40
Admin state UP, Oper state UP
Source IP 10.2.2.1, Vrf default-vrf
Destination IP 10.1.1.1
```

### NOTE

Ensure that there are no discrepancies in the operational states and source IP addresses across RBridges.

## Confirming source and destination IP and MAC addresses

Confirm the source and destination IP and MAC addresses, by using the **show tunnel** command:

```
switch# show tunnel 61441

Tunnel 61441, mode VXLAN, rbridge-ids 10,40
Ifindex 2080374796, Admin state up, Oper state up
Overlay gateway "test", ID 1
Source IP 10.2.2.1 ( Loopback 100 ), Vrf default-vrf
Destination IP 10.1.1.1, Site VCS_2
Active next hops on rbridge 10:
  IP: 10.2.2.2, Vrf: default-vrf
  Egress L3 port: Ve 20, Outer SMAC: 0027.f86f.cc18
  Outer DMAC: 0011.bbbb.dddd
  Egress L2 Port: Po 10, Outer cttag: 20
  BUM forwarder: no

  IP: 10.3.3.3, Vrf: default-vrf
  Egress L3 port: Ve 30, Outer SMAC: 0027.f86f.2233
  Outer DMAC: 0011.bbbb.1111
  Egress L2 Port: Po 30, Outer cttag: 30
  BUM forwarder: yes

Active next hops on rbridge 40:
  IP: 10.1.1.1, Vrf: default-vrf
  Egress L3 port: Te 20/0/1, Outer SMAC: 0027.f86f.3344
  Outer DMAC: 0000.0000.dddd
  Egress L2 Port: Po 10, Outer cttag: 20
  BUM forwarder: no

Packet count: RX 0          TX 0
Byte count   : RX (NA)     TX 00
```

### NOTE

You can also use the **rbridge-id** keyword. Watch out for discrepancies in the operational states and source and destination IP addresses across Rbridges. The "Active next hops . . ." lines can vary across participating Rbridges. Ensure that BUM forwarding is enabled for the next hop, which carries egress BUM traffic. There must be only one such next hop for the extension tunnel.

To view tunnel details for the site, you can use the **show tunnel site** command with the **brief** keyword:

```
switch# show tunnel site VCS_2 brief

Tunnel 61441, mode VXLAN, rbridge-ids 10
Admin state UP, Oper state UP
Source IP 10.2.2.1, Vrf default-vrf
Destination IP 10.1.1.1
```

### NOTE

You can also use the **rbridge-id** keyword.

## Viewing tunnel statistics of the VXLAN Layer 2 extension overlay gateway

Confirm the transmission of packets on tunnels, by using the **show tunnel statistics** command:

### NOTE

Receive bytes are not available.

```
switch# show tunnel statistics
Tnl ID   RX packets   TX packets   RX bytes   TX bytes
=====
61441    123           456          (NA)       4560
61442    567           890          (NA)       8900
```

## Confirming the MAC addresses for VLANs and tunnels

Confirm the MAC addresses and the state of the tunnels for the appropriate VLANs:

```
switch# show mac-address-table

VlanId  Mac-address      Type      State  Ports
-----  -
30      0000.0000.0001  Dynamic  Active Tu 61441
30      0000.0000.0002  Dynamic  Active Tu 61441
30      0000.0000.0003  Dynamic  Active Tu 61441
30      0000.0000.0004  Dynamic  Active Tu 61441
30      0000.0000.0005  Dynamic  Active Tu 61442
30      0000.0000.0006  Dynamic  Active Tu 61442
20      0027.f880.1890  System   Remote XX 40/X/X
20      0027.f880.328f  Dynamic  Active  Po 1
```

### NOTE

Only an Active state confirms that the MAC address is getting forwarded locally unto the tunnel.

## Viewing VXLAN overlay gateway statistics

Confirm transmit and receive packets for the VLAN, by using the **show overlay-gateway** command:

```
switch# show overlay-gateway name test vlan statistics

VLAN ID  RX packets      TX packets
-----  -
30      1234            5678
```

## Confirming the tunnel SPAN status

Confirm the session status and the source and destination addresses by using the **show monitor** command:

```
switch# show monitor

Session           : 10
Description       : [None]
State             : Enabled
Source Interface  : Tu 61442 (Down)
Destination Interface : Te 1/0/48 (Up)
Direction        : Both
```

Confirm all sFlow details by using the **show sflow all** command:

```
switch# show sflow all

sFlow services are:          enabled
Global default sampling rate: 32768 pkts
Global default counter polling interval: 20 secs
Rbridge-Id                  Collector server address          Number of samples sent
-----
2                            1.1.1.1:6343                    1212
sflow info for tunnel ifindex: 0x7c00f001
-----
sFlow services are:          enabled
Samples received from hardware: 1212
Effective sample-rate:       512
```

## Configuring CML with Virtual Fabrics

Beginning with Network OS release 5.0.0, support is added for conversational MAC learning (CML) on classified VLANs as well as on 802.1Q VLANs. For an overview and applicable configuration examples, refer to [Conversational MAC learning](#) on page 66.

## Upgrading and downgrading firmware with Virtual Fabrics

Refer to [Virtual Fabrics upgrade and downgrade considerations](#) on page 83. The following applies where there are no Brocade VDX 6720 and VDX 6730 series RBridges in the fabric.

1. Do the following to upgrade to a VF-enabled fabric.
  - a) Configure the fabric in management cluster mode.
  - b) Perform an ISSU on all VF-capable RBridges; the fabric reaches a VF-capable state.
  - c) In global configuration mode, issue the **vcs virtual-fabric enable** command. The fabric reaches a VF-enabled state.

### NOTE

Step 1b and Step 1c are nondisruptive. Existing 802.1Q traffic is forwarded without disruption.

2. Do the following to downgrade from a VF-enabled fabric.
  - a) Remove all service or transport VF configurations in the fabric.
  - b) In global configuration mode, issue the **no vcs virtual-fabric enable** command to disable service or transport VF configurations. The fabric reaches a VF-incapable state. This command will succeed only if the switch state is capable of supporting existing 802.1Q VLANs in a VF-disabled state.
  - c) Perform an ISSU downgrade after Virtual Fabrics is disabled. When the ISSU downgrade is complete, the fabric is in a VF-disabled state.

Step 2b and Step 2c are nondisruptive.

## Troubleshooting Virtual Fabrics

Use the following **show** commands to view the status of Virtual Fabric configurations. For details, refer to the *Network OS Command Reference*.

**TABLE 18** Virtual Fabrics show commands

Command	Description
<b>show vlan brief</b>	Displays all classified VLANs that are configured, provisioned (active) or unprovisioned (inactive).
<b>show port profile</b>	Displays the AMPP port-profile configuration information.
<b>show overlapping-vlan-resource usage</b>	For VDX 6740 series only. Displays the utilization of the hardware table entries that support classified or transport VLAN classifications that use overlapping C-TAGs in a Virtual Fabric context.
<b>show virtual-fabric status</b>	Displays the status of the Virtual Fabric: VF-capable, VF-incapable, or VF-enabled.



# Configuring STP-Type Protocols

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- [STP overview.....](#) 121
- [Configuring and managing STP and STP variants.....](#) 125

## STP overview

The IEEE 802.1D Spanning Tree Protocol (STP) runs on bridges and switches that are 802.1D-compliant. STP prevents loops in the network by providing redundant links. If a primary link fails, the backup link is activated and network traffic is not affected. Without STP running on the switch or bridge, a link failure can result in a loop. This chapter addresses both basic STP and its variants, referred to collectively as *xSTP*. These variants are Rapid STP (RSTP), Multiple STP (MSTP), Per-VLAN Spanning Tree Plus (PVST+), and Rapid-PVST+ (RPVST+).

When the spanning tree algorithm is run, the network switches transform the real network topology into a spanning tree topology in which any LAN in the network can be reached from any other LAN through a unique path. The network switches recalculate a new spanning tree topology whenever there is a change to the network topology.

For each LAN, the switches that attach to the LAN choose a designated switch that is the closest switch to the root switch. This designated switch is responsible for forwarding all traffic to and from the LAN. The port on the designated switch that connects to the LAN is called the designated port.

The switches decide which of their ports will be part of the spanning tree. A port is included in the spanning tree if it is a root port or a designated port.

With STP, data traffic is allowed only on those ports that are part of the spanning tree topology. Ports that are not part of the spanning tree topology are automatically changed to a blocking (inactive) state. They are kept in the blocking state until there is a break in the spanning tree topology, at which time they are automatically activated to provide a new path.

The STP interface states for every Layer 2 interface running STP are as follows:

- *Blocking* — The interface does not forward frames.
- *Listening* — The interface is identified by the spanning tree as one that should participate in frame forwarding. This is a transitional state after the blocking state.
- *Learning* — The interface prepares to participate in frame forwarding.
- *Forwarding* — The interface forwards frames.
- *Disabled* — The interface is not participating in spanning tree because of a shutdown port, no link on the port, or no spanning tree instance running on the port.

A port participating in spanning tree moves through these states:

- From initialization to blocking
- From blocking to listening or to disabled
- From listening to learning or to disabled
- From learning to forwarding, blocking, or disabled
- From forwarding to disabled

The following STP features are considered optional features although you might use them in your STP configuration:

- *Root guard* — Refer to [Enabling guard root \(DCB\)](#) on page 142.
- *Port fast BPDU guard and BPDU filter* — Refer to [Enabling port fast \(DCB\)](#) on page 144.

## STP configuration guidelines and restrictions

Follow these configuration guidelines and restrictions when configuring STP:

- You have to disable one form of xSTP before enabling another.
- Packet drops or packet flooding may occur if you do not enable xSTP on all devices connected on both sides of parallel links.
- Network OS switches in logical chassis cluster mode or fabric cluster mode drop all tagged xSTP frames that originate from the Brocade MLX-MCT.
- LAGs are treated as normal links, and by default are enabled for STP.
- You can have 32 MSTP instances and one MSTP region.
- Create VLANs before mapping them to MSTP instances.
- The MSTP force-version option is not supported.
- When a misconfigured local area network running spanning tree has one or more loops, a traffic storm of spanning tree BPDUs can occur. In certain circumstances, VDX switches can reboot when subjected to an extended period of traffic storm involving spanning tree BPDUs.
- Additionally, when a misconfigured local area network running spanning tree has one or more loops, a traffic storm of spanning tree BPDUs can occur. Edge Loop Detection (ELD) protocol cannot eliminate loops during a traffic storm involving control packets, such as spanning tree BPDUs.
- Do not force an alternate root path through root path cost with PVST+ or R-PVST+ on legacy Foundry equipment, such as the Brocade NetIron MLX or Brocade Turbolron. This can cause traffic issues on the network.
- For load balancing across redundant paths in the network to work, all VLAN-to-instance mapping assignments must match; otherwise, all traffic flows on a single link.
- When you enable MSTP by using the global **protocol spanning-tree mstp** command, RSTP is automatically enabled.
- For two or more switches to be in the same MSTP region, they must have the same VLAN-to-instance map, the same configuration revision number, and the same name.
- Spanning tree topologies must not be enabled on any direct server connections to the front-end 10-gigabit Ethernet ports that may run FCoE traffic. This may result in lost or dropped FCoE logins.
- The **gigabitethernet rbridge-id/slot/port** keyword is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8. The prompt for these ports is in the following format: switch(config-if-gi-22/0/1)#.

## RSTP

### NOTE

Rapid Spanning Tree Protocol is designed to be compatible and interoperate with STP. However, the advantages of the RSTP fast reconvergence are lost when it interoperates with switches running STP.

The IEEE 802.1w Rapid Spanning Tree Protocol (RSTP) standard is an evolution of the 802.1D STP standard. It provides rapid reconvergence following the failure of a switch, a switch port, or a LAN. It provides rapid reconvergence of edge ports, new root ports, and ports connected through point-to-point links.

The RSTP interface states for every Layer 2 interface running RSTP are as follows:

- *Learning* — The interface prepares to participate in frame forwarding.
- *Forwarding* — The interface forwards frames.
- *Discarding* — The interface discards frames. Note that the 802.1D disabled, blocking, and listening states are merged into the RSTP discarding state. Ports in the discarding state do not take part in the active topology and do not learn MAC addresses.

The following table lists the interface state changes between STP and RSTP.

**TABLE 19** STP versus RSTP state comparison

STP interface state	RSTP interface state	Is the interface included in the active topology?	Is the interface learning MAC addresses?
Disabled	Discarding	No	No
Blocking	Discarding	No	No
Listening	Discarding	Yes	No
Learning	Learning	Yes	Yes
Forwarding	Forwarding	Yes	Yes

With RSTP, the port roles for the new interface states are also different. RSTP differentiates explicitly between the state of the port and the role it plays in the topology. RSTP uses the root port and designated port roles defined by STP, but splits the blocked port role into backup port and alternate port roles:

- *Backup port* — Provides a backup for the designated port and can only exist where two or more ports of the switch are connected to the same LAN; the LAN where the bridge serves as a designated switch.
- *Alternate port* — Serves as an alternate port for the root port providing a redundant path towards the root bridge.

Only the root port and the designated ports are part of the active topology; the alternate and backup ports do not participate in it.

When the network is stable, the root and the designated ports are in the forwarding state, while the alternate and backup ports are in the discarding state. When there is a topology change, the new RSTP port roles allow a faster transition of an alternate port into the forwarding state.

## MSTP

IEEE 802.1s Multiple STP (MSTP) helps create multiple loop-free active topologies on a single physical topology. MSTP enables multiple VLANs to be mapped to the same spanning tree instance (forwarding path), which reduces the number of spanning tree instances needed to support a large number of VLANs. Each MSTP instance has a spanning tree topology independent of other spanning tree instances. With MSTP you can have multiple forwarding paths for data traffic. A failure in one instance does not affect other instances. With MSTP, you are able to more effectively utilize the physical resources present in the network and achieve better load balancing of VLAN traffic.

### NOTE

In MSTP mode, RSTP is automatically enabled to provide rapid convergence.

Multiple switches must be configured consistently with the same MSTP configuration to participate in multiple spanning tree instances. A group of interconnected switches that have the same MSTP configuration is called an MSTP region.

### NOTE

Brocade supports 32 MSTP instances and one MSTP region.

MSTP introduces a hierarchical way of managing switch domains using regions. Switches that share common MSTP configuration attributes belong to a region. The MSTP configuration determines the MSTP region where each switch resides. The common MSTP configuration attributes are as follows:

- Alphanumeric configuration name (32 bytes)
- Configuration revision number (2 bytes)
- 4096-element table that maps each of the VLANs to an MSTP instance

Region boundaries are determined by the above configuration. A multiple spanning tree instance is an RSTP instance that operates inside an MSTP region and determines the active topology for the set of VLANs mapping to that instance. Every region has a common internal spanning tree (CIST) that forms a single spanning tree instance that includes all the switches in the region. The difference between the CIST instance and the MSTP instance is that the CIST instance operates across the MSTP region and forms a loop-free topology across regions, while the MSTP instance operates only within a region. The CIST instance can operate using RSTP if all the switches across the regions support RSTP. However, if any of the switches operate using 802.1D STP, the CIST instance reverts to 802.1D. Each region is viewed logically as a single STP/RSTP bridge to other regions.

## PVST+ and Rapid PVST+

A network topology of bridges typically contains redundant connections to provide alternate paths in case of link failures. However, because there is no concept of TTL in Ethernet frames, this could result in permanent circulation of frames if there are loops in the network. To prevent loops, a spanning tree connecting all the bridges is formed in real time. The redundant ports are put in a blocking (nonforwarding) state. They are enabled when required.

In order to build a spanning tree for the bridge topology, the bridges must exchange control frames (BPDUs - Bridge Protocol Data Units). The protocols define the semantics of the BPDUs and the required state machine. The first Spanning Tree Protocol (STP) became part of the IEEE 802.1d standard.

Because the convergence time of STP is 50 seconds in the case of link failures, this delay soon became increasingly unacceptable. Keeping the main skeleton of STP the same, the state machine was changed to speed up the convergence time as part of the Rapid Spanning Tree protocol (RSTP). RSTP became part of the IEEE 802.1w standard.

Both STP and RSTP build a single logical topology. A typical network has multiple VLANs. A single logical topology does not efficiently utilize the availability of redundant paths for multiple VLANs. If a port is set to "blocked/discarding" for one VLAN (under STP/RSTP), it is the same for all other VLANs too.

Per-VLAN Spanning Tree Plus (PVST+) protocol runs a spanning tree instance for each VLAN in the network. The version of PVST+ that uses the RSTP state machine is called Rapid-PVST Plus (R-PVST+). R-PVST+ has one instance of spanning tree for each VLAN on the switch.

PVST+ is not a scalable model when there are many VLANs in the network, as it consumes a lot of CPU power. A reasonable compromise between the two extremes of RSTP and R-PVST+ is the Multiple Spanning Tree protocol (MSTP), which was standardized as IEEE 802.1s and later incorporated into the IEEE 802.1Q-2003 standard. MSTP runs multiple instances of spanning tree that are independent of VLANs. It then maps a set of VLANs to each instance.

### NOTE

Network OS 4.0 and later supports PVST+ and R-PVST+ only. The PVST and R-PVST protocols are proprietary to Cisco and are not supported.

## *PVST+ and R-PVST+ guidelines and restrictions*

Consider the following when configuring PVST+ and R-PVST+:

- Disabling the tagging of native VLANs is required on edge ports in fabric cluster mode; otherwise, PVST+/R-PVST+ does not converge and forms a loop on the native VLAN. The tagged native VLAN data traffic is ignored. The native VLAN untagged data is forwarded.
- If a VLAN is configured with tagged ports that do not have PVST+ mode enabled on the interface and are connected to the VDXs, and RSTP is enabled under the VLAN (PVST+), then BPDUs from the tagged ports that are received by the VDX are dropped.

## Spanning Tree Protocol and VCS mode

Network OS 4.0 and later supports any version of STP to run in VCS mode and function correctly between interconnecting VCS nodes, or between VCS and other vendor's switches. This feature is called Distributed Spanning Tree Protocol (DiST).

The purpose of DiST is as follows:

- To support VCS to VCS connectivity and automatic loop detection and prevention.
- To assist deployment plans for replacing the legacy xSTP enabled switches in your network.

DiST supports any of the following flavors of xSTP:

- IEEE STP
- IEEE RSTP
- IEEE MSTP
- Cisco PVST
- Cisco PVRST

DiST treats one VCS as one virtual xSTP bridge from an external view. Each VCS has a unique RBridge ID and Priority. DiST can be enabled on VCS edge ports connecting to other VCS nodes. The Port Ids used for xSTP are dynamically assigned and unique within the VCS.

It is important to note that in fabric cluster mode, it is assumed that the global xSTP configuration is the same on all the member nodes of the VCS. Mismatched global configurations of xSTP across different nodes in VCS are not supported. For example, if one of the nodes in a VCS is configured for RSTP and another one is configured for STP or MSTP, this scenario is unsupported and the fabric will not form.

Each RBridge runs the spanning tree instance in a distributed manner. Each spanning tree instance considers all the edge ports and the best information from the remote RBridges to arrive at the spanning tree topology. Each RBridge updates all the other members about its best information for a given spanning tree instance.

Each RBridge maintains a table of best information from the other RBridges in the cluster. This table is identical across all the RBridges in the cluster. This information is used to derive the port roles for the local edge ports. The shared information of the whole cluster is considered in the spanning tree calculations for port roles and states of local edge ports. Thus, all the remote RBridges' edge port information could affect the port role selection and port state transitions for the local edge ports. This ensures that each RBridge considers the port roles and states of all the other RBridges to arrive at a final spanning tree topology.

In the event of a change of the "best" information on any member RBridge, that RBridge would update its own next best information to the other RBridges. Some of the scenarios in which this could happen are the following:

- Operational status change of port associated with the "best" information
- Reception of superior information by another edge port on the RBridge
- Reception of superior or inferior information by the "best" port on the RBridge
- Nonreception of BPDUs on the best port for a given period of time

The xSTP update information is received by all member nodes of the cluster. Each node updates its internal database with the received information. If this results in a best-information change, the update is applied on to the logical port for the node. This triggers the xSTP state machine for all local ports.

## Configuring and managing STP and STP variants

Before proceeding, refer to [STP configuration guidelines and restrictions](#) on page 122.

## Understanding the default STP configuration

It is helpful to understand the STP defaults before you make configuration changes. The following table lists the default STP configuration.

**TABLE 20** Default STP configuration

Parameter	Default setting
Spanning-tree mode	By default, STP, RSTP, and MSTP are disabled
Bridge priority	32768
Bridge forward delay	15 seconds
Bridge maximum aging time	20 seconds
Error disable timeout timer	Disabled
Error disable timeout interval	300 seconds
Port-channel path cost	Standard
Bridge hello time	2 seconds

The following table lists those switch defaults which apply only to MSTP configurations.

**TABLE 21** Default MSTP configuration

Parameter	Default setting
Cisco interoperability	Disabled
Switch priority (when mapping a VLAN to an MSTP instance)	32768
Maximum hops	20 hops
Revision number	0

The following table lists the switch defaults for the 10-gigabit Ethernet DCB interface-specific configuration.

**TABLE 22** Default 10-gigabit Ethernet DCB interface-specific configuration

Parameter	Default setting
Spanning tree	Disabled on the interface
Automatic edge detection	Disabled
Path cost	2000
Edge port	Disabled
Guard root	Disabled
Hello time	2 seconds
Link type	Point-to-point
Port fast	Disabled
Port priority	128
DCB interface root port	Allow the DCB interface to become a root port.
DCB interface BPDU restriction	Restriction is disabled.

## Saving configuration changes

Enter the **copy running-config startup-config** command to save your configuration changes.

## Configuring basic STP

### NOTE

The **gigabitethernet** *rbridge-id/slot/port* keyword is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8 switches. The prompt for these ports is in this format: `switch(config-if-gi-22/0/1)#`.

The process for configuring STP is as follows:

1. Enter global configuration mode.
2. Enable STP by using the global **protocol spanning-tree** command. For details, refer to [Enabling STP, RSTP, MSTP, PVST+ or R-PVST+](#) on page 133.

```
switch(config)# protocol spanning-tree stp
```

3. Designate the root switch by using the **bridge-priority** command. For details, refer to [Specifying the bridge priority](#) on page 134. The range is 0 through 61440 and the priority values can be set only in increments of 4096.

```
switch(conf-stp)# bridge-priority 28672
```

4. Enable port fast on switch ports by using the **spanning-tree portfast** command. For details, refer to [Enabling port fast \(DCB\)](#) on page 144.

### NOTE

Port fast only needs to be enabled on ports that connect to workstations or PCs. Repeat these commands for every port connected to workstations or PCs. Do not enable port fast on ports that connect to other switches.

### NOTE

If BPDUs are received on a port fast enabled interface, the interface loses the edge port status unless it receives a shut/no shut.

### NOTE

Enabling port fast on ports can cause temporary bridging loops, in both trunking and nontrunking mode.

```
switch(config)# interface tengigabitethernet 1/0/10
switch(conf-if-te-1/0/10)# spanning-tree portfast
switch(conf-if-te-1/0/10)# exit
switch(config)# interface tengigabitethernet 1/0/11
switch(conf-if-te-1/0/11)# spanning-tree portfast
switch(conf-if-te-1/0/11)# exit
```

Repeat these commands for every port connected to workstations or PCs.

5. To interoperate with non-Brocade switches in PVST+/R-PVST+ mode, you may need to configure the interface that is connected to that switch by using the **spanning-tree bpdu-mac** command.

```
switch(config)# interface tengigabitethernet 1/0/12
switch(conf-if-te-0/12)# spanning-tree bpdu-mac 0100.0ccc.cccd
```

6. Specify port priorities by using the **spanning-tree priority** command to influence the selection of root/designated ports on the following:
  - All ports of the root switch
  - The root port
  - The designated port

7. Enable the guard root feature with the **spanning-tree guard root** command. The guard root feature provides a way to enforce the root bridge placement in the network. For detailed information, refer to [Enabling guard root \(DCB\)](#) on page 142.

All other switch ports connect to other switches and bridges are automatically placed in blocking mode.

This does not apply to ports connected to workstations or PCs; these ports remain in the forwarding state.

8. Return to privileged EXEC mode.

```
switch(conf-if-te-1/0/12)# end
```

9. Enter the **copy running-config startup-config** command to save the running configuration to the startup configuration.

```
switch# copy running-config startup-config
```

When the spanning tree topology is completed, the network switches send and receive data only on the ports that are part of the spanning tree. Data received on ports that are not part of the spanning tree is blocked.

#### NOTE

Brocade recommends leaving other STP variables at their default values.

For more information on STP, refer to [Configuring and managing STP and STP variants](#) on page 125.

## Configuring RSTP

The basic process for configuring RSTP is as follows.

1. Enter the **config** command to change to global configuration mode.

```
switch# config
```

2. Enable RSTP by using the global **protocol spanning-tree** command. For details, refer to [Enabling STP, RSTP, MSTP, PVST+ or R-PVST+](#) on page 133.

```
switch(config)# protocol spanning-tree rstp
```

3. Designate the root switch by using the **bridge-priority** command. For more details, refer to [Specifying the bridge priority](#) on page 134. The range is 0 through 61440 and the priority values can be set only in increments of 4096.

```
switch(conf-stp)# bridge-priority 28582
```

4. Configure the bridge forward delay value. For more details, refer to [Specifying the bridge forward delay](#) on page 135.

```
switch(conf-stp)# forward-delay 20
```

5. Configure the bridge maximum aging time value. For more details, refer to [Specifying the bridge maximum aging time](#) on page 135.

```
switch(conf-stp)# max-age 25
```

6. Enable the error-disable-timeout timer. For more details, refer to [Enabling the error disable timeout timer](#) on page 137.

```
switch(conf-stp)# error-disable-timeout enable
```

7. Configure the error-disable-timeout interval value. For more details, refer to [Specifying the error disable timeout interval](#) on page 137.

```
switch(conf-stp)# error-disable-timeout interval 60
```



8. Configure the port-channel path cost. For more details, refer to [Specifying the port-channel path cost](#) on page 138.

```
switch(conf-stp)# port-channel path-cost custom
```

9. Configure the bridge hello-time value. For more details, refer to [Specifying the bridge hello time](#) on page 136.

```
switch(conf-stp)# hello-time 5
```

10. Enable port fast on switch ports by using the **spanning-tree portfast** command. For more details, refer to [Enabling port fast \(DCB\)](#) on page 144.

The **gigabitethernet** *rbridge-id/slot/port* keyword is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8. The prompt for these ports is in the following format: switch(config-if-gi-22/0/1)#

#### NOTE

Port fast only needs to be enabled on ports that connect to workstations or PCs. Repeat these commands for every port connected to workstations or PCs. Do not enable port fast on ports that connect to other switches.

#### NOTE

Enabling port fast on ports can cause temporary bridging loops, in both trunking and nontrunking mode.

```
switch(config)# interface tengigabitethernet 1/0/10
switch(conf-if-te-1/0/10)# spanning-tree portfast
switch(conf-if-te-1/0/10)# exit
switch(config)# interface tengigabitethernet 1/0/11
switch(conf-if-te-1/0/11)# spanning-tree portfast
switch(conf-if-te-1/0/11)# exit
switch(config)#
```

Repeat these commands for every port connected to workstations or PCs.

11. Specify port priorities by using the **spanning-tree priority** command to influence the selection of root/designated ports on the following:
- All ports of the root switch
  - The root port
  - The designated port

For details, refer to [Specifying the port priority \(DCB\)](#) on page 145.

12. Enable the guard root feature with the **spanning-tree guard root** command. The guard root feature provides a way to enforce the root bridge placement in the network. For detailed information, refer to [Enabling guard root \(DCB\)](#) on page 142.

All other switch ports connected to other switches and bridges are automatically placed in blocking mode.

This does not apply to ports connected to workstations or PCs; these ports remain in the forwarding state.

13. Return to privileged EXEC mode.

```
switch(config)# end
```

14. Enter the **copy running-config startup-config** command to save the running configuration to the startup configuration.

```
switch# copy running-config startup-config
```

## Configuring MSTP

The basic process for configuring MSTP is as follows.

1. Enter the **config** command to change to global configuration mode.

```
switch# config
```

2. Enable MSTP by using the global **protocol spanning-tree** command. Refer to [Enabling STP, RSTP, MSTP, PVST+ or R-PVST+](#) on page 133 for more details.

```
switch(config)# protocol spanning-tree mstp
```

3. Specify the region name by using the **region region\_name** command. Refer to [Specifying a name for an MSTP region](#) on page 132 for more details.

```
switch(config-mstp)# region brocade1
```

4. Specify the revision number by using the **revision** command. Refer to [Specifying a revision number for MSTP configuration](#) on page 132 for more details.

```
switch(config-mstp)# revision 1
```

5. Map a VLAN to an MSTP instance by using the **instance** command. Refer to [Mapping a VLAN to an MSTP instance](#) on page 131 for more details.

```
switch(config-mstp)# instance 1 vlan 2, 3
switch(config-mstp)# instance 2 vlan 4-6
switch(config-mstp)# instance 1 priority 4096
```

6. Specify the maximum hops for a BPDU to prevent the messages from looping indefinitely on the interface by using the **max-hops hop\_count** command. Refer to [Specifying the maximum number of hops for a BPDU \(MSTP\)](#) on page 132 for more details.

```
switch(config-mstp)# max-hops 25
```

7. Return to privileged EXEC mode.

```
switch(config)# end
```

8. Enter the **copy running-config startup-config** command to save the running configuration to the startup configuration.

```
switch# copy running-config startup-config
```

For more information on MSTP, refer to [Configuring and managing STP and STP variants](#) on page 125.

### Configuring additional MSTP parameters

The following sections discuss how to configure additional MSTP parameters.

#### Enabling and disabling Cisco interoperability (MSTP)

In MSTP mode, use the **cisco-interoperability** command to enable or disable the ability to interoperate with certain legacy Cisco switches. If Cisco interoperability is required on any switch in the network, then all switches in the network must be compatible, and therefore enabled by means of this command. The default is Cisco interoperability is disabled.

**NOTE**

The **cisco-interopability** command is necessary because the "version 3 length" field in the MSTP BPDU on some legacy Cisco switches does not conform to current standards.

To enable interoperability with certain legacy Cisco switches, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to change to global configuration mode.

```
switch# config
```

2. Enter the **protocol** command to enable MSTP.

```
switch(config)# protocol spanning-tree mstp
```

3. Enter the **cisco-interopability enable** command to enable interoperability with certain legacy Cisco switches.

```
switch(config-mstp)# cisco-interopability enable
```

4. (Optional) To disable interoperability with certain legacy Cisco switches, perform the following steps from privileged EXEC mode.

- a) Enter the **config** command to access global configuration mode.
- b) Enter the **protocol** command to enable MSTP.

```
switch(config)# protocol spanning-tree mstp
```

- c) Disable interoperability with certain legacy Cisco switches.

```
switch(config-mstp)# cisco-interopability disable
```

### Mapping a VLAN to an MSTP instance

In MSTP mode, use the **instance** command to map a VLAN to an MTSP. You can group a set of VLANs to an instance. This command can be used only after the VLAN is created. VLAN instance mapping is removed from the configuration if the underlying VLANs are deleted.

To map a VLAN to an MSTP instance, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to change to global configuration mode.

```
switch# config
```

2. Enter the **protocol** command to enable MSTP.

```
switch(config)# protocol spanning-tree mstp
```

3. Map a VLAN to an MSTP instance.

```
switch(config-mstp)# instance 5 vlan 300
```

4. Return to privileged EXEC mode.

```
switch(config-mstp)# end
```

5. Enter the **copy running-config startup-config** command to save the running configuration to the startup configuration.

```
switch# copy running-config startup-config
```

### Specifying the maximum number of hops for a BPDU (MSTP)

In MSTP mode, use the **max-hops** command to configure the maximum number of hops for a BPDU in an MSTP region. Specifying the maximum hops for a BPDU prevents the messages from looping indefinitely on the interface. When you change the number of hops, it affects all spanning tree instances. The range is 1 through 40. The default is 20 hops.

To configure the maximum number of hops for a BPDU in an MSTP region, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to change to global configuration mode.

```
switch# config
```

2. Enter the **protocol** command to enable MSTP.

```
switch(config)# protocol spanning-tree mstp
```

3. Enter the **max-hops 30** command to change the maximum number of hops from the default for a BPDU in an MSTP region.

```
switch(config-mstp)# max-hops 30
```

4. Return to privileged EXEC mode.

```
switch(config-mstp)# end
```

5. Enter the **copy running-config startup-config** command to save the running configuration to the startup configuration.

```
switch# copy running-config startup-config
```

### Specifying a name for an MSTP region

In MSTP mode, use the **region** command to assign a name to an MSTP region. The region name has a maximum length of 32 characters and is case-sensitive.

To assign a name to an MSTP region, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.

```
switch# config
```

2. Enter the **protocol** command to enable MSTP.

```
switch(config)# protocol spanning-tree mstp
```

3. Enter the **region** command to assign a name to an MSTP region.

```
switch(config-mstp)# region sydney
```

4. Return to privileged EXEC mode.

```
switch(config-mstp)# end
```

5. Enter the **copy running-config startup-config** command to save the running configuration to the startup configuration.

```
switch# copy running-config startup-config
```

### Specifying a revision number for MSTP configuration

In MSTP mode, use the **revision** command to specify a revision number for an MSTP configuration. The range is 0 through 255. The default is 0.

To specify a revision number for an MSTP configuration, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to change to global configuration mode.

```
switch# config
```

2. Enter the **protocol spanning-tree mstp** command to enable MSTP.

```
switch(config)# protocol spanning-tree mstp
```

3. Enter the **revision** command to specify a revision number for an MSTP configuration.

```
switch(config-mstp)# revision 17
```

4. Return to privileged EXEC mode.

```
switch(config-mstp)# end
```

5. Enter the **copy running-config startup-config** command to save the running configuration to the startup configuration.

```
switch# copy running-config startup-config
```

## Configuring PVST+ or R-PVST+

To configure PVST+ or R-PVST+, use the **protocol spanning-tree pvst** and **protocol spanning-tree rpvt** commands. Refer to the *Network OS Command Reference* for details.

### NOTE

Before proceeding, refer to [PVST+ and R-PVST+ guidelines and restrictions](#) on page 124.

For example, the following script configures PVST+:

```
switch(config)# protocol spanning-tree pvst
switch(config-pvst)# bridge-priority 4096
switch(config-pvst)# forward-delay 4
switch(config-pvst)# hello-time 2
switch(config-pvst)# max-age 7
```

## Enabling STP, RSTP, MSTP, PVST+ or R-PVST+

Enable STP to detect or avoid loops. STP is not required in a loop-free topology. You must turn off one form of STP before turning on another form. By default, STP, RSTP, MSTP, PVST+, or R-PVST+ are not enabled.

Perform the following steps from privileged EXEC mode.

1. Enter the **config** command to change to global configuration mode.

```
switch# config
```

2. Enter the **protocol spanning-tree mode\_name** command to enable STP, RSTP, MSTP, PVST+, or R-PVST+.

```
switch(config)# protocol spanning-tree pvst
```

## Disabling STP, RSTP, MSTP, PVST+, or R-PVST+

### NOTE

Using the **no protocol spanning-tree** command deletes the context and all the configurations defined within the context or protocol for the interface.

To disable STP, RSTP, MSTP, PVST+, or R-PVST+, perform the following steps from privileged EXEC mode. By default, STP, RSTP, MSTP, PVST+, or R-PVST+ are not enabled.

1. Enter the **config** command to access global configuration mode.

```
switch# config
```

2. Enter the **no protocol spanning-tree** command to disable STP, RSTP, MSTP, PVST+, or R-PVST+.

```
switch(config)# no protocol spanning-tree
```

## Shutting down STP, RSTP, MSTP, PVST+, or R-PVST+ globally

To shut down STP, RSTP, MSTP, PVST+, or R-PVST+ globally, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to change to global configuration mode.

```
switch# config
```

2. Enter the **shutdown** command to shut down STP, RSTP, MSTP, PVST+, or R-PVST+ globally. The **shutdown** command works in all modes.

