BROCADE

ADMINISTRATION GUIDE

Network OS Administration Guide

Supporting Network OS v4.1.x

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Contents

Copyright Statement

Preface

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
bold text	Identifies command names
	Identifies keywords and operands
	Identifies the names of user-manipulated GUI elements
	Identifies text to enter at the GUI
italic text	Identifies emphasis
	Identifies variables and modifiers
	Identifies paths and Internet addresses
	Identifies document titles
`Courier font`	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
bold text	Identifies command names, keywords, and command options.
italic text	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, **--show** WWN.
[ ]	Syntax components displayed within square brackets are optional.
	Default responses to system prompts are enclosed in square brackets.
{ **x** | **y** | **z** }	A choice of required parameters is enclosed in curly brackets separated by vertical bars. You must select one of the options.

Convention	Description
	In Fibre Channel products, square brackets may be used instead for this purpose.
x | **y**	A vertical bar separates mutually exclusive elements.
< >	Nonprinting characters, for example, passwords, are enclosed in angle brackets.
...	Repeat the previous element, for example, *member*[*member*...].
\	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.

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- Adapter documentation is available on the Downloads and Documentation for Brocade Adapters page. Select your platform and scroll down to the Documentation section.
- For all other products, 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. You can register at no cost to obtain a user ID and password.

Release notes are available on MyBrocade under Product Downloads.

White papers, online demonstrations, and data sheets are available through the Brocade website.

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Online	Telephone	E-mail
Preferred method of contact for non-urgent issues: • My Cases through MyBrocade • Software downloads and licensing tools • Knowledge Base	Required for Sev 1-Critical and Sev 2-High issues: • Continental US: 1-800-752-8061 • Europe, Middle East, Africa, and Asia Pacific: +800-AT FIBREE (+800 28 34 27 33) • For areas unable to access toll free number: +1-408-333-6061 • Toll-free numbers are available in many countries.	support@brocade.com Please include: • Problem summary • Serial number • Installation details • Environment description

Brocade OEM customers

If you have purchased Brocade product support from a Brocade OEM/Solution Provider, contact your OEM/Solution Provider for all of your product support needs.

- OEM/Solution Providers are trained and certified by Brocade to support Brocade® products.
- 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

To send feedback and report errors in the documentation you can use the feedback form posted with the document or you can e-mail the documentation team.

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.
- By sending your feedback to 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

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 4.1.0, documenting all possible configurations and scenarios is beyond the scope of this document.

NOTE

The 100-gigabit interface subtype is not supported for Network OS 4.1.0, even though this subtype is referenced in some of the Network OS 4.1.0 user documentation.

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

- Brocade VDX 6710-54
- Brocade VDX 6720
  - Brocade VDX 6720-24
  - Brocade VDX 6720-60
- Brocade VDX 6730
  - Brocade VDX 6730-32
  - Brocade VDX 6730-76
- 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 v4.1.0, refer to the documentation specific to that OS version.

What's new in this document

This document supports Network OS v4.1.3 and later; and the new features in this release include:

- Mixed-version support for Fabric Cluster

- Corrections and updates from previous versions

For complete information, refer to the Release Notes.

Related documents

The documents that support this release are listed below. For details on how to obtain supporting documents, refer to "Brocade resources" in the Preface.

TABLE 1 Documents supporting this release

Document	Description
Network OS Administration Guide	This document. Support for configuring, managing, and troubleshooting Network OS VCS Fabrics.
Network OS Command Reference	Detailed Network OS command line interface (CLI) syntax and examples.
Network OS YANG Reference Manual	Support for the YANG data modeling language, used to model configuration and state data for manipulation by the NETCONF network configuration protocol.
Network OS NETCONF Operations Guide	Support for the NETCONF network configuration protocol and the YANG data-modeling language.
Network OS Message Reference	Support for RASLog messages, which log system events related to configuration changes of system error conditions.
Network OS MIB Reference	Support for Simple Network Management Protocol (SNMP), to monitor and manage network devices.
Network OS Software Licensing Guide	Support for all Brocade software licensing issues. Replaces content that was previously in the *Network OS Administration Guide*
Network OS FIPS Configuration Guide	Support for configurations required by the Federal Information Processing Standards (FIPS) regarding cryptographic modules. Replaces content that was previously in the *Network OS Administration Guide*
Release Notes	Detailed summary of issues specific to the current release.

Section I: Network OS Administration

Introduction to Network OS and Brocade VCS Fabric Technology

Introduction to Brocade Network OS

Brocade Network OS (NOS) is a scalable network operating system available for the Brocade data center switching portfolio products, including the VDX product line.

Purpose-built for mission-critical, next-generation data centers, Network OS supports the following capabilities:

Simplified network management	Brocade VCS fabrics are self-forming and self-healing, providing an operationally scalable foundation for very large or dynamic cloud deployments. Multi-node fabrics can be managed as a single logical element, and fabrics can be deployed and easily re-deployed in a variety of configurations optimized to the needs of particular workloads. For more information on Brocade VCS Fabric technology, refer to Introduction to Brocade VCS Fabric technology on page 32 for an overview and Configuring Brocade VCS Fabrics on page 143 for configuration details.
High resiliency	Brocade VCS fabrics use hardware-based Inter-Switch Link (ISL) Trunking to provide automatic link failover without traffic interruption.
Improved network utilization	Transparent Interconnection of Lots of Links (TRILL)-based Layer 2 routing service provides equal-cost multipaths in the network, resulting in improved network utilization. Brocade VCS Fabric technology also delivers multiple active, fully load-balanced Layer 3 gateways to remove constraints on Layer 2 domain growth, eliminate traffic tromboning, and enable inter-VLAN routing within the fabric. Virtual Router Redundancy Protocol (VRRP) eliminates a single point of failure in a static, default-route environment by dynamically assigning virtual IP routers to participating hosts. The interfaces of all routers in a virtual router must belong to the same IP subnet. There is no restriction against reusing a virtual router ID (VRID) with a different address mapping on different LANs. Refer to Fabric overview on page 143 for additional information about TRILL. Refer to VRRP overview on page 615 for additional information on VRRP/VRRP-E.
Server virtualization	Automatic Migration of Port Profile (AMPP) functionality provides fabric-wide configuration of network policies, achieves per-port profile forwarding, and enables network-level features to support Virtual Machine (VM) mobility. Refer to Configuring AMPP on page 329 for more information about AMPP.
Network convergence	Data Center Bridging (DCB)-based lossless Ethernet service provides isolation between IP and storage traffic over a unified network infrastructure. Multi-hop Fibre Channel over Ethernet (FCoE) allows an FCoE initiator to communicate with an FCoE target that is a number of hops away. Refer to End-to-end FCoE on page 342 for more information about multi-hop FCoE.

In Network OS, all features are configured through a single, industry-standard command line interface (CLI). Refer to the *Network OS Command Reference* for an alphabetical listing and detailed description of all the Network OS commands.

Brocade VCS Fabric terminology

The following terms are used in this document.

Edge ports	In an Ethernet fabric, all switch ports used to connect external equipment, including end stations, switches, and routers.
Ethernet fabric	A topologically flat network of Ethernet switches with shared intelligence, such as the Brocade VCS Fabric.
Fabric ports	The ports on either end of an Inter-Switch Link (ISL) in an Ethernet fabric.
Inter-Switch Link (ISL)	An interface connected between switches in a VCS fabric. The ports on either end of the interface are called ISL ports or Fabric ports. The ISL can be a single link or a bundle of links forming a Brocade trunk. This trunk can either be created as a proprietary Brocade trunk, or a standard IEEE 802.3ad based link aggregation.
RBridge	A physical switch in a VCS fabric.
RBridge ID	A unique identifier for an RBridge, each switch has a unique RBridge ID. In commands, the RBridge ID is used in referencing all interfaces in the VCS fabric. Refer to Configuring a Brocade VCS Fabric on page 146 for information about setting the RBridge ID.
VCS ID	A unique identifier for a VCS fabric. The factory default VCS ID is 1. All switches in a VCS fabric must have the same VCS ID.
WWN	World Wide Name. A globally unique ID that is burned into the switch at the factory.

Introduction to Brocade VCS Fabric technology

Brocade VCS Fabric technology is an Ethernet technology that allows you to create flatter, virtualized, and converged data center networks. Brocade VCS Fabric technology is elastic, permitting you to start small, typically at the access layer, and expand your network at your own pace.

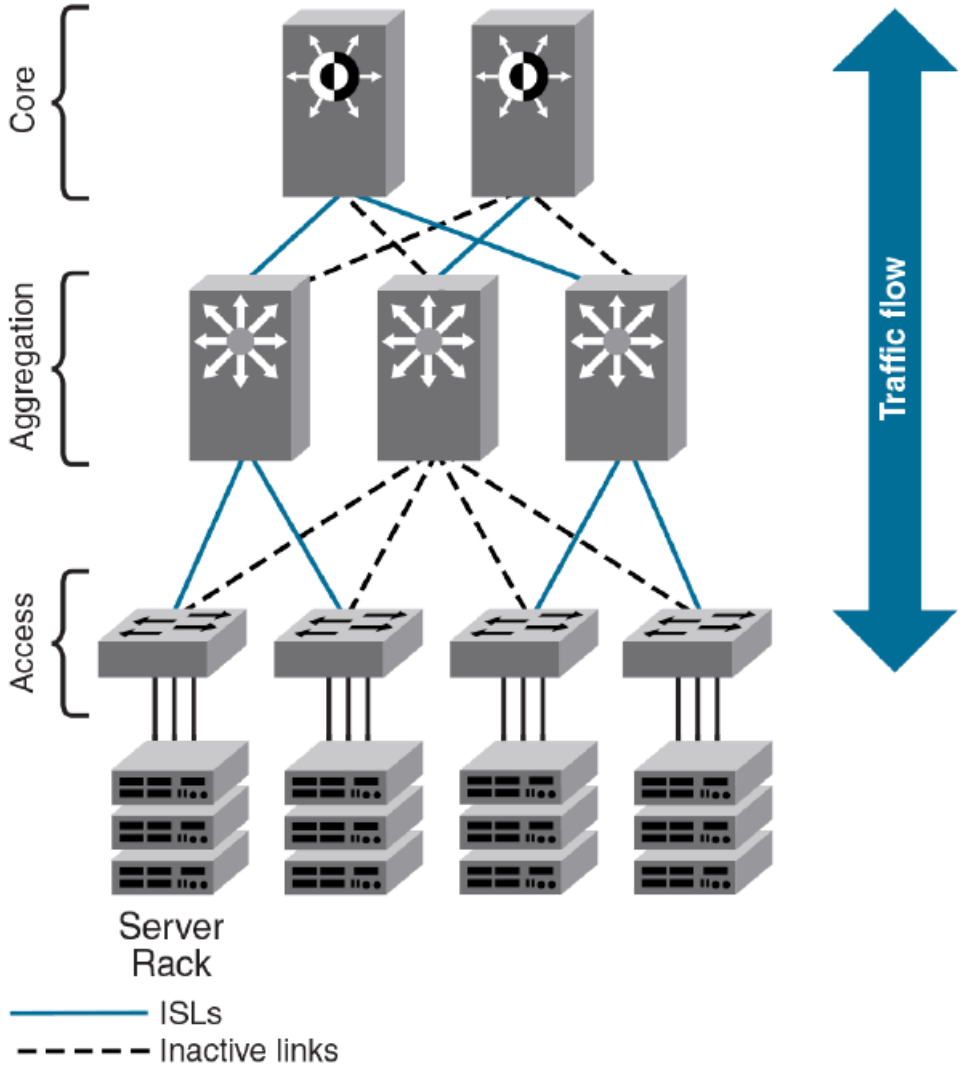
Brocade VCS Fabric technology is built upon three core design principles:

- Automation
- Resilience
- Evolutionary design

When two or more Brocade VCS Fabric switches are connected together, they form an *Ethernet fabric* and exchange information among each other using *distributed intelligence*. To the rest of the network, the Ethernet fabric appears as a single *logical chassis*.

The following shows an example of a data center with a classic hierarchical Ethernet architecture and the same data center with a Brocade VCS Fabric architecture. The Brocade VCS Fabric architecture provides a simpler core-edge topology and is easily scalable as you add more server racks.

FIGURE 1 Comparison of classic Ethernet and Brocade VCS Fabric architectures



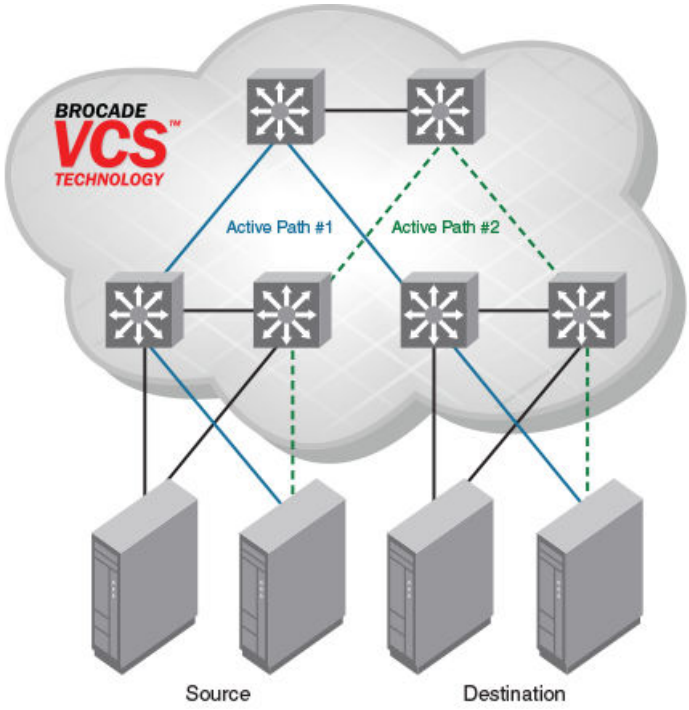
Automation

Resilience is a foundational attribute of Brocade Fibre Channel storage networks and resilience is also a requirement in modern data centers with clustered applications and demanding compute Service-Level Agreements (SLAs). In developing its VCS Fabric technology, Brocade naturally carried over this core characteristic to its Ethernet fabric design.

In traditional Ethernet networks running STP, only 50 percent of the links are active; the rest (shown as dotted lines in the following figure) act as backups in case the primary connection fails.

When you connect two or more Brocade VCS Fabric mode-enabled switches they form an Ethernet fabric (provided the two switches have a unique RBridge ID and same VCS ID), as shown below.

FIGURE 2 Ethernet fabric with multiple paths



The Ethernet fabric has the following characteristics:

- It is a switched network. The Ethernet fabric utilizes an emerging standard called Transparent Interconnection of Lots of Links (TRILL) as the underlying technology.
- All switches automatically know about each other and all connected physical and logical devices.
- All paths in the fabric are available. Traffic is always distributed across equal-cost paths. As illustrated above, traffic from the source to the destination can travel across two paths.
- Traffic travels across the shortest path.
- If a single link fails, traffic is automatically rerouted to other available paths. In the topology above, if one of the links in Active Path #1 goes down, traffic is seamlessly rerouted across Active Path #2.
- Spanning Tree Protocol (STP) is not necessary because the Ethernet fabric appears as a single logical switch to connected servers, devices, and the rest of the network.
- Traffic can be switched from one Ethernet fabric path to the other Ethernet fabric path.

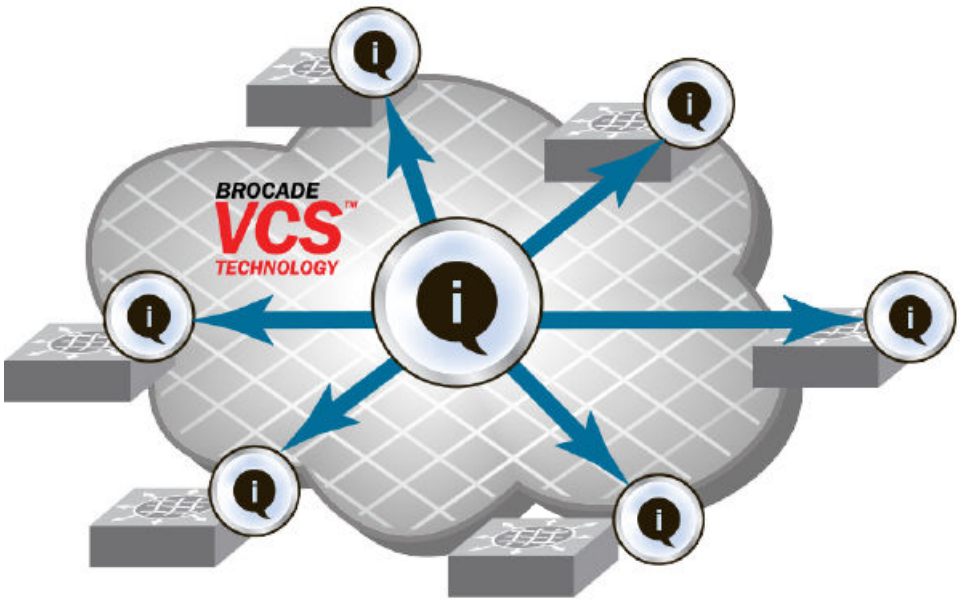
Distributed intelligence

With Brocade VCS Fabric technology, all relevant information is automatically distributed to each member switch to provide unified fabric functionality, as illustrated below.

A Brocade VCS fabric is designed to be managed as a single "logical chassis," so that each new switch inherits the configuration of the fabric, and the new ports become available immediately. The fabric then appears to the rest of the network as a single switch. This significantly reduces complexity for the management layer, which in turn improves reliability and reduces troubleshooting.

In addition, VCS fabrics provides a Netconf Application Programming Interfaces (API), as well as extensions to OpenStack Quantum to orchestrate both physical and logical networking resources as part of Virtual Machine deployment to support multi-tiered application topologies.

FIGURE 3 Distributed intelligence in an Ethernet fabric



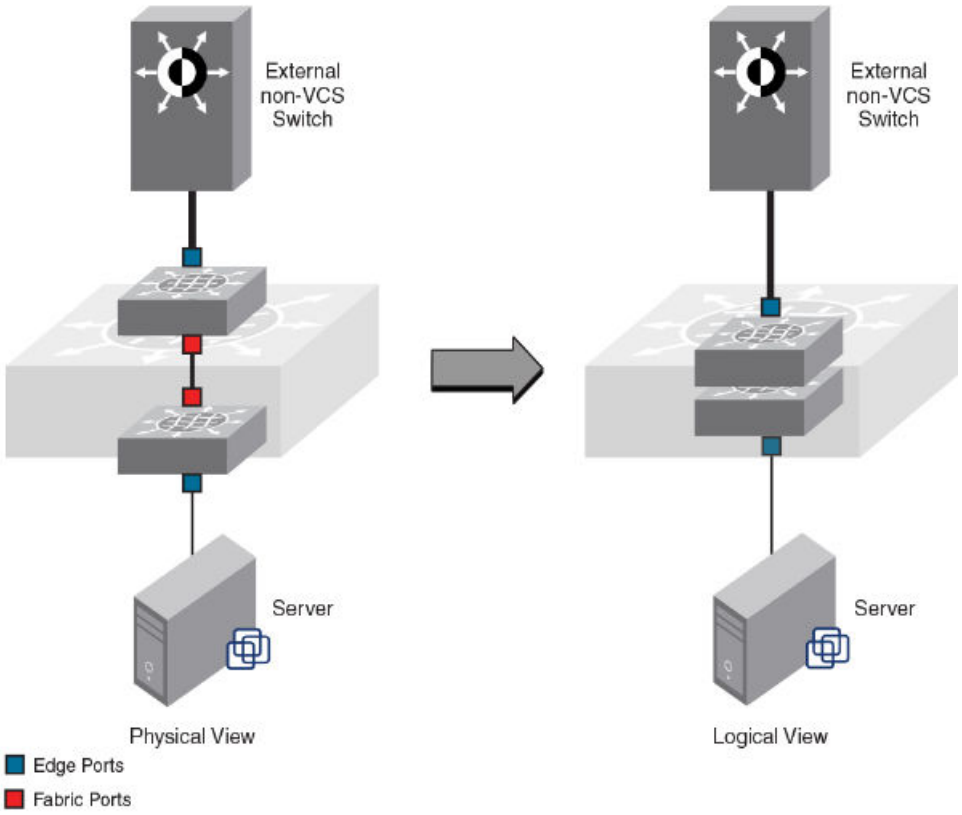
Distributed intelligence has the following characteristics:

- The fabric is self-forming. When two Brocade VCS Fabric mode-enabled switches are connected, the fabric is automatically created and the switches discover the common fabric configuration.
- The fabric is masterless. No single switch stores configuration information or controls fabric operations. Any switch can fail or be removed without causing disruptive fabric downtime or delayed traffic.
- The fabric is aware of all members, devices, and virtual machines (VMs). If the VM moves from one Brocade VCS Fabric port to another Brocade VCS Fabric port in the same fabric, the port-profile is automatically moved to the new port, leveraging Brocade's Automatic Migration of Port Profiles (AMPP) feature.

Logical chassis

All switches in an Ethernet fabric are managed as if they were a single logical chassis. To the rest of the network, the fabric looks no different from any other Layer 2 switch. The following illustrates an Ethernet fabric with two switches. The rest of the network is aware of only the edge ports in the fabric, and is unaware of the connections within the fabric.

FIGURE 4 Logical chassis in Ethernet fabric



Each physical switch in the fabric is managed as if it were a blade in a chassis. When a Brocade VCS Fabric mode-enabled switch is connected to the fabric, it inherits the configuration of the fabric and the new ports become available immediately.

Ethernet fabric formation

Brocade VCS Fabric protocols are designed to aid the formation of an Ethernet fabric with minimal user configuration. Refer to Brocade VCS Fabric formation on page 143 for detailed information about the Ethernet fabric formation process.

All supported switches are shipped with Brocade VCS Fabric mode disabled. Refer to Configuring Brocade VCS Fabrics on page 143 for information about disabling and enabling Brocade VCS Fabric mode on your switches.

Automatic neighbor node discovery

When you connect a switch to a Brocade VCS Fabric mode-enabled switch, the Brocade VCS Fabric mode-enabled switch determines whether the neighbor also has Brocade VCS Fabric mode enabled. If the switch has Brocade VCS Fabric mode enabled and the VCS IDs match, the switch joins the Ethernet fabric.

Refer to Configuring Brocade VCS Fabrics on page 143 for information about changing the VCS ID.

Automatic ISL formation and hardware-based trunking

When a switch joins an Ethernet fabric, ISLs automatically form between directly connected switches within the fabric.

If more than one ISL exists between two switches, then Brocade ISL trunks can form automatically. All ISLs connected to the same neighboring Brocade switch attempt to form a trunk. The trunks are formed only when the ports belong to the same port group. No user intervention is necessary to form these trunks.

Refer to Configuring fabric interfaces on page 148 for information about enabling and disabling ISLs and trunks.

Principal RBridge election

The RBridge with the lowest WWN in the Ethernet fabric is elected as the principal RBridge.

The role of the principal RBridge is to decide whether a new RBridge joining the fabric conflicts with any of the RBridge IDs already present in the fabric. If a conflict arises, the principal RBridge keeps the joining RBridge segmented.

Refer to Configuring a Brocade VCS Fabric on page 146 for information about setting the RBridge ID.

Brocade VCS Fabric technology use cases

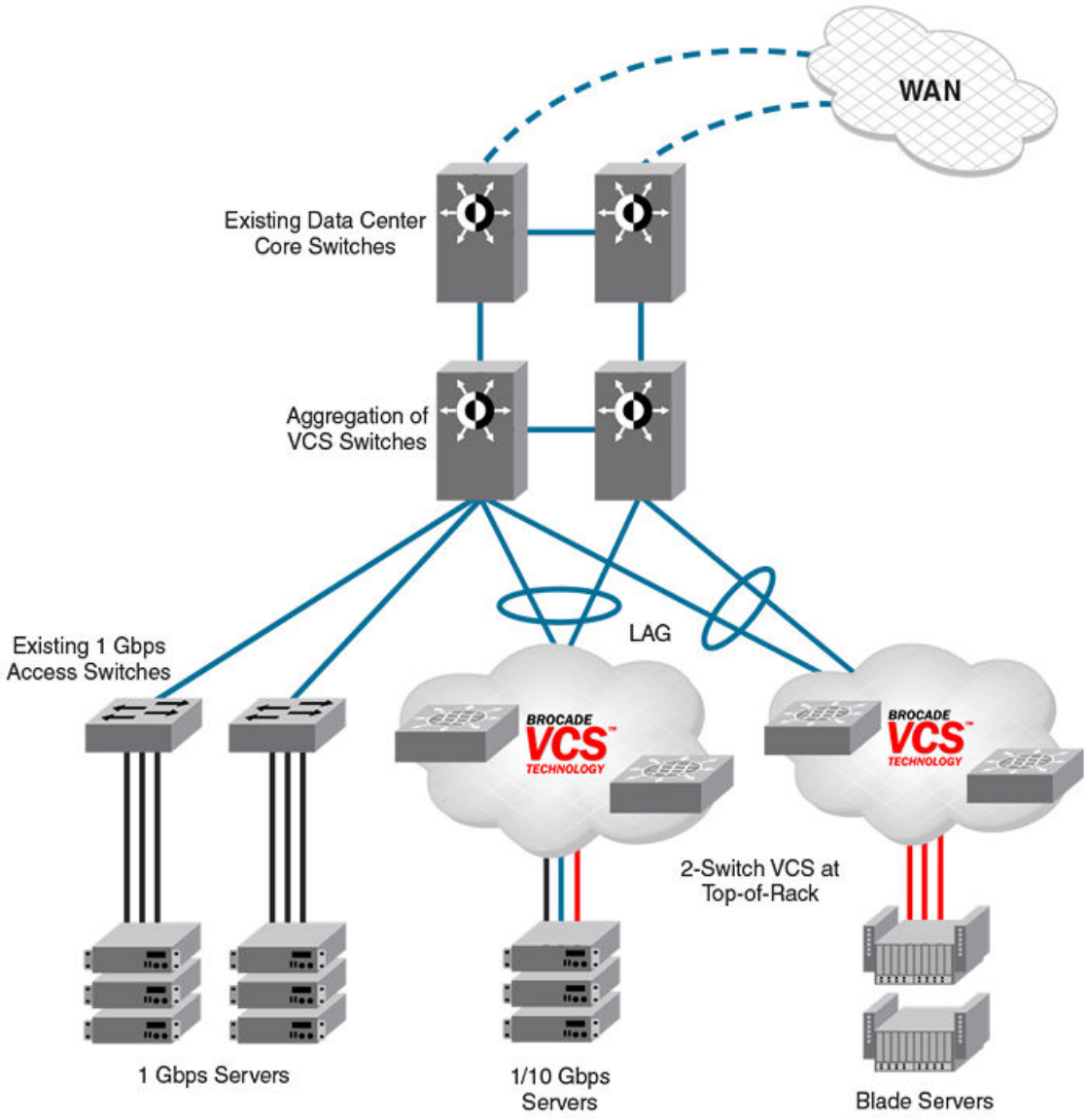
This section describes the following use cases for Brocade VCS Fabric technology:

- Classic Ethernet
- Large-scale server virtualization

Classic Ethernet access and aggregation use case

Brocade VCS Fabric can be deployed in the same fashion as existing top-of-rack switches, as shown below. In the right-most two server racks, a two-switch Ethernet fabric replaces the Ethernet switch at the top of each rack.

FIGURE 5 Pair of Brocade VDX switches at the top of each server rack



The servers perceive a single top-of-rack switch, allowing for active/active connections running end-to-end.

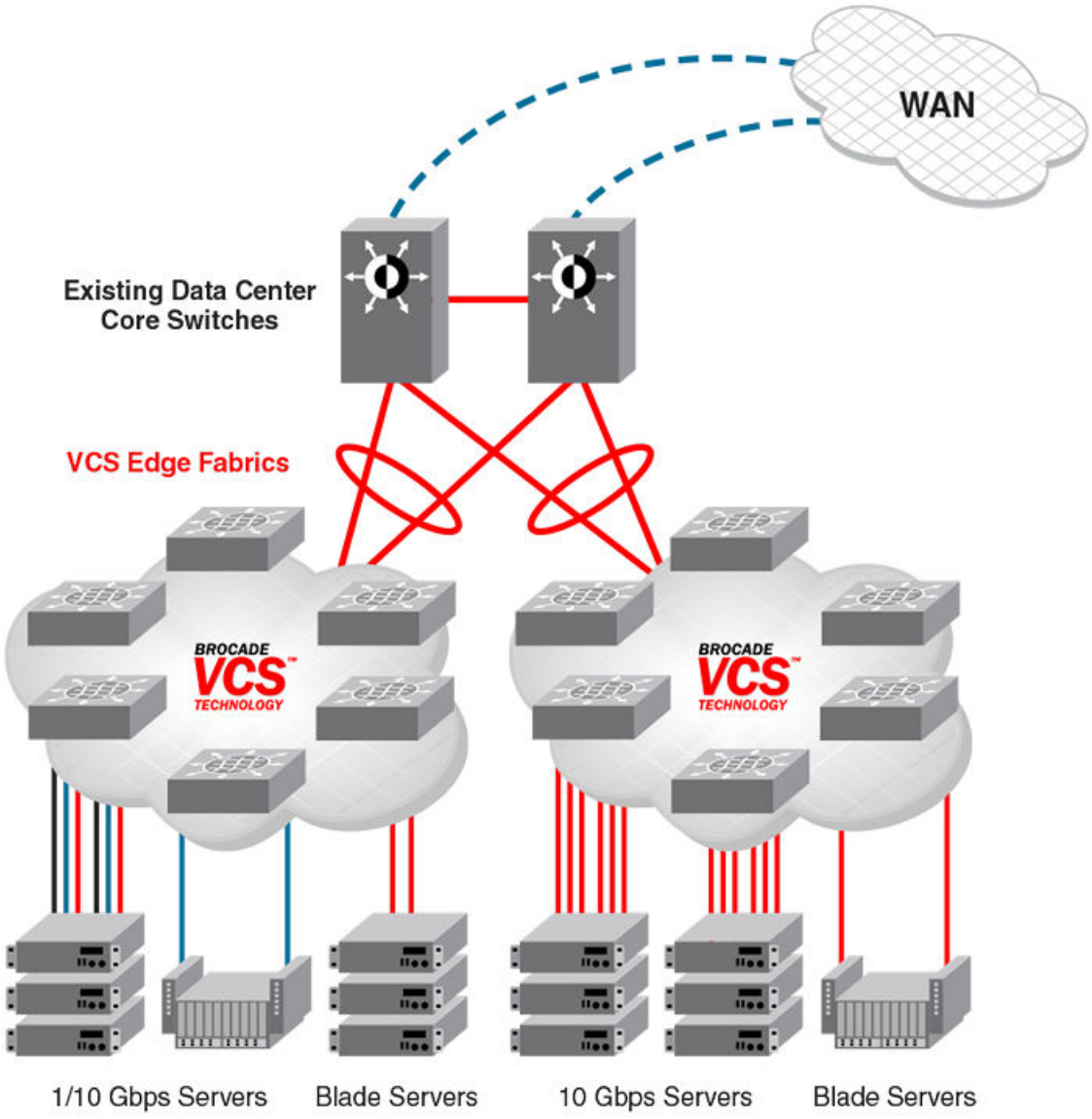
Brocade VCS Fabric technology in this use case provides the following advantages:

- Multiple active-active connections, with increased effective bandwidth
- Preserves existing architecture
- Works with existing core and aggregation networking products
- Co-exists with existing access switches
- Supports 1- and 10-Gbps server connectivity
- Works with server racks or blade servers

Large-scale server virtualization use case

The following shows a logical two-tier architecture with Brocade VCS fabrics at the edge. Each Brocade VCS fabric appears as a single virtual switch to the switches outside the fabric, which results in flattening the network.

FIGURE 6 Collapsed, flat Layer 3 networks enabling virtual machine mobility



Brocade VCS Fabric technology in this use case provides the following advantages:

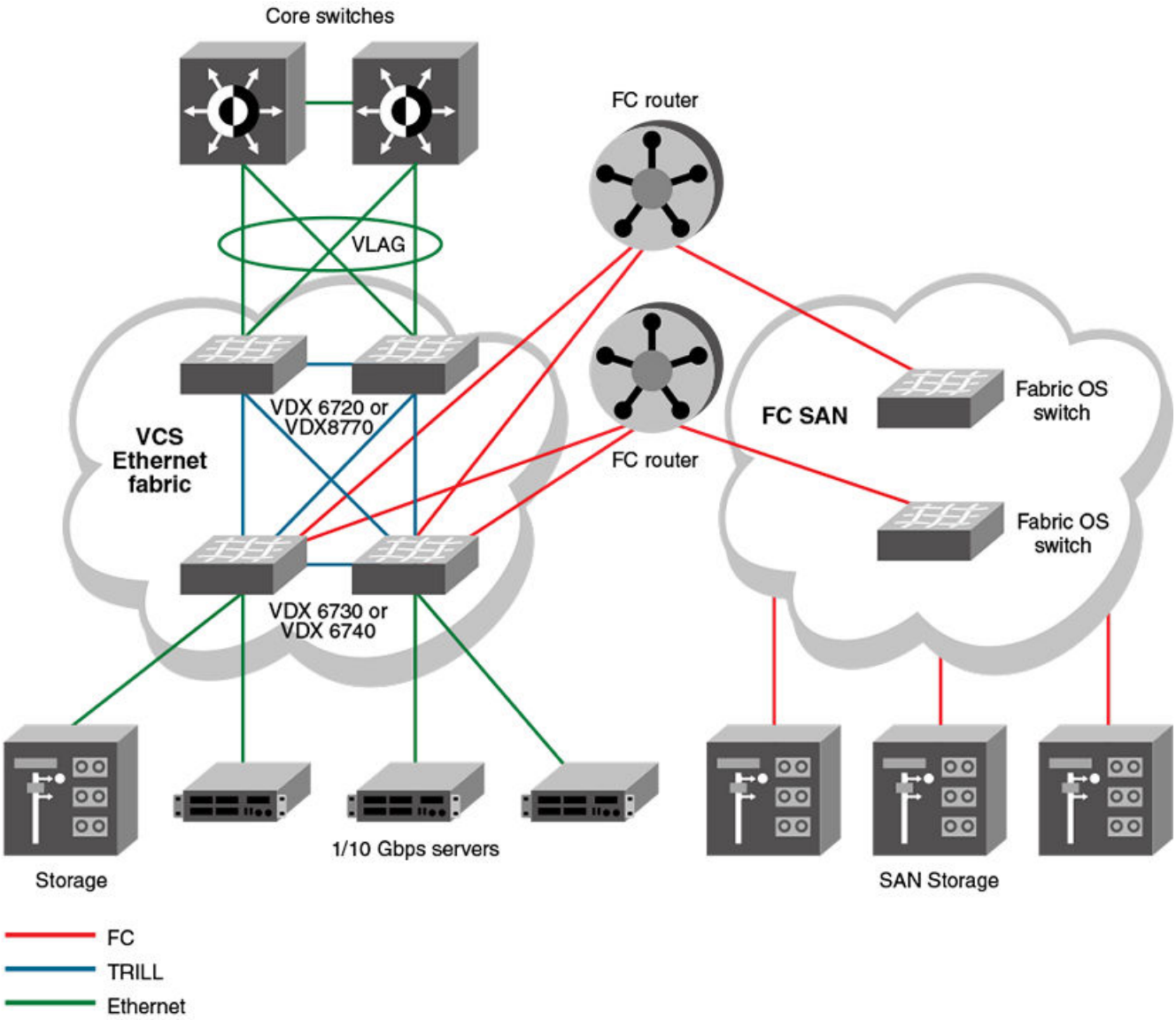
- Optimizes the multipath network (all paths and Layer 3 gateways are active, no single point of failure, and STP is not necessary)
- Increases sphere of Virtual Machine (VM) mobility

Brocade VCS Fabric connectivity with Fibre Channel SAN

In Network OS 2.1.1 and later, Fibre Channel ports on the Brocade VDX 6730 provide support for connecting a Brocade VCS Fabric to a Fibre Channel SAN. Fibre Channel routers provide the connectivity, which provides access to Fibre Channel devices while preserving isolation between the fabrics. Brocade zoning allows you to determine which FCoE devices can access which storage devices on the Fibre Channel SAN.

Brocade VDX 6730 switches can be deployed into your Brocade VCS Fabric as access-level switches, aggregation-level switches, or as a means of attachment to Brocade VCS Fabric aggregation-level switches. Brocade recommends deployment as access-level switches to minimize congestion issues for storage traffic and isolating FCoE traffic from non-FCoE traffic. The following shows such a deployment.

FIGURE 7 Brocade VDX 6730 switches deployed as access-level switches



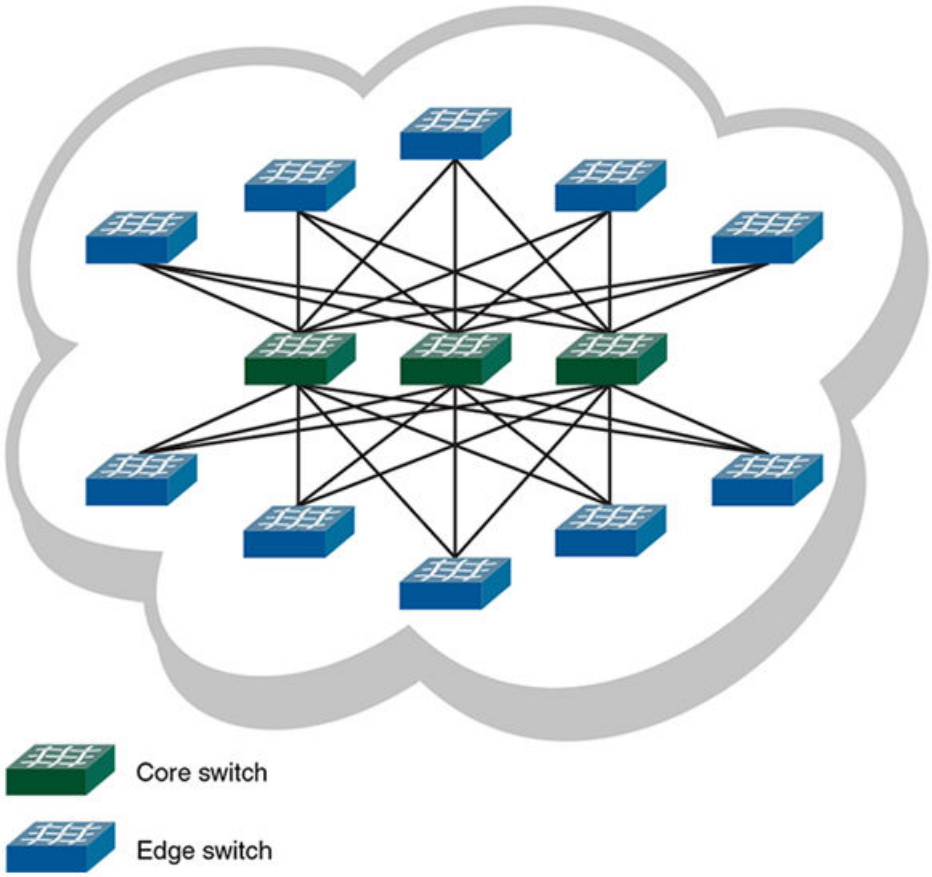
Topology and scaling

Up to 24 switches can exist in a Brocade VCS Fabric. Although you can use any network topology to build a Brocade VCS Fabric, the following topics discuss the scaling, performance, and availability considerations of topologies more commonly found in data centers:

Core-edge topology

Core-edge topology, devices connect to edge switches which are connected to each other through core switches. The example shown below uses three core switches. You could use more or fewer switches in the core, depending on whether you need higher availably and greater throughput, or a more efficient use of links and ports.

FIGURE 8 Core-edge topology



This topology is reliable, fast, and scales well. It is reliable because it has multiple core switches. If a core switch or a link to a core switch fails, an alternate path is available. As you increase the number of core switches, you also increase the number of link or core switch failures your cluster can tolerate.

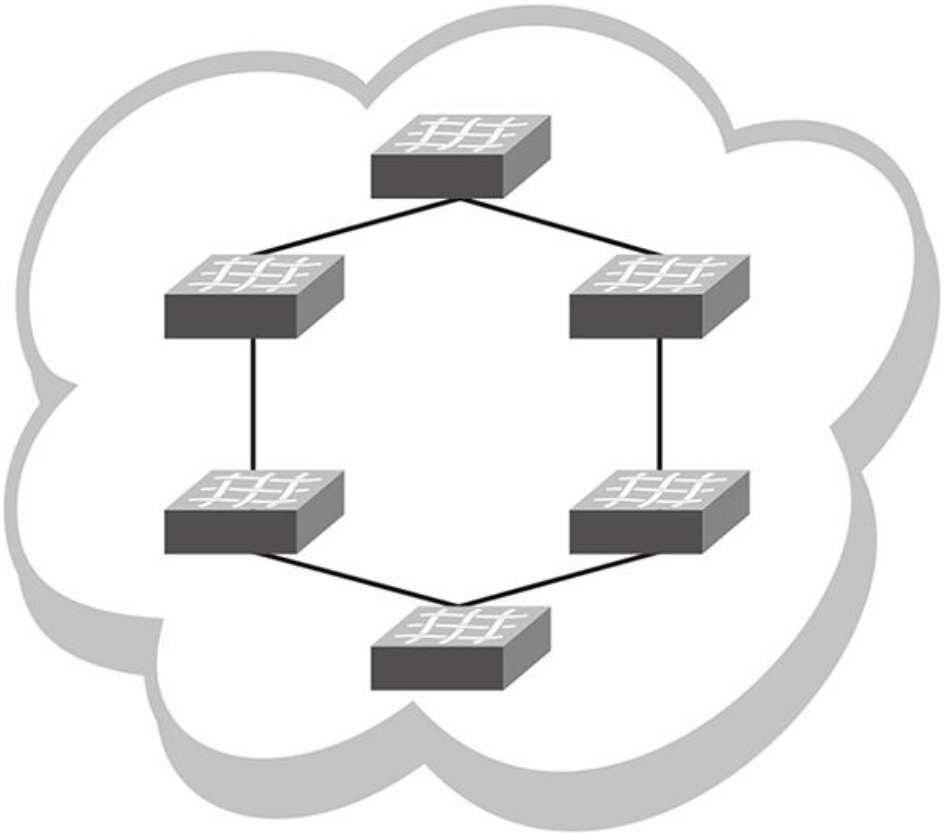
High performance and low latency are ensured because throughput is high and the hop count is low. Throughput is high because multiple core switches share the load. Two hops get you from any edge switch to any other edge switch. If you need greater throughput, simply add another core switch.

Scaling the topology also requires additional core switches and links. However, the number of additional links you need is typically not as great as with, for example, a full mesh topology.

Ring topology

Ring topology connects each node to exactly two other nodes, forming a single continuous pathway. Data travels from node to node, with each node along the path handling every packet of the data. The following shows a ring topology.

FIGURE 9 Ring topology

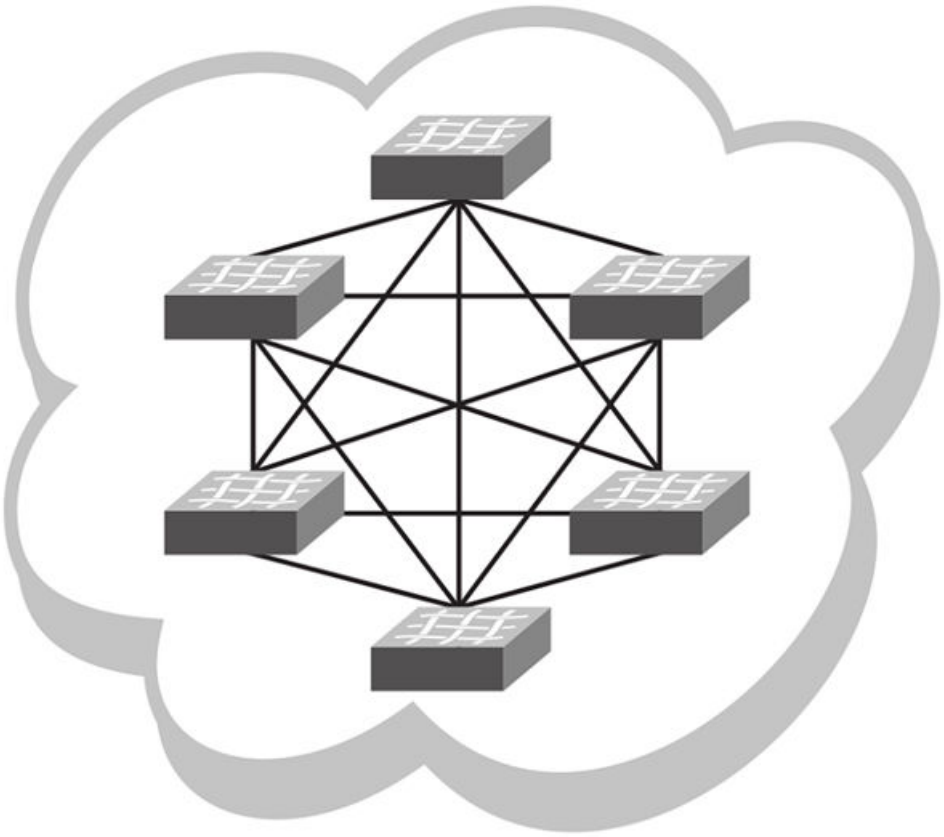


This topology is highly scalable, yet susceptible to failures and traffic congestion. It is highly scalable because of its efficient use of interswitch links and ports; an additional node requires only two ports to connect to the ring. It is susceptible to failures because it provides only one path between any two nodes. Throughput of the fabric is limited by the slowest link or node. Latency can be high because of the potentially high number of hops it takes to communicates between two given switches. This topology is useful where economy of port use is critical, but availability and throughput are less critical.