```
switch(config-mstp)# shutdown
```

## Specifying bridge parameters

There are a variety of options for configuring the behavior of the STP bridging function, as shown in the following subsections.

### *Specifying the bridge priority*

In PVST+ or R-PVST+ mode, use the **bridge-priority** command to specify the priority of the switch. After you decide on the root switch, set the appropriate values to designate the switch as the root switch. If a switch has a bridge priority that is lower than that of all the other switches, the other switches automatically select the switch as the root switch.

The root switch should be centrally located and not in a "disruptive" location. Backbone switches typically serve as the root switch because they often do not connect to end stations. All other decisions in the network, such as which port to block and which port to put in forwarding mode, are made from the perspective of the root switch.

Bridge Protocol Data Units (BPDUs) carry the information exchanged between switches. When all the switches in the network are powered up, they start the process of selecting the root switch. Each switch transmits a BPDU to directly connected switches on a per-VLAN basis. Each switch compares the received BPDU to the BPDU that the switch sent. In the root switch selection process, if switch 1 advertises a root ID that is a lower number than the root ID that switch 2 advertises, switch 2 stops the advertisement of its root ID, and accepts the root ID of switch 1. The switch with the lowest bridge priority becomes the root switch.

Additionally, you may specify the bridge priority for a specific VLAN. If the VLAN parameter is not provided, the priority value is applied globally for all per-VLAN instances. However, for the VLANs that have been configured explicitly, the per-VLAN configuration takes precedence over the global configuration.

To specify the bridge priority, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to change to global configuration mode.

```
switch# config
```

2. Enter the **protocol spanning-tree** command to enable PVST+ or R-PVST+.

```
switch(config)# protocol spanning-tree pvst
```

3. Specify the bridge priority. The range is 0 through 61440 and the priority values can be set only in increments of 4096. The default priority is 32678.

```
switch(conf-stp)# bridge-priority 20480
```

4. Specify the bridge priority for a specific VLAN.

```
switch(conf-stp)# bridge-priority 20480 vlan 10
```

### Specifying the bridge forward delay

In STP, RSTP, MSTP, PVST+, or R-PVST+ mode, use the **forward-delay** command to specify how long an interface remains in the listening and learning states before the interface begins forwarding all spanning tree instances. The valid range is from 4 through 30 seconds. The default is 15 seconds. The following relationship should be kept:

$$2 * (\text{forward\_delay} - 1) \geq \text{max\_age} \geq 2 * (\text{hello\_time} + 1)$$

Additionally, you may specify the forward delay for a specific VLAN. If the VLAN parameter is not provided, the priority value is applied globally for all per-VLAN instances. However, for the VLANs that have been configured explicitly, the per-VLAN configuration takes precedence over the global configuration.

To specify the bridge forward delay, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to change to global configuration mode.

```
switch# config
```

2. Enter the **protocol spanning-tree** command to enable STP, RSTP, MSTP, PVST+, or R-PVST+.

```
switch(config)# protocol spanning-tree stp
```

3. Specify the bridge forward delay.

```
switch(conf-stp)# forward-delay 20
```

4. Specify the bridge forward delay for a specific VLAN.

```
switch(conf-stp)# forward-delay 20 vlan 10
```

### Specifying the bridge maximum aging time

In STP, RSTP, MSTP, PVST+, or R-PVST+ mode, use the **max-age** command to control the maximum length of time that passes before an interface saves its BPDU configuration information.

When configuring the maximum aging time, you must set the max-age to be greater than the hello time. The range is 6 through 40 seconds. The default is 20 seconds. The following relationship should be kept:

$$2 * (\text{forward\_delay} - 1) \geq \text{max\_age} \geq 2 * (\text{hello\_time} + 1)$$

Additionally, you may specify the maximum aging for a specific VLAN. If the VLAN parameter is not provided, the priority value is applied globally for all per-VLAN instances. However, for the VLANs that have been configured explicitly, the per-VLAN configuration takes precedence over the global configuration.

To specify the bridge maximum aging time, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to change to global configuration mode.

```
switch# config
```

2. Enter the **protocol spanning-tree** command to enable STP, RSTP, MSTP, PVST+, or R-PVST+.

```
switch(config)# protocol spanning-tree stp
```

3. Specify the bridge maximum aging time.

```
switch(conf-stp)# max-age 25
```

4. (Optional) Specify the bridge maximum aging time for a specific VLAN.

```
switch(conf-stp)# max-age 25 vlan 10
```

### Specifying the bridge hello time

In STP, RSTP, MSTP, PVST+, or R-PVST+ mode, use the **hello-time** command to configure the bridge hello time. The hello time determines how often the switch interface broadcasts hello BPDUs to other devices. The range is from 1 through 10 seconds. The default is 2 seconds.

When configuring the hello time, you must set the maximum age to be greater than the hello time. The following relationship should be kept:

$$2 * (\text{forward\_delay} - 1) \geq \text{max\_age} \geq 2 * (\text{hello\_time} + 1)$$

Additionally, you may specify the hello time for a specific VLAN. If the VLAN parameter is not provided, the priority value is applied globally for all per-VLAN instances. However, for the VLANs that have been configured explicitly, the per-VLAN configuration takes precedence over the global configuration.

To specify the bridge hello time, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to change to global configuration mode.

```
switch# configure terminal
```

2. Enter the **protocol spanning-tree** command to enable STP, RSTP, MSTP, PVST+, or R-PVST+.

```
switch(config)# protocol spanning-tree stp
```

3. Specify the time range in seconds for the interval between the hello BPDUs sent on an interface.

```
switch(conf-stp)# hello-time 5
```

4. (Optional) Specify the time range in seconds for the interval between the hello BPDUs sent on an interface for a specific VLAN.

```
switch(conf-stp)# hello-time 5 vlan 10
```

5. Return to privileged EXEC mode.

```
switch(config)# end
```



6. Enter the **copy running-config startup-config** command to save the running configuration to the startup configuration.

```
switch# copy running-config startup-config
```

## Configuring STP timers

You must configure the error disable timeout timer before you can use it.

### Enabling the error disable timeout timer

In STP, RSTP, MSTP, PVST+, or R-PVST+ mode, use the **error-disable-timeout** command to enable a timer that will bring a port out of the disabled state. When the STP BPDU guard disables a port, the port remains in the disabled state unless the port is enabled manually. This command allows you to enable the port from the disabled state. For details on configuring the error disable timeout interval, refer to [Specifying the error disable timeout interval](#) on page 137.

To enable the error disable timeout timer, perform the following steps from privileged EXEC mode. By default, the timeout feature is disabled.

1. Enter the **config** command to change to global configuration mode.

```
switch# config
```

2. Enter the **protocol spanning-tree** command to enable STP, RSTP, MSTP, PVST+, or R-PVST+.

```
switch(config)# protocol spanning-tree stp
```

3. Enable the error disable timeout timer.

```
switch(conf-stp)# error-disable-timeout enable
```

### Specifying the error disable timeout interval

In STP, RSTP, MSTP, PVST+, or R-PVST+ mode, use the **error-disable-timeout** command to specify the time in seconds it takes for an interface to time out. The range is from 10 through 1000000 seconds. The default is 300 seconds. By default, the timeout feature is disabled.

To specify the time in seconds it takes for an interface to time out, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to change to global configuration mode.

```
switch# config
```

2. Enter the **protocol spanning-tree** command to enable STP, RSTP, MSTP, PVST+, or R-PVST+.

```
switch(config)# protocol spanning-tree stp
```

3. Specify the time in seconds it takes for an interface to time out.

```
switch(conf-stp)# error-disable-timeout interval 60
```

## Specifying the port-channel path cost

In STP, RSTP, MSTP, PVST+, or R-PVST+ mode, use the **port-channel path-cost** command to specify the port-channel path cost. The default port cost is **standard**. The path cost options are as follows:

- **custom** — Specifies that the path cost changes according to the port-channel's bandwidth.
- **standard** — Specifies that the path cost does not change according to the port-channel's bandwidth.

To specify the port-channel path cost, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to change to global configuration mode.

```
switch# config
```

2. Enter the **protocol spanning-tree** command to enable STP, RSTP, MSTP, PVST+, or R-PVST+.

```
switch(config)# protocol spanning-tree stp
```

3. Specify the port-channel path cost.

```
switch(config-stp)# port-channel path-cost custom
```

4. Return to privileged EXEC mode.

```
switch(config)# end
```

5. Enter the **copy running-config startup-config** command to save the running configuration to the startup configuration.

```
switch# copy running-config startup-config
```

## Specifying the transmit hold count (RSTP, MSTP, and R-PVST+)

In RSTP, MSTP, or R-PVST+ mode, use the **transmit-holdcount** command to configure the BPDU burst size by specifying the transmit hold count value. The command configures the maximum number of BPDUs transmitted per second for RSTP and MSTP before pausing for 1 second. The range is 1 through 10. The default is 6.

To specify the transmit hold count, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to change to global configuration mode.

```
switch# config
```

2. Specify the transmit hold count.

```
switch(config-mstp)# transmit-holdcount 5
```

3. Return to privileged EXEC mode.

```
switch(config)# end
```

4. Enter the **copy running-config startup-config** command to save the running configuration to the startup configuration.

```
switch# copy running-config startup-config
```

## Clearing spanning tree counters

To clear spanning tree counters on all interfaces or on the specified interface, use **clear spanning-tree counter** command in privileged EXEC mode.

1. Use the **clear spanning-tree counter** command to restart the protocol migration process on all the interfaces.

```
switch# clear spanning-tree counter
```

2. Alternatively, use the **clear spanning-tree counter interface** command to restart the protocol migration process associated with a specific port-channel or DCB port interface.

```
switch# clear spanning-tree counter interface tengigabitethernet 1/0/1
```

## Clearing spanning tree-detected protocols

To restart the protocol migration process (force the renegotiation with neighboring switches) on either all interfaces or on a specified interface, use the **clear spanning-tree detected-protocols** command in privileged EXEC mode.

To restart the protocol migration process, perform either of the following tasks:

1. Use the **clear spanning-tree detected-protocols** command to clear all spanning tree counters on all interfaces:

```
switch# clear spanning-tree detected-protocols
```

2. Alternatively, use the **clear spanning-tree detected-protocols interface** *interface\_ID* command to clear the spanning tree counters associated with a specific port-channel or DCB port interface:

```
switch# clear spanning-tree detected-protocols interface tengigabitethernet 0/1
```

## Displaying STP, RSTP, MSTP, PVST+, or R-PVST+ information

Enter the **show spanning-tree brief** command in privileged EXEC mode to display all STP, RSTP, MSTP, PVST+, or R-PVST+-related information.

### NOTE

The **show spanning-tree brief** command output shows the port state as ERR, not root\_inc, when **root guard** is in effect.

## Configuring STP, RSTP, or MSTP on DCB interface ports

This section details the commands for enabling and configuring STP, RSTP, or MSTP on individual 10-gigabit Ethernet Data Center Bridging (DCB) interface ports.

### *Enabling and disabling STP (DCB)*

Do the following to enable or disable spanning tree, as appropriate.

#### Enabling spanning tree (DCB)

From the DCB interface, use this command to enable spanning tree on the DCB interface. By default, spanning tree is disabled.

To enable spanning tree on the DCB interface, run the following steps in privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.
2. Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following format: switch(config-if-gi-22/0/1)#

```
switch(config)# interface tengigabitethernet 1/0/1
```

3. Enter the **no shutdown** command to enable the DCB interface.

```
switch(conf-if-te-1/0/1)# no shutdown
```

4. Enter the **no spanning-tree shutdown** command to enable spanning tree on the DCB interface.

```
switch(conf-if-te-1/0/1)# no spanning-tree shutdown
```

### Disabling spanning tree (DCB)

From the DCB interface, use the **spanning-tree shutdown** command to disable spanning tree on the DCB interface. By default, spanning tree is disabled.

To disable spanning tree on the DCB interface, perform the following steps in privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.
2. Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8. The prompt for these ports is in the following format: switch(config-if-gi-22/0/1)#

```
switch(config)# interface tengigabitethernet 1/0/1
```

3. Enter the **no shutdown** command to enable the DCB interface.

```
switch(conf-if-te-1/0/1)# no shutdown
```

4. Enter the **spanning-tree shutdown** command to disable spanning tree on the DCB interface.

```
switch(conf-if-te-1/0/1)# spanning-tree shutdown
```

### Enabling automatic edge detection (DCB)

From the DCB interface, use the **spanning-tree autoedge** command to identify the edge port automatically. The port can become an edge port if no BPDU is received. By default, automatic edge detection is disabled.

To enable automatic edge detection on the DCB interface, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.
2. Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8. The prompt for these ports is in the following example format: switch(config-if-gi-22/0/1)#

```
switch(config)# interface tengigabitethernet 1/0/1
```

3. Enter the **no shutdown** command to enable the DCB interface.

```
switch(conf-if-te-1/0/1)# no shutdown
```

4. Enter the **spanning-tree autoedge** command to enable automatic edge detection on the DCB interface.

```
switch(conf-if-te-1/0/1)# spanning-tree autoedge
```

### Configuring the path cost (DCB)

From the DCB interface, use the **spanning-tree cost** command to configure the path cost for spanning tree calculations. The lower the path cost means there is a greater chance of the interface becoming the root port. The range is 1 through 200000000. The default path cost is 2000 for a 10-gigabit Ethernet interface.

Additionally, you may specify the spanning tree cost for a specific VLAN. If the VLAN parameter is not provided, the priority value is applied globally for all per-VLAN instances. However, for the VLANs that have been configured explicitly, the per-VLAN configuration takes precedence over the global configuration.

To configure the path cost for spanning tree calculations on the DCB interface, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.
2. Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet** *rbridge-id/slot/port* keyword is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8. The prompt for these ports is in the following example format: `switch(config-if-gi-22/0/1)#`

```
switch(config)# interface tengigabitethernet 1/0/1
```

3. Enter the **no shutdown** command to enable the DCB interface.

```
switch(conf-if-te-1/0/1)# no shutdown
```

4. Enter the **spanning-tree cost** command to configure the path cost for spanning tree calculations on the DCB interface.

```
switch(conf-if-te-1/0/1)# spanning-tree cost 10000
```

5. Enter the **spanning-tree vlan** command to configure the path cost for spanning tree calculations on the DCB interface.

```
switch(conf-if-te-1/0/1)# spanning-tree vlan 10 cost 10000
```

6. Return to privileged EXEC mode.

```
switch(conf-if-te-1/0/1)# end
```

7. Enter the **copy running-config startup-config** command to save the running configuration to the startup configuration.

```
switch# copy running-config startup-config
```

### Enabling a port (interface) as an edge port (DCB)

From the DCB interface, use the **spanning-tree edgeport** command to enable the port as an edge port to allow the port to quickly transition to the forwarding state.

#### NOTE

The **spanning-tree edgeport** command is only for RSTP and MSTP. Use the **spanning-tree portfast** command for STP (refer to [Enabling port fast \(DCB\)](#) on page 144).

Follow these guidelines to configure a port as an edge port:

- A port can become an edge port if no BPDU is received.
- When an edge port receives a BPDU, it becomes a normal spanning tree port and is no longer an edge port.
- Because ports that are directly connected to end stations cannot create bridging loops in the network, edge ports transition directly to the forwarding state and skip the listening and learning states.

To enable the DCB interface as an edge port, run the following steps in privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.
2. Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8. The prompt for these ports is in the following example format: switch(config-if-gi-22/0/1)#

```
switch(config)# interface tengigabitethernet 1/0/1
```

3. Enter the **no shutdown** command to enable the DCB interface.

```
switch(conf-if-te-1/0/1)# no shutdown
```

4. Enter the **spanning-tree edgeport** command to enable the DCB interface as an edge port.

```
switch(conf-if-te-1/0/1)# spanning-tree edgeport
```

## Enabling guard root (DCB)

From the DCB interface, use this command to enable the guard root feature on the switch. This feature provides a way to enforce the root bridge placement in the network. With guard root enabled on an interface, the switch is able to restrict which interface is allowed to be the spanning tree root port or the path to the root for the switch. The root port provides the best path from the switch to the root switch. By default, guard root is disabled.

Guard root protects the root bridge from malicious attacks and unintentional misconfigurations where a bridge device that is not intended to be the root bridge becomes the root bridge. This causes severe bottlenecks in the data path. Guard root ensures that the port on which it is enabled is a designated port. If the guard-root-enabled port receives a superior BPDU, it goes to a discarding state.

Additionally, you may enable guard root for a specific VLAN. If the VLAN parameter is not provided, the priority value is applied globally for all per-VLAN instances. However, for the VLANs that have been configured explicitly, the per-VLAN configuration takes precedence over the global configuration.

To enable guard root on a DCB interface, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.
2. Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet** *rbridge-id/slot/port* keyword is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8. The prompt for these ports is in the following example format: switch(config-if-gi-22/0/1)#

```
switch(config)# interface tengigabitethernet 1/0/1
```

3. Enter the **no shutdown** command to enable the DCB interface.

```
switch(conf-if-te-1/0/1)# no shutdown
```

4. Enter the **spanning-tree guard root** command to enable guard root on a DCB interface.

```
switch(conf-if-te-1/0/1)# spanning-tree guard root
```

- Optionally, enter the **spanning-tree** command to enable guard root for a specific VLAN.

```
switch(conf-if-te-1/0/1)# spanning-tree guard root vlan 10
```

### Specifying the STP hello time (DCB)

From the DCB interface, use **spanning-tree hello-time** command to set the time interval between BPDUs sent by the root switch. Changing the hello time affects all spanning tree instances.

The maximum age setting must be greater than the hello time setting (refer to [Specifying the bridge maximum aging time](#) on page 135). The range for the **spanning-tree hello-time** command is 1 through 10 seconds. The default value is 2 seconds.

To specify the MSTP hello time on a DCB interface, perform the following steps from privileged EXEC mode.

- Enter the **config** command to access global configuration mode.
- Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8. The prompt for these ports is in the following example format: switch(config-if-gi-22/0/1)#

```
switch(config)# interface tengigabitethernet 1/0/1
```

- Enter the **no shutdown** command to enable the DCB interface.

```
switch(conf-if-te-1/0/1)# no shutdown
```

- Enter the **spanning-tree** command to specify the hello time on a DCB interface.

```
switch(conf-if-te-1/0/1)# spanning-tree hello-time 5
```

- Return to privileged EXEC mode.

```
switch(conf-if-te-1/0/1)# end
```

- Enter the **copy running-config startup-config** command to save the running configuration to the startup configuration.

```
switch# copy running-config startup-config
```

### Specifying restrictions for an MSTP instance (DCB)

From the DCB interface, use the **spanning-tree instance** command to specify restrictions on the interface for an MSTP instance.

To specify restrictions for an MSTP instance on a DCB interface, perform the following steps.

- Enter the **config** command to access global configuration mode from privileged EXEC mode.
- Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8. The prompt for these ports is in the following example format: switch(config-if-gi-22/0/1)#

```
switch(config)# interface tengigabitethernet 1/0/1
```

- Enter the **no shutdown** command to enable the DCB interface.

```
switch(conf-if-te-1/0/1)# no shutdown
```

4. Enter the **spanning-tree instance restricted-tcn** command to restrict Topology Change Notification (TCN) BPDUs for an MSTP instance on a DCB interface.

```
switch(conf-if-te-1/0/1)# spanning-tree instance 5 restricted-tcn
```

5. Return to privileged EXEC mode.

```
switch(conf-if-te-1/0/1)# end
```

6. Enter the **copy running-config startup-config** command to save the running configuration to the startup configuration.

```
switch# copy running-config startup-config
```

## Specifying a link type (DCB)

From the DCB interface, use the **spanning-tree link-type** command to specify a link type. Specifying the **point-to-point** keyword enables rapid spanning tree transitions to the forwarding state. Specifying the **shared** keyword disables spanning tree rapid transitions. The default setting is point-to-point.

To specify a link type on a DCB interface, perform the following steps from privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.
2. Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet rbridge-id/slot/port** operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8. The prompt for these ports is in the following example format: `switch(config-if-gi-22/0/1)#`

```
switch(config)# interface tengigabitethernet 1/0/1
```

3. Enter the **no shutdown** command to enable the DCB interface.

```
switch(conf-if-te-1/0/1)# no shutdown
```

4. Enter the **spanning-tree link-type shared** command, as in the following example, to change the link type from the default.

```
switch(conf-if-te-1/0/1)# spanning-tree link-type shared
```

## Enabling port fast (DCB)

From the DCB interface, use the **spanning-tree portfast** command to enable port fast on an interface to allow the interface to transition quickly to the forwarding state. Port fast immediately puts the interface into the forwarding state without having to wait for the standard forward time.

### NOTE

If you enable the **portfast bpduguard** option on an interface and the interface receives a BPDU, the software disables the interface and puts the interface in the ERR\_DISABLE state.



### CAUTION

Enabling port fast on ports can cause temporary bridging loops, in both trunking and nontrunking mode.

Use the **spanning-tree edgeport** command for MSTP, RSTP, and R-PVST+ (refer to [Enabling a port \(interface\) as an edge port \(DCB\)](#) on page 141).

To enable port fast on the DCB interface for STP, perform the following steps in privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.



2. Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8. The prompt for these ports is in the following example format: switch(config-if-gi-22/0/1)#

```
switch(config)# interface tengigabitethernet 0/1
```

3. Enter the **no shutdown** command to enable the DCB interface.

```
switch(conf-if-te-0/1)# no shutdown
```

4. Enter the **spanning-tree portfast** command to enable port fast on the DCB interface.

```
switch(conf-if-te-0/1)# spanning-tree portfast
```

### Specifying the port priority (DCB)

From the DCB interface, use the **spanning-tree priority** command to specify the port priority. The range is from 0 through 240 in increments of 16. The default value is 128.

In addition, you may specify the spanning tree priority for a specific VLAN. If the VLAN parameter is not provided, the priority value is applied globally for all per-VLAN instances. However, for the VLANs that have been configured explicitly, the per-VLAN configuration takes precedence over the global configuration.

To specify the port priority on the DCB interface, run the following steps in privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.
2. Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8. The prompt for these ports is in the following example format: switch(config-if-gi-22/0/1)#

```
switch(config)# interface tengigabitethernet 1/0/1
```

3. Enter the **no shutdown** command to enable the DCB interface.

```
switch(conf-if-te-1/0/1)# no shutdown
```

4. Enter the **spanning-tree** command to specify the port priority on the DCB interface.

```
switch(conf-if-te-1/0/1)# spanning-tree priority 32
```

5. (Optional) Enter the **spanning-tree vlan priority** command to specify the port priority for a specific VLAN.

```
switch(conf-if-te-1/0/1)# spanning-tree vlan 10 priority 32
```

### Restricting the port from becoming a root port (DCB)

From the DCB interface, use the **spanning-tree restricted-role** command to restrict a port from becoming a root port. The default is to allow the DCB interface to become a root port. This procedure affects MSTP only.

To restrict the DCB interface from becoming a root port, run the following steps in privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.

2. Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8. The prompt for these ports is in the following example format: switch(config-if-gi-22/0/1)#

```
switch(config)# interface tengigabitethernet 1/0/1
```

3. Enter the **no shutdown** command to enable the DCB interface.

```
switch(config-if-te-1/0/1)# no shutdown
```

4. Enter the **spanning-tree restricted-role** command to restrict the DCB interface from becoming a root port.

```
switch(config-if-te-1/0/1)# spanning-tree restricted-role
```

### Restricting the topology change notification (DCB)

From the DCB interface, use the **spanning-tree restricted-tcn** command to restrict the Topology Change Notification (TCN) BPDUs sent on the interface. By default, the restriction is disabled. This procedure affects MSTP only.

To restrict the TCN BPDUs sent on the DCB interface, perform the following steps in privileged EXEC mode.

1. Enter the **config** command to access global configuration mode.
2. Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following example format: switch(config-if-gi-22/0/1)#

```
switch(config)# interface tengigabitethernet 1/0/1
```

3. Enter the **no shutdown** command to enable the DCB interface.

```
switch(config-if-te-1/0/1)# no shutdown
```

4. Enter the **spanning-tree restricted-tcn** command to restrict the TCN BPDUs sent on the DCB interface.

```
switch(config-if-te-1/0/1)# spanning-tree restricted-tcn
```

## Configuring DiST

By default, spanning tree is disabled at the global and interface configuration levels. With respect to Distributed STP (DiST), server ports must be configured as an xSTP edge port.

### NOTE

DiST is supported on the VCS edge ports only. DiST cannot be enabled on ISL ports participating in the TRILL-based fabric within VCS. DiST does not update the port state of ISL ports.

xSTP can be enabled on the VCS by means of the **protocol spanning-tree** command. An interface begins participating in the spanning tree once it is configured by the **spanning-tree enable** command. Refer to [Configuring and managing STP and STP variants](#) on page 125.

The following table describes the behavior of interface based on global and interface level configuration.

**TABLE 23** Interface behavior by global and interface configuration

Global config	Interface config	Interface type where STP BPDU is received	Action
Disable	N/A	Layer 2 (switchport, FCoE)	Flood to all Layer 2 ports
Disable	N/A	Layer 3	Drop
Enable	Disable	Layer 2 (switchport, FCoE)	Drop
Enable	N/A	Layer 3	Drop
Enable	Enable	(switchport, FCoE)	Trap



# Configuring UDLD

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## UDLD overview

The UniDirectional Link Detection (UDLD) protocol is a nonstandard Layer 2 protocol that detects when a physical link becomes unidirectional by means of the exchange of UDLD protocol data units (PDUs). A unidirectional loop can lead to the creation of a loop in a network, which the Spanning Tree Protocol (STP) could inadvertently allow to occur.

## UDLD requirements

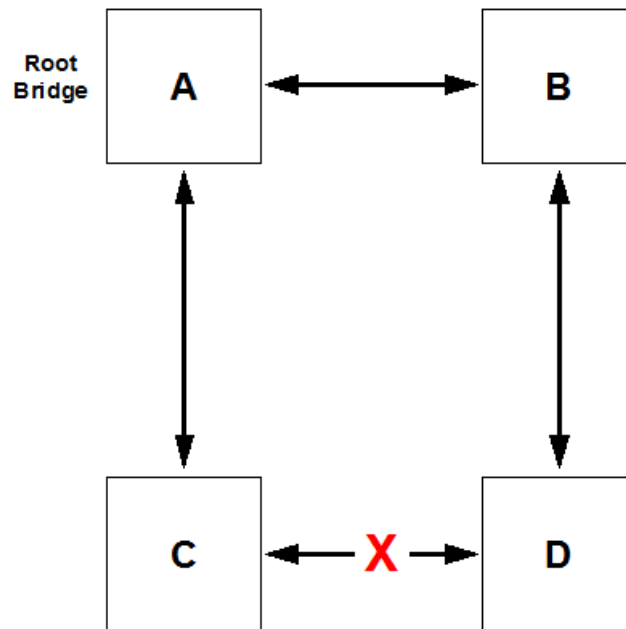
Note the following requirements for UniDirectional Link Detection:

- Network OS 4.0 or later.
- UDLD runs only on physical ports assigned to a port channel.
- UDLD is supported on directly connected switches only.
- In VCS mode, UDLD applies only to edge ports.
- UDLD can interoperate with Brocade IP products.

## How UDLD works

The following shows a simple four-switch network in which two paths connect to each switch. STP blocks traffic on as many ports as necessary so that only one operational path exists from the STP root bridge to all nodes in the network.

FIGURE 16 Four-switch example for UDLD



In the figure above, STP detects that the port on switch D that is connected to switch C should be put into a blocked state. Therefore, no data traffic gets transmitted or received on this port. Data traffic remains blocked as long as switch D receives bridge protocol data units (BPDUs) from both switches C and B.

If the link between switch C and switch D becomes unidirectional (for reasons such as hardware failure or incorrect cabling) in the direction from D to C, switch D ages out the status that it was receiving BPDUs from switch C. This eventually causes STP to put the port in a forwarding state, thus allowing all data traffic. This creates a loop for all BUM traffic that enters the network. BUM traffic can go from switch B to switch D to switch C to switch A, and then back to switch B.

To prevent this loop from forming, UDLD can be used to detect that the link between switch C and switch D has become unidirectional.

The UDLD protocol is disabled by default. To use the UDLD protocol, you must first enable the protocol globally and then enable UDLD on each desired individual physical port. For a configuration example, refer to [Configuring UDLD](#) on page 149.

UDLD determines that a link has become unidirectional if the UDLD daemon stops receiving UDLD PDUs from the other end of the link. The UDLD daemon then blocks the physical link. The physical link remains up but the line protocol goes down. During this time, the link continues to transmit and receive UDLD PDUs.

#### NOTE

In a VCS environment, the UDLD protocol is applicable only to the edge ports in the VCS. A configuration command to enable the UDLD protocol on a logical port or a non-edge port will be rejected.

## Configuring UDLD

Follow the steps below to configure basic UDLD on your switch.

1. Enter global configuration mode by entering the **configure** command from the desired switch:

```
switch# configure
```

- To enable the UDLD protocol, as well as to enter protocol UDLD configuration mode, enter the **protocol udld** command.

```
switch(config)# protocol udld
```

- (Optional) You can change the interval at which UDLD PDUs are transmitted from edge ports. The default interval, in counts of one hundred milliseconds, is 5 (500 milliseconds). To change the interval to 2,000 milliseconds, enter the **hello 20** command:

```
switch(config-udld)# hello 20
```

- You can change the timeout multiplier value to affect the UDLD PDU timeout interval. The UDLD timeout interval is the product of the hello time interval at the other end of the link and the timeout multiplier value. To change the timeout multiplier from the default of 5 to the value 8, run the **multiplier 8** command:

```
switch(config-udld)# multiplier 8
```

- Enter interface subconfiguration mode for the edge port on which you want to enable UDLD:

```
switch(config-udld)# end
switch# configure
switch(config)# interface te 5/0/1
switch(config-int-te-5/0/1)# udld enable
```

- Repeat the preceding step for each edge port on which you wish to enable UDLD.

#### NOTE

When the UDLD protocol is enabled on one end of a link, the timeout period might elapse before the UDLD protocol is enabled on the other end of the link. In this case, the link becomes temporarily blocked. When the UDLD protocol is enabled at the other end of the link and a UDLD PDU is received, UDLD automatically unblocks the link.

## Additional UDLD-related commands

Among additional UDLD commands that you can use are the following:

- clear udld statistics** — Clears either all UDLD statistics or clears the statistics on a specified port.
- debug udld packet** — Enables debugging for UDLD
- show debug udld** — Displays UDLD debug status on the switch.
- show udld** — Displays global UDLD information.
- show udld interface** — Displays UDLD information for one or all ports.
- show udld statistics** — Displays either all UDLD statistics or the statistics on a specified port.

For more information about how to use UDLD commands, refer to the *Network OS Command Reference*.





# Configuring Link Aggregation

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## Link aggregation overview

Link aggregation allows you to bundle multiple physical Ethernet links to form a single logical trunk providing enhanced performance and redundancy. The aggregated trunk is referred to as a Link Aggregation Group (LAG). The LAG is viewed as a single link by connected devices, the Spanning Tree Protocol, IEEE 802.1Q VLANs, and so on. When one physical link in the LAG fails, the other links stay up and there is no disruption to traffic.

To configure links to form a LAG, the physical links must be the same speed and all links must go to the same neighboring device. Link aggregation can be done by manually configuring the LAG or by dynamically configuring the LAG using the IEEE 802.3ad Link Aggregation Control Protocol (LACP).

When queuing traffic from multiple input sources to the same output port, all input sources are given the same weight, regardless of whether the input source is a single physical link or a trunk with multiple member links.

### NOTE

The LAG or LAG interface is also referred to as a *port-channel*.

The benefits of link aggregation are summarized as follows:

- Increased bandwidth (The logical bandwidth can be dynamically changed as the demand changes.)
- Increased availability
- Load sharing
- Rapid configuration and reconfiguration

The Brocade VDX family of switches supports the following trunk types:

- Static, standards-based LAG
- Dynamic, standards-based LAG using LACP
- Static, Brocade-proprietary LAG
- Dynamic, Brocade-proprietary LAG using proprietary enhancements to LACP

## Link Aggregation Control Protocol

Link Aggregation Control Protocol (LACP) is an IEEE 802.3ad standards-based protocol that allows two partner systems to dynamically negotiate attributes of physical links between them to form logical trunks. LACP determines whether a link can be aggregated into a LAG. If a link can be aggregated into a LAG, LACP puts the link into the LAG. All links in a LAG inherit the same administrative characteristics.

LACP operates in two modes:

- *Passive mode* — LACP responds to Link Aggregation Control Protocol Data Units (LACPDU) initiated by its partner system but does not initiate the LACPDU exchange.
- *Active mode* — LACP initiates the LACPDU exchange regardless of whether the partner system sends LACPDU.

## Dynamic link aggregation

Dynamic link aggregation uses LACP to negotiate which links can be added and removed from a LAG. Typically, two partner systems sharing multiple physical Ethernet links can aggregate a number of those physical links using LACP. LACP creates a LAG on both partner systems and identifies the LAG by the LAG ID. All links with the same administrative key and all links that are connected to the same partner switch become members of the LAG. LACP continuously exchanges LACPDUs to monitor the health of each member link.

## Static link aggregation

In static link aggregation, links are added into a LAG without exchanging LACPDUs between the partner systems. The distribution and collection of frames on static links is determined by the operational status and administrative state of the link.

## LACP configuration guidelines and restrictions

This section applies to standards-based and Brocade-proprietary LAG configurations, except where specifically noted otherwise.

Follow these LACP configuration guidelines and restrictions when configuring LACP:

- All ports on the Brocade VDX hardware can operate only in full-duplex mode.
- On Brocade-proprietary LAGs only, all LAG member links must be part of the same port-group.
- Interfaces configured as "switchport" interfaces cannot be aggregated into a LAG. However, a LAG can be configured as a switchport.

## Brocade-proprietary aggregation

Brocade-proprietary aggregation is similar to standards-based link aggregation but differs in how the traffic is distributed. It also has additional rules that member links must meet before they are aggregated:

- The most important rule requires that there is not a significant difference in the length of the fiber between the member links, and that all member links are part of the same port-group.
- A maximum of four Brocade LAGs can be created per port-group.

## LAG distribution process and conditions

The LAG aggregator is associated with the collection and distribution of Ethernet frames. The collection and distribution process is required to guarantee the following:

- Inserting and capturing control PDUs.
- Restricting the traffic of a given conversation to a specific link.
- Load balancing between individual links.
- Handling dynamic changes in LAG membership.

You can configure a maximum of 24 LAGs with up to 16 links per standard LAG, or four links per Brocade-proprietary LAG. Each LAG is associated with an aggregator. The aggregator manages the Ethernet frame collection and distribution functions.

On each port, link aggregation control does the following:

- Maintains configuration information to control port aggregation.
- Exchanges configuration information with other devices to form LAGs.
- Attaches ports to and detaches ports from the aggregator when they join or leave a LAG.

- Enables or disables an aggregator's frame collection and distribution functions.

Each link in the Brocade VDX hardware can be associated with a LAG; a link cannot be associated with more than one LAG. The process of adding and removing links to and from a LAG is controlled statically, dynamically, or through LACP.

Each LAG consists of the following components:

- A MAC address that is different from the MAC addresses of the LAG's individual member links.
- An interface index for each link to identify the link to neighboring devices.
- An administrative key for each link. Only links having the same administrative key value can be aggregated into a LAG. On each link configured to use LACP, LACP automatically configures an administrative key value equal to the port-channel identification number.

## Virtual LAGs

Configuring a virtual LAG (vLAG) is similar to configuring a LAG. Once the Brocade VCS Fabric detects that the LAG configuration spans multiple switches, the LAG automatically becomes a vLAG.

LACP on the Brocade VCS Fabric emulates a single logical switch by sending the same LACP system ID and sending the same admin and operational key.

Note these vLAG features :

- Only ports with the same speed are aggregated.
- Brocade proprietary LAGs are not available for vLAGs.
- LACP automatically negotiates and forms the vLAG.
- A port-channel interface is created on all the vLAG members.
- The Brocade VCS Fabric relies on you to consistently configure all nodes in the vLAG.
- Similar to static LAGs, vLAGs are not able to detect configuration errors.
- A zero port vLAG is allowed.
- IGMP snooping fits into the primary link of a vLAG to carry multicast traffic.
- Interface statistics are collected and shown per vLAG member switch. The statistics are not aggregated across switches participating in a vLAG.
- In order to provide link and node level redundancy, the Brocade VCS Fabric supports static vLAGs.

A Brocade VCS Fabric vLAG functions with servers that do not implement LACP because it supports static vLAGs as well.

## Link aggregation setup

The following sections discuss how to set up link aggregation.

### vLAG configuration overview

Network OS 4.0 and later supports the option of setting the "Allowed Speed" of the port-channel to either 1 Gbps or 10 Gbps. The default is 10 Gbps. If the port-channel is 1 Gbps, then the speed needs to be configured before the port-channel is enabled. Otherwise, the physical links are throttled down because of a speed mismatch. Refer to the *Network OS Command Reference* for information on the **speed** command.

The following conditions and requirements should be kept in mind when configuring vLAGs:

- FCoE and DCB capabilities are not supported by vLAG. FCoE traffic is treated similarly to normal LAN data traffic.
- Static vLAGs are not supported on internal ports.
- Perform this procedure on all member nodes of a vLAG.

## Configuring vLAGs

To configure a vLAG, perform the following steps:

1. Change to global configuration mode.
2. Configure a LAG between two switches within the Brocade VCS Fabric.

Refer to [LAG distribution process and conditions](#) on page 154 for more information. Once the Brocade VCS Fabric detects that the LAG configuration spans multiple switches, the LAG automatically becomes a vLAG.

3. Enter **interface port-channel** *ID* on every switch in the vLAG to configure them to treat FCoE MAC addresses as being multi-homed hosts, similar to LAN traffic.

The default configuration is to treat FCoE traffic as non-vLAG traffic.