Full mesh topology

Full mesh topology connects each node to all other cluster nodes, as shown below.

FIGURE 10 Full mesh topology



This topology is highly reliable and fast, but it does not scale well. It is reliable because it provides many paths through the fabric in case of cable or node failure. It is fast with low latency because you can get to any node in the fabric in just one hop. It does not scale well because each additional node increases the number of fabric links and switch ports exponentially. This topology is suitable for smaller fabrics only.

Using the Network OS CLI

Network OS CLI overview

The Brocade Network OS command line interface (CLI) is designed to support the management of Data Center Bridging (DCB) and Layer 2 Ethernet switching functionality. The Network OS CLI uses an industry-standard hierarchical shell familiar to Ethernet/IP networking administrators.

The system starts up with the default Network OS configuration and the DCB startup configuration. After logging in, you are in the Network OS shell. For information on accessing the DCB commands from the Network OS shell, refer to Network OS CLI command modes on page 46.

Understanding roles

This section discusses the use of roles in Network OS.

RBAC permissions

Role-Based Access Control (RBAC) defines the capabilities that a user account has based on the role the account has been assigned.

A role is an entity that defines the access privileges of the user accounts on the switch. A user is associated with one role. Refer to Understanding and managing role-based access control (RBAC) on page 269 for information about RBAC.

Default roles

Attributes of default roles cannot be modified; however, the default roles can be assigned to non-default user accounts. The following roles are default roles:

- The **admin** role has the highest privileges. All CLIs are accessible to the user associated with the admin role. By default, the admin role has read and write access.
- The **user** role has limited privileges that are mostly restricted to show commands in privileged EXEC mode. User accounts associated with the user role cannot access configuration CLIs that are in global configuration mode. By default, the user role has read-only access.

For information on creating a user-defined role, refer to User-defined roles on page 269.

Accessing the Network OS CLI through Telnet

NOTE
While this example uses the **admin** role to log in to the switch, both roles can be used.

The procedure to access the Network OS CLI is the same through either the console interface or through a Telnet session; both access methods bring you to the login prompt.

```
switch login: admin
Password:**********
switch#
```

Multiple users can open Telnet sessions and issue commands by using privileged EXEC mode. Network OS 4.0 and later supports up to 32 Telnet sessions with the admin login.

Saving your configuration changes

Any configuration changes made to the switch are written into the *running-config* file. This is a dynamic file that is lost when the switch reboots. During the boot sequence, the switch resets all configuration settings to the values in the *startup-config* file.

To make your changes permanent, use the **copy** command to commit the *running-config* file to the *startup-config* file, as shown below.

Here is an example of entering the **copy running-config** in privileged EXEC mode:

```
switch# copy running-config startup-config
```

Network OS CLI command modes

For examples of Network OS CLI command modes, refer to the *Network OS Command Reference*.

Network OS CLI keyboard shortcuts

The following lists Network OS CLI keyboard shortcuts.

TABLE 2 Network OS CLI keyboard shortcuts

Keystroke	Description
Ctrl+B (or the left arrow key)	Moves the cursor back one character.
Ctrl+F (or the right arrow key)	Moves the cursor forward one character.
Ctrl+A	Moves the cursor to the beginning of the command line.
Ctrl+E	Moves the cursor to the end of the command line.
Esc B	Moves the cursor back one word.
Esc F	Moves the cursor forward one word.
Ctrl+Z	Returns to privileged EXEC mode.
Ctrl+P (or the up arrow key)	Displays commands in the history buffer with the most recent command displayed first.
Ctrl+N (or the down arrow key)	Displays commands in the history buffer with the most recent command displayed last.

NOTE
In privileged EXEC mode, use the **show history** command to list the commands most recently entered. The switch retains the history of the last 1000 commands entered for the current session.

Using the do command as a shortcut

You can use the **do** command to save time when you are working in any configuration mode and you want to run a command in privileged EXEC mode.

For example, if you are configuring LLDP and you want to execute a privileged EXEC mode command, such as the **dir** command, you would first have to exit the LLDP configuration mode. By using the **do** command with the **dir** command, you can ignore the need to change configuration modes, as shown in the following example.

```
switch(conf-lldp)# do dir
Contents of flash://
  -rw-r-----      1276  Wed Feb 4 07:08:49 2009  startup_rmon_config
  -rw-r-----      1276  Wed Feb 4 07:10:30 2009  rmon_config
  -rw-r-----      1276  Wed Feb 4 07:12:33 2009  rmon_configuration
  -rw-r-----      1276  Wed Feb 4 10:48:59 2009  startup-config
```

Completing Network OS CLI commands

To complete the spelling of commands or keywords automatically, begin typing the command or keyword and then press **Tab**. For example, at the CLI command prompt, type `te` and press **Tab**:

```
switch# te
```

The CLI displays the following command.

```
switch# terminal
```

If there is more than one command or keyword associated with the characters typed, the Network OS CLI displays all choices. For example, at the CLI command prompt, type `show l` and press **Tab**.

```
switch# show l
```

The CLI displays the following command.

```
Possible completions:
 lacp     LACP commands
 license  Display license keys installed on the switch.
 lldp     Link Layer Discovery Protocol(LLDP).
 logging  Show logging
```

Displaying Network OS CLI commands and command syntax

Enter a question mark (?) in any command mode to display the list of commands available in that mode.

```
switch(conf-lldp)# ?
Possible completions:
 advertise           The Advertise TLV configuration.
 description         The User description
 disable             Disable LLDP
 do                  Run an operational-mode command
```

```
 exit                Exit from current mode
 hello               The Hello Transmit interval.
 help                Provide help information
 iscsi-priority      Configure the Ethernet priority to advertise for iSCSI
 mode                The LLDP mode.
 multiplier          The Timeout Multiplier
 no                  Negate a command or set its defaults
 profile             The LLDP Profile table.
 pwd                 Display current mode path
 system-description  The System Description.
 system-name         The System Name
 top                 Exit to top level and optionally run command
```

To display a list of commands that start with the same characters, type the characters followed by the question mark (**?**).

```
switch# e?
Possible completions:
 exit  Exit the management session
```

To display the keywords and arguments associated with a command, enter the keyword followed by the question mark (?).

```
switch# terminal ?
Possible completions:
 length    Sets Terminal Length for this session
 monitor   Enables terminal monitoring for this session
 no        Sets Terminal Length for this session to default :24.
 timeout   Sets the interval that the EXEC command interpreter wait for user input.
```

If the question mark (?) is typed within an incomplete keyword, and the keyword is the only keyword starting with those characters, the CLI displays help for that keyword only.

```
switch# show d?
Possible completions:
 debug  Debug
 diag   Show diag related information
 dot1x  802.1x configuration
 dpod   Provides DPOD license information.
```

If the question mark (?) is typed within an incomplete keyword but the keyword matches several keywords, the CLI displays help for all the matching keywords.

```
switch# show i?
 interface Interface status and configuration
 ip     Internet Protocol (IP)
```

The Network OS CLI accepts abbreviations for commands. This example is the abbreviation for the **show qos interface all** command.

```
switch# sh q i a
```

If the switch does not recognize a command after **Enter** is pressed, an error message displays.

```
switch# hookup
                ^
syntax error: unknown argument.
```

If an incomplete command is entered, an error message displays.

```
switch# show
                   ^
syntax error: unknown argument.
```

Using Network OS CLI command output modifiers

You can filter the output of the Network OS CLI **show** commands by using the output modifiers described below.

TABLE 3 Network OS CLI command output modifiers

Output modifier	Description
append	Appends the output to a file.
redirect	Redirects the command output to the specified file.
include	Displays the command output that includes the specified expression.
exclude	Displays the command output that excludes the specified expression.
begin	Displays the command output that begins with the specified expression.
last	Displays only the last few lines of the command output.
tee	Redirects the command output to the specified file. Notice that this modifier also displays the command output.
until *string*	Ends the output when the output text matches the string.
count	Counts the number of lines in the output.
linnum	Enumerates the lines in the output.
more	Paginates the output.
nomore	Suppresses the pagination of the output.
FLASH	Redirects the output to flash memory.

Considerations for show command output

Network OS contains many versions of the **show** command. The output of the **show** command changes depending on your configuration and situation. However, in general terms the **show** command falls into one of two categories:

- Any **show** commands that are fabric (global configuration) in nature, such as VLAN, MAC Address table, AMPP, Zoning, and so on, should display or clear the information for all nodes in a logical chassis.
- Any **show** commands that are local to a switch, such as Layer 3 or Layer 2 functionality (for example, sFlow, SPAN, and so on), should display the local information by default, and display different switch information specific to an RBridge ID.

Basic Switch Management

Switch management overview

In addition to connecting to Brocade switches, an understanding of switch types, attributes, and operational modes is essential to the successful installation and management of networks. This chapter introduces the operational modes, command modes and submodes, and other switch-related activities (such as troubleshooting and managing high-availability scenarios), providing an essential reference for everyday management operations.

Connecting to a switch

You can connect to your switch through a console session on the serial port, or through a Telnet or Secure Shell (SSH) connection to the management port. You can use any account login present in the local switch database or on a configured authentication, authorization, and accounting (AAA) server for authentication. For initial setup procedures, use the preconfigured administrative account that is part of the default switch configuration.

The switch must be physically connected to the network. If the switch network interface is not configured or the switch has been disconnected from the network, use a console session on the serial port.

- Refer to the *Brocade VDX Hardware Reference* manuals for information on connecting through the serial port.
- Refer to Configuring Ethernet management interfaces on page 69 for details on configuring the network interface.

Telnet and SSH overview

Telnet and Secure Shell (SSH) are mechanisms for allowing secure access to management functions on a remote networking device. SSH provides a function similar to Telnet, but unlike Telnet, which offers no security, SSH provides a secure, encrypted connection to the device.

SSH and Telnet support is available in privileged EXEC mode on all Brocade VDX platforms. Both IPv4 and IPv6 addresses are supported.

Telnet and SSH services are enabled by default on the switch. When the Telnet server or SSH server is disabled, access to the switch is not allowed for inbound Telnet or SSH connections, thereby restricting remote access to the switch.

In configuration mode, the CLI can be used to disable Telnet or SSH service on the switch. Doing so will terminate existing inbound Telnet or SSH connections and block any new inbound Telnet or SSH connections to the switch. Additional inbound Telnet or SSH

connections will not be allowed until the Telnet server or SSH server is re-enabled. If you have admin privileges, you can re-enable inbound Telnet or SSH connections from configuration mode.

If you are in logical chassis cluster mode (refer to Operational modes on page 58), the command for enabling or disabling Telnet or SSH services is not distributed across the cluster. The RBridge ID of the node should be used to configure the service on individual nodes.

In operational mode, you can use the **show** command to display whether Telnet or SSH is enabled or disabled on the switch.

SSH server key exchange and authentication

The Secure Sockets Handling (SSH) protocol allows users to authenticate using public and private key pairs instead of passwords. In password-based authentication, the user must enter a password for authentication purposes. In public-key authentication, the user should have a private key in the local machine and a public key in the remote machine. The user should be logged in to the local machine to be authenticated. If a passphrase is provided while generating the public and private key pair, it must be entered to decrypt the private key while getting authenticated.

SSH key-exchange specifies the method used for generating the one-time session keys for encryption and authentication with the SSH server. A user is allowed to configure the SSH server key-exchange method to DH Group 14. When the SSH server key-exchange method is configured to DH Group 14, the SSH connection from a remote SSH client is allowed only if the key-exchange method at the client is also configured to DH Group 14.

The following steps briefly describe public-key authentication:

1. The user generates a pair of encryption keys in a local machine using the **ssh-keygen** command, along with the public and private key (as shown below). Messages encrypted with the private key can only be decrypted by the public key, and vice-versa.

```
switch# ssh-keygen -t rsa
 generates RSA public and private keypair
switch# ssh-keygen -t dsa
 generates DSA public and private keypair
```

2. The user keeps the private key on the local machine, and uploads the public key to the switch.
3. When attempting to log in to the remote host, the user receives an encrypted message from the remote host containing the public key. After the message is decrypted in the local host by means of the private key, the user is authenticated and granted access.

   The **ssh-keygen** command is not distributed across the cluster. The RBridge ID of the node should be used to configure service on individual nodes.

Feature support for Telnet

The following features are not supported with Telnet:

- Displaying Telnet sessions
- Terminating hung Telnet sessions

Feature support for SSH

SSHv2 is the supported version of SSH, but not all features typically available with SSHv2 are supported on the Brocade VDX family of switches.

The following encryption algorithms are supported:

- **3des** Triple-DES (default)

- **aes256-cbc** : AES in CBC mode with 256-bit key
- **aes192-cbc** : AES in CBC mode with 192-bit key
- **aes128-cbc** : AES in CBC mode with 128-bit key

The following HMAC (Hash-based Message Authentication Code) message authentication algorithms are supported:

- **hmac-md5** : MD5 encryption algorithm with 128-bit key (default).
- **hmac-md5-96** : MD5 encryption algorithm with 96-bit key.
- **hmac-sha1** : SHA1 encryption algorithm with 160-bit key.
- **hmac-sha1-96:** SHA1 encryption algorithm with 96-bit key.

SSH user authentication is performed with passwords stored on the device or on an external authentication, authorization, and accounting (AAA) server.

The following features are not supported with SSH:

- Displaying SSH sessions
- Deleting stale SSH keys

Firmware upgrade and downgrade considerations with Telnet or SSH

Downgrading the firmware on a switch to a Network OS version earlier than 4.0 is not allowed when either the Telnet server or the SSH server on the switch is disabled. To downgrade to a lower version, both the Telnet Server and SSH Server must be enabled.

Upgrading to Network OS 4.0 or later is automatically allowed because the Telnet server and SSH server status are enabled by default.

For more information, refer to Installing and Maintaining Firmware on page 109.

Using DHCP Automatic Deployment (DAD)

DHCP Automatic Deployment (DAD) is a method used to bring up the switch with new firmware or a preset configuration automatically.

DHCP Automatic Deployment (DAD) is a method used to bring up the switch with new firmware or preset configuration automatically.

In Network OS 4.1.0 and later, you can automatically bring up a switch with new firmware or a preset configuration, omitting the need for logging in to the switch console to configure the switch. If you are in standalone mode or fabric cluster mode, you can apply either the default configuration or a preset configuration. For node replacement in logical chassis cluster mode, the switch is set to the default configuration.

> NOTE
> The DAD process is disruptive to traffic.

You must be using DHCP to use DAD. You utilize the DHCP process to retrieve certain parameters (for example, the firmware path, VCS ID, VCS mode, RBridge ID, and preset configuration file) needed by the DAD process to perform the firmware and configuration downloads. Currently, only DHCPv4 is supported.

You must enable DAD from the CLI, after which the switch is rebooted automatically. After the DAD process is triggered and completed, DAD is automatically disabled. If you attempt to download new firmware that is already installed on the switch, the DAD process is aborted.

> NOTE
> If DAD is enabled, you are warned when initiating a firmware download from the CLI that the firmware download will be unsuccessful.

After a firmware download begins, DAD will report firmware download success or failure status.

DAD depends on DHCP automatic firmware download to load the firmware and configuration onto the switch. For this to occur, you must first adhere to the following dependencies:

- The management interface of the switch must be set up as DHCP. After setting up the management interface on a switch in either standalone or fabric cluster mode, you must use the **copy running-config startup-config** for the configuration to take effect.
- The DHCP server must have the FTP server IP address and configuration file path.
- The configuration file is on the FTP server and it contains the firmware path, new configuration file path, VCS ID, VCS mode, and RBridge ID.

DAD supports the following typical use cases:

- Invoking a firmware upgrade (and optional configuration download) on many switches at the same time in standalone and fabric cluster mode.
- Replacing a switch in a cluster by upgrading the firmware and setting up the switch to a preset configuration. (In this instance, DAD must be completed on the new switch hardware (in order to update the firmware) before the new switch can be incorporated into the cluster.)

Note the following considerations when using DAD:

- The DAD process is disruptive.
- Configuration download is not supported during a firmware downgrade.
- Configurations are not downloaded if the DAD process is aborted due to a sanity check failure, or if you are downloading the same firmware version before the firmware download started.
- If an existing firmware download session is either occurring or paused, such as during a firmware commit, DAD is not triggered. Instead, the last firmware download session continues. If a firmware download is in progress and you attempt to enable DAD, you are prompted to try again later.
- In-Service Software Upgrade (ISSU) is not supported at this time.
- For dual management module (MM) chassis, the dual MM must be in sync from the chassis bootup (not from HA failover). In a chassis system, both MMs are rebooted at the same time.

Configuring the DHCP Automatic Deployment process for replacing logical chassis cluster switches

Provides procedures for configuring DHCP Automatic Deployment (DAD) when replacing switches in logical chassis cluster mode.

The following procedure configures DHCP Automatic Deployment (DAD) when replacing switches in logical chassis cluster mode.

For logical chassis cluster switches, the DAD process applies to a new switch and the principal switch.

1. Disconnect the existing switch from the cluster.
2. Connect the new switch to the cluster. The new switch should be the same model and use the same cable connection as the old switch.
   The new switch should successfully load Network OS 4.1.0. Note, however, that the new switch cannot join the cluster just yet.
3. From the principal switch, manually run the node replacement with the WWN and RBridge ID.

4. Establish a DAD environment for the new switch. (Make sure DHCP is enabled on the management interface.)
    a) The management interface of the switch must be set up as DHCP. After setting up the management interface on a switch in either standalone or fabric cluster mode, you must use the **copy running-config startup-config** for the configuration to take effect.
    b) The DHCP server must have the FTP server IP address and configuration file path.
    c) The configuration file is on FTP server and it contains the firmware path, new configuration file path, VCS ID, VCS mode, and RBridge ID.
    d) The DHCP server and FTP server must be up-and-running.
    e) DAD must be enabled on the switch using the CLI.
5. Enable DAD by using the **dhcp auto-deployment enable** command, and enter **yes** when prompted to reboot the system.
6. After the new switch is rebooted, DHCP auto-download process downloads the DAD configuration file to get the VCS mode, VCS ID, and RBridge ID. The RBridge ID should be configured the same as the previous node in the cluster.
7. The DHCP auto-download process sets the VCS ID and RBridge ID for a switch in logical chassis cluster mode. No reboot is triggered.
8. The DHCP auto-download process invokes a firmware download if new firmware is detected. Firmware download completes successfully and the switch comes up with the new firmware and configuration settings.

    NOTE
    The DAD process will abort if any error is detected.

9. When the new switch comes up, it will join the cluster with the same configuration as the previous switch.
10. Use the **show dadstatus** command to view the current DAD configuration.

Configuring the DAD process for standalone and fabric cluster switches

Provides procedures for configuring DHCP Automatic Deployment (DAD) for switches in standalone mode or fabric cluster mode.

For the standalone and fabric cluster switches, the DHCP Automatic Deployment (DAD) process is applicable to both cluster upgrades and node replacement.

The following procedure configures DAD on switches in standalone mode and fabric cluster mode.

1. Establish a DAD environment for the new switch. (Make sure DHCP is enabled on the management interface.)
    a) The management interface of the switch must be set up as DHCP. After setting up the management interface on a switch in either standalone mode or fabric cluster mode, you must use the **copy running-config startup-config** for the configuration to take effect.
    b) The DHCP server must have the FTP server IP address and configuration file path.
    c) The configuration file is on FTP server and it contains the firmware path, new configuration file path, VCS ID, VCS mode, and RBridge ID.
    d) The DHCP server and FTP server must be up-and-running.
    e) DAD must be enabled on the switch using the CLI.

2. Enable DAD by using the **dhcp auto-deployment enable** command, and enter **yes** when prompted to reboot the system. During system bootup, the DHCP auto-download process downloads the DAD configuration file and obtains the VCS mode for a standalone switch, and VCS ID and RBridge ID settings for a switch in fabric cluster mode. The switch configuration is retrieved from the FTP server if one is set up.

   NOTE
   The DAD process will abort if any error is detected.

3. If node configuration needs to be downloaded, set up the new configuration as the startup configuration so it will be applied automatically.
   The DHCP auto-download process invokes a firmware download if new firmware is detected. After the firmware download completes successfully, the switch comes up with the new firmware and configuration settings.
4. Use the **show dadstatus** command to view the current DAD configuration.

Telnet and SSH considerations and limitations

- Access to the switch is not allowed for both inbound Telnet and SSH connections from both IPv4 and IPv6 addresses when the Telnet or SSH server are disabled.
- Outgoing Telnet or SSH connections from the switch to any remote device is not affected by disabling or enabling the Telnet or SSH server in the switch.
- No RASLog or auditlog messages are reported when the Telnet or SSH server is disabled or enabled.

Ethernet management interfaces

The Ethernet network interface provides management access, including direct access to the Network OS CLI. You must configure at least one IP address using a serial connection to the CLI before you can manage the system with other management interfaces. You can either configure static IP addresses, or you can use a Dynamic Host Configuration Protocol (DHCP) client to acquire IP addresses automatically. For IPv6 addresses, both static IPv6 and stateless IPv6 autoconfiguration are supported.

ATTENTION
Setting static IP addresses and using DHCP are mutually exclusive. If DHCP is enabled, remove the DHCP client before you configure a static IP address.

Brocade VDX Ethernet interfaces

The Brocade VDX compact switches have a single configurable Ethernet interface, Eth0, which can be configured as a management interface.

The modular chassis, the Brocade VDX 8770-8 and the Brocade VDX 8770-4, have two redundant management modules, MM1 and MM2. Each management module can communicate with each of the line cards (interface modules) through an Ethernet connection. Each management module has two Ethernet interfaces, Eth0 and Eth2.

Eth0 is the management interface and can be configured with an IP address. Eth2 provides connectivity to the other management module and the line cards in the chassis. The Eth2 IP addressing scheme uses default IP addresses to communicate between the modules; these addresses are not user-configurable.

To set a virtual IP address for the chassis, use the **chassis virtual-ip** command in RBridge ID configuration mode.

Stateless IPv6 autoconfiguration

IPv6 allows the assignment of multiple IP addresses to each network interface. Each interface is configured with a link local address in almost all cases, but this address is only accessible from other hosts on the same network. To provide for wider accessibility, interfaces are typically configured with at least one additional global scope IPv6 address. IPv6 autoconfiguration allows more IPv6 addresses, the number of which is dependent on the number of routers serving the local network and the number of prefixes they advertise.

When IPv6 autoconfiguration is enabled, the platform will engage in stateless IPv6 autoconfiguration. When IPv6 autoconfiguration is disabled, the platform will relinquish usage of any autoconfigured IPv6 addresses that it may have acquired while IPv6 autoconfiguration was enabled. This same enabled and disabled state also enables or disables the usage of a link local address for each managed entity (though a link local address will continue to be generated for each switch) because those link local addresses are required for router discovery.

The enabled or disabled state of autoconfiguration does not affect any static IPv6 addresses that may have been configured. Stateless IPv6 autoconfiguration and static IPv6 addresses can coexist.

Switch attributes

A switch can be identified by its IP address, World Wide Name (WWN), switch ID or RBridge ID, or by its host name and chassis name. You can customize the host name and chassis name with the **switch-attributes** command.

- A host name can be from 1 through 30 characters long. It must begin with a letter, and can contain letters, numbers, and underscore characters. The default host name is "sw0." The host name is displayed at the system prompt.
- Brocade recommends that you customize the chassis name for each platform. Some system logs identify the switch by its chassis name; if you assign a meaningful chassis name, logs are more useful. A chassis name can be from 1 through 30 characters long, must begin with a letter, and can contain letters, numbers, and underscore characters. The default chassis name is VDX 6710, VDX 6720-24, VDX 6720-60, VDX 6730-32, or VDX 6730-76, VDX 8770-4, or VDX 8770-8 depending on the switch model.

Switch types

The *switchType* attribute is a unique device model identifier that is displayed when you issue the **show chassis** or the **show rbridge-id** commands. When you are gathering information for your switch support provider, you may be asked for the Brocade product name. Use the following to convert the switchType identifier to a Brocade product name.

TABLE 4 Mapping switchType to Brocade product names

switchType	Brocade product name	Description
95.1 - 95.2	VDX 6720-24	24 1/10-GbE SFP+ ports
96.2	VDX 6730-32	24 1/10-GbE SFP+ ports and 8 8-Gbps FC ports
97.4	VDX 6720-60	60 1/10-GbE SFP+ ports
107.x	VDX 6730-76	60 1/10-GbE SFP+ ports and 16 8-Gbps FC ports
112	Management Module	Internal component on the switch
113	Switch Fabric Module	Internal component on the switch
116.2	VDX 6710-54	48 1-GbE copper and 6 1/10-GbE SFP+ ports

TABLE 4 Mapping switchType to Brocade product names (continued)

switchType	Brocade product name	Description
131	VDX 6740	48 10-GbE SFP+ ports and 4 40-GbE QSFP+ ports
137	VDX 6740T	48 10-GbE 10BASE-T ports and 4 40-GbE QSFP+ ports
151	VDX 6740T-1G	Same as VDX 6740T, but ships with ports set to 1 GbE
1000.x	VDX 8770-4	4 I/O slot chassis supporting 48x1 GbE, 48x10 GbE, 48x10G-T, 12x40 GbE, 27x40 GbE, or 6x100 GbE line cards
1001.x	VDX 8770-8	8 I/O slot chassis supporting 48x1 GbE, 48x10 GbE, 48x10G-T, 12x40 GbE, 27x40 GbE, or 6x100 GbE line cards

Operational modes

Network OS supports three operational modes for Brocade VDX switches.

The three operational modes are:

- *Logical chassis cluster mode* — One of two types of "VCS" modes for a switch. This mode requires Network OS 4.0.0 or later. In this mode, both the data and configuration paths are distributed. The entire cluster is configured from the principal node. Refer to Logical chassis cluster mode on page 58 for more information.
- *Fabric cluster mode* — The second of two types of "VCS" modes for a switch. In this mode, the data path for nodes is distributed, but the configuration path is not distributed. Each node keeps its configuration database independently. Refer to Fabric cluster mode on page 61 for more information.
- *Standalone mode* — Only the Brocade VDX 6710-54, 6720, and 6730 support this mode. Refer to Standalone mode on page 61 for more information.

When a new switch boots up, the switch enters either standalone mode or fabric cluster mode, depending on the switch model.

> **ATTENTION**
> The generic term *VCS mode* in this manual applies to both fabric cluster mode and logical chassis cluster mode unless otherwise stated.

Logical chassis cluster mode

Logical chassis cluster mode is defined as a fabric in which both the data and configuration paths are distributed. The entire cluster must be globally configured from the principal node. Logical chassis cluster mode requires Network OS 4.0.0 or later.

Logical chassis cluster mode support for platforms

The following platforms support logical chassis cluster mode and is used in any combination:

- Brocade VDX 6710
- Brocade VDX 6720
- Brocade VDX 6730
- Brocade VDX 6740
- Brocade VDX 6740T

- Brocade 6740T-1G
- Brocade VDX 8770-4
- Brocade VDX 8770-8

Logical chassis cluster mode characteristics

The following are the main characteristics of logical chassis cluster mode:

- The maximum number of nodes supported in a logical chassis cluster is 24 for the Brocade VDX 6710, 6720, and 6730; the maximum is 32 for the Brocade VDX 6740, 6740T, 6740T-1G, and 8770.
- Physical connectivity requirements for logical chassis cluster deployment are the same as those for fabric cluster deployment.
- A single global configuration exists across all nodes, while each node can contain its unique local configuration. However, each node contains the local configuration information for all other nodes in the cluster.
- Global and local configurations for the entire logical chassis cluster is performed from one node —the principal node only.
- Startup configurations are not maintained by the cluster; each node preserves its running configuration.
- A logical chassis cluster can be transitioned into a fabric cluster while preserving configurations if you follow the steps provided later in this section
- An existing fabric cluster can be transitioned into a logical chassis cluster while preserving configurations if you follow the steps provided later in this section
- A node that is a member of a logical chassis cluster can be transitioned to standalone mode. Platforms that allow standalone mode are the Brocade VDX 6710-54, 6720, and 6730.
- Cluster-wide firmware upgrades can be performed.
- Cluster-wide supportSave can be performed.

Command blocking in logical chassis cluster mode

In logical chassis cluster mode, some commands cannot be run while other commands or events are processing.

If one of the following CLI command types or events is in progress in the cluster, then any one of the CLI command types listed below will be rejected until the current command or event has finished.

1. *Copy file running-config commands*
2. *HA failover commands*
3. *VCS ID/RbridgeID change commands*
4. *Cluster mode change from logical chassis cluster to fabric cluster*
5. *Copy default-config startup-config commands*
6. *Configuration updates by individual commands*
7. *Cluster formation events, such as initial cluster formation or secondary joining or rejoining of a cluster*

These command and events are considered to be blocked from occurring simultaneously. However, if the principal node changes during one of these operations or HA failover occurs on principal switch, the new principal will not retain the information that the commands or events not in progress are in a blocked state.

In the case of commands being blocked, the following are some of the error messages that could result:

- Cluster formation is in progress. Please try again later.
- User Configuration update is in progress. Please try again later.

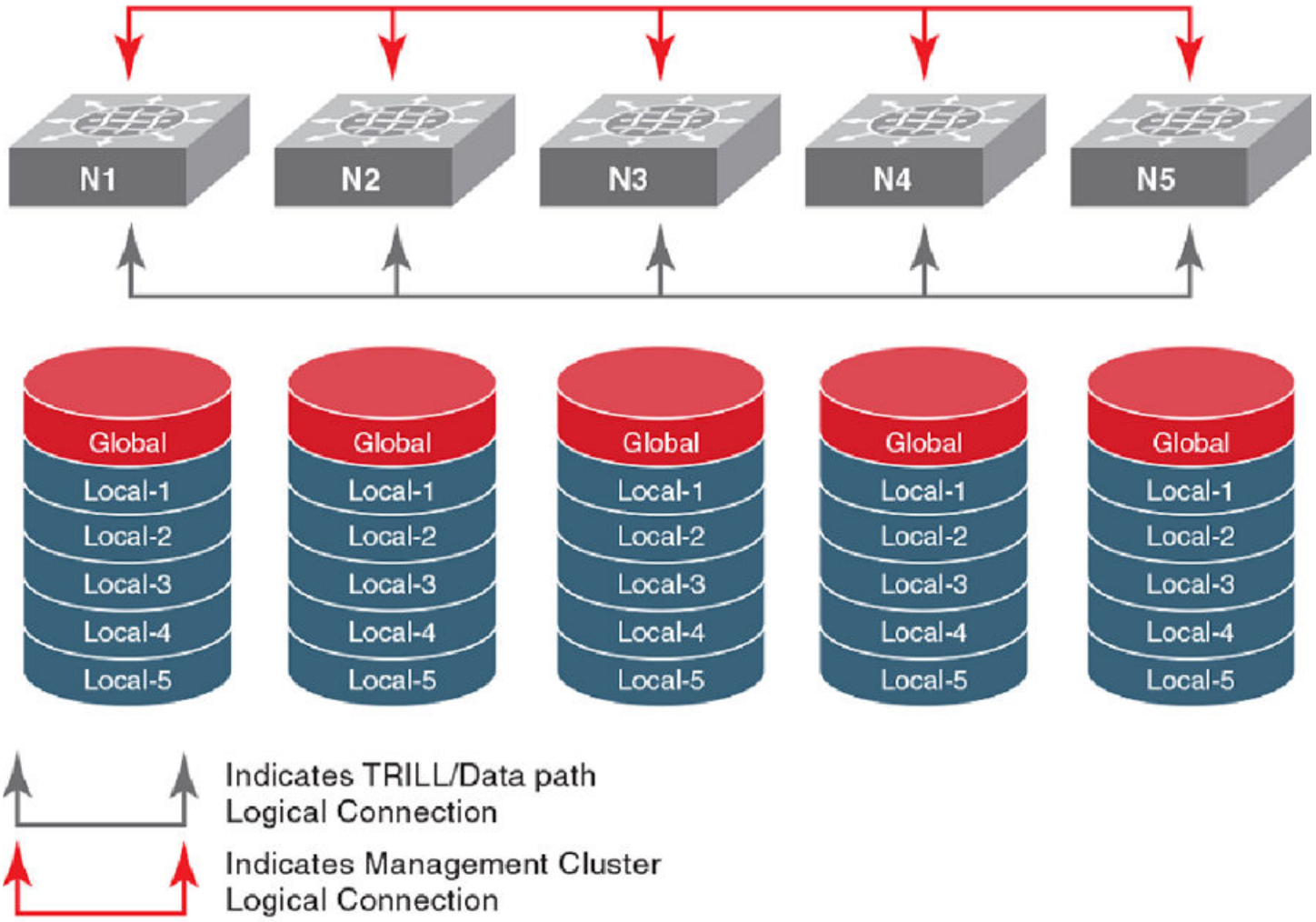
- Configuration file replay is in progress. Please try again later.
- HA failover is in progress in the cluster. Please try again later.
- VCS Config change is in progress in the cluster. Please try again later.
- Copy default-config startup-config is in progress. Please try again later.

Logical chassis cluster mode configuration

In logical chassis cluster mode, any operation that results in writing to the configuration database gets automatically distributed. There are no exceptions.

Each node in the logical chassis cluster maintains an individual copy of the configuration to enable high availability of the cluster. The following illustrates nodes in a logical chassis cluster. Each node has its own databases, and the databases kept by each node are identical at all times.

FIGURE 11 Configuration database in a logical chassis cluster



Network OS switches contain both global and local configuration. In a logical chassis cluster, a single global configuration exists across all cluster members, while each individual member has its own local configuration. (Conversely, in fabric cluster mode, each cluster member can have its own unique global configuration.)

Global configuration is required for cluster-wide operations, whereas local configuration is specific to the operation of an individual node. For more information and examples of each type of configuration, refer to Examples of global and local configurations on page 84.

Fabric cluster mode

Fabric cluster mode is defined as a fabric in which the data path for nodes is distributed, but the configuration path is not distributed. Each node keeps its configuration database independently.

By default, the following platforms boot up in fabric cluster mode and will attempt to form Inter-Switch Links (ISLs):

- Brocade VDX 8770-4
- Brocade VDX 8770-8
- Brocade VDX 6740
- Brocade VDX 6740T
- Brocade VDX 6740T-1G

If the chassis is not connected to another switch, it forms a "single node VCS fabric." This means that the chassis operates as a standalone system, but the operational mode is always VCS-enabled. You cannot disable the VCS mode on any of the models listed above.

Standalone mode

All Brocade VDX compact switches (VDX 6710, VDX 6720, and VDX 6730) boot up in standalone (SA) mode. In this restricted mode, the switch supports only legacy features that were available in Network OS v2.1.1, with the exception of IP static routes and in-band management. All other Layer 3 features, or any other features introduced in later versions of Network OS are not available in standalone mode.

> **NOTE**
> The Brocade VDX 8770, 6740, 6740T, and 6740T-1G do not support standalone mode.

Modular platform basics

The Brocade VDX 8770 platform features two redundant management modules, three or six switch fabric modules, and four or eight line cards depending on the switch model. The Brocade VDX 8770-4 supports four line cards and the Brocade VDX 8770-8 supports eight line cards.

The following lists the modules supported on each platform.

TABLE 5 Modules supported on the Brocade VDX 8770 platform

Type MM	Module ID	Slot numbers VDX 8770-4	Slot numbers VDX 8770-8	Description
	0x70 = 112	M1, M2	M1, M2	Management module (an 8-core 1.5-GHz Control Processor)
SFM	0x71 = 113	S1 - S3	S1 - S6	Switch fabric module (core blade)

TABLE 5 Modules supported on the Brocade VDX 8770 platform (continued)

Type MM	Module ID	Slot numbers VDX 8770-4	Slot numbers VDX 8770-8	Description
LC48X10G	0x72 = 114	L1 - L4	L1 - L8	48-port 10-GbE line card
LC12X40G	0x7F = 127	L1 - L4	L1 - L8	12-port 40-GbE line card
LC48X1G	0x83 = 131	L1 - L4	L1 - L8	48-port 1-GbE line card
LC48X10G-T	0x97 = 151	L1 - L4	L1 - L8	48-port 10 Gbps Base-T line card
LC27X40G	0x96 = 150	L1 - L4	L1 - L8	27-port 40-GbE line card
LC6X100G	0x95 = 149	L1 - L4	L1 - L8	6-port 100-GbE line card

Management modules

Two management modules (MMs) provide redundancy and act as the main controller on the Brocade VDX 8770-4 and VDX 8770-8 chassis. The management modules host the distributed Network OS that provides the overall control plane management for the chassis. You can install a redundant management module in slot M1 or M2 in any of the Brocade VDX 8770 chassis. By default, the system considers the module in slot M1 the active management module and the module in slot M2 the redundant, or standby, management module. If the active module becomes unavailable, the standby module automatically takes over management of the system.

Each management module maintains its own copy of the configuration database. The startup configuration is automatically synchronized with the other management module.

Brocade recommends that each management module (primary and secondary partition) should maintain the same firmware version. For more information on maintaining firmware, refer to Installing and Maintaining Firmware on page 109.

Each management module has two Ethernet interfaces, Eth0 and Eth2. Eth0 is the management interface and can be configured with an IP address. For more information on configuring the management interface, refer to Connecting to a switch on page 51.

HA failover

Warm-recovery HA failover is supported for both fabric cluster mode and logical chassis cluster mode.

Warm recovery includes the following behaviors:

- No data path disruption results for Layer 2 and FCoE traffic.
- All Layer 2 control protocol states are retained.
- The topology state and interface state are retained.
- All running configuration is retained (including the last accepted user configuration just before HA failover).
- HA Management Module failover may result in data path and control path disruption for the Layer 3 protocol.
- Layer 3 configuration is replayed post-failover.
- During a warm recovery, the principal switch in a logical chassis cluster remains the principal switch. After warm recovery, the principal switch reestablishes cluster management layer connection with other switches and reforms the cluster.
- A secondary switch in a logical chassis cluster reestablishes cluster management layer connection with the principal switch and rejoins the cluster after warm recovery.
- If you run a **reload** command on an active MM, the principal switch in a logical chassis cluster goes into cold recovery and comes back up as a secondary switch.
- HA behavior during In-service software upgrades (ISSUs) is the same as for warm-recovery failover.

Support for In-service software upgrades

In-service software upgrades (ISSUs) are supported in Network OS 4.0.0 and later. An ISSU allows a dual management module system to be upgraded non-disruptively and is invoked by entering the **firmware download** command from the active management module.

ISSUs are supported in both fabric cluster mode and logical chassis cluster mode for the following Network OS upgrade paths:

- 4.0.0 to 4.0.1
- 4.0.0 to 4.1.0
- 4.0.1 to 4.1.0

ISSUs are supported in both fabric cluster mode and logical chassis cluster mode for the following downgrade path: 4.1.0 to 4.0.1

High Availability behavior during ISSUs is the same as that of warm recovery described in HA failover on page 62. For more information, refer to Upgrading firmware on a modular chassis on page 110.

Switch fabric modules

The switch fabric modules play a dual role in the fabric connectivity between line cards, providing both the data-plane connectivity and the control-plane connectivity needed for end-to-end credit management in each of the line cards.

In each chassis model, two slots are designated for supporting the control-plane connectivity. In the Brocade VDX 8770-4, the slots S1 and S2 are the designated control-plane slots. In the Brocade VDX 8770-8, the slots S3 and S4 are the designated control-plane slots. At least one of the control-plane slots must be populated to maintain operation. If you remove the switch fabric modules from both the control-plane slots, all line cards will be faulted and the chassis is no longer operational.

Line cards

The following line cards provide I/O ports for network Ethernet protocols:

- LC48x1G - forty eight 1-GbE/10-GbE SFP+ front ports.
- LC48x10G - forty eight 1-GbE/10-GbE SFP+ front ports.
- LC12x40G - twelve 40-GbE QSFP front ports.
- LC48x10G-T - forty eight 10 Gbps Base-T front ports.
- LC27x40G - twenty seven 40-GbE QSFP front ports.
- LC6x100G - six 100-GbE front ports.

Line card interface ports are named as follows:

- The 10-GbE interfaces are named "TenGigabitEthernet" or "TE".
- The 1-GbE interfaces are named "GigabitEthernet" or "GE".
- The 40-GbE QSFP interfaces are named "FortyGigabitEthernet" or "FO".

Supported interface modes

All interfaces in the Brocade VDX 8770 chassis come online as Fabric Inter-Switch Links ("Fabric ISLs") by default and will attempt to form a Brocade VCS fabric. If the ISL formation fails, the interfaces come up as "Edge ports".

NOTE

The Brocade VDX 8770 chassis always comes up in VCS mode. Standalone mode is not supported on the Brocade VDX 8770 platform.

Slot numbering and configuration

The slot number specifies the physical location of a module in a switch or router, and the number of available slots of each type (interface, management, or switch fabric) depends on the router. Slot configuration is done on a slot-by-slot basis, and the configurations are stored in a persistent database on the switch.

Slot numbering

The slot numbering on the Brocade VDX 8770 chassis is based on the module type. The slot numbers for the line card are numbered L1 through L4 on the Brocade VDX 8770-4, and L1 through L8 on the Brocade VDX 8770-8. The slots for the management modules are numbered M1 and M2. The slots for the switch fabric modules are numbered S1 through S3 on the Brocade VDX 8770-4, and S1 through S6 on the Brocade VDX 8770-8.

Slot configuration

Line cards are registered with the system by type, and the slot must be configured with the correct type before you can install an line card in that slot. When you install a new line card, the system checks whether or not a previous configuration is associated with the slot. The following rules apply when you install or replace an line card:

- When you install an line card and boot it up to an online state in a slot that was never occupied or configured, the module type information is automatically detected and saved to the database. No special configuration is required.
- If you install an line card in a slot that was previously occupied by an line card of the same type and the slot is configured for that same type, you can hot-swap the modules without powering off the line cards. No slot configuration changes are required.
- If the slot was previously configured for a different type of line card, the installation fails and the module is faulted with a "Type mismatch" error. A RASLog error message is generated. You must power off the line card and clear the slot configuration with the **no linecard** command before you can configure the slot for a new line card.

The slot configuration persists in the database even after the line card is physically removed, powered off, or faulted since it first came online. All configuration data associated with the slot is automatically preserved across reboot or hot-swap of the line card with the same type.

Connecting to a switch

You can connect to your switch through a console session on the serial port, or through a Telnet or Secure Shell (SSH) connection to the management port. You can use any account login present in the local switch database or on a configured authentication, authorization, and accounting (AAA) server for authentication. For initial setup procedures, use the preconfigured administrative account that is part of the default switch configuration.

The switch must be physically connected to the network. If the switch network interface is not configured or the switch has been disconnected from the network, use a console session on the serial port.

- Refer to the *Brocade VDX Hardware Reference* manuals for information on connecting through the serial port.
- Refer to Configuring Ethernet management interfaces on page 69 for details on configuring the network interface.

Establishing a physical connection for a Telnet or SSH session

1. Connect through a serial port to the switch.

2. Verify that the switch's network interface is configured and that it is connected to the IP network through the RJ-45 Ethernet port.
3. Log off the switch's serial port.
4. From a management station, open a Telnet or SSH connection using the management IP address of the switch to which you want to connect.

   For more information on setting the management IP address, refer to Connecting to a switch on page 51.
5. Enter the password.

   Brocade recommends that you change the default account password when you log in for the first time. For more information on changing the default password, refer to the *Brocade VDX Hardware Reference* manuals.
6. Verify that the login was successful.

   The prompt displays the host name followed by a pound sign (#).

```
switch# login as: admin

admin@10.20.49.112's password:******

-----------------------------------------------------
WARNING: The default password of 'admin' and 'user' accounts have not been changed.
Welcome to the Brocade Network Operating System Software
admin connected from 10.110.100.92 using ssh on VDX 6720-24
```

Telnet services

You can use the Telnet service to connect to a switch.

Establishing a Telnet connection

A Telnet session allows you to access a switch remotely using port 23. However, it is not secure. If you need a secure connection, use SSH.

1. To establish a Telnet session connection, enter **telnet** followed by the switch IP address.

```
switch# telnet 10.17.37.157
```

   If the switch is active and the Telnet service is enabled on it, a display similar to the following will appear.

```
Trying 10.17.37.157...
Connected to 10.17.37.157.
Escape character is '^]'.
Network OS (sw0)
switch login:
```

2. Once you have established the Telnet connection, you can log in normally.

   NOTE
   You can override the default port by using the **telnet** *ip_address* command with the optional **port** operand (range 0-65535). However, the device must be listening on that port for the connection to succeed.

The following example overrides the default port.

```
switch# telnet 10.17.37.157 87
Trying 10.17.37.157...
Connected to 10.17.37.157.
Escape character is '^]'.
Network OS (sw0)
switch# login:
```

Shutting down the Telnet service

Shutting down the Telnet service will forcibly disconnect all Telnet sessions running on a switch.

You must be in global configuration mode to shut down the Telnet service on a switch.

The Telnet service runs by default.

To shut down the Telnet service on a switch, enter **telnet server shutdown**.

```
switch(config)# telnet server shutdown
switch(config)#
```

All Telnet sessions are immediately terminated, and cannot be re-established until the service is re-enabled.