```
switch(config)# interface port-channel 10
```

4. Enter **end** to return to privileged EXEC mode.

```
switch(config-Port-channel-10)# end
switch#
```

5. Enter **show port-channel detail** to verify the port-channel details.

```
switch# show port-channel detail
LACP Aggregator: Po 27
Aggregator type: Standard
Ignore-split is disabled
Actor System ID - 0x8000,00-05-33-6f-18-18
Admin Key: 0027 - Oper Key 0027
Receive link count: 4 - Transmit link count: 4
Individual: 0 - Ready: 1
Partner System ID - 0x8000,00-05-1e-cd-6e-9f
Partner Oper Key 0027
Member ports on rbridge-id 231:
Link: Te 231/0/22 (0xE718160201) sync: 1 *
Link: Te 231/0/23 (0xE718170202) sync: 1
Link: Te 231/0/36 (0xE718240305) sync: 1
Link: Te 231/0/37 (0xE718250306) sync: 1
```

6. Enter **show portport-channel** to verify the port-channel interface details.

```
switch# show port port-channel tengigabitethernet 1/0/21
LACP link info: te0/21 -0x18150014
Actor System ID: 0x8000,01-e0-52-00-01-00
Actor System ID Mapped Id: 0
Partner System ID: 0x0001,01-80-c2-00-00-01
Actor priority: 0x8000 (32768)
Admin key: 0x000a (10) Operkey: 0x0000 (0)
Receive machine state : Current
Periodic Transmission machine state : Slow periodic
Muxmachine state : Collecting/Distr
Admin state: ACT:1 TIM:0 AGG:1 SYN:0 COL:0 DIS:0 DEF:1 EXP:0
Operstate: ACT:1 TIM:0 AGG:1 SYN:1 COL:1 DIS:1 DEF:0 EXP:0
Partner operstate: ACT:1 TIM:0 AGG:1 SYN:1 COL:1 DIS:1 DEF:0 EXP:0
Partner oper port: 100
```

## Configuring vLAGs to minimize packet loss

This topic provides background on configuring a vLAG to minimize packet loss.

In scenarios where a vLAG spans more than one node, the **vlag ignore-split** command minimizes the extent of packet loss in the event of one of the nodes in the vLAG going down, and also reduces vLAG failover downtime. The scope of this configuration is per port-channel on LACP-based vLAGS.

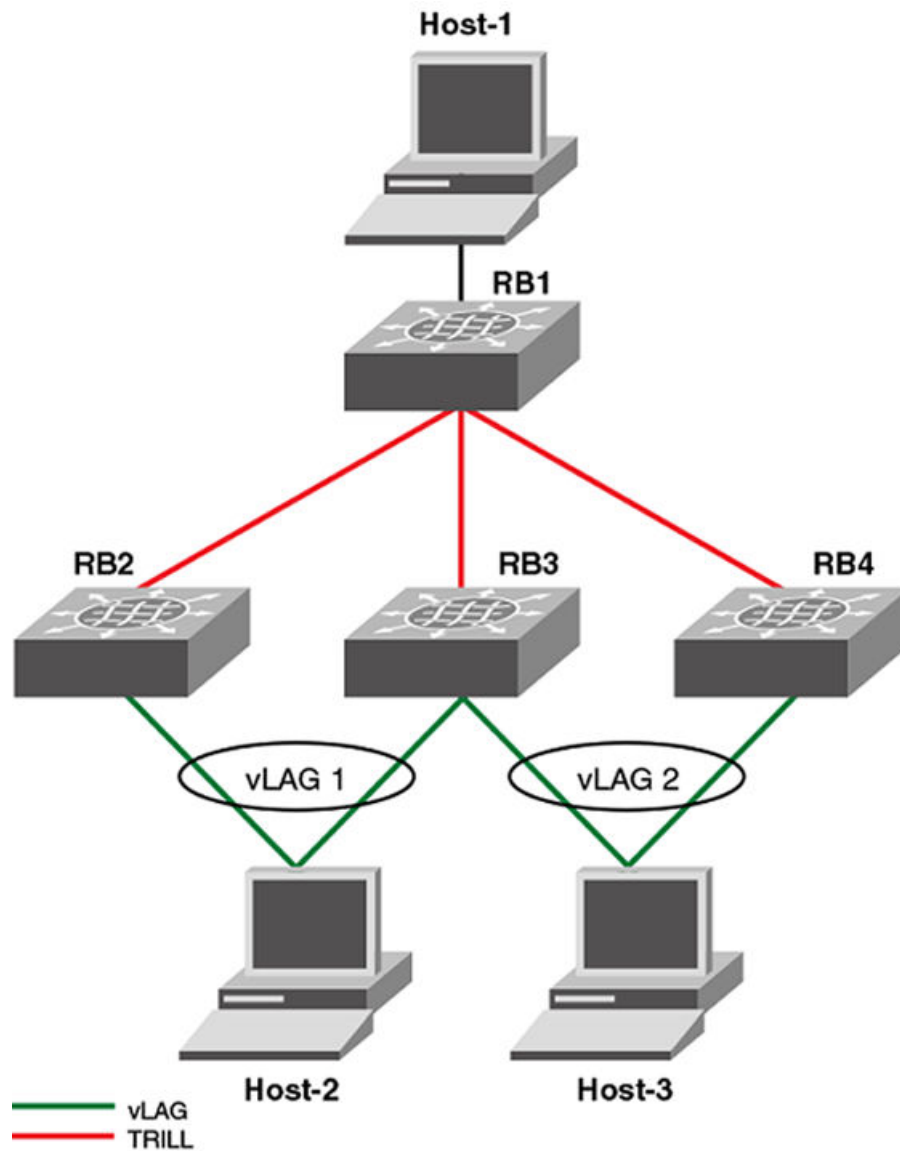
In a case where connectivity between nodes is lost because of a fabric split (as opposed to one of members going down), there will be duplication of multicast/broadcast packets. Brocade recommends that you build redundancy in the fabric so that individual links are not single points of failure.

### NOTE

With **ignore-split** active, a vLAG node reboot can result in a more than one-second loss while interoperating with a Linux server/nic-team/CNA, because of premature egress of traffic from the server.

The figure below displays a dual-vLAG configuration with three legs of RB2, RB3, and RB4. If RB2, RB3, or RB4 reboots while Host-1 is communicating to Host-2 or Host3, a momentary traffic disruption may occur.

FIGURE 17 vLAG configuration of the ignore-split feature



To reduce vLAG failover down time, you must configure **ignore-split** on all of the legs in the vLAG (RB2, RB3 and RB4 in this case).

#### NOTE

By default, **vlag ignore-split** is already activated in VCS.

[Configuring the vLAG ignore-split feature](#) on page 158 walks you through setting up the vLAG ignore-split feature.

### Configuring the vLAG ignore-split feature

This topic describes how to configure the vLAG ignore-split feature.

The switch must be in global configuration mode.

To configure the vLAG ignore-split feature, perform the following steps.

**NOTE**

The following example is based on the illustration in [Configuring vLAGs](#) on page 156.

1. Log in to RB2, the first leg of the vLAG 1.

2. Access the port-channel for the first leg.

```
switch(config)# interface port-channel 1
```

3. Activate vLAG ignore split.

```
switch(config-Port-channel-1)# vlag ignore-split
```

4. Log in to RB3, the second leg of vLAG 1.

5. Access the port-channel for the second leg.

```
switch(config)# interface port-channel 2
```

6. Activate vLAG ignore split.

```
switch(config-Port-channel-2)# vlag ignore-split
```

7. Access the port-channel for the third leg.

```
switch(config)# interface port-channel 3
```

8. Activate vLAG ignore split.

```
switch(config-Port-channel-3)# vlag ignore-split
```

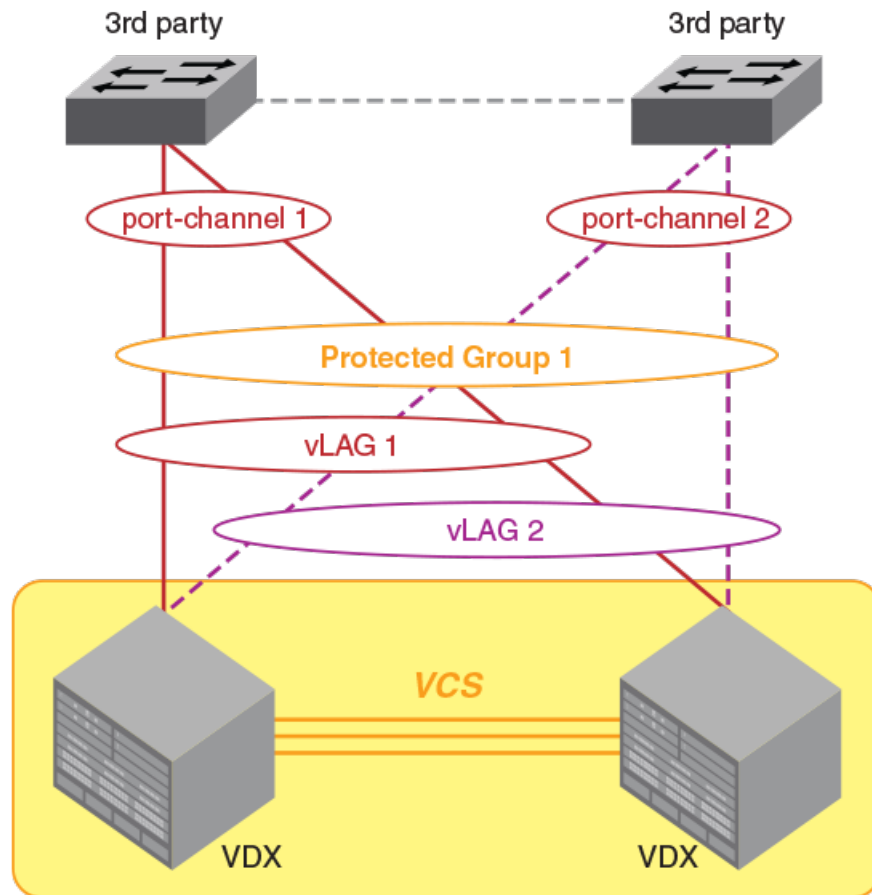
### *Port-channel redundancy groups*

A port-channel redundancy group is used as an alternative to the spanning-tree-protocol for faster convergence and failover in the critical path of the redundant network.

Port-channel redundancy groups minimize disruption to the network by protecting critical links from data loss.

A Port-channel redundancy group is a pair vLAGs (or LAGs) configured to act as one active and one backup vLAG connection. The vLAGs and the corresponding port-channels must be configured before the port-channel redundancy groups can be configured. At any point in time only one vLAG is actively forwarding the traffic and the other vLAG is in a discarding state. If the active vLAG goes down, the backup vLAG take over, by changing the vLAG port state from discarding to forwarding. The failover occurs within milliseconds. The port-channel redundancy group controls the port state of the member vLAGs to avoid looping errors.

FIGURE 18 port-channel redundancy group configuration



There is no restriction on the membership of the Active or Backup vLAG in the fabric. Either the Active or the Backup vLAG can coexist in a single RBridge, or they can exist in different RBridges.

Consider the following guidelines and restrictions when configuring a port-channel redundancy group:

- The maximum number of supported port-channel redundancy groups is 255.
- Port-channel redundancy groups are supported only on port-channel interfaces.
- If you designate the active vLAG when configuring the port-channel redundancy group, it will always resume the active vLAG role after a failure, and the other vLAG will return to the backup role.
- If you do not designate one of the vLAGs as "active" then the system assigns the vLAG that comes first in the protected group as the active vLAG, and the second becomes the backup vLAG. If the active vLAG fails and the backup vLAG takes over, the backup vLAG will retain the active role when the original vLAG resets.
- Brocade Trunks shall not be a member of a protected group.
- Membership in a port-channel redundancy group cannot be altered when the group is in the active state. To modify the protected group or to change the 'active' role, first deactivate the protected group.
- Port-channel redundancy groups do not support the STP family of protocols.



## Configuring port-channel redundancy groups

Two port-channels are placed into a protected group. In this protected group, one port-channel acts as the active link, and the other port-channel acts as the standby link.

This task assumes that the port channels have already been created using the instructions in [Configuring vLAGs](#) on page 156.

To configure a port-channel redundancy group, perform the following task in global configuration mode.

1. Open the port-channel redundancy-group configuration mode with the **port-channel-redundancy-group** command.

```
switch(config)#port-channel-redundancy-group 27
switch(config-port-channel-redundancy-group-27)#
```

2. Add the active port-channel to the group with the **port-channel** command.

```
switch(config-port-channel-redundancy-group-27)# port-channel 3 active
```

3. Add the standby port-channel to the group with the **port-channel** command.

```
switch(config-port-channel-redundancy-group-27)# port-channel 5
```

4. Activate the port-channel redundancy group with the **activate** command.

```
switch(config-port-channel-redundancy-group-27)# activate
```

5. Confirm the configuration with the **show port-channel-redundancy-group** command.

```
switch#show port-channel-redundancy-group 27
Group ID                : 27
Member Ports            : Port-channel 3, Port-channel 5
Configured Active Port-channel: Port-channel 3
Current Active Port-channel  : Port-channel 3
Backup Port-channel     : Port-channel 5
```

## Configuring load balancing on a remote RBridge

This feature allows you to configure the load-balancing feature on a remote RBridge, which is not a member of the vLAG (also known as a non-local RBridge), to forward traffic to a vLAG. To distribute the traffic among the possible paths towards the vLAG, you can configure the vLAG load-balancing flavor on RB2. Available flavors are listed below.

**TABLE 24** Load balancing flavors

Flavor	Definition
dst-mac-vid	Destination MAC address and VID-based load balancing.
src-mac-vid	Source MAC address and VID-based load balancing.
src-dst-mac-vid	Source and Destination MAC address and VID-based load balancing.
src-dst-ip	Source and Destination IP address-based load balancing.
src-dst-ip-mac-vid	Source and Destination IP and MAC address and VID-based load balancing.
src-dst-ip-port	Source and Destination IP and TCP/UDP port-based load balancing.
src-dst-ip-mac-vid-port	Source and Destination IP, MAC address, VID and TCP/UDP port-based load balancing.

Additionally, an RBridge can be set to a different flavor for different vLAGs present in the cluster. This feature is available for each RBridge and each vLAG, so different load-balancing flavors can be set for traffic directed towards different vLAGs. The **show running-config rbridge-id rbridgeID** command displays the configuration information.

**NOTE**

When configuring load balancing on a Brocade VDX 6740, it should be configured consistently for all port-channels on the switch. These switches support one load-balancing scheme at a time, and apply the last loaded load-balancing scheme to all port-channels on the switch. This is not required for the Brocade VDX 8770 platform, as it supports multiple port-channel load-balancing schemes.

The following example sets the flavor to "destination MAC address and VID-based load balancing."

```
switch(config)# rbridge-id 2
switch(config-rbridge-id-2)# fabric port-channel 20 load-balance dst-mac-vid
switch(config-rbridge-id-2)# end
switch# show running-config rbridge-id 2
rbridge-id 2
  interface-nodespecific ns-vlan 10
  interface-nodespecific ns-ethernet 100
  fabric vlag 10 load-balance src-dst-mac-vid
  fabric vlag 20 load-balance dst-mac-vid
  no protocol vrrp
switch# show fabric port-channel load-balance 10
Fabric Vlag Load-Balance Information
-----
Rbridge-Id      : 2
Vlag           : 10
Load-Balance Flavor : Source and Destination MAC address and VID based load balancing

switch# show fabric port-channel all

Fabric Vlag Load-Balance Information
-----
Rbridge-Id      : 2
Vlag           : 10
```

## Configuring and managing LACP

The following sections discuss working with the Link Aggregation Control Protocol (LACP) on Brocade devices.

### Understanding the default LACP configuration

The table below lists the default LACP configuration. Consider this when making changes to the defaults.

**TABLE 25** Default LACP configuration

Parameter	Default setting
System priority	32768
Port priority	32768
Timeout	Long (standard LAG) or short (Brocade LAG)

### Enabling LACP on a DCB interface

The switch must be in privileged EXEC mode.

To add additional interfaces to an existing LAG, repeat this procedure using the same LAG group number for the new interfaces.

Enter the **copy running-config startup-config** command to save your configuration.

To enable LACP on a DCB interface, perform the following step:

1. Enter the **configure terminal** command to access global configuration mode.

2. Enter the **interface** command to specify the DCB interface type and slot/port number.

**NOTE**

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710. The prompt for these ports is in the format: switch(config-if-gi-22/0/1)#.

```
switch(config)# interface tengigabitethernet 0/1
```

3. Enter the **no shutdown** command to enable the DCB interface.
4. Enter the **channel-group** command to configure the LACP for the DCB interface.

```
switch(conf-if)# channel-group 4 mode active type standard
```

### Configuring the LACP system priority

The switch must be in privileged EXEC mode.

You configure the LACP system priority on each switch running LACP. LACP uses the system priority with the switch MAC address to form the system ID and also during negotiation with other switches.

The system priority value must be a number in the range of 1 through 65535. The higher the number, the lower the priority. The default priority is 32768.

To configure the global LACP system priority, perform the following steps:

1. Enter the **configure terminal** command to access global configuration mode.
2. Specify the LACP system priority.

```
switch(config)# lacp system-priority 25000
```

### Configuring the LACP timeout period on a DCB interface

The switch must be in privileged EXEC mode.

The LACP timeout period indicates how long LACP waits before timing out the neighboring device. The **short** timeout period is 3 seconds and the **long** timeout period is 90 seconds. The default is **long**.

To configure the LACP timeout period on a Data Center Bridging (DCB) interface, perform the following steps:

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter the **interface** command to specify the DCB interface type and slot/port number.

**NOTE**

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8 switches. The prompt for these ports is in the format: switch(config-if-gi-22/0/1)#.

```
switch(config)# interface tengigabitethernet 0/1
```

3. Enter the **no shutdown** command to enable the DCB interface.
4. Specify the LACP timeout period for the DCB interface.

```
switch(conf-if-te-0/1)# lacp timeout short
```

## Clearing LACP counter statistics on a LAG

This topic describes how to clear LACP counter statistics on a single LAG.

To clear LACP counter statistics on a LAG, use the following command:

Enter **clear lacp LAG\_group\_number counters** to clear the LACP counter statistics for the specified LAG group number.

```
switch# clear lacp 42 counters
```

## Clearing LACP counter statistics on all LAG groups

This topic describes how to clear the LACP counter statistics for all LAG groups.

To clear LACP counter statistics on all LAG groups, use the following command:

Enter **clear lacp counter** to clear the LACP counter statistics for all LAG groups.

```
switch# clear lacp counter
```

## Displaying LACP information

You can use the **show** command in Privileged EXEC mode to display Link Aggregation Control Protocol (LACP) information.

- Enter **show lacp sys-id** to display the LACP system ID and priority.

```
switch# show lacp sys-id
% System 8000,00-05-1e-76-1a-a6
```

- Enter **show lacp counter** to display the LACP system ID and priority.

```
switch# show lacp counter
Traffic Statistics
Port          LACPDU          Marker          Pckt err
             Sent    Recv          Sent    Recv          Sent    Recv
12            123     0             2       0             0       0
```

Refer to the *Network OS Command Reference* for information.

## Troubleshooting LACP

To troubleshoot problems with your LACP configuration, use the following troubleshooting tips.

If a standard IEEE 802.3ad-based dynamic trunk is configured on a link and the link is not able to join the LAG, do the following:

- Make sure that both ends of the link are configured as **standard** for the trunk type.
- Make sure that both ends of the link are *not* configured for **passive** mode. They must be configured as **active /active, active /passive, or passive /active**.
- Make sure that the port-channel interface is in the administrative "up" state by ensuring that the **no shutdown** command was entered on the interface on both ends of the link.
- Make sure the speed parameter is configured to 1000 if the port-channel is using the gigabit interface.
- Make sure that the links that are part of the LAG are connected to the same neighboring switch.
- Make sure that the system ID of the switches connected by the link is unique. You can verify this by entering the **show lacp sys-id** command on both switches.
- You can verify the system ID of the switches in the Brocade VCS Fabric cluster with the **show lacp sys-id** command.

- Make sure that LACPDU's are being received and transmitted on both ends of the link and that there are no error PDU's. You can verify this by entering the **show lacp counters number** command and looking at the receive mode (rx) and transmit mode (tx) statistics. The statistics should be incrementing and should not be at zero or a fixed value. If the PDU rx count is not incrementing, check the interface for possible CRC errors by entering the **show interface link-name** command on the neighboring switch. If the PDU tx count is not incrementing, check the operational status of the link by entering the **show interface link-name** command and verifying that the interface status is "up."

If a Brocade-based dynamic trunk is configured on a link and the link is not able to join the LAG, do the following:

- Make sure that both ends of the link are configured as **Brocade** for trunk type.
- Make sure that both ends of the link are *not* configured for **passive** mode. They must be configured as **active /active, active / passive, or passive /active**.
- Make sure that the port-channel interface is in the administrative "up" state by ensuring that the **no shutdown** command was entered on the interface on both ends of the link.
- Make sure that the links that are part of the LAG are connected to the same neighboring switch.
- Make sure that the system ID of the switches connected by the link is unique. This can be verified by entering the **show lacp sys-id** command on both switches.
- Make sure that LACPDU's are being received and transmitted on both ends of the link and there are no error PDU's. This can be verified by entering the **show lacp counters number** command and looking at the rx and tx statistics. The statistics should be incrementing and should not be at zero or a fixed value. If the PDU rx count is not incrementing, check the interface for possible CRC errors by entering the **show interface link-name** command on the neighboring switch.
- Make sure that the fiber length of the link has a deskew value of 7 microseconds. If it does not, the link will not be able to join the LAG and the following RASLog message is generated: *Deskew calculation failed for link <link-name>.*

When a link has this problem, the **show port-channel** command displays the following message:

```
Mux machine state: Deskew not OK.
```

If a Brocade-based static trunk is configured on a link and the link is not able to join the LAG, do the following:

- Make sure that both ends of the link are configured as **Brocade** for trunk type and verify that the mode is "on."
- Make sure that the port-channel interface is in the administrative "up" state by ensuring that the **no shutdown** command was entered on the interface on both ends of the link.

If a standards-based static trunk is configured on a link and the link is not able to join the LAG, do the following:

- Make sure that both ends of the link are configured as **standard** for trunk type and verify that the mode is "on."
- Make sure that the port-channel interface is in the administrative "up" state by ensuring that the **no shutdown** command was entered on the interface on both ends of the link.



# Configuring LLDP

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## LLDP overview

The IEEE 802.1AB Link Layer Discovery Protocol (LLDP) enhances the ability of network management tools to discover and maintain accurate network topologies and simplify LAN troubleshooting in multi-vendor environments. To efficiently and effectively operate the various devices in a LAN you must ensure the correct and valid configuration of the protocols and applications that are enabled on these devices. With Layer 2 networks expanding dramatically, it is difficult for a network administrator to statically monitor and configure each device in the network.

Using LLDP, network devices such as routers and switches advertise information about themselves to other network devices and store the information they discover. Details such as device configuration, device capabilities, and device identification are advertised. LLDP defines the following:

- A common set of advertisement messages.
- A protocol for transmitting the advertisements.
- A method for storing the information contained in received advertisements.

### NOTE

LLDP runs over the data-link layer which allows two devices running different network layer protocols to learn about each other.

LLDP information is transmitted periodically and stored for a finite period. Every time a device receives an LLDP advertisement frame, it stores the information and initializes a timer. If the timer reaches the time to live (TTL) value, the LLDP device deletes the stored information ensuring that only valid and current LLDP information is stored in network devices and is available to network management systems.

## Layer 2 topology mapping

The LLDP protocol lets network management systems accurately discover and model Layer 2 network topologies. As LLDP devices transmit and receive advertisements, the devices store information they discover about their neighbors. Advertisement data such as a neighbor's management address, device type, and port identification is useful in determining what neighboring devices are in the network.

### NOTE

The Brocade LLDP implementation supports up to two neighbors.

The higher level management tools, such as the Brocade Network Advisor, can query the LLDP information to draw Layer 2 physical topologies. The management tools can continue to query a neighboring device through the device's management address provided in the LLDP information exchange. As this process is repeated, the complete Layer 2 topology is mapped.

In LLDP the link discovery is achieved through the exchange of link-level information between two link partners. The link-level information is refreshed periodically to reflect any dynamic changes in link-level parameters. The basic format for exchanging information in LLDP is in the form of a type, length, value (TLV) field.

LLDP keeps a database for both local and remote configurations. The LLDP standard currently supports three categories of TLVs. Brocade's LLDP implementation adds a proprietary Brocade extension TLV set. The four TLV sets are described as follows:

- Basic management TLV set — This set provides information to map the Layer 2 topology and includes the following TLVs:
  - Chassis ID TLV — Provides the ID for the switch or router where the port resides. This is a mandatory TLV.
  - Port description TLV — Provides a description of the port in an alphanumeric format. If the LAN device supports RFC-2863, the port description TLV value equals the "ifDescr" object. This is a mandatory TLV.
  - System name TLV — Provides the system-assigned name in an alphanumeric format. If the LAN device supports RFC-3418, the system name TLV value equals the "sysName" object. This is an optional TLV.
  - System description TLV — Provides a description of the network entity in an alphanumeric format. This includes system name, hardware version, operating system, and supported networking software. If the LAN device supports RFC-3418, the value equals the "sysDescr" object. This is an optional TLV.
  - System capabilities TLV — Indicates the primary functions of the device and whether these functions are enabled in the device. The capabilities are indicated by two octets. The first octet indicates Other, Repeater, Bridge, WLAN AP, Router, Telephone, DOCSIS cable device, and Station, respectively. The second octet is reserved. This is an optional TLV.
  - Management address TLV — Indicates the addresses of the local switch. Remote switches can use this address to obtain information related to the local switch. This is an optional TLV.
- IEEE 802.1 organizational TLV set — This set provides information to detect mismatched settings between local and remote devices. A trap or event can be reported once a mismatch is detected. This is an optional TLV. This set includes the following TLVs:
  - Port VLANID TLV — Indicates the port VLAN ID (PVID) that is associated with an untagged or priority tagged data frame received on the VLAN port.
  - PPVLAN ID TLV — Indicates the port- and protocol-based VLAN ID (PPVID) that is associated with an untagged or priority tagged data frame received on the VLAN port. The TLV supports a "flags" field that indicates whether the port is capable of supporting port- and protocol-based VLANs (PPVLANs) and whether one or more PPVLANs are enabled. The number of PPVLAN ID TLVs in a Link Layer Discovery Protocol Data Unit (LLDPDU) corresponds to the number of the PPVLANs enabled on the port.
  - VLAN name TLV — Indicates the assigned name of any VLAN on the device. If the LAN device supports RFC-2674, the value equals the "dot1QVLANStaticName" object. The number of VLAN name TLVs in an LLDPDU corresponds to the number of VLANs enabled on the port.
  - Protocol identity TLV — Indicates the set of protocols that are accessible at the device's port. The protocol identity field in the TLV contains a number of octets after the Layer 2 address that can enable the receiving device to recognize the protocol. For example, a device that wishes to advertise the spanning tree protocol includes at least eight octets: 802.3 length (two octets), LLC addresses (two octets), 802.3 control (one octet), protocol ID (two octets), and the protocol version (one octet).
- IEEE 802.3 organizational TLV set — This is an optional TLV set. This set includes the following TLVs:
  - MAC/PHY configuration/status TLV — Indicates duplex and bit rate capabilities and the current duplex and bit rate settings of the local interface. It also indicates whether the current settings were configured through auto-negotiation or through manual configuration.
  - Power through media dependent interface (MDI) TLV — Indicates the power capabilities of the LAN device.
  - Link aggregation TLV — Indicates whether the link (associated with the port on which the LLDPDU is transmitted) can be aggregated. It also indicates whether the link is currently aggregated and provides the aggregated port identifier if the link is aggregated.
  - Maximum Ethernet frame size TLV — Indicates the maximum frame size capability of the device's MAC and PHY implementation.



## DCBX

Storage traffic requires a lossless communication which is provided by DCB. The Data Center Bridging (DCB) Capability Exchange Protocol (DCBX) is used to exchange DCB-related parameters with neighbors to achieve more efficient scheduling and a priority-based flow control for link traffic.

DCBX uses LLDP to exchange parameters between two link peers; DCBX is built on the LLDP infrastructure for the exchange of information. DCBX-exchanged parameters are packaged into organizationally specific TLVs. The DCBX protocol requires an acknowledgment from the other side of the link, therefore LLDP is turned on in both transmit and receive directions. DCBX requires version number checking for both control TLVs and feature TLVs.

DCBX interacts with other protocols and features as follows:

- *LLDP* – LLDP is run in parallel with other Layer 2 protocols such as RSTP and LACP. DCBX is built on the LLDP infrastructure to communicate capabilities supported between link partners. The DCBX protocol and feature TLVs are treated as a superset of the LLDP standard.
- *QoS management* – DCBX capabilities exchanged with a link partner are passed down to the QoS management entity to set up the Brocade VDX hardware to control the scheduling and priority-based flow control in the hardware.

The DCBX QoS standard is subdivided into two features sets, discussed below:

- [Enhanced Transmission Selection](#) on page 169
- [Priority Flow Control](#) on page 169

### Enhanced Transmission Selection

In a converged network, different traffic types affect the network bandwidth differently. The purpose of Enhanced Transmission Selection (ETS) is to allocate bandwidth based on the different priority settings of the converged traffic. For example, Inter-process communications (IPC) traffic can use as much bandwidth as needed and there is no bandwidth check; LAN and SAN traffic share the remaining bandwidth. The table below displays three traffic groups: IPC, LAN, and SAN. ETS allocates the bandwidth based on traffic type and also assigns a priority to the three traffic types as follows: Priority 7 traffic is mapped to priority group 0 which does not get a bandwidth check, priority 2 and priority 3 are mapped to priority group 1, priorities 6, 5, 4, 1 and 0 are mapped to priority group 2.

The priority settings shown in the following table are translated to priority groups in the Brocade VDX hardware.

**TABLE 26** ETS priority grouping of IPC, LAN, and SAN traffic

Priority	Priority group	Bandwidth check
7	0	No
6	2	Yes
5	2	Yes
4	2	Yes
3	1	Yes
2	1	Yes
1	2	Yes
0	2	Yes

### Priority Flow Control

With Priority Flow Control (PFC), it is important to provide lossless frame delivery for certain traffic classes while maintaining existing LAN behavior for other traffic classes on the converged link. This differs from the traditional 802.3 PAUSE type of flow control where the pause affects all traffic on an interface.

PFC is defined by a one-byte bitmap. Each bit position stands for a user priority. If a bit is set, the flow control is enabled in both directions (Rx and Tx).

#### NOTE

When PFC is enabled, the Brocade VDX 6740 series platforms support up to three PGIDs with the execution of **cee-map default**. By default, PGID 1 (with TC3) and PGID 15.0 (for network control traffic) are enabled when PFC is enabled.

## LLDP configuration guidelines and restrictions

Follow these LLDP configuration guidelines and restrictions when configuring LLDP:

- Brocade's implementation of LLDP supports Brocade-specific TLV exchange in addition to the standard LLDP information.
- Mandatory TLVs are always advertised.
- The exchange of LLDP link-level parameters is transparent to the other Layer 2 protocols. The LLDP link-level parameters are reported by LLDP to other interested protocols.

#### NOTE

DCBX configuration simply involves configuring DCBX-related TLVs to be advertised. Detailed information is provided in [Configuring and managing LLDP](#) on page 170.

# Configuring and managing LLDP

The following sections discuss working with the Link Layer Discovery Protocol (LLDP) on Brocade devices.

## Understanding the default LLDP

The following table lists the default LLDP configuration. Consider this when making changes to the defaults.

**TABLE 27** Default LLDP configuration

Parameter	Default setting
LLDP global state	Enabled
LLDP receive	Enabled
LLDP transmit	Enabled
Transmission frequency of LLDP updates	30 seconds
Hold time for receiving devices before discarding	120 seconds
DCBX-related TLVs to be advertised	dcbx-tlv

## Enabling LLDP globally

The **protocol lldp** command enables LLDP globally on all interfaces unless it has been specifically disabled on an interface, or the global LLDP disable command has been executed. LLDP is globally enabled by default.

To enable LLDP globally, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Enter LLDP configuration mode.

```
switch(config)# protocol lldp
```

3. Enter the **copy running-config startup-config** command to save your configuration changes.

## Disabling LLDP globally

LLDP is enabled globally by default. These instructions allow you to disable LLDP globally without changing any other aspect of the LLDP configuration.

### NOTE

The **disable** command executed in LLDP protocol configuration mode disables LLDP globally. To re-enable LLDP, refer to [Enabling LLDP globally](#) on page 170.

To disable LLDP globally, perform the following steps from global configuration mode.

1. Enter the **protocol lldp** command to enter protocol configuration mode.

```
switch(config)# protocol lldp
```

2. Enter the **disable** command to disable LLDP globally.

```
switch(conf-lldp)# disable
```

## Resetting LLDP globally

The **no protocol lldp** command returns all configuration settings made using the protocol LLDP commands to their default settings.

To reset LLDP globally, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Reset LLDP globally.

```
switch(config)# no protocol lldp
```

## Configuring LLDP global command options

After entering the **protocol lldp** command from global configuration mode, you are in LLDP configuration mode, which is designated with the switch(conf-lldp)# prompt. Using the keywords in this mode, you can set nondefault parameter values that apply globally to all interfaces.

### *Specifying a system name for the Brocade VDX hardware*

The global system name for LLDP is useful for differentiating between switches. By default, the "host-name" from the chassis/entity management information base is used. By specifying a descriptive system name, you will find it easier to configure the switch for LLDP.

To specify a global system name for the Brocade VDX hardware, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter LLDP configuration mode.

```
switch(config)# protocol lldp
```

3. Specify an LLDP system name for the DCB switch.

```
switch(conf-lldp)# system-name Brocade_Alpha
Brocade_Alpha(conf-lldp)#
```

## Specifying an LLDP system description for the Brocade VDX hardware

### NOTE

Brocade recommends you use the operating system version for the description or use the description from the chassis/entity management information base (MIB). Do not use special characters, such as #!@, as part of the system name and description.

To specify an LLDP system description for the Brocade VDX hardware, perform the following steps from privileged EXEC mode. The system description is seen by neighboring switches.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter LLDP configuration mode.

```
switch(config)# protocol lldp
```

3. Specify a system description for the Brocade VDX hardware.

```
switch(conf-lldp)# system-description IT_1.6.2_LLDP_01
```

## Specifying a user description for LLDP

To specify a user description for LLDP, perform the following steps from privileged EXEC mode. This description is for network administrative purposes and is not seen by neighboring switches.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter LLDP configuration mode.

```
switch(config)# protocol lldp
```

3. Specify a user description for LLDP.

```
switch(conf-lldp)# description Brocade-LLDP-installed-jan-25
```

## Enabling and disabling the receiving and transmitting of LLDP frames

By default both transmit and receive for LLDP frames is enabled. To enable or disable the receiving (rx) and transmitting (tx) of LLDP frames, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.

2. Enter the **mode** command to do one of the following:

- Enable only receiving of LLDP frames:

```
switch(conf-lldp)# mode rx
```

- Enable only transmitting of LLDP frames:

```
switch(conf-lldp)# mode tx
```

- Enable both transmit and receive modes.

```
switch(conf-lldp)# no mode
```

### Configuring the transmit frequency of LLDP frames

To configure the transmit frequency of LLDP frames, perform the following steps from privileged EXEC mode. The default is 30 seconds.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter LLDP configuration mode.

```
switch(config)# protocol lldp
```

3. Configure the transmit frequency of LLDP frames.

```
switch(conf-lldp)# hello 45
```

### Configuring the hold time for receiving devices

To configure the hold time for receiving devices, perform the following steps from privileged EXEC mode. This configures the number of consecutive LLDP hello packets that can be missed before removing the neighbor information. The default is 4.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter LLDP configuration mode.

```
switch(config)# protocol lldp
```

3. Configure the hold time for receiving devices.

```
switch(conf-lldp)# multiplier 6
```

### Advertising the optional LLDP TLVs

To advertise the optional LLDP TLVs, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter LLDP configuration mode.

```
switch(config)# protocol lldp
```

3. Advertise the optional LLDP TLVs.

```
switch(conf-lldp)# advertise optional-tlv management-address port-description system-capabilities
system-name system-description
```

## Configuring the advertisement of LLDP DCBX-related TLVs

For a switch in Brocade VCS Fabric mode the following TLVs are advertised by default:

- dcbx-tlv
- dcbx-fcoe-app-tlv
- dcbx-fcoe-logical-link-tlv

To configure the LLDP DCBX-related TLVs to be advertised, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter LLDP configuration mode.

```
switch(config)# protocol lldp
```

3. Advertise the LLDP DCBX-related TLVs by using one of these commands:

- switch(conf-lldp)# advertise dcbx-fcoe-app-tlv
- switch(conf-lldp)# advertise dcbx-fcoe-logical-link-tlv
- switch(conf-lldp)# advertise dcbx-tlv

## Configuring LLDP profiles

You can configure up to 64 profiles on a switch. Entering **no profile name** deletes the entire profile.

To configure LLDP profiles, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter LLDP configuration mode.

```
switch(config)# protocol lldp
```

3. Configure the profile name.

```
switch(conf-lldp)# profile UK_LLDP_IT
```

4. Specify a description for the profile.

```
switch(conf-lldp-profile-UK_LLDP_IT)#description standard_profile_by_Jane
```

5. Enable the transmitting and receiving of LLDP frames.

```
switch(conf-lldp-profile-UK_LLDP_IT)# no mode
```

6. Configure the transmission frequency of LLDP updates.

```
switch(conf-lldp-profile-UK_LLDP_IT)# hello 10
```

7. Configure the hold time for receiving devices.

```
switch(conf-lldp-profile-UK_LLDP_IT)# multiplier 2
```

8. Advertise the optional LLDP TLVs.

```
switch(conf-lldp)# advertise optional-tlv management-address port-description
system-capabilities system-name system-description
```

9. Advertise the LLDP DCBX-related TLVs.

```
switch(conf-lldp-profile-UK_LLDP_IT)# advertise advertise dcbx-tlv
switch(conf-lldp-profile-UK_LLDP_IT)# advertise dcbx-fcoe-logical-link-tlv
switch(conf-lldp-profile-UK_LLDP_IT)# advertise dcbx-fcoe-app-tlv
switch(conf-lldp-profile-UK_LLDP_IT)# advertise dcbx-iscsi-app-tlv
```

#### NOTE

Brocade recommends against advertising dot1.tlv and dot3.tlv LLDPs if your network contains CNAs from non-Brocade vendors, as doing so may cause functionality problems.

10. Return to privileged EXEC mode.

```
switch(conf-lldp-profile-UK_LLDP_IT)# end
```

11. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch(conf-lldp-profile-UK_LLDP_IT)# end
switch# copy running-config startUp-config
```

## Configuring iSCSI priority

The iSCSI TLV is used only to advertise the iSCSI traffic configuration parameters to the attached CEE enabled servers and targets. No verification or enforcement of the usage of the advertised parameters by the iSCSI server or target is done by the switch. The iSCSI priority setting is used to configure the priority to be advertised in the DCBx iSCSI TLV.

To configure the iSCSI priority, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter LLDP configuration mode.

```
switch(config)# protocol lldp
```

3. Configure the iSCSI priority.

```
switch(conf-lldp)# iscsi-priority 4
```

#### NOTE

The default iscsi-priority is 4 and does not display unless you change the iscsi-priority to a different value.

4. Advertise the TLV.

```
switch (conf-lldp)# advertise dcbx-iscsi-app-tlv
```

## Configuring the iSCSI profile

You can configure an iSCSI profile to be applied to individual interfaces. However, the priority bit must be set manually for each interface. Using the **no profile name** command deletes the entire profile.

To configure iSCSI profiles, perform the following steps from privileged EXEC mode.

1. Configure the CEE map, if it has not already been created. For information on the **cee-map** command structure, refer to the *Network OS Command Reference*.

```
switch(config)# cee-map default
switch(conf-ceemap)# priority-group-table 1 weight 50 pfc
switch(conf-ceemap)# priority-group-table 2 weight 30 pfc on
switch(conf-ceemap)# priority-group-table 3 weight 20 pfc on
switch(conf-ceemap)# priority-table 1 1 1 1 2 3 1 1
```

The **priority-table** command syntax is as follows:

```
priority-table PGID0 PGID1 PGID2 PGID3 PGID4 PGID5 PGID6 PGID7
```

For all PGID values, the PGID value range is 0 through 7 for the DWRR Priority Group, and 15.0 through 15.7 for the Strict Priority Group. The PGID value and the CoS value are equivalent, so that specifying PGID0 sets the Priority Group ID for all packets with CoS = 0, specifying PGID1 sets the Priority Group ID for all packets with CoS = 1, all the way through specifying PGID7, which sets the Priority Group ID for all packets with CoS = 7.

Priority-Table in CEE map configuration requires that PGID 15.0 is dedicated for CoS7. Because of this restriction, make sure that PGID15.0 is configured only as the last parameter for Priority-Table configuration.

An explanation of syntax "priority-table 1 2 2 2 2 2 15.0" is as follows:

This shows the definition of a CEE Map with Priority to Priority Group mapping of CoS=1, CoS=2, CoS=3, CoS=4, CoS=5, and CoS=6 to a DWRR Priority Group ID of 2, and CoS=0 to a Priority Group ID of 1, and CoS=7 to a Strict Priority Group.

This is one way to provision the CEE Priority to Priority Group Table, which maps each of the eight ingress CoS into a Priority Group.

In VCS mode, traffic classes are either all strict priorities (802.1Q default) or a combination of strict and DWRR traffic classes.

2. Enter LLDP configuration mode.

```
switch(conf-ceemap)# protocol lldp
```

3. Create an LLDP profile for iSCSI.

```
switch(conf-lldp)# profile iscsi_config
```

4. Advertise the iSCSI TLV.

```
switch(conf-lldp-profile-iscsi_config)# advertise dcbx-iscsi-app-tlv
```

5. Enter configuration mode for the specific interface.

The **gigabit** Ethernet ports on the Brocade VDX 6710 do not allow the **cee default** command. This port type does not support PFC or iSCSI App TLV.

```
switch (conf-lldp-profile-iscsi_config)# interface te 0/1
```

6. Apply the CEE provisioning map to the interface.

```
switch(conf-if-te-0/1)# cee default
```

7. Apply the LLDP profile you created for iSCSI.

```
switch(conf-if-te-0/1)# lldp profile iscsi_config
```



- Set the iSCSI priority bits for the interface.

```
switch(conf-if-te-0/1)# lldp iscsi-priority 4
```

- Repeat steps 5 through 8 for additional interfaces.

## Configuring LLDP interface-level command options

Only one LLDP profile can be assigned to an interface. If you do not use the **lldp profile** option at the interface level, the global configuration is used on the interface. If there are no global configuration values defined, the global default values are used.

To configure LLDP interface-level command options, perform the following steps from privileged EXEC mode.

- Enter the **interface** command to specify the DCB interface type and slot/port number.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following format: switch(config-if-gi-22/0/1)#.

```
switch(config)# interface tengigabitethernet 0/10
```

- Apply an LLDP profile to the interface.

```
switch(conf-if-te-0/10)# lldp profile network_standard
```

- Return to privileged EXEC mode.

```
switch(conf-if-te-0/10)# end
```

- Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Displaying LLDP-related information

To display LLDP-related information, perform the following steps from privileged EXEC mode.

- Use the **show lldp** command to display LLDP general information.

```
switch# show lldp
```

- Use the **show lldp** command to display LLDP interface-related information.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following format: switch(config-if-gi-22/0/1)#.

```
switch# show lldp interface tengigabitethernet 0/1
LLDP information for gi 22/0/1
State:                               Enabled
Mode:                                 Receive/Transmit
Advertise Transmitted:                30 seconds
Hold time for advertise:              120 seconds
Re-init Delay Timer:                  2 seconds
Tx Delay Timer:                        1 seconds tengigabitethernet
DCBX Version :                         CEE
Auto-Sense :                           Yes
Transmit TLVs:                         Chassis ID           Port ID
                                         TTL                     IEEE DCBX
                                         DCBX FCoE App           DCBX FCoE Logical Link
                                         Link Prim                 Brocade Link
DCBX FCoE Priority Bits: 0x8
```

- Use the **show lldp** command to display LLDP neighbor-related information.

```
switch# show lldp neighbors interface tengigabitethernet 0/1 detail
Neighbors for Interface Te 1/0/1

MANDATORY TLVs
=====
Local Interface: Te 1/0/1 (Local Interface MAC: 0027.f854.501e)
Remote Interface: TenGigabitEthernet 3/0/1 (Remote Interface MAC: 0005.334b.7198)
Dead Interval: 120 secs
Remaining Life : 117 secs
Chassis ID: 0005.334b.7173
LLDP PDU Transmitted: 1165 Received: 1164

OPTIONAL TLVs
=====
DCBX TLVs
=====
Version : CEE
DCBX Ctrl OperVersion: 0 MaxVersion: 0 SeqNo: 2 AckNo: 2
DCBX ETS OperVersion: 0 MaxVersion: 0 Enabled: 1 Willing: 0 Error: 0
Enhanced Transmission Selection (ETS)
  Priority-Group ID Map:
    Priority : 0 1 2 3 4 5 6 7
    Group ID : 0 0 0 0 0 0 0 0
  Group ID Bandwidth Map:
    Group ID : 0 1 2 3 4 5 6 7
    Percentage: 0 0 0 0 0 0 0 0
  Number of Traffic Classes supported: 8
DCBX PFC OperVersion: 0 MaxVersion: 0 Enabled: 1 Willing: 0 Error: 0
Priority-based Flow Control (PFC)
  Enabled Priorities: none
  Number of Traffic Class PFC supported: 8
FCoE App OperVersion: 0 MaxVersion: 0 Enabled: 1 Willing: 0 Error: 0
FCoE Application Protocol
  User Priorities: none
FCoE LLS OperVersion: 0 MaxVersion: 0 Enabled: 1 Willing: 0 Error: 0
FCoE Logic Link Status: Down
LAN LLS OperVersion: 0 MaxVersion: 0 Enabled: 1 Willing: 0 Error: 0
LAN Logic Link Status: Up
```

## Clearing LLDP-related information

To clear LLDP-related information, perform the following steps from privileged EXEC mode.

- Use the **clear** command to clear LLDP neighbor information.

```
switch# clear lldp neighbors interface tengigabitethernet 0/1
```

- Use the **clear** command to clear LLDP statistics.

```
switch# clear lldp statistics interface tengigabitethernet 0/1
```

## Manually enabling lossless RDMA over Ethernet

Manually enabling lossless Remote Direct Memory Access (RDMA) over Ethernet is an alternate to the default automatic method of enabling lossless Ethernet.

In Network OS, lossless 10 Gbps or 40 Gbps Ethernet is enabled automatically when an attached host signals the desire to do so through the Data Center Bridging Capability Exchange protocol (DCBX) extension mechanism

DCBX advertises this lossless request by exchanging protocol information through Type, Length, and Value attributes (DCBX TLV). This is an automatic mechanism that does not require Network OS configuration because both LLDP and DCBX are enabled by default. This is used to enable lossless Ethernet for FCoE and for some iSCSI targets which support the DCBX TLV, such as Dell EqualLogic arrays.

There are cases where lossless 10 Gbps or 40 Gbps Ethernet is desired, but where the host does not support enabling this automatically through DCBX TLV. A common example is to support Remote Direct Memory Access (RDMA) over Ethernet (also known as "RDMA over Converged Enhanced Ethernet" or "RoCE"). One example of this is to support SMB Direct in Microsoft Windows Server 2012.

Networks adapters which support RDMA over Ethernet need to have DCB Priority Flow Control (DCB PFC) enabled, and the network switches in the path also need to have DCB PFC set to the same priority in order to provide lossless Ethernet. The following are the steps needed to manually configure lossless Ethernet in Network OS (Network OS 4.0.1 or greater is required):

1. For VDX switch interfaces that are attached to hosts requiring lossless Ethernet support, disable LLDP at the 10GbE or 40GbE interface level by issuing the **lldp disable** command.
2. Also at the interface level, enable the cee map by issuing the **cee default** command.
3. Configure the host's network adapter to enable DCB PFC and to set it for PFC class 3 (priority 3). This will match the default PFC class setting in Network OS. These instructions are provided by the network adapter manufacturer.
4. It is important that the DCB PFC settings match on both the VDX switch and the host's network adapter. Ensure that the global NOS setting for the CEE map remains at its default: `cee-map default`

This simplifies configuration and ensures that lossless Ethernet will be automatically and correctly set up across the VCS fabric. This gives the added benefit of automatic, end-to-end lossless Ethernet throughout the VCS Ethernet fabric. When lossless Ethernet is enabled manually for PFC class 3, this will preclude support of FCoE or other protocols on PFC class 3. For this reason, do not mix FCoE configurations with manual lossless Ethernet configurations.



# Configuring QoS

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## QoS overview

Quality of Service (QoS) provides you with the capability to control how the traffic is moved from switch to switch. In a network that has different types of traffic with different needs (specified by Class of Service, or CoS), the goal of QoS is to provide each traffic type with a virtual pipe. FCoE uses traffic class mapping, scheduling, and flow control to provide quality of service.

Traffic running through the switches can be classified as either multicast traffic or unicast traffic. Multicast traffic has a single source but multiple destinations. Unicast traffic has a single source with a single destination. With all this traffic going through inbound and outbound ports, QoS can be set based on egress port and priority level of the CoS.

QoS can also be set on interfaces where the end-station knows how to mark traffic with QoS and it lies with the same trusted interfaces. An untrusted interface occurs when the end-station is untrusted and is at the administrative boundaries.

## QoS features

The principal QoS features are as follows:

- **Rewriting.** Rewriting or marking a frame allows for overriding header fields such as the priority and VLAN ID. Refer to [Rewriting](#) on page 182 for more information.
- **Queueing.** Queueing provides temporary storage for frames while waiting for transmission. Queues are selected based on ingress ports, egress ports, and configured user priority level. Refer to [Queueing](#) on page 182 for more information.
- **Congestion control.** When queues begin filling up and all buffering is exhausted, frames are dropped. This has a detrimental effect on application throughput. Congestion control techniques are used to reduce the risk of queue overruns without adversely affecting network throughput. Congestion control features include IEEE 802.3x Ethernet Pause, Tail Drop, Ethernet Priority Flow Control (PFC), and Random Early Discard (RED). Refer to [Congestion control](#) on page 182 for more information.
- **Multicast rate limiting.** Many multicast applications cannot be adapted for congestion control techniques and the replication of frames by switching devices can exacerbate this problem. Multicast rate limiting controls frame replication to minimize the impact of multicast traffic. This feature is called BUM Storm Control on Brocade VDX 8770-4, VDX 8770-8, and later platforms. Refer to [Multicast rate limiting](#) on page 186 for more information.
- **BUM\_storm\_control.** A traffic storm occurs when packets flood the LAN, creating excessive traffic and degrading network performance. [BUM storm control](#) on page 187 allows you to limit the amount of broadcast, unknown unicast, and multicast (BUM) traffic admitted to the system to prevent disruptions on Layer 2 physical ports. All traffic received at a physical port in excess of a configured maximum rate for BUM traffic will be discarded. You can also specify whether to shut down an interface if the maximum rate has been exceeded within a 5-second sampling period and receive a LOG indication for the disabled interface. This feature is supported on Brocade VDX 8770 series, VDX 6740, and VDX 6740-T platforms.
- **Data Center Bridging.** DCB describes an enhanced Ethernet that will enable convergence of various applications in data centers (LAN, SAN, and IPC) onto a single interconnect technology.

## Rewriting

Rewriting a frame header field is typically performed by an edge device. Rewriting occurs on frames as they enter or exit a network because the neighboring device is untrusted, unable to mark the frame, or is using a different QoS mapping.

The frame rewriting rules set the Ethernet CoS and VLAN ID fields. Egress Ethernet CoS rewriting is based on the user-priority mapping derived for each frame as described later in the queueing section.

## Queueing

Queue selection begins by mapping an incoming frame to a configured user priority, then each user-priority mapping is assigned to one of the switch's eight unicast traffic class queues or one of the eight multicast traffic class queues.

## User-priority mapping

There are several ways an incoming frame can be mapped into a user-priority. If the neighboring devices are untrusted or unable to properly set QoS, then the interface is considered untrusted. All traffic must be user-priority mapped using explicit policies for the interface to be trusted; if it is not mapped in this way, the IEEE 802.1Q default-priority mapping is used. If an interface is trusted to have QoS set then the CoS header field can be interpreted.

### NOTE

The user priority mapping discussed in this chapter applies to both unicast and multicast traffic.

## Congestion control

Queues can begin filling up for a number of reasons, such as over subscription of a link or backpressure from a downstream device. Sustained, large queue buildups generally indicate congestion in the network and can affect application performance through increased queuing delays and frame loss.

Congestion control covers features that define how the system responds when congestion occurs or active measures taken to prevent the network from entering a congested state.

### NOTE

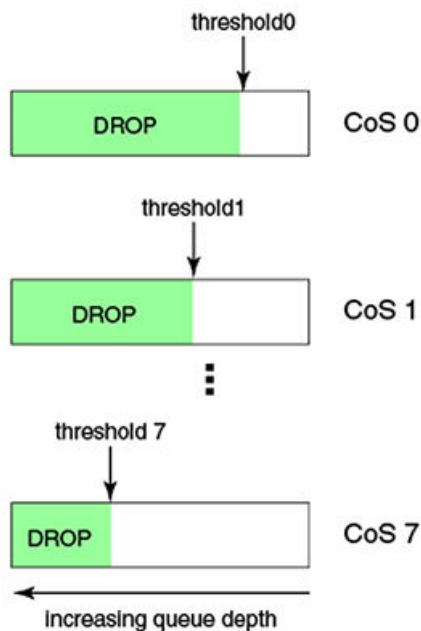
You cannot configure CoS thresholds and multicast tail drop on Brocade VDX 8770-4 and VDX 8770-8 platforms. Random Early Discard (RED) is supported only on Brocade VDX 6740, VDX 8770-4 and VDX 8770-8 platforms.

## Tail drop

Tail drop queuing is the most basic form of congestion control. Frames are queued in FIFO order and queue buildup can continue until all buffer memory is exhausted. This is the default behavior when no additional QoS has been configured.

The basic tail drop algorithm does not have any knowledge of multiple priorities and per traffic class drop thresholds can be associated with a queue to address this. When the queue depth breaches a threshold, then any frame arriving with the associated priority value will be dropped. The figure below illustrates how you can utilize this feature to ensure that lower-priority traffic cannot totally consume the full buffer memory.

FIGURE 19 Queue depth



Thresholds can also be used to bound the maximum queuing delay for each traffic class. Additionally, if the sum of the thresholds for a port is set below 100 percent of the buffer memory, then you can also ensure that a single port does not monopolize the entire shared memory pool allocated to the port. The tail drop algorithm can be extended to support per-priority drop thresholds. When the ingress port CoS queue depth breaches a threshold, then any frame arriving with the associated priority value will be dropped.

### CoS thresholds

Every port has associated with it a total of 9 CoS thresholds, one for the port tail-drop threshold and the other eight are thresholds for per priority. To give a fair allocation of buffers for the traffic from all priorities, the port buffers are allocated among different priorities. That is achieved through per-priority tail-drop thresholds. The port tail-drop threshold represents the amount of buffers given to the port, and the per-priority tail-drop threshold (called the CoS tail-drop threshold from here on) represents the buffers allocated to each CoS.

#### NOTE

CoS thresholds apply only to multicast traffic.

Whenever the buffers allocated to a priority are fully exhausted, all the traffic coming in on that priority is dropped. In the absence of per-priority tail-drop thresholds (and with only port tail-drop thresholds), the buffers would be consumed on a first-come, first-served basis, resulting in an unfair share of buffers among all the priorities. If you know which priority traffic is most seen, then providing a sufficient number of buffers for those priorities results in fewer packet drops for those priorities.

Instead of using the standard priority values, you can assign anywhere from 0% through 100% priority to any threshold, as long as the sum of all eight priorities does not exceed 100%. For example, using the priorities 5 5 5 5 50 20 2 8 adds up to 100%, as shown in the following example:

```
switch(conf-if-te-0/1)# qos rcv-queue cos-threshold 5 5 5 5 50 20 2 8
switch(conf-if-te-0/1)# do show qos in te 0/1
Interface TenGigabitEthernet 0/1
CoS-to-Traffic Class map 'default'
-----
In-CoS: 0 1 2 3 4 5 6 7
```

```

Out-CoS/TrafficClass: 0/1 1/0 2/2 3/3 4/4 5/5 6/6 7/7
Per-Traffic Class Tail Drop Threshold (bytes)
TC: 0      1      2      3      4      5      6      7
-----
Threshold: 10180 10180 10180 10180 101808 40723 4072 16289

```

**NOTE**

Tail drop thresholds are not allowed to collectively exceed 100%, but the sum can be below 100%. For example, if the tail drop thresholds entered sum to less than 100%, then the buffer allocation is made on the basis of what has been configured.

## Random Early Discard

**NOTE**

This feature is only supported on Brocade VDX 8770-4, VDX 8770-8, VDX 6740, VDX 6740T, and VDX 6740T-1G.

Traditionally, Random Early Discard (RED) is used for TCP traffic streams, which are generally more aggressive, as well as reactive, to network drops. If RED is not configured, queues build up at the switch and become full, resulting in tail drop. Tail drop situations can cause head-of-line blocking issues at the switch, which is not desirable. By configuring RED, you set a probability for dropping packets before traffic in the queue reaches a specific threshold. This allows congestion to ease more gradually, avoids retransmit synchronization, resolves "bursty" TCP connections during congestion conditions, and controls packet latency.

Configure RED using the following parameters:

- RED profile identification (0-384)
- Minimum threshold of a queue (0-100%)
- Maximum threshold of a queue (0-100%)
- Drop probability (0-100%)

**NOTE**

Beginning with Network OS release 5.0.0, the maximum number of RED profiles at the system level is 3 on the Brocade VDX 8770 series, and 16 on the Brocade VDX 6740 and VDX 6740-T.

The ASIC driver maps the configured minimum and maximum percentages to the actual queue size in bytes, depending on the bandwidth of the port (buffers are allocated to a port according to port speed). When buffers in the queue build up to the set minimum threshold, packets being queued are randomly dropped. The drop probability parameter defines the randomness of the drops. When the queues exceed the minimum threshold, packets are dropped according to the configured drop probability value. When the queue buffers exceed the set maximum threshold, packets are dropped with 100% probability. The higher the probability set, the more likely packets will be dropped when the minimum percentage is reached.

You can also map a specific CoS priority value (0 through 7) to a specific RED profile.

## Configuring dynamic buffer sharing

If there is bursty, lossy traffic for certain flows in the system, you can borrow the buffers from less bursty flows, in order to reduce the traffic loss. The **qos** command is used to configure the egress or ingress queue limit, such as the maximum number of kilobytes of data that can be queued in the egress or ingress queue. The **tx-queue** keyword controls the egress, and the **rcv-queue** keyword controls the ingress.

This command only functions on the Brocade VDX 6740 and the Brocade VDX 6740-T. This configuration is applied on individual RBridges.



To configure dynamic buffer sharing, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Enter RBridge ID configuration mode.

```
switch(config)# rbridge-id 154
```

3. Configure the dynamic buffer sharing. The following example sets the egress limit to 512 kilobytes.

```
(config-rbridge-id-154)# qos tx-queue limit 512
```

The following example sets the ingress limit to 1024 kilobytes.

```
(config-rbridge-id-154)# qos rcv-queue limit 1024
```

4. Return to privileged EXEC mode.

```
(config-rbridge-id-154)# end
```

5. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Ethernet Pause

Ethernet Pause is an IEEE 802.3 standard flow-control mechanism for back pressuring a neighboring device. Pause messages are sent by utilizing the optional MAC control sublayer. A PAUSE frame contains a 2-byte pause number, which states the length of the pause in units of 512 bits. When a device receives a PAUSE frame, it must stop sending any data on the interface for the specified length of time, once it completes the transmission of any frame in progress. You can use this feature to reduce Ethernet frame losses by using a standardized mechanism. However, the pause mechanism does not have the ability to selectively back-pressure data sources multiple hops away, or to exert any control per VLAN or per priority, so it is disruptive to all traffic on the link.

### Ethernet Pause features

Ethernet Pause includes the following features:

- All configuration parameters can be specified independently per interface.
- Pause On/Off can be specified independently for TX and RX directions. No support is provided for disabling autonegotiation.
- Pause generation is based on input (receive) queueing. Queue levels are tracked per input port. When the instantaneous queue depth crosses the high-water mark, then a PAUSE frame is generated. If any additional frames are received and the queue length is still above the low-water mark, then additional PAUSE frames are generated. Once the queue length drops below the low-water mark, then the generation of PAUSE frames ceases.
- A PAUSE frame that is received and processed halts transmission of the output queues associated with the port for the duration specified in the PAUSE frame.

## 1-Gbps pause negotiation

When a 1-Gbps local port is already online, and the **qos flowcontrol** command is issued, the pause settings take effect immediately on that local port. However, when the link is toggled, pause is renegotiated. The local port will advertise the most recent **qos flowcontrol** settings. After autonegotiation completes, the local port pause settings may change, depending on the outcome of the pause negotiation, per 802.3 Clause 28B, as shown in the table below.

**TABLE 28** Pause negotiation results

Advertised LOCAL cfg	Advertised REMOTE cfg	Negotiated result
Rx=off Tx=on	Rx=on Tx=on	asymmetrical: LOCAL Tx=on -> pause -> REMOTE Rx=on
Rx=on Tx=on	Rx=off Tx=on	asymmetrical: LOCAL Rx=on <- pause <- REMOTE Tx=on
Rx=on Tx=n/a	Rx=on Tx=n/a	symmetrical: LOCAL Tx/Rx=on <- pause -> REMOTE Tx/Rx=on
Rx=n/a Tx=n/a	Rx=off Tx=off	disable pause both sides

## Ethernet Priority Flow Control

Ethernet Priority Flow Control (PFC) is a basic extension of Ethernet Pause. The Pause MAC control message is extended with eight 2-byte pause numbers and a bitmask to indicate which values are valid. Each pause number is interpreted identically to the base Pause protocol; however, each number is applied to the corresponding Ethernet priority/class level. For example, the Pause number 0 applies to priority zero, Pause number 1 applies to priority one, and so on. This addresses one shortcoming of the Ethernet Pause mechanism, which is disruptive to all traffic on the link. However, it still suffers from the other Ethernet Pause limitations.

### NOTE

The Brocade VDX 6740 series platforms support only two PFCs.

Ethernet Priority Flow Control includes the following features:

- Everything operates exactly as in Ethernet Pause described above, except there are eight high-water and low-water thresholds for each input port. This means queue levels are tracked per input port plus priority.
- Pause On/Off can be specified independently for TX and RX directions per priority.
- Pause time programmed into Ethernet MAC is a single value covering all priorities.
- Both ends of a link must be configured identically for Ethernet Pause or Ethernet Priority Flow Control because they are incompatible.

## Multicast rate limiting

Multicast rate limiting provides a mechanism to control multicast frame replication and cap the effect of multicast traffic.

Multicast rate limit is applied to the output of each multicast receive queue. Rate limits apply equally to ingress receive queuing (first-level expansion) and egress receive queuing (second-level expansion), because the same physical receive queues are utilized. You can set policies to limit the maximum multicast frame rate differently for each traffic class level and cap the total multicast egress rate out of the system.

Multicast rate limiting includes the following features:

- All configuration parameters are applied globally. Multicast rate limits are applied to multicast receive queues as frame replications are placed into the multicast expansion queues. The same physical queues are used for both ingress receive queues and egress receive queues, so rate limits are applied to both ingress and egress queuing.

- The rate limit value represents the maximum multicast expansion rate in packets per second (pps).

#### NOTE

Multicast rate limiting is not supported on the Brocade VDX 6740 series or the Brocade VDX 8770-4 and 8770-8 platforms. For these products, refer to [BUM storm control](#) on page 187.

## BUM storm control

A traffic storm occurs when packets flood the LAN, creating excessive traffic and degrading network performance. Broadcast, unicast, and unknown multicast (BUM) storm control can prevent disruptions on Layer 2 physical ports. This feature is supported only at the interface level.

BUM storm control allows you to limit the amount of broadcast, unknown unicast, and multicast ingress traffic on a specified interface or on the entire system. All traffic received in excess of the configured rate gets discarded. You also have the option to specify whether to shut down an interface if the maximum defined rate is exceeded within a five-second sampling period. When a port is shut down, you receive a log message. You must then manually re-enable the interface by using the **no shut** command.

### *BUM storm control considerations and limitations*

- BUM storm control must be configured on one of the following physical interfaces:
  - 1-gigabit Ethernet
  - 10-gigabit Ethernet
  - 40-gigabit Ethernet
  - 100-gigabit Ethernet
- BUM storm control and input service-policy are mutually exclusive features. Only one can be enabled at a time on a given interface.
- BUM storm control replaces the multicast rate-limit feature for Brocade VDX 6740, VDX 8770-4 and VDX 8770-8, and later platforms.

## Scheduling

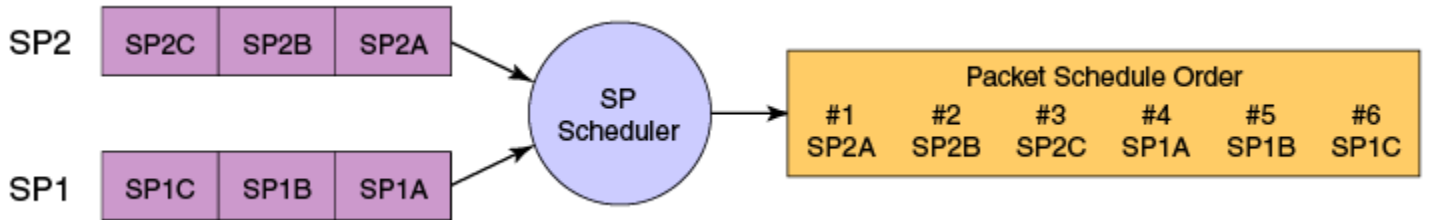
Scheduling arbitrates among multiple queues waiting to transmit a frame. The Brocade switch supports both Strict Priority (SP) and Deficit Weighted Round Robin (DWRR) scheduling algorithms. Also supported is the flexible selection of the number of traffic classes using SP-to-DWRR. When there are multiple queues for the same traffic class, then scheduling takes these equal-priority queues into consideration.

### *Strict priority scheduling*

Strict priority scheduling is used to facilitate support for latency-sensitive traffic. A strict priority scheduler drains all frames queued in the highest-priority queue before continuing on to service lower-priority traffic classes. A danger with this type of service is that a queue can potentially starve out lower-priority traffic classes.

The following figure displays the frame scheduling order for an SP scheduler servicing two SP queues. The higher-numbered queue, SP2, has a higher priority.

FIGURE 20 Strict priority schedule — two queues

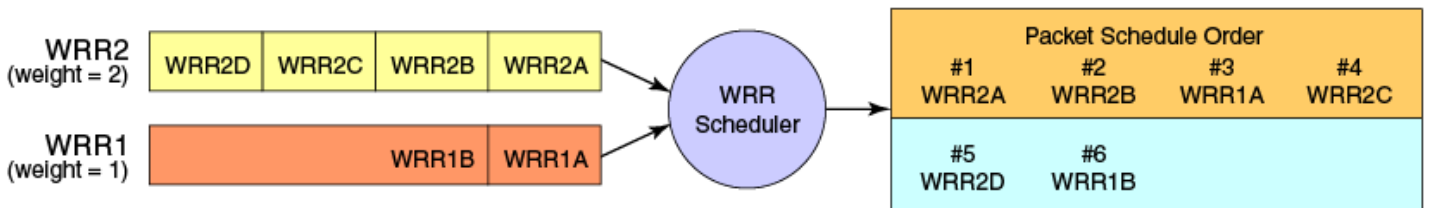


### Weighted Round Robin scheduling

Weighted Round Robin (WRR) scheduling is used to facilitate controlled sharing of the network bandwidth. WRR assigns a weight to each queue; that value is then used to determine the amount of bandwidth allocated to the queue. The round robin aspect of the scheduling allows each queue to be serviced in a set order, sending a limited amount of data before moving onto the next queue and cycling back to the highest-priority queue after the lowest-priority queue is serviced.

The following figure displays the frame scheduling order for a WRR scheduler servicing two WRR queues. The higher-numbered queue is considered higher priority (WRR2), and the weights indicate the network bandwidth should be allocated in a 2:1 ratio between the two queues. In this figure WRR2 receives 66 percent of the bandwidth and WRR1 receives 33 percent. The WRR scheduler tracks the extra bandwidth used and subtracts it from the bandwidth allocation for the next cycle through the queues. In this way, the bandwidth utilization statistically matches the queue weights over longer time periods.

FIGURE 21 WRR schedule — two queues



Deficit Weighted Round Robin (DWRR) is an improved version of WRR. DWRR remembers the excess used when a queue goes over its bandwidth allocation and reduces the queue’s bandwidth allocation in the subsequent rounds. This way the actual bandwidth usage is closer to the defined level when compared to WRR.

### Traffic class scheduling policy

Traffic classes are numbered from 0 to 7, with higher-numbered traffic classes treated as having a higher priority. Brocade switches provide full flexibility in controlling the number of SP-to-WRR queues. The number of SP queues is specified as SP1 through 8, then the highest-priority traffic classes are configured for SP service and the remaining eight are WRR serviced. The supported scheduling configurations listed in the table below describes the set of scheduling configurations supported.

When you configure the QoS queue to use strict priority 4 (SP4), then traffic class 7 will use SP4, traffic class 6 will use SP3, and so on down the list. You use the strict priority mappings to control how the different traffic classes will be routed in the queue.