NOTE

If you are in VCS mode, you must enter RBridge ID configuration mode before issuing the command, as shown in the example below.

```
switch(config)# rbridge-id 3
switch(config-rbridge-id-3)# telnet server shutdown
```

Re-enabling the Telnet service

Re-enabling the Telnet service permits Telnet access to a switch.

You must be in global configuration mode to shut down the Telnet service on a switch.

To re-enable the Telnet service on a switch enter **no telnet server shutdown**.

```
switch(config)# no telnet server shutdown
```

NOTE

If you are in VCS mode, you must enter RBridge ID configuration mode before issuing the command, as shown in the example below.

```
switch(config)# rbridge-id 3
switch(config-rbridge-id-3)# no telnet server shutdown
```

Connecting with SSH

Connecting to a switch using the SSH (Secure Socket Handling) protocol permits a secure (encrypted) connection.

For a listing and description of all configuration modes discussed here, refer to Operational modes on page 58.

Establishing a SSH connection

A SSH (Secure Socket Handling) connection allows you to securely access a switch remotely.

You must be in privileged EXEC mode to make a SSH connection to a switch.

1. To establish an SSH connection with default parameters, enter **ssh -l** followed by the *username* you want to use and the *ip_address* of the switch.

```
switch# ssh -l admin 10.20.51.68
```

2. Enter **yes** if prompted.

```
The authenticity of host '10.20.51.68 (10.20.51.68)' can't be established.
RSA key fingerprint is ea:32:38:f7:76:b7:7d:23:dd:a7:25:99:e7:50:87:d0.
Are you sure you want to continue connecting (yes/no)? yes

Warning: Permanently added '10.20.51.68' (RSA) to the list of known hosts.
admin@10.20.51.68's password: ********

WARNING: The default password of 'admin' and 'user' accounts have not been changed.
Welcome to the Brocade Network Operating System Software

admin connected from 10.20.51.66 using ssh on C60_68F
```

NOTE

You can use the **-m** and **-c** options to override the default encryption and hash algorithms.

```
switch# ssh -l admin -m hmac-md5 -c aes128-cbc 10.20.51.68
```

Importing an SSH public key

Importing an SSH public key allows you to establish an authenticated login for a switch.

You must be in privileged EXEC mode to import an SSH public key to a switch.

1. NOTE

   The following example allows you to import the SSH public key for the user "admin" from a remote host using the credentials shown.

   To import an SSH public key, enter **certutil import sshkey**, followed by **user** *Username* **host** *IP_Address* **directory** *File_Path* **file** *Key_filename* **login** *Login_ID*.

```
switch# certutil import sshkey user admin host 10.70.4.106 directory /users/home40/bmeenaks/.ssh
file id_rsa.pub login fvt
```

2. Enter the password for the user.

```
Password: ***********

switch# 2012/11/14-10:28:58, [SEC-3050], 75,, INFO, VDX6720-60, Event: sshutil, Status: success,
Info: Imported SSH public key from 10.70.4.106 for user 'admin'.
```

NOTE

If you are in VCS mode, you must enter RBridge ID configuration mode before issuing the command, as shown in the example below.

```
switch# certutil import sshkey user admin host 10.70.4.106 directory /users/home40/bmeenaks/.ssh file
id_rsa.pub login fvt rbridge-id 3
```

Deleting an SSH public key

Deleting an SSH public key from a switch prevents it from being used for an authenticated login.

You must be in privileged EXEC mode to delete an SSH public key from a switch.

To delete an SSH public key, enter **no certutil sshkey user** *Username* followed by either **rbridge-id** *rbridge-id* or **rbridge-id all**.

```
switch# no certutil sshkey user admin rbridge-id all
```

Specifying a specific RBridge ID removes the key from that RBridge ID; specifying all removes it from all RBridge IDs on the switch.

Shutting down the SSH service

Shutting down the SSH (Secure Socket Handling) service will forcibly disconnect all SSH sessions running on a switch.

You must be in global configuration mode to shut down the SSH service on a switch.

The SSH service runs by default.

To shut down the SSH service on a switch, enter **ssh server shutdown**.

```
switch(config)# ssh server shutdown
switch(config)#
```

All SSH sessions are immediately terminated, and cannot be re-established until the service is re-enabled.

NOTE

If you are in VCS mode, you must enter RBridge ID configuration mode before issuing the command, as shown in the example below.

```
switch(config)# rbridge-id 3
switch(config-rbridge-id-3)# ssh server shutdown
switch(config-rbridge-id-3)#
```

Re-enabling the SSH service

Re-enabling the SSH (Secure Socket Handling) service permits SSH access to a switch.

You must be in global configuration mode to shut down the SSH service on a switch.

To re-enable the SSH service on a switch enter **no ssh server shutdown**.

```
switch(config)# no ssh server shutdown
switch(config)#
```

NOTE

If you are in VCS mode, you must enter RBridge ID configuration mode before issuing the command, as shown in the example below.

```
switch(config)# rbridge-id 3
switch(config-rbridge-id-3)# no ssh server shutdown
```

Configuring and managing switches

The following sections describe how to configure and manage Brocade switches.

Configuring Ethernet management interfaces

The Ethernet network interface provides management access, including direct access to the Network OS CLI. You must configure at least one IP address using a serial connection to the CLI before you can manage the system with other management interfaces. You can either configure static IP addresses, or you can use a Dynamic Host Configuration Protocol (DHCP) client to acquire IP addresses automatically. For IPv6 addresses, both static IPv6 and stateless IPv6 autoconfiguration are supported.

ATTENTION
Setting static IP addresses and using DHCP are mutually exclusive. If DHCP is enabled, remove the DHCP client before you configure a static IP address.

NOTE
You must connect through the serial port to set the IP address if the network interface is not configured already. Refer to the *Brocade VDX Hardware Reference* manual for your specific product for information on connecting through the serial port.

Configuring static IP addresses

Use static Ethernet network interface addresses in environments where the DHCP service is not available. To configure a static IPv4 or IPv6 address, you must first disable DHCP. Refer to Configuring an IPv4 address with DHCP on page 70 for more information.

Configuring a static IPv4 Ethernet address

1. Connect to the switch through the serial console.
2. In privileged EXEC mode, issue the **configure terminal** command to enter global configuration mode.
3. Enter the **interface management** *rbridge-id/port* command to configure the management port.

   This command enters a management interface configuration mode where you can choose configuration parameters for IPv4 and IPv6 addresses.

   - A compact switch has a single management port, and the port number for the management port is always 0.
   - On a modular switch with two redundant management modules, you can configure two management ports. The port numbers are 1 and 2.
4. Enter the **no ip address dhcp** command to disable DHCP.
5. Enter the **ip address** *IPv4_address/prefix_length* command.
6. Use the **ip route 0.0.0.0/0 gw-ip** command to configure the gateway address.

   NOTE
   The **ip gateway-address** command is not available on the Brocade VDX series if the L3 or Advanced license is installed. In that case, use the following command sequence:

   ```
   switch(config)# rbridge-id 1
   switch(config-rbridge-id-1)# ip route 0.0.0.0/0 default_gateway_address
   ```

7. Verify the configuration with the **do show running-config interface management** command.

   NOTE
   Specifying an IPv4 address with a subnet mask is not supported. Instead, enter a prefix number in Classless Inter-Domain Routing (CIDR) notation. To enter a prefix number for a network mask, type a forward slash (/) and the number of bits in the mask immediately after the IP address. For example, enter, "209.157.22.99/24" for an IP address that has a network mask with 24 leading 1s in the network mask, representing 255.255.255.0.

```
switch(config-Management-1/0)# do show running-config interface management
interface Management 1/0
 no ip address dhcp
 ip address 10.24.85.81/20
 r-bridge-id1
 ip route 0.0.0.0/0 10.24.80.1
 no ipv6 address autoconfig
```

8. Apart from the two IP addresses on the management modules, modular switches also supports a chassis virtual IP address. Using this virtual IP address, you can login to the switch. The VCS virtual IP address binds to the active MM automatically.

```
switch(config)# rbridge-id 1
switch(config-rbridge-id-1)# chassis virtual-ip 10.24.85.90/20
```

   NOTE
   In DHCP mode, the chassis IP address is obtained by means of DHCP.

Configuring a static IPv6 Ethernet address

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Enter the **interface management** *rbridge-id/port* command.

   This command enters a management interface configuration mode where you can choose configuration parameters for IPv4 and IPv6 addresses.

   - A compact switch has a single management port, and the port number for the management port is always 0.
   - On a modular switches with two redundant management modules, you can configure two management ports. The port numbers are 1 and 2.

3. Enter the **ipv6 address** *IPv6_addresss/prefix_length* command.

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# interface management 1/0
switch(config-Management-1/0)# ipv6 address fd00:60:69bc:832:e61f:13ff:fe67:4b94/64
```

4. Apart from the two IP addresses on the management modules, modular switches also support a chassis virtual IP address. Using this virtual IP address, you can log in to the switch. The VCS virtual IP address binds to the active MM automatically.

```
switch(config)# rbridge-id 1
switch(config-rbridge-id-1)# chassis virtual-ipv6 2001:db8:8086:6502/64
```

Configuring an IPv4 address with DHCP

NOTE
DHCP is not supported for IPv6 addresses.

By default, DHCP is disabled. You must explicitly enable the service. Use the **ip address dhcp** command to enable DHCP for IPv4 addresses, and the **ipv6 address dhcp** command to enable DHCP for IPv6 addresses. The Network OS DHCP clients support the following parameters:

- External Ethernet port IP addresses and prefix length
- Default gateway IP address

NOTE
When you connect the DHCP-enabled switch to the network and power on the switch, the switch automatically obtains the Ethernet IP address, prefix length, and default gateway address from the DHCP server. The DHCP client can only connect to a DHCP server on the same subnet as the switch. Do not enable DHCP if the DHCP server is not on the same subnet as the switch.

The following example enables DHCP for IPv4 addresses.

```
switch(config)# interface management 1/1
switch(config-Management-1/1)# ip address dhcp
```

The following example enables DHCP for IPv6 addresses.

```
switch(config)# interface management 1/1
switch(config-Management-1/1)# ipv6 address dhcp
```

The **show running-config interface management** command indicates whether DHCP is enabled. The following example shows a switch with DHCP enabled for IPv4 addresses.

```
switch# show running-config interface management
interface Management 2/0
ip address dhcp
ip route 0.0.0.0/0 10.24.80.1
ip address 10.24.73.170/20
no ipv6 address autoconfig
```

NOTE
Enabling DHCP removes all configured static IP addresses.

Configuring IPv6 autoconfiguration

Refer also to Stateless IPv6 autoconfiguration on page 57.

1. In privileged EXEC mode, issue the **configure terminal** command to enter global configuration mode.
2. Take the appropriate action based on whether you want to enable or disable IPv6 autoconfiguration.
   - Enter the **ipv6 address autoconfig** command to enable IPv6 autoconfiguration for all managed entities on the target platform.
   - Enter the **no ipv6 address autoconfig** command to disable IPv6 autoconfiguration for all managed entities on the target platform.

NOTE
On the Brocade VDX 8770, the **autoconfig** command can be issued only on the interface *rbridge-id* /1. However, this operation enables auto-configuration for the entire chassis.

Displaying the network interface

If an IP address has not been assigned to the network interface, you must connect to the Network OS CLI using a console session on the serial port. Otherwise, connect to the switch through Telnet or SSH. Enter the **show interface management** command to display the management interface.

The following example shows the management interface on a Brocade VDX compact switch.

```
switch# show interface management
interface Management 9/0
 ip address 10.24.81.65/20
 ip route 0.0.0.0/0 10.24.80.1
 ipv6 ipv6-address [ ]
 ipv6 ipv6-gateways [ fe80::21b:edff:fe0f:bc00 fe80::21b:edff:fe0c:c200 ]
 line-speed actual "1000baseT, Duplex: Full"
 line-speed configured Auto
```

The following example shows the management interfaces on a Brocade VDX 8770-4. IPv6 autoconfiguration is enabled for the entire chassis, and, as a result, a stateless IPv6 address is assigned to both management interfaces.

```
switch# show interface management
interface Management 110/1
 ip address 10.20.238.108/21
 ip route 0.0.0.0/0 10.24.80.1
 ipv6 ipv6-address [ "stateless fd00:60:69bc:85:205:33ff:fe78:7d88/64 preferred" ]
 ipv6 ipv6-gateways [ fe80::21b:edff:fe0b:7800 fe80::21b:edff:fe0b:2400 ]
 line-speed actual "1000baseT, Duplex: Full"
 line-speed configured Auto
interface Management 110/2
 ip address 10.20.238.109/21
 ip route 0.0.0.0/0 10.24.80.1
 ipv6 ipv6-address [ "stateless fd00:60:69bc:85:205:33ff:fe78:be14/64 preferred" ]
 ipv6 ipv6-gateways [ fe80::21b:edff:fe0b:7800 fe80::21b:edff:fe0b:2400 ]
 line-speed actual "1000baseT, Duplex: Full"
 line-speed configured Auto
```

Configuring the management interface speed

By default, the speed of the interface is set to autoconfiguration, which means the interface speed is optimized dynamically depending on load and other factors. You can override the default with a fixed speed value of 10 Mbps full duplex or 100 Mbps full duplex.

1. In privileged EXEC mode, issue the **configure terminal** command to enter global configuration mode.

   ```
   switch# configure terminal
   Entering configuration mode terminal
   ```

2. Enter the **interface management** command followed by *rbridge-id***/0** .

   This command places you in the management interface subconfiguration mode.

   ```
   switch(config)# interface management 1/0
   switch(config-Management-1/0)#
   ```

3. Enter the **speed** command with the selected speed parameter. The valid values are **10**, **100**, and **auto.**

   ```
   switch(config-Management-1/0)# speed auto
   ```

4. Enter the **do show interface management** command followed by *rbridge-id*/**0** to display the new settings.

```
switch(config-Management-1/0)# do show interface management 1/0
interface Management 1/0
ip address 10.24.81.65/20
ip route 0.0.0.0/0 10.24.80.1
ipv6 ipv6-address [ ]
ipv6 ipv6-gateways [fe80::21b:edff:fe0f:bc00 fe80::21b:edff:fe0c:c200]
line-speed actual "1000baseT, Duplex: Full"
line-speed configured Auto
```

5. Save the configuration changes by using the **copy running-config startup-config** command.

```
switch(config-Management-1/0)# do copy running-config startup-config
```

Configuring a switch banner

A banner is a text message that displays on the switch console. It can contain information about the switch that an administrator may want users to know when accessing the switch.

The banner can be up to 2048 characters long. To create a multi-line banner, enter the **banner login** command followed by the **Esc-m** keys. Enter **Ctrl-D** to terminate the input.

If you are in logical chassis cluster mode, the configuration is applied to all nodes in the cluster.

Do the following to set and display a banner.

1. In privileged EXEC mode, issue the **configure terminal** command to enter global configuration mode.
2. Enter the **banner login** command and a text message enclosed in double quotation marks (" ").
3. Enter the **do show running-config banner** command to display the configured banner.

```
switch# configure terminal

Entering configuration mode terminal
switch(config)# banner login "Please do not disturb the setup on this switch"

switch(config)# do show running-config banner

banner login "Please do not disturb the setup on this switch"
```

Use the **no banner login** command to remove the banner.

Configuring switch attributes

Refer also to:

- Switch attributes on page 57.
- Switch types on page 57.

Setting and displaying the host name

1. In privileged EXEC mode, issue the **configure terminal** command to enter global configuration mode.
2. If Telnet is not activated on the switch, enter the **no telnet server disable** command to activate Telnet.
3. Enter the **switch-attributes** command, followed by a question mark (?) to determine the local RBridge ID.
4. Enter the **switch-attributes** command, followed by the RBridge ID.
5. Enter the **host-name** operand, followed by the host name.

6. Save the configuration changes by using the **do copy running-config startup-config** command.

   NOTE
   This step is used for switches in standalone mode or fabric cluster mode only. If you are using logical chassis cluster mode, startup configurations are not maintained by the cluster; each node preserves its running configuration. For more information about logical chassis cluster mode, refer to Logical chassis cluster mode on page 58.

7. Verify the configuration with the **do show running-config switch-attributes** *rbridge-id* command.

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# no telnet server disable
switch(config)# switch-attributes ?
Possible completions: <NUMBER:1-239>  Specify the rbridge-id 1
switch(config)# switch-attributes 1
switch(config-switch-attributes-1)# host-name lab1_vdx0023
switch(config-switch-attributes-1)# exit
switch(config)# do copy running-config startup-config
switch(config)# do show running-config switch-attributes 1
switch-attributes 1
 chassis-name VDX 6720-24
 host-name lab1_vdx0023
```

Setting and displaying the chassis name

1. In privileged EXEC mode, issue the **configure terminal** command to enter global configuration mode.
2. Enter the **switch-attributes** command, followed by a question mark (?) to determine the local RBridge ID.
3. Enter the **switch-attributes** command, followed by the RBridge ID.
4. Enter the *chassis-name* operand, followed by the chassis name.
5. Save the configuration changes using the **do copy running-config startup-config** command.

   NOTE
   This step is used for switches in standalone mode or fabric cluster mode only. If you are using logical chassis cluster mode, startup configurations are not maintained by the cluster; each node preserves its running configuration. For more information about logical chassis cluster mode, refer to Logical chassis cluster mode on page 58.

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# switch-attributes ?
Possible completions: <NUMBER:1-239> Specify the rbridge-id 1
switch(config)# switch-attributes 1
switch(config-switch-attributes-1# chassis-name lab1_vdx0023
switch(config)# do copy running-config startup-config
switch(config)# do show running-config switch-attributes 1
switch-attributes 1
 chassis-name lab1_vdx0023
 host-name lab1_vdx0023
```

Viewing switch types

The switchType attribute is a unique device model identifier that allows you to identify the model of a switch from the command line.

In this example, the number 1000 is the value of the switchType attribute. An optional number (.x) indicates the revision of the motherboard.

Refer also to Switch types on page 57.

Enter **show chassis**.

```
switch# show chassis
Chassis Family: VDX 87xx
Chassis Backplane Revision: 1
switchType: 1000 <== Use table to convert this parameter
     (output truncated)
```

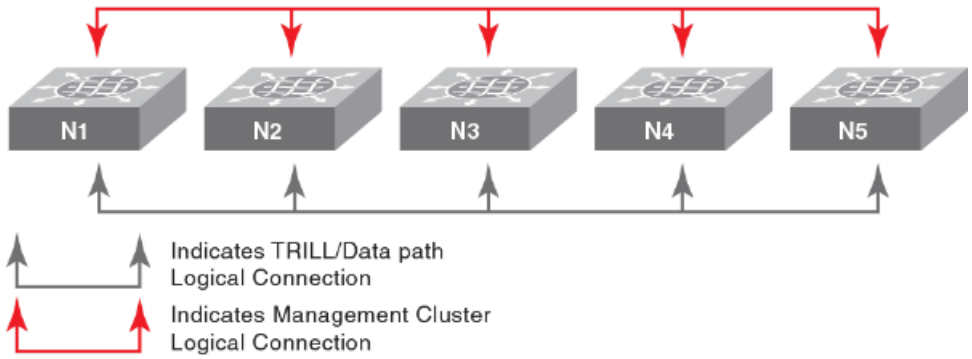
Configuring a switch in logical chassis cluster mode

Refer to Logical chassis cluster mode on page 58.

Creating a logical chassis cluster

This section covers the basic steps to create a logical chassis cluster, with the assumption that all physical connectivity requirements have been met. The following figure is a representation of a five-node logical chassis cluster.

FIGURE 12 Five-node logical chassis cluster



To create a logical chassis cluster, follow the steps in the following example:

1. Log in to one switch that will be a member of the logical chassis cluster you are creating:
2. In privileged EXEC mode, enter the **vcs** command with options to set the VCD ID, the RBridge ID and enable logical chassis mode for the switch. The VCS ID and RBridge IDs shown are chosen for the purposes of this example.

   ```
   switch# vcs vcsid 22 rbridge-id 15 logical-chassis enable
   ```

3. The switch reboots after you run the **vcs** command. You are asked if you want to apply the default configuration; answer **yes**.
4. Repeat the previous steps for each node in the cluster, changing only the RBridge ID each time. You must, however, set the VCS ID to the same value on each node that belongs to the cluster.

5. When you have enabled the logical chassis mode on each node in the cluster, run the **show vcs** command to determine which node has been assigned as the cluster principal node. The arrow (>) denotes the principal node. The asterisk (*) denotes the current logged-in node.

```
switch# show vcs
Config Mode    : Distributed
VCS Mode       : Logical Chassis
VCS ID         : 44
VCS GUID       : bcab366e-6431-42fe-9af1-c69eb67eaa28
Total Number of Nodes           : 3
Rbridge-Id       WWN                              Management IP   VCS Status       Fabric Status        HostName
-----------------------------------------------------------------------------------------------------------
144               10:00:00:27:F8:1E:3C:8C         10.18.245.143   Offline          Unknown              sw0
152              >10:00:00:05:33:E5:D1:93*        10.18.245.152   Online           Online               cz41-h06-
m-r2
158               10:00:00:27:F8:F9:63:41         10.18.245.158   Offline          Unknown
sw0
```

The RBridge ID with the arrow pointing to the WWN is the cluster principal. In this example, RBridge ID 154 is the principal.

6. Set the clock and time zone for the principal node. Time should be consistent across all the nodes. Refer to Network Time Protocol overview on page 95.
7. Log in to the principal cluster and make any desired global and local configuration changes. These changes then are distributed automatically to all nodes in the logical chassis cluster.

NOTE

You can enter the RBridge ID configuration mode for any RBridge in the cluster from the cluster principal node. You can change the principal node by using the **logical-chassis principal priority** and **logical chassis principal switchover** commands. For more information about cluster principal nodes, refer to Selecting a principal node for the cluster on page 80.

Taking precautions for mode transitions

Ensure that all nodes to be transitioned are running the same version of Network OS. Logical chassis cluster mode is supported starting with Network OS release 4.0.0

If you are merging multiple global configuration files to create one new global configuration file, be sure that the same entity name does not exist in the merged file. For example, if mac access-list extended **test1** contains the entries shown in the "Node 1 global configuration" and "Node 2 global configuration" below, when you merge the files you can rename mac access-list extended **test1** from Node 2 to mac access-list extended **test2** , as shown in the "Combined global configuration."

Node 1 global configuration

```
mac access-list extended test1
seq 10 permit any 1111.2222.333a ffff.ffff.ffff
seq 20 deny any 1111.2222.333b ffff.ffff.ffff
seq 30 deny any 1111.2222.333c ffff.ffff.ffff
seq 40 permit any any
```

Node 2 global configuration

```
mac access-list extended test1
seq 10 permit any 4444.5555.666d ffff.ffff.ffff
seq 20 deny any 4444.5555.666e ffff.ffff.ffff
seq 30 permit any any
```

Combined global configuration

```
mac access-list extended test1
seq 10 permit any 1111.2222.333a ffff.ffff.ffff
seq 20 deny any 1111.2222.333b ffff.ffff.ffff
seq 30 deny any 1111.2222.333c ffff.ffff.ffff
seq 40 permit any any
!
mac access-list extended test2
seq 10 permit any 4444.5555.666d ffff.ffff.ffff
seq 20 deny any 4444.5555.666e ffff.ffff.ffff
seq 30 permit any any
```

The local configuration for Node 2 also needs to be changed accordingly. In this example, one of the local configuration changes would be the interface TenGigabitEthernet. Instead of referencing **test1**, the local configuration file for Node 2 needs to reference **test2** because of the change that was made to the global configuration file. This is shown in the "Node 2 local configuration..." sections below.

Node 2 local configuration *before* matching the combined global configuration

```
interface TenGigabitEthernet 4/0/3
fabric isl enable
fabric trunk enable
switchport
switchport mode access
switchport access vlan 1
spanning-tree shutdown
mac access-group test1 in
no shutdown
```

Node 2 local configuration *after* matching the combined global configuration

```
interface TenGigabitEthernet 4/0/3
fabric isl enable
fabric trunk enable
switchport
switchport mode access
switchport access vlan 1
spanning-tree shutdown
mac access-group test2 in
no shutdown
```

ATTENTION
Be sure to take the following precautions.

- Note that the **copy default-config to startup-config** command in logical chassis cluster mode causes a cluster-wide reboot and returns the entire logical chassis cluster to the default configuration. Therefore, use this command only if you want to purge all existing configuration in the logical chassis cluster.
- Make sure that the backup files for global and local configurations are available in a proper SCP or FTP location that can be easily retrieved in logical chassis cluster mode during restore. Do not save the files in the local flash, because they may not be available on the principal node for replay of local configurations.

Converting a fabric cluster to a logical chassis cluster

You can convert an existing fabric cluster to a logical chassis cluster using the default configuration file.

1. Be sure all nodes are running the same firmware version. Logical chassis cluster functionality is supported in Network OS 4.0.0 and later.
2. Be sure all the nodes that you intend to transition from a fabric cluster to a logical chassis cluster are online. Run either the **show vcs** or **show vcs detail** command to check the status of the nodes.

3. Log into one switch that you are converting from fabric cluster mode to logical chassis cluster mode.
4. In Privileged EXEC mode, enter the **vcs logical-chassis enable** command with desired options; for example you can convert all RBridges with one command:

```
switch# vcs logical-chassis enable rbridge-id all default-config
```

NOTE
To convert a specific RBridge from fabric cluster mode to logical chassis mode, use the RBridge ID value in place of the "all" option. You can also specify a range, such as "1,3,4-6". Refer to the *Network OS Command Reference* for details.

The nodes automatically reboot in logical chassis cluster mode. Allow for some down time during the mode transition.

5. Run either the **show vcs** or the **show vcs detail** command to check that all nodes are online and now in logical chassis cluster (listed as "Distributed" in the command output) mode.
6. The **show vcs** command output can also be used to determine which node has been assigned as the cluster principal node.

```
switch# show vcs
R-Bridge   WWN                     Switch-MAC            Status
_____________________________________________________________________
1      > 11:22:33:44:55:66:77:81    AA:BB:CC::DD:EE:F1    Online
2        11:22:33:44:55:66:77:82    AA:BB:CC::DD:EE:F2    Online
3        11:22:33:44:55:66:77:83*      AA:BB:CC::DD:EE:F3    Online
```

The RBridge ID with the arrow pointing to the WWN is the cluster principal. In this example, RBridge ID 1 is the principal.

7. Log in to the principal cluster and make any desired global and local configuration changes. These changes then are distributed automatically to all nodes in the logical chassis cluster.

NOTE
You can enter the RBridge ID configuration mode for any RBridge in the cluster from the cluster principal node.

NOTE
You can change the principal node by using the **logical-chassis principal priority** and **logical chassis principal switchover** commands. For more information about cluster principal nodes, refer to Selecting a principal node for the cluster on page 80.

Converting a fabric cluster while preserving configuration

There is no specific command that can convert a fabric cluster to a logical chassis cluster while preserving current configurations, but you can accomplish this task as follows:

1. Be sure that all nodes are running the same firmware version. Logical chassis cluster functionality is supported in Network OS 4.0 and later.
2. Make sure all the nodes that you intend to transition from a fabric cluster to a logical chassis cluster are online. Run either the **show vcs** or **show vcs detail** command to check the status of the nodes.

3. Determine which node contains the global configuration you want to use on the logical chassis cluster, and make a backup of this configuration by running the **copy global-running-config** command and saving the configuration to a file on a remote ftp, scp, sftp or usb location:

   NOTE
   If you need to combine the global configurations of two or more nodes, manually combine the required files into a single file which will be replayed after the transition to logical chassis cluster mode by using the **copy global-running-config** *location_config_filename* command. Refer to the section Taking precautions for mode transitions on page 76

4. Back up the local configurations of all individual nodes in the cluster, by running the **copy local-running-config** command on each node and saving the configuration to a file on a remote ftp, scp, sftp, or usb location:

   copy local-running-config *location_config_filename*

5. Perform the mode transition from fabric cluster to logical chassis cluster by running the **vcs logical-chassis enable rbridge-id all default-config** command, as shown in Converting a fabric cluster to a logical chassis cluster on page 77.

   The nodes automatically reboot in logical chassis cluster mode. Allow for some down time during the mode transition.

6. Run either the **show vcs** or the **show vcs detail** command to check that all nodes are online and now in logical chassis cluster (listed as "Distributed" in the command output) mode.

7. The **show vcs** command output can also be used to determine which node has been assigned as the cluster principal node.

```
switch# show vcs
R-Bridge   WWN                       Switch-MAC            Status
_____________________________________________________________________
1     >    11:22:33:44:55:66:77:81    AA:BB:CC::DD:EE:F1    Online
2          11:22:33:44:55:66:77:82    AA:BB:CC::DD:EE:F2    Online
3          11:22:33:44:55:66:77:83*   AA:BB:CC::DD:EE:F3    Online
```

   The RBridge ID with the arrow pointing to the WWN is the cluster principal. In this example, RBridge ID 1 is the principal.

8. While logged on to the principal node in the logical chassis cluster, copy the saved global configuration file from the remote location to the principal node as follows:

   copy *location_config_filename* **running-config**

9. Verify that the global configuration is available by running the **show global-running-config** command.

10. While logged on to the principal node in the logical chassis cluster, copy each saved local configuration file from the remote location to the principal node as follows:

    copy *location_config_filename* **running-config**

    NOTE
    You must run this command for each local configuration file you saved (one for each node).

    The configuration file is automatically distributed to all nodes in the logical chassis cluster. Each node will contain the same global configuration after the above steps are performed. Each node will also contain the local configuration information of all the other nodes.

11. Verify that the local configurations are available by running the **show local-running-config** command.

12. Log in to the principal cluster and make any desired global and local configuration changes. These changes then are distributed automatically to all nodes in the logical chassis cluster.

    NOTE
    You can enter the RBridge ID configuration mode for any RBridge in the cluster from the cluster principal node. You can change the principal node by using the **logical-chassis principal priority** and **logical chassis principal switchover** commands. For more information about cluster principal nodes, refer to Selecting a principal node for the cluster on page 80.

Selecting a principal node for the cluster

Logical chassis cluster principal node behavior includes:

- All configuration for the logical chassis cluster must be performed on the principal node.
- By default, the node with the lowest WWN number becomes the principal node.
- You can run the **show vcs** command to determine which node is the principal node. An arrow in the display from this command points to the WWN of the principal node.
- You can select any node in the logical chassis cluster to become the principal by running the **logical chassis principal priority** command, followed by the **logical-chassis principal switchover** command, as shown in the following example (in this example, RBridge ID 5 is being assigned with the highest priority):

```
switch# configure
switch(config)# rbridge-id 5
switch(config-rbridge-id-5)# logical-chassis principal-priority 1
switch(config-rbridge-id-5)# end
switch# logical-chassis principal-switchover
```

A lower number means a higher priority. Values range from 1 to 128.

Until you run the **logical-chassis principal switchover** command, the election of the new principal node does not take effect.

Converting a logical chassis cluster to a fabric cluster

To transition all nodes in a logical chassis cluster to a fabric cluster, using default configurations, perform these steps:

1. Make sure all the nodes that you intend to transition from a logical chassis cluster to a fabric cluster are online. Run either the **show vcs** or **show vcs detail** command to check the status of the nodes.
2. Log in to the principal node on the logical chassis cluster.
3. Run the following command to convert all RBridge IDs: **no vcs logical-chassis enable rbridge-id** *all* **default-config**.

   NOTE
   To convert just one RBridge ID, specify the ID as shown in the following example: **no vcs logical-chassis enable rbridge-id** *rbridge-id* **default-config**.

   The nodes automatically reboot in fabric cluster mode. Plan for some down time for this transition.
4. Run either the **show vcs** or **show vcs detail** command to check that all nodes are online and now in fabric cluster (listed as "Local-only" in the command output) mode.

Converting to a fabric cluster while preserving configuration

There is no specific command that can convert a logical chassis cluster to a fabric cluster while preserving current configurations, but you can accomplish this task as follows:

1. Make sure all the nodes that you intend to transition from a logical chassis cluster to a fabric cluster are online. Run either the **show vcs** or **show vcs detail** command to check the status of the nodes.
2. Back up the configurations of all nodes in the cluster by running the **copy rbridge-running-config rbridge-id** command on each node and saving the configuration to a file on a remote ftp, scp, sftp, or usb location:

   copy rbridge-running-config rbridge-id *rbridge-id location_configfilename*

   This command copies both the global and local configurations for the specified RBridge ID.
3. From the principal node of the logical chassis cluster, transition the entire cluster to fabric cluster mode (using the default configuration) by running the following command:

   no vcs logical-chassis enable rbridge-id all default-config

   The nodes automatically reboot in fabric cluster mode. Plan for some down time for this transition.
4. Run either the **show vcs** or **show vcs detail** command to check that all nodes are online and now in fabric cluster (listed as "Local-only" in the command output) mode.
5. Restore the global and local configurations on each individual node for which you backed up these configurations by running the following command on each node:

   copy *location_configfilename* **running-config**
6. To cause this downloaded configuration to be persistent for a node, run the **copy running-config startup-config** command.

Adding a node to a logical chassis cluster

Nodes can be dynamically added to an existing logical chassis cluster. If the proper physical connections exist between the existing logical chassis cluster and the new node, the process is automatic.

Log into the new node and run the **vcs logical-chassis enable** command with the desired options. You must assign the new node the VCS ID of the existing cluster.

You can run the **show vcs** command to verify that the status of the added node is "online."

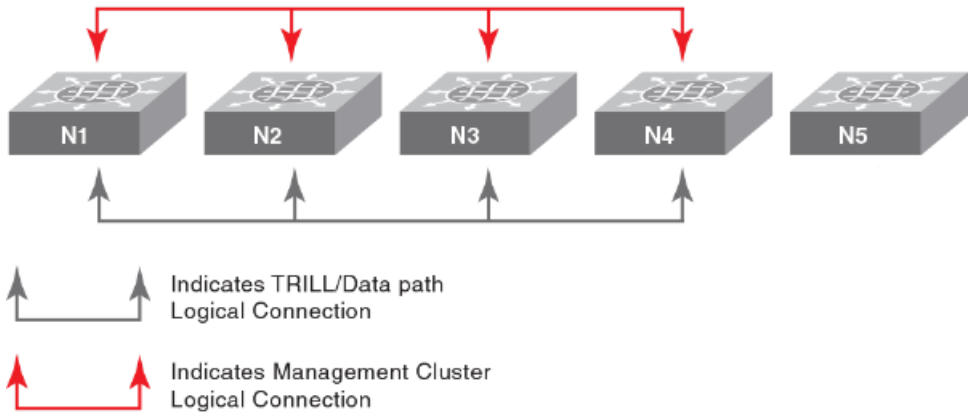
Removing a node from a logical chassis cluster

If the **no vcs enable** command is executed on a switch that is currently in logical chassis cluster mode, the switch boots in standalone mode. (Only the Brocade VDS 6710-54, 6720, and 6730 support standalone mode.) If the **no vcs logical-chassis enable** command is executed on a switch that is currently in logical chassis cluster mode, the switch boots in fabric cluster mode.

Once the node is removed, all configurations corresponding to that node are removed from the cluster configuration database. Similarly, the removed node does not retain any configurations corresponding to the other nodes in the cluster.

The following shows the cluster after node N5 has been removed. Nodes N1 through N4 remain in the cluster, and N5 is an island. There is no data path or management path connectivity between the two islands.

FIGURE 13 Removal of Node N5 from the logical chassis cluster



Rejoining a node to the cluster

Nodes that are temporarily isolated from a logical chassis cluster can re-join the cluster as long as no configuration or cluster membership changes have taken place on either the deleted node or the cluster. Run the **vcs logical-chassis enable** command with the desired options to rejoin the node to the cluster.

However, if configuration changes have occurred on either the node or cluster since the node was removed, you must reboot the node with its default configuration by issuing **copy default-config startup-config** on the segmented node.

Replacing a node in a logical chassis cluster

If a node in a logical chassis cluster becomes damaged and no longer be used, a similar node with identical capabilities can be used in its place.

The new node must use the same RBridge ID of the node that is being replaced. When the new node is detected, it joins the cluster as a previously known node instead of being considered a new node.

To replace a node that has an RBridge ID of 3 and then enter the WWN of the new node, follow the steps shown in the following example:

1. Run the following command on the principal switch:

```
switch# vcs replace rbridge-id 3
Enter the WWN of the new replacement switch: 11:22:33:44:55:66:77:81
```

2. Assign the RBridge ID of 3 to the new node by running the following command on the new node, assuming the new node is already VCS enabled:

```
switch# vcs rbridge-id 3
```

NOTE

If the new node is not yet VCS enabled, you can do so at the same time you assign the RBridge ID. Refer to the **vcs** command options in the *Network OS Command Reference*.

Merging two logical chassis clusters

You can merge two logical chassis clusters that have the same VCS ID. Follow these steps:

1. Make all required physical connections between the two independent clusters.
2. Decide which cluster should retain the configuration after the merge. Only one configuration can be retained.
3. On the cluster whose configuration will not be retained, issue the **copy default-config startup-config** command so that the nodes in this cluster will reboot with the default configuration.
4. Reboot all nodes in each cluster. The logical chassis cluster whose configuration is being retained recognizes the nodes from the other cluster as new nodes and adds them accordingly.
5. Re-apply the configuration to the cluster whose configuration was not retained.

Changing an RBridge ID on a switch within a fabric

It may become necessary to change the RBridge ID number on a switch that rebooted and has become orphaned from the cluster.

1. Backup the global configuration before changing the RBridge ID, because the local configuration will be reset to default values. Refer to Backing up configurations on page 102.
2. On the rebooted switch, execute the **chassis disable** command.

```
switch# chassis disable
```

3. From the fabric principal switch, execute the **no vcs enable rbridge-id** *rbridge-id* command, where *rbridge-id* is the switch that was orphaned.

```
switch# no vcs enable rbridge-id 3
```

4. On the rebooted switch, execute the **vcs rbridge-id** *rbridge-id* command, where *rbridge-id* is the RBridge you want to use.
5. The VCSID should already be set, if it's not set it with the **vcs rbridge-id** *rbridge-id*.
6. Reboot the orphaned switch.

   The following behavior will take effect after the switch reboots:

   - All interfaces will be in *shutdown* state. You must perform a **no shutdown** command on ISL interfaces before the switch will rejoin the cluster.
   - The original configuration will be lost and the switch will have a default configuration when it rejoins the cluster with the new RBridge ID.

7. Use the **show vcs detail** command to verify that the switch is in the fabric.

```
switch# show vcs detail
Config Mode : Local-Only
VCS ID : 1
Total Number of Nodes : 6
Node :1
Serial Number : BKN2501G00R
Condition : Good
Status : Connected to Cluster
VCS Id : 1
Rbridge-Id : 38
Co-ordinator : NO
WWN : 10:00:00:05:33:52:2A:82
Switch MAC : 00:05:33:52:2A:82
FCF MAC : 0B:20:B0:64:10:27
Switch Type : BR-VDX6720-24-C-24
Internal IP : 127.1.0.38
Management IP : 10.17.10.38
Node :2
Serial Number : BZA0330G00P
```

Examples of global and local configurations

The table below provides examples of global and local configuration commands that are available under the respective configuration modes. These settings can be viewed respectively by means of the **show global-running-config** command and the **show local-running-config** command.

TABLE 6 Global and local configuration commands

Global	Local
Interface vlan	switch-attributes
interface port-channel	interface management
port-profile	interface ve
mac access-list	diag post
ip access-list	dpod
sflow	switch-attributes
snmp-server	fabric route mcast
protocol lldp	rbridge-id
zoning	ip route
cee-map	linecard
username	router ospf
	router bgp
	protocol vrrp
	vrrp-group
	interface management
	interface gigabitethernet
	interface tengigabitethernet
	interface fortygigabitethernet
	interface fcoe

Use the **copy snapshot** commands if you need to upload or download configuration snapshot files to and from an ftp or scp server. You may need to use these commands if you took a snapshot of a configuration on a node that was disconnected from the cluster.

Refer to the *Network OS Command Reference* for detailed information about these and other logical chassis server commands.

Configuring a switch in fabric cluster mode

Refer also to Fabric cluster mode on page 61. When you issue the **show vcs** command to display the VCS configuration for the chassis, the command output shows a single-node VCS with a VCS ID of 1 and an RBridge ID of 1. Use the **vcs** command to change the default values.

```
switch0# show vcs
Config Mode  : Local-Only
VCS ID       : 1
Total Number of Nodes : 1
Rbridge-Id WWN                       Management IP VCS Status Fabric Status HostName
-----------------------------------------------------------------------------------
1         >10:00:00:05:33:51:63:42*  10.17.37.154  Online     Online        switch0
                                     2607:f0d0:1002:ff51:ffff:ffff:ffff:fff5
```

Configuring a switch in standalone mode

When you display the VCS configuration for a Top-of-Rack (ToR) switch in default mode, it shows that VCS mode is disabled. Always confirm the status of a switch before making configuration changes.

```
switch# show vcs
state: Disabled
```

Refer also to Standalone mode on page 61.

Displaying switch interfaces

Interfaces on the VDX 8770 platform are identified by the RBridge ID, slot number, and port number, separated by forward slashes (/). For example, the notation 9/2/8 indicates port 8 located in slot 2 on a chassis with the RBridge ID of 9.

Enter the **show running-config interface** *interface_type* command to display the interfaces and their status.

```
switch# show running-config interface tengigabitethernet
interface tengigabitethernet 1/1/1
fabric isl enable
fabric trunk enable
no shutdown
!
interface tengigabitethernet 1/1/2
fabric isl enable
fabric trunk enable
no shutdown
!
interface tengigabitethernet 1/1/3
fabric isl enable
fabric trunk enable
no shutdown
!
interface tengigabitethernet 1/1/4
fabric isl enable
fabric trunk enable
no shutdown
!
interface tengigabitethernet 1/1/5
fabric isl enable
fabric trunk enable
no shutdown
!
interface tengigabitethernet 1/1/6
fabric isl enable
```

```
fabric trunk enable
no shutdown
```

Enter the **show interface** *interface_type rbridge_id/slot/port* command to display the configuration details for the specified interface.

```
switch# show interface tengigabitethernet 1/1/9
tengigabitethernet 1/1/9 is up, line protocol is up (connected)
Hardware is Ethernet, address is 0005.3315.df5a
Current address is 0005.3315.df5a
Pluggable media present
Interface index (ifindex) is 4702109825
MTU 9216 bytes
LineSpeed Actual   : 10000 Mbit
LineSpeed Configured : Auto, Duplex: Full
Flowcontrol rx: off, tx: off
Priority Tag disable
Last clearing of show interface counters: 04:12:03
Queueing strategy: fifo
Receive Statistics:
1580 packets, 140248 bytes
Unicasts: 0, Multicasts: 1580, Broadcasts: 0
64-byte pkts: 0, Over 64-byte pkts: 1561, Over 127-byte pkts: 17
Over 255-byte pkts: 2, Over 511-byte pkts: 0, Over 1023-byte pkts: 0
Over 1518-byte pkts(Jumbo): 0
Runts: 0, Jabbers: 0, CRC: 0, Overruns: 0
Errors: 0, Discards: 0, TrillportCtrlFrames: 1564
Transmit Statistics:
1583 packets, 140120 bytes
Unicasts: 0, Multicasts: 1583, Broadcasts: 0
Underruns: 0
Errors: 0, Discards: 0, TrillportCtrlFrames: 1583
Rate info:
Input 0.000000 Mbits/sec, 0 packets/sec, 0.00% of line-rate
Output 0.000000 Mbits/sec, 0 packets/sec, 0.00% of line-rate
Time since last interface status change: 00:15:53
```

Refer also to Slot numbering and configuration on page 64.

Displaying slots and module status information

Use the **show slots** command to display information for all slots in the chassis. The following example shows slot information for the Brocade VDX 8770-8.

```
switch# show slots
Slot  Type         Description                ID      Status
-------------------------------------------------------------------------
M1    MM           Management Module          112     ENABLED
M2    MM           Management Module          112     ENABLED
S1    SFM          Switch Fabric Module       113     ENABLED
S2                                                    VACANT@
S3    SFM          Switch Fabric Module       113     ENABLED#
S4    SFM          Switch Fabric Module       113     ENABLED#
S5    SFM          Switch Fabric Module       113     ENABLED
S6    SFM          Switch Fabric Module       113     ENABLED
L1                                                    VACANT
L2                                                    VACANT
L3    LC48X10G     48-port 10GE card          114     DIAG RUNNING POST1
L4    LC48X10G     48-port 10GE card          114     ENABLED
L5                                                    VACANT
L6                                                    VACANT
L7    LC48X1G      48-port 1GE card           114     ENABLED
L7                                                    VACANT
L8                                                    VACANT
# = At least one enabled SFM in these slots is required.
@ = The SFM Optical Switch is open.
```

Alternatively, you can use the following commands to display slots per module type:

- Use the **show mm** command to display information for the management modules.
- Use the **show sfm** command to display information for the switch fabric modules.
- Use the **show linecard** command to display information for the line cards.

To make the slot configuration persistent across a chassis reboot (which involves reloading the management modules), you must save the configuration persistently by issuing the **copy running-config startup-config** command after the line card reaches the online state and before the system reboots.

Replacing a line card

You can remove a line card without powering it off. However, doing so will not remove the configuration. When you replace a card with a different type, you must first remove the configuration and then reconfigure the slot for the new line card type.

Install a new line card only if it is supported by the firmware running in the chassis. Inserting a line card into a chassis running firmware that does not support the line card may result in unexpected behavior.

Do the following to replace a line card.

CAUTION
Removing the configuration requires the card to be powered off.

1. Power off the line card by issuing the **power-off linecard** command followed by the slot number.
2. Enter the **configure terminal** command to enter global configuration mode.
3. Enter the **rbridge-id** *rbridge-id* command to enter RBridge ID configuration mode.
4. Enter the **no linecard** *slot_number* command to clear the slot configuration.
5. Remove the line card.
6. Enter the **linecard** *slot_number* command followed by a question mark (?) to display the line card menu.
7. Select a line card type and enter the **linecard** *slot_number linecard_type* command.
8. Enter the **exit** command twice to return to privileged EXEC mode.
9. Insert the new line card into the configured slot.
10. Enter the **power-on linecard** command to power on the line card.
11. Save the configuration persistently by issuing the **copy running-config startup-config** command after the line card reaches the online state.

12. Verify the configuration with the **show running-config linecard** *linecard* command.