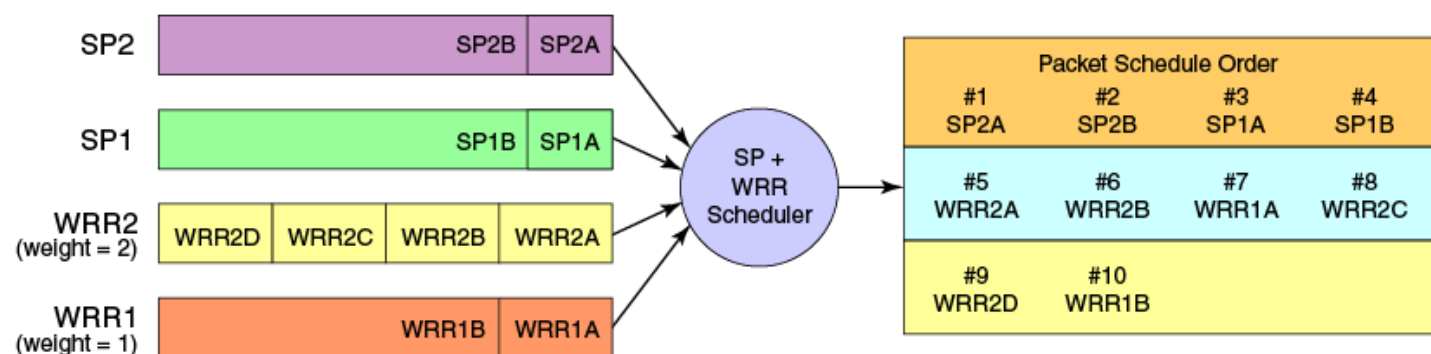
TABLE 29 Supported scheduling configurations

Traffic Class	SP0	SP1	SP2	SP3	SP4	SP5	SP6	SP8
7	WRR8	SP1	SP2	SP3	SP4	SP5	SP6	SP8

**TABLE 29** Supported scheduling configurations (continued)

Traffic Class	SPO	SP1	SP2	SP3	SP4	SP5	SP6	SP8
6	WRR7	WRR7	SP1	SP2	SP3	SP4	SP5	SP7
5	WRR6	WRR6	WRR6	SP1	SP2	SP3	SP4	SP6
4	WRR5	WRR5	WRR5	WRR5	SP1	SP2	SP3	SP5
3	WRR4	WRR4	WRR4	WRR4	WRR4	SP1	SP2	SP4
2	WRR3	WRR3	WRR3	WRR3	WRR3	WRR3	SP1	SP3
1	WRR2	WRR2	WRR2	WRR2	WRR2	WRR2	WRR2	SP2
0	WRR1	WRR1	WRR1	WRR1	WRR1	WRR1	WRR1	SP1

The figure below shows that extending the frame scheduler to a hybrid SP+WRR system is fairly straightforward. All SP queues are considered strictly higher priority than WRR so they are serviced first. Once all SP queues are drained, then the normal WRR scheduling behavior is applied to the non-empty WRR queues.

**FIGURE 22** Strict priority and Weighted Round Robin scheduler

### Multicast queue scheduling

The multicast traffic classes are numbered from 0 to 7; higher numbered traffic classes are considered higher priority. A fixed mapping from multicast traffic class to equivalent unicast traffic class is applied to select the queue scheduling behavior. The Multicast traffic class equivalence mapping table below presents the multicast traffic class with the equivalence mapping applied.

Once the multicast traffic class equivalence mapping has been applied, then scheduling and any scheduler configuration are inherited from the equivalent unicast traffic class. Refer to the table below for details on exact mapping equivalencies.

**TABLE 30** Multicast traffic class equivalence mapping

Multicast traffic class	Equivalent unicast traffic class
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7

Unicast ingress and egress queueing utilizes a hybrid scheduler that simultaneously supports SP+WRR service and multiple physical queues with the same service level. Multicast adds additional multicast expansion queues. Because multicast traffic classes are equivalent to unicast service levels, they are treated exactly as their equivalent unicast service policies.

## Data Center Bridging QoS

Data Center Bridging (DCB) QoS covers frame classification, priority and traffic class (queue) mapping, congestion control, and scheduling. Under the DCB provisioning model, all of these features are configured on the basis of two configuration tables, Priority Group Table and Priority Table.

The DCB Priority Group Table defines each Priority Group ID (PGID) and its scheduling policy (Strict Priority versus DWRR, DWRR weight, relative priority), and partially defines the congestion control (PFC) configuration. There are 16 rows in the DCB Priority Group Table.

The table below presents the default DCB Priority Group Table configuration.

**TABLE 31** Default DCB Priority Group Table configuration

PGID	Bandwidth%	PFC
15.0	-	Y
15.1	-	N
15.2	-	N
15.3	-	N
15.4	-	N
15.5	-	N
15.6	-	N
15.7	-	N
0	0	N
1	0	Y
2	0	N
3	0	N
4	0	N
5	0	N
6	0	N
7	0	N

### NOTE

Only a single CoS can be mapped to a PFC-enabled priority queue. The switch automatically maps the CoS number to the same TC number when PFC is enabled. The PGID can be anything from 0 through 7. If your configuration violates this restriction an error message displays and the Priority Group Table is set back to the default values. When the DCB map is applied, and the interface is connected to the CNA, only one Strict Priority PGID (PGID 15.0 through PGID 15.7) is allowed.

Strict Priority versus DWRR is derived directly from the PGID value. All PGIDs with prefix 15 receive Strict Priority scheduling policy, and all PGIDs in the range 0 through 7 receive DWRR scheduling policy. Relative priority between Priority Group is exactly the ordering of entries listed in the table, with PGID 15.0 being highest priority and PGID 7 being lowest priority. Congestion control configuration is partially specified by toggling the PFC column On or Off. This provides only partial configuration of congestion control because the set of priorities mapped to the Priority Group is not known, which leads into the DCB Priority Table.

The DCB Priority Table defines each CoS mapping to Priority Group, and completes PFC configuration. The table below shows an example of mapping in the DCB Priority Table.

**TABLE 32** Example of mapping DCB priority table values

CoS	PGID
0	15.6
1	15.7
2	15.5
3	15.4
4	15.3
5	15.2
6	15.1
7	15.0

## Brocade VCS Fabric QoS

Brocade VCS Fabric QoS requires very little user configuration. The only options to modify are the fabric priority and the lossless priority.

Brocade VCS Fabric reserves a mapping priority and fabric priority of seven (7). Any traffic that enters the Brocade VCS Fabric cluster from upstream that is using the reserved priority value is automatically remapped to a lower priority.

Changing the mapping or fabric priority is not required. By default the values are set to zero (0) for both of the remapped priorities.

In Brocade VCS Fabric mode:

- All incoming priority 7 tagged packets are redefined to the default or user-defined value.
- Untagged control frames are counted in queue 7 (TC7).

All switches in the Brocade VCS Fabric cluster must have matching remapping priority values and the same priority-group-table values.

### *Restrictions for Layer 3 features in VCS mode*

When the switch is in VCS mode, the lossless priority for carrying FCoE traffic and the fabric priority for carrying fabric traffic must be isolated from any Layer 3 QoS markings and classification. Therefore, specific restrictions apply to some Layer 3 DSCP QoS features when the switch is working in VCS mode:

The following are restrictions for using applicable Layer 3 DSCP-Traffic-Class map, DSCP-CoS map, and DSCP Trust features in VCS mode. Note that DSCP mutation maps and the egress RED feature are not affected in VCS mode.

- DSCP trust is disabled in VCS mode as it is for CoS trust.
- There are no default DSCP maps in VCS mode.
- A nondefault DSCP-Traffic-Class map has the following restrictions:
  - A DSCP value cannot be classified to Traffic Class 7.
  - A DSCP value cannot be classified to a queue that carries lossless traffic (by default Traffic Class 3).
- A nondefault DSCP-CoS map has the following restrictions:
  - A DSCP value cannot be marked to CoS 7.
  - A DSCP value cannot be marked to lossless priority (by default CoS 3).
- Lossless priorities are identified through the CEE map.
- To enable DSCP based marking or classification, a nondefault DSCP-Traffic-Class map and a DSCP-CoS map have to be applied on the interface.

- To apply a DSCP-Traffic-Class or DSCP-CoS map to an interface, the CoS and Traffic Class values have to be remarked for lossless priorities. For example, when DSCP-Traffic-Class map "abcd" is created, it will have the default contents. When this map is applied to an interface, an error will display that the fabric and lossless priorities are used in the map and it cannot be applied on the interface.
- When a valid DSCP-Traffic-Class map and DSCP-CoS map are applied on the interface, then DSCP trust is enabled with the configured maps.

## Port-based Policer

The port-based Policer feature controls the amount of bandwidth consumed by an individual flow or aggregate of flows by limiting the inbound and outbound traffic rate on an individual port according to criteria defined by the user. The Policer provides rate control by prioritizing or dropping ingress and egress packets classified according to a two-rate, three-color marking scheme defined by RFC 4115.

### Port-based Policer features

The Policer supports the following features.

- A color-based priority mapping scheme for limiting traffic rates.
  - One-rate, two-color policing with "conform" color options. "Violate" color traffic will be dropped.
  - Two-rate, three-color policing with "conform" and "exceed" color options. "Violate" color traffic will be dropped.
- A policing option that allows packet headers to be modified for IP precedence.
- Policing options that allow packet headers to be modified for Class of Service (CoS).
- Policing options that allow packet headers to be modified for Differentiated Services Code Point (DSCP).
- Policing options that allow packets to be assigned to a traffic class (0-7).

### Color-based priority

The following is the color-based priority mapping scheme for limiting traffic rate:

- Traffic flagged to the green or "conform" color priority conforms to the committed information rate (CIR) as defined by the *cir-rate* variable for the policy-map (refer to [Policing parameters](#) on page 192). This rate can be anything from 40000 to 400000000000 bps.
- Traffic flagged as yellow or "exceed" exceeds the CIR, but conforms to the Excess Information Rate (EIR) defined by the *eir-rate* variable for the policy-map (refer to [Policing parameters](#) on page 192). This rate can be set from 0 through 400000000000 bps.
- Traffic flagged as red or "violate" are not compared to CIR or EIR and will be dropped.

Using policing parameters, you can define metering rates, such as CIR and EIR, and actions for traffic flagged as conforming or exceeding the rates. As a simple example, traffic within the "conform" rate may be sent at a certain CoS priority, traffic flagged at the "exceed" rate may be sent at a lower priority, and traffic that violates the set rates can be dropped (default and only option).

### Policing parameters

Policing parameters provide values for CIR, CBS, EIR, and EBS, for classifying traffic by a specific class for color-based priority mapping. They also specify specific actions to perform on traffic with a color-class priority, such as having packet DSCP priority, traffic class (internal queue assignment), or traffic class (internal queue assignment) set to specific values.



## CIR and CBS

The Committed Information Rate (CIR) is the maximum number of bits that a port can receive or send during one-second over an interface. For CIR, there are two parameters that define the available traffic: CIR and the Committed Burst Size (CBS). The CIR represents a portion of the interface's total bandwidth expressed in bits per second (bps). It cannot be larger than the interface's total bandwidth. CBS controls the bursty nature of the traffic. Traffic that does not use the configured CIR accumulates credits until the credits reach the configured CBS. These credits can be used when the rate temporarily exceeds the configured CIR. When credits are not available, the traffic is either dropped or subject to the policy set for the Excess Information Rate (EIR). The traffic limited by the CIR can have its priority, traffic class, and DSCP values changed.

CIR is mandatory policing parameter for configuring a class map.

```
cir cir-rate
```

The **cir** command defines the value of the CIR as the rate provided in the *cir-rate* variable. Acceptable values are in multiples of 40000 in the range 40000-100000000000 bps.

```
cbs cbs-size
```

The **cbs** command defines the value of the CBS as the rate provided in the *cbs-size* variable. Acceptable values are 1250-12500000000 bytes in increments of 1 byte.

## EIR and EBS

The Excess Information Rate (EIR) provides an option for traffic that has exceeded the CIR. For EIR, there are two parameters that define the available traffic: the EIR and the Excess Burst Size (EBS). The EIR and EBS operate exactly like the CIR and CBS, except that they act only upon traffic that has been passed to the EIR because it could not be accommodated by the CIR. Like the CIR, the EIR provides an initial bandwidth allocation to accommodate inbound and outbound traffic. Like the CBS, the bandwidth available for burst traffic from the EBS is subject to the amount of bandwidth that is accumulated during periods when traffic allocated by the EIR policy is not used. When inbound or outbound traffic exceeds the bandwidth available (accumulated credits or tokens), it is be dropped. The traffic rate limited by the EIR can have its priority, traffic class, and DSCP values changed.

EIR and EBS parameters are optional policing parameters. If not set, they are considered disabled.

```
eir eir-rate
```

The **eir** parameter defines the value of the EIR as the rate provided in the *eir-rate* variable. Acceptable values are in multiples of 40000 in the range 0-1000000000000 bps.

```
ebs ebs-size
```

The **ebs** parameter defines the value of the EBS as the rate provided in the *ebs-size* variable. Acceptable values are 1250-12500000000 bytes in increments of 1 byte.

## Parameters that apply actions to conform and exceed traffic

Following are policing parameters that apply actions to conform or exceed color traffic:

- **conform-set-dscp** *dscp-num*.

The **conform-set-dscp** parameter specifies that traffic with bandwidth requirements within the rate configured for CIR will have its packet DSCP priority set to the value specified in the *dscp-num* variable. Acceptable values for *dscp-num* are 0-63.

- **conform-set-prec** *prec-num*.

The **conform-set-prec** parameter specifies that traffic with bandwidth requirements within the rate configured for CIR will have its packet IP precedence value (first 3 bits of DSCP) set to the value in the *prec-num* variable. Acceptable values for *prec-num* are 0–7.

- **conform-set-tc** *trafficclass*.

The **conform-set-tc** parameter specifies that traffic with bandwidth requirements within the rate configured for CIR will have its traffic class (internal queue assignment) set to the value in the *trafficclass* variable. Acceptable values for *trafficclass* are 0–7.

- **exceed-set-dscp** *dscp-num*.

The **exceed-set-dscp** parameter specifies that traffic with bandwidth requirements that exceeds the rate configured for CIR and sent to the EIR bucket will have its packet DSCP priority set to the value in the *dscp-num* variable. Acceptable values for *dscp-num* are 0–63.

- **exceed-set-prec** *prec-num*.

The **exceed-set-prec** parameter specifies that traffic with bandwidth requirements that exceed the rate configured for CIR and sent to the EIR bucket will have its packet IP precedence set to the value in the *prec-num* variable. Acceptable values for *prec-num* are 0–7.

- **exceed-set-tc** *trafficclass*.

The **exceed-set-tc** parameter specifies that traffic with bandwidth requirements that exceed the rate configured for CIR and is in the limit of what is configured for EIR will have its traffic class (internal queue assignment) set to the value in the *trafficclass* variable. Acceptable values for *trafficclass* are 0–7.

- **set-priority** *priority-mapname*.

The **set-priority** parameter specifies the mapping used for setting QoS priority (802.1p priority) in the packet. The *priority-mapname* name variable should be same as configured for the priority-map (police-priority-map), which will have a set priority and color type (conform or exceed).

## Policer considerations and limitations

Consider the topics discussed below when configuring the port-based Policer feature.

### Best practices for Policer

Follow these best practices when configuring the port-based Policer feature:

- Avoid mapping lossy priority to lossless priority in conform and exceed CoS maps.
- Configure rate (CIR or EIR) and burst size (CBS or EBS) based on interface speed.
- Set conform and exceed token count (Tc) to the same values to avoid any reordering issues.

### Configuration rules and considerations for Policer

The following are rules for configuring maps and using policing parameters for the Policer feature:

- A policy-map, class map, priority-map name must be unique among all maps of that type.
- A policy-map is not supported on an ISL port.
- A Policer name must begin with a-z, or A-Z. You can use underscore, hyphen, and numeric values 0–9 except as the first character.
- You cannot delete a policy-map, class map, or priority-map if is active on the interface.
- You cannot delete a class map from a policy-map when the policy-map is active on the interface.

- Configure **CIR** and **EIR** in multiples of 40000 bps.
- Percentage as a rate limit is not supported.
- Policer actions are applicable only to data traffic. Control traffic, FCoE, and internal VLAN traffic is not subjected to policing.
- The egress Policer can overwrite ingress Policer results such as CoS mapping and DSCP mapping.
- If a policy-map is applied to an interface and no Policer attributes are present in that policy-map, then ingress and egress packets on that interface is marked as green (conforming).
- If the configured CBS value is less than 2\*MTU value, then 2\*MTU is programmed as the CBS in the hardware. For example, if you configure CBS at 4000 bytes and the MTU on an interface is 3000 bytes, when a policy-map is applied on this interface, the CBS programmed in the hardware is 2\*MTU (6000 bytes).
- If CBS and EBS values are not configured, then these values are derived from CIR and EIR values, respectively. Burst size calculation is as follows:  $Burst\ size\ (cbs\ or\ ebs) = 1.2 * information\ rate\ (CIR/EIR) / 8$
- If you do not configure EIR and EBS, then the single-rate, two-color scheme is applied (packets are marked as either green or red).
- You must configure rate limit threshold values on an interface based on interface speed. No validation is performed for user-configured values against interface speed.

### Limitations for Policer

- The incremental step size for CIR or EIR is set to 40000 bps.
- The Policer operates in color-blind mode. In other words, color is evaluated at ingress and egress Policers independently. This may result in packets that are marked as yellow in the inbound Policer to be evaluated as green at the outbound Policer, depending on Policer settings.
- Because inbound queue scheduling is performed before outbound policing, setting traffic class (**set-conform-tc** or **set-exceed-tc**) based on policing results does not affect packet forwarding at the outbound side.
- Packets drops caused by any action other than ACLs are included in Policer counters.
- Layer 3 control packets are policed at the outbound side.
- Policing is enabled on lossless priorities at the outbound side.
- Policing is not enabled for control traffic that is trapped or dropped.

### Considerations for vLAGs with Policer

Because a virtual link aggregation group (vLAG) spans multiple switches, it is not possible to associate flows on each LAG member port to a common Policer. Instead, apply the same policy-map on individual member ports so that traffic flow on member ports is controlled by a Policer configured on that member port. The total rate-limit threshold value on a vLAG consists of the cumulative values of rate-limit thresholds on all member ports.

### Lossless traffic with Policer

The following are considerations for lossless traffic:

- Policing is applicable only for lossy traffic. Lossless traffic should not get policed. For port-based policing, apply a policy-map to an interface even if PFC is configured on that interface. The CoS value (priority) on which PFC is applied is excluded from being policed.
- Remapped priority values should not include lossless priorities. Do not remap lossy traffic priorities to lossless traffic priorities and vice-versa.
- Policer attributes **conform-set-tc** and **exceed-set-tc** should not be set to a lossless traffic class.

# Configuring QoS

The following sections discuss configuring QoS, including fundamentals, traffic class mapping, congestion control, rate limiting, BUM storm control, scheduling, DCB QoS, Brocade VCS Fabric QoS, policer functions, and Auto QoS.

## Configuring QoS fundamentals

### NOTE

Refer to [User-priority mapping](#) on page 182.

### *Understanding default user-priority mappings for untrusted interfaces*

When Layer 2 QoS trust is set to **untrusted**, then the default is to map all Layer 2 switched traffic to the port default user priority value of 0 (best effort), unless the user priority is configured to a different value.

The following table presents the Layer 2 QoS **untrusted** user-priority generation table.

**TABLE 33** Default priority value of untrusted interfaces

Incoming CoS	User Priority
0	port <user priority> (default 0)
1	port <user priority> (default 0)
2	port <user priority> (default 0)
3	port <user priority> (default 0)
4	port <user priority> (default 0)
5	port <user priority> (default 0)
6	port <user priority> (default 0)
7	port <user priority> (default 0)

### NOTE

Nontagged Ethernet frames are interpreted as having an incoming CoS value of 0 (zero).

You can override the default user-priority mapping by applying explicit user-priority mappings.

When neighboring devices are trusted and able to properly set QoS, then Layer 2 QoS trust can be set to **CoS** and the IEEE 802.1Q default-priority mapping is applied.

The following table presents the Layer 2 CoS user-priority generation table conforming to 802.1Q default mapping. You can override this default user-priority table per port if you want to change (mutate) the CoS value.

**TABLE 34** IEEE 802.1Q default priority mapping

Incoming CoS	User Priority
0	0
1	1
2	2
3	3
4	4
5	5
6	6

**TABLE 34** IEEE 802.1Q default priority mapping (continued)

Incoming CoS	User Priority
7	7

## Configuring QoS mappings

Consider the topics discussed below when configuring the QoS mappings.

### Configuring the QoS trust mode

The QoS trust mode controls user priority mapping of incoming traffic. The Class of Service (CoS) mode sets the user priority based on the incoming CoS value. If the incoming packet is not priority tagged, then fallback is to the Interface Default CoS value.

#### NOTE

When a CEE map is applied on an interface, the **qos trust** command is not allowed. The CEE map always puts the interface in the CoS trust mode.

To configure the QoS trust mode, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Specify the Ethernet interface.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8. The prompt for these ports is in the following format: `switch(config-if-gi-22/0/1)#`

```
switch(config)# interface tengigabitethernet 2/1/2
```

3. Set the interface mode to CoS trust.

```
switch(config-if-te-2/1/2)# qos trust cos
switch(config-if-te-2/1/2)# qos cos-traffic-class test
```

#### NOTE

To deactivate CoS trust from an interface, enter **no qos trust cos**

4. Return to privileged EXEC mode.

```
switch(config-if-te-0/2)# end
```

5. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

### Verifying CoS trust

To verify applied CoS trust, you can enter the following command from global configuration mode, where **tengigabitethernet 0/2** is the interface name.

```
switch(config)# do show qos interface tengigabitethernet 0/2
```

### Configuring user-priority mappings

To configure user-priority mappings, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Specify the Ethernet interface.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following format: switch(config-if-gi-22/0/1)#.

```
switch(config)# interface tengigabitethernet 1/2/2
```

3. Configure the interface to priority 3.

```
switch(conf-if-te-1/2/2)# qos cos 3
```

4. Return to privileged EXEC mode.

```
switch(conf-if-te-1/2/2)# end
```

5. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

### Creating a CoS-to-CoS mutation QoS map

To create a CoS-to-CoS mutation, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Create the CoS-to-CoS mutation QoS map. In this example "test" is the map name.

```
switch(config)# qos map cos-mutation test 0 1 2 3 4 5 6 7
```

3. Enter the **do copy** command to save the *running-config* file to the *startup-config* file.

```
switch(config)# do copy running-config startup-config
```

### Applying a CoS-to-CoS mutation QoS map to an interface

To apply a CoS-to-CoS mutation QoS map, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Specify the Ethernet interface.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8.

```
switch(config)# interface tengigabitethernet 2/1/2
```

3. Activate or apply changes made to the CoS-to-CoS mutation QoS map. In this example, "test" is the map name.

```
switch(conf-if-te-2/1/2)# qos cos-mutation test
```

#### NOTE

To deactivate the mutation map from an interface, enter **no qos cos-mutation** *name*.

4. Specify the trust mode for incoming traffic.

Use this command to specify the interface ingress QoS trust mode, which controls user-priority mapping of incoming traffic. The untrusted mode overrides all incoming priority markings with the Interface Default CoS. The CoS mode sets the user priority based on the incoming CoS value, if the incoming packet is not priority tagged, then fallback is to the Interface Default CoS value.

```
switch(conf-if-te-2/1/2)# qos trust dscp
```

5. Return to privileged EXEC mode.

```
switch(conf-if-te-2/1/2)# end
```

6. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Verifying CoS-to-CoS mutation QoS mapping

To verify applied QoS maps, you can use one or both of the following options from global configuration mode.

- Verify the CoS mutation mapping for a specific map by using the **do show qos maps qos-mutation** command and the map name.

```
switch(config)# do show qos maps cos-mutation test
```

- Verify all QoS mapping by using the **do show qos maps** command with just the **cos-mutation** parameter only.

```
switch(config)# do show qos maps cos-mutation
```

- Verify the interface QoS mapping by using the **do show qos interface** command.

```
switch(config)# do show qos interface te 2/1/2
```

## Configuring DSCP mappings

Consider the topics discussed below when configuring the DSCP mappings.

### Configuring the DSCP trust mode

Like QoS trust mode, the Differentiated Services Code Point (DSCP) trust mode controls the user-priority mapping of incoming traffic. The user priority is based on the incoming DSCP value. When this feature is not enabled, DSCP values in the packet are ignored.

When DSCP trust is enabled, the following table shows default mapping of DSCP values to user priority.

**TABLE 35** Default DSCP priority mapping

DSCP Values	User Priority
0-7	0

**TABLE 35** Default DSCP priority mapping (continued)

DSCP Values	User Priority
8-15	1
16-23	2
24-31	3
32-39	4
40-47	5
48-55	6
56-63	7

**NOTE**

Note the restrictions for using this feature in VCS mode under [Restrictions for Layer 3 features in VCS mode](#) on page 191.

To configure DSCP trust mode, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Specify the Ethernet interface.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8.

```
switch(config)# interface tengigabitethernet 10/0/2
```

3. Set the interface mode to QoS DSCP trust.

```
switch(conf-if-te-10/0/2)# qos trust dscp
```

**NOTE**

To deactivate the DSCP trust mode from an interface, enter **no qos trust dscp**.

4. Return to privileged EXEC mode.

```
switch(conf-if-te-10/0/2)# end
```

5. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

**Verifying DSCP trust**

To verify applied DSCP trust, you can enter the following command from global configuration mode, where **tengigabitethernet 10/0/2** is the interface name.

```
switch(config)# do show qos interface tengigabitethernet 10/0/2
```

**Creating a DSCP mutation map****NOTE**

This feature is only supported on Brocade VDX 8770-4, VDX 8770-8, VDX 6740, VDX 6740T, and VDX 6740T-1G.



To create a DSCP mutation map and re-map the incoming DSCP value of the ingress packet to egress DSCP values, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Create the DSCP mutation map by specifying a map name. The following command uses "test" as the map name and places the system in DSCP mutation mode so that you can map to traffic classes.

```
switch(config)# qos map dscp-mutation test
```

3. Once the system is in DSCP mutation mode for the configured map (in this case dscp-mutation-test), you can map ingress DSCP values to egress DSCP values by using the **mark** command as in the following examples:

```
switch(dscp-mutation-test)# mark 1,3,5,7 to 9
switch(dscp-mutation-test)# mark 11,13,15,17 to 19
switch(dscp-mutation-test)# mark 12,14,16,18 to 20
switch(dscp-mutation-test)# mark 2,4,6,8 to 10
```

This sets the following:

- DSCP values 1, 3, 5, and 7 are set to output as DSCP number 9.
  - DSCP values 11, 13, 15, and 17 are set to output as DSCP number 19.
  - DSCP values 12, 14, 16, and 18 are set to output as DSCP number 20.
  - DSCP values 2, 4, 6, and 8 are set to output as DSCP number 10.
4. Enter the **do copy** command to save the *running-config* file to the *startup-config* file.

```
switch(config)# do copy running-config startup-config
```

### Applying a DSCP mutation map to an interface

To apply a configured DSCP mutation map to an interface, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Specify the Ethernet interface.

```
switch(config)# interface tengigabitethernet 3/1/2
```

3. Activate or apply changes made to the DSCP mutation map to the interface. In this example "test" is the map name.

```
switch(conf-if-te-3/1/2)# qos dscp-mutation test
```

#### NOTE

To deactivate a map from an interface, enter **no qos dscp-mutation name**.

4. Specify the DSCP trust mode for incoming traffic.

```
switch(conf-if-te-2/1/2)# qos dscp-cos test
switch(conf-if-te-2/1/2)# qos dscp-traffic-class test
```

5. Return to privileged EXEC mode.

```
switch(conf-if-te-3/1/2)# end
```

- Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

### Verifying the DSCP mutation mapping

To verify applied DSCP maps, you can use one or both of the following options from global configuration mode.

- Verify DSCP mapping for a specific map using the **do show qos maps dscp-mutation** command and the map name.

```
switch(config)# do show qos maps dscp-mutation test
```

- Verify all DSCP mapping by using the **do show qos maps** command with the **dscp-mutation** operand only.

```
switch(config)# do show qos maps dscp-mutation
```

- Verify DSCP mutation mapping for an interface by using the **show qos interface** command and specifying the interface:

```
switch(config)# do show qos interface te 3/1/2
```

### Configuring DSCP-to-CoS mappings

Consider the topics discussed below when configuring the DSCP-to-CoS mappings.

#### Creating a DSCP-to-CoS mutation map

You can use the incoming DSCP value of ingress packets to remap the outgoing 802.1P CoS priority values by configuring a DSCP-to-COS mutation map on the ingress interface. Use the following steps.

#### NOTE

The restrictions for using this feature in VCS mode are listed at [Restrictions for Layer 3 features in VCS mode](#) on page 191.

- Enter global configuration mode.

```
switch# configure terminal
```

- Create the DSCP-to-CoS map by specifying a map name. The following command uses "test" as the map name and places the system in dscp-cos map mode so that you can map DSCP values to CoS values.

```
switch(configure)# qos map dscp-cos test
```

- Once the system is in dscp-cos map mode for the configured map (in this case dscp-cos-test), you can map incoming DSCP values to outgoing CoS priority values by using the **mark** command as in the following examples:

```
switch(dscp-cos-test)# mark 1,3,5,7 to 3
switch(dscp-cos-test)# mark 11,13,15,17 to 5
switch(dscp-cos-test)# mark 12,14,16,18 to 6
switch(dscp-cos-test)# mark 2,4,6,8 to 7
```

This sets the following:

- DSCP values 1, 3, 5, and 7 are set to output as CoS priority 3.
- DSCP values 11, 13, 15, and 17 are set to output as CoS priority 5
- DSCP values 12, 14, 16, and 18 are set to output as CoS priority 6
- DSCP values 2, 4, 6, and 8 are set to output as CoS priority 7.

4. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch(config)# copy running-config startup-config
```

### Applying a DSCP-to-CoS map to an interface

To apply a DSCP-to-CoS mutation map to an interface, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Specify the Ethernet interface.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8.

```
switch(config)# interface tengigabitethernet 1/1/2
```

3. Apply the changes made to the DSCP-to-CoS mutation map to enable DSCP trust on the interface. In this example, "test" is the map name.

```
switch(conf-if-te-1/1/2)# qos dscp-cos test
```

#### NOTE

To deactivate a map from an interface, enter **no qos dscp-cos** *name*.

4. Apply the changes made to the DSCP-to-Traffic-Class map to enable DSCP trust on the interface. In this example, "traffic\_test" is the map name.

```
switch(conf-if-te-1/1/2)# qos dscp-traffic-class traffic_test
```

5. Return to privileged EXEC mode.

```
switch(conf-if-te-1/1/2)# end
```

6. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

### Verifying a DSCP-to-CoS mutation map

To verify applied DSCP-to-CoS maps, you can use one or both of the following options from global configuration mode.

- Verify DSCP mapping for a specific map using the **do show qos maps dscp-cos** command and the map name.

```
switch(config)# do show qos maps dscp-cos test
```

- Verify all DSCP mapping by using the **do show qos maps** command with the **dscp-cos** operand only.

```
switch(config)# do show qos maps dscp-cos
```

- Verify DSCP-to-CoS mutation mapping for an interface by using the **show qos interface** command and specifying the interface:

```
switch(config)# do show qos interface te 1/1/2
```

## Configuring traffic class mapping for flexibility

Where additional flexibility in queue selection is required, refer to [Configuring traffic class mapping](#) on page 204.

## Configuring traffic class mapping

The Brocade switch supports eight unicast traffic classes to provide isolation and to control servicing for different priorities of application data. Traffic classes are numbered from 0 through 7, with higher values designating higher priorities.

### NOTE

For information on user priority mapping, refer to [User-priority mapping](#) on page 182.

The traffic class mapping stage provides some flexibility in queue selection:

- The mapping may be many-to-one, such as mapping one-byte user priority (256 values) to eight traffic classes.
- There may be a nonlinear ordering between the user priorities and traffic classes.

## Understanding unicast and multicast traffic defaults

The following table displays the Layer 2 default traffic **unicast** class mapping supported for a CoS-based user priority to conform to .

**TABLE 36** Default user priority for unicast traffic class mapping

User priority	Traffic class
0	1
1	0
2	2
3	3
4	4
5	5
6	6
7	7

You are allowed to override these default traffic class mappings per port. Once the traffic class mapping has been resolved, it is applied consistently across any queuing incurred on the ingress and the egress ports.

The Brocade switch supports eight multicast traffic classes for isolation and to control servicing for different priorities of application data. Traffic classes are numbered from 0 through 7, with higher values designating higher priorities. The traffic class mapping stage provides some flexibility in queue selection.

The following table displays the Layer 2 default traffic **multicast** class mapping supported for a CoS-based user priority to conform to 802.1Q default mapping.

**TABLE 37** Default user priority for multicast traffic class mapping

User Priority	Traffic class
0	1
1	0
2	2
3	3
4	4

**TABLE 37** Default user priority for multicast traffic class mapping (continued)

User Priority	Traffic class
5	5
6	6
7	7

Once the traffic class mapping has been resolved for inbound traffic, it is applied consistently across all queuing incurred on the ingress and egress ports.

You can configure an interface with either a CoS-to-traffic class-map or a DSCP-to-traffic class-map.

### Configuring CoS-to-traffic-class maps

Consider the topics discussed below when configuring the CoS-to-traffic-class mappings.

#### Applying CoS-to-Traffic-Class mapping to an interface

To activate a CoS-to-traffic-class mapping, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Specify the Ethernet interface.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8.

```
switch(config)# interface tengigabitethernet 12/2/2
```

3. Activate the CoS-to-Traffic-Class mapping. In this case, "test" is the map name.

```
switch(conf-if-te-12/2/2)# qos cos-traffic-class test
```

#### NOTE

To deactivate the mutation map from an interface, enter **no qos cos-traffic-class name**

4. Return to privileged EXEC mode.

```
switch(conf-if-te-12/2/2)# end
```

5. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

#### Verifying CoS-to-Traffic-Class mapping

To verify a CoS-to-Traffic-Class mapping, you can use one or both of the following options from global configuration mode.

- Verify CoS-Traffic-Class mapping for a specific map by using the **do show qos maps cos-traffic-class** command and specifying a map name.

```
switch(config)# do show qos map cos-traffic-class test
```

- Verify all COS-to-Traffic-Class mapping by using the **do show qos maps** command with the **cos-traffic-class** operand only.

```
switch(config)# do show qos maps cos-traffic-class
```

- Verify CoS-to-Traffic-Class mapping for an interface by using the **do show qos interface** command and specifying the interface:

```
switch(config)# do show qos interface te 12/2/2
```

## Configuring congestion control

Refer also to [Congestion control](#) on page 182.

### Changing the multicast tail-drop threshold

To change the tail drop threshold, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Change the tail drop threshold for each multicast traffic class. In this example, a threshold of 1000 packets is used.

```
switch(config)# qos rcv-queue multicast threshold 1000 1000 1000 1000 1000 1000 1000 1000
```

3. Return to privileged EXEC mode.

```
switch(config)# end
```

4. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

### Configuring Random Early Discard

Consider the topics discussed below when configuring Random Early Discard (RED) mappings.

#### Understanding RED profiles

Consider the following when configuring RED.

- Trunk ports cannot share RED profiles with any other ports because the bandwidth for a trunk port changes according to the number of active links in the trunk.
- When queue thresholds in a RED profile are configured by percentage, the switch maps this to a total number of bytes as buffers allocated to a port depend on the port speed.
- A total of 384 RED profiles are supported per chassis.

Consider the following when using RED profiles for link aggregation (LAG) interfaces:

- RED profiles can be enabled on LAG interfaces. However, the profile is configured on the individual member interfaces of the LAG.
- Because LAG members may belong to different port groups, one of the port groups may not have enough resources available to support a new RED configuration for the member interface. In this case, an error log will indicate that the RED application failed on the specific member interface. When a new member is added to the port-channel, the same error may occur if the

new member belongs to an port groups with all resources used. To apply the RED profile on the failed member interface, you must remove the RED configuration on other all interfaces in the port group so that resources are available and remove or add the member interface to the LAG.

## Configuring RED profiles

To configure an egress RED profile, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Configure a RED profile. For the profile ID, 10 is used in this case. The *min-threshold*, *max-threshold*, and *drop-probability* values are percentages.

```
switch(config)# qos red-profile 10 min-threshold 10 max-threshold 80 drop-probability 80
```

3. Return to privileged EXEC mode.

```
switch(config)# end
```

4. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Mapping a traffic-class to an RED profile on an interface

To map a traffic-class value for a port to the RED profile created under [Understanding RED profiles](#) on page 206, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Specify the Ethernet interface.

```
switch(config)# interface tengigabitethernet 1/2/2
```

3. Map the profile to use a traffic-class for a port. In the following example, CoS priority 3 is mapped to RED profile ID 10.

```
switch(conf-if-te-1/2/2)# qos random-detect traffic-class 3 red-profile-id 10
```

### NOTE

To deactivate the map from an interface, enter **no qos random-detect cos value**

4. Return to privileged EXEC mode.

```
switch(conf-if-te-1/2/2)# end
```

5. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Verifying RED profiles

Verify a configured RED profiles by using the **show qos red profiles** command.

```
switch# show qos red profiles
Red Profile 1
  Minimum Threshold: 10
  Maximum Threshold: 100
  Drop Probability: 100

  Activated on the following interfaces:
Te 1/1/11 traffic-class: 1

Red Profile 2
  Minimum Threshold: 10
  Maximum Threshold: 100
  Drop Probability: 100

  Activated on the following interfaces:
Te 1/1/11 traffic-class: 2

Red Profile 3
  Minimum Threshold: 10
  Maximum Threshold: 100
  Drop Probability: 100

  Activated on the following interfaces:
Te 1/1/11 traffic-class: 3
```

Examine the applied RED profiles for an interface by using the **show qos red statistics interface *interface-name*** command. This displays the RED profile, as well as all QoS configurations applied to the interface, such as DSCP trust, DSCP-to-DSCP map, CoS-Traffic Class map, and others.

```
switch# show qos red statistics interface te 1/2/2
interface TenGigabitEthernet 1/2/2
fabric isl enable
fabric trunk enable
qos random-detect traffic-class 1 red-profile-id 1
qos random-detect traffic-class 2 red-profile-id 2
qos random-detect traffic-class 3 red-profile-id 3
no shutdown
!
```

## Configuring FlowControl

This task configures FlowControl in addition to enabling the Ethernet pause frames. Brocade recommends that you also configure the flow control parameters on the connecting device, and not leave the options set to "auto".

Refer to [Ethernet Pause](#) on page 185.

## Enabling Ethernet Pause

To enable Ethernet Pause, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```



- Specify the Ethernet interface.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 8770-4 and Brocade VDX 8770-8.

```
switch(config)# interface tengigabitethernet 3/0/2
```

- Enable Ethernet Pause on the interface for both TX and RX traffic.

```
switch(config-if-te-3/0/2)# qos flowcontrol tx on rx on
```

#### NOTE

To deactivate Ethernet pause on an interface, enter **no qos flowcontrol**

- Return to privileged EXEC mode.

```
switch(config-if-te-3/0/2)# end
```

- Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

- Verify the Ethernet Pause with the **show qos flowcontrol** command.

```
switch# show qos flowcontrol interface all 3/0/2
```

## Configuring dynamic buffer sharing

If there is bursty, lossy traffic for certain flows in the system, you can borrow the buffers from less bursty flows, in order to reduce the traffic loss. The **qos** command is used to configure the egress or ingress queue limit, such as the maximum number of kilobytes of data that can be queued in the egress or ingress queue. The **tx-queue** keyword controls the egress, and the **rcv-queue** keyword controls the ingress.

This command only functions on the Brocade VDX 6740 and the Brocade VDX 6740-T. This configuration is applied on individual R Bridges.

To configure dynamic buffer sharing, perform the following steps from privileged EXEC mode.

- Enter global configuration mode.

```
switch# configure terminal
```

- Enter R Bridge ID configuration mode.

```
switch(config)# rbridge-id 154
```

- Configure the dynamic buffer sharing. The following example sets the egress limit to 512 kilobytes.

```
(config-rbridge-id-154)# qos tx-queue limit 512
```

The following example sets the ingress limit to 1024 kilobytes.

```
(config-rbridge-id-154)# qos rcv-queue limit 1024
```

- Return to privileged EXEC mode.

```
(config-rbridge-id-154)# end
```

5. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Configuring rate limiting

Refer also to [Multicast rate limiting](#) on page 186.

To create a receive queue multicast rate-limit, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Create a lower maximum multicast frame expansion rate. In this example, the rate is set to 10000 pps.

```
switch(config)# qos rcv-queue multicast rate-limit 10000
```

3. Return to privileged EXEC mode.

```
switch(config)# end
```

4. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Configuring BUM storm control

Refer also to [BUM storm control](#) on page 187.

To configure storm control on the 10-gigabit Ethernet interface 101/0/2, with the **broadcast** traffic type and **limit-rate** of 1000000 bps, perform the following steps:

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Specify the Ethernet interface for the traffic you want to control. In the following example, interface 101/0/2 is in *rbridge-id/slot/port* format:

```
switch(config)# interface tengigabitethernet 101/0/2
```

3. Issue the **storm-control ingress** command to set a traffic limit for broadcast traffic on the interface:

```
switch(conf-if-te-101/0/2)# storm-control ingress broadcast 1000000
```

- Verify the storm control verification with the **show storm-control** command.

```
switch(conf-if-te-101/0/2)# do show storm-control
Interface Type          rate (Mbps) conformed violated total
Te102/4/1 broadcast          100,000    12500000000 12500000000 25000000000
Te102/4/1 unknown-unicast 100,000    12500000000 12500000000 25000000000
Te102/4/1 multicast      100,000    12500000000 12500000000 25000000000
Te102/4/2 broadcast          100,000    12500000000 12500000000 25000000000
Te102/4/3 broadcast          100,000    12500000000 12500000000 25000000000
Te102/4/4 unknown-unicast 100,000    12500000000 12500000000 25000000000
```

#### NOTE

To deactivate storm control from an interface, enter **no storm-control ingress** followed by the mode (**broadcast**, **unknown-unicast**, or **multicast**) the limit (**limit-bps** or **limit-percent**), **rate**, and optionally either **monitor** or **shutdown**.

## Configuring scheduling

Refer also to [Scheduling](#) on page 187.

### Scheduling the QoS multicast queue

To schedule the QoS multicast queue, perform the following steps from privileged EXEC mode.

- Enter global configuration mode.

```
switch# configure terminal
```

- Specify the schedule to use and the traffic class to bandwidth mapping.

```
switch(config)# qos queue multicast scheduler dwrr 10 20 20 10 10 10 10 10
```

- Return to privileged EXEC mode.

```
switch(config)# end
```

- Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Configuring DCB QoS

Refer also to [Data Center Bridging QoS](#) on page 190.

### Creating a DCB map

To create a DCB map, perform the following steps from privileged EXEC mode.

- Enter global configuration mode.

```
switch# configure terminal
```

- Select the DCB map by using the **cee-map** command.

The only map name allowed is "default."

```
switch(config)# cee-map default
```

- Return to privileged EXEC mode.

```
switch(config)# exit
```

- Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

### Defining a DCB priority group table

To define a priority group table map, perform the following steps from privileged EXEC mode.

- Enter global configuration mode.

```
switch# configure terminal
```

- Specify the name of the DCB map to define by using the **cee-map** command.

#### NOTE

The only map name allowed is "default."

```
switch(config)# cee-map default
```

- Define the DCB map for PGID 0.

```
switch(config-cee-map-default)# priority-group-table 0 weight 50 pfc on
```

- Define the DCB map for PGID 1.

```
switch(config-cee-map-default)# priority-group-table 1 weight 50 pfc off
```

- Return to privileged EXEC mode.

```
switch(config-cee-map-default)# end
```

- Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

### Defining a DCB priority-table map

To define a priority-table map, perform the following steps from privileged EXEC mode.

- Enter global configuration mode.

```
switch# configure terminal
```

- Specify the name of the DCB map to define by using the **cee-map** command.

```
switch(config)# cee-map default
```

3. Define the map.

```
switch(config-cee-map
)# priority-table 1 1 1 0 1 1 1 15.0
```

#### NOTE

For information about priority-table definitions, refer to the **cee-map (configuration)** command in the *Network OS Command Reference*

4. Return to privileged EXEC mode.

```
switch(config-cee-map)# end
```

5. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Applying a DCB provisioning map to an interface

To apply a DCB provisioning map, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Specify the Ethernet interface. In this example, 101/0/2 is used.

```
switch(config)# interface tengigabitethernet 101/0/2
```

3. Apply the DCB map on the interface.

```
switch(conf-if-te-101/0/2)# cee default
```

#### NOTE

To deactivate the map on the interface, enter **no cee**.

4. Return to privileged EXEC mode.

```
switch(conf-if-te-101/0/2)# end
```

5. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Verifying the DCB maps

To verify the CoS DCB map, use the **show cee maps default** command from privileged EXEC mode.

```
switch# show cee maps default
```

## Configuring Brocade VCS Fabric QoS

Refer also to [Brocade VCS Fabric QoS](#) on page 191.

To configure the remapping priorities for the Brocade VCS Fabric, perform the following steps from global configuration mode.

1. Use the **cee-map** command to enter CEE map configuration mode.

```
switch(config)# cee-map default
```

2. Use the **remap lossless priority** command to set the lossless priority for Brocade VCS Fabric QoS.

The default lossless remap priority is set to 0 (zero).

```
switch(config-cee-map-default)# remap lossless-priority priority 2
```

3. Use the **remap fabric priority** command to set the fabric priority for Brocade VCS Fabric QoS.

The default FCoE remap fabric priority is set to 0 (zero).

```
switch(fabric-cee-map-default)# remap fabric-priority priority 2
```

4. Use the **exit** command to return to global configuration mode.

```
switch(config-cee-map)# exit
```

5. Specify the incoming Ethernet interface.

```
switch(config)# interface tengigabitethernet 22/0/1
```

6. Apply the CEE Provisioning map to the interface.

```
switch(conf-if-te-22/0/1)# cee default
```

## Flow-based QoS

Consider the topics discussed below when configuring the flow-based QoS functions.

### Configuring flow-based QoS

#### NOTE

Flow-based QoS functions only in the ingress direction.

To configure flow-based QoS functions, do the following while the switch is in global configuration mode:

1. Configure a class-map to classify traffic according to the traffic properties required for your flow-based QoS needs. Refer to [Configuring a class-map](#) on page 215.
2. Configure a policy-map to associate a policy-map with the class-map and also add the QoS action to be applied on the type of flow determined by the class-map. Refer to [Configuring flow-based QoS actions using policy-map](#) on page 215.
3. Bind the policy-map to a specific interface using the **service-policy** command, or bind the policy-map to an Rbridge ID. Refer to [Binding the policy-map to an interface](#) on page 220 and [Binding flow-based QoS at the system level](#) on page 220.

## Configuring flow-based QoS classifications using a class-map

Consider the topics discussed below when configuring the flow-based QoS classifications.

### Configuring a class-map

The classification map or *class-map* classifies traffic based on match criteria that you configure using the **class-map** command. If traffic matches the criteria, it belongs to the class. Currently, the only match criterion is "match access-group".

To configure a class-map, use the following steps:

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Create an access-list (either a MAC, IP, or VLAN-based ACL) to define the traffic. Refer to the Network OS Security Guide for details on creating access-lists.

```
switch(config)# mac access-list standard ACL1
switch(conf-macl-std)# permit host 0000.00aa.aa00
switch(conf-macl-std)# exit
```

3. Create a class-map by providing a class-map name. This enables class-map configuration mode.

```
switch(config)# class-map class1
```

The name for the class-map (in this case class1) can be a character string up to 64 characters.

#### NOTE

The "default" class-map and "cee" class-map name is reserved and intended to match everything. It is always created and cannot be removed.

4. Provide match criteria for the class.

```
switch(config-classmap)# match access-group ACL1
```

5. Exit the class-map configuration mode.

```
switch(config-classmap)# exit
```

6. Return to privileged EXEC mode.

```
switch(config)# end
```

7. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

#### NOTE

Enter the **no class-map name** command while in global configuration mode to remove the classification map.

### Configuring flow-based QoS actions using policy-map

Configure a rate-limit policy-map to associate a policy-map with the class-map and add a QoS action to be applied to the type of QoS flow defined by the class-map.

To configure a policy-map, add a classification map, and configure QoS policing parameters for the classification map, use the following steps:

1. Enter the global configuration mode.

```
switch# configure terminal
```

2. Configure a policy-map by providing a policy-map name. This enables policy-map configuration mode.

```
switch(config)# policy-map pmap1
```

3. Exit the policy-map configuration mode.

```
switch(config-policymap)# exit
```

4. Return to privileged EXEC mode.

```
switch(config)# end
```

5. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Configuring flow-based QoS actions using policy-map

Consider the topics discussed below when configuring the flow-based QoS actions.

### Configuring QoS policier action

Add color-based priority CoS mapping by configuring a police priority-map. A police priority-map remaps frame class of service CoS values (802.1p priority bits in VLAN tag) to conform or exceed color values when rates conform to or exceed limits set in a classification map.

The police priority-map re-marks CoS values according to color-based green (conform), yellow (exceed), and red (violate) priorities. Creating a police priority-map is optional. If you do not define priority mapping for a color, the map defaults to priorities of 0, 1, 2, 3, 4, 5, 6, and 7 (in other words, nothing is modified). You can configure a maximum of 32 priority-maps (one is reserved as the default), but only one map can be associated with a policer.

#### NOTE

You can set a priority-map when creating a policy-map by using appropriate policer attributes.

To configure a priority-map, use the following steps:

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Create a priority-map by providing a priority-map name. This enables police priority-map configuration mode.

```
switch(config)# police-priority-map pmap1
```

The name for the priority-map (in this case pmap1) can be a character string up to 64 characters.



3. Create color-based priority mapping. The following example sets the CoS for traffic that conforms to the CIR set in the policy-map.

```
switch(config-policemap)# conform 0 1 1 2 1 2 2 1 1
```

The following example sets the CoS for traffic that exceeds the CIR setting, but conforms to the EIR set in the policy-map.

```
switch(config-policemap)# exceed 3 3 3 3 4 5 6 7
```

4. Return to global configuration mode with the **exit** command.

```
switch(config-policemap)# exit
switch(config)#
```

5. Configure a policy-map by providing a policy-map name. This enables policy-map configuration mode.

```
switch(config)# policy-map pmap1
```

6. Configure a class-map in the policy-map by providing the class-map name. This enables policy class-map configuration mode. Note that the class-map name in the following example matches the name provided when you create the class-map by using the **class-map** command (refer to [Configuring a class-map](#) on page 215).

```
switch(config-policymap)# class class1
```

7. Set QoS and policing parameters for the class-map as shown in the following example. For information on all of the optional parameters for this command, refer to the *Network OS Command Reference*.

```
switch(config-policymap)# police cir 40000 cbs 5000 eir 40000 ebs 3000 set-priority pmap1 conform-
set-dscp 61 conform-set-tc 7 exceed- set-dscp 63 exceed-set-tc 3
```

The CIR parameter is mandatory for QoS policier. All other parameters are optional. Note that the parameter for set-priority (pmap1) includes the name for the created priority-map (refer to [Configuring QoS policier action](#)). For details on setting QoS and policing parameters, refer to [Policing parameters](#) on page 192.

8. Return to privileged EXEC mode with the **end** command.

```
switch (config-policymap)# end
```

9. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Configuring QoS mutation map actions

You can specify the mutation-map to be used on a port. This can lead to possible contradictions if there are other user-defined classes used in the same policy-map that have a set **cos action** configured. In this case-defined cos takes priority over the **mutation map**.

Perform the following task in global configuration mode.

1. Select the policy-map.

```
switch(config)# policy-map p1
```

2. Select the class.

```
switch(config-policymap)# class class-default
```

- Specify the mutation map to be used on the port. Different kinds of mutations can be used depending on the command. For complete information, refer to *Network OS Command Reference*. The available commands are:

- dscp-mutation
- dscp-cos
- dscp-traffic-class

```
switch(config-policyclass)# map cos-mutation plsmap
```

### Configuring QoS shaping action

You can specify the shaping rate per port attached to the policy-map. You can use this command to smooth out the traffic egressing an interface. This command is allowed only for the egress direction. This command is mutually exclusive of the **scheduler** and **police** commands.

Perform the following task in global configuration mode.

- Select the policy-map.

```
switch(config)# policy-map p1
```

- Select the class.

```
switch(config-policymap)# class class-default
```

- Specify the shaping rate for the port.

```
switch(config-policyclass)# shape 30000
```

### Configuring the QoS scheduling action

You can specify the scheduling attributes along with per TC shape rate. There are total of eight queues on an interface. The number of DWRR queues present depends on the SP\_COUNT value. For example, if the SP\_COUNT is 2, then there are two strict priority queues and six DWRR queues. This command is allowed only for the egress direction and is mutually exclusive of the **scheduler** and **police** commands.

Perform the following task in global configuration mode.

- Select the policy map.

```
switch(config)# policy-map p1
```

- Select the class.

```
switch(config-policymap)# class class-default
```

- Specify the scheduling attributes. For complete information, refer to the *Network OS Command Reference*.

```
switch(config-policyclass)# scheduler strict-priority 3 dwrr 10 10 10 10 60 TC5 35000 TC6 36000 TC7 37000
```

## Configuring the sFlow profile action

You can specify the sFlow profile attached to the policy map.

This feature only functions in the the ingress direction. It can be configured both in user-defined class-maps and in the universal class-map "default". If you use the class-map "default", port-based sFlow is enabled.

Refer to [Configuring an sFlow policy map and binding it to an interface](#) on page 247.

Perform the following task in global configuration mode.

1. Select the policy-map.

```
switch(config)# policy-map p1
```

2. Select the class.

```
switch(config-policymap)# class class1
```

3. Specify the sFlow map for the port.

```
switch(config-policyclass)# map sflow mysflowmap
```

## Configuring the CEE map action

The priority-mapping-table can support features provided by the Cisco Modular Quality of Service (MQC) provisioning mode to bring partial Converged Enhanced Ethernet (CEE) map content into an MQC class. MQC does not allow ingress and egress feature to be present in a same policy-map. By definition, they are two different entities and should be provisioned through two separate policy-maps. However, a CEE map provisions ingress and egress features in a single provisioning command. Because of this conflict, only the following features are inherited from a CEE map.

- Priority-Group Table.
- Priority-Mapping Table.
- Priority Flow Control Configuration.
- Lossless Priority Remapping.
- Fabric Priority Remapping.

### NOTE

In Brocade switches, the CEE map scheduler configuration is global. Unless an egress scheduling policy is applied on an interface, the default scheduler is present.

Perform the following task in global configuration mode.

1. Select the policy-map.

```
switch(config)# policy-map p1
```

2. Select the class.

```
switch(config-policymap)# class cee
```

3. Attach the policy-map to the CEE map.

```
switch(config-policyclass)# priority-mapping-table import cee default
```

## Configuring flow-based QoS targets

Consider the topics discussed below when configuring the flow-based QoS targets. You may apply one policy-map per interface for inbound traffic direction by using the `service-policy` command. Flow-based QoS functions only in the ingress direction.

### Binding the policy-map to an interface

Use the **service-policy** command to associate a policy-map to an interface to apply policing parameters.

1. Enable the global configuration mode.

```
switch# configure terminal
```

2. Specify the Ethernet interface, as in the following 10-gigabit Ethernet example

```
switch(config)# interface te 1/1/2
```

3. Bind a policy-map to ingress traffic on the interface. The following associates binds `polycmap1` to outbound traffic on the interface.

```
switch(config-if-te-1/1/2)# service-policy in polycmap1
```

You can unbind the policy-map by using the **no** keyword.

```
switch(config-if-te-1/1/2)# no service-policy in
```

4. Bind a policy-map to inbound traffic on the interface. The following associates binds `polycmap1` to inbound traffic on the interface.

```
switch(config-if-te-1/1/2)# service-policy in polycmap1
```

You can unbind the policy-map by using the **no** keyword.

```
switch(config-if-te-1/1/2)# no service-policy in
```

5. Return to privileged EXEC mode.

```
switch(conf-if-te-1/1/2)# end
```

6. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

### Policer binding rules

Consider the following rules when binding a policy-map to an interface:

- You can bind the same policy-map to multiple interfaces but only one policy per interface per direction is allowed.
- You cannot bind policy-maps to an interface if the policy-map has no class-map associations.

### Binding flow-based QoS at the system level

Use the **qos service-policy** command to bind an existing policy-map to a single Rbridge ID or all Rbridge IDs to apply policing parameters to the interfaces in a VCS fabric.

Refer to [Flow-based QoS](#) on page 214 for information on creating a service policy.

**NOTE**

The class-maps titled "default" and "cee" can not be bound at the system level.

1. Enable the global configuration mode.

```
switch# configure terminal
```

2. Bind the policy-map to inbound traffic.

```
switch(config)# qos service-policy in pmap1
```

3. Bind a policy-map to ingress traffic on the Rbridge ID. The Rbridge ID can be a single ID, a range of IDs, or you may use all to bind the policy-map to all Rbridge-IDs. The following associates binds policymap1 to inbound traffic on RBridge ID 14 through 18. Only one policy per interface per direction is allowed.

```
switch(config-service-policy)# attach rbridge-id add 14-18
```

4. Return to privileged EXEC mode.

```
switch(config-service-policy)# end
```

5. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Displaying flow-based QoS configuration and operational data

Consider the topics discussed below when displaying policing settings and policy-maps.

### Displaying policy-maps

In the following example, the **show policymap** command is used to display Policer policies and parameters set for the 10-gigabit Ethernet interface 4/1 inbound traffic.

```
switch(conf-if-te-5/1/33)# do show policy-map interface tengigabitethernet 5/1/33
Ingress Direction :
  Policy-Map pmap1
    Class default
      Police cir 43454
      Stats:
        Operational cir:39944 cbs:6518 eir:0 ebs:0
        Conform Byte:0 Exceed Byte:0 Violate Byte:0
Egress Direction :
  Policy-Map pmap1
    Class default
      Police cir 43454
      Stats:
        Operational cir:39944 cbs:6518 eir:0 ebs:0
        Conform Byte:0 Exceed Byte:0 Violate Byte:0
```

Entering **show policymap system rbridge-id** displays the policy-map information for the specified Rbridge ID.

```
switch(conf-if-te-2/0/11)# do show policy-map system rbridge-id 14

Ingress Direction :
  Policy-Map pmap1
    Class cmap1
      matches 0 packets
      Police cir 43454
      Stats:
        Operational cir:39944 cbs:6518 eir:0 ebs:0
        Conform Byte:0 Exceed Byte:0 Violate Byte:0
```

Entering **show policymap** without identifying an interface and specify inbound traffic displays policy-maps bound on all switch interfaces.

```
switch(conf-if-te-5/1/33)# do show policy-map
Number of policy maps : 1

Policy-Map pmap1
  Bound To: Te 5/1/33(in), Te 5/1/33(out)
           Rbridges:14,15,16,17,18

switch(conf-if-te-5/1/33)# do show policy-map detail pmap1
Policy-Map pmap1
  Class cmap1
    Police cir 43454

  Bound To: Te 5/1/33(in), Te 5/1/33(in)
           Rbridges:14,15,16,17,18
```

The following example displays the running configured policy-map by means of the **show running-config policy-map** command.

```
switch(conf-if-te-5/1/33)# do show running-config interface tengigabitethernet 5/1/33
interface TenGigabitEthernet 5/1/33
  service-policy in pmap1
  service-policy in pmap1
  fabric isl enable
  fabric trunk enable
  no shutdown
```

The following example displays the running configured service-policy by means of the **show running-config qos** command.

```
switch(conf-if-te-2/0/11)# do show running-config qos service-policy
qos service-policy in pmap1
  attach rbridge-id add 14-18
```

## Displaying class-maps

The following example displays the running configured class-map name and configured match attribute by means of the **show running-config class-map** command.

```
switch(config-classmap)# do show running-config class-map
class-map cee
!
class-map class_map1
  match access-group stdacl1
!
class-map default
```

## Auto QoS

Auto QoS automatically classifies traffic based on either a source or a destination IPv4 or IPv6 address. Once the traffic is identified, it is assigned to a separate priority queue. This allows a minimum bandwidth guarantee to be provided to the queue so that the identified traffic is less affected by network traffic congestion than other traffic.

### NOTE

As this command was created primarily to benefit Network Attached Storage devices, the commands used in the following sections use the term "NAS". However, there is no strict requirement that these nodes be actual NAS devices, as Auto QoS will prioritize the traffic for any set of specified IP addresses.

## Auto QoS for NAS

There are four steps to enabling and configuring Auto QoS for NAS:

1. Enable Auto QoS.
2. Set the Auto QoS CoS value.
3. Set the Auto QoS DSCP value.
4. Specify the NAS server IP addresses.

For detailed instructions, refer to [Enabling Auto QoS for NAS](#) on page 225.

## Auto QoS configuration guidelines

When configuring Auto QoS, the following configuration guidelines should be followed.

- Auto QoS is enabled and disabled globally.
- Auto QoS supports virtual fabrics.
- When Auto QoS is enabled, you can modify the CEE map subject to the following restrictions:
  - You can set the Auto QoS class of service (CoS) to any value other than “fabric” or “fcoe priority”.
  - Only one CoS can map to PGID 3.
  - PGID 2 and PGID 3 in the CEE map cannot be deleted.
  - The priority table cannot be deleted. (This sets CoS to be mapped to strict priority PGID.)
  - Strict-priorities cannot be assigned to CoS values, with the exception of strict-priority 15.0 being assigned to cos 7.
  - The Auto QoS CoS value (the PGID mapping) cannot be modified in the priority table.
- Avoid mixing L2 level multitenancy and L3 level multitenancy (VLAN and VRF), as this will cause Auto QoS statistics to not be displayed properly.
- The source and destination server IP addresses identifying NAS traffic are contained in the NAS server IP list. Refer to [Specifying NAS server IP addresses for Auto QoS](#) on page 226 and [Removing NAS server IP addresses for Auto QoS](#) on page 227 for instructions on adding and removing NAS server IP addresses.
- Enter more specific entries (those using fewer wild card values) first to have statistics display properly. For example, if you enter **nas server-ip 10.10.0.0/16** followed by **nas server-ip 10.10.10.0/24**, the number of matched packets will always be zero for the second entry.

## Auto QoS restrictions

- Auto QoS is supported only on Brocade VDX 8770-series platforms and VDX 6740-series platforms. While Auto QoS is not supported on the Brocade VDX 6710, VDX 6720, and VDX 6730 switches, these platforms can act as a pass-through entity for Auto QoS within VCS fabrics in either:
  - Logical chassis cluster mode without any extra configuration
  - Fabric cluster mode with the proper Converged Enhanced Ethernet (CEE) map configuration
- Auto QoS can only be activated when the CEE map is set to the default values.
- If long distance ISL is configured, you cannot enable Auto QoS.
- Different NAS traffic types are not distinguished, and all NAS traffic types are treated equally. This means all NAS traffic, whatever the type, share a common bandwidth guarantee. Individual traffic types do not get separate bandwidth guarantees.
- In order to provide a minimum bandwidth guarantee for NAS traffic across switches in the fabric, when Auto QoS is enabled for NAS, the CEE map reserves 20% of the available bandwidth for NAS traffic. After enabling Auto-nas, NAS bandwidth can be modified by modifying CEE-MAP.

- Port-level configuration has higher precedence than the NAS configuration. This means that any interface-specific configuration will override the global configuration.
- The *conform* and *exceed* traffic class values are not set for the NAS traffic class when Auto QoS for NAS is enabled.
- If all QoS Ternary Content-Addressable Memory (TCAM) space is used up already, enabling Auto QoS will not have any impact on NAS traffic.
- The ACL byte counter is not supported on Brocade VDX 6740 series platforms.
- PFC is always turned OFF for the NAS classified traffic and cannot be made lossless.
- Auto QoS traffic classification is always done in the ingress RBridge. Once the traffic is classified, all other nodes in the cluster automatically provision the default bandwidth guarantee of 20% through their CEE map.
- Automatic Migration of Port Profiles (AMPP) and Auto-NAS cannot be active on the same switch. This means that if the CEE map is part of AMPP port profile, Auto QoS cannot be enabled, and if Auto QoS is enabled and the CEE map is then associated to AMPP port profile, Auto QoS cannot be disabled. In order to disable Auto QoS, you must:
  1. Disassociate the CEE map from the port profile.
  2. Disable Auto QoS.
  3. Associate the CEE map with the AMPP port profile.

## Auto QoS and CEE maps

In order to provide minimum bandwidth guarantee for NAS traffic across switches in the fabric, the default CEE map has to be changed to accommodate NAS traffic. By default, the bandwidth division in the CEE map is 40% for FCoE traffic and 60% for LAN traffic. As NAS traffic has to co-exist with FCoE traffic, some of the LAN traffic bandwidth allocation is given over to NAS traffic. When Auto QoS is enabled, the default bandwidth allocations are 40% for FCoE traffic, 20% for NAS traffic and 40% for LAN traffic. The purpose of using a CEE map is to pass along the scheduler weights to ISLs in the fabric so that they will treat the NAS traffic accordingly.

When Auto QoS is enabled, the modified CEE map will be similar to the following:

```
switch# show cee maps

CEE Map 'default'
Precedence: 1
Remap Fabric-Priority to Priority 0
Remap Lossless-Priority to Priority 0
Priority Group Table
 1: Weight 40, PFC Enabled, BW% 40
 2: Weight 40, PFC Disabled, BW% 40
 3: Weight 20, PFC Disabled, BW% 20
15.0: PFC Disabled
15.1: PFC Disabled
15.2: PFC Disabled
15.3: PFC Disabled
15.4: PFC Disabled
15.5: PFC Disabled
15.6: PFC Disabled
15.7: PFC Disabled

Priority Table
CoS:      0    1    2    3    4    5    6    7
-----
PGID:    2    2    3    1    2    2    2    2    15.0
```

In the example above a PGID with an ID of "3" is defined with a bandwidth allocation of 20 which is then mapped to a user-configured CoS value. If the CoS value is not configured, the PGID value is mapped to the default QoS CoS value (2) in the priority table. This shows that when this CEE map is applied to an interface, the CoS will be allotted 20% of the overall bandwidth.



## Enabling Auto QoS for NAS

Auto QoS (Quality of Service) for NAS creates a minimum bandwidth guarantee for Network Attached Storage traffic. Auto QoS for NAS is disabled by default; you must enable Auto QoS to allow tagged NAS packets to have the correct service levels.

All steps must be performed in route-map configuration mode.

The **cee-map** priority group and priority-map settings must be their default values.

Enabling Auto QoS for NAS:

- Changes the CoS value of tagged NAS packets to 2
- Reduces the weight of PGID 2 from 60 to 40
- Creates a new PGID 3 with a weight of 20
- Modifies the priority table to include PGID 3 for the user-configured NAS CoS, or the default NAS CoS if the CoS has not been otherwise modified

Use the following procedure to enable Auto QoS for NAS traffic.

1. Enable Auto QoS for all NAS traffic by entering **nas auto-qos**.

```
switch(config)# nas auto-qos
```

2. Set the Class of Service for all NAS traffic by entering: **set cos cos\_value**.

The CoS value affects how Auto QoS operated by specifying the User-Priority field value and traffic-class value in the VLAN packet header. If you do not specify a CoS value, the NAS CoS value is set to the default of 2.

This example sets the CoS value to 3:

```
switch(config)# set cos 3
```

3. Set the DSCP value for all NAS traffic by entering **set dscp dscp\_value**.

The Differentiated Services Code Point (DSCP) value affects how Auto QoS operates by specifying the priority value for Network Attached Storage traffic on IP networks. If you do not specify a DSCP value, the DSCP value is set to the default of 0. Higher numbers provide a higher level of priority.

The following example sets the DSCP value to 56:

```
switch(config)# set dscp 56
```

4. Identify the IPv4 network addresses (either origination or destination) used by the NAS devices by entering **nas server-ip** followed by the IP address including the mask and then one of the following:

- **vlan** *vlan\_ID*
- **vrf** *vrf\_Name*

### NOTE

Associating both a VRF and a VLAN value to the same server IP address is strongly discouraged, as this will cause errors in reporting NAS statistics.

5. Press **Enter** after you add each address entry.

The following example adds two addresses, one using a VLAN mask, and the other a VRF mask.

```
switch(config)# nas server-ip 10.192.100.100/32 vlan 100
switch(config)# nas server-ip 10.192.100.101/32 vrf bruce
```

## Disabling Auto QoS for NAS

Disabling Auto QoS (Quality of Service) for NAS removes the minimum bandwidth guarantee for Network Attached Storage traffic.

Disabling Auto QoS for NAS:

- Disables Auto QoS functionality for NAS
- Restores the default bandwidth settings if you have not made any changes to the CEE map after enabling Auto QoS. If you have made changes, the portion of the bandwidth you assigned to NAS traffic will revert to the LAN bandwidth.
- Replaces PGID 3 with PGID 2 in the priority table
- Deletes PGID 3
- Increases the weight of PGID 2 by the weight of PGID 3, so that the weight of PGID 2 equals the weight of PGID 2 plus the weight of PGID 3

Use the following procedure to disable Auto QoS for NAS traffic and restore the default CoS and DSCP values.

1. Enter **no nas auto-qos** in configuration mode.

```
switch(config)# no nas auto-qos
```

2. Enter **no set cos** in route-map configuration mode to disable CoS for NAS and restore the default value.

```
switch(config)# no set cos
```

3. Enter **no set dscp** in route map configuration mode to disable DSCP for NAS and restore the default value.

```
switch(config)# no set dscp
```

## Displaying Auto-NAS configurations

Network OS allows you to display Network Attached Storage server configurations for all NAS servers.

Use the following command to display the Auto-NAS configuration for a switch.

Enter **show system internal nas**.

The following example shows a typical output of this command, showing that Auto-NAS is enabled on two IP address (one using VLAN, and one using VRF), that it has the values of CoS 2 and DSCP 0, and a Traffic Class of 5.

```
switch# show system internal nas
Auto-NAS Enabled
Cos 2
Dscp 0
Traffic Class 5
NAS server-ip 10.192.100.100/32 vlan 100
NAS server-ip 10.192.100.101/32 vrf broceliande
```

## Specifying NAS server IP addresses for Auto QoS

To enable Auto QoS for NAS, you must identify the IPv4 network addresses used by the NAS devices and tell the platform to tag all packets with this network address as NAS traffic so that they have the correct priority.

The **nas server-ip** command can accept a single IPv4 address (10.192.100.100/32), or an entire sub-net (10.192.100.0/24 vlan 100) as input. You can specify either a Virtual Routing and Forwarding (VRF) ID, or a VLAN ID. If no ID identifier is specified, the default VRF is assumed. When a subnet is specified, all the servers in the sub-net will have Auto QoS enabled for NAS. Subnet masks are not supported (for example: 10.192.100.0 255.255.255.0 is not a supported address).

**NOTE**

Only IPv4 addressing is supported for Auto QoS for NAS.

To add a NAS address to the NAS server IP list:

1. In configuration mode, enter **nas server-ip** followed by the IP address with mask and then one of the following:
  - **vlan** *vlan\_ID*
  - **vrf** *vrf\_Name*
2. Press **Enter** after you add each address entry.

The following example adds two addresses, one using a VLAN mask, and the other a VRF mask.

```
switch(config)# nas server-ip 10.192.100.100/32 vlan 100
switch(config)# nas server-ip 10.192.100.101/32 vrf broceliande
```

### Removing NAS server IP addresses for Auto QoS

Removing NAS server IP addresses sets the Auto QoS values for those addresses back to their defaults.

The **no nas server-ip** command can accept a single IPv4 address (10.192.100.100/32), or an entire sub-net (10.192.100.0/24 vlan 100) as input. When a subnet is specified, all the servers in the sub-net will have Auto QoS for NAS removed. Subnet masks are not supported (for example: 10.192.100.0 255.255.255.0 is not a supported address).

To remove an address from the NAS server IP list:

1. In config mode, enter **no nas server-ip** followed by the IPv4 address including the mask and then one of the following:
  - **vlan** *vlan\_ID*
  - **vrf** *vrf\_Name*
2. Press **Enter** after you add each individual address entry.

The following example removes two addresses, one using a VLAN mask, and the other a VRF mask.