```
switch# power-off linecard 4
switch# configure terminal
Entering configuration mode terminal
switch(config)# rbridge-id 1
switch(config-rbridge-id-1)# no linecard 4
switch(config-rbridge-id-1)# linecard 4 ?
Possible completions:
LC12x40G  12X40G linecard
LC48x1G        48X1G linecard
LC48x10G  48X10G linecard
LC72x1G  72X1G linecard
LC48x10GT    48X10G Base-T linecard
LC27X40G        27X40G linecard
LC6X100G        6X100G linecard
switch(config-rbridge-id-1)# linecard 4 LC48x10G
Creating new linecard configuration was successful.
switch(config-rbridge-id-1)# exit
switch(config)# exit
switch# copy running-config startup-config
switch# show running-config rbridge-id 4 linecard
rbridge-id 1
linecard 1 LC48x10G
linecard 4 LC48x10G
```

Configuring high availability

The following sections provide you with information on configuring High Availability (HA) support on Brocade switches.

Using HA commands

A variety of high-availability (HA) commands are available on the switch in privileged EXEC mode.

- **show ha** displays the management module status.

```
switch# show ha
Local (M2): Active, Cold Recovered
Remote (M1): Standby, Healthy
HA enabled, Heartbeat Up, HA State synchronized
```

- **ha failover** forces the active management module to fail over. The standby management module will take over as the active management module.
- **reload system** reboots the entire chassis. This command is supported only on the active management module. This command is not supported on the standby management module. Both management modules must be in sync for the HA reboot operation to succeed. In logical chassis cluster mode, this command can be issued from the principal node to reset one remote node or all of the remote nodes by specifying either the individual rbridge-id or "all".
- **ha sync start** enables HA state synchronization after an **ha sync stop** command has been invoked.
- **show ha all-partitions** displays details for all line cards and the MM HA state.

NOTE
For additional HA commands and related commands, refer to the *Network OS Command Reference*

Understanding expected behaviors for reload and failover

The following tables identify expected behaviors that result from controlled and uncontrolled reload and failover conditions.

TABLE 7 Expected behaviors for controlled reload and failover

Command syntax	Behavior in fabric cluster and logical chassis cluster
reload	Cold failover to standby management module (MM). NOTE When MMs are out of sync, the **reload** command does not work. Use the **reload system** command to reboot the switch in this case.
reload standby	Reboot the standby MM.
reload system	Reboot both MMs. MMs will retain the HA roles.
ha failover	Warm failover to standby MM.

TABLE 8 Expected behaviors for uncontrolled failover

Command syntax	Behavior in fabric cluster and logical chassis cluster
Panic	Warm failover to standby MM.
MM removal	Warm failover to standby MM.
Power cycle	MMs will retain the HA roles upon booting up.

Disabling and enabling a chassis

The chassis is enabled after power is turned on, and diagnostics and switch initialization routines have finished. All interfaces are online. You can disable and re-enable the chassis as necessary.

- Use the **chassis disable** command if you want to take all interfaces offline. If the switch was part of an Ethernet fabric, the fabric reconfigures.
- Use the **chassis enable** command to bring the interfaces back online. All interfaces that were enabled before the chassis was disabled are expected to come back online. If the switch was part of an Ethernet fabric, it rejoins the fabric.

  NOTE
  Disabling the chassis is a disruptive operation. Use the **shutdown** command to disable or enable a few selected interfaces only. Refer to the *Network OS Command Reference* for more information on this command.

Rebooting a switch

Network OS provides several commands to reboot your system: **reload**, **fastboot**, **reload system**, and **ha chassisreboot**.

CAUTION
All reboot operations are disruptive, and the commands prompt for confirmation before executing. When you reboot a switch connected to a fabric, all traffic to and from that switch stops. All ports on that switch remain inactive until the switch comes back online.

Rebooting a compact switch

- The **reload** command performs a "cold reboot" (power off and restart) of the control processor (CP). If the power-on self-test (POST) is enabled, POST is executed when the system comes back up.
- The **fastboot** command performs a "cold reboot" (power off and restart) of the control processor (CP), bypassing POST when the system comes back up. Bypassing POST can reduce boot time significantly.

CAUTION
Do not perform a reload command between a chassis disable command and a chassis enable command. Your ports will be closed.

Rebooting a modular chassis

A chassis reboot brings up the system in sequential phases. First, software services are launched on the management modules and brought up to the active state. Then, the line cards are powered on and initialized. Software services are launched on the line cards and brought up to the active state. When the line card initialization reaches the final state, the chassis is ready to accept user commands from the CLI interface.

During the boot process system initialization, configuration data (default or user-defined) are applied to the switch through configuration replay. For more information, refer to Managing configurations across redundant management modules on page 105.

- On a modular chassis, the **reboot** and the **fastboot** commands only reboot the management module on which the command is executed. If you log in to the switch IP address and execute one of these commands, only the active management module reboots and POST is bypassed.
- The **ha chassisreboot** command performs a "cold reboot" (power off and restart) of the entire chassis. If the power-on self-test (POST) is enabled, POST is executed when the system comes back up.

Troubleshooting switches

This section presents an overview of a variety of techniques for capturing data and system messages, which can be helpful in interactions with technical support.

Capturing and managing supportSave data

If you are troubleshooting a production system, you will have to capture data for further analysis or send the data to your switch service provider. The **copy support** command provides a mechanism for capturing critical system data and uploading the data to an external host or saving the data to an attached USB device.

Uploading supportSave data to an external host

To upload supportSave data interactively, enter the **copy support-interactive** command and provide input as prompted. Specifying an IPv6 address for the server requires Network OS v3.0.0 or later. For a non-interactive version of the command, refer to the *Network OS Command Reference*.

```
switch# copy support-interactive

Server Name or IP Address: 10.38.33.131
Protocol (ftp, scp): ftp
User: admin
Password: ********
Directory: /home/admin/support
VCS support [y/n]? (y): n
Module timeout multiplier [Range: 1 to 5. Default: 1]: 1

copy support start
Saving support information for chassis:sw0, module:RAS...(output truncated)
```

Saving supportSave data to an attached USB device

You can use a Brocade-branded USB device to save the support data. The Brocade-branded USB device comes with factory-configured default directories and interacts with the Network OS CLI.

1. Enter the **usb on** command to enable the USB device.
2. Enter the **usb dir** command to display the default directories.
3. Enter the **copy support usb***directory* command.

```
switch# usb on
USB storage enabled
switch# usb dir

firmwarekey\ 0B 2010 Aug 15 15:13
support\ 106MB 2010 Aug 24 05:36
support1034\ 105MB 2010 Aug 23 06:11
config\ 0B 2010 Aug 15 15:13
firmware\ 380MB 2010 Aug 15 15:13
Available space on usbstorage 74%
switch# copy support usb directory support
```

If you are in logical chassis cluster mode, you can use the **rbridge-id** *all* option to invoke supportSave on all nodes at the same time. The **copy support rbridge-id all** command is a blocking command. The Telnet session from which the command is issued will be blocked until supportSave is completed on all nodes in the cluster; however, users can again Telnet into the same node or any other nodes in the cluster. When the command is in progress, output messages from all nodes are shown that include the respective node RBridge IDs. The **copy support** command, when executed with USB as the protocol option, will collect support files to the USB device that is connected to the respective nodes. All USB devices connected to each of the nodes should be enabled before the **copy support usb** command is executed.

The following example shows the **copy support** command with the **rbridge-id** *all* option.

```
switch# copy support ftp host 10.1.2.30 user fvt password pray4green directory /support rbridge-id all
switch 100: copy support start
switch 117: Saving support information for chassis:sw0, module:RAS...
switch 100: Saving support information for chassis:sw, module:RAS...
switch 117: Saving support information for chassis:sw0, module:CTRACE_OLD...
......
switch 100: copy support completed
switch 117: copy support completed
2011/04/07-18:03:07, [SS-1000], 2752,, INFO, VDX6720-24, copy support has uploaded support information to the
host with IP address 10.70.4.101.
```

Displaying the status of a supportSave operation

Enter the **show copy-support status** command.

```
switch# show copy-support status
Slot Name       SS type         Completion Percentage
# # # # # # # # # # # # # # # # # # # # # # # # # # #
M1              NORMAL          [100%]
L1/0            NORMAL          [100%]
L1/1            NORMAL          [100%]
L2/0            NORMAL          [100%]
L2/1            NORMAL          [100%]
L4/0            NORMAL          [100%]
L4/1            NORMAL          [100%]
```

Configuring automatic uploading of supportSave data

You can configure a switch to upload first-fault data capture (FFDC) and trace data files automatically to a remote server that is specifically set up for collecting information that results from the **supportSave** command. To enable this feature, you must configure a dedicated server, then invoke the **autoupload-param** command to set the parameters, followed by the **support autoupload enable** command to enable the configurations.

```
switch(config)# support autoupload-param hostip 10.31.2.27 username supportadmin directory /users/support/
ffdc_autoupload protocol ftp password (<string>): ******
```

Displaying the autoupload configuration

Enter the **show running-config support autoupload-param** command to display the autoupload configuration on the local switch.

```
switch(config)# do show running-config support autoupload-param

support autoupload-param hostip 10.31.2.27 username supportadmin directory /users/support/ffdc_autoupload
protocol ftp password "3iTYxJWEUHp9axZQt2tbvw==\n"
```

Using additional supportSave commands

Use the following commands to configure additional supportSave data collection parameters:

- Use the **show support** command to display a list of core files on the switch.
- Use the **clear support** command to erase support data on the switch.

Refer to the *Network OS Command Reference* for more information on these commands.

Logging error messages

Network OS provides several mechanisms for logging error messages including syslog, RASLog, and audit log. The types of message logging available and the setup procedures are documented in the "Introduction to Brocade Error Message Logging" chapter of the *Network OS Message Reference Manual*.

Mixed-version fabric cluster support

A mixed-version fabric cluster is a group of fabric cluster nodes running Network OS v4.1.3 and Network OS v5.0.0. This allows legacy hardware to continue to function with hardware running Network OS v5.0.0.

The following limitations and considerations apply to mixed node support:

- Mixed-versions are supported only in fabric cluster mode and are not supported in logical chassis cluster mode.
- For a fabric cluster running Network OS v4.1.3 and Network OS v5.0.0, the cluster supports the Network OS v4.1.3 feature set. For a list of features that the nodes running Network OS v5.0.0 support, refer to the Network OS v5.0.0 release notes.

Because only Network OS v4.1.3 and Network OS v5.0.0 are supported in a mixed-version fabric cluster, you should:

- Upgrade all Brocade VDX 2740, 6740, 6740T, 6740T-1G, and 8770 units to Network OS v5.0.0.
- Update all other Brocade hardware to Network OS v4.1.3.

When a fabric cluster is loaded with mixed-versions, the cluster only works with the older feature set. Any cluster-wide features that were introduced in Network OS v5.0.0 are not supported in the mixed-version fabric cluster. Most fabric cluster features work properly in a mixed-version cluster. You can perform cluster management normally, as in a normal fabric cluster with all nodes running the same Network OS releases.

During a VCS cluster upgrade, all nodes are not necessarily upgraded at the same time. During this time, the cluster is in a mixed-version state with the VCS cluster in an incomplete state, but the fabric connections remain intact.

TABLE 9 Feature support for mixed-version fabric clusters

Network OS feature	Description of support
Modular HA	Yes, but only on the Network OS v5.0.0 switch.
Modular ISSU	Yes, but only on the Network OS v5.0.0 switch.
Fixed-port ISSU	Yes, but only on the Network OS v5.0.0 switch.
AutoFabric (Pre-provisioning)	No
Flexports	Yes, but only on the Network OS v5.0.0 switch.
IPv6	Yes, but only on the Network OS v5.0.0 switch.
CML	No
REST API	Yes, but only on the Network OS v5.0.0 switch.
OpenStack	No, this feature is only available in Local Chassis mode.
Access Gateway/NPIV	No
Virtual Fabric (Basic + Enhancements)	No

Using Network Time Protocol

Network Time Protocol overview

Network Time Protocol (NTP) maintains uniform time across all switches in a network. The NTP commands support the configuration of an external time server to maintain synchronization between all local clocks in a network.

To keep the time in your network current, it is recommended that each switch have its time synchronized with at least one external NTP server. External NTP servers should be synchronized among themselves in order to maintain fabric-wide time synchronization.

All switches in the fabric maintain the current clock server value in nonvolatile memory. By default, this value is the local clock server of the switch.

Date and time settings

Brocade switches maintain the current date and time inside a battery-backed real-time clock (RTC) circuit. Date and time are used for logging events. Switch operation does not depend on the date and time; a switch with incorrect date and time settings can function correctly. However, because the date and time are used for logging, error detection, and troubleshooting, you should set them correctly.

Time zone settings

You can set the time zone by specifying a geographic region and city by name. You can choose one of the following the regions: Africa, America, Pacific, Europe, Antarctica, Arctic, Asia, Australia, Atlantic, and Indian.

The time zone setting has the following characteristics:

- The setting automatically adjusts for Daylight Savings Time.
- Changing the time zone on a switch updates the local time zone setup and is reflected in local time calculations.
- By default, all switches are in the Greenwich Mean Time (GMT) time zone (0,0). If all switches in a fabric are in one time zone, it is possible for you to keep the time zone setup at the default setting.
- System services that have already started will reflect the time zone changes only after the next reboot.
- Time zone settings persist across failover for high availability.
- Time zone settings are not affected by NTP server synchronization.

Configuring NTP

The following sections discuss how to correctly configure the Network Time Protocol for Brocade switches.

Configuration considerations for NTP

If you are in Standalone mode, Network Time Protocol (NTP) commands must be configured on each individual switch. Network time synchronization is guaranteed only when a common external time server is used by all switches. If you are in VCS mode, when an **ntp server** command is invoked on one switch in a cluster, the configuration is applied to all switches in the cluster.

The **ntp server** command accepts up to five server addresses in IPv4 or IPv6 format. When you configure multiple NTP server addresses, the **ntp server** command sets the first obtainable address as the active NTP server. If there are no reachable time servers, then the local switch time is the default time until a new active time server is configured.

Setting the date and time

The **clock set** command sets the local clock date and time. Valid date and time values must be in the range between January 1, 1970 and January 19, 2038. If a time zone is not configured, the time zone defaults to Greenwich Mean Time (GMT). If an active NTP server is configured for the switch, it overrides the local time settings.

Enter the **clock set** *CCYY-MM-DDTHH:MM:SS* command.

The variables represent the following values:

- *CCYY* specifies the year; the valid range is 1970 through 2038.
- *MM* specifies the month; the valid range is 01 through 12.
- *DD* specifies the day; the valid range is 01 through 31.
- *HH* specifies the hour; the valid range is 00 through 23.
- *MM* specifies the minutes; the valid range is 00 through 59.
- *SS* specifies the seconds; the valid range is 00 through 59.

If you are in VCS mode, setting the time and date is done using the RBridge ID of the node.

Here is an example of setting and displaying the date and time in standalone mode:

```
switch# clock set 2013-06-06T12:15:00
switch# show clock
rbridge-id 1: 2013-06-06 12:15:05 Etc/GMT+0
```

Here is an example of setting and displaying the date and time in VCS mode:

```
switch# clock set 2013-06-06T12:15:00 rbridge-id all
switch# show clock
rbridge-id all: 2013-06-06 12:15:05 Etc/GMT+0
```

Setting the time zone

Use the **clock timezone** command to set the time zone for a switch. You must use the command for all switches for which a time zone must be set. However, you only need to set the time zone once on each switch, because the value is written to nonvolatile memory.

If you are in VCS mode, setting the time and date is done by using the RBridge ID of the node.

Refer to refer to Using Network Time Protocol on page 95 for a complete list of configurable regions and cities.

Enter the **clock timezone** *region/city* command.

Example of setting and displaying the date and time in standalone mode:

```
switch# clock timezone America/Los_Angeles
```

Example of setting and displaying the date and time in VCS mode:

```
switch# clock timezone America/Los_Angeles rbridge-id all
```

NOTE
After upgrading your switch firmware, you might need to reconfigure the time zone information.

Displaying the current local clock and time zone

The **show clock** command returns the local time, date, and time zone.

NOTE
This command is currently supported on the local switch.

This example shows the local switch clock time:

```
switch# show clock
rbridge-id 1: 2012-05-04 16:01:51 America/Los Angeles
```

This example shows the clock time for all switches in the cluster (logical chassis cluster mode only):

```
switch# show clock rbridge-id all
2012-05-04 17:31:41 America/Los Angeles
```

This example shows the clock time for the switch with rbridge-id 16:

```
switch# show clock rbridge-id 16
rbridge-id 16: 2012-05-04 18:18:51 America/Los Angeles
```

Removing the time zone setting

Use the **no clock timezone** command to remove the time zone setting for the local clock. This operation returns the local time zone to the default value (GMT). When using the **no** operand, you do not need to reference a timezone setting.

Enter the **no clock timezone** command.

This example removes the time zone setting in standalone mode:

```
switch# no clock timezone
```

This example removes the time zone setting in VCS mode:

```
switch# no clock timezone rbridge-id 5
```

Synchronizing the local time with an external source

Use the **ntp server** command to synchronize the local switch time with an NTP server. You can configure up to five IP address. At least one IP address in the list must be a reachable, configured NTP server or the request will fail.

The following example synchronizes the time on the local switch with the ntp server at 192.168.10.1.

Enter the **ntp server** *ip_address* command.

```
switch(config)# ntp server 192.168.10.1
```

Displaying the active NTP server

Use the **show ntp status** command to display the current active NTP server IP address. If an NTP server is not configured or the server is unreachable, the output displays LOCL (for local switch time. Otherwise, the command displays the NTP server IP address. The command displays the local NTP server configuration only.

If the RBridge ID parameter is not provided, status results default to the local switch (LOCL). If **rbridge-id all** is specified, the command displays the status for all switches in the cluster.

This example shows the local switch NTP status when an NTP server is not configured:

```
switch# show ntp status
 rbridge-id 1: active ntp server is LOCL
```

This example shows the configured NTP server:

```
switch# show ntp status
 active ntp server is 10.31.2.81
```

This example shows NTP status for all switches in a cluster.

```
switch# show ntp status rbridge-id all
rbridge-id 7: active ntp server is LOCL
```

Removing an NTP server IP address

To remove an NTP server IP address from the list of server IP addresses on a switch, enter **no ntp server** followed by the server IP address.

The following example removes the NTP server at 192.168.10.1 from the local server IP address database.

```
switch(config)# no ntp server 192.168.10.1
switch# show ntp status
rbridge-id 1: active ntp server is LOCL
```

IMPORTANT

At least one IP address in the remaining list must be for a reachable and configured NTP server; if there is not one the remove request will fail.

Configuration Management

Configuration management overview

Maintaining consistent configuration settings among switches in the same fabric is an important part of switch management and minimizes fabric disruptions. As part of standard maintenance procedures, it is recommended that you back up all important configuration data for every switch on an external host for emergency reference.

Typical configuration management tasks include the following actions:

- Saving the running configuration to the startup configuration file (Saving configuration changes on page 101).
- Uploading the configuration files to a remote location (Backing up configurations on page 102).
- Restoring a configuration file from a remote archive (Configuration restoration on page 103).
- Archiving configuration files for all your switches to a remote location (Managing configurations in Brocade VCS Fabric mode on page 105).
- Downloading a configuration file from a remote location to multiple switches (Managing configurations in Brocade VCS Fabric mode on page 105).

Configuration file types

Brocade Network OS supports three types of configuration files. The table below lists the standard configuration files and their functions.

TABLE 10 Standard switch configuration files

Configuration file	Description
Default configuration • defaultconfig.novcs • defaultconfig.vcs	Part of the Network OS firmware package. The default configuration is applied, if no customized configuration is available. There are different default configuration files for standalone and Brocade VCS Fabric mode.
Startup configuration • startup-config	Configuration effective on startup and after reboot.
Running configuration • running-config	Current configuration active on the switch. Whenever you make a configuration change, it is written to the running configuration. For fabric cluster mode, the running configuration does not persist across reboot, unless you copy it to the startup configuration. However, when the switch is in logical chassis cluster mode, the running-config file is saved automatically and it does not need to be copied.

Configuration management follows a transaction model. When you boot up a switch for the first time, the running configuration is identical to the startup configuration. As you configure the switch, the changes are written to the running configuration. To save the

changes, you must save the currently effective configuration (the running configuration) as the startup configuration. When the switch reboots, the configuration changes become effective.

Default configuration

Network OS provides two different configuration files for switches in standalone and Brocade VCS Fabric mode. When you change from standalone to Brocade VCS Fabric mode, the system chooses the appropriate default configuration based on the mode (Brocade VCS Fabric or standalone). Default configuration files are part of the Network OS firmware package and are automatically applied to the startup configuration under the following conditions:

- When the switch boots up for the first time and no customized configuration is available.
- When you enable or disable Brocade VCS Fabric mode, the appropriate default configuration is applied when the switch reboots.
- When you restore the default configuration.

You cannot remove, rename, or change the default configuration.

Startup configuration

NOTE
There is no startup configuration for logical chassis cluster mode. Switches in a logical chassis cluster always preserve their running configuration.

The startup configuration is persistent. It is applied when the system reboots.

- When the switch boots up for the first time, the switch uses the default configuration as the startup configuration, depending on the mode.
- The startup configuration always matches the current Brocade VCS Fabric mode. It is deleted when you change modes, unless you make a backup copy.
- When you make configuration changes to the running configuration and save the changes to the startup configuration with the **copy** command, the running configuration becomes the startup configuration.

Running configuration

The configuration currently effective on the switch is referred to as the running configuration. Any configuration change you make while the switch is online is made to the running configuration.

- The running configuration is nonpersistent.
- To save configuration changes, you must copy the running configuration to the startup configuration. If you are not sure about the changes, you can copy the changes to a file, and apply the changes later.

Displaying configurations

The following examples illustrate how to display the default, startup, and running configurations, respectively.

Displaying the default configuration

To display the default configuration, enter the **show file** *filename* command in privileged EXEC mode.

```
switch# show file defaultconfig.novcs
switch# show file defaultconfig.vcs
```

Displaying the startup configuration

To display the contents of the startup configuration, enter the **show startup-config** command in privileged EXEC mode.

```
switch# show startup-config
```

Displaying the running configuration

To display the contents of the running configuration, enter the **show running-config** command in the privileged EXEC mode.

```
switch# show running-config
```

Saving configuration changes

Configuration changes are nonpersistent and are lost on reboot unless you save them permanently. You have two options for saving configuration changes:

- Copy the running configuration to the startup configuration. The changes become effective upon reboot.
- Copy the running configuration to a file, and apply it at some later date.

NOTE
Always make a backup copy of your running configuration before you upgrade or downgrade the firmware.

Saving the running configuration

To save the configuration changes you made, copy the running configuration to the startup configuration. The next time the switch reboots, it uses the startup configuration and the changes you made earlier become effective.

NOTE
When the switch is in logical chassis cluster mode, the running-config file is saved automatically and it does not need to be copied.

Enter the **copy running-config startup-config** command in privileged EXEC mode.

```
switch# copy running-config startup-config
copy running-config startup-config
This operation will modify your startup configuration. Do you want to continue? [Y/N]: y
```

Saving the running configuration to a file

If you want to save the changes you made to the configuration, but you do not want the changes to take effect when the switch reboots, you can save the running configuration to a file. You can apply the changes at some later time.

1. Enter the **copy running-config** *file* command in privileged EXEC mode. Specify the file name as the file URL.

```
switch# copy running-config flash://myconfig
```

2. Verify the transaction by listing the directory contents.

```
switch# dir
total 32
drwxr-xr-x   2 root     sys          4096 Feb 17 17:50 .
drwxr-xr-x   3 root     root         4096 Jan  1  1970 ..
-rwxr-xr-x   1 root     sys           417 Oct 12  2010 defaultconfig.novcs
-rwxr-xr-x   1 root     sys           697 Oct 12  2010 defaultconfig.vcs
-rw-r--r--   1 root     root         6777 Feb 17 17:50 myconfig
-rw-r--r--   1 root     root         6800 Feb 13 00:37 startup-config
```

Applying previously saved configuration changes

When you are ready to apply the configuration changes you previously saved to a file, copy the file (*myconfig* in the example) to the startup configuration. The changes take effect after the switch reboots.

Enter the **copy** *filename* **startup-config** command in privileged EXEC mode. Specify the file name as the file URL.

```
switch# copy flash://myconfig startup-config
This operation will modify your startup configuration. Do you want to continue? [Y/N]: y
```

Backing up configurations

Always keep a backup copy of your configuration files, so you can restore the configuration in the event the configuration is lost or you make unintentional changes.

> NOTE
> This operation is not supported in logical chassis cluster mode, because the running-config will be auto-synced to the startup-config.

The following recommendations apply:

- Keep backup copies of the startup configuration for all switches in the fabric.
- Upload the configuration backup copies to an external host or to an attached Brocade-branded USB device.
- Avoid copying configuration files from one switch to another. Instead restore the switch configuration files from the backup copy.

Uploading the startup configuration to an external host

Enter the **copy startup-config** *destination_file* command in privileged EXEC mode.

In the following example, the startup configuration is copied to a file on a remote server by means of FTP.

```
switch# copy startup-config ftp://admin:******@122.34.98.133//archive/startup-config_vdx24-08_20101010
```

Backing up the startup configuration to a USB device

When you make a backup copy of a configuration file on an attached USB device, the destination file is the file URL on the USB device. You do not need to specify the target directory. The file is automatically recognized as a configuration file and stored in the default configuration directory.

1. Enable the USB device.

```
switch# usb on
USB storage enabled
```

2. Enter the **copy startup-config** *destination_file* command in privileged EXEC mode.

```
switch# copy startup-config usb://startup-config_vdx24-08_20101010
```

Configuration restoration

Restoring a configuration involves overwriting a given configuration file on the switch by downloading an archived backup copy from an external host or from an attached USB device.

There are two typical scenarios for configuration restoration:

- Restoring a previous startup configuration from backup on page 103.
- Restoring the default configuration on page 104.

The configuration restoration operation behaves differently depending on whether the switch is in standalone mode or part of a Brocade VCS Fabric.

In standalone mode, all interfaces are shut down. When the switch comes back up, the restored default configuration is used. The following parameters are unaffected by this command:

- Interface management IP address
- Software feature licenses installed on the switch

In VCS Fabric mode, all interfaces remain online. The following parameters are unaffected by this command:

- Interface management IP address
- Software feature licenses installed on the switch
- Virtual IP address

NOTE
Configuration files that were created using Brocade Network OS 2.x should not be loaded onto a system running Brocade Network OS 3.x or later. The ACL and VLAN configuration information has changed in Brocade Network OS 3.x or later, and the affected lines of configuration are skipped when loading a Brocade Network OS 2.x configuration file.

Restoring a previous startup configuration from backup

There are two cases where you might want to restore a previous configuration from a backed-up copy:

- You want to back out of configuration changes you made earlier by overwriting the startup configuration with a modified running configuration.
- You want to take the switch from Brocade VCS Fabric mode back to standalone mode and reapply your original standalone startup configuration.

RESTRICTION
This task only applies to Brocade VDX 6720-30 switches.

ATTENTION
Make sure that the configuration file you are downloading is the one that belongs to the switch you want to restore. It is a good idea to identify archived configuration files by switch name and date.

1. Disable Brocade VCS Fabric mode and reboot the switch.

   The startup configuration associated with Brocade VCS Fabric mode is automatically deleted. The switch boots up in standalone mode and loads the corresponding default configuration (which is different from the archived startup configuration). The switch automatically reboots at this point.

   ```
   switch# no vcs enable
   ```

2. Copy the archived startup configuration file from an FTP server or from an attached USB device to the running configuration.

   ```
   switch# copy ftp://admin:******@122.34.98.133//archive/\ startup-config_vdx24-08_20101010 running-
   config
   ```

Restoring the default configuration

This restoration procedure resets the configuration to the factory defaults. The default configuration files for Brocade VCS Fabric and standalone mode are always present on the switch and can be restored with the **copy** command.

To restore the default configuration, perform the following procedure in privileged EXEC mode.

1. Enter the **copy** *source_file destination_file* command to overwrite the startup configuration with the default configuration.

   ```
   switch# copy  default-configstartup-config
   ```

2. Confirm that you want to make the change by entering Y when prompted.

   ```
   This operation will modify your startup configuration. Do you want to continue? [Y/N]: y
   ```

3. Reboot the switch.

   ```
   switch# reload system
   ```

Managing configurations on a modular chassis

NOTE
When the switch is in logical chassis cluster mode, the running-config file is saved automatically and does not need to be copied. There is no startup configuration for logical chassis cluster mode; therefore, the information about startup configuration does not apply to logical chassis cluster mode.

The configuration data on a modular chassis are managed in a distributed fashion. The Brocade VDX 8770-4 and VDX 8770-8 chassis maintain two types of configuration data, global configuration parameters and slot configuration parameters. The global configuration, such as the VLAN configuration, applies to the entire chassis. The slot configuration includes specific parameters that apply only to the line cards.

The startup configuration is maintained at the chassis level and includes both chassis-wide and slot-specific configuration parameters.

Managing configurations on line cards

When an line card (interface module) boots up in a slot which was never occupied previously or is not configured, the module type is automatically saved in the configuration database. The type configuration associated with a given slot persists in the database even after the line card is physically removed, powered off, or faulted. This mechanism ensures that all configuration data associated with a given slot is automatically preserved across reboots or hot swaps with the same type of line card.

If you insert an line card in a slot that was previously occupied by a module of a different type, the line card will be faulted with a "type mismatch" error. Before you replace an line card with a different type, you must clear the existing type configuration from the database. Refer to Replacing a line card on page 87 for more information.

NOTE

The line card configuration is non-persistent. You must issue the **copy running-config startup-config** command after the line card comes online. Otherwise, all configuration data associated with the slot along with line module type will be lost after a chassis reboot.

Managing configurations across redundant management modules

In modular switches with redundant management modules, the VCS configuration, the startup configuration, and the startup database are synchronized and shared between the two management modules. The initial configuration synchronization occurs when the system boots up. After the initial synchronization has been completed successfully, synchronization can be triggered during the following events:

- When a failover occurs from the active management module to the standby management module. Unsaved configuration changes made on the active management module are lost after a failover. Issue the **copy running-config startup-config** command on the active management module to preserve the running configuration across a management module failover.
- When you insert a standby management module into a chassis after the active management module is already fully initialized.
- When you change the startup configuration by issuing the **copy running-config startup-config** command on the active management module.
- When you restore the default configuration by issuing the **copy default-config startup-config** command on the active management module.
- When you change the VCS configuration (VCS mode, RBridge ID, or VCS ID), the configuration change is synchronized with the standby management module and saved persistently. This event triggers a chassis reboot after the synchronization is complete.
- When you initiate a firmware download. Refer to Configuration Management on page 99 for more information.

Managing configurations in Brocade VCS Fabric mode

With the exception of a few parameters, configuration changes you make to a single switch in a Brocade VCS Fabric are not automatically distributed. When configuring Ethernet fabric parameters and software features on multiple switches, you must configure each switch individually. To simplify the procedure, you can upload a configuration file from one switch and download it to the other switches in the fabric, provided the switches are of the same type.

NOTE

The switches must be of the same model to share a configuration file. For example, downloading a configuration file from a Brocade VDX 6720-24 to a Brocade VDX 6720-60 or to a switch with a different firmware version may cause the switch to misapply the configuration and lead to unpredictable behavior.

To determine the switch type, issue the **show system** command. To map the switch type to the Brocade switch model name, refer to Switch types on page 57.

If you need to reset affected switches, restore the default configuration as described in Restoring the default configuration on page 104.

Automatic distribution of configuration parameters

A few configuration parameters are fabric-wide in fabric cluster mode. This means they are automatically distributed to all switches in a VCS fabric when you configure one or more of these parameters on a single RBridge that is part of a VCS fabric. These parameters include the following:

- Zoning configuration
- vCenter parameters
- Virtual IP address

NOTE
In logical chassis cluster mode, all configuration is automatically distributed.

The **show running configuration** command displays the same configuration for these features on all RBridges in the VCS fabric. Copy operations from any RBridge include all fabric-wide configuration parameters.

Downloading a configuration to multiple switches

NOTE
This section does not apply to logical chassis cluster mode because, in that mode, configuration is automatically distributed.

1. Configure one switch.
2. Copy the running configuration to the startup configuration as described in Saving the running configuration on page 101.
3. Upload the configuration to an external host (Uploading the startup configuration to an external host on page 102) or to an attached USB device as described in Backing up the startup configuration to a USB device on page 103.
4. Download the configuration file to each of the target switches. Refer to Configuration restoration on page 103 for more information.

Managing flash files

Brocade Network OS provides a set of tools for removing, renaming, and displaying files you create in the switch flash memory. You can use the display commands with any file, including the system configuration files. The **rename** and **delete** commands only apply to copies of configuration files you create in the flash memory. You cannot rename or delete any of the system configuration files.

Listing the contents of the flash memory

To list the contents of the flash memory, enter the **dir** command in privileged EXEC mode.

```
switch# dir
drwxr-xr-x   2 root     sys          4096 Feb 13 00:39 .
drwxr-xr-x   3 root     root         4096 Jan  1  1970 ..
-rwxr-xr-x   1 root     sys           417 Oct 12  2010 defaultconfig.novcs
```

```
-rwxr-xr-x   1 root     sys           697 Oct 12  2010 defaultconfig.vcs
-rw-r--r--   1 root     root         6800 Feb 13 00:37 startup-config
```

Deleting a file from the flash memory

To delete a file from the flash memory, enter the **delete** *file* command in privileged EXEC mode.

```
switch# delete myconfig
```

Renaming a flash memory file

To rename a file in the flash memory, enter the **rename** *source_file destination_file* command in privileged EXEC mode.

```
switch# rename myconfig myconfig_20101010
```

Viewing the contents of a file in the flash memory

To investigate the contents of a file in the flash memory, enter the **show file** *file* command in privileged EXEC mode.

```
switch# show file defaultconfig.novcs
!
no protocol spanning-tree
!
vlan dot1q tag native
!
cee-map default
remap fabric-priority priority 0
remap lossless-priority priority 0
priority-group-table 1 weight 40 pfc on
priority-group-table 2 weight 60 pfc off
priority-group-table 15.0 pfc off
priority-table 2 2 2 1 2 2 2 15.0
!
interface Vlan 1
shutdown
!
port-profile default
vlan-profile
 switchport
 switchport mode trunk
 switchport trunk allowed vlan all
!
protocol lldp
!
end
!
```

NOTE

To display the contents of the running configuration, use the **show running-config** command. To display the contents of the startup configuration, use the **show startup-config** command.

Installing and Maintaining Firmware

Firmware management overview

ATTENTION

The **firmware download default-cfg** command is disruptive. In a chassis system, both management modules are rebooted at the same time.

Because the configuration is not preserved by means of the **default-config** command option, you must run **copy running-config** *file* before running the **firmware download** command to save the configuration, then run **copy** *file* **running-config** after the command to restore the configuration.

Brocade firmware upgrades consist of multiple firmware packages listed in a `.plist` file. The `.plist` file contains specific firmware information (time stamp, platform code, version, and so forth) and the names of the firmware packages to be downloaded. These packages are made available periodically to add features or to remedy defects in the firmware. In Network OS 4.0.0 and later, firmware upgrade is performed incrementally. The **firmware download** command compares the new firmware packages against the current installation and only downloads the packages that contain new features or have been modified.

Network OS provides a single command line interface (CLI) to download firmware to a Top-of-Rack (ToR) switch with a single control processor or to a modular chassis with two management modules. You can download the firmware from a remote server by means of the File Transfer Protocol (FTP), SSH File Transfer Protocol (SFTP), or the Secure Copy Protocol (SCP), or you can download the firmware from an attached Brocade-branded USB device. If you want to download firmware from a remote server, you must connect the management Ethernet port of the switch to the server. In a modular chassis, both management Ethernet ports need to be connected.

In-service software upgrades (ISSUs) are supported in Network OS v4.0.0 and later in modular chassis systems. Network OS v5.0.0, supports ISSUs in ToR switches. An ISSU allows a dual management module system to be upgraded non-disruptively and is invoked by entering the firmware download command from the active management module. Refer to Downloading firmware in the default mode on page 114.

In Network OS v4.0.0 and later, the **logical-chassis firmware download** command allows you to upgrade a single switch or multiple switches of your choice that are connected in logical chassis cluster mode. This command can only be executed from the principal node (coordinator). The firmware can only be downloaded from the file server through the management Ethernet port, so all nodes must have the management Ethernet ports connected. Only one **logical-chassis firmware download** command instance can run at any given time.

In Network OS v4.1.0, the one-version upgrade and downgrade is no longer enforced, (for example, the need to downgrade from Network OS v4.1.0 to v4.0.0, in order to download Network OS v3.1.0), and you can skip versions when performing upgrades and downgrades, (for example, downgrading from Network OS v4.1.0 to v3.1.0); however, the previous configurations are not preserved after the upgrade or downgrade. This new capability is recognized using the **firmware download default-cfg** command. Refer to Downloading firmware by using the default-config option on page 118.

If you are in logical chassis cluster mode, after you perform a firmware upgrade, you may find that the switch reverts to its default configurations. To preserve the configurations after an upgrade, back up the configuration using the **copy running-config** *filename* command before the firmware download. After the upgrade is completed, run the **copy** *filename* **running-config** command.

If a **firmware download** session is interrupted by an unexpected reboot, Network OS attempts to recover the previously installed firmware. Success depends on the state of the firmware download. You must wait for the recovery to complete before initiating another firmware download.

Obtaining and decompressing firmware

Firmware upgrades are available for customers with support service contracts and for partners on the Brocade website at www.mybrocade.com.

You must download the firmware package either to an FTP server or to a USB device and decompress the package *before* you can use the **firmware download** command or **firmware download logical-chassis** command (if you are in VCS mode) to upgrade the firmware on your equipment. Use the UNIX **tar** command for .tar files, the **gunzip** command for all .gz files, or a Windows unzip program for all .zip files.

When you unpack the downloaded firmware, it expands into a directory that is named according to the firmware version. When issued with the path to the directory where the firmware is stored, the **firmware download** command or **firmware download logical-chassis** command (if you are in logical chassis cluster mode) performs an automatic search for the correct package file type associated with the device.

Upgrading firmware on a compact switch

All Brocade compact switches maintain two partitions of nonvolatile storage areas, a primary and a secondary, to store two firmware images. The following steps describe the default behavior after you enter the **firmware download** command (without options) on a compact switch with a single control processor. The procedure applies to all Brocade VDX compact switches.

1. Network OS downloads the firmware to the secondary partition.
2. The switch swaps partitions and performs a reboot. After the system comes back up, the former secondary partition is the primary partition.
3. The system copies the firmware from the primary to the secondary partition and commits the new firmware.

   The upgrade process first downloads and then commits the firmware. Use the **show firmwaredownloadstatus** command to monitor the upgrade progress.

Upgrading firmware on a modular chassis

In Network OS 4.0.0 and later in-service software upgrade (ISSU) is supported. An ISSU allows a dual management module (MM) system to be upgraded nondisruptively and is invoked when the user enters the **firmwaredownload** command from the active management module.

On a dual management module system, the **firmwaredownload** command uses the ISSU protocol to upgrade the system. However, before the actual downloading occurs, the system runs an ISSU sanity check to determine whether the ISSU will succeed. If the sanity check fails, users are notified to resort to the auto-leveling protocol to upgrade the system.

Automatic firmware synchronization

When you replace or insert a second management module into a chassis, the active management module automatically synchronizes the hot-plugged standby management module with the same firmware version. The standby management module reboots with the upgraded firmware. The automatic firmware synchronization takes place only if all of the following conditions are met:

- The standby management module is inserted while the chassis is already up (hot-plugged insert).
- There was no firmware download process running when the standby management module was inserted.

- The active and standby firmware versions must be different.

  NOTE
  Automatic firmware synchronization is intrinsic to Network OS v4.0.0 and later and no corresponding **enable** or **disable** commands are associated with the feature. As a result, the feature cannot be disabled.

Upgrading and downgrading firmware

In most cases, you will be upgrading firmware by installing a more recent firmware version than the one you are currently running. However, some circumstances may require that you downgrade the firmware to an earlier version. The procedures described in the following section assume that you are upgrading firmware, but they work for downgrading as well, provided that the firmware version you are downgrading to is compatible with the version you are currently running. The following lists supported firmware versions by platform.

TABLE 11 Network OS firmware support by platform

Platform	2.0.0	2.1.0	2.1.1	3.0.0	4.0.0	4.1.0
Brocade VDX 6710	no	yes	yes	yes	yes	yes
Brocade VDX 6720	yes	yes	yes	yes	yes	yes
Brocade VDX 6730	no	yes	yes	yes	yes	yes
Brocade VDX 6740 Brocade VDX 6740T	no	no	no	no	yes	yes
Brocade VDX 6740T-1G	no	no	no	no	no	yes
Brocade VDX 8770	no	no	no	yes	yes	yes

If you are using a Brocade VDX 6740, 6740T, or 6740T-1G, you cannot download firmware earlier than Network OS 4.0.0.

Always refer to the release notes for compatibility information and take note of restrictions that may exist regarding upgrades and downgrades under particular circumstances.

Mixed-node fabric cluster support

A mixed-node fabric cluster is a group of fabric cluster nodes running Network OS v4.1.3 and Network OS v5.0.0. This allows obsoleted hardware to continue to function with hardware running Network OS v5.0.0.

The following limitations and considerations apply to mixed node support:

- Mixed-versions are supported only in fabric cluster mode and are not supported in logical cluster mode.
- For a fabric cluster running Network OS v4.1.3 and Network OS v5.0.0, the cluster supports the Network OS v4.1.3 feature set. For a list of features that the nodes running Network OS v5.0.0 support, refer to the Network OS v5.0.0 release notes.

Because only Network OS v4.1.3 and Network OS v5.0.0 are supported in a mixed-node fabric cluster, you should:

- Upgrade all Brocade VDX 2740, 6740, 6740T, and 8770 units to Network OS v5.0.0.
- Update all other Brocade hardware to Network OS v4.1.3.

When an fabric cluster is loaded with mixed-nodes, the cluster only works with the older feature set. Any cluster-wide features that were introduced in Network OS v5.0.0 are not supported in the mixed-node fabric cluster. Most fabric cluster features work properly in a mixed-node cluster. You can perform cluster management normally, as in a normal fabric cluster with all nodes running the same Network OS releases.

During a VCS cluster upgrade, all nodes are not necessarily upgraded at the same time. During this time, the cluster is in a mixed-version state with the VCS cluster in an incomplete state, but the fabric connections remain intact.

TABLE 12 Feature support for mixed-node fabric clusters

Network OS feature	Description of support
Modular HA	Yes, but only on the Network OS v5.0.0 switch.
Modular ISSU	Yes, but only on the Network OS v5.0.0 switch.
Fixed-port ISSU	Yes, but only on the Network OS v5.0.0 switch.
AutoFabric (Pre-provisioning)	No
Flexports	Yes, but only on the Network OS v5.0.0 switch.
IPv6	Yes, but only on the Network OS v5.0.0 switch.
CML	No
REST API	Yes, but only on the Network OS v5.0.0 switch.
OpenStack	No, this feature is only available in Local Chassis mode.
Access Gateway/NPIV	No
Virtual Fabric (Basic + Enhancements)	No

Upgrading firmware on a local switch

This section provides overviews and examples of upgrading firmware in a variety of ways.

Preparing for a firmware download

To prepare for a firmware download, perform the tasks listed in this section. In the unlikely event of a failure or timeout, you will be able to provide your switch support provider the information required to troubleshoot the firmware download.

1. Verify the current firmware version. Refer to Obtaining the firmware version on page 113 for details.
2. Download the firmware package from the Brocade website to an FTP server.
3. Decompress the firmware archive. Refer to Obtaining and decompressing firmware on page 110.
4. Decide on a migration path. Check the connected devices to ensure firmware compatibility and that any older versions are supported. Refer to the "Network OS Compatibility" section of the *Network OS Release Notes* for the recommended firmware version.
5. In a modular system, if you are to download firmware from a file server, verify that the management ports on both MMs are connected to the firmware file server.
6. Back up your switch configuration prior to the firmware download. Refer to Installing and Maintaining Firmware on page 109 for details.
7. For additional support, connect the switch to a computer with a serial console cable. Ensure that all serial consoles and any open network connection sessions, such as Telnet, are logged and included with any trouble reports.
8. Enter the **copy support** command to collect all current core files prior to executing the firmware download. This information helps to troubleshoot the firmware download process in the event of a problem.
9. Enter the **clear logging raslog**command to erase all existing messages in addition to internal messages.

Connecting to the switch

When you upgrade firmware in default mode, you connect to the switch through the management IP address. Modular switches have one management IP address for the chassis and separate IP addresses for each management module. To upgrade both management modules, you can either connect to the chassis management IP address or to the IP address of the active management module. If you want to upgrade a single management module only, you must connect to the IP address of that management module and run the **firmware download** command in manual mode. In manual mode, only the local management module is upgraded.

Use the **show system** command to display the management IP address for the chassis.