```
switch(config)# no nas server-ip 10.192.100.100/32 vlan 100
switch(config)# no nas server-ip 10.192.100.101/32 vrf broceliande
```

### Displaying NAS server IP addresses

How to display the IP addresses for network-attached storage (NAS) servers.

You must be in config mode to run this command.

Use the following command to display all the configured NAS server IPv4 addresses. IPv6 addresses are not supported:

**show running-config nas server-ip.**

The following example shows the IP addresses of the active NAS servers.

```
switch(config)# show running-config nas server-ip
nas server-ip 10.192.100.100/32 vlan 100
nas server-ip 10.192.100.101/32 vrf broceliande
```

### Displaying NAS server statistics

Network OS allows you to display Network Attached Storage (NAS) server statistics for a single server or for all servers.

The **show nas statistics all** command displays the number of incoming IP packets which are NAS-classified for every RBridge in the cluster. It does not show any egressing NAS-classified packets.

Traffic matching the NAS Auto QoS server IP rule works in the same way as matching sequence entries in user-configured ACLs. If the first entry is hit, it will not proceed with any more entry checks.

The order of Auto QoS server IP addresses in the system is not necessarily (or always) same as the order of server IPs programmed in the hardware.

1. To display all NAS server statistics, enter **show nas statistics all**.

```
switch# show nas statistics all
RBridge 1
-----
nas server-ip 10.1.1.1/32 vrf default-vrf
matches 0 packets 0 bytes

RBridge 2
-----
nas server-ip 10.1.1.1/32 vrf default-vrf
matches 0 packets 0 bytes
```

2. To display NAS server statistics for a single server, enter: **show nas statistics server-ip** followed by the IPv4 address and the appropriate VLAN or VRF mask and RBridge ID.

This command can accept a single IPv4 address (10.192.100.100/32), or an entire sub-net (10.192.100.0/24 vlan 100) as input. When a subnet is specified, all the servers in the sub-net with Auto-NAS QoS will be shown. Subnet masks are not supported (for example: 10.192.100.0 255.255.255.0 is not a supported address). The first following example shows the statistics for all ports using RBridge ID 1; the second example shows the statistics for 10.1.1.0/24 vrf brad.

```
switch# show nas statistics all rbridge-id 1
RBridge 1
-----
nas server-ip 10.1.1.1/32 vrf default-vrf
matches 0 packets 0 bytes

switch# show nas statistics server-ip 10.1.1.0/24 vrf brad
nas server-ip 10.1.1.0/24 vrf brad
matches 2000000 packets 40000000 bytes
```

## Clearing NAS server statistics

You can use this command to clear the statistics for a single IPv4 address (10.192.100.100/32), or an entire sub-net (10.192.100.0/24 vlan 100). When a subnet is specified, the NAS statistics for all the servers in the sub-net will be cleared. Subnet masks are not supported (for example: 10.192.100.0 255.255.255.0 is not a supported address).

1. To clear NAS server statistics for a single server, enter: **show nas statistics server-ip** followed by the IPv4 address and the appropriate VLAN or VRF mask and RBridge ID.

The following example shows clearing the NAS statistics for "10.1.1.0/24 vrf brad" and then the effect of this clearing.

```
switch# clear nas statistics server-ip 10.1.1.0/24 vrf brad
switch# show nas statistics server-ip 10.1.1.0/24 vrf brad
nas server-ip 10.1.1.0/24 vrf brad
matches 0000000 packets 00000000 bytes
```

2. To clear all NAS server statistics, enter **clear nas statistics all**.

# Configuring IGMP

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## IGMP overview

Internet Group Management Protocol (IGMP) is a communications protocol that allows hosts and routers to establish group memberships, and is an integral part of IP multicast. This chapter does not address all aspects of IGMP, but rather focuses on the snooping mechanism, as described below. For additional commands that support basic IGMP configuration, refer to [Using additional IGMP commands](#) on page 234.

## IGMP snooping overview

The forwarding of multicast control packets and data through a Layer 2 switch configured with VLANs is most easily achieved by the Layer 2 forwarding of received multicast packets on all the member ports of the VLAN interfaces. However, this simple approach is not bandwidth efficient, because only a subset of member ports may be connected to devices interested in receiving those multicast packets. In a worst-case scenario, the data would get forwarded to all port members of a VLAN with a large number of member ports (for example, all 24 ports), even if only a single VLAN member is interested in receiving the data. Such scenarios can lead to loss of throughput for a switch that gets hit by a high rate of multicast data traffic.

Internet Group Management Protocol (IGMP) snooping is a mechanism by which a Layer 2 switch can effectively address this issue of inefficient multicast forwarding to VLAN port members. Snooping involves "learning" forwarding states for multicast data traffic on VLAN port members from the IGMP control (join/leave) packets received on them. The Layer 2 switch also provides for a way to configure forwarding states statically through the CLI.

## Multicast routing and IGMP snooping

Multicast routers use IGMP snooping to learn which groups have members on each of their attached physical networks. A multicast router keeps a list of multicast group memberships for each attached network, and a timer for each membership.

### NOTE

"Multicast group memberships" means that at least one member of a multicast group on a given attached network is available.

There are two ways that hosts join multicast routing groups:

- By sending an unsolicited IGMP join request.
- By sending an IGMP join request as a response to a general query from a multicast router.

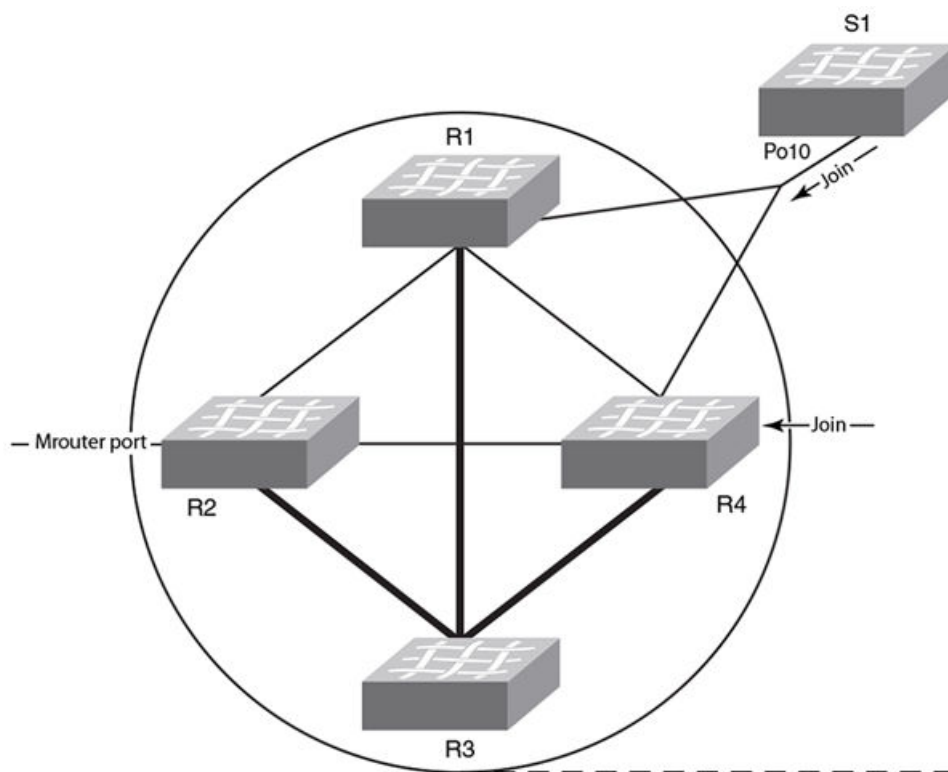
In response to the request, the switch creates an entry in its Layer 2 forwarding table for that VLAN. When other hosts send join requests for the same multicast, the switch adds them to the existing table entry. Only one entry is created per VLAN in the Layer 2 forwarding table for each multicast group.

## vLAG and LAG primary port with IGMP snooping

The current data center Ethernet (DCE) implementation of vLAGs and LAGs uses the concept of a so-called primary port. One of the member ports of the vLAG and LAG is selected to be the primary port, and all multicast traffic egressing from the LAG or vLAG is sent on the primary port. Thus, normal hash-based forwarding is not performed for multicast traffic, whether it is control traffic or data. Now, consider the case where RBridge R1 receives an IGMP join request for group G1 on Po10, shown in the figure below. This causes Po10 to be added to the list of IGMP receivers for group G1. Now, assume that the primary port of the vLAG is the link connecting R4 and S1. Therefore, any multicast traffic received by the cluster for group G1 egresses on vLAG Po10 from R4 and not from R1, even though the original join was received on R1.

If the primary port for the vLAG changes, such as if the link between R4 and S1 in the figure below went down, then multicast traffic would egress out of the new primary port on the vLAG. In the above case, the new primary port would be the link connecting R1 and S1.

FIGURE 23 IGMP snooping in Brocade VCS Fabric mode



## PIM multicast router presence detection

The PIM hello-based multicast router presence detection feature scans the network traffic for incoming PIM hellos. This is enabled by default.

When a PIM hello is detected, that port is marked for the presence of a multicast router and the information is saved. This prevents unnecessary flooding if the PIM designated router (DR) goes offline, as IGMP reports are forwarded to the multicast routers and not only the snooping-enabled router.

## IGMP snooping scalability

Here are the scalability limits of IGMP snooping feature in various modes of switch operation for Network OS 4.1.0. The table explains the various metrics involved in describing the scalability limits.

IGMP Metric	Description
Maximum number of IGMP groups supported	This metric is based on the available hardware resources, such as multicast group ID (MGID), configuration replay, and Ethernet Name Server (eNS) distribution bandwidth.
Maximum number of VLANs supported with IGMP snooping configuration	This metric is limited by the general-query packet-generation capacity of IGMP software processes running on the switch, as well as by eNS distribution bandwidth.
Maximum IGMP packet-processing rate per switch	The scalability number described by this metric suggests the upper limit on the number of packets that can be processed by IGMP software processes running on the switch. If the packets are incoming from multiple ports/VLANs, the same processing bandwidth is shared.
Maximum IGMP packet-processing rate per Brocade VCS Fabric cluster	This metric specifies the upper limit on the maximum rate of IGMP packets incoming to a logical Brocade VCS Fabric switch. It is limited by the eNS distribution bandwidth and the number of nodes in the Brocade VCS Fabric cluster.

## IGMP snooping in Brocade VCS Fabric cluster mode

When supporting a flat Layer 2 network in a data center, VDX switches can be connected in any order to form a cluster. The number of nodes involved in a cluster ranges from four nodes to 24 nodes. Metrics are detailed in the following tables.

**TABLE 38** IGMP snooping: four-node cluster metrics

Metric	Limit	Comments
Maximum number of IGMP groups supported	2000	Join requests are sent on four ports of the same switch.
Maximum number of VLANs supported with IGMP configuration	128	
Maximum IGMP packet-processing rate per switch	512 packets/sec	
Maximum IGMP packet-processing rate per Brocade VCS Fabric cluster	512 packets/sec	

**TABLE 39** IGMP snooping: 24-node cluster metrics

Metric	Limit	Comments
Maximum number of IGMP groups supported	2000	Join requests are sent on four ports of the same switch.
Maximum number of VLANs supported with IGMP configuration	128	
Maximum IGMP packet-processing rate per switch	512 packets/sec	
Maximum IGMP packet processing rate per Brocade VCS Fabric cluster	512 packets/sec	

**TABLE 40** IGMP snooping: Brocade VDX 8770-4 and VDX 8770-8 cluster metrics

Metric	Limit	Comments
Maximum number of IGMP groups supported	8000	Join requests are sent on four ports of the same switch.
Maximum number of VLANs supported with IGMP configuration	256	
Maximum IGMP packet processing rate per switch	512 packet/second	
Maximum IGMP packet processing rate per Brocade VCS Fabric cluster	512 packet/second	

**TABLE 41** IGMP snooping: IP multicast metrics

Metric	Limit	Comments
Number of Layer 3 forwarding entries	256	
Number of IGMP snooping forwarding entries	8000	
Number of multicast flows	10000	
PIM interfaces supported	32	
IGMP interfaces supported	32	
IGMP snooping interfaces supported	256	
Learning rate for PIM-SM	32 flows/second	
Learning rate for IGMP snooping	512 groups/second	

## Configuring IGMP snooping

By default, IGMP snooping is globally disabled on all VLAN interfaces. Refer to the *Network OS Command Reference* for complete information about the commands in this section.

### Enabling IGMP snooping

Use the following procedure to enable IGMP snooping on a Data Center Bridging (DCB)/Fibre Channel over Ethernet (FCoE) switch.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter the **ip igmp snooping enable** command to enable IGMP for all interfaces.

This command ensures that IGMP snooping is active on all interfaces.

```
switch(config)# ip igmp snooping enable
```

3. Enter the **interface** command to select the VLAN interface number.

```
switch(config)# interface vlan 10
```

4. Optional: Activate the default IGMP querier functionality for the VLAN.

```
switch(config-vlan-10)# ip igmp snooping querier enable
```

5. Optional: Activate the IGMP querier functionality with additional features.

#### NOTE

The IGMP snooping configuration must be the same for all switches in the same VCS Fabric cluster. For example, if you configure **ip igmp snooping enable** on VLAN 2 on a VDX switch, you must configure that same command on VLAN 2 on all VDX switches in the cluster.

### Configuring IGMP snooping querier

If your multicast traffic is not routed because Protocol-Independent Multicast (PIM) and IGMP are not configured, use the IGMP snooping querier in a VLAN.

IGMP snooping querier sends out IGMP queries to trigger IGMP responses from switches that are to receive IP multicast traffic. IGMP snooping listens for these responses to map the appropriate forwarding addresses.



**NOTE**

An IGMP snooping querier cannot be configured on the same interface as a multicast router (mrouter) interface.

Refer to the *Network OS Command Reference* for complete information about the commands in this section.

Use the following procedure to configure the IGMP snooping querier.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter the **interface** command to select the VLAN interface number.

```
switch(config)# interface vlan 25
```

3. Activate IGMP querier functionality for the VLAN.

The valid range is 1 to 18000 seconds. The default is 125 seconds.

```
switch(config-vlan-25)# ip igmp query-interval 125
```

4. Set the last member query interval.

The valid range is 1000 to 25500 milliseconds. The default is 1000 milliseconds.

```
switch(config-vlan-25)# ip igmp last-member-query-interval 1000
```

5. Set the Max Response Time (MRT).

The valid range is 1 to 25 seconds. The default is 10 seconds.

```
switch(config-vlan-25)# ip igmp query-max-response-time 10
```

6. Activate the IGMP querier functionality for the VLAN.

```
switch(config-vlan-25)# ip igmp snooping querier enable
```

## Monitoring IGMP snooping

Monitoring the performance of your IGMP traffic allows you to diagnose any potential issues on your switch. This helps you utilize bandwidth more efficiently by setting the switch to forward IP multicast traffic only to connected hosts that request multicast traffic.

Refer to the *Network OS Command Reference* for complete information about the commands in this section.

Use the following procedure to monitor IGMP snooping on a DCB/FCoE switch.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter the **show ip igmp groups** command to display all information on IGMP multicast groups for the switch.

Use this command to display the IGMP database, including configured entries for either all groups on all interfaces, all groups on specific interfaces, or specific groups on specific interfaces.

```
switch# show ip igmp groups
```

3. Use the **show ip igmp statistics** command to display the IGMP statistics for a VLAN or interface.

```
switch# show ip igmp snooping statistics interface vlan 10
```

- Use the **show ip igmp snooping mrouter** command to display mrouter port-related information for all VLANs, or a specific VLAN.

```
switch# show ip igmp snooping mrouter
```

or

```
switch# show ip igmp snooping mrouter interface vlan 10
```

- When you have reviewed the IGMP statistics for the switch, refer to [Configuring IGMP snooping](#) on page 232 or [Configuring IGMP snooping querier](#) on page 232 to make any needed corrections.

#### NOTE

Refer to the *Network OS Command Reference* for additional information on IGMP CLI commands.

## Using additional IGMP commands

The following commands provide additional support for basic IGMP functionality. For details, refer to the *Network OS Command Reference*.

Command	Description
<b>ip igmp immediate-leave</b>	Removes a group from the multicast database. Use this command to treat the interface as if it had one multicast client, so that a receipt of a Leave Group request on the interface causes the group to be immediately removed from the multicast database.
<b>ip igmp static-group</b>	Configures the static group membership entries for a specific interface.

# Configuring 802.1x Port Authentication

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## 802.1x protocol overview

The 802.1x protocol defines a port-based authentication algorithm involving network data communication between client-based supplicant software, an authentication database on a server, and the authenticator device. In this situation the authenticator device is the Brocade VDX hardware.

As the authenticator, the Brocade VDX hardware prevents unauthorized network access. Upon detection of the new supplicant, the Brocade VDX hardware enables the port and marks it "unauthorized." In this state, only 802.1x traffic is allowed. All other traffic (for example, DHCP and HTTP) is blocked. The Brocade VDX hardware transmits an Extensible Authentication Protocol (EAP) Request to the supplicant, which responds with the EAP Response packet. The Brocade VDX hardware then forwards the EAP Response packet to the RADIUS authentication server. If the credentials are validated by the RADIUS server database, the supplicant may access the protected network resources.

When the supplicant logs off, it sends an EAP Logoff message to the Brocade VDX hardware, which then sets the port back to the "unauthorized" state.

### NOTE

802.1x port authentication is not supported by LAG (Link Aggregation Group) or interfaces that participate in a LAG.

### NOTE

The EAP-MD5, EAP-TLS, EAP-TTLS and PEAP-v0 protocols are supported by the RADIUS server and are transparent to the authenticator switch.

## Configuring 802.1x authentication

The tasks in this section describe the common 802.1x operations that you will need to perform. For a complete description of all the available 802.1x CLI commands for the Brocade VDX hardware, refer to the *Network OS Command Reference*.

## Understanding 802.1x configuration guidelines and restrictions

When configuring 802.1x, be aware of this 802.1x configuration guideline and restriction: If you globally disable 802.1x, then all interface ports with 802.1x authentication enabled automatically switch to force-authorized port-control mode.

## Configuring authentication

The **radius-server** command attempts to connect to the first RADIUS server. If the RADIUS server is not reachable, the next RADIUS server is contacted. However, if the RADIUS server is contacted and the authentication fails, the authentication process does not check for the next server in the sequence.

Perform the following steps to configure authentication.

1. Enter the **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Use the **radius-server** command to add RADIUS to the switch as the authentication server. This command can be repeated for additional servers. However, this command moves the new RADIUS server to the top of the access list.

```
switch(config)# radius-server host 10.0.0.5
```

3. Enable 802.1x authentication globally

```
switch(config)# dot1x enable
```

4. Use the **interface** command to select the interface port to modify.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, Brocade VDX 8770-4, and Brocade VDX 8770-8. The prompt for these ports is in the following format: `switch(config-if-gi-22/0/1)#`.

```
switch(config)# interface tengigabitethernet 1/12
```

5. Use the **dot1x authentication** command to enable 802.1x authentication.

```
switch(conf-if-te-1/12)# dot1x authentication
```

6. Return to privileged EXEC mode.

```
switch(conf-if-te-1/12)# end
```

7. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Configuring interface-specific administrative features for 802.1x

It is essential to configure the 802.1x port authentication protocol globally on the Brocade VDX hardware, and then enable 802.1x and make customized changes for each interface port. Because 802.1x is enabled and configured in [Configuring 802.1x authentication](#) on page 235, use the administrative tasks in this section to make any necessary customizations to specific interface port settings.

### Enabling an 802.1x readiness check

The 802.1x readiness check monitors 802.1x activity on all the switch ports and displays information about the devices connected to the ports that support 802.1x. You can use this feature to determine if the devices connected to the switch ports are 802.1x-capable.

The 802.1x readiness check is allowed on all ports that can be configured for 802.1x. The readiness check is not available on a port that is configured by the **dot1x force-unauthorized** command.

When you configure the **dot1x test eapol-capable** command on an 802.1x-enabled port, and the link comes up, the port queries the connected client about its 802.1x capability. When the client responds with a notification packet, it is 802.1x-capable. A RASLog message is generated if the client responds within the timeout period. If the client does not respond to the query, the client is not 802.1x-capable, and a syslog message is generated saying the client is not EAPOL-capable.

Follow these guidelines to enable the readiness check on the switch:

- The readiness check is typically used before 802.1x is enabled on the switch.
- 802.1x authentication cannot be initiated while the 802.1x readiness test is in progress.

- The 802.1x readiness test cannot be initiated while 802.1x authentication is active.
- 802.1x readiness can be checked on a per-interface basis. Readiness check for all interfaces at once is not supported.
- The 802.1x test timeout is shown in **show dot1x** command.
- The **gigabitethernet** *rbridge-id/slot/port* is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following format: switch(config-if-gi-22/0/1)#.

This example shows how to enable a readiness check on a switch to query a port. It also shows the response received from the queried port verifying that the device connected to it is 802.1x-capable:

```
switch# dot1x test eapol-capable interface gigabitethernet 0/13
DOT1X_PORT_EAPOL_CAPABLE:DOT1X: MAC 00-01-02-4b-f1-a3 on gigabitethernet0/13 is EAPOL capable.
```

### Configuring 802.1x port authentication on specific interface ports

To configure 802.1x port authentication on a specific interface port, perform the following steps from privileged EXEC mode. Repeat this task for each interface port you wish to modify.

1. Enter the **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Use the **interface** command to select the interface port to modify.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following format: switch(config-if-gi-22/0/1)#.

```
switch(config)# interface tengigabitethernet 1/12
```

3. Use the **dot1x authentication** command to enable 802.1x authentication.

```
switch(config-if-te-1/12)# dot1x authentication
```

4. Return to privileged EXEC mode.

```
switch(config-if-te-1/12)# end
```

5. Save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

### Configuring 802.1x timeouts on specific interface ports

#### NOTE

While you are free to modify the timeout values, Brocade recommends that you leave all timeouts set to their defaults.

To configure 802.1x timeout attributes on a specific interface port, perform the following steps from privileged EXEC mode. Repeat this task for each interface port you wish to modify.

1. Enter the **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Use the **interface** command to select the interface port to modify.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following format: switch(config-if-gi-22/0/1)#.

```
switch(config)# interface tengigabitethernet 1/12
```

3. Configure the **dot1x timeout** interval.

```
switch(conf-if-te-1/12)# dot1x timeout supp-timeout 40
```

4. Return to privileged EXEC mode.

```
switch(conf-if-te-1/12)# end
```

5. Save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

### Configuring 802.1x port reauthentication on specific interface ports

To configure 802.1x port reauthentication on a specific interface port, perform the following steps from privileged EXEC mode. Repeat this task for each interface port you want to modify.

1. Enter the **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Use the **interface** command to select the interface port to modify.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following format: switch(config-if-gi-22/0/1)#.

```
switch(config)# interface tengigabitethernet 1/12
```

3. Use the **dot1x authentication** command to enable 802.1x authentication for the interface port.

```
switch(conf-if-te-1/12)# dot1x authentication
```

4. Configure reauthentication for the interface port.

```
switch(conf-if-te-1/12)# dot1x reauthentication
switch(conf-if-te-1/12)# dot1x timeout re-authperiod 4000
```

5. Return to privileged EXEC mode.

```
switch(conf-if-te-1/12)# end
```

6. Save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Configuring 802.1x port-control on specific interface ports

To configure 802.1x port-control on a specific interface port, perform the following steps from privileged EXEC mode. Repeat this task for each interface port you want to modify.

1. Use the **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Use the **interface** command to select the interface port to modify.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following format: switch(config-if-gi-22/0/1)#.

```
switch(config)# interface tengigabitethernet 1/12
```

3. Use the **dot1x authentication** command to enable 802.1x authentication for the interface port.

```
switch(config-if-te-1/12)# dot1x authentication
```

4. Change the port authentication mode to **auto**, **force-authorized** or **force-unauthorized**.

```
switch(config-if-te-1/12)# dot1x port-control overlay gateway
```

5. Return to privileged EXEC mode.

```
switch(config-if-te-1/12)# end
```

6. Save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

## Reauthenticating specific interface ports

To reauthenticate a supplicant connected to a specific interface port, perform the following steps from privileged EXEC mode. Repeat this task for each interface port you wish to reauthenticate.

1. Use the **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Use the **interface** command to select the interface port to modify.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following format: switch(config-if-gi-22/0/1)#.

```
switch(config)# interface tengigabitethernet 1/12
```

3. Use the **dot1x reauthenticate** command to re-authenticate a port where dot1x is already enabled.

```
switch(config-if-te-1/12)# dot1x reauthenticate
```

4. Return to privileged EXEC mode.

```
switch(config-if-te-1/12)# end
```

5. Save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

### Disabling 802.1x on specific interface ports

To disable 802.1x authentication on a specific interface port, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Use the **interface** command to select the interface port to modify.

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following format: switch(config-if-gi-22/0/1)#.

```
switch(config)# interface tengigabitethernet 1/12
```

3. Use the **no dot1x port-control** command to disable 802.1x authentication.

```
switch(conf-if-te-1/12)# no dot1x port-control
```

4. Return to privileged EXEC mode.

```
switch(conf-if-te-1/12)# end
```

5. Save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

### Disabling 802.1x globally

To disable 802.1x authentication globally, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Use the **no dot1x enable** command to disable 802.1x authentication.

```
switch(config)# no dot1x enable
```

3. Return to privileged EXEC mode.

```
switch(config)# end
```

4. Save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

### Checking 802.1x configurations

To check 802.1x configurations, perform the following steps from privileged EXEC mode.

1. To view all dot1x configuration information, use the **show dot1x** command with the **all** keyword.

```
switch# show dot1x all
```



2. To check 802.1x configurations for specific interface ports, use the **interface** command to select the interface port to modify. The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following format: switch(config-if-gi-22/0/1)#.

```
switch(config)# interface tengigabitethernet 1/12
```

3. To check 802.1x authentication statistics on specific interface ports, use the **show dot1x** command with the **statistics interface** keyword.

```
switch# show dot1x statistics interface tengigabitethernet 1/12
```

4. To check all diagnostics information of the authenticator associated with a specific interface port, use the **show dot1x** command with the **diagnostics interface** keyword.

```
switch# show dot1x diagnostics interface tengigabitethernet 1/12
```

5. To check all statistical information of the established session, use the **show dot1x** command with the **session-info interface** keyword.

```
switch# show dot1x session-info interface tengigabitethernet 1/12
```



# Configuring sFlow

---

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## sFlow protocol overview

The sFlow protocol is an industry-standard technology for monitoring high-speed switched networks. The sFlow standard consists of an sFlow agent that resides anywhere within the path of the packet and an sFlow collector that resides on a central server. This release is compliant with sFlow Version 5.

The sFlow agent combines the flow samples and interface counters into sFlow datagrams and forwards them to the sFlow Collector at regular intervals. The datagrams consist of information on, but not limited to, packet header, ingress and egress interfaces, sampling parameters, and interface counters. Packet sampling is typically performed by the ASIC. The sFlow collector analyzes the sFlow datagrams received from different devices and produces a network-wide view of traffic flows. You can configure up to five collectors, using both IPv4 and IPv6 addresses.

The sFlow datagram provides information about the sFlow version, its originating agent's IP address, a sequence number, one sample, and protocol information.

The sFlow agent uses two forms of operation:

- Time-based sampling of interface counters
- Statistical sampling of switched packets

Be aware of the following limitations:

- If both port-based sampling and flow-based sampling are enabled on an interface, samples are based on port rate only.
- Port-based and flow-based sFlow are not supported on port channels, FCoE ports, or ISL ports.

## Interface flow samples

A flow sample is based on random packets being forwarded to the sFlow collector at defined numeric intervals, either for the entire Brocade switch or for a single port interface. For example, every 4,096th packet is forwarded to the sFlow collector for analysis and storage.

The sampling rate is adaptive, and the sFlow agent is free to schedule the sampling to maximize internal efficiency.

### NOTE

This type of random sampling provides estimated flow rates, but not perfect accuracy.

## Packet counter samples

A polling interval defines how often the sFlow octet and packet counter for a specific interface are sent to the sFlow collector, but the sFlow agent is free to schedule the polling in order to maximize internal efficiency.

## Hardware support matrix for sFlow

The following table identifies Brocade VDX 8770 and VDX 67xx device support for specific sFlow features.

**TABLE 42** sFlow feature support

Feature	Brocade VDX 8770	Brocade VDX 67xx
sFlow global configurations for enabling sFlow, polling interval, collector, and sample rate	All are supported	All are supported
sFlow data source interface	Supports 1-Gbps, 10-Gbps, and 40-Gbps interfaces	Supports 10-Gbps interfaces only
sFlow data source: Front port trunks and VLANs	Not supported	Not supported
sFlow scanning for inbound, outbound, or both directions on a port	Supports inbound only	Supports inbound only
sFlow counter polling support on per-port, per-VLAN, or per-trunk basis	Supports only per-port counter polling	Supports only per-port counter polling
All standard <b>if_counters</b> and <b>Ethernet</b> counters	Supported	Supported
Multiple collector configuration	A maximum of five collectors can be configured.	A maximum of five collectors can be configured.
Extended Gateway, Extended router, and NAT/MPLS/URL header formats	Not supported	Not supported
Subagent-ID	Filled with slot number of the interface	Filled with a zero (0)
Agent IP address	Preference 1: Chassis IP Preference 2: Management CP IP	Management IP
Maximum packets per second	272 pkts/sec/ASIC VDX 8770-4: 6528 pkts/sec VDX 8770-8: 13056 pkts/sec	96 pkts/sec/ASIC
Sample rate calculation	Dropped packets (such as errors and ACL dropped packets) are not counted for the calculations used for sample generation	Dropped packets (such as errors and ACL dropped packets) are counted for the calculations used for sample generation
Maximum sFlow raw packet header size	228 bytes The hardware truncates the packet.	128 bytes The software truncates the packet.

## Flow-based sFlow

Flow-based sFlow is used to analyze a specific type of traffic (flow based on access control lists, or ACLs). This involves configuring an sFlow policy map and binding it to an interface.

### Flow-based sFlow considerations and limitations

The following considerations and limitations for flow-based sFlow should be kept in mind:

- A maximum of 16 profiles is allowed on Brocade VDX 8770 series platforms and 8 on a Brocade VDX 6740 series platforms.
- The purpose of flow-based sFlow is not to drop or trap packets on the basis of ACLs, but rather just to match traffic. Packets are still sampled and allowed, and sFlow samples are generated for any rule.
- Port-based sFlow takes precedence over flow-based sFlow. Both cannot operate simultaneously.
- On Brocade VDX 8770 series platforms, if a packet is classified as a Layer 3 IPv4 packet, with a match on destination address and IP type, and even if a packet's destination or source address matches a Layer 2 ACL, flow-based sFlow samples are not generated. This is not the case with Brocade VDX 6740 series platforms.

- Because all samples of different rates are sent to the collector from a single port, only the lowest sampling rate is used.

On Brocade VDX 6740 series platforms, if the traffic is Layer 2 then samples with a MAC ACL sample rate are collected. If the traffic is Layer 3, then samples with a Layer 3 ACL sample rate are collected.

## Configuring the sFlow protocol

Consider the following topics when configuring the sFlow protocol.

### Configuring the sFlow protocol globally

Brocade recommends that you globally configure sFlow on the Brocade switch first, and then enable sFlow on specific interface ports and make custom alterations, because sFlow parameters at the interface level can differ from those at the global level. For details, refer to [Configuring sFlow for interfaces](#) on page 246.

Enabling sFlow globally does not enable it on all interface ports. sFlow must be explicitly enabled on all the required interface ports. Refer to [Enabling and customizing sFlow on specific interfaces](#) on page 246.

For complete information on the sFlow CLI commands for the Brocade switch, refer to the *Network OS Command Reference*.

To configure sFlow globally, perform the following steps in global configuration mode.

1. Enter the **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Globally enable the sFlow protocol.

```
switch(config)# sflow enable
```

3. Designate the IP address (up to five addresses) for the sFlow collector server. Optionally, you can designate the port number.

#### NOTE

Both IPv4 and IPv6 addresses are supported. However, each address must be entered individually by means of a separate **sflow collector** command.

```
switch(config)# sflow collector 10.10.138.176 6343
switch(config)# sflow collector fd00::1900:4545:3:200:f8ff:fe21:67cf port 6343
switch(config)# sflow collector fd00::200:f8ff:fe21:67cf
```

4. Set the sFlow polling interval (in seconds).

```
switch(config)# sflow polling-interval 35
```

5. Set the sFlow sample-rate.

```
switch(config)# sflow sample-rate 4096
```

6. Return to privileged EXEC mode.

```
switch(config)# end
```

- Confirm the sFlow configuration status by using the **show sflow** or **show sflow all** commands.

```
switch# show sflow
sFlow services are:                enabled
Global default sampling rate:      32768 pkts
Global default counter polling interval: 20 secs
Collector server address           Number of samples sent
-----
fd00::1900:4545:3:200:f8ff:fe21:67cf 0
fd00::200:f8ff:fe21:67cf             0
10.10.138.176                        0

switch# show sflow all
sFlow services are:                enabled
Global default sampling rate:      32768 pkts
Global default counter polling interval: 20 secs
Collector server address           Number of samples sent
-----
fd00::1900:4545:3:200:f8ff:fe21:67cf:6343 0
fd00:fd00::200:f8ff:fe21:67cf:          0
10.10.138.176: 6343                    0
```

- Clear any existing sFlow statistics to ensure accurate readings.

```
switch# clear sflow statistics
```

## Configuring sFlow for interfaces

After the global sFlow configuration, sFlow must be explicitly enabled on all the required interface ports.

### NOTE

When sFlow is enabled on an interface port, it inherits the sampling rate and polling interval from the global sFlow configuration.

### Enabling and customizing sFlow on specific interfaces

Perform the following steps in privileged EXEC mode to enable and customize sFlow on an interface. This task assumes that sFlow has already been enabled at the global level; refer to [Configuring the sFlow protocol globally](#) on page 245.

- Enter the **interface** command to specify the DCB interface type, the RBridge ID, and the slot/port number.

### NOTE

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following example format: `switch(config-if-gi-22/0/1)#`.

```
switch(config)# interface tengigabitethernet 0/16
```

- Configure the sFlow polling interval.

```
switch(conf-if-te-0/16)# sflow polling interval 35
```

- Use the **sflow enable** command to enable sFlow on the interface.

```
switch(conf-if-te-0/16)# sflow enable
```

- Set the sFlow sample-rate.

```
switch(conf-if-te-0/16)# sflow sample-rate 8192
```

5. Confirm the sFlow configuration status on the specified interface.

```
switch# show sflow interface tengigabitethernet 22/0/16

sFlow info for interface TenGigabitEthernet 22/0/16
-----
Configured sampling rate:      100 pkts
Actual sampling rate:         100 pkts
Counter polling interval:     100 secs
Samples received from hardware: 32
Port backoff-threshold :     272
Counter samples collected :   147
```

## Configuring an sFlow policy map and binding it to an interface

Perform the following steps to configure an sFlow policy map and bind it to an interface.

1. Enter the **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Create a standard MAC access control list (ACL).

```
switch# mac access-list standard acl1
switch(conf-macl-std)# permit any
```

3. Create a class map and attach the ACL to the class map.

```
switch(conf-macl-std)# class-map class1
switch(config-classmap)# match access-group acl1
```

4. Create a policy map and attach the class map to the policy map.

```
switch(config-classmap)# policy-map policy1
switch(config-policymap)# class class1
```

5. Add an sFlow profile name by using the **map** command.

This example assigns the profile name "policy1."

```
switch(config-policymap-class)# map sflow policy1
```

6. Bind the policy map to an interface.