```
switch# show system
Stack MAC                     : 00:05:33:15:FA:70
  -- UNIT 0 --
Unit Name                     : sw0
Switch Status                 : Online
Hardware Rev                  : 1000.0
TengigabitEthernet Port(s)    : 56
Up Time                       : up 8:38
Current Time                  : 16:39:56 GMT
NOS Version                   : 4.0.0
Jumbo Capable                 : yes
Burned In MAC                 : 00:05:33:15:FA:70
Management IP                 : 10.24.73.131 <- Chassis Management IP address
Management Port Status        : UP
```

Use the **show interface management** command to display the IP addresses for the management modules.

```
switch# show interface management
interface Management 10/1
 ip address 10.24.73.130/20
 ip gateway-address 10.24.64.1
 ipv6 ipv6-address [ ]
 ipv6 ipv6-gateways [ ]
 line-speed actual "1000baseT, Duplex: Full"
 line-speed configured Auto
interface Management 10/2
 ip address 10.24.74.23/20
 ip gateway-address 10.24.64.1
 ipv6 ipv6-address [ ]
 ipv6 ipv6-gateways [ ]
 line-speed actual "1000baseT, Duplex: Full"
 line-speed configured Auto
```

Obtaining the firmware version

Enter the **show version** command with the **all-partitions** option to obtain the firmware version for both primary and secondary partitions of each module.

```
switch# show version all-partitions
Network Operating System Software
Network Operating System Version: 4.1.0
Copyright (c) 1995-2014 Brocade Communications Systems, Inc.
Firmware name:      NOS_v4.1.0
Build Time:         16:33:57 Jan 10, 2014
Install Time:       10:44:48 Jan 12, 2014
Kernel:             2.6.34.6
BootProm:           1.0.0
Control Processor:  e500mc with 7168 MB of memory
Slot    Name    Primary/Secondary Versions                          Status
-----------------------------------------------------------------------------
 M1     NOS     NOS_v4.1.0                                          ACTIVE*
                NOS_v4.1.0
 M2     NOS     NOS_v4.1.0                                          STANDBY
                NOS_v4.1.0
 L1/0   NOS     NOS_v4.1.0                                          ACTIVE
                NOS_v4.1.0
```

```
  L1/1    NOS      NOS_v4.1.0                                    STANDBY
                   NOS_v4.1.0
```

Using the firmware download command

Depending upon specific information in the Release Notes, you can invoke different options for firmware download.

CAUTION

Do not interrupt the firmware download process. If you encounter a problem, wait for the timeout (30 minutes for network problems) before issuing the firmware download command again. Disrupting the process (for example, by disconnecting the switch from its power source) can render the switch inoperable and may require you to seek help from your switch service provider.

Downloading firmware in the default mode

Under normal circumstances, Brocade recommends that you run the **firmware download** command in default mode. On a compact switch, if you enter the **firmware download** command without any options, the command by default will download firmware to the switch, reboot the switch, and commit the new firmware. On a modular chassis, if you enter if you enter the **firmware download** command on the active MM without any options, the command by default will invoke the ISSU process to upgrade the entire system.

If you decide to invoke other **firmware download** options, refer to the following:

- Downloading firmware by using the noactivate option on page 116
- Downloading firmware by using the manual option on page 116

To download firmware from an attached USB device, refer to Downloading firmware from a USB device on page 115.

When upgrading multiple switches, complete the following steps on each switch before you upgrade the next one.

1. Perform the steps described in Preparing for a firmware download on page 112.
2. Verify that the FTP or SSH server is running on the remote server and that you have a valid user ID and password on that server.
3. Connect to the switch or management module you are upgrading.

   Refer to Connecting to the switch on page 113 for more information.
4. Issue the **show version** command to determine the current firmware version.
5. Enter the **firmware download interactive** command to download the firmware interactively. When prompted for input, choose the defaults whenever possible.

6. If you invoked the **firmware download** command using the **interactive** option, at the `Do you want to continue? [y/n]:` prompt, enter `y`.

```
switch# firmware
download interactive
Server name or IP address: 10.31.2.25
File name: /users/home40/Builds/NOS_v4.0.0
Protocol (ftp, sftp, scp): ftp
User: fvt
Password: **********
Do manual download [y/n]: n
System sanity check passed.
Do you want to continue? [y/n]:y
switch# firmware downloadscp host 10.70.12.110 directory /dist file
release.plist user fvt password pray4green
Performing system sanity check...
This command will use the ISSU protocol to upgrade the system. It will cause
a WARM reboot and will require that existing telnet, secure telnet or SSH
sessions be restarted.
Do you want to continue? [y/n]: y
```

NOTE

To be able to address the FTP server by its name, ensure that a Domain Name System (DNS) entry is established for the server.

Downloading firmware from a USB device

The Brocade VDX 6710, VDX 6720, VDX 6730, and VDX 6740 switches, as well as the Brocade VDX 8770, support firmware download from a Brocade-branded USB device. You cannot use a third-party USB device. Before you can access the USB device, you must enable the device and mount it as a file system. The firmware images to be downloaded must be stored in the factory-configured `firmware` directory. Multiple images can be stored under this directory.

1. Ensure that the USB device is connected to the switch.
2. Enter the **usb on** command in privileged EXEC mode.

```
switch# usb on
Trying to enable USB device. Please wait...
USB storage enabled
```

3. Enter the **usb dir** command.

```
switch# usb dir
firmwarekey\ 0B 2013 Jun 15 15:13
support\ 106MB 2013 Jun 24 05:36
config\ 0B 2013 Jun 15 15:13
firmware\ 380MB 2013 Jun 15 15:13
NOS_v4.0.0\ 379MB 2013 Jun 15 15:31
Available space on usbstorage 74%
```

4. Enter the **firmware download usb** command followed by the relative path to the firmware directory.

```
switch# firmware download usb directory vdx
```

5. Unmount the USB storage device.

```
switch# usb off
Trying to disable USB device. Please wait...
USB storage disabled.
```

Downloading firmware by using the noactivate option

The **noactivate** option in the **firmware download** command allows you to download new firmware onto a switch without rebooting the system. In a chassis system, you use this option on the active MM only; the firmware is then downloaded onto both the active and standby MMs.

The following example shows the results of the **firmware download noactivate** command.

```
switch# firmware download scp noactivate host 10.70.12.110 directory /users/home24/tliang/tliang_taurus2
user fvt password pray4green
Performing system sanity check...

You are running firmware download without Activating the downloaded firmware. Please use firmware activate
to activate the firmware.

Do you want to continue? [y/n]: y
```

After the new firmware is downloaded, you can later execute the **firmware activate** command on the switch to reboot the switch and activate the new firmware.

CAUTION
Do not execute the reboot command to activate the new firmware. Doing so causes the old firmware to be restored.

In a cluster environment, you can download firmware by using the **noactivate** option on all of the switches and download firmware onto all of them first, then execute the **firmware activate** command to activate the new firmware on the switches in the desired order. This can shorten the period during which the switches are running different versions of firmware and minimize the disruption in the cluster.

CAUTION
The firmware activate command invokes the ISSU protocol and causes a warm recovery on the switch.

The following example shows a request to activate the node after running **firmware activate** command.

```
switch# firmware activate
This command will use the ISSU protocol to upgrade the system. It will cause a WARM reboot and will require
that existing telnet, secure telnet or SSH sessions be restarted.
Do you want to continue? [y/n]: y
2010/01/29-23:48:35, [HAM-1004], 226, switchid 1, CHASSIS | VCS, INFO, Brocade_Elara2, Switch will be
rebooted with the new firmware.
```

Downloading firmware by using the manual option

The following procedure applies to a compact switch or a single management module.

1. Verify that the FTP, SFTP, or SSH server is running on the host server and that you have a user ID on that server.
2. Obtain the firmware file from the Brocade website at http://www.mybrocade.com or from your switch support provider and store the file on the FTP, SFTP, or SSH server.
3. Unpack the compressed firmware archive.
4. Enter the **show version** command to view the current firmware version.
5. Enter the **firmware download interactive** command and respond to the prompts.

6. At the `Do Auto-Commit after Reboot? [y/n]:` prompt, enter `n`.

```
switch# firmware download interactive
Server name or IP address: 10.31.2.25
File name: /users/home40/Builds/NOS_v4.1.0
Protocol (ftp, scp): ftp
User: fvt
Password: **********
Do manual download [y/n]: y
Reboot system after download? [y/n]:y
Do Auto-Commit after Reboot? [y/n]:n
System sanity check passed.
You are running firmware download on dual MM system with 'manual' option. This will upgrade the
firmware only on the local MM.
This command will cause a cold/disruptive reboot and will require that existing telnet, secure
telnet or SSH sessions be restarted.
Do you want to continue? [y/n]:y
```

   The switch performs a reboot and comes up with the new firmware. Your current CLI session will automatically disconnect.

7. Enter the **show version all-partitions** command to confirm that the primary partitions of the switch contain the new firmware.

Upgrading firmware by using the manual option

On a compact switch, this manual option allows you to specify the **noreboot** and **nocommit** options so that you have exact control over the firmware download sequence. In a dual management-module (MM) system, the manual mode allows you to upgrade only the MM on which the firmware download command is issued. Furthermore, the manual option allows you to specify the noreboot or nocommit options. Therefore, you need to invoke the **firmware download** command with this option on both MMs.

CAUTION

Using the manual option causes disruption to the traffic. However, sometimes it is necessary to use this option to download firmware to both MMs,

and to reboot boot MMs at the same time to avoid firmware compatibility issues between the old and new firmware. Refer to the Release Notes for further instructions.

The following procedure applies to a compact switch or a single MM.

1. Enter the **firmware download interactive** command and respond to the prompts.
2. At the `Do manual download [y/n]:` prompt, enter `y`.
3. At the `Reboot system after download? [y/n]:` prompt, you can enter `n` if you want to reboot the system manually after downloading the firmware.
4. At the `Do Auto-Commit after Reboot [y/n]:` prompt, enter `n` if you want to commit the firmware manually after downloading the firmware.

```
switch# firmware download interactive
Server name or IP address: 10.31.2.25
File name: /users/home40/Builds/NOS_v4.1.0
Protocol (ftp, scp): ftp
User: fvt
Password: **********
Do manual download [y/n]: y
Reboot system after download? [y/n]:n
Do Auto-Commit after Reboot? [y/n]:n
System sanity check passed.
You are running firmware download on dual MM system with 'manual' option. This
will upgrade the firmware only on the local MM.
Do you want to continue? [y/n]:y
(output truncated)
```

5. After download completes, enter the **show version all-partitions** command to confirm that the primary partitions of the switch contain the new firmware.
6. If you entered `n` after the `Reboot system after download?` prompt, enter the **reload** command to reboot the switch. If you entered `y` after the prompt, the switch will reboot automatically. The switch performs a reboot and comes up with the new firmware. Your current CLI session will automatically disconnect.
7. Log back into the switch. If you entered n in the `Do Auto-Commit after Reboot?` prompt, enter the **firmware commit** command to commit the new firmware. If you entered `y` after the prompt, the switch will commit the firmware automatically upon booting up.

```
switch# firmware commit
Validating primary partition...
Doing firmwarecommit now.
Please wait ...
Replicating kernel image
..............
FirmwareCommit completes successfully.
```

8. Enter the **show version** command with the **all-partitions** option. Both partitions on the switch or on the modules should contain the new firmware.

Downloading firmware by using the default-config option

You can download firmware on a local switch and optionally change the VCS mode, the VCS ID, and the RBridge ID before rebooting the switch with the new firmware.

To download firmware by using the **default-config** option with VCS mode 1, VCS ID 7, and RBridge 10, use the following command:

```
sw0# firmware download default-config ftp host 10.20.1.3 user fvt password pray4green directory dist file
release.plist vcs-mode 1 vcs-id 7 rbridge-id 10

Performing system sanity check...
This command will set the configuration to default and set the following parameters: vcs-mode, vcs-id and
rbridge-id.
This command will cause Cold reboot on both MMs at the same time and will require that existing telnet,
secure telnet or SSH sessions be restarted.

Do you want to continue? [y/n]: y
```

Monitoring and verifying a firmware download session

Regardless of the options that you invoke, while the upgrade is proceeding you can start a separate CLI session on the switch and use the **show firmwaredownloadstatus** command to monitor the progress of the upgrade.

After the firmware download completes, you can verity that the download has completed properly by doing the following:

1. Execute the **show version all-partitions** command to verify that the MMs and all line-card partitions have the correct firmware.
2. Execute the **show ha all-partitions** command to verify that the MMs and all line-card partitions are in HA sync.
3. Execute the **show slots** command to verify that the MMs and all line cards are in the "enabled" state.
   If the MMs are running different firmware, you need to execute the **firmware download** command with the **manual** option to update the standby MM to the same level as the active MM. If a line card is in the faulty state or the line-card partitions are not in sync, you must execute the **poweroff linecard** and **power-on linecard** commands to recover the line card.

Upgrading firmware in Brocade fabric cluster mode

The **firmware download** command supports local switch upgrades only. To upgrade all switches in a VCS fabric, you must execute the **firmware download** command on each switch separately.

> NOTE
> For each switch in the fabric, complete the firmware download on the current switch before initiating a firmware download on another switch. This process minimizes traffic disruption.

Enter the **show firmwaredownloadstatus** command to verify that the download process is complete, and then move to the next switch.

You can also run the **firmware download** command with the **noactivate** option to download firmware to the nodes without rebooting them. After the firmware is downloaded to all nodes in the cluster, you can run **firmware activate** on each of the nodes to activate the firmware. This allows you to control the reboot sequence of the nodes to avoid traffic disruption in the cluster.

In the following example, a cluster contains four nodes (RBridge IDs 1 through 4). Node 1 is the principal node (coordinator). In the example, the switches need to be rebooted in a specific order, namely node 2, followed by node 3, then node 4, and finally node 1. This can be accomplished by invoking the following sequence of commands from any node.

1. Enter **firmware download noactivate** on all of the switches. The **noactivate** option prevents the switches from rebooting automatically.
2. After the new firmware has been downloaded to all of the switches, execute the **firmware activate** command on each node in the following order:
   a) **firmware activate rbridge-id 2**
   b) **firmware activate rbridge-id 3**
   c) **firmware activate rbridge-id 4**
   d) **firmware activate rbridge-id 1**

Upgrading firmware in Brocade logical chassis cluster mode

In logical chassis cluster mode, you can upgrade the cluster by logging in to individual nodes and running the **firmware download** command the same as in fabric cluster mode.

Another method for upgrading the logical chassis cluster is by specifying the **logical-chassis** and **rbridge-id** options in the **firmware download** command, which is also referred to as the **firmware download logical-chassis** command. This command allows users to upgrade one or more nodes in the cluster from the principal node. The nodes to be upgraded are specified in the **rbridge-id** option.

After the **firmware download logical-chassis** command is issued, firmware is downloaded to the specified nodes simultaneously through their respective management ports. The number of nodes does not change the download time. By default, after firmware is downloaded to all of the specified nodes, the **firmware download logical-chassis** command exits. It does *not* reboot the nodes.

You will then need to explicitly issue the **firmware activate rbridge-id** command to activate the new firmware in the nodes. This way, you have exact control over the reboot sequence of the nodes in the cluster. To automatically activate the new firmware, the **auto-activate** option must be specified.

> CAUTION
> **When the auto-activate option is specified, all of the specified nodes in the command will be rebooted at the same time, which can cause traffic disruption. Auto-activate is therefore not recommended.**

While the **firmware download logical-chassis** command is executing, you can run the **show firmwaredownloadstatus rbridge-id all** command to verify the download status on the nodes. The status of the nodes after logical-chassis firmware download is completed should display "Ready to activate." You can also run the **show version rbridge-id all** command to verify the firmware versions on the nodes.

The general procedure for upgrading firmware in logical chassis cluster mode is as follows:

1. Execute the **firmware download logical-chassis rbridge-id all** command to upgrade all nodes in the cluster.

```
switch# firmware download logical-chassis protocol ftp host 10.10.10.10 user fvt password buzz
directory /dist/nos/4.1.0 file release.plist rbridge-id all
Rbridge-id   Sanity Result         Current Version
-----------------------------------------------
  1          Non-disruptive(ISSU)        4.1.0
  2          Disruptive                  4.1.0
  3          Disruptive                  4.1.0
```

2. Execute the **show firmwaredownloadstatus summary rbridge-id all** command and the **show version rbridge-id all** command to check the firmware download status of the nodes.

```
switch# show firmwaredownloadstatus summary bridge-id all
Rid 1: INSTALLED (Ready for activation)
Rid 2: INSTALLED (Ready for activation)
Rid 3: INSTALLED (Ready for activation)
switch# show version rbridge-id all
rbridge-id 1
Network Operating System Software
Network Operating System Version: 4.1.0
Copyright (c) 1995-2012 Brocade Communications Systems, Inc.
Firmware name:      4.1.0
Build Time:         19:59:29 Jan 10, 2014
Install Time:       20:36:28 Jan 12, 2014
Kernel:             2.6.34.6
BootProm:           2.2.0
Control Processor:  e500v2 with 2048 MB of memory
Appl     Primary/Secondary Versions
----------------------------------------
NOS      4.1.0
         4.1.0
```

3. If any nodes fail to download, execute another **firmware download logical-chassis rbridge-id** command to download firmware to the failed nodes and bring all nodes to the same firmware level. Verify that the secondary partition of the nodes has the new firmware before proceeding with the output of this command.
4. Execute the **firmware activate rbridge-id** *rbridge-id* command to activate the nodes in the desired order.

> NOTE
> All of the nodes specified in the *rbridge-id* parameter in the **firmware activate** command will be rebooted at the same time.

```
switch# firmware activate rbridge-id 1-2,3
This command will activate the firmware on the following nodes.
Rbridge-id      Sanity Result
-------------------------------------
  1           Non-disruptive(ISSU)
  2           Disruptive
  3           Disruptive
It will cause these nodes to reboot at the same time.
Do you want to continue? [y/n]: y
```

Verifying firmware download in logical chassis cluster mode

Any node failure or principal node failover can cause the logical chassis firmware download to be aborted. After the **firmware download logical-chassis** command is returned, you should verify that the command has been completed successfully:

1. Run **show firmwaredownloadstatus rbridge-id***rbridge-id* to verify that the nodes have completed the installation and are in the "Ready for activation" state.
2. Run **show version rbridge-id***rbridge-id* to verify that the nodes have the correct firmware.

   If any nodes are not in the "Ready for activation" state or do not have the correct firmware installed, you should issue another **firmware download logical-chassis** command to upgrade the failed nodes before activating the new firmware.

   If the logical chassis firmware download keeps failing on any of the nodes, you might need to log in to the failed nodes and recover them. For instructions, refer to Upgrading firmware in Brocade logical chassis cluster mode on page 119.

Upgrading and downgrading firmware within a VCS Fabric

Use this procedure, illustrated by an example topology, to upgrade or downgrade firmware within a VCS Fabric.

It is important to reduce the downtime incurred by planned software upgrades. This section describes how to upgrade and downgrade Brocade Network OS firmware images efficiently and safely onto a variety of platforms in a VCS Fabric.

> ATTENTION
> This procedure illustrates an upgrade to Network OS release 4.1.1. For the limitations and caveats related to a specific Network OS release, refer to the Release Notes for that release.

Although it is necessary to reboot the switches after the installation, the following benefits are achieved:

- An optimal upgrade cycle for the entire fabric cluster
- Minimal loss of traffic
- No loss of configuration status

This procedure is supported on the following Brocade platforms:

- VDX 6710
- VDX 6720-24 and VDX 6720-60
- VDX 6730-60
- VDX 6740 and VDX 6740T
- VDX 8770-4 and VDX 8770-8

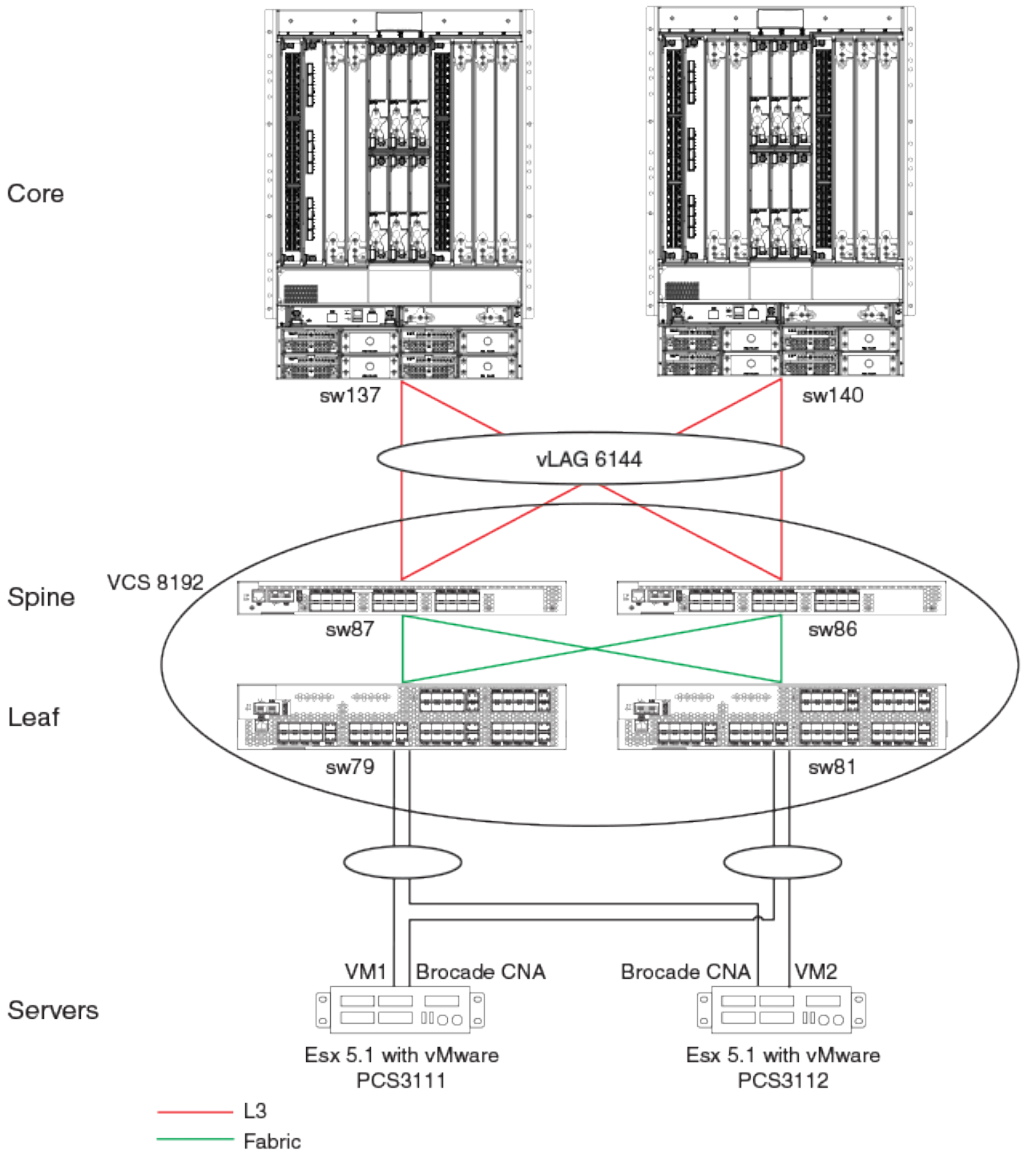
The example approach presented here, tested in a Brocade lab topology, is intended as a best-practices model that is to be modified for existing customer deployments. Software release versions will vary.

Tested topology

Tested topology

The tested topology, illustrated below, is a four-node VDX cluster VCS 8192. The cluster consists of two spine nodes and two leaf nodes, connected to the core through a vLAG. Two servers, running Brocade CNA, are dual-homed through two vLAGs to both the leaf nodes of VCS 8192.

FIGURE 14 Tested topology



The following table summarizes the tested components.

TABLE 13 Tested components and roles

Position	VCS name	Chassis type	Description
Leaf	8192	VDX 6720-60	Dual-homed TOR VDX
Spine	8192	VDX 6720-24	Dual-homed
Core	NA	VDX 8770	Connected to spine nodes of VCS 8192 through 16-port vLAG
Servers	NA	ESX 5.1 with Brocade CNA	Dual-homed to both leaf nodes through a vLAG

Upgrading nodes by using an odd/even approach

To reduce downtimes during planned software upgrades, the network design illustrated here has been provisioned with redundancy in all layers. Once such in-built redundancy is in place, an "odd/even" approach is used, whereby the cluster is split equally into odd and even nodes that represent both sides of the redundant traffic path. Therefore, both groups (either all odd or all even) have traffic connectivity to all hosts and end devices during the upgrade process. As a result, reloading any one group results in minimal traffic loss.

The following summarizes the classification of the odd and even nodes that were tested.

TABLE 14 Classification of odd and even nodes

Position	Chassis type	Description	Odd group	Even group
Leaf	VDX 6720-60	Dual-homed TOR VDX	sw81	sw79
Spine	VDX 6720-24	Dual-homed	sw87	sw86
Servers	ESX 5.1 with Brocade CNA	Dual-homed to both leaf nodes through a vLAG		

Preparing for the maintenance window

Do the following before the start of the maintenance window.

1. Take a "golden" snapshot of the running configuration, by copying the running configuration onto flash or an external FTP or SCP server. The following copies the running configuration to flash memory.

```
sw87# copy running-config flash://running.Config.master
```

2. Establish Telnet connections and console connections to all VDX Fabric cluster nodes. Telnet sessions are used to perform configurations, while console sessions are used to monitor the switches.

3. View the running configuration (as illustrated below) to ensure that all the port-channel interfaces have been configured by means of the **vlag ignore-spit** command on all VDX nodes.

   NOTE
   By default, port-channel configurations have "vlag ignore-split" enabled. However, if this default has been changed it must be re-established.

```
sw87# conf t
Entering configuration mode terminal
sw87(config)# int po 6144
sw87(config-Port-channel-6144)# vlag ignore-split
sw87(config-Port-channel-6144)# exit
sw87(config)# exit
sw87#

sw87# show running-config interface Port-channel 6144
interface Port-channel 6144
 vlag ignore-split
 switchport
 switchport mode trunk
 switchport trunk allowed vlan all
 switchport trunk tag native-vlan
 no shutdown
!
sw87#
```

4. Check the state of the system by using the following **show** commands.
   a) Verify that all the nodes to be upgraded are running the same version, by using the **show version** command.

```
sw87# show version

Network Operating System Software
Network Operating System Version: 3.0.1
Copyright (c) 1995-2012 Brocade Communications Systems, Inc.
Firmware name:      3.0.1c
Build Time:         23:15:48 Oct 18, 2013
Install Time:       04:27:13 Dec  3, 2013
Kernel:             2.6.34.6

BootProm:           2.2.0
Control Processor:  e500v2 with 2048 MB of memory

Appl     Primary/Secondary Versions
----------------------------------------
NOS      3.0.1c
         3.0.1c

sw87#
```

   b) Verify the state of the fabric, by using the **show fabric all** command.

```
sw87# show fabric all

VCS Id: 8192
Config Mode: Local-Only

Rbridge-id           WWN             IP Address         Name
-------------------------------------------------------------
  79         10:00:00:27:F8:44:50:C2    10.20.53.79        "sw79"
  81         10:00:00:05:33:FA:44:08    10.20.53.81        "sw81"
  86         10:00:00:27:F8:0C:D1:BD    10.20.53.86       >"sw86"
  87         10:00:00:05:33:FA:4A:48    10.20.53.87        "sw87"*

The Fabric has 4 Rbridge(s)

sw87#
```

   c) Verify that all fabric ISLs are up, by using the **show fabric isl** command.

```
sw87# show fabric isl

Rbridge-id: 87   #ISLs: 3

 Src        Src            Nbr        Nbr
Index    Interface    Index    Interface        Nbr-WWN                    BW    Trunk  Nbr-Name
------------------------------------------------------------------------------------
0        Te 87/0/1     14      Te 79/0/15    10:00:00:27:F8:44:50:C2  10G   Yes    "sw79"
3        Te 87/0/4     7       Te 86/0/8     10:00:00:27:F8:0C:D1:BD  10G   Yes    "sw86"
4        Te 87/0/5     3       Te 81/0/4     10:00:00:05:33:FA:44:08  10G   Yes    "sw81"

sw87#
```

   d) Verify the state of the port-channels, by using the **show port-channel summary** command.

```
sw87# show port-channel summary
 LACP Aggregator: Po 6144 (vLAG)
 Aggregator type: Standard
 Ignore-split is enabled
  Member rbridges:
    rbridge-id: 86 (16)
    rbridge-id: 87 (16)
  Admin Key: 6144 - Oper Key 6144
 Member ports on rbridge-id 87:
   Link: Te 87/0/9 (0x5718050008) sync: 1
```

```
    Link: Te 87/0/10 (0x5718050009) sync: 1
    Link: Te 87/0/11 (0x571805800A) sync: 1
    Link: Te 87/0/12 (0x571806000B) sync: 1
    Link: Te 87/0/13 (0x571806800C) sync: 1
    Link: Te 87/0/14 (0x571807000D) sync: 1
    Link: Te 87/0/15 (0x571807800E) sync: 1
    Link: Te 87/0/16 (0x571808000F) sync: 1
    Link: Te 87/0/17 (0x5718088010) sync: 1
    Link: Te 87/0/18 (0x5718090011) sync: 1
    Link: Te 87/0/19 (0x5718098012) sync: 1
    Link: Te 87/0/20 (0x57180A0013) sync: 1
    Link: Te 87/0/21 (0x57180A8014) sync: 1
    Link: Te 87/0/22 (0x57180B0015) sync: 1
    Link: Te 87/0/23 (0x57180B8016) sync: 1
    Link: Te 87/0/24 (0x57180C0017) sync: 1

sw87#
```

e) Verify that the required ports and port-channels are up, by using the **show ip interface brief** command.

```
sw87# show ip interface brief

Interface                    IP-Address      Status                   Protocol
==========================   ==========      ====================     ========
Port-channel 6144            unassigned      up                         up
TenGigabitEthernet 87/0/1    unassigned      up                       up  (ISL)
TenGigabitEthernet 87/0/2    unassigned      up                       down
TenGigabitEthernet 87/0/3    unassigned      administratively down    down
TenGigabitEthernet 87/0/4    unassigned      up                       up  (ISL)
TenGigabitEthernet 87/0/5    unassigned      up                       up  (ISL)
TenGigabitEthernet 87/0/6    unassigned      up                         down
TenGigabitEthernet 87/0/7    unassigned      up                       down
TenGigabitEthernet 87/0/8    unassigned      up                       up
TenGigabitEthernet 87/0/9    unassigned      administratively down    down
TenGigabitEthernet 87/0/10   unassigned      up                       up
<Snip>
```

f) Verify the number of MAC addresses in the cluster and other details, by using the **show mac-address-table count** and **show mac-address-table** commands.

```
sw87# show mac-address-table count
Dynamic Address Count  : 11
Static Address  Count  : 0
Internal Address Count : 3
Total MAC addresses    : 14
sw87#
sw87# show mac-address-table
VlanId   Mac-address       Type     State        Ports
99       0005.3378.442a    Dynamic  Active       Po 6144
99       0005.3378.5242    Dynamic  Active       Po 6144
99       0005.33fa.4429    System   Remote       XX 81/X/X
99       0027.f80c.d1de    System   Remote       XX 86/X/X
99       0027.f844.50e3    System   Remote       XX 79/X/X
208      0009.8a06.6cbd    Dynamic  Active       Po 6144
208      0050.5656.3d02    Dynamic  Remote       Po 100
208      0050.5656.3d03    Dynamic  Remote       Po 100
208      0050.5656.3f42    Dynamic  Remote       Po 400
208      0050.5656.3f43    Dynamic  Remote       Po 400
208      0050.5661.2b00    Dynamic  Remote       Po 300
208      0050.566c.c929    Dynamic  Remote       Po 200
208      0050.56b3.18e3    Dynamic  Remote       Po 300
208      0050.56b3.2801    Dynamic  Remote       Po 400
Total MAC addresses    :  14
sw87#
```

g) Check the traffic rate on all the ports and port-channels along the traffic path, by using the **show interface** command with the following output option.

```
sw87# show interface port-channel 6144 | inc rate
Queueing strategy: fifo
    Input 86.487040 Mbits/sec, 84460 packets/sec, 8.65% of line-rate
    Output 86.487040 Mbits/sec, 84460 packets/sec, 8.65% of line-rate
```

h) Copy the running configuration to the startup configuration on all nodes, as well as to an external FTP/SCP server (by means of the **ftp://** or **scp://** options, not shown here).

```
sw87# copy running-config startup-config
This operation will modify your startup configuration. Do you want to continue? [y/n]:y
2013/12/05-21:30:52, [DCM-1101], 8374,, INFO, VDX6720-24, Copy running-config to startup-config
operation successful on this node.
sw87#
```

5. Identify the principal and multicast root nodes of the fabric.

a) **NOTE**

In logical chassis cluster mode, the **copy running-config startup-config** command is not applicable. Use **copy running-config ftp** or **copy running-config scp**.

Identify the principal node (RBridge), by using the **show fabric all** command.

```
sw87# show fabric all

VCS Id: 8192
Config Mode: Local-Only

Rbridge-id           WWN           IP Address         Name
-------------------------------------------------------------------------
  79       10:00:00:27:F8:44:50:C2   10.20.53.79        "sw79"
  81       10:00:00:05:33:FA:44:08   10.20.53.81        "sw81"
  86       10:00:00:27:F8:0C:D1:BD   10.20.53.86       >"sw86"
  87       10:00:00:05:33:FA:4A:48   10.20.53.87        "sw87"*

The Fabric has 4 Rbridge(s)

sw87#
```

b) Identify the multicast root node (RBridge), by using the **show fabric route multicast** command.

```
sw87# show fabric route multicast

Root of the Multicast-Tree
==========================
 Rbridge-id: 79
 Mcast Priority: 1
 Enet IP Addr: 10.20.53.79
 WWN: 10:00:00:27:f8:44:50:c2
 Name: sw79
 Rbridge-id: 87
Src-Index  Src-Port       Nbr-Index  Nbr-Port         BW    Trunk
-----------------------------------------------------------------
0          Te 87/0/1      14         Te 79/0/15       10G   Yes

sw87#
```

6. Identify "odd" and "even" nodes in the cluster, as defined previously in Upgrading nodes by using an odd/even approach on page 123.

Once the cluster is dual-homed and redundancy in all layers is established, split the cluster into "odd" and "even" nodes so that all nodes, either all odd or all even, have traffic connectivity to all hosts and end devices, resulting in minimal traffic loss.

7. Terminate any Fibre Channel sessions that traverse the fabric.

   NOTE
   For fabrics that do not support HA, FC/FCoE logins are affected during reloads.

8. Check memory utilization by using the **show process memory** command, and ensure that the 70% threshold is not exceeded.

Optimizing reconvergence in the VCS Fabric

While the VCS Fabric is reconverging after odd/even groups are reloaded or coming back into the fabric, there may be momentary spikes in traffic that can result in traffic loss. Before upgrading/reloading VDX nodes, it is crucial to ensure that flow control is enabled on the following interfaces to minimize the impact of reconvergence:

- Access ports that face servers or hosts. These can be port-channel or physical interfaces, depending upon the host or server configuration.
- Uplink interfaces that connect to the core (port-channel 6144 in our example topology).
- Interfaces supporting the VCS Fabric topology on all core and end-devices.

  NOTE
  ISL interfaces have flow control enabled by default.

Do the following to optimize reconvergence.

1. Confirm whether flow control is enabled, by using the **qos flowcontrol tx rx** command on the interfaces listed above, as in the following example.

```
sw87# show running-config interface Port-channel 6144
interface Port-channel 6144
 vlag ignore-split
 switchport
 switchport mode trunk
 switchport trunk allowed vlan all
 switchport trunk tag native-vlan
 qos flowcontrol tx on rx on
 no shutdown
!
sw87#
```

2. To enable flow control on an interface that does not have it enabled, use the **qos flowcontrol tx rx** command.
3. Where servers are connected to cluster leaf nodes, is recommended that Link Aggregation Control Protocol (LACP) vLAGs be used to minimize traffic loss.

Maintaining the VCS Fabric

During a VCS Fabric maintenance window, it is recommended that you do the following.

1. Download the required firmware on all VDX cluster nodes by using the **nocommit**, **noreboot**, and **coldboot** options as appropriate. The last option applies to non-ISSU firmware downloads.

   CAUTION
   Do not use the coldboot option unless directed to do so by Brocade Technical Support. If you do not select the nocommit option, firmware is downloaded automatically. This prevents you from backing out of an upgrade should that become necessary. Refer to Restoring firmware in the VCS Fabric **on page 130.**

   NOTE
   In this test topology, because the upgrade is from 3.0.1c to 4.1.1, 4.1.1 is loaded on all VDX cluster nodes. Your versions will vary accordingly.

2. Verify that there is no control or data traffic outage during the firmware download process.
3. After the firmware completes downloading on all nodes, in large-scale deployments it is recommended that you reload the fabric principal and multicast root nodes either separately or along with the "even" nodes.

   NOTE
   Because the fabric principal and multicast rood nodes have already been identified previously as "even" nodes, we reload the "odd" nodes first, then the "even" nodes. In the example below, sw87 and sw81 are reloaded at the same time. Refer to Understanding traffic outages on page 130 for details of the traffic outages that occurred at different phases of the process in the tested topology.

4. Wait at least 5 minutes for the switches (in our example sw81 and sw87) to come back up.

   NOTE
   The time required for the switches to come back up with the configuration replay complete depends on the number of configuration lines that must be read. Refer to Understanding traffic outages on page 130 for example traffic-outage times.

5. Wait at least 10 minutes for the fabric to converge and all back-end processes to be completed.

   NOTE
   At this point in the process, sw79 and sw86 are at 3.0.1c, while sw87 and sw81 are at 4.1.1.

6. Verify that all four nodes are part of the same cluster, by using the **show fabric all** command.
7. At this point, reboot all the "even" nodes, including the principal and the multicast root node. Refer to Understanding traffic outages on page 130 for example traffic-outage times.
8. Wait at least 10 minutes for the fabric to converge and all back-end processes to be completed.

   NOTE
   At this point, all nodes are at 4.1.1.

9. Verify that all nodes have joined the fabric, by using the **show fabric all** and **show vcs** commands.

   ATTENTION
   Ensure that there are no traffic
   outages.

10. Verify that system health is as discussed in Step 4 of Preparing for the maintenance window on page 123.

11. Evaluate the state of the upgrade process at this point. The upgraded firmware should have been downloaded onto the primary partition, while the original firmware should be present in the second partition.
12. To complete the process commit the firmware, by using the **firmware commit** command.
13. If an unexpected development occurs, you can roll back to the original firmware. Refer to Restoring firmware in the VCS Fabric on page 130.

Understanding traffic outages

For example traffic-outage times as measured by various traffic-analysis tools, note the following.

1. Note the following traffic-outage times that occurred when the "odd" switches, sw87 and sw81, were reloaded.

TABLE 15 Traffic outage times: "Odd" switches, upgrading from 3.0.1c to 4.0.1

Tool	Traffic path 2	Traffic path 1
Layer 2 traffic	0 ms (within same rack)	~118 ms (ping from server to sw137)
Layer 3 traffic-generator traffic	N/A	0 ms

TABLE 16 Traffic outage times: "Odd" switches, reloading within 3.0.1c

Tool	Traffic path 2	Traffic path 1
Layer 2 traffic	0 ms (within same rack)	~122 ms (ping from server to sw137)
Layer 3 traffic-generator traffic	N/A	0 ms

2. Note the following traffic-outage times that occurred when the "even" switches, sw79 and sw86, were reloaded.

TABLE 17 Traffic outage times: "Even" switches, upgrading from 3.0.1c to 4.0.1

Tool	Traffic path 2	Traffic path 1
Layer 2 traffic	0 ms (within same rack)	~129 (ping from server to sw137)
Layer 3 traffic-generator traffic	N/A	0 ms

TABLE 18 Traffic outage times: "Even" switches, reloading within 3.0.1c

Tool	Traffic path 2	Traffic path 1
Layer 2 traffic	0 ms (within same rack)	~123 (ping from server to sw137)
Layer 3 traffic-generator traffic	N/A	0 ms

Restoring firmware in the VCS Fabric

At times it may be necessary to back out of a firmware upgrade. In this case, do the following on the appropriate node or nodes.

ATTENTION
This option works only if autocommit mode was disabled during the firmware download, by means of the **nocommit** option in the **firmware download** command.

1. Enter the **firmware restore** command.
The switch reboots with the original (previous) firmware, which is copied from the primary partition to the secondary partition. When this process is complete, both partitions will have the original firmware. This operation may take several minutes to complete.

2. Wait at least five minutes to ensure that all processes have completed and the switch is fully up and operational.
3. Enter the **show version** command and verify that both partitions on the switch have the original firmware.

Downgrading firmware in the VCS Fabric

Do the following to downgrade firmware on nodes in the VCS Fabric.

CAUTION
The downgrade process will disrupt service.

1. Ensure that the VCS cluster is in fabric cluster mode.
2. Back up the running configuration.
3. NOTE
   You can back up this file to an FTP or SCP server.

   Download the previous version of firmware onto the nodes to be downgraded.

   ATTENTION
   Do not reboot at this point. You will be prompted to remove any vCenter configurations if they are present.

4. After removing any vCenter configurations, reboot the nodes.
   The startup configuration is replayed onto the running configuration.

   NOTE
   Unsupported configurations will be discarded.

5. (Optional) You can copy the running configuration file saved in Step 3 from the FTP or SCP server to the local running configuration.
6. Save the running configuration to the startup configuration.

Configuring SNMP

Simple Network Management Protocol overview

Simple Network Management Protocol (SNMP) is a set of protocols for managing complex networks. SNMP protocols are application layer protocols. Using SNMP, devices within a network send messages, called protocol data units (PDUs), to different parts of a network. Network management using SNMP requires three components:

- SNMP Manager
- SNMP Agent
- Management Information Base (MIB)

SNMP Manager

The SNMP Manager can communicate to the devices within a network using the SNMP protocol. Typically, SNMP Managers are network management systems (NMS) that manage networks by monitoring the network parameters, and optionally, setting parameters in managed devices. Normally, the SNMP Manager sends read requests to the devices that host the SNMP Agent, to which the SNMP Agent responds with the requested data. In some cases, the managed devices can initiate the communication, and send data to the SNMP Manager using asynchronous events called traps.

SNMP Agent

The SNMP agent is a software that resides in the managed devices in the network, and collects data from these devices. Each device hosts an SNMP Agent. The SNMP Agent stores the data, and sends these when requested by an SNMP Manager. In addition, the Agent can asynchronously alert the SNMP Manager about events, by using special PDUs called traps.

Management Information Base (MIB)

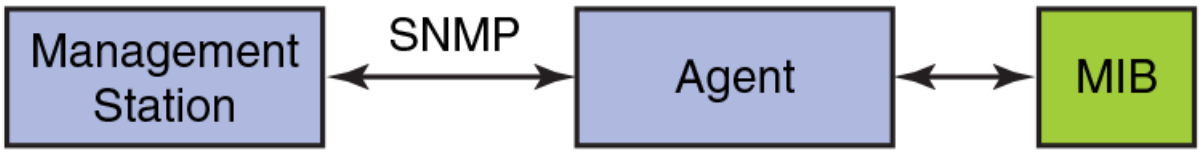
SNMP Agents in the managed devices store the data about these devices in a database called Management Information Base (MIB). The MIB is a hierarchical database, which is structured on the standard specified in the RFC 2578 [Structure of Management Information Version 2 (SMIv2)].

The MIB is a database of objects that can be used by a network management system to manage and monitor devices on the network. The MIB can be retrieved by a network management system that uses SNMP. The MIB structure determines the scope of management access allowed by a device. By using SNMP, a manager application can issue read or write operations within the scope of the MIB.

Basic SNMP operation

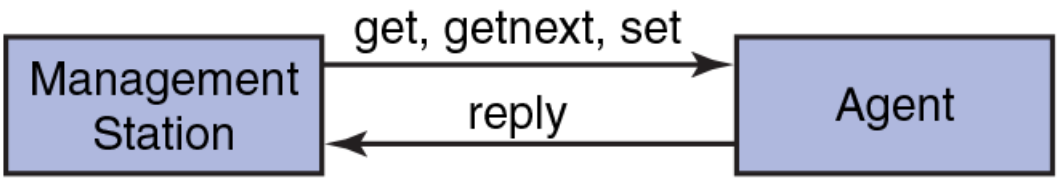
Every Brocade device carries an *agent* and management information base (MIB), as shown in the next figure. The agent accesses information about a device and makes it available to an SNMP network management station.

FIGURE 15 SNMP structure



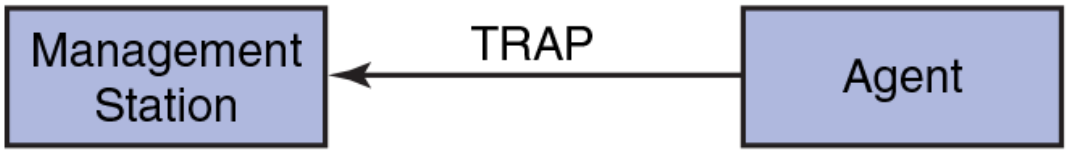
When active, the management station can "get" information or "set" information when it queries an agent. SNMP commands, such as **get** , **set**, **getnext**, and **getresponse**, are sent from the management station, and the agent replies once the value is obtained or modified as shown in the next figure. Agents use variables to report such data as the number of bytes and packets in and out of the device, or the number of broadcast messages sent and received. These variables are also known as managed objects. All managed objects are contained in the MIB.

FIGURE 16 SNMP query



The management station can also receive *traps*, unsolicited messages from the switch agent if an unusual event occurs as shown in the next figure.

FIGURE 17 SNMP trap



The agent can receive queries from one or more management stations and can send traps to up to six management stations.

Understanding MIBs

The management information base (MIB) is a database of monitored and managed information on a device, in this case a Brocade switch. The MIB structure can be represented by a tree hierarchy. The root splits into three main branches: International Organization for Standardization (ISO), Consultative Committee for International Telegraph and Telephone (CCITT), and joint ISO/CCITT. These branches have short text strings and integers (OIDs) to identify them. Text strings describe *object names*, while integers allow software to create compact, encoded representations of the names.

Brocade MIB structure

Each MIB variable is assigned an object identifier (OID). The OID is the sequence of numeric labels on the nodes along a path from the root to the object. For example, as shown in the figure below, the Entity MIB OID is:

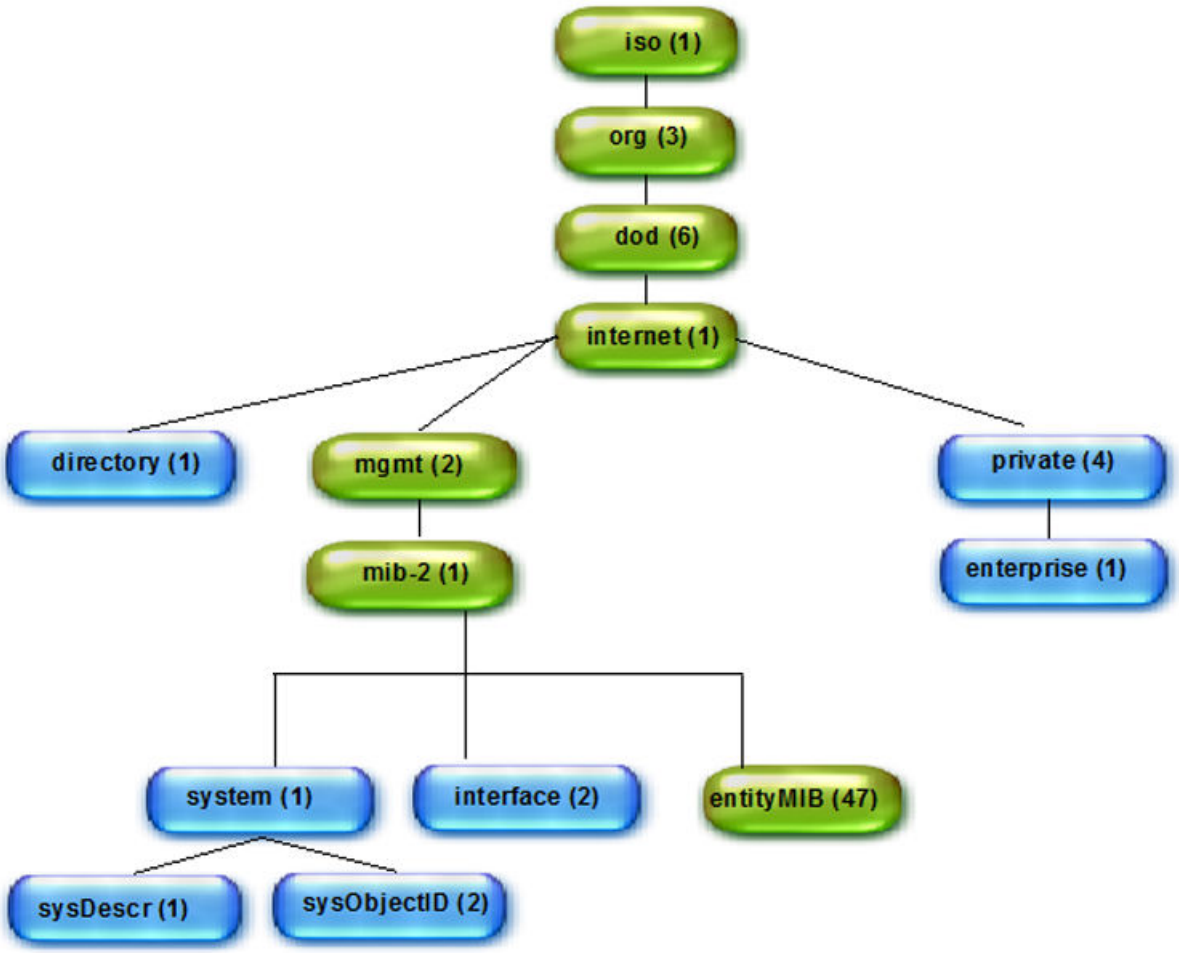
```
1.3.6.1.2.1.47
```

The corresponding name is:

```
iso.org.dod.internet.mgmt.mib-2.entityMIB
```

The other branches are part of the standard MIBs, and the portions relevant to configuring SNMP on a Brocade switch are referenced in the remainder of this chapter.

FIGURE 18 Brocade MIB tree location



Access to MIB variables

You can use a MIB browser to access the MIB variables: all MIB browsers perform queries and load MIBs.

Once loaded, MAX-ACCESS provides access levels between the agent and management station. The access levels are described in the following table.

TABLE 19 MIB access levels

Access level	Description
not accessible	You cannot read or write to this variable.
read create	Specifies a tabular object that can be read, modified, or created as a new row in a table.
read only - Public	You can only monitor information.
read-write - Private	You can read or modify this variable.
accessible-to-notify	You can read this information only through traps.

Brocade MIBs

The Brocade MIB is a set of variables that are private extensions to the Internet standard MIB-II. The Brocade agents support many other Internet-standard MIBs. These standard MIBs are defined in RFC publications. To find specific MIB information, examine the Brocade proprietary MIB structure and the standard RFC MIBs supported by Brocade.

Brocade MIB files

The Brocade MIB files are as follows:

- BRCD_NOS_PRODUCTS.mib
- BROCADE-PRODUCTS-MIB.mib
- BROCADE-REG-MIB.mib
- BRCD_TC.mib
- SWBase.mib
- Resource.mib
- System.mib
- FA.mib
- HA.mib
- FOUNDRY-SN-NOTIFICATION.mib

Agent Capability MIBs

In SNMP, capability MIBs provide the implementation details for the associated MIBs. These MIBs, called AGENT-CAPABILITY MIBs, list supported conformance groups and any deviations from the MIBs as implemented in the associated software version. The following lists the Brocade supported capability MIBs.

TABLE 20 Agent Capabilities

Capability MIBs	Description
BROCADE-IEEE8021-PAE-CAPABILITY-MIB	Provides the implementation details for the IEEE8021-PAE-MIB
BROCADE-IEEE8023-LAG-CAPABILITY-MIB	Provides the implementation details for the IEEE8023-LAG-MIB
BROCADE-LLDP-CAPABILITY-MIB	Provides the implementation details for the LLDP-MIB
BROCADE-LLDP-EXT-DOT3-CAPABILITY-MIB	Provides the implementation details for the LLDP-EXT-DOT3-MIB

Standard MIBs

Standard MIBs are not distributed through Brocade. You can download the following MIBs from http://www.oidview.com/:

- IF-MIB

- LLDP-MIB
- BRIDGE-MIB
- LLDP-EXT-DOT3-MIB
- LLDP-EXT-DOT1-MIB
- RSTP-MIB
- RFC1213-MIB
- IEEE8023-LAG-MIB
- Q-BRIDGE-MIB
- IEEE8021-PAE-MIB
- P-BRIDGE-MIB
- RMON-MIB
- SFlow-MIB
- INET-ADDRESS-MIB
- IANAifType-MIB
- IANA-RTPROTO-MIB
- SNMPV2-MIB
- SNMP-FRAMEWORK-MIB
- IANA-ADDRESS-FAMILY-NUMBERS-MIB
- FC-MGMT-MIB
- SNMP-MPD-MIB
- SNMP-TARGET-MIB
- SNMP-VIEW-BASED-ACM-MIB
- SNMP-COMMUNITY-MIB
- SNMP-MPD-MIB
- SNMP-TARGET-MIB
- SNMP-VIEW-BASED-ACM-MIB

MIB loading order

Many MIBs use definitions that are defined in other MIBs. These definitions are listed in the IMPORTS section near the top of the MIB. When loading the Brocade MIBs, refer to the following table to ensure that any MIB dependencies are loading in the correct order.

NOTE
Before loading the Brocade MIB files, ensure that you have the correct version of SNMP for the Brocade Network OS. All versions of Network OS support SNMPv1, SNMPv2c, and SNMPv3. SNMPv2c informs are not supported.

TABLE 21 Brocade SNMP MIB dependencies

MIB Name	Dependencies
Brocade-REG-MIB	RFC1155-SMI
Brocade-TC	Brocade-REG-MIB SNMPv2-TC SNMPv2-SMI

TABLE 21 Brocade SNMP MIB dependencies (continued)

MIB Name	Dependencies
BRCD_NOS_PRODUCTS.mib	SNMPv2-SMI Brocade-REG-MIB
BROCADE-PRODUCTS-MIB.mib	SNMPv2-SMI Brocade-REG-MIB
SWBase.mib	SNMPv2-TC SNMPv2-SMI Brocade-REG-MIB
Resource.mib	SNMPv2-TC SNMPv2-SMI SWBASE-MIB
System.mib	SNMPv2-TC Brocade-TC SWBASE-MIB
FA.mib	RFC1155-SMI RFC-1212 RFC1213-MIB RFC-1215
HA-mib	SNMPv2-SMI Brocade-REG-MIB SW-MIB ENTITY-MIB SNMPv2-TC
FOUNDRY-SN-NOTIFICATION.mib	SNMPv2-SMI FOUNDRY-SN-ROOT-MIB IF-MIB DOT3-OAM-MIB FOUNDRY-SN-SWITCH-GROUP-MIB FOUNDRY-SN-AGENT-MIB FOUNDRY-SN-SWITCH-GROUP-MIB FOUNDRY-SN-SW-L4-SWITCH-GROUP-MIB FOUNDRY-SN-WIRELESS-GROUP-MIB FOUNDRY-SN-OSPF-GROUP-MIB IEEE8021-CFM-MIB

SNMP configuration

The following sections discuss configuring the Simple Network Management Protocol on Brocade devices. This includes configuring SNMP community strings, SNMP server hosts, SNMP server contexts, password encryption for SNMPv3 users, and displaying SNMP configurations.

Configuring SNMP community strings

SNMP versions 1 and 2c use community strings to restrict access to the switch. There are six default community strings: three read-write strings and three read-only strings. There is support for a total of 256 SNMP communities, all user-configurable.

The following default community strings are read-write:

- Secret C0de
- OrigEquipMfr
- private

The following default community strings are read-only:

- public
- common
- ConvergedNetwork

Adding an SNMP community string

The **snmp-server community** command sets the community string and read-write or read-only access for each community, and is applicable to SNMPv1 and SNMPv2c. You can execute this command in global configuration mode.

1. Enter the **configure terminal** command.
2. Enter the **snmp-server community** *string* [**ro** |**rw**] command.

```
switch(config)# snmp-server community private rw
```

   - The *string* variable specifies the community string name. The string can be from 2 to 16 characters long.
   - The **ro** or **rw** option specifies whether the string is read-only (ro) or read-write (rw).

   The command in the example adds the read-write SNMP community string "private" with read-write access.

Changing the access of a read-only community string

This example changes the access of "user123" from read-only to read-write.

1. Enter the **configure terminal** command.
2. Enter the **snmp-server community** *string* **rw** command.

```
switch(config)# snmp-server community user123 rw
```

Removing an SNMP community string

This example removes the community string "private".

1. Enter the **configure terminal** command.

2. Enter the **no snmp-server community** *string* [**ro** | **rw**] command.

```
switch(config)# no snmp-server community private
```

Configuring SNMP server hosts

The **snmp-server host** command sets the trap destination IP addresses, SNMP version, community string for SNMPv1and SNMPv2c, contact information, the destination port for the SNMP server host, and the severity level.

To configure SNMP trap hosts associated with community strings, you must create the community string using the **snmp-server community** command before configuring the host.

The SNMP agent supports six default communities and their associated trap recipients and trap recipient severity levels. The default value for each attribute is as follows: host = 0.0.0.0; udp-port = 162; severity-level = none. The length of the community string must be from 2 through 16 characters. The community strings have the following default values:

String name	String value
common	read-only
public	read-only
ConvergedNetwork	read-only
OrigEquipMfr	read-write
private	read-write
Secret C0de	read-write

Setting the SNMP server host

You can execute SNMP server commands in global configuration mode.

1. Enter the **configure terminal** command.
2. Enter the **snmp-server host** *ipv4_host* | *ipv6_host* | *dns_host community-string* [**version** { **1** | **2c** }] [**udp-port** *port*] [**severity-level** | **none** | **debug** | **info** | **warning** | **error** | **critical** }] command.
   - The *ipv4_host* | *ipv6_host* | *dns_host* variable specifies the IP address of the host.
   - The *community-string* variable sets the community string.
   - The **version** option specifies either SNMPv1- or SNMPv2c-related configuration parameters. These parameters include the community string. The default SNMP version is 1.
   - The **udp-port** *port* option specifies the UDP port where SNMP traps will be received. The default port is 162. The acceptable range of ports is from 0 through 65535.
   - The **severity** *sev_level* option provides the ability to filter traps based on severity level on both the host and the v3host. Only RASLog (swEvent) traps can be filtered based on severity level. If the severity level of None is specified, all traps are filtered and no RASLog traps are received. If the severity level of Critical is specified, no traps are filtered and all traps are received by the host.

   Severity level options include None, Debug, Info, Warning, Error, and Critical.

   The following example sets up "commaccess" as a read-only community string and sets 10.32.147.6 as a trap recipient with SNMPv2c on target port 162.

```
switch(config)# snmp-server host 10.32.147.6 commaccess version 2c udp-port 162 severity warning
```

Removing the SNMP server host

The **no snmp-server host** *host* **community-string** *string* **version 2c** command brings version 2c down to version 1.

The **no snmp-server host** *host* **community-string** *string* command or the **no snmp-server v3host host** command removes the SNMP server host from the switch configuration altogether.

Configuring the SNMP system group

The following tasks allow you to configure the system contact and system location objects for the SNMP system group.

Setting the SNMP server contact

Use the **snmp-server contact** command to set the SNMP server contact string. The default contact string is "Field Support." The number of characters allowed is from 4 through 255.

1. Enter the **configure terminal** command.
2. Enter the **snmp-server contact** *string* command.

```
switch(config)# snmp-server contact "Operator 12345"
```

The example changes the default contact string to "Operator 12345." You must enclose the text in double quotes if the text contains spaces.

Removing the SNMP server contact

The **no snmp-server contact** *string* command restores the default contact information (Field Support).

Setting the SNMP server location

Use the **snmp-server location** command to set the SNMP server location string. The default SNMP server location string is "End User Premise." The number of characters allowed is from 4 through 255.

1. Enter the **configure terminal** command.
2. Enter the **snmp-server location** *string* command.

```
switch(config)# snmp-server location "Building 3 Room 214"
```

3. Enter the **no snmp-server location** command to remove the location.

The example changes the default location string to "Building 3 Room 214." You must enclose the text in double quotes if the text contains spaces.

Setting the SNMP server description

Use the **snmp-server sys-descr** command to set the SNMP server description string. The default SNMP server description string is "Brocade-VDX-VCS <vcsid>." The number of characters allowed is from 4 through 255.

1. Enter the **configure terminal** command.
2. Enter the **snmp-server sys-descr** *string* command.

```
switch(config)# snmp-server sys-descr "Brocade-VDX Test Bed"
```

3. Enter the **no snmp-server sys-descr** command to remove the location.

   The example changes the default location string to "Brocade-VDX Test Bed." You must enclose the text in double quotes if the text contains spaces.

Configuring multiple SNMP server contexts

A single SNMP agent can be supported by the multiple instances of the same MIB module by mapping the context name with the VRF instance. The context can be mapped to a VRF instance as described below. The SNMP agent supports 256 contexts to support context-to-VRF mapping. Do the following to set the SNMP server context, using the **snmp-server context** command to map a context to the name of a VPN routing and forwarding (VRF) instance.

1. Enter the **configure terminal** command.
2. Enter the **snmp-server context** *context_name* **vrf-name** *vrf_name* command.

```
switch(config)# snmp-server context mycontext vrf-name myvrf
```

   The example maps the context name "mycontext" to the VRF name "myvrf."

Configuring password encryption for SNMPv3 users

For SNMPv3 user, the passwords for **auth-password** and **priv-password** are encrypted. You can configure either with a plain-text password or an encrypted password. In both cases, the passwords are shown in the **show running-config** command as encrypted.

```
sw0(config# snmp-server user snmpadmin2 groupname snmpadmin auth md5 auth-password "MVb+360X3kcfBzug5Vo6dQ==
\n" priv DES priv-password "ckJFoHbzVvhR0xFRPjsMTA==\n" encrypted
```

NOTE

This command may not be successful where encrypted passwords are generated by third-party or open-source tools.

Displaying SNMP configurations

Use the **show running-config snmp-server** command to display the current SNMP configurations for the SNMP host, community string, contact, and location, as well as other SNMP configuration options such as SNMPv3 host address, context, and VRF mapping. There are no default configurations for this command. This command can be executed only in privileged EXEC command mode.

Enter the **show running-config snmp-server** command.

```
switch# show running-config snmp-server
snmp-server contact "Field Support."
snmp-server location "End User Premise."
snmp-server sys-descr "Brocade VDX Switch."
snmp-server community ConvergedNetwork
snmp-server community OrigEquipMfr rw
snmp-server community "Secret C0de" rw
snmp-server community common
snmp-server community private rw
snmp-server community public
snmp-server user snmpadmin1 groupname snmpadmin
snmp-server user snmpadmin2 groupname snmpadmin
snmp-server user snmpadmin3 groupname snmpadmin
snmp-server user snmpuser1
snmp-server user snmpuser2
snmp-server user snmpuser3
```

Configuring Brocade VCS Fabrics

Fabric overview

The Brocade VCS Fabric Ethernet fabric is defined as a group of switches that exchange information between each other to implement distributed intelligence. The Brocade Ethernet fabric uses Transparent Interconnection of Lots of Links (TRILL) protocol, designed for the sole purpose of scaling Ethernet networks by allowing a set of devices, called routing bridges (RBridges), to connect with each other.

A link state dynamic routing protocol, rather than Spanning Tree Protocol, determines how the traffic is forwarded between the inter-connected RBridges. Link state routing in Brocade VCS Fabric-based TRILL networks is performed using Fabric Shortest Path First (FSPF) protocol.

TRILL enables Layer 2 networks to behave like routed Layer 3/IP networks. TRILL also defines native support for forwarding both unicast and multicast traffic, and therefore unifies support for both of these different classes of applications over a single transport.

Brocade VCS Fabric formation

Brocade VCS Fabric technology uses RBridge identifiers (IDs) to discover fabric creation problems, such as duplicate IDs. The RBridge ID of a cluster unit is equal to the domain ID of an FC switch. RBridge ID assignment is implemented by leveraging the domain ID assignment protocols in the FC SANs. Request for Domain ID (RDI) and Domain ID Assignment (DIA) protocols ensure that a single switch (the principal switch) is centrally allocating the domain IDs for every RBridge in the fabric and detecting any domain ID conflicts in the fabric. In case of conflict, the conflicting node is segmented from the fabric. You must take action to resolve the conflict

> NOTE
> Fabrics based on Network OS 4.0.0 and later can have a maximum of 239 RBridges in a single Brocade VCS Fabric. However, Brocade recommends using only 24 RBridges per fabric.

The following sequence of events describes the Brocade VCS Fabric formation process:

- Each Brocade VCS Fabric is identified by a VCS ID.
- All Brocade VCS Fabric-capable switches are configured with a factory default VCS ID of 1.
- The switch software searches for the "VCS enable" attribute.

  > NOTE
  > If the software cannot locate the "VCS enable" attribute, the switch goes into standalone mode and operates like a regular 802.1x switch.

- Assuming the switch is Brocade VCS Fabric-enabled, the switch software invokes a series of protocols:
  - Brocade Link Discovery Protocol (BLDP) attempts to discover if a Brocade VCS Fabric-capable switch is connected to any of the edge ports. Refer to Neighbor discovery on page 144 for more information.
  - BLDP attempts to merge the adjacent Brocade switch into the Brocade VCS Fabric environment at the link level.
- A series of FC fabric formation protocols (RDI, DIA, and FSPF) are initiated once a link level relationship has been established between two neighbor switches. Refer to Fabric formation on page 145 for more information.
- The "Merge and Join" protocol invokes a merge of switch configuration between the cluster units once the fabric has successfully formed.

How RBridges work

RBridges find each other by exchanging FSPF Hello frames. Like all TRILL IS-IS frames, Hello frames are transparently forwarded by RBridges and are processed by RBridge Inter-Switch Link (ISL) ports. Using the information exchanged in the Hello frames, the RBridges on each link elect the designated RBridge for that link.

The RBridge link state includes information such as VLAN connectivity, multicast listeners, and multicast router attachment, claimed nicknames, and supported ingress-to-egress options. The designated RBridge specifies the appointed forwarder for each VLAN on the link (which could be itself) and the designated VLAN for inter-RBridge communication. The appointed forwarder handles native frames to and from that link in that VLAN.

The Ingress RBridge function encapsulates frames from the link into a TRILL data frame. The Egress RBridge function decapsulates native frames destined for the link from the TRILL data frames. TRILL data frames with known unicast destinations are forwarded by RBridge next hop. Multi-destination frames (broadcast, unknown unicast, and multicast) are forwarded on a tree rooted at the multicast root RBridge.

- Unicast forwarding is handled by combining domain routing generated by FSPF and MAC-to-RBridge learning generated by MAC learning and a distributed MAC database.
- Multicast forwarding usually uses one tree that is rooted at the RBridge with the lowest RBridge ID. However, there are several rules for Multicast root tree selection. It is not always the lowest RBridge ID.

If a duplicated RBridge ID is found while the links are still coming up, the links are segmented. Both sides recognize the error and segment the link. If the RBridge ID overlap cannot be found at ISL link bringup time (in the case where a new switch is brought from an offline state into the fabric) it will be found during the fabric build and the conflicting switch is isolated.

An RBridge requests a specific RBridge ID from the coordinator switch. If the coordinator switch detects that this RBridge ID is already used, it returns the next unused RBridge ID. The requesting RBridge is not allowed to take another RBridge ID and it segments itself from the fabric. In this case, you cannot boot the ISLs. The ISLs have to be explicitly disabled and then enabled again in order for the RBridge with the overlapping RBridge ID to be removed.

Neighbor discovery

Brocade VCS Fabric-capable neighbor discovery involves the following steps:

- Discover whether the neighbor is a Brocade switch.
- Discover whether the Brocade neighbor switch is Brocade VCS Fabric-capable.

Only Brocade VCS Fabric-capable switches with the same VCS ID can form a virtual cluster switch. The default settings for Brocade Network OS switches are Brocade VCS Fabric capable and a VCS ID of "1."

Brocade trunks

Network OS 4.0.0 and later supports Brocade trunks (hardware-based link aggregation groups, or LAGs). These LAGs are dynamically formed between two adjacent switches. The trunk formation is controlled by the same Fibre Channel Trunking protocol that controls the trunk formation on FC switches. As such, it does not require user intervention or configuration except enabling or disabling, which instructs the switch software to form a trunk at the global level or not. All ISL ports connected to the same neighbor Brocade switch will attempt to form a trunk. Refer to Enabling a fabric trunk on page 149 for instructions.

Ports groups have been established on supported standalone switches and on line cards in chassis systems for trunking. For a successful trunk formation, all ports on the local switch must be part of the same port group and must be configured at the same speed.

Following are the number of ports allowed per trunk from port groups in supported platforms. For details on how port groups are arranged on these platforms, refer to the switch or chassis system Hardware Reference Manual.

- VDX 6720 and 6730 - up to eight ports allowed per trunk. - eight ports per trunk.
- VDX 6740 switches - up to sixteen ports per trunk.
- 48x10 GbE line card - up to eight ports per trunk.
- 48x10G-T line card - up to 16 ports per trunk.
- 12x40 GbE line card - up to two 40GbE ports are allowed per trunk, and these ports must be configured in breakout mode.
- 27x40 GbE line card - up to two 40GbE ports are allowed per trunk, and these ports must be configured in breakout mode. Note that breakout mode is only allowed on the first two ports in port groups that are configured in Performance operating mode. Refer to the *Brocade 8770 Hardware Reference Manual* for more information on line card operating modes.

The following additional rules apply to Brocade trunks:

- On Brocade VDX 6740 switches, low-volume traffic below certain thresholds may not be evenly distributed on all links. This threshold can be as low as 64K.
- The trunk is turned on by default.
- Trunks are not supported between the Brocade 8000 and the Brocade VDX 8770.

Fabric formation

Brocade VCS Fabric technology leverages proven FC Fabric protocols to build a TRILL fabric. The main functions of the fabric formation protocols are as follows:

- Assign the Brocade VCS Fabric-wide unique RBridge IDs (Domain ID Assignment).
- Create the network topology database using link state routing protocol (Fabric Shortest Path First, or FSPF). FSPF calculates the shortest path routes to a destination RBridge.
- Distribute fabric multicast traffic.

Principal switch selection

Every Brocade VCS Fabric-enabled switch, upon boot-up and after the Fabric port formation, declares itself to be a principal switch and advertises this intent on all fabric ports. The intent includes a priority and its switch WWN. If all switches boot up at the same time, the default priority is the same and all switches will compare their mutual intents. The switch with the lowest Switch WWN becomes the principal switch. The WWN is an industry-standard burnt-in switch identifier, similar to the Bridge-MAC except it is 8 bytes. The role of the principal switch is to decide whether a new RBridge joining the fabric conflicts with any of the RBridge IDs already present in the fabric. At the end of the principal switch selection process, all the switches in the cluster have formed a tree with the principal switch at the root.

NOTE
Brocade VDX Data Center switches are shipped with factory-programmed world wide names (WWNs) that are unique.

NOTE
In a logical chassis cluster, you can select the principal node by using the command line interface. For more information, refer to Selecting a principal node for the cluster on page 80.

RBridge ID allocation

RBridge ID assignment is implemented by leveraging proven Domain ID assignment protocols from FC SANs. Request for Domain ID (RDI) and Domain ID Assignment (DIA) protocols ensure that a single switch (the principal switch) centrally allocates the domain IDs for every RBridge in the fabric and detects and resolves any domain ID collisions in the fabric. Brocade VCS Fabric supports up to 24 RBridge IDs.

Only the principal switch can allocate RBridge IDs (domain IDs) for all other switches in the fabric. The principal switch starts the allocation process by allocating an RBridge ID for itself (using the ID value supplied by the user), and initiates the DIA messages on all ports.

Other switches, which are now in subordinate mode, upon receiving the DIA frames respond with an RDI message towards the principal switch. The process continues until all the switches in the fabric have been allocated a unique ID.

Fabric routing protocol

After a RBridge ID is assigned to a switch, the Fabric Shortest Path First (FSPF) link state routing protocol begins to form adjacencies and collects topology and inter-connectivity information with its neighbors. Brocade VCS Fabric uses FSPF to calculate and elect a loop-free multicast tree rooted at the multicast root RBridge. The multicast tree is calculated after the unicast routes are computed.

Configuring a Brocade VCS Fabric

Refer to the following tables for commands and examples used in configuring a Brocade VCS Fabric. For command details, refer to the *Network OS Command Reference*.

The following lists command examples for enabling Brocade VCS logical chassis cluster mode:

TABLE 22 Command examples for enabling logical chassis cluster mode

Command	Command Behavior
`switch# vcs logical-chassis enable`	The VCS ID becomes the default value of 1, the RBridge ID is not changed, and Brocade VCS logical chassis cluster mode is enabled.
`switch# vcs vcsid 22 rbridge-id 15 logical-chassis enable`	The VCS ID is changed to 22, the RBridge ID is changed to 15, and Brocade VCS logical chassis cluster mode is enabled.
`switch# vcs vcsid 11 logical-chassis enable`	The VCS ID is changed to 11, the RBridge ID is not changed, and Brocade VCS logical chassis cluster mode is enabled.
`switch# vcs rbridge-id 6 logical-chassis enable`	The VCS ID becomes the default value of 1, the RBridge ID is changed to *6* , and Brocade VCS logical chassis cluster mode is enabled.

The following lists command examples for enabling Brocade VCS fabric cluster mode:

TABLE 23 Command examples for enabling fabric cluster mode

Command	Command Behavior
`switch# vcs enable`	The VCS ID becomes 1, the RBridge ID is not changed, and Brocade VCS fabric cluster mode is enabled.
`switch# vcs vcsid 55 rbridge-id 19 enable`	The VCS ID is changed to *55* , the RBridge ID is changed to 19, and Brocade VCS fabric cluster mode is enabled.
`switch# vcs vcsid 73 enable`	The VCS ID is changed to the value of *73* , the RBridge ID is not changed, and Brocade VCS fabric cluster mode is enabled.
`switch# vcs rbridge-id 10 enable`	The VCS ID becomes the default value 1, the RBridge ID is changed to 10, and Brocade VCS fabric cluster mode is enabled.

The following lists command examples for switches that are already in either fabric cluster mode or logical chassis cluster mode.

TABLE 24 Command examples for when one of the VCS modes is already enabled:

Command	Command Behavior
`switch# vcs vcsid 44 rbridge-id 22`	The VCS ID is changed to 44 and the RBridge ID is changed to 22.
`switch# vcs vcsid 34`	The VCS ID is changed to 34.

Adding a new switch into a fabric

Complete the following configuration steps to add a new switch into a fabric.

1. Connect to the switch and log in using an account assigned to the admin role.
2. Enter the **vcs rbridge-id** *rbridge-id* **enable** command.

   The switch remembers its RBridge ID once it has been assigned. The **vcs rbridge-id** *rbridge-id* **enable** command also sets the insistent RBridge ID property on the switch.

3. Reboot the system.

   After the required reboot the switch participates in the RBridge ID allocation protocol, which insists that the same value that was manually configured prior to reboot be allocated after reboot.

   The switch is not allowed into the fabric if there is a conflict; for example, if another switch with the same ID exists and is operational in the fabric. You have the opportunity to select a new RBridge ID by using the same CLI.

   Once an ID has been assigned by the fabric protocol, these IDs are then numerically equated to RBridge IDs and are treated as such after that.

   Use the **vcs** command to configure the Brocade VCS Fabric parameters, VCS ID, and the switch RBridge ID, and to enable Brocade VCS Fabric mode (also called *VCS mode*).

   VCS mode encompasses two mode types:

   - *Fabric cluster mode* — The data path for nodes is distributed, but the configuration path is not distributed. Each node keeps its configuration database independently.
   - *Logical chassis cluster mode* — Both the data and configuration paths are distributed. The entire cluster can be configured from the principal node. Logical chassis cluster mode requires Network OS 4.0 or later.

   The generic term *VCS mode* in this manual applies to both fabric cluster mode and logical chassis cluster mode unless otherwise stated.

   You can set the Brocade VCS Fabric parameters and enable VCS mode at the same time, or you can enable VCS mode and then perform the ID assignments separately. Refer to Configuring a Brocade VCS Fabric on page 146 for details.

   After configuring the Brocade VCS Fabric parameters, the switch applies the changes and reboots.

   The switch disable is not saved across a reboot, so if the switch was disabled prior to the reboot, the switch returns to the enabled state when it finishes the boot cycle.

Configuring fabric interfaces

A physical interface in a virtual switch cluster can either be an edge port or a fabric port, but not both. Similar to a switch-port configuration on a physical interface, you can also change a fabric-port configuration on its physical interface by using the **fabric ISL enable** and **fabric trunk enable** commands, described below.

Enabling a fabric ISL

The **fabric isl enable** command controls whether an ISL should be formed between two cluster members. With the default setting of ISL discovery to **auto** and the ISL formation mode to **enable** , an ISL automatically forms between two cluster switches.

Performing a **fabric isl enable** command on an operational ISL has no effect. However, performing a **no fabric isl enable** command on an interface toggles its link status and subsequently disables ISL formation. In addition, the **no fabric isl enable** command triggers the switch to inform its neighbor that the local interface is ISL disabled. Upon receiving such information, a neighbor switch stops its ISL formation activity regardless of its current interface state.

NOTE
After you repair any segmented or disabled ISL ports, toggle the fabric ISL in order to propagate the changes.

NOTE
A **shutdown** command on an operating ISL interface not only brings down the physical link but also its FSPF adjacency. The main difference between a **shutdown** command and a **no fabric isl enable** command is that the link stays up after a **no fabric isl enable**, while the link stays down after a shutdown.

NOTE
Upon a fabric reconvergence that due to a topology change involving the ECMP fabric-isl path, there may be sub-second flooding of known unicast traffic.

Disabling a fabric ISL

The **no fabric isl enable** command takes this interface out of the trunk group if this interface happens to be currently part of the trunk. If you know and would like to fix the edge and fabric port assignments on a switch, then this command allows you to completely turn off ISL formation logic and shorten any link bring-up delays on edge ports.

1. Connect to the switch and log in using an account assigned to the admin role.
2. Enter the **no fabric isl enable** command.

Enabling a fabric trunk

NOTE
Trunks are not supported between the Brocade 8000 and the Brocade VDX 8770.

1. Connect to the switch and log in using an account assigned to the admin role.
2. Enter the **fabric trunk enable** command.

Disabling a fabric trunk

Fabric trunking is enabled by default. Enter the **no fabric trunk enable** command to revert the ISL back to a standalone adjacency between two Brocade VCS Fabric switch.

Configuring broadcast, unknown unicast, and multicast forwarding

All switches in a Brocade VCS Fabric cluster share a single multicast tree rooted at the RBridge with the lowest RBridge ID (domain ID). All broadcast, unknown unicast, and multicast traffic between two edge RBridges is forwarded on this multicast tree inside the Brocade VCS Fabric. The multicast tree includes all RBridges in the Brocade VCS Fabric.

Multicast distribution tree-root selection

Network OS v4.0.0 software supports the following distribution tree behaviors.

- The root of the distribution tree is the switch with the lowest RBridge ID. The automated selection process does not require any user intervention.
- Each switch in the cluster optionally carries a multicast root priority. This priority setting overrides the automatically-selected multicast root. In deployments where a multicast root is required to be a specific switch that does not have the lowest RBridge ID, then the priority setting on that switch can override the root selection. If there are two switches with the same priority, then the switch with the lower RBridge ID prevails.
- A back-up multicast root is pre-selected, which is the switch with the next lowest RBridge ID. The back-up multicast root is automatically selected by all switches should the current multicast root fail.

Configuring priorities

As stated above, the root of the tree is auto-selected as the switch with the lowest RBridge ID. For example, if you had a cluster with RBridge IDs 5, 6, 7, and 8, then 5 would be the root. If you then added RBridge ID 1 to this fabric, the tree would be re-calculated with 1 as the root.

In order to avoid this behavior, you can set a priority (default is 1). The highest priority overrides the lowest RBridge ID and becomes the root.

For example, to build a fabric with RBridge ID 7 or 8 as the root, set their priority to something higher than 1 (priority values are 1 through 255). If there is a tie in priority, the lower RBridge is still chosen. If RBridge ID 7 and 8 are both set to priority 1, 7 becomes the root.

Changing the priority

1. Connect to the switch and log in using an account assigned to the admin role.
2. Enter the **fabric route mcast rbridge-id** command.

   Here is an example of changing an RBridge multicast priority:

```
switch(config)# fabric route mcast rbridge-id 12 priority 10
```

Displaying the running configuration

The **show running-config fabric route mcast** command allows you to display fabric route multicast configuration information. The configuration currently effective on the switch is referred to as the running configuration. Any configuration change you make while the switch is online is made to the running configuration. The running configuration is nonpersistent.

> NOTE
> To save configuration changes, you must save the running-config file to a file, or you can apply the changes by copying the running configuration to the startup configuration.

1. Connect to the switch and log in using an account assigned to the admin role.
2. Enter the show running-config fabric route mcast command.

```
switch# show running-config fabric route mcast priority
fabric route mcast rbridge-id 12 priority 10
```

Configuring VCS virtual IP addresses

A virtual IP address is assigned for each VCS cluster. This virtual IP address is tied to the principal switch in the cluster. The management interface of the principal switch can be accessed by means of this virtual IP address. Because the virtual IP address is a property of the fabric cluster and logical chassis cluster, in the event that the principal switch goes down, the next principal switch is assigned this address.

Virtual IP address can be configured by means of the **vcs virtual ip address** command:

```
switch(config)# vcs virtual ip address 10.0.0.23
```

This command can be used in logical chassis cluster and fabric cluster modes only. When the virtual IP address is configured for the first time, the current principal switch in the cluster is assigned this IP address.

Virtual IP configuration is global in nature. All the nodes in the cluster are configured with the same virtual IP address, but address is bound to the current principal switch only. Make sure that the assigned virtual IP address is not a duplicate of an address assigned to any other management port in the cluster or network.

Brocade recommends that you use the same subnet as the IP address of management interface. To display the currently configured virtual IP address, use the **show vcs** command:

```
switch# show vcs virtual-ip

Virtual IP             : 10.21.87.2/20
Associated rbridge-id       : 2
```

To remove the currently configured virtual IP address, use the **no vcs virtual ip address** command.

```
switch(config)# no vcs virtual ip address
switch# show running-config vcs virtual ip address
% No entries found.
```

> NOTE
> You should not use the **no vcs virtual ip address** command when logged onto the switch through the virtual IP address. Use the management port IP address of the principal switch, or the serial console connection of the principal switch.

If you wish to rebind this virtual IP address to this management interface, remove the currently configured virtual IP address and reconfigure it. This situation can arise when the virtual IP address is not bound to management interface of the principal switch as a result of duplicate address detection.

A separate gateway cannot be configured for virtual IP address. The default gateway is the same as the gateway address for the management port of the same switch.

Virtual IP address configuration scenarios

Virtual IP address may be assigned to a switch whenever it is the principal switch in the cluster. The configuration scenarios that may occur are described below.

TABLE 25 Virtual IP address configuration scenarios

Scenario	Description
First time cluster formation	When the cluster is first being formed, and if the virtual IP address is already configured, the principal switch is assigned the Virtual IP address. If no Virtual IP configuration exists, then the principal switch can be access using the management port IP address.
Virtual IP configuration	When you configure the virtual IP address for a cluster the first time, the address is bound to the management interface of the principal switch.
Principal switch failover	If the principal switch becomes a secondary switch while the virtual IP address is assigned to its management interface, then the virtual IP address is reassigned to the new principal switch.
Principal switch goes down	When the principal switch in the cluster goes down, the virtual IP address is released from its management interface. The virtual IP address will be assigned to the next switch that becomes the principal switch.
Principal switch chassis is disabled	When the **chassis disable** command is executed on the principal switch, the virtual IP address is released from its management interface. The virtual IP address will be assigned to the next switch that becomes the principal switch.
Virtual IP removal	If you remove the virtual IP address from the configuration, then the address is unbound from management interface of the principal switch. In this case, the principal switch can still be accessed by using the management port's IP address.

TABLE 25 Virtual IP address configuration scenarios (continued)

Scenario	Description
Trivial merge	In the event that two clusters merge together, the global configuration of the smaller cluster (Cluster A) is overwritten by the larger cluster (Cluster B). During this time, the virtual IP address is unbound from the principal switch of Cluster A. The virtual IP address of Cluster B can now be used to access the principal of new merged cluster. If the virtual IP address of Cluster B is not configured, there will not be a virtual IP address in the merged cluster.
Cluster reboot	When the cluster reboots, the virtual IP address is persistent and is bound to the new principal switch.
Cluster Islanding	If the ISL link goes down between two or more clusters that are forming, the principal switch in the original cluster retains the virtual IP address. The new principal switch in the second cluster will perform a check to confirm that the virtual IP address is not in use. If it is in use, then the address is not assigned to the switch and an error is logged in RASLog.
Standalone node behavior	A virtual IP address cannot be configured on a Standalone node in VCS mode.
Virtual MAC address	Virtual MAC address are not supported by virtual IP addresses.
Management port primary IPv4 address	For a virtual IP address to work correctly, the management port's IPv4 address should be assigned and functional.

Configuring fabric ECMP load balancing

Traffic towards ECMP paths are load-balanced using following eight fields as the Key; VlanID, MAC DA/SA, L3_ULP, L3 DA/SA, L4 Dst/Src. For some pattern of streams, most of the traffic falls into one ECMP path, and rest of the ECMP paths are underutilized. This results in loss of data traffic, even though more ECMP paths are available to offload the traffic. You can configure the ECMP path selection method within the fabric by using the **fabric ecmp load-balance** command. The operands for this command are listed and described below.

TABLE 26 ECMP load-balancing operands

Operand	Description
dst-mac-vid	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-mac-vid-port	Source and Destination IP, MAC address, VID and TCP/UDP port based load balancing
src-dst-ip-port	Source and Destination IP and TCP/UDP port-based load balancing
src-dst-mac-vid	Source and Destination MAC address and VID-based load balancing
src-mac-vid	Source MAC address and VID-based load balancing

Additionally, you can choose to swap adjacent bits of the hash key using the fabric ecmp load-balance-hash-swap command. This is useful in cases where a choice of any of the hash key combinations causes the distribution of traffic to not be uniform.

The **fabric ecmp load-balance-hash-swap** command is used to configure the swapping of the input fields before feeding them to the hash function. The integer is interpreted as a bitwise control of the 212-bit key. Each bit controls whether the two adjacent bits of the key are to be swapped. This 32-bit control value is written to all four hash swap control registers. This value is replicated in 32-bit block to form a 106-bit value. A value of 0x0 does not swap any input fields while a value of 0xffffffff swaps all 106 input bit-pairs.

To configure the ECMP load-balancing feature, perform the following steps in global configuration mode.

1. Enter RBridge ID configuration mode.

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

2. Execute the **fabric ecmp load-balance** command for the stream you want to favor.

   This example uses the Destination MAC address and VID-based load balancing flavor.

```
switch(config-rbridge-id-2)# fabric ecmp load-balance dst-mac-vid
```

3. Optional: Use the **fabric ecmp load-balance-hash-swap** command to swap the input fields before feeding them to the hash function.

```
switch(config-rbridge-id-2)# fabric ecmp load-balance-hash-swap 0x4
```

4. Use the **show fabric ecmp load-balance** command to display the current configuration of hash field selection and hash swap.