```
switch(conf-if-te-1/8/1)# service-policy in policy1
```

## Disabling sFlow on specific interfaces

### NOTE

Disabling sFlow on the interface port does not completely shut down the network communication on the interface port.

To disable sFlow on a specific interface, perform the following steps in interface configuration mode.

1. Disable the sFlow interface.

```
switch(conf-if)# no sflow enable
```

2. Return to privileged EXEC mode.

```
switch(conf-if)# end
```

3. Confirm the sFlow configuration status on the specific interface.

**NOTE**

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following example format: switch(config-if-gi-22/0/1)#.

```
switch# show sflow interface tengigabitethernet 0/12
```

## Enabling flow-based sFlow

Refer also to [Flow-based sFlow](#) on page 244.

Perform the following steps, beginning in global configuration mode.

**NOTE**

The "deny ACL" rule is not supported for flow-based sflow. Only the permit action is supported.

1. Create an sFlow profile. Be sure to specify the sampling-rate as a power of 2.

```
switch(config)# sflow-profile profile1 sampling-rate 256
```

2. Create a standard MAC ACL.

```
switch# mac access-list standard acl1
switch(conf-macl-std)# permit any
```

3. Create a class map and attach the ACL to the class map.

```
switch(conf-macl-std)# class-map class1
switch(config-classmap)# match access-group acl1
```

4. Create a policy map and attach the class map to the policy map.

```
switch(config-classmap)# policy-map policy1
switch(config-policymap)# class class1
```

5. Use the **map** command to add an sFlow profile name.

This example assigns the profile name "profile1."

```
switch(config-policymap-class)# map sflow profile1
```

6. Switch to interface configuration mode.

```
switch(config-policymap-class)# exit
switch(config)# interface ten 1/8/1
switch(conf-if-te-1/8/1)#
```

7. Bind the policy map to an interface.

```
switch(conf-if-te-1/8/1)# service-policy in policy1
```

## Disabling flow-based sFlow on specific interfaces

To disable sFlow on a specific interface, perform the following steps in interface configuration mode.



**NOTE**

Disabling sFlow on an interface port does not completely shut down the network communication on the interface port.

1. Disable the sFlow interface.

```
switch(conf-if)# no sflow enable
```

2. Return to privileged EXEC mode.

```
switch(conf-if)# end
```

3. Switch to interface configuration mode.

```
switch(config-policymap-class)# exit
switch(config)# interface ten 1/8/1
switch(conf-if-te-1/8/1)#
```

4. Disable flow-based sFlow by removing the policy map.

```
switch(conf-if-te-1/8/1)# no service-policy in
```

5. Confirm the sFlow configuration status on the specific interface.

**NOTE**

The **gigabitethernet** *rbridge-id/slot/port* operand is used only for the Brocade VDX 6710, VDX 8770-4, and VDX 8770-8. The prompt for these ports is in the following example format: switch(config-if-gi-22/0/1)#.

```
switch# show sflow interface tengigabitethernet 0/12
```

## Configuring sFlow for VXLAN overlay gateway tunnels

Once an sFlow profile is created, you can apply it to a tunnel endpoint or all endpoints in VXLAN overlay-gateway configuration mode.

1. In global configuration mode, create an sFlow profile and set a sampling rate.

```
switch(config)# sflow-profile profile1 sampling-rate 256
```

**NOTE**

Sampling rates must be a power of 2. The default sampling rate is 32768 packets.

2. In global configuration mode, configure a VXLAN overlay gateway.

```
switch(config)# overlay-gateway gateway1
switch(config-overlay-gw-gateway1)#
```

3. In VXLAN overlay-gateway configuration mode, use the **sflow remote-endpoint** command with the profile name to specify the IPv4 address of a tunnel endpoint and add a VLAN.

```
switch(config-overlay-gw-gateway1)# sflow profile1 remote-endpoint 10.10.20.31 add vlan 2000
```

4. Alternatively, you can specify all tunnel endpoints and a range of VLANs.

```
switch(config-overlay-gw-gateway1)# sflow profile1 remote-endpoint any add vlan 2000-3000
```

5. Use the **remove** keyword to remove VLANs.

```
switch(config-overlay-gw-gateway1)# sflow profile1 remote-endpoint any remove vlan 2000-2500
```

6. Use the **show sflow all** command to confirm the configuration

```
switch# show sflow all

sFlow services are:                enabled
Global default sampling rate:      32768 pkts
Global default counter polling interval: 20 secs
Rbridge-Id          Collector server address      Number of samples sent
-----

sflow info for Tunnel
-----
ifindex: 1950351360
sFlow services are:                enabled
Samples received from hardware:    0
Effective sample-rate:             256
```

# Configuring Switched Port Analyzer

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## Switched Port Analyzer protocol overview

The Switched Port Analyzer (SPAN) is used on a network switch to send a copy of network packets seen on one switch port to a network monitoring connection on another switch port. If you are interested in listening to or snooping on traffic that passes through a particular port, SPAN artificially copies the packets to a port connected to your analyzer. Usually, this traffic is limited to incoming or outgoing packets, but Network OS 4.0.0 and later allows bidirectional traffic monitoring on the source port.

### SPAN in logical chassis cluster

SPAN in logical chassis cluster supports mirroring of a source port to a destination port lying on a different switch in the cluster. SPAN in logical chassis cluster is configured in the same manner, with the exception of the **source** command.

### RSPAN

Remote SPAN, or RSPAN, extends SPAN by enabling remote monitoring of multiple switches across your network. The traffic for each RSPAN session is carried over a user-specified RSPAN VLAN that is dedicated for that RSPAN session in all participating switches. The SPAN traffic from the sources is copied onto the RSPAN VLAN and then forwarded over trunk ports that are carrying the RSPAN VLAN to any RSPAN destination sessions monitoring the RSPAN VLAN.

#### NOTE

RSPAN is supported only on Brocade VDX 8770 and VDX 6740 platforms.

RSPAN consists of an RSPAN source interface and an RSPAN VLAN. The configured source port is mirrored to the RSPAN VLAN and the ports that are members of this VLAN receive the mirrored traffic.

All participating switches must be trunk-connected at Layer 2, and the remote VLAN must be configured on all the switches participating in the RSPAN session.

## SPAN guidelines and limitations

Consider the following topics when configuring SPAN.

### *Standard SPAN guidelines and limitations*

Brocade recommends that you be aware of the following standard guidelines for and limitations of SPAN connections:

- If there is congestion at the ingress span queue resulting from bandwidth-related back pressure at the ISL, the SPAN mirrored packets will be dropped and traffic will be lost.
- FCoE mirroring is not supported.

- For the traffic flowing across the switch, if the source port is in unknown mode (the node is in Layer 2 or Layer 3), then the untagged packets are dropped.
- The mirror port should not be configured to carry normal traffic.
- A port cannot be mirrored to multiple locations in the same direction.
- A port cannot be made a destination port for bidirectional mirroring if a different port supported by that ASIC is already configured as destination port for any type of mirroring.
- If a port is configured as a destination port for bidirectional mirroring, no other port supported by that ASIC can be made a destination port for any type of mirroring.
- The destination mirror port can handle from 1 to 40 Gbps (line rate) worth of mirror traffic, depending on the capability of the destination port. If multiple ports, or both flows on the same port, are mirrored to the same destination mirror port, then only the destination port's capacity worth of mirror traffic is mirrored and the remaining traffic is ignored.
- If the source port receives burst traffic and the destination mirror port cannot handle all the bursts, some of the burst traffic is not mirrored.
- Mirroring of Inter-Switch Link (ISL) ports is supported, but the destination port should reside on the same RBridge.
- Mirroring of LAG or port-channel interfaces is not supported, but LAG members can be mirrored.
- TRILL ports cannot be designated as a destination port.
- TRILL ports can be a source port, but mirroring is restricted to the port local to the source node ports.
- Ethernet Pause frames are not mirrored.
- Mirroring of trunk port is not supported, although the ASIC supports the mirroring of a trunk. To mirror a trunk, you must individually enable mirroring on all member ports.
- The multicast and broadcast statistics are correctly updated on TX ports for mirrored traffic.
- All commands except for **shutdown** and **no shutdown** are blocked on a destination mirror port.
- The interface counters are cleared when a port is successfully designated as a destination mirror port.
- The **show interface** command hides the Receive Statistics and Rate Info (Input) information for a destination mirror port.
- The MTU of a port should be set to the default value of 2500 bytes before it is made a destination mirror port. When the port is successfully designated as the destination mirror, the MTU of that port is automatically set to the maximum value of 9216 bytes. When the port becomes a non-destination mirror, the MTU is restored to the default value.
- Port mirroring is supported on any physical front-end user-configurable port. The source port can be part of a LAG, VLAG, VLAN, or any other user configuration
- A maximum of 512 mirror sessions are supported in logical chassis cluster and fabric cluster modes. A mirror session consists of either a single egress port, a single ingress port, or both.

## RSPAN guidelines and limitations

The following configurations and restrictions for RSPAN should be kept in mind.

### Basic considerations

- All participating switches must be connected by Layer 2 trunks.
- Inter-Switch Link (ISL) mirroring is not supported on RSPAN.
- The source and destination ports cannot both be TRILL (ISL) ports.
- RSPAN supports multi-hop.

- RSPAN can support both the fabric cluster and logical chassis cluster modes. However, using RSPAN in logical chassis cluster mode uses unnecessary ISL bandwidth because it floods the traffic on the ISL as well as the trunk port.
- If the source port is not Layer 2 and untagged traffic is mirrored, it will be dropped for RSPAN because untagged and unclassified traffic is dropped on an ISL trunk.
- On the Brocade VDX 6740 series platforms, if source port is in unknown mode, that is neither Layer 2 nor Layer 3, the packets are dropped and are not mirrored.
- Ethernet Pause frames are not mirrored.

### VLAN considerations

- Before you configure an RSPAN session, you must create the RSPAN VLAN.
- A native VLAN cannot be made the RSPAN VLAN.
- The VLAN used for RSPAN should not be used for other purposes; furthermore, if the VLAN has ports as its members, it cannot be made an RSPAN VLAN. Only when the session is deconfigured, and the VLAN is deleted as an RSPAN VLAN, should the VLAN number be used for another purpose.
- You can configure any VLAN as an RSPAN VLAN as long as all participating network devices support the configuration of RSPAN VLANs and you use the same RSPAN VLAN for each RSPAN session in all participating network devices.
- You must configure the RSPAN VLANs on all source, intermediate, and destination network devices.
- Do not configure any ports in an RSPAN VLAN except the ports selected to carry RSPAN traffic. However, all configurations are allowed on the RSPAN destination port.
- The **vlan-id** of the packets marked for RSPAN will change to the RSPAN vlan-id.
- Access ports can be added to an RSPAN VLAN as destination ports.
- MAC address learning is disabled in the RSPAN VLAN.

## Configuring SPAN

Refer also to [Standard SPAN guidelines and limitations](#) on page 251.

### Configuring ingress SPAN

To configure SPAN for incoming packets only, do the following:

1. Open a monitor session and assign a session number.

```
switch(config)# monitor session 1
```

2. Configure the source port and the destination port, with the **rx** parameter for received packets.

The destination port is always an external port.

```
switch(config-session-1)# source tengigabitethernet 1/0/15 destination tengigabitethernet 1/0/18
direction rx
```

#### NOTE

If the following error is displayed, use the interface **no lldp** command to disable LLDP on the destination port before preceding: % Error: Destination port cannot be in L2/L3/Qos/ACL/802.1x/LAG member/Lldp/Port-profile/non-default-MTU.

- Optional: Use the **description** command to add a label to the monitor session.

```
switch(config-session-1)# description Hello World!
```

- Optional: Repeat steps 1 and 2 as needed for additional ports.

A monitor session can have only one source port. For additional ports you must create additional monitor sessions as needed for additional port mirroring sessions.

## Configuring egress SPAN

To configure SPAN for outgoing packets only, do the following.

- Open a monitor session and assign a session number

```
switch(config)# monitor session 1
```

- Configure the source port and the destination port, with the **tx** parameter for transmitted packets.

The destination port is always an external port.

```
switch(config-session-1)# source tengigabitethernet 1/0/15 destination tengigabitethernet 1/0/18
direction tx
```

### NOTE

If the following error is displayed, use the interface **no lldp** command to disable LLDP on the destination port before preceding: % Error: Destination port cannot be in L2/L3/Qos/ACL/802.1x/LAG member/Lldp/Port-profile/non-default-MTU.

- Optional: Use the **description** command to add a label to the monitor session.

```
switch(config-session-1)# description Hello World!
```

- Optional: Repeat steps 1 and 2 as needed for additional ports.

A monitor session can have only one source port. For additional ports you must create additional monitor sessions as needed for additional port mirroring sessions.

## Configuring bidirectional SPAN

To configure SPAN for packets traveling in both directions, do the following.

- Open a monitor session and assign a session number

```
switch(config)# monitor session 1
```

2. Configure the source port and the destination port, with the **both** parameter for all packets.

The destination port is always an external port.

```
switch(config-session-1)# source tengigabitethernet 1/0/15 destination tengigabitethernet 1/0/18
direction both
```

#### NOTE

One of the following error messages may appear. If so, use the interface **no lldp** command to disable LLDP on the destination port before preceding.

- % Error: Destination port cannot have LLDP configuration on it.
- % Error: Destination port cannot be in L2/L3/Qos/ACL/802.1x/LAG member/Lldp/Port-profile/non-default-MTU.

3. Optional: Use the **description** command to add a label to the monitor session.

```
switch(config-session-1)# description Hello World!
```

4. Optional: Repeat steps 1 and 2 as needed for additional ports.

A monitor session can have only one source port. For additional ports you must create additional monitor sessions as needed for additional port mirroring sessions.

## Deleting a SPAN connection from a session

To remove a single connection from a SPAN session, do the following.

1. Display the existing configuration of the monitor session.

```
switch# show monitor session 1
```

2. Open an existing monitor session.

```
switch(config)# monitor session 1
```

3. Use the **no** keyword to delete a particular port connection.

```
switch(config-session-1)# no source tengigabitethernet 1/0/15 destination tengigabitethernet 1/0/18
direction both
```

4. Display the monitor session again to confirm the deletion of the connection.

```
switch# show monitor session 1
```

## Deleting a SPAN session

To remove a SPAN session, do the following:

1. Display the existing configuration of the monitor session.

```
switch# show monitor session 1
```

2. Delete the existing monitor session by using the **no monitor session** command.

```
switch(config)# no monitor session 1
```

3. Return to Privileged EXEC mode with the **exit** command.

4. Display the monitor session again to confirm the deletion of the connection.

```
switch# show monitor session 1
```

## Configuring RSPAN

Refer also to [RSPAN guidelines and limitations](#) on page 252.

The principal difference between configuring SPAN and RSPAN is that RSPAN requires a remote VLAN to be created first, by means of the **rspan-vlan** command. This example demonstrates the configuration of a bidirectional RSPAN.

1. Create a remote VLAN on the destination interface.

```
switch(config)# interface vlan 100
```

2. Execute the **rspan-vlan** command to make the VLAN remote.

```
switch(config-vlan-100)# rspan-vlan
```

3. Exit the VLAN configuration mode.

```
switch(config-vlan-100)#end
```

4. Open a monitor session and assign a session number

```
switch(config)# monitor session 1
```

5. Configure the source port and the destination port, with the **both** parameter for bidirectional port mirroring.

By modifying the direction parameter, you can control whether this is an ingress, egress, or a bidirectional SPAN.

In the case of RSPAN, the destination is the VLAN, instead of a destination interface.

```
switch(config-session-1)# source tengigabitethernet 1/0/15 destination rspan-vlan 100 direction both
```

6. Optional: Use the **description** command to add a label to the monitor session.

```
switch(config-session-1)# description Hello World!
```

7. Use the **switchport** command to add a port to the RSPANVLAN to access the mirrored packets.

```
switch(config-session-1)# exit
switch (config)# interface ten 1/0/15
switch(conf-if-te-1/0/15)# switchport access rspan-vlan 100
```

8. Display the results of the configuration.

```
switch(conf-if-te-1/0/15)# do show vlan rspan-vlan
```

## Flow-based SPAN and RSPAN

You can snoop on traffic that passes through a particular port, using flow-based SPAN or RSPAN to copy the packets to a port connected to the analyzer.

Flow-based SPAN selectively mirrors the traffic coming on the source port that matches an ACL-based filter to a destination port, which can be a local node or remote node to support RSPAN.



For example, assume there are two streams of traffic, one from the source Mac1 and other from source Mac2 are being forwarded from port te1/0/1 to port te1/0/2. You can, with the help of an ACL to permit only source Mac1 traffic, configure a flow-based SPAN session with the source on port te1/0/1 and port te1/0/2 as the destination port. All traffic coming in on port te1/0/1 originating from source Mac1 will be duplicated and sent to port te1/0/2. No mirroring occurs for traffic originating from source Mac2.

Consider the following guidelines and restrictions for flow-based SPAN and RSPAN:

- Flow-based SPAN source port cannot be an ISL port.
- Bi-directional association of the service policy cannot be supported with the current infrastructure. You must apply the service policy in both directions in two separate commands.
- Port-based or VXLAN-based SPAN sessions cannot be specified as the SPAN action.
- Deny rules in an service ACL is a pass through in flow-based QoS. Only permit rules with SPAN action result in flow-based SPAN.
- If a rule is configured as permit in flow-based ACL with SPAN action and the same rule is configured as deny in a user policy, the packet is dropped as per the user policy and the same is mirrored to the SPAN destination port.
- In a class map, if the SPAN action co-exists with any other QoS action (such as DSCP marking which results in frame editing), the mirrored packet is the original packet and hence does not reflect the frame editing done, as per the QoS action.

## Configuring flow-based SPAN and RSPAN

You can replicate traffic from a defined source and direct it to snooping software on a designated port.

This task assumes you have already completed the following tasks:

- You have already created a policy map instance.
- You have already created a class map for the policy map.

To configure flow-based SPAN, perform the following task in privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Create the monitor session.

```
switch(config)# monitor session 1
```

3. Set the destination port for the replicated traffic for SPAN.

### NOTE

Remote ports are supported for RSPAN. Use the **rspan** *vlan\_id* variable to configure for RSPAN.

```
switch(config)# destination rspan 100
```

4. Activate the pre-defined policy map.

```
switch(config)# policy-map policymap
```

5. Activate the pre-defined class for the policy map.

```
switch(config-policymap)# class policyclass
```

6. Activate the span session and assign it an identifying number.

```
switch(config-policyclass)# span session 1
```

7. Return to global configuration mode by executing the **exit** command twice.

```
switch(config-policyclass)# exit
switch(config-policymap)# exit
switch(config)#
```

8. Enter configuration mode for the source interface.

```
switch(config)#interface ten 1/0/1
```

9. Bind the policy to the interface.

```
switch(conf-te-1/0/1)# service-policy in policyclass
```

10. Confirm the session with the **show monitor** command.

```
switch# show monitor
Session           : 1
Type              : Remote source session
Description       : [None]
Session Type:    Flow based
Enabled on Source Interfaces:
*****
Ifname           State      Direction
*****
gil/0/2          (Up)      Rx
tel/0/1          (Up)      Rx
Destination Interface : Vlan 100
```

## Deleting the flow-based SPAN session

You remove the flow-based SPAN session by disassociating the span session from the policy-map . The pre-defined policy map and class as such are not deleted.

1. Activate the pre-defined policy map.

```
switch(config)# policy-map policymap
```

2. Unbind the session from the policy map.

```
switch(config)# no monitor session 1
```

3. Activate the pre-defined class for the policy map.

```
switch(config-policymap)# class policyclass
```

4. Deactivate the span session with the **no span session** version of the command and the identifying number.

```
switch(config-policyclass)# no span session 1
```

# Configuring SFP Breakout Mode

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- [Configuring breakout mode for a chassis system](#)..... 261
- [Configuring additional breakout mode scenarios](#).....264

## SFP breakout overview

SFP breakout is a new port configuration parameter. Breakout interfaces are those interfaces created on the breakout SFP. The number of interfaces created is dependent on the SFP type. For example, when a Quad SFP (QSFP) is not in breakout mode, only one 40-Gbps interface exists; however, when that QSFP has breakout mode enabled, four 10-Gbps interfaces are created. These interfaces, no matter whether breakout mode is enabled or disabled, are administered and operate exactly the same as any other interface created on a regular SFP with no breakout capability. As a result, existing DCE module operations are not affected.

While the DCE module has no dependency on the breakout interfaces operation, the creation and deletion of interfaces is similar to that for regular interfaces, so that modules do not require special handling as a result of an SFP mode change. Currently, only static configuration is supported, whereby the reincarnation of a breakout interface resembles the sequence that an interface executes during a **poweroff linecard > no linecard > poweron linecard** operation. If the existing DCE module supports this line-card removal sequence, the changed SFP mode operational sequence is implicitly supported. The slight difference is that the SFP mode change initiates a "no linecard" equivalent at the port level, rather than attempting to remove all configurations for all interfaces on the line card.

Fabric Inter-Switch Links (ISLs) are supported in breakout mode, and the default admin state for breakout interfaces is enabled.

## Breakout mode properties

A breakout interface basically supports all operations or configurations that a regular interface supports (with few exceptions, which are noted in [Breakout mode limitations](#) on page 261). As such, it has the following properties:

- Has its own admin and operational state.
- Has its own ASIC resources interface statistics.
- Supports any configuration applicable to any regular SFP interface.
- Can be a port-channel or vLAG member.
- Can be static or dynamic depending on the targeted platform or line card.

The default state for an SFP is "no breakout."

## Breakout mode support

The table below lists the current platforms that support breakout mode.

**TABLE 43** Platforms supporting breakout

Platform	Port configuration	QSFP ports
VDX 6740	48 10G plus 4 40G	4 (with 40GbE Port Upgrade license)
VDX 6740T	VDX 6740T-1G ports can be upgraded from to 10G with Port Upgrade license.	
VDX 6740T-1G		
VDX 8770-4	12x 40G and 27x40G	12 (12x40G) and 27 (27x40G)

**TABLE 43** Platforms supporting breakout (continued)

Platform	Port configuration	QSFP ports
VDX 8770-8		

### 27x40G line card restrictions

The 27x40G line card supports nine port groups of three ports each that you can configure for Performance or Density operating modes. If a port group is configured for Performance mode, the first two ports in a group are enabled in Performance mode, but the third port is disabled. If a port group is set for Density mode, all three ports operate in Density mode. Breakout mode can only be configured on ports enabled for Performance mode.

For more information on these modes, line card port groups, and instructions for configuring Performance mode on port groups, refer to the following sections in the *Brocade VDX 8770-4 Hardware Reference Manual* or *Brocade VDX 8770-8 Hardware Reference Manual*:

- "27x40 GbE operating modes"
- "Configuring operating modes on 27x40 GbE line cards"

## Breakout mode interfaces

The SFP connector ID identifies a physical front-end SFP and has the same meaning as the port ID used in the interface name. The connector ID infers which interfaces are created or deleted as a result of the breakout mode change. All interfaces at this connector must be disabled before the command is accepted. An interface created on an SFP in breakout-enabled mode adds a numeric suffix followed by a colon to the existing interface name.

This nomenclature identifies that a port is in breakout mode. For example, consider line card 2 port 1 on a node with RBridge ID 3 that has a Quad SFP (QSFP) in breakout disabled mode. If breakout is then set to enabled, the existing interface Fo 3/2/1 is deleted and four new interfaces —Te 3/2/1:1, Te 3/2/1:2, Te 3/2/1:3 and Te 3/2/1:4— are created. When the interface is deleted, any configuration on this interface is deleted as well. The new interfaces created have the default port configuration. If breakout is then set to disabled, the four Te interfaces are deleted and a single Fo interface is created.

The condition in which the command is executed and becomes effective is both line card-dependent and platform-dependent.

- On chassis systems, if a line card supports only static configuration, then this command is supported only when the line card is in the power off state, and the mode change is effective only after the switch is powered on.
- On the Brocade VDX 6740 series platforms, this command is supported only when the interface is in the shutdown state, and the mode change is effective only after the switch reboots.
- For Brocade 27x40G line cards, breakout mode is supported only on port groups configured in Performance operating mode and only on the first two 40G ports in those port groups. For more information, refer to the Brocade 8770 Hardware Reference Manuals under the section on configuring operating modes for the 27x40 GbE line card.

The table below shows an example of an SFP in breakout mode and its respective interface names.

**TABLE 44** SFP breakout values

SFP # (rbridge/slot/port)	SFP type	Interface name	
		Breakout disabled	Breakout enabled
3/2/1	QSFP (4 x10G)	Fo 3/2/1	Te 3/2/1:1
			Te 3/2/1:2
			Te 3/2/1:3
			Te 3/2/1:4

## Breakout mode limitations

In most circumstances, breakout interfaces behave the same as nonbreakout (normal) interfaces with regard to port attributes and states. Each breakout interface maintains its administrative state, operational state, and statistics. The exception is at the physical layer, whereby the hardware platform does not have per-breakout interface information.

- SFP media

In breakout mode, there is only SFP and no per-breakout media information. The **show media** command displays the same media information for all breakout interfaces.

### NOTE

The TX Power Field in the **show media** command is not supported by the 40G optics.

- LED state

For Brocade VDX 6740 series platforms, the LED state for a breakout interface is deterministic. For all other supported platforms, the LED state for a breakout interface *is not* deterministic.

## Breakout mode high-availability considerations

The active control processor (CP) needs to sync the SFP breakout state to the standby CP. After a failover, you should reconfirm the existence of interfaces, as well as note any possible configuration differences between what is expected for breakout mode and what is actually present.

Because changing the SFP mode requires associated interfaces to be disabled first, there is no data-traffic disruption during failover.

# Configuring breakout mode for a chassis system

To configure breakout mode on a blade in a chassis, complete the following procedure.

### NOTE

Breakout mode is only supported on 27x40GbE line card ports configured in Performance operating mode. An error will occur if you try to configure breakout mode on ports that are not in this mode. With the line card powered off, you can configure Performance mode on specific 27x40GbE ports, then enable breakout mode for these ports. For more information on 27x40GbE line card operating modes and configuration, refer to [Breakout mode support](#) on page 259.

1. Enter **power-off linecard card\_#** to power off the line card.
  - a) Applications will remove all interfaces.
  - b) Operational CLI command will not show any interfaces on this line card.
  - c) Interface and interface configurations still exist in the DCM database. Entering **show running-config interface** will show the interface and interface configurations.
2. Apply the SFP breakout command to the target port(s).
  - a) Existing interface(s) under the old mode and the associated configurations are removed from the DCM database. If the target is a QSFP, the disabled breakout deletes four Te (10 Gbps) interfaces and the enabled breakout deletes one Fo (40 Gbps) interface. Configuration of a nontarget port is not affected.
  - b) SFP breakout mode is updated in the DCM database.

3. Copy the *running-config* file to the *startup-config* file.
  - a) Save the *running-config* file to the *startup-config* file. The SFP configuration must be saved in the startup database, which is used after the line card is rebooted.
  - b) If you are in logical chassis cluster mode, you do not need to copy the *running-config* file to the *startup-config* file.

4. Enter **power-on linecard *card\_#*** to power on the line card.
  - a) The platform creates interfaces corresponding to the SFP breakout mode of each port. For QSFP, a single Fo interface is created in disable mode and four Te interfaces are created in enable mode.
  - b) The SFP interfaces under the new mode come up in default configurations, just as if the system were booted up for the first time. Unaffected interfaces retain their original configurations before the slotpoweroff command was applied.

The following example shows the enable breakout mode on port 11.

```
switch# show ip int bri
Interface
=====
FortyGigabitEthernet 1/2/1      unassigned  up    up
FortyGigabitEthernet 1/2/2      unassigned  up    up
FortyGigabitEthernet 1/2/3      unassigned  up    up
FortyGigabitEthernet 1/2/4      unassigned  up    up
FortyGigabitEthernet 1/2/5      unassigned  up    up
FortyGigabitEthernet 1/2/6      unassigned  up    up
FortyGigabitEthernet 1/2/7      unassigned  up    up
FortyGigabitEthernet 1/2/8      unassigned  up    up
FortyGigabitEthernet 1/2/9      unassigned  up    up
FortyGigabitEthernet 1/2/10     unassigned  up    up
FortyGigabitEthernet 1/2/11     unassigned  up    up
FortyGigabitEthernet 1/2/12     unassigned  up    up
#Power off line card

switch# power-off linecard 2

switch# show ip int bri
Interface
=====
IP-Address
=====
Status
=====
Protocol
=====

switch# config t

switch(config)# hardware

switch(config-hardware)# connector 1/2/11

switch(config-connector-1/2/11)# sfp breakout
# Interfaces under new mode are not created at this time..

switch# show ip int bri
Interface
=====
IP-Address
=====
Status
=====
Protocol
=====
#In SA/FC mode, save running-config to start-up config"

switch# copy running-config startup-config
#Power on line card

switch# power-on linecard 2

switch# show ip int bri
Interface
=====
IP-Address
=====
Status
=====
Protocol
=====
FortyGigabitEthernet 1/2/1      unassigned  up    up
FortyGigabitEthernet 1/2/2      unassigned  up    up
FortyGigabitEthernet 1/2/3      unassigned  up    up
FortyGigabitEthernet 1/2/4      unassigned  up    up
FortyGigabitEthernet 1/2/5      unassigned  up    up
FortyGigabitEthernet 1/2/6      unassigned  up    up
FortyGigabitEthernet 1/2/7      unassigned  up    up
FortyGigabitEthernet 1/2/8      unassigned  up    up
FortyGigabitEthernet 1/2/9      unassigned  up    up
FortyGigabitEthernet 1/2/10     unassigned  up    up
FortyGigabitEthernet 1/2/12     unassigned  up    up
TenGigabitEthernet 1/2/11:1     unassigned  up    down
TenGigabitEthernet 1/2/11:2     unassigned  up    down
TenGigabitEthernet 1/2/11:3     unassigned  up    down
TenGigabitEthernet 1/2/11:4     unassigned  up    down
```

## Configuring additional breakout mode scenarios

The following configuration examples show how to set a 40G QSFP into breakout mode, reserve a 40G QSFP port while in breakout mode, and release a 40G QSFP port while in breakout mode.

### Setting a 40G QSFP port into breakout mode

The following example shows you how to set a 40G QSFP port into breakout mode and then manually reserving and releasing the 40G port DPOD reservation.

#### NOTE

When the **copy default-config startup-config** command is issued in logical chassis mode, the breakout interface configuration will be lost, along with the rest of the configuration. To apply breakout mode, you must shut down the 40G port, then start the configuration download operation. If the port is not shut down during configuration download, you must configure breakout mode manually.

```
switch# config
Entering configuration mode terminal

switch(config)# interface FortyGigabitEthernet 48/0/49

switch(config-if-fo-48/0/49)# shut

switch(config-if-fo-48/0/49)# exit

switch(config)# hardware

switch(config-hardware)# connector 48/0/49

switch(config-connector-48/0/49)# sfp breakout
%Warning: Sfp Breakout is a disruptive command.
Please save the running-config to startup-config and a power-cycle for the changes to take place.

switch(config-connector-48/0/49)# do copy running-config startup-config
This operation will modify your startup configuration. Do you want to continue? [y/n]:y

switch(config-connector-48/0/49)# do reload
Warning: Unsaved configuration will be lost. Please run `copy running-config startup-config` to save the
current configuration if not done already.
Are you sure you want to reload the switch? [y/n]:y

The system is going down for reload NOW !!
switch# show ip int br
Interface                               IP-Address      Vrf              Status          Protocol
=====                               =
FortyGigabitEthernet 48/0/50         unassigned      default-vrf      up down
FortyGigabitEthernet 48/0/51         unassigned      default-vrf      up down
FortyGigabitEthernet 48/0/52         unassigned      default-vrf      up down
TenGigabitEthernet 48/0/1          unassigned      default-vrf      up up (ISL)
TenGigabitEthernet 48/0/2          unassigned      default-vrf      up down
TenGigabitEthernet 48/0/3          unassigned      default-vrf      up down
TenGigabitEthernet 48/0/47          unassigned      default-vrf      up down
TenGigabitEthernet 48/0/48          unassigned      default-vrf      up down
TenGigabitEthernet 48/0/49:1        unassigned      default-vrf      up down (ISL)
TenGigabitEthernet 48/0/49:2        unassigned      default-vrf      up down (ISL)
TenGigabitEthernet 48/0/49:3        unassigned      default-vrf      up down (ISL)
TenGigabitEthernet 48/0/49:4        unassigned      default-vrf      up down (ISL)
Vlan 1                                unassigned      administratively  down down
Vlan 4093                             unassigned      administratively  up down
Vlan 4095                             unassigned      administratively  down down
```



## Reserving a 40G QSFP port while in breakout mode

The following example shows you how to reserve a 40G QSFP port while in breakout mode.

```
switch# config
Entering configuration mode terminal

switch(config)# dpod 48/0/
Possible completions:
 1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
39 40 41 42 43 44 45 46 47 48 49 50 51 52

switch(config)# dpod 48/0/49:1 reserve
Invalid InterfaceId.

switch(config)# dpod 48/0/49 reserve

switch(config-dpod-48/0/49)# do show dpod
rbridge-id: 48
 48 10G ports are available in this switch
 4 40G ports are available in this switch
10G Port Upgrade license is installed
40G Port Upgrade license is installed
Dynamic POD method is in use
48 10G port assignments are provisioned for use in this switch:
 24 10G port assignments are provisioned by the base switch license
 24 10G port assignments are provisioned by the 10G Port Upgrade license
 2 10G ports are assigned to installed licenses:
 2 10G ports are assigned to the base switch license
 0 10G ports are assigned to the 10G Port Upgrade license
10G ports assigned to the base switch license:
48/0/1, 48/0/31
10G ports assigned to the 10G Port Upgrade license:
None
10G ports not assigned to a license:
48/0/2, 48/0/3, 48/0/4, 48/0/5, 48/0/6, 48/0/7, 48/0/8, 48/0/9, 48/0/10, 48/0/11
48/0/12, 48/0/13, 48/0/14, 48/0/15, 48/0/16, 48/0/17, 48/0/18, 48/0/19, 48/0/20, 48/0/21
48/0/22, 48/0/23, 48/0/24, 48/0/25, 48/0/26, 48/0/27, 48/0/28, 48/0/29, 48/0/30, 48/0/32
48/0/33, 48/0/34, 48/0/35, 48/0/36, 48/0/37, 48/0/38, 48/0/39, 48/0/40, 48/0/41, 48/0/42
48/0/43, 48/0/44, 48/0/45, 48/0/46, 48/0/47, 48/0/48
46 license reservations are still available for use by unassigned ports
 4 40G port assignments are provisioned for use in this switch:
 0 40G port assignments are provisioned by the base switch license
 4 40G port assignments are provisioned by the 40G Port Upgrade license
 2 40G ports are assigned to installed licenses:
 0 40G ports are assigned to the base switch license
 2 40G ports are assigned to the 40G Port Upgrade license
40G ports assigned to the base switch license:
None
40G ports assigned to the 40G Port Upgrade license:
48/0/49, 48/0/50
40G ports not assigned to a license:
48/0/51, 48/0/52
 2 license reservations are still available for use by unassigned ports
```

## Releasing a 40G QSFP port while in breakout mode

The following example shows you how to release a 40G QSFP port while in breakout mode.

```
switch(config-dpod-48/0/49)# dpod 48/0/49 release
Port should be Offline to change POD assignment.

switch(config-dpod-48/0/49)# exit

switch(config)# interface TenGigabitEthernet 48/0/49:1
switch(conf-if-te-48/0/49:1)# shut
```

```
switch(conf-if-te-48/0/49:1)# interface TenGigabitEthernet 48/0/49:2
switch(conf-if-te-48/0/49:2)# shut

switch(conf-if-te-48/0/49:2)# interface TenGigabitEthernet 48/0/49:3
switch(conf-if-te-48/0/49:3)# shut

switch(conf-if-te-48/0/49:3)# interface TenGigabitEthernet 48/0/49:4
switch(conf-if-te-48/0/49:4)# shut

switch(conf-if-te-48/0/49:4)# exit
switch(config)# dpod 48/0/49 release
switch(config-dpod-48/0/49)#
```