```
switch# show fabric ecmp load-balance
Fabric Ecmp Load Balance Information
------------------------------------
Rbridge-Id         : 2
Ecmp-Load-Balance Flavor  : Destination MAC address and VID based load balancing
Ecmp-Load-Balance HashSwap : 0x4
```

Configuring Metro VCS

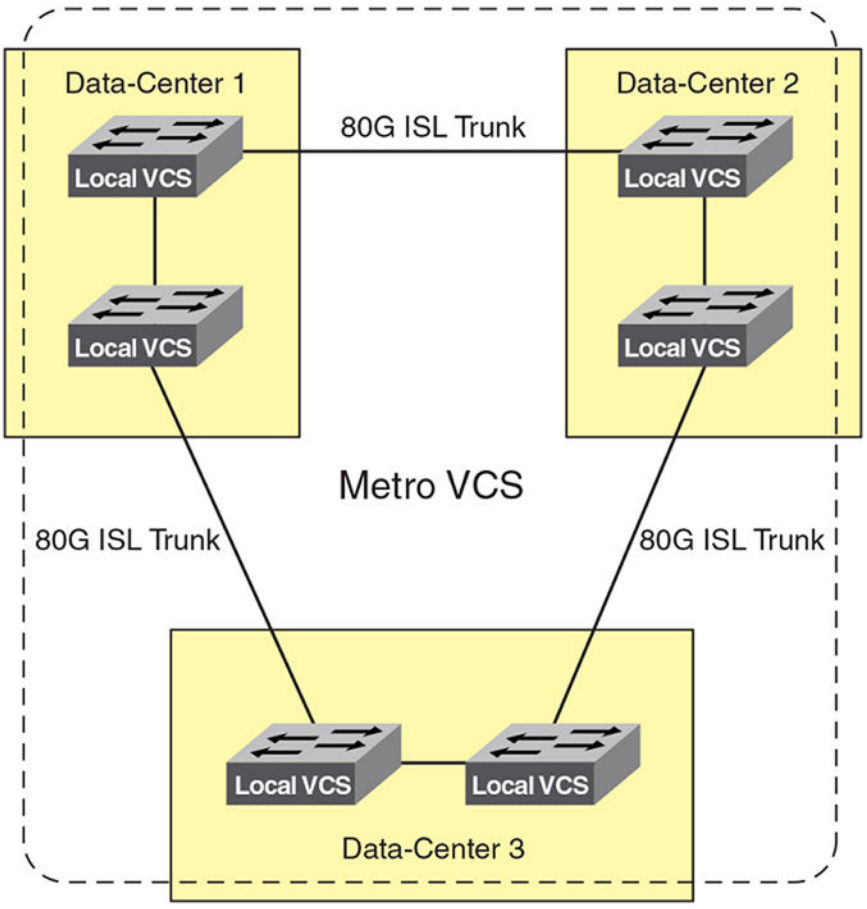
Metro VCS overview

Metro VCS allows you to interconnect different locations and form clusters of data centers over long distance in order to provide disaster protection/recovery and load sharing.

There are multiple ways to stretch an Ethernet fabric over distance. By using Inter-Switch Links (ISLs) over long distances (more than the standard 1000 m), Ethernet fabrics can be distributed across data centers located in geographically different locations.

If more complex setups are needed within different locations, then local VCS fabrics can be used, as shown below.

FIGURE 19 Metro VCS configuration example



If Metro VCS is configured by using standard ISLs, with distances of up to 1000 m, no limitations occur for supported service types or the supported number of MAC addresses. Also, no special buffer arrangements (long-distance ISL configuration) need to be done. Refer to Metro VCS using long-distance ISLs on page 156.

If Metro VCS is configured using long-distance ISLs, special configurations have to be used and the supported fabric functionality is limited. Refer to Metro VCS using standard-distance ISLs on page 157.

Metro VCS using long-distance ISLs

Extending Ethernet Fabrics over distance is accomplished by using long-distance ISLs. The buffer allocation within a single port group is optimized, which extends the supported ISL distance.

Metro VCS supports long-distance ISL ports up to 30 km on the Brocade VDX platforms listed below. Links up to 10 km are lossless. You can have eight 1-km links forming a Brocade trunk. You can also have mixed-length cables forming the ISL. For ECMP purposes, you can have eight 8-link ECMP trunks.

TABLE 27 Limitations for long-distance Metro VCS

Supported hardware	Extended ISL up to 2 km	Extended ISL up to 5 km	Extended ISL up to 10 km	Extended ISL up to 30 km
Brocade VDX 6720-60	yes	yes	yes	yes
Brocade VDX 6730-76	yes	yes	yes	yes
Brocade VDX 6740 Brocade 6740T Brocade 6740T-1G	yes	yes	yes	yes
Brocade VDX 8770 - VDX LC48x10G linecard	yes	yes	yes	yes

The following lists the conditions on extended ISLs for Network OS hardware.

TABLE 28 Conditions for long-distance Metro VCS

Condition	Extended ISL up to 2 km	Extended ISL up to 5 km	Extended ISL up to 10 km	Extended ISL up to 30 km
Support for lossless FCoE/iSCSI traffic on the Metro VCS port group	yes	yes	yes	no
Layer 2/IP lossy traffic support	yes	yes	yes	yes
Number of Metro VCS long-distance ports supported per port group	1	1	1	1
Number of regular ISLs supported on a port group configured for long distance	1	1	0	0
Trunking support between multiple long-distance ISLs	no	no	no	no
CEE map or FCoE port allowed in same port group	no	no	no	no
eNS Sync (MAC address table sync)	yes	yes	yes	yes
Zoning	yes	yes	yes	yes
HA failover	yes	yes	yes	yes

TABLE 28 Conditions for long-distance Metro VCS (continued)

Condition	Extended ISL up to 2 km	Extended ISL up to 5 km	Extended ISL up to 10 km	Extended ISL up to 30 km
Node redundancy check	yes	yes	yes	yes
vMotion	yes	yes	yes	yes
Maximum PFCs supported	3 (2 on the Brocade VDX 6740, 6740T, 6740T-1G)	3(2 on the Brocade VDX 6740, 6740T, 6740T-1G)	3 (2 on the Brocade VDX 6740, 6740T, 6740T-1G)	3 (2 on the Brocade VDX 6740, 6740T, 6740T-1G)

The following lists the port groups and number of port groups available on each platform for long-distance Metro VCS.

TABLE 29 Long-distance Metro VCS port-group schema

Platform	Port groups	Number of port groups on platform
Brocade VDX 6720-60 (10 GbE)	1-10, 11-20, 21-30, 31-40, 41-50, 51-60	6
Brocade VDX 6730-76 (10 GbE)	1-10, 11-20, 21-30, 31-40, 41-50, 51-60	6
Brocade VDX 6740, 6740T, 6740T-1G	1-32, 33-48	2 *
Brocade VDX 8770 (VDX LC48x10G linecard)	1-8, 9-16, 17-24, 25-32, 33-40, 41-48	6 per 10GbE blade

* Not a valid deployment scenario at distances longer than 5 km, as no normal ISLs are allowed if both port groups are configured with long-distance ISLs for 10 km and 30 km.

Guidelines and restrictions for long-distance Metro VCS

Consider the following when configuring long-distance Metro VCS:

- For fabrics with more than two nodes, the VCS license must be installed on all switches in the fabric clusters.
- The Metro VCS fabric is only supported on 10-G interface links.
- Brocade trunking is not supported with long-distance ISLs, but up to eight 8-link ECMP trunks can be used.
- Edge ports cannot be configured with DCB maps.
- Edge ports and port groups with long-distance links cannot be configured by means of the **fcoeport default** command.
- A maximum of three PFCs can be supported on a Metro VCS configured platform. By default, PFC is enabled by class 3 and 7.
- The Brocade VDX 6740, 6740T, and 6740T-1G switches support only two PFCs.
- All the ports in the port group are rebooted when a port is configured for long distance.
- For 2-, 5-, 10-km long distance, use Brocade-supported long-range (LR) optics for direct connectivity.
- For 30-km long distance, use Brocade-supported extended-range (ER) optics for direct connectivity.
- A port group containing a long-distance port cannot have a CEE map configuration on any edge port.

Metro VCS using standard-distance ISLs

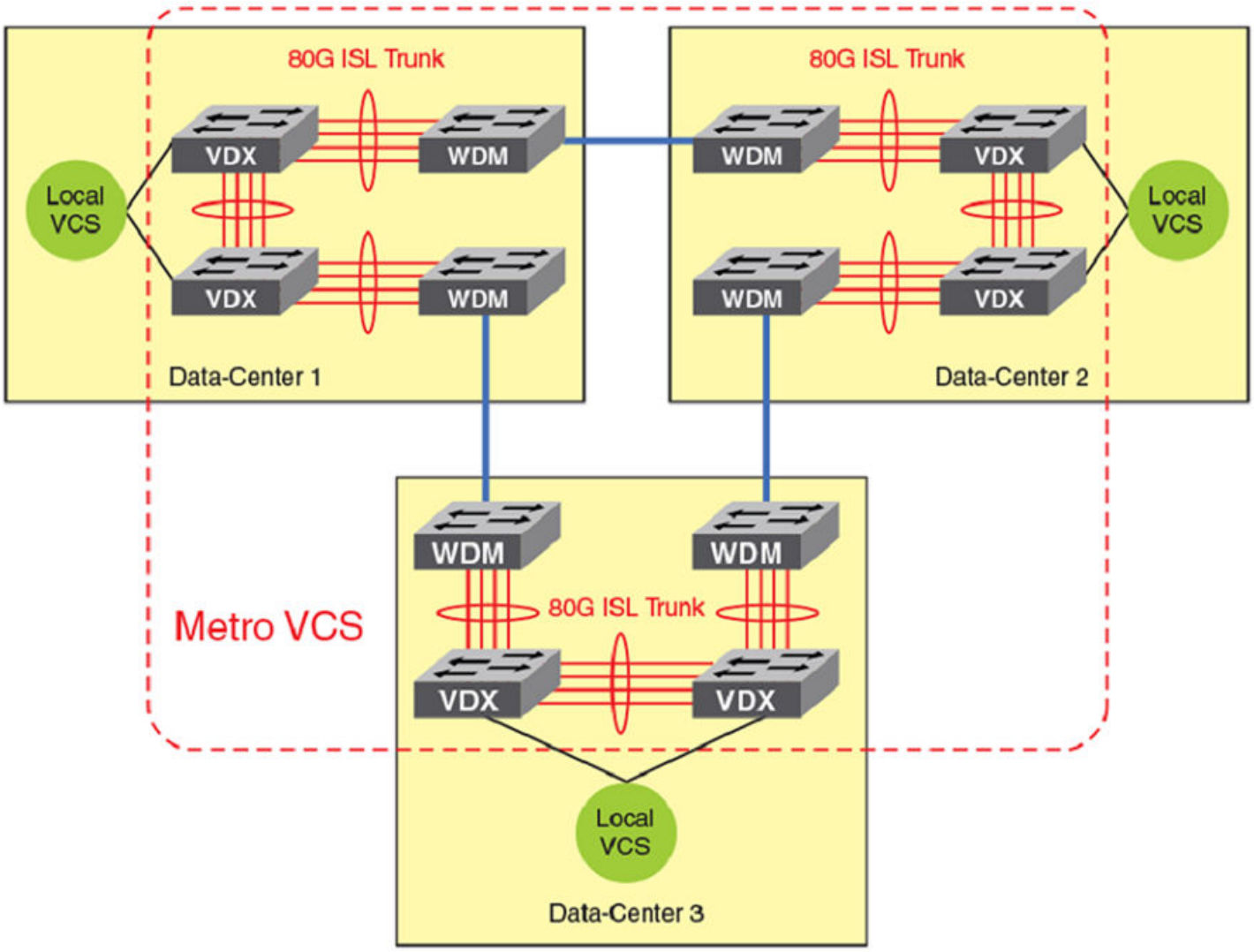
In order to deploy Metro VCS using standard-distance ISLs, no configuration is required on the ISL. The default configuration on the 10-Gbps interface by means of the **fabric isl enable** and **fabric trunk enable** commands allows ISL formation with other Brocade VDX switches in the same VCS cluster automatically. BLDP negotiation takes place to form ISLs for distances up to 30 km. (Refer to Configuring Brocade VCS Fabrics on page 143.)

Metro VCS using standard ISLs is supported on the following platforms:

- Brocade VDX 6720-60
- Brocade VDX 6730-76
- Brocade VDX 6740, VDX 6740T, and VDX 6740T-1G
- Brocade VDX 8770 with the VDX LC48x10G line card

The following is a typical deployment topology supported for interconnecting data centers by extending Brocade VCS Ethernet fabrics using standard-distance ISLs. The local VCS clusters are connected to the Metro VCS clusters by Brocade vLAGs. In this case, local data-center Ethernet fabrics from both site are not merged while providing seamless Layer 2 extension. For Metro VCS, Brocade standard-distance ISL trunking is supported, with up to a maximum of eight ISLs to form 80-G trunks.

FIGURE 20 Typical deployment topology for Metro VCS using standard-distance ISLs



The following lists the port groups and number of port groups available on each platform for Metro VCS using standard-distance ISLs.

TABLE 30 Standard Metro VCS port-group schema

Platform	Port groups	Number of port groups on platform
Brocade VDX 6720-60 (10 GbE)	1-10, 11-20, 21-30, 31-40, 41-50, 51-60	6
Brocade VDX 6730-76 (10 GbE)	1-10, 11-20, 21-30, 31-40, 41-50, 51-60	6
Brocade VDX 6740 Brocade VDX 6740T Brocade VDX 6740T-1G	1-16, 17-32, 33-40, 41-48	4
Brocade VDX 8770 (VDX LC48x10G line card)	1-8, 9-16, 17-24, 25-32, 33-40, 41-48	6 per 10GbE blade

Guidelines and restrictions for standard-distance Metro VCS

Consider the following when configuring Metro VCS with standard-distance ISLs:

- Only two data-center and three data-center topologies are supported.
- A maximum of two nodes are supported for each site, which provides node redundancy. If more-complex local designs are required, a local VCS sub-fabric design must be used.
- Only standard Ethernet services are supported. DCB and FCoE are not supported.
- Brocade trunking with up to 80-G (8x10-G) links is supported.
- There are no additional limitations on the supported overall number of MAC addresses.

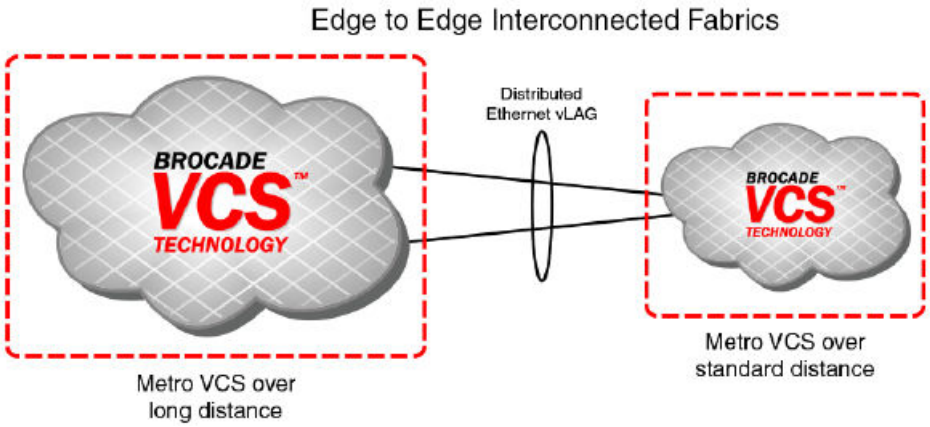
Metro VCS and distributed Ethernet vLAGs

Outside of Metro distances, and whenever bit transparency may be a problem, edge-to-edge interconnected fabrics using 10-G vLAG over multiple standard Ethernet links can be used. This allows you to connect separate Ethernet fabrics that can be located in different data centers, even if the distance between those locations is more than 30 km. This is currently supported for distances up to 100 km.

Metro VCS over a long-distance fabric

As illustrated below, one side can be a Metro VCS over a long-distance fabric.

FIGURE 21 Metro VCS and distributed Ethernet fabrics



In order to connect two distinct VCS Ethernet fabrics between data centers, a third Metro VCS fabric can be formed, and the distinct local VCS Ethernet fabrics can connect to the Metro VCS fabric by means of Virtual Link Aggregation (vLAG).

Alternatively, the distinct VCS Ethernet fabrics in the respective data centers can be directly connected to each other by means of vLAG over xWDM up to a distance of 30 km. Wherever bit-transparency is not achievable in xWDM equipment, this solution can be successfully deployed for edge-to-edge interconnectivity (using 10-G vLAG over multiple standard Ethernet links). This deployment is referred to as "*Distributed Ethernet Fabrics using vLAG*".

This implementation eliminates the need for the creation of a separate Metro VCS fabric to achieve local VCS cluster isolation while providing Layer 2 connectivity. In such a deployment, DCB/FCoE lossless Ethernet traffic is not supported.

> NOTE
> When a port-channel from a node in one VCS (or on from any standalone switch) spans across multiple RBridges in other VCS luster, a vLAG is formed on the RBridges in the VCS cluster that are part of the same port-channel. For *Distributed Ethernet Fabrics using vLAG* over long distances, only LACP-based standard port-channels are supported. For details on how to create port-channels and vLAGs, refer to Configuring Link Aggregation on page 443.

Supported platforms for Distributed Ethernet Fabrics using vLAG

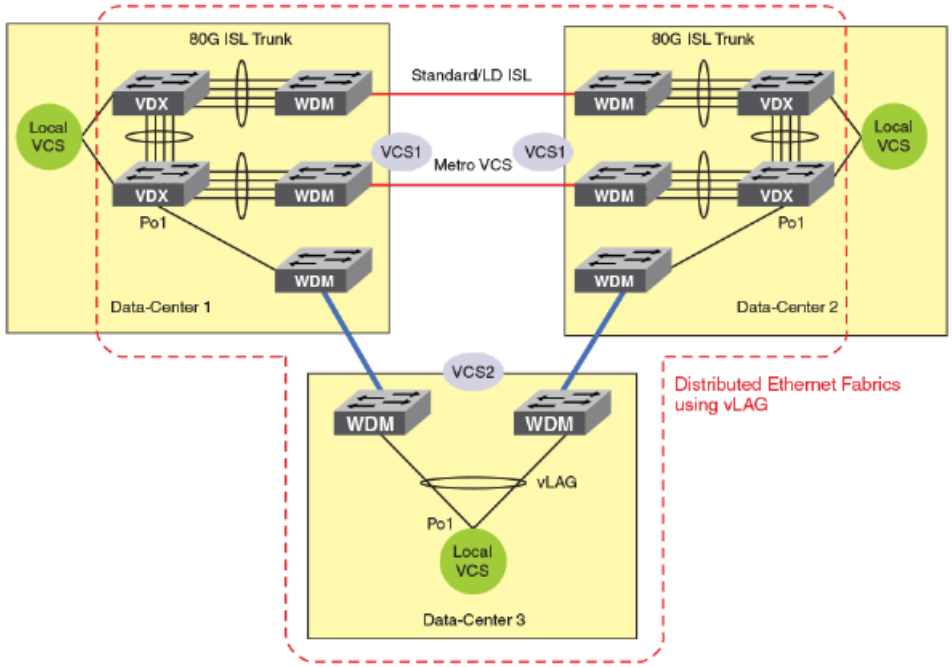
The following VDX platforms are supported for *Distributed Ethernet Fabrics using vLAG*:

- Brocade VDX 6720-60
- Brocade VDX 6730-76
- Brocade VDX 6740, 6740T, and 6740T-1G
- Brocade VDX 8770 with the VDX LC48x10G line card

Topology for Distributed Ethernet Fabrics using vLAG

The following is a typical deployment topology that uses *Distributed Ethernet Fabrics using vLAG* to interconnect data centers.. A node from the local VCS cluster is connected by means of xWDM to the nodes in other VCS clusters to form a vLAG. The other VCS cluster could be spanned across two data centers over standard-distance or long-distance ISLs, as shown below. In this case, the vLAG between the two data centers provides VCS fabric isolation while providing seamless Layer 2 connectivity; the first port-channel (Po1) forms the vLAG between VCS1 and VCS2 over long distance through xWDM.

FIGURE 22 Connecting local VCS clusters over long-distance using vLAG



Guidelines and restrictions for Distributed Ethernet Fabrics using vLAG

Note the following guidelines and restrictions for *Distributed Ethernet Fabrics using vLAG* .

- Only dynamic vLAG is supported.
- DCB/FCoE lossless Ethernet traffic is not supported.
- The maximum supported distance is 100 km.

Configuring a Metro VCS port

To configure a Metro VCS port, perform the following steps in privileged EXEC mode. Each long-distance ISL port of a VCS must be connected to a long-distance ISL port on the remote VCS.

1. Verify that the default standard-distance ISL configuration is correct by using the **show running-config** command.

```
switch# show running-config interface tengigabitethernet 51/0/1
interface TenGigabitEthernet 51/0/1
fabric isl enable
fabric trunk enable
no shutdown
```

2. Set the port to support Metro VCS up to 30 km by using the **long-distance-isl** command.

```
switch# interface tengigabit 51/0/1
switch(conf-if-te-51/0/1)# long-distance-isl 30000
```

3. Perform the same long-distance ISL configuration on the interface of the peer RBridge on the remote sites of the Metro VCS.

4. Verify that the long-distance ISL is correctly formed by using the **show fabric isl** and **show fabric islports** command.

```
switch(conf-if-te-51/0/1)# do show fabric isl
Rbridge-id: 51   #ISLs: 1
 Src       Src           Nbr       Nbr
Index   Interface       Index   Interface              Nbr-WWN           BW   Trunk  Nbr-Name
------------------------------------------------------------------------------------------
4       Te 51/0/1        4      Te 53/0/1       10:00:00:05:33:65:3B:50   10G   Yes   "VCS3-53"
switch(conf-if-te-51/0/1)# do show fabric islports
Name:       VCS3-51
Type:       131.4
State:      Online
Role:       Fabric Principal
VCS Id:     3
Config Mode:Local-Only
Rbridge-id: 51
WWN:        10:00:00:05:33:e5:d0:4b
FCF MAC:    00:05:33:e5:d0:cf
 Index   Interface      State   Operational State
==========================================================================
  0     Fo 51/0/49        Down
  1     Fo 51/0/50        Down
  2     Fo 51/0/51        Down
  3     Fo 51/0/52        Down
  4     Te 51/0/1         Up    ISL 10:00:00:05:33:65:3B:50 "VCS3-53" (Trunk Primary)
<Truncated>
```

Configuring Distributed Ethernet Fabrics using vLAG

In order to deploy *Distributed Ethernet Fabrics using vLAG*, create a port-channel interface on the RBridges that are to be connected. Then add the member interfaces to the port-channel and bring them online. Configure switchport and add the VLANs that are to be allowed over the port-channel. After the port-channels on all the RBridges are online, the vLAG forms automatically on the RBridge that connects to multiple nodes on the other VCS cluster. In the deployment topology shown in Topology for Distributed Ethernet Fabrics using vLAG on page 160, the vLAG forms on the RBridges that are part of port-channel Po1 in Data-Centers 1 and 2 that forms VCS 1.

This configuration needs to be applied on RBridges that connect the two VCS instances. Perform the following task in global configuration mode.

1. Create a port-channel interface on all RBridges that are directly connected to RBridges in other VCS instances.

   NOTE
   In logical chassis cluster mode, the port-channel is created only from the principal node and is applied globally.

```
switch(config)# interface port-channel 300
```

2. Verify that the port-channel is created correctly by using the **show running-config** command.

```
switch(config-Port-channel-300)# do show running-config interface port-channel 300

interface Port-channel 300
 vlag ignore-split
 shutdown
```

3. Configure the port-channel interface for the switchport trunk and add the VLANs to be allowed on the trunk interface by using the **switchport** command.

```
switch(config-Port-channel-300)# switchport
switch(config-Port-channel-300)# switchport mode trunk
switch(config-Port-channel-300)# switchport trunk allowed vlan all
```

4. Verify the port-channel interface configuration by using the **show running-config** command.

```
switch(config-Port-channel-300)# do show running-config interface Port-channel 300

interface Port-channel 300
 vlag ignore-split
 switchport
 switchport mode trunk
 switchport trunk allowed vlan all
 switchport trunk tag native-vlan
 spanning-tree shutdown
 shutdown
```

5. Add member interfaces to the port-channel interface by using the **channel-group** command. Do this for all interfaces that need to be part of the port-channel.

```
switch(conf-if-te-53/0/31)# channel-group 300 mode active type standard
switch(conf-if-te-53/0/31)# do show running-config interface

TenGigabitEthernet 53/0/31
interface TenGigabitEthernet 53/0/31
 fabric isl enable
 fabric trunk enable
 channel-group 300 mode active type standard
 lacp timeout long
 no shutdown
```

6. Bring the port-channel online in both VCS instances by executing **no shutdown** on the port-channel interface.

```
switch(config-Port-channel-300)# no shutdown
```

7. Verify the port-channel interface configuration by using the **show running-config** command.

```
switch(config-Port-channel-300)# do show running-config interface Port-channel 300

interface Port-channel 300
 vlag ignore-split
 switchport
 switchport mode trunk
 switchport trunk allowed vlan all
 switchport trunk tag native-vlan
 spanning-tree shutdown
 no shutdown
```

8. Verify that console RASLogs indicate the formation of the vLAG by using the **no shutdown** command.

```
switch(config-Port-channel-300)# no shutdown

2013/06/17-16:40:53, [NSM-1023], 224126, DCE, INFO, VCS1-51, RBridge ID 51 has joined Port-channel
300. Port-channel is a vLAG with RBridge IDs 52 51.
```

9. Verify the formation of the port-channel vLAG by using the **show port-channel** command.

```
switch# show port-channel 300
LACP Aggregator: Po 300 (vLAG)
Aggregator type: Standard
Ignore-split is enabled
  Member rbridges:
    rbridge-id: 51 (2)
    rbridge-id: 52 (2)
  Admin Key: 0010 - Oper Key 0010
  Partner System ID - 0x8000,01-e0-52-00-00-02
  Partner Oper Key 0010
Member ports on rbridge-id 51:
   Link: Te 51/0/31 (0x19180E801C) sync: 1
   Link: Te 51/0/32 (0x19180F001D) sync: 1
```

Administering Zones

Zoning overview

Zoning is a fabric-based service that enables you to partition your network into logical groups of devices that can access each other and prevent access from outside the group. Grouping devices into zones in this manner not only provides security, but also relieves the network from Registered State Change Notification (RSCN) storms that occur when too many native FCoE devices attempt to communicate with one another.

You can use zoning to partition your network in many ways. For example, you can partition your network into two zones, *winzone* and *unixzone*, so that your Windows servers and storage do not interact with your UNIX servers and storage. You can use zones to logically consolidate equipment for efficiency or to facilitate time-sensitive functions; for example, you can create a temporary zone to back up nonmember devices.

A device in a zone can communicate only with other devices connected to the fabric within the same zone. A device not included in the zone is not available to members of that zone. When zoning is enabled, devices that are not included in *any* zone configuration are inaccessible to all other devices in the fabric.

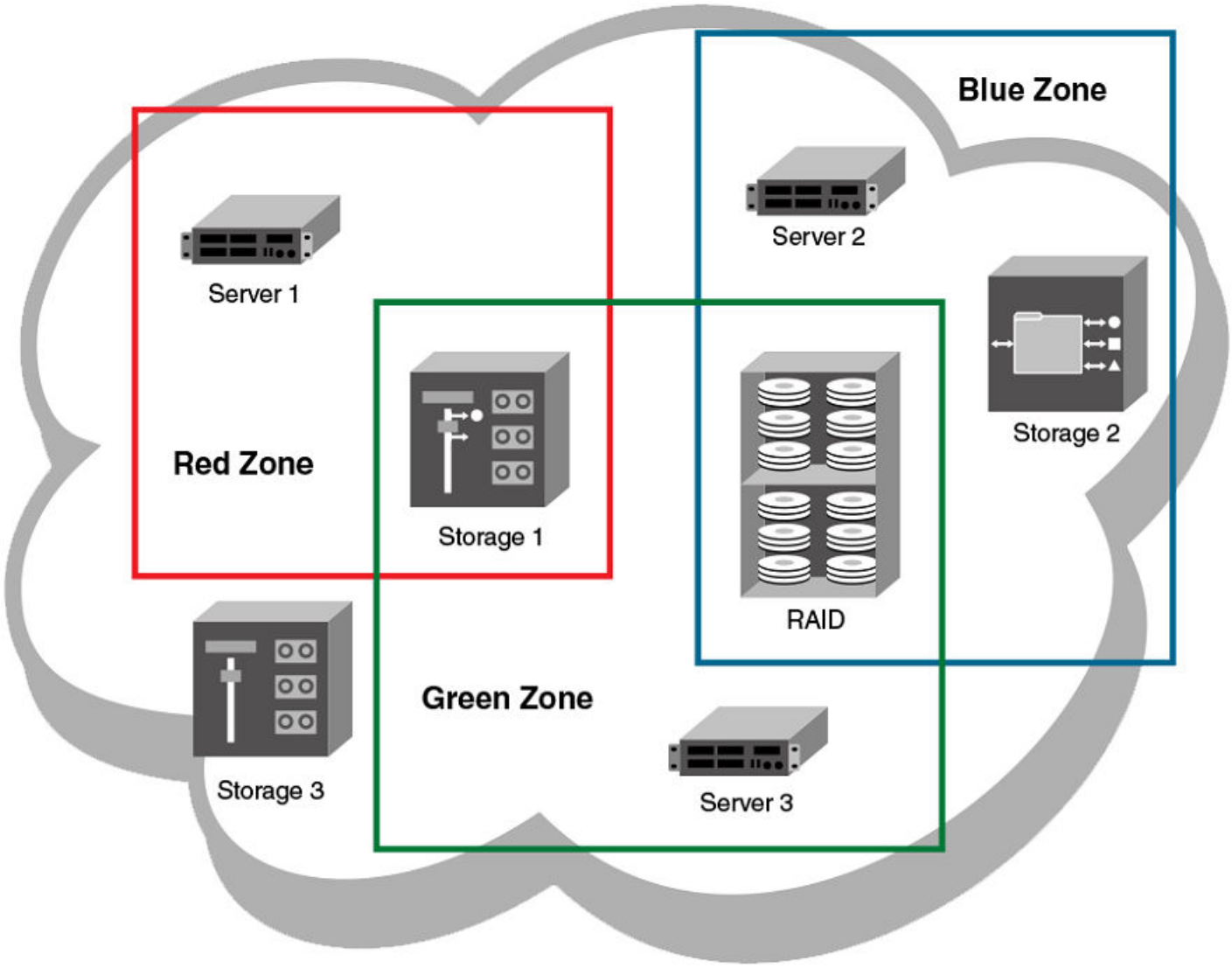
Zones can be configured dynamically. They can vary in size, depending on the number of fabric-connected devices, and devices can belong to more than one zone.

Example zoning topology

Consider the following figure, which shows three configured zones: Red, Green, and Blue. In this figure the following is true:

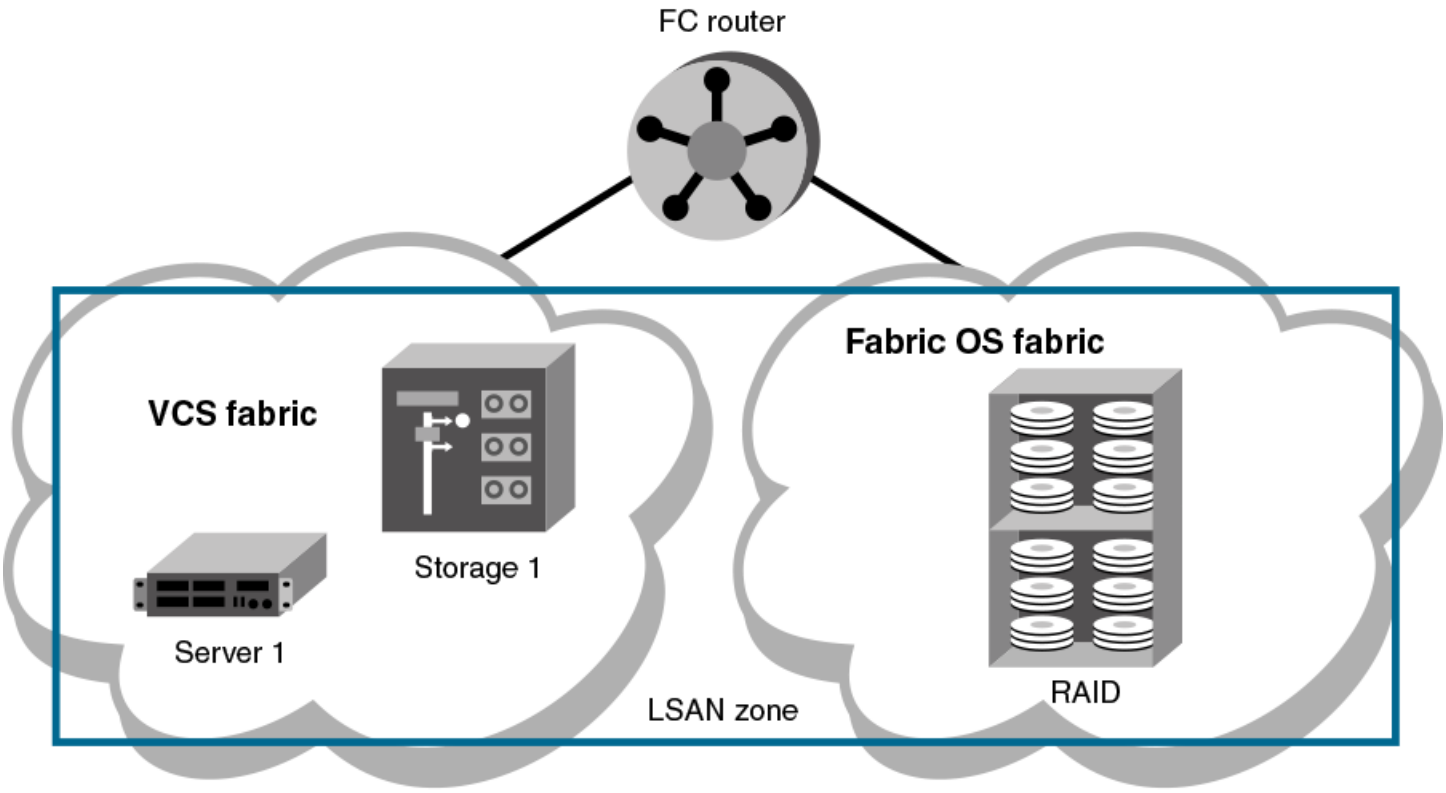
- Server 1 can communicate only with the Storage 1 device.
- Server 2 can communicate only with the RAID and Storage 2 devices.
- Server 3 can communicate with the RAID and Storage 1 devices.
- The Storage 3 is not assigned to a zone; no other zoned fabric device can access it.

FIGURE 23 Zoning



Connecting to another network through a Fibre Channel (FC) router, you can create a Logical SAN (LSAN) zone to include zone objects on other fabrics, including Fabric OS networks. No merging takes place across the FC router when you create an LSAN zone. The figure below shows an example in which Server 1, which is connected to switch in a Brocade VCS Fabric cluster, has access to local storage and to RAID storage on a Fabric OS fabric. (For a detailed discussion of LSAN zones, refer to LSAN zones on page 167.)

FIGURE 24 LSAN zoning



NOTE

Zoning in Network OS 4.0.0 and later has the following restrictions:

- Zone objects based on physical port number or port ID (D,I ports) are not supported.
- You cannot access a target on a Network OS fabric from a server on the Fabric OS fabric.

LSAN zones

LSAN zones are distinct from conventional zones. This section details how to define and manage LSAN zones and provides recommendations about LSAN zone naming.

LSAN zones overview

A Logical SAN (LSAN) consists of zones in two or more edge or backbone fabrics that contain the same devices. LSANs essentially provide selective device connectivity between fabrics without forcing you to merge those fabrics. FC routers provide multiple mechanisms to manage inter-fabric device connectivity through extensions to existing switch management interfaces. For details of this FC-FC routing service, refer to the *Fabric OS Administrator's Guide*.

NOTE

A backbone fabric consists of one or more FC switches with configured EX_Ports. These EX_Ports in the backbone connect to edge fabric switches through E_Ports. This type of EX_Port-to-E_Port connectivity is called an "*Inter-Fabric Link* (IFL)".

The Brocade VCS Fabric connection to the FC router is an ISL that connects an FC port on a Brocade VDX 6730 to an EX_Port on the FC router. Similarly, an FC port on the Fabric OS fabric connects to an EX_Port on the FC router.

You can define and manage LSANs using the same zone management tools as for regular zones. The FC router makes LSAN zoning possible by importing devices in effective zones. For example, consider two devices:

- 11:22:33:44:55:66:77:99 is connected to a switch in a Brocade VCS Fabric cluster.
- 11:22:33:44:55:66:77:88 is connected to a switch in a Fabric OS fabric.

The FC-FC routing service on the FC router that connects the two fabrics presents 11:22:33:44:55:66:77:88 as a phantom device to the Brocade VCS Fabric and also presents 11:22:33:44:55:66:77:99 as a phantom device to the Fabric OS fabric. You can then use the regular zone management tools on the Brocade VCS Fabric cluster to incorporate 11:22:33:44:55:66:77:99 into an LSAN zone on the Brocade VCS Fabric. Similarly, you can use the regular zone management tools in Fabric OS to incorporate 11:22:33:44:55:66:77:88 into an LSAN zone in the Fabric OS fabric. Once both the Brocade VCS Fabric zone and the Fabric OS zone are enabled, the FC router imports devices common to both zones and makes them available to the zones in each fabric.

LSAN naming

Zones that contain hosts and targets that are shared between the two fabrics need to be explicitly coordinated. To share devices between any two fabrics, you must create an LSAN zone in both fabrics containing the WWNs of the devices to be shared. Although you manage an LSAN zone by using the same tools as any other zone on the edge fabric, two behaviors distinguish an LSAN zone from a conventional zone:

- A required naming convention. The name of an LSAN zone begins with the prefix "LSAN_". The LSAN name is case-insensitive; for example, lsan_ is equivalent to LSAN_, Lsan_, and so on.
- LSAN zone members in all fabrics must be identified by their WWN. You cannot use the port IDs that are supported only in Fabric OS fabrics.

  NOTE
  The "LSAN_" prefix must appear at the beginning of the zone name.

To enable device sharing across multiple fabrics, you must create LSAN zones on the edge fabrics (and optionally on the backbone fabric as well), using normal zoning operations to create zones with names that begin with the special prefix "LSAN_", and adding host and target port WWNs from both local and remote fabrics to each local zone as desired. Zones on the backbone and on multiple edge fabrics that share a common set of devices will be recognized as constituting a single multi-fabric LSAN zone, and the devices that they have in common will be able to communicate with each other across fabric boundaries.

Managing domain IDs

FCoE connectivity across the Fibre Channel link between Brocade VCS Fabric clusters and FC routers uses domain IDs to identify switches. Within a Brocade VCS Fabric cluster, a domain ID is the same as a routing bridge ID. When you connect to a Fibre Channel router, the FC Fabric Fibre Channel router service emulates virtual *phantom* FC domains in the FCoE fabric. Each FCR-enabled switch emulates a single "front" phantom domain and each FC fabric is represented by a *translate* phantom domain.

It is important to ensure that front domain IDs and translate domain IDs presented by the FC router do not overlap routing bridge IDs in the FCoE fabric; otherwise, the connectivity will fail and the Network OS switch with the overlapping routing bridge ID becomes isolated from the fabric. To prevent potential overlap, use the **portCfgExport -d** Fabric OS command on the FC router to apply a unique front domain ID — one that will not be used in the FCoE fabric. Similarly, use the **fcrXlateConfig** *importedFID exportedFID preferredDomainID* Fabric OS command to set the translate domain ID to a unique value that is also not used as a routing bridge ID.

Refer to the *Fabric OS Command Reference Manual* for details about the **portCfgExport** and **fcrXlateConfig** commands.

Approaches to zoning

The following lists the various approaches you can take when implementing zoning in a Network OS fabric.

TABLE 31 Approaches to fabric-based zoning

Zoning approach	Description
Recommended approach	
Single HBA	Zoning by single HBA most closely re-creates the original SCSI bus. Each zone created has only one HBA (initiator) in the zone; each of the target devices is added to the zone. Typically, a zone is created for the HBA and the disk storage ports are added. If the HBA also accesses tape devices, a second zone is created with the HBA and associated tape devices in it. In the case of clustered systems, it could be appropriate to have an HBA from each of the cluster members included in the zone; this zoning is equivalent to having a shared SCSI bus between the cluster members and assumes that the clustering software can manage access to the shared devices. In a large fabric, zoning by single HBA requires the creation of possibly hundreds of zones; however, each zone contains only a few members. Zone changes affect the smallest possible number of devices, minimizing the impact of an incorrect zone change. *This zoning philosophy is the preferred method.*
Alternative approaches	
Application	Zoning by application typically requires zoning multiple, perhaps incompatible, operating systems into the same zones. This method of zoning creates the possibility that a minor server in the application suite could disrupt a major server (such as a Web server disrupting a data warehouse server). Zoning by application can also result in a zone with a large number of members, meaning that more notifications, such as RSCNs, or errors, go out to a larger group than necessary.
Operating system	Zoning by operating system has issues similar to zoning by application. In a large site, this type of zone can become very large and complex. When zone changes are made, they typically involve applications rather than a particular server type. If members of different operating system clusters can detect storage assigned to another cluster, they might attempt to own the other cluster's storage and compromise the stability of the clusters.
Port allocation	Avoid zoning by port allocation unless the administration team has very rigidly enforced processes for port and device allocation in the fabric. It does, however, provide some positive features. For instance, when a storage port, server HBA, or tape drive is replaced, the change of WWN for the new device is of no consequence. As long as the new device is connected to the original port, it continues to have the same access rights. The ports on the edge switches can be pre-associated to storage ports, and control of the fan-in ratio (the ratio of the input port to output port) can be established. With this pre-assigning technique, the administrative team cannot overload any one storage port by associating too many servers with it.
Not recommended	
No zoning	Using no zoning is the least desirable zoning option because it allows devices to have unrestricted access on the fabric and causes RSCN storms. Additionally, any device attached to the fabric, intentionally or maliciously, likewise has unrestricted access to the fabric. This form of zoning should be used only in a small and tightly controlled environment, such as when host-based zoning or LUN masking is deployed.

Zone objects

A zone object can be one of the following types: a zone, a zone member, an alias for one or more zone members, or a zoning configuration.

Zones

A zone is made up of one or more zone members. Each zone member can be a device, a port, or an alias. If the zone member is a device, it must be identified by its Node World Wide Name (node WWN). If it is a port, it must be identified by its Port World Wide Name (port WWN). Port WWNs and node WWNs can be mixed in the same zone. For LSAN zones, only port WWNs can be used.

World Wide Names are specified as 8-byte (16-digit) hexadecimal numbers, separated by colons (:) for example, 10:00:00:90:69:00:00:8a. When a zone object is the node WWN, only the specified device is in the zone. When a zone object is the port WWN name, only the single port is in the zone.

NOTE
You are not restricted from configuring more than 255 zone members. However, that figure is considered a best-practices limit, and exceeding it can lead to unpredictable results.

Zone aliases

A zone alias is a name assigned to a device or a group of devices. By creating an alias, you can assign a familiar name to one or more devices and refer to these devices by that name. Aliases simplify cumbersome data entry by allowing you to create an intuitive naming structure (such as using "NT_Hosts" to define all NT hosts in the fabric).

As a shortcut for zone members, zone aliases simplify the entry and tracking of zone objects that are defined by their WWNs. For example, you can use the name "Eng" as an alias for "10:00:00:80:33:3f:aa:11".

Naming zones for the initiator they contain can also be useful. For example, if you use the alias SRV_MAILSERVER_SLT5 to designate a mail server in PCI slot 5, then the alias for the associated zone is ZNE_MAILSERVER_SLT5. This kind of naming strategy clearly identifies the server host bus adapter (HBA associated with the zone).

Zone configurations

A *zone configuration* is a group of one or more zones. A zone can be included in more than one zone configuration. When a zone configuration is enabled, all zones that are members of that configuration are enabled.

Several zone configurations can reside on a switch at once, and you can quickly alternate between them. For example, you might want to have one configuration enabled during the business hours and another enabled overnight. However, only one zone configuration can be enabled at a time.

The different types of zone configurations are:

- Defined Configuration

The complete set of all zone objects defined in the fabric.

- Enabled Configuration

A single zone configuration that is currently in effect. The enabled configuration is built when you enable a specified zone configuration.

If you disable the enabled configuration, zoning is disabled on the fabric, and default zoning takes effect. When default zoning takes effect, either all devices within the fabric can communicate with all other devices, or no device communicate with any other device, depending on how default zoning is configured. Disabling the configuration does not mean that the zone database is deleted, however, only that no configuration is active in the fabric.

On power-up, the switch automatically reloads the saved configuration. If a configuration was active when it was saved, the same configuration is reinstated on the local switch.

Naming conventions

Naming zones and zone configurations is flexible. You can devise prefixes to differentiate between zones used for production, backup, recovery, or testing. One configuration should be named PROD_*fabricname*, where *fabricname* is the name that the fabric has been assigned. The purpose of the PROD configuration is to easily identify the configuration that can be implemented and provide the most generic services. If you want to use other configurations for specific purposes, you can use names such as "BACKUP_A," "RECOVERY_2," and "TEST_18jun02".

Zoning enforcement

Zone enforcement is by name server. The name server filters queries and RSCNs based on the enabled zoning configuration.

Considerations for zoning architecture

This table lists considerations for zoning architecture.

TABLE 32 Considerations for zoning architecture

Item	Description
Effect of changes in a production fabric	Zone changes in a production fabric can result in a disruption of I/O under conditions when an RSCN is issued because of the zone change and the HBA is unable to process the RSCN fast enough. Although RSCNs are a normal part of a functioning SAN, the pause in I/O might not be acceptable. For these reasons, you should perform zone changes only when the resulting behavior is predictable and acceptable. Ensuring that the HBA drivers are current can shorten the response time in relation to the RSCN.
Allowing time to propagate changes	Zoning commands make changes that affect the entire fabric. When executing fabric-level configuration tasks, allow time for the changes to propagate across the fabric before executing any subsequent commands. For a large fabric, you should wait several minutes between commands.
Confirming operation	After changing or enabling a zone configuration, you should confirm that the nodes and storage can identify and access one another. Depending on the platform, you might need to reboot one or more nodes in the fabric with the new changes.
Use of aliases	The use of aliases is optional with zoning. Using aliases requires structure when defining zones. Aliases aid administrators of zoned fabrics in understanding the structure and context of zoning.

Operational considerations for zoning

Consider the topics discussed below when configuring zoning.

Supported modes for zoning

Zoning is supported only in VCS mode. When you save, enable, or disable a configuration, the changes are automatically distributed to all switches in the VCS Fabric.

Zoning is not supported in standalone mode and all zoning commands are hidden in this mode. The zone database is cleared and disabled when you transition from VCS Fabric mode to standalone mode.

Supported firmware for zoning

Zoning is supported only if all RBridges in the fabric are running Network OS 2.1 or later.

Connecting an RBridge running Network OS 2.0 to an RBridge running Network OS 2.1 or later merges the two networks only if the RBridge running Network OS 2.1 or later is in Brocade VCS Fabric mode and no zone database elements are defined or enabled.

A switch running Network OS v3.0.0 will segment if it is attached to a switch running Network OS v2.0.0 regardless of zoning configuration. A switch running Network OS v3.0.0 will join the fabric with a 2.1.x switch and zones will be merged, but the cluster will not form, so no further zoning commands will be allowed until all switches are upgraded to the same firmware version and the cluster has formed.

The Inter-Switch Links (ISLs) connecting the two RBridges will segment if the RBridge running Network OS 2.1 or later has any zone defined or enabled, or the default zone is set to No Access. Any such configuration requires automatic distribution of zoning configuration data, which is not compatible with RBridges running Network OS 2.0.

Firmware downgrade and upgrade considerations for zoning

A firmware downgrade from Network OS 4.1.0 to Network OS 2.1.x is not permitted under the following conditions:

1. One or more zone aliases are configured on the switch. You must remove all references to zone aliases prior to a firmware downgrade. Use the **no zoning defined-configuration alias** command to delete all zone alias objects. Then issue the **zoning enabled-configuration cfg-action**{**cfg-save** | **cfg-disable**} command or the **zoning enabled-configuration cfg-name** *cfg_name* command to commit the operation before re-attempting a firmware download.
2. An open zone transaction in progress. You must either commit or abort the current open transaction before re-attempting a firmware download. Use the **zoning enabled-configuration cfg-action** {**cfg-save** | **cfg-disable**} command or the **zoning enabled-configuration cfg-name cfg_name** command to commit the current open transaction. Alternately, use the **zoning enabled-configuration cfg-action cfg-transaction-abort** command to abort the open transaction.

   You cannot downgrade any switch in a Brocade VCS Fabric to Network OS 2.0 or earlier if any zone definition exists in the defined configuration. Any attempt to do so will fail while attempting to download the earlier firmware. For the downgrade to succeed, you must clear the defined configuration, disable any active configuration, set the default zoning mode to *All Access,* and then try again to download the firmware.

   When you upgrade from Network OS 2.1.0 to versions 2.1.1 or later, the zone database is cleared.

   CAUTION
   Clearing the defined configuration clears the zoning database for the entire fabric. If you want to downgrade just one switch without affecting the rest of the fabric, disconnect the switch from the fabric before deleting the defined configuration.

Configuring and managing zones

Zone configuration management overview

You can perform zoning operations on any RBridge in the VCS Fabric, but they are always executed on the principal RBridge. In Logical Chassis mode, any edits made to the zoning database are allowed only from the principal RBridge, and you can issue **show** commands from non-principal switches in this mode. In Fabric Cluster mode, you can make edits from any RBridge.

Automatic distribution of the zoning configuration ensures that the effects of these operations are shared and instantly visible on all switches in the VCS Fabric. However, these operations are not permanent until a transaction commit operation saves them to nonvolatile memory, which holds the master copy of the zoning database. In fabric cluster mode, any user can commit the transaction on any switch, and the commit operation saves the operations performed by all users. Once the zoning configuration is saved in permanent memory, it persists across reboot operations.

A transaction commit occurs when you or another user initiates any of the following zoning operations:

- Saving the database to nonvolatile memory with the **zoning enabled-configuration cfg-action cfg-save** command.
- Enable a specific zone configuration with the **zoning enabled-configuration cfg-name** command.
- Disabling the currently enabled zone configuration with the **no zoning enabled-configuration cfg-name** command.

Executing the **zoning enabled-configuration cfg-action cfg-transaction-abort** command cancels the currently open transaction.

If the principal RBridge reboots or goes down, Network OS selects a new principal and any pending zoning transaction is rolled back to the last committed transaction, which is the effective zoning configuration saved in nonvolatile memory. Any changes made to the effective configuration prior to an abort operation must be re-entered.

If an RBridge other than the principal reboots or goes down, the ongoing transaction is not backed out. Any zoning operations initiated by the RBridge are still part of the global transaction maintained on the principal RBridge.

If a fabric segments, the newly elected principal RBridge determines whether transaction data are retained. If a segment retains the original principal, it also retains ongoing transaction data. If a segment elects a new principal, the transaction is aborted.

The zone startup configuration is always equal to the running configuration. The running configuration will always be overwritten by the information from the master copy of the zoning database in nonvolatile memory at startup, so you always start up with the previous running configuration. It is not necessary to copy the running configuration to the startup configuration explicitly.

You can save a snapshot of the current running configuration using the **copy running-config** *file* command. You can add configuration entries from a saved configuration using the **copy** *file* **running-config** command. When saving the snapshot you must ensure that the saved running configuration contains no zoning transaction data, otherwise failures will occur when you attempt to restore configuration entries from the saved file. Any transaction data would cause such a failure, including empty configuration definitions or empty zones.

Notes

- When you re-enable the enabled-configuration (using the **zoning enabled-configuration** command) on the principal switch in the cluster, the system propagates the enabled-configuration across the cluster. There is a slight risk of doing this in that the defined-configuration may contain configuration edits that you may not want to enable yet. This feature prevents switches in the cluster from having mismatched enabled-configurations.
- When restoring the running configuration, Brocade recommends copying the file to the running configuration in the absence of any other command line input.
- When you restore a configuration using the **copy** command, the contents of the file are added to the defined configuration; they do not replace the defined configuration. The result is cumulative, is as if the input came from the command line.

Understanding and managing default zoning access modes

The default zoning mode controls device access if zoning is not implemented or if there is no enabled zone configuration. Default zoning has two access modes:

- *All Access* — All devices within the fabric can communicate with all other devices.
- *No Access* — Devices in the fabric cannot access any other device in the fabric.

The default setting is All Access. Changing the default access mode requires committing the ongoing transaction for the change to take effect.

The default zoning mode takes effect when you disable the effective zone configuration. If your default zone has a large number of devices, to prevent RSCN storms from overloading those devices, you should set the default zoning mode to No Access before attempting to disable the zone configuration. If your default zone includes more than 300 devices, the zoning software prevents you from disabling the zoning configuration if the default zoning mode is All Access.

Setting the default zoning mode

1. In privileged EXEC mode, enter the **configure terminal** command to enter the global configuration mode.
2. Enter one of the following commands, depending on the default access mode you want to configure:
   - To set the default access mode to All Access, enter **zoning enabled-configuration default-zone-access allaccess**.
   - To set the default access mode to No Access, enter **zoning enabled-configuration default-zone-access noaccess**.
3. Enter the **zoning enabled-configuration cfg-action cfg-save** or **zoning enabled-configuration cfg-name** command to commit the ongoing transaction and save the access mode change to nonvolatile memory.

4. Enter the **show running-config zoning enabled-configuration** command to verify the access mode change.

   Example of setting the default zoning mode to no access:

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning enabled-configuration default-zone-access noaccess
switch(config)# zoning enabled-configuration cfg-action cfg-save
switch(config)# do show running-config zoning enabled-configuration
zoning enabled-configuration cfg-name cfg1
zoning enabled-configuration default-zone-access noaccess
zoning enabled-configuration cfg-action cfg-save
```

Understanding and managing zone database size

The maximum size of a zone database is the upper limit for the defined configuration, and it is determined by the amount of memory available for storing the master copy of the defined configuration in flash memory.

Use the following information displayed by the **show zoning operation-info** command to determine whether there is enough space to complete outstanding transactions:

- db-max — Theoretical maximum size of the zoning database kept in nonvolatile memory
- db-avail — Theoretical amount of free space available
- db-committed — The size of the defined configuration currently stored in nonvolatile memory
- db-transaction — The amount of memory required to commit the current transaction

The supported maximum zone database size is 100 KB. If the outstanding transaction data (db-transaction field) is less than the remaining supported space (100 KB minus db-committed), enough space exists to commit the transaction.

> NOTE
> The db-max field has a theoretical zone database limit of approximately 1 MB. However, performance might become unacceptable if the zoning database exceeds 150 KB.

Viewing database size information

In privileged EXEC mode, enter the **show zoning operation-info** command.

Database and transaction size information is displayed in bytes.

```
switch# show zoning operation-info
db-max 1045274
db-avail 1043895
db-committed 367
db-transaction 373
transaction-token 1
last-zone-changed-timestamp 2011-11-16 16:54:31 GMT-7:00
last-zone-committed-timestamp 2011-11-16 16:23:44 GMT-7:00
```

Managing zone aliases

A zone alias is user-defined name for a logical group of ports or WWNs. You can simplify the process of creating and managing zones by first specifying aliases for zone members. Aliases facilitate tracking and eliminate the need for long lists of individual zone member names. An alias can be a member of a zone, but it cannot be a member of a zoning configuration.

Creating an alias

1. In privileged EXEC mode, enter the **show name-server detail** command to list the WWNs of devices and targets available in the Brocade VCS Fabric.
2. Enter the **configure terminal** command to enter global configuration mode.
3. Enter the **zoning defined-configuration alias** command followed by a name for the alias.

   A subconfiguration mode prompt appears.
4. Enter the subconfiguration mode **member-entry** command to specify at least one member entry.

   The member entry must be specified as a port WWN or a node WWN.

   You can add multiple members in one operation by separating each member entry with a semicolon (;). No spaces are allowed after the semicolon.
5. Enter the **exit** command to return to global configuration mode.
6. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the configuration to nonvolatile memory.

   The following is an example of creating an alias with one member node WWN:

```
switch# show name-server detail
PID: 013100
Port Name: 20:00:00:00:00:00:00:01
Node Name: 10:00:00:00:00:00:00:01
      (output truncated)
switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning defined-configuration alias alias1
switch(config-alias-alias1)# member-entry 10:00:00:00:00:00:00:01
switch(config-alias-alias1)# exit
switch(config)# zoning enabled-configuration cfg-action cfg-save
```

Adding additional members to an existing alias

1. In privileged EXEC mode, enter the **show name-server detail** command to list the WWNs of devices and targets available in the Brocade VCS Fabric.
2. Enter the **configure terminal** command to enter global configuration mode.
3. Enter the **zoning defined-configuration alias** command followed the name of an existing zone alias.

   A subconfiguration mode prompt appears.
4. Enter the subconfiguration mode **member-entry** command to specify at least one member entry.

   The member entry must be specified as a port WWN or a node WWN.

   You can add multiple members in one operation by separating each member entry with a semicolon (;). No spaces are allowed after the semicolon.
5. Enter the **exit** command to return to global configuration mode.

6. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the configuration to nonvolatile memory.

   Example of adding two member node WWNs to an existing alias:

```
switch# show name-server detail
PID: 013200
Port Name: 20:00:00:00:00:00:00:02
Node Name: 10:00:00:00:00:00:00:02
(output truncated)
PID: 013300
Port Name: 20:00:00:00:00:00:00:03
Node Name: 10:00:00:00:00:00:00:03
(output truncated)
switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning defined-configuration alias alias1
switch(config-alias-alias1)# member-entry 10:00:00:00:00:00:00:02;10:00:00:00:00:00:00:03
switch(config-alias-alias1)# exit
switch(config)# zoning enabled-configuration cfg-action cfg-save
switch(config)#
```

Removing a member from an alias

1. In privileged EXEC mode, enter the **show running-config zoning** command to display the alias and its member WWNs.
2. Enter the **configure terminal** command to enter global configuration mode.
3. Enter the **zoning defined-configuration alias** command followed the name of an existing zone alias.

   A subconfiguration mode prompt appears.
4. Enter the subconfiguration mode **no member-entry** command to specify the WWN to be removed from the zone alias.

   You can only remove one member at a time.
5. Enter the **exit** command to return to the global configuration mode.
6. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the configuration to nonvolatile memory.

   The following provides an example of removing two members from an alias:

```
switch# show running-config zoning
zoning defined-configuration alias alias1
 member-entry 10:00:00:00:00:00:00:01
 member-entry 10:00:00:00:00:00:00:02
 member-entry 10:00:00:00:00:00:00:03
      (output truncated)
switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning defined-configuration alias alias1
switch(config-alias-alias1)# no member-entry 10:00:00:00:00:00:00:02
switch(config-alias-alias1)# no member-entry 10:00:00:00:00:00:00:03
switch(config-alias-alias1)# exit
switch(config)# zoning enabled-configuration cfg-action cfg-save
```

Deleting an alias

1. In privileged EXEC mode, enter the **show running-config zoning** command to display the alias and its member WWNs.
2. Enter the **configure terminal** command to enter global configuration mode.
3. Enter the **no zoning defined-configuration alias** command followed by the name of the alias you want to delete.
4. Enter the **show running-config zoning** command to verify the change in the defined configuration (optional).

5. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the configuration to nonvolatile memory.

   Example of deleting an alias:

```
switch# show running-config zoning
zoning defined-configuration alias alias1
 member-entry 10:00:00:00:00:00:00:01
!
zoning enabled-configuration cfg-name ""
zoning enabled-configuration default-zone-access allaccess
zoning enabled-configuration cfg-action cfg-none
switch#
switch# configure terminal
Entering configuration mode terminal
switch(config)# no zoning defined-configuration alias alias1
switch(config)# do show running-config zoning
zoning enabled-configuration cfg-name ""
zoning enabled-configuration default-zone-access allaccess
zoning enabled-configuration cfg-action cfg-none
switch(config)# zoning enabled-configuration cfg-action cfg-save
```

Creating zones

Consider the topics below when creating zones.

Creating a zone

A zone cannot persist without any zone members. When you create a new zone, the **zoning defined-configuration zone** command places you in a command subconfiguration mode where you can add the first zone member entry. You can specify multiple members by separating each member from the next by a semicolon (;).

> NOTE
> Zones without any zone members cannot exist in volatile memory. They are deleted when the transaction commits successfully.

The following procedure adds a new zone to the defined configuration.

1. In privileged EXEC mode, enter the **show name-server detail** command to obtain the WWNs of servers and targets available in the Brocade VCS Fabric.
2. Enter the **configure terminal** command to enter global configuration mode.
3. Enter the **zoning defined-configuration zone** command and enter a new zone name to add a new zone.

   A subconfiguration mode prompt appears.
4. Enter the subconfiguration mode **member-entry** command to specify at least one member entry.

   The member entry must be specified as a port WWN, a node WWN, or an alias. You can mix WWNs and aliases.

   Add multiple members in one operation by separating each member entry with a semicolon (;). No spaces are allowed after the semicolon.
5. Enter the **exit** command to return to global configuration mode.

6. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified configuration to nonvolatile memory.

   Example of creating a zone with two members, a WWN and an alias:

```
switch# show name-server detail
PID: 012100
Port Name: 10:00:00:05:1E:ED:95:38
Node Name: 20:00:00:05:1E:ED:95:38
      (output truncated)

switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning defined-configuration zone zone1
switch(config-zone-zone1)# member-entry 20:00:00:05:1E:ED:95:38;alias2
switch(config-zone-zone1)# exit
switch(config)# zoning enabled-configuration cfg-action cfg-save
```

Adding a member to a zone

1. In privileged EXEC mode, enter the **show name-server detail** command to list the WWNs of devices and targets available on the Brocade VCS Fabric cluster.
2. Enter the **configure terminal** command to enter global configuration mode.
3. Enter the **zoning defined-configuration zone** command and enter the name of an existing zone.

   A subconfiguration mode prompt appears.
4. Enter the subconfiguration mode **member-entry** command and specify the member you want to add.

   The new member can be specified by a port WWN, a node WWN, or a zone alias.

   Add multiple members in one operation by separating each member with a semicolon (;).
5. Enter the **exit** command to return to the global configuration mode.
6. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified configuration to nonvolatile memory.

   Example of adding three members to a zone, two node WWNs and an alias:

```
switch# show name-server detail
PID: 012100
Port Name: 50:05:07:61:00:1b:62:ed
Node Name: 50:05:07:61:00:1b:62:ed
      (output truncated)
PID: 012200
Port Name: 50:05:07:61:00:09:20:b4
Node Name: 50:05:07:61:00:09:20:b4
      (output truncated)

switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning defined-configuration zone zone1
switch(config-zone-zone1)# member-entry 50:05:07:61:00:1b:62:ed;50:05:07:61:00:09:20:b4;alias3
switch(config-zone-zone1)# exit
switch(config)# zoning enabled-configuration cfg-action cfg-save
```

Removing a member from a zone

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.

2. Enter the **zoning defined-configuration zone** command and enter the name of the zone from which you want to remove a member.

   A subconfiguration mode prompt appears.
3. Enter the subconfiguration mode **no member-entry** parameter and specify the WWN or the alias of the member you want to remove.

   You can remove only one member at a time. To remove more than one member, you must issue the **no member-entry** command for each member you want to remove.
4. Enter the **exit** command to return to global configuration mode.
5. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified configuration to nonvolatile memory.

   NOTE
   Saving the configuration to nonvolatile memory also deletes the zone if the member you are removing is the last member in the zone.

Example of removing more than one member from a zone:

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning defined-configuration zone zone1
switch(config-zone-zone1)# no member-entry 50:05:07:61:00:09:20:b4
switch(config-zone-zone1)# no member-entry alias3
switch(config-zone-zone1)# exit
switch(config)# zoning enabled-configuration cfg-action cfg-save
```

Deleting a zone

Before deleting a zone, ensure that the zone is not a member of any enabled zone configuration. Although the deletion will proceed in RAM, you will not be able to save the configuration to nonvolatile memory if an enabled zone configuration has the deleted zone as a member.

1. In privileged EXEC mode, enter the **show running-config zoning defined-configuration** command and verify that the zone you want to delete is not a member of an enabled zone configuration. If the zone is a member of an enabled zone configuration, remove it.
2. Enter the **configure terminal** command to enter the global configuration mode.
3. Enter the **no zoning defined-configuration zone** command and enter the name of the zone you want to delete.

4. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified configuration to nonvolatile memory.

   NOTE
   Saving the configuration to nonvolatile memory also deletes the zone configuration if the zone you are removing is the last member zone in the configuration.

   Example of removing a zone from the defined configuration:

```
switch# show running-config zoning defined-configuration
zoning defined-configuration zone zone1
member-entry 10:00:00:00:00:00:00:01
!
zoning defined-configuration zone zone2
member-entry 10:00:00:00:00:00:00:02
!
switch# configure terminal
Entering configuration mode terminal
switch(config)# no zoning defined-configuration zone zone2
switch(config)# zoning enabled-configuration cfg-action cfg-save
Updating flash ...
switch(config)# exit
switch# show running-config zoning defined-configuration
zoning defined-configuration zone zone1
member-entry 10:00:00:00:00:00:00:01
```

Managing zones

Consider the topics below when managing zones.

Viewing the defined configuration

To view the defined configuration, in privileged EXEC mode enter the **show running-config zoning defined-configuration** command.

For each configuration, the command lists each member zone. For each zone, the command lists the WWN or alias name of each member. The following example illustrates this.

```
switch# show running-config zoning defined-configuration

zoning defined-configuration cfg cfg0
 member-zone zone_0_1
 member-zone zone_0_2
 member-zone zone_0_3
 member-zone zone_0_4
 member-zone zone_same
!
zoning defined-configuration cfg cfg1
 member-zone zone_1_1
 member-zone zone_1_2
 member-zone zone_1_3
 member-zone zone_1_4
 member-zone zone_same
!
zoning defined-configuration cfg cfg2
 member-zone zone_2_1
 member-zone zone_2_2
 member-zone zone_2_3
 member-zone zone_2_4
 member-zone zone_same
!
zoning defined-configuration cfg cfg4
 member-zone zone2
 member-zone zone3
```

```
!
zoning defined-configuration zone zone0
 member-entry 11:22:33:44:55:66:77:80
 member-entry 11:22:33:44:55:66:77:81
 member-entry 11:22:33:44:55:66:77:82
 member-entry 11:22:33:44:55:66:77:83
 member-entry 11:22:33:44:55:66:77:84
!
zoning defined-configuration zone zone1
 member-entry 11:22:33:44:55:66:77:80
 member-entry 11:22:33:44:55:66:77:81
 member-entry 11:22:33:44:55:66:77:82
 member-entry 11:22:33:44:55:66:77:83
 member-entry 11:22:33:44:55:66:77:84
!
zoning defined-configuration zone zone2
 member-entry 11:22:33:44:55:66:77:80
 member-entry 11:22:33:44:55:66:77:81
 member-entry 11:22:33:44:55:66:77:82
 member-entry 11:22:33:44:55:66:77:83
 member-entry 11:22:33:44:55:66:77:84
!
     (output truncated)
```

Viewing the enabled configuration

To view the enabled configuration, in privileged EXEC mode enter the **show zoning enabled-configuration** command. The following information about the enabled configuration is displayed:

- The name of the configuration
- The configuration action
- The mode of the default zone — the mode that will be active if you disable the enabled configuration

NOTE
In Network OS 4.0.0 and later, the enabled-zone output is no longer available from the **show running-config zoning enabled-configuration enabled-zone** command. It is now available from the **show running-config zoning enabled-configuration** command.

The configuration name has CFG_MARKER asterisk (*) appended to it if an outstanding transaction exists; the asterisk is not present if no outstanding transaction exists. Similarly, the configuration action is flagged as "cfg-save" if no outstanding transaction exists; "cfg-none" indicates that an outstanding transaction exists. A CFG_MARKER flag is appended to the configuration if the enabled configuration does not exactly match the defined configuration. This scenario occurs when you have an enabled configuration and make changes to the defined-configuration, and then, instead of enabling the defined configuration, you issue the **cfg-save** command.

CAUTION
When edits are made to the defined configuration, and those edits affect a currently enabled zone configuration, issuing a "cfg-save" command makes the enabled configuration effectively stale. Until the enabled configuration is reenabled, the merging of new RBridges into the cluster is not recommended. This merging may cause unpredictable results, with the potential for mismatched enabled-zoning configurations among the RBridges in the cluster.

Example of viewing the zoning enabled configuration:

```
switch# show zoning enabled-configuration

zoning enabled-configuration cfg-name cfg1
zoning enabled-configuration enabled-zone zone1 member-entry 10:00:00:00:00:00:00:01
zoning enabled-configuration enabled-zone zone2 member-entry 10:00:00:00:00:00:00:02
```

Creating a zone configuration

A zone configuration cannot persist without any member zones. When creating a new zone configuration, the **zoning defined-configuration cfg** command places you in a command sub-configuration mode where you must add at least one member zone. While zone configurations without any member zones can exist in volatile memory, they are deleted when the transaction commits successfully.

The following procedure adds a new zone configuration to the defined configuration.

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Enter the **zoning defined-configuration cfg** command and enter a new configuration name.

   A subconfiguration mode prompt appears.
3. Enter the **member-zone** subconfiguration mode command and specify the name of at least one zone.

   Add multiple zones in one operation by separating each zone name with a semicolon (;).
4. Enter the **exit** command to return to global configuration mode.
5. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified configuration to nonvolatile memory.

   Example of creating a zone configuration with one member zone:

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning defined-configuration cfg config1
switch(config-cfg-config1)# member-zone zone1
switch(config-cfg-config1)# exit
switch(config)# zoning enabled-configuration cfg-action cfg-save
```

   NOTE
   Zone aliases are not valid zone configuration members. Adding an alias to an existing zone configuration will not be blocked. However, the attempt to enable a zone configuration that contains aliases will fail with an appropriate error message.

Adding a zone to a zone configuration

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Enter the **zoning defined-configuration cfg** command and enter the name of the configuration to which you want to add zones.

   The command prompt changes to indicate a subconfiguration mode.
3. Enter the **member-zone** subconfiguration mode command and specify the name of at least one member zone.

   Add multiple zones in one operation by separating each zone name with a semicolon (;).
4. Enter the **exit** command to return to global configuration mode.
5. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified configuration to nonvolatile memory.

   Example of adding two zones to config1:

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning defined-configuration cfg config1
switch(config-cfg-config1)# member-zone zone2;zone3
switch(config-cfg-config1)# exit
switch(config)# zoning enabled-configuration cfg-action cfg-save
```

Removing a zone from a zone configuration

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Enter the **zoning defined-configuration cfg** command and enter the name of the configuration from which you want to remove a zone.

   The command prompt changes to indicate a subconfiguration mode.
3. Enter the **no member-zone** subconfiguration mode command and specify the name of the zone you want to remove from the configuration.

   You can remove only one member at a time. To remove more than one member, you must issue the **no member-zone** command for each member you want to remove.
4. Enter the **exit** command to return to global configuration mode.
5. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified configuration to nonvolatile memory.

   NOTE
   Saving the configuration to nonvolatile memory deletes the configuration if the zone you are removing is the last member in the configuration.

Example of removing two zones from config1:

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning defined-configuration cfg config1
switch(config-cfg-config1)# no member-zone zone2
switch(config-cfg-config1)# no member-zone zone3
switch(config-cfg-config1)# exit
switch(config)# zoning enabled-configuration cfg-action cfg-save
```

Enabling a zone configuration

Only one zone configuration can be enabled in a VCS Fabric. The following procedure selects a configuration from the defined configuration and makes it the enabled configuration. If a zone configuration is currently enabled, the newly enabled configuration replaces the previously enabled configuration.

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.

2. Enter the **zoning enabled-configuration cfg-name** command with the name of the configuration you want to enable.

   In addition to enabling the specified configuration, this command also saves any changes made to the zoning database in volatile memory to nonvolatile memory. The saved configuration is persistent.

   If the configuration refers to a nonexistent zone or a zone with no members assigned to it, the operation fails and the command returns an error message. The following example enables config1.

   Example of enabling a zone configuration:

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning enabled-configuration cfg-name config1
```

   Example of a failed enable operation:

   The enable operation fails because the configuration contains a zone without members.

```
switch(config)# do show running-config zoning
zoning defined-configuration cfg cfg1
member-zone-zone1
member-zone zone2
!
zoning defined-configuration zone zone1 <------------Zone with no member
!
zoning defined-configuration zone zone2
member-entry 20:03:00:11:0d:bc:76:09
!
zoning enabled-configuration cfg-name ""
zoning enabled-configuration default-zone-access allaccess
zoning enabled-configuration cfg-action cfg-none
switch(config)# zoning enabled-configuration cfg-name cfg1
% Error: Command Failed. Cfg contains empty zone object "zone1"
```

Disabling a zone configuration

Disabling the currently enabled configuration returns the fabric to no-zoning mode. All devices can then access one another or not at all, depending on the default zone access mode setting.

> NOTE
> For fabrics with many devices, Brocade recommends setting the default zone access mode to No Access before disabling a zone configuration to avoid RSCN storms.

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Enter the **no zoning enabled-configuration cfg-name** command.

   In addition to disabling the currently enabled configuration, this command also saves any changes made to the zoning database in volatile memory to nonvolatile memory. The saved configuration is persistent.

   Example of disabling a zone configuration:

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# no zoning enabled-configuration cfg-name
```

Deleting a zone configuration

The following procedure deletes a zone configuration from the defined configuration.

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.

2. Enter the **no zoning defined-configuration cfg** command and the name of the zone configuration you want to delete.
3. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified defined configuration to nonvolatile memory.

   Example of deleting a zone configuration:

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# no zoning defined-configuration cfg cfg2
switch(config)# zoning enabled-configuration cfg-action cfg-save
```

   NOTE
   If you try to delete the enabled configuration from the defined configuration, the **zoning enabled-configuration cfg-action cfg-save** command returns an error. However, if you commit the transaction with the **zoning enabled-configuration cfg-action cfg-disable** command, the operation proceeds without error.

Clearing changes to a zone configuration

The following procedure aborts all pending transactions and removes all uncommitted operations from the database. It returns the configuration in volatile memory to the state it was in when a **zoning enabled-configuration cfg-action cfg-save** or **zoning enabled-configuration cfg-name** command was last executed successfully.

1. In privileged EXEC mode, enter the **configure terminal** command to enter the global configuration mode.
2. Enter the **zoning enabled-configuration cfg-action cfg-transaction-abort** command.

   Example of aborting a transaction:

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning enabled-configuration cfg-action cfg-transaction-abort
```

Clearing all zone configurations

The following procedure clears all zone configurations from the defined configuration and enables the default zone.

NOTE
For fabrics with many devices, Brocade recommends setting the default access mode to No Access before clearing all zone configurations to avoid RSCN storms.

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Enter the **zoning enabled-configuration cfg-action cfg-clear** command.
3. Enter one of the following commands, depending on whether an enabled zone configuration exists:
   - If no enabled zone configuration exists, enter the **zoning enabled-configuration cfg-action cfg-save** command.
   - If an enabled zone configuration exists, enter the **no zoning enabled-configuration cfg-name** command to disable and clear the zone configuration in nonvolatile memory for all switches in the fabric.

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning enabled-configuration cfg-action cfg-clear
switch(config)# no zoning enabled-configuration cfg-name
```

Backing up the zone configuration

To back up your zoning configuration you copy it to a file and store it on a server or on an attached USB device. You can use the copy to restore the configuration if needed.

> NOTE
> Ensure that no transaction is pending before you perform the copy operation, otherwise failures will occur when you attempt to restore configuration entries from the saved file. Any transaction data would cause such a failure, including empty configuration definitions or empty zones.

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Empty the transaction buffer by either committing the transaction to nonvolatile memory or aborting the transaction.
   - To commit the transaction, enter the **zoning enabled-configuration cfg-action cfg-save** command, the **zoning enabled configuration cfg-name** command, or the **zoning enabled-configuration cfg-action cfg-disable** command.
   - To abort the transaction, enter the **zoning enabled-configuration cfg-action cfg-transaction-abort** command.
3. Enter the **exit** command to return to privileged EXEC mode.
4. Enter the **copy** command. For the source file, use **running-config** . For the destination file, use the file name you want the configuration copied to.

   Example of making a backup copy on a USB device:

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning enabled-configuration cfg-action cfg-save
switch(config)# exit
switch# copy running-config usb://myconfig
```

Restoring a configuration from backup

When you restore a configuration from backup and add to the running configuration, the zone configuration identified in the backup copy as the enabled configuration becomes the new enabled configuration.

In privileged EXEC mode, enter the **copy** command. For the source file use the file where the saved configuration is stored. For the destination file, use **running-config**.

This operation updates the defined configuration in RAM.

> NOTE
> The **copy** command adds to the defined configuration. It does not replace the defined configuration.

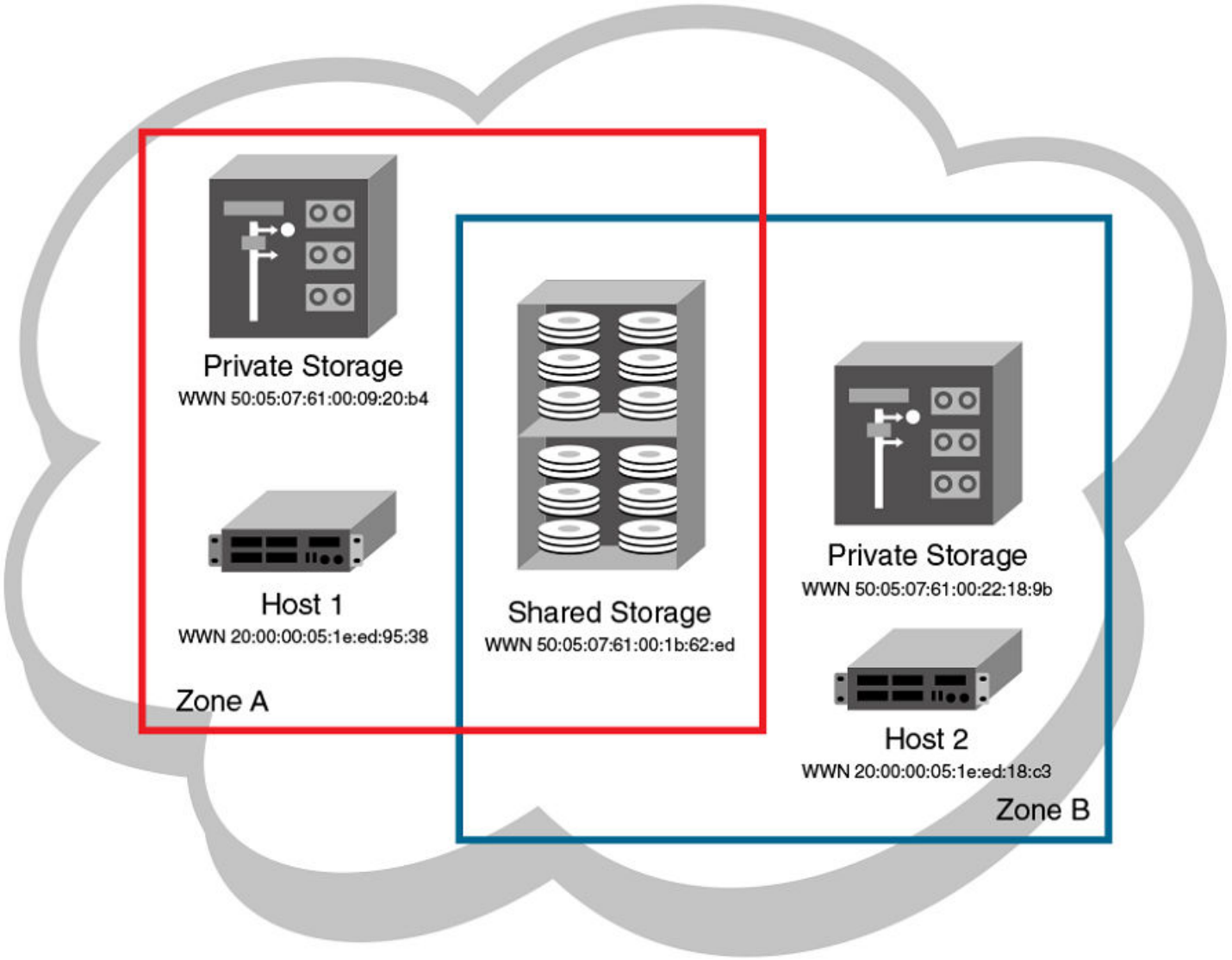
The following example adds the configuration in the file named myconfig on the attached USB device to the defined configuration.

```
switch# copy usb://myconfig running-config
```

Zone configuration scenario example

This example creates the zone configuration shown below. The example assumes that two hosts need access to the same storage device, while each host needs private storage of its own. You create two zones: Zone A contains Host 1, its private storage device, and the shared storage device; Zone B contains Host 2, its private storage device, and the shared storage device. In addition, you create two zone configurations: cfg1 in which only Zone A is effective; cfg2, in which both zones are effective.

FIGURE 25 Zone configuration example



1. Log in to any switch in the Brocade VCS Fabric.
2. Enter the **show name-server detail** command to list the available WWNs,
3. Enter the **configure terminal** command to enter global configuration mode.
4. Enter the **zoning defined-configuration zone** command to create Zone A.
5. Enter the **zoning defined-configuration zone** command to create Zone B.
6. Enter the **zoning defined-configuration cfg** command to create the configuration cfg1 with Zone A as its only member.
7. Enter the **zoning defined-configuration cfg** command to create the configuration cfg2 with Zone A and Zone B as its members.
8. Enter the **zoning running-config defined-configuration** command to view the defined zone configuration.
9. Enter the **zoning enabled-configuration cfg-name** command to enable cfg2.

10. Verify the enabled zoning configuration, by means of the **show zoning enabled-configuration** command.

```
switch# show name-server detail
switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning defined-configuration zone ZoneA
switch(config-zone-ZoneA)# member-entry 20:00:00:05:1e:ed:
95:38;50:05:07:61:00:09:20:b4;50:05:07:61:00:1b:62:ed
switch(config-zone-ZoneA)# exit
switch(config)# zoning defined-configuration zone ZoneB
switch(config-zone-ZoneB)# member-entry 20:00:00:05:1e:ed:18:c3;50:05:07:61:00:22:18:9b;
50:05:07:61:00:1b:62:ed
switch(config-zone-ZoneB)# exit
switch(config)# zoning defined-configuration cfg cfg1
switch(config-cfg-cfg1)# member-zone ZoneA
switch(config-cfg-cfg1)# exit
switch(config)# zoning defined-configuration cfg cfg2
switch(config-cfg-cfg2)# member-zone ZoneA;ZoneB
switch(config-cfg-cfg2)# exit
switch(config)# zoning enabled-configuration cfg-name cfg2
switch(config)# exit
switch# show zoning enabled-configuration
zoning enabled-configuration cfg cfg1
 member-zone ZoneA
!
zoning enabled-configuration cfg cfg2
 member-zone ZoneA
 member-zone ZoneB
!
zoning enabled-configuration zone ZoneA
 member-entry 20:00:00:05:1e:ed:95:38
 member-entry 50:05:07:61:00:09:20:b4
 member-entry 50:05:07:61:00:1b:62:ed
!
zoning enabled-configuration zone ZoneB
 member-entry 20:00:00:05:1e:ed:18:c3
 member-entry 50:05:07:61:00:22:18:9b
 member-entry 50:05:07:61:00:1b:62:ed
```

Merging zones

This section provides the background needed to merge zones successfully. The tables at the end of this section summarize scenarios involving Switch A and Switch B and the results to be expected following a merge.

Preconditions for zone merging

When a new switch is added to a VCS fabric, it automatically inherits the zone configuration information from the fabric. You can verify the zone configuration on any switch by using the procedure described in Viewing the defined configuration on page 180. Take care to avoid mismatched enabled-configuration scenarios.

CAUTION

When edits are made to the defined configuration, and those edits affect a currently enabled zone configuration, issuing a "cfg-save" command makes the enabled configuration effectively stale. Until the enabled configuration is reenabled, the merging of new RBridges into the cluster is not recommended. This merging may cause unpredictable results, with the potential for mismatched enabled-zoning configurations among the RBridges in the cluster.

If you are adding a switch that is already configured for zoning, you must clear the zone configuration on that switch before connecting it to the zoned fabric. Refer to Clearing all zone configurations on page 185 for instructions.

Adding a new fabric that has no zone configuration information to an existing zoned fabric is very similar to adding a new switch. All switches in the new fabric inherit the zone configuration data. If the existing fabric has an effective zone configuration, then the same configuration becomes the effective configuration for all switches in the added fabric.

NOTE
To prevent an unwanted zone merge, use the **no fabric isl enable** command on ISL interfaces instead of the **shutdown** command on tengigabitethernet ports.

Before the new fabric can merge successfully, it must satisfy the following criteria:

- Before merging
  - Ensure that all switches adhere to the default zone merge rules as described in Zone merging scenarios on page 190.
  - Ensure that the enabled and defined zone configurations match. If they do not match and you merge with another switch, the merge might be successful, but unpredictable zoning and routing behavior can occur. Refer to the Caution above and refer to Viewing the defined configuration on page 180.
- Merging and segmentation

The system checks each port as it comes online to determine whether the ports should be segmented. E_Ports come online on power up, enabling a switch, or adding a new switch, and the system checks the zone database to detect if the two database that can be merged safely. Refer to Zone merging scenarios on page 190.

Observe the following rules when merging zones:

- Merging rules
  - Local and adjacent configurations: If the local and adjacent zone database configurations are the same, they will remain unchanged after the merge.
  - Enabled configurations: If there is an enabled configuration between two switches, the enabled zone configurations must match.
  - Zone membership: If a zoning object has the same name in both the local and adjacent defined configurations, the content and order of the members are important.
  - Objects in adjacent configurations: If a zoning object appears in an adjacent defined configuration, but not in the local defined configuration, the zoning object is added to the local defined configuration. The modified zone database must fit in the nonvolatile memory area allotted for the zone database.
  - Local configuration modification: If a local defined configuration is modified because of a merge, the new zone database is propagated to the other switches within the merge request.
- Merging two fabrics

For best practices, the default-zone access modes should match, although this is not a requirement. Refer to Zone merging scenarios on page 190.

If the two fabrics have conflicting zone configurations, they will not merge. If the two fabrics cannot join, the ISLs between the switches will segment.

The transaction state after the merge depends on which switch is elected as the principal RBridge. The newly elected principal RBridge retains the same transaction information it had before the merge. Transaction data is discarded from any switch that lost its principal status during the merge.

- Merge conflicts

When a merge conflict is present, a merge does not take place and the ISLs will segment.

If the fabrics have different zone configuration data, the system attempts to merge the two sets of zone configuration data. If the zones cannot merge, the ISLs will be segmented.

- A merge is not possible under any of the following conditions:
  - Configuration mismatch: Zoning is enabled in both fabrics and the zone configurations that are enabled are different in each fabric.
  - Zone Database Size: The zone database size exceeds the maximum limit of another switch.

  NOTE
  If the zone members on two switches are not listed in the same order, the configuration is considered a mismatch, and the switches will segment from the fabric. For example: `cfg1 = z1; z2` is different from `cfg1 = z2; z1` , even though the members of the configuration are the same. If zone members on two switches have the same names defined in the configuration, make sure the zone members are listed in the same order.

Fabric segmentation and zoning

If the connections between two fabrics are no longer available, the fabric segments into two separate fabrics. Each new fabric retains the previous zone configuration.

If the connections between two fabrics are replaced and no changes have been made to the zone configuration in either of the two fabrics, the two fabrics can merge back into one single fabric. If any changes that cause a conflict have been made to either zone configuration, a fabric merge may fail.

Zone merging scenarios

The following tables provide information on merging zones and the expected results.

TABLE 33 Zone merging scenarios: Defined and enabled configurations

Description	Switch A	Switch B	Expected results
Switch A has a defined configuration. **Switch B** does not have a defined configuration.	defined:cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: none	defined: none enabled: none	Configuration from **Switch A** propagates throughout the fabric in an inactive state, because the configuration is not enabled.
Switch A has a defined and enabled configuration. **Switch B** has a defined configuration but no enabled configuration.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: none	Configuration from **Switch A** propagates throughout the fabric. The configuration is enabled after the merge in the fabric.
Switch A and **Switch B** have the same defined configuration. Neither have an enabled configuration.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: none	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: none	No change (clean merge).
Switch A and **Switch B** have the same defined and enabled configuration.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1:	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1:	No change (clean merge).
Switch A does not have a defined configuration. **Switch B** has a defined configuration.	defined: none enabled: none	defined:cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: none	**Switch A** absorbs the configuration from the fabric.

TABLE 33 Zone merging scenarios: Defined and enabled configurations (continued)

Description	Switch A	Switch B	Expected results
Switch A does not have a defined configuration. **Switch B** has a defined and enabled configuration.	defined: none enabled: none	defined:cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1	**Switch A** absorbs the configuration from the fabric, with cfg1 as the enabled configuration.
Switch A and **Switch B** have the same defined configuration. Only **Switch B** has an enabled configuration.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: none	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1	Clean merge, with cfg1 as the enabled configuration.
Switch A and **Switch B** have different defined configurations. Neither have an enabled configuration.	defined: cfg2 zone2: 10:00:00:90:69:00:00:8c; 10:00:00:90:69:00:00:8d enabled: none	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: none	Clean merge. The new configuration will be a composite of the two. defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b defined: cfg2 zone2: 10:00:00:90:69:00:00:8c; 10:00:00:90:69:00:00:8d enabled: none
Switch A and **Switch B** have different defined configurations. **Switch B** has an enabled configuration.	defined: cfg2 zone2: 10:00:00:90:69:00:00:8c; 10:00:00:90:69:00:00:8d enabled: none	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1	Clean merge. The new configuration is a composite of both, with cfg1 as the enabled configuration.
Switch A does not have a defined configuration. **Switch B** has a defined configuration and an enabled configuration, but the enabled configuration is different from the defined configuration.	defined: none enabled: none	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b effective: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b zone2: 10:00:00:90:69:00:00:8c, 10:00:00:90:69:00:00:8d	Clean merge. **Switch A** absorbs the defined configuration from the fabric, with cfg1 as the effective configuration. In this case, however, the effective configurations for **Switch A** and **Switch B** are different. You should issue a **zoning enabled-configuration cfg-name** command from the switch with the proper effective configuration.

TABLE 34 Zone merging scenarios: Different content

Description	Switch A	Switch B	Expected results
Enabled configuration mismatch.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b	defined: cfg2 zone2: 10:00:00:90:69:00:00:8c; 10:00:00:90:69:00:00:8d enabled: cfg2 zone2: 10:00:00:90:69:00:00:8c; 10:00:00:90:69:00:00:8d	Fabric segments due to mismatching zone configurations
Configuration content mismatch.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: irrelevant	defined: cfg1 zone1: 10:00:00:90:69:00:00:8c; 10:00:00:90:69:00:00:8d enabled: irrelevant	Fabric segments due to mismatching zone content

TABLE 35 Zone merging scenarios: Different names

Description	Switch A	Switch B	Expected results
Same content, different enabled configuration name.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b	defined:cfg2 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg2 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b	Fabric segments due to mismatching zone configurations
Same content, different zone name.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: irrelevant	defined: cfg1 zone2: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: irrelevant	Fabric segments due to mismatching zone content
Same name, same content, different order.	defined: cfg1zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b; 10:00:00:90:69:00:00:8c enabled: irrelevant	defined: cfg1zone1: 10:00:00:90:69:00:00:8b; 10:00:00:90:69:00:00:8c; 10:00:00:90:69:00:00:8a enabled: irrelevant	Fabric segments due to mismatching zone content
Same name, different types.	effective: zone1: MARKETING	enabled: cfg1: MARKETING	Fabric segments due to mismatching types

TABLE 36 Zone merging scenarios: Default access mode

Description	Switch A	Switch B	Expected results
Different default zone access mode settings.	default zone: All Access	default zone: No Access	Clean merge. No Access takes precedence and default zone configuration from **Switch B** propagates to fabric. default zone: No Access
Same default zone access mode settings.	default zone: All Access	default zone: All Access	Clean merge. Default zone configuration is All Access in the fabric.
Same default zone access mode settings.	default zone: No Access	default zone: No Access	Clean merge. Default zone configuration is No Access in the fabric.
Enabled zone configuration.	No enabled configuration. default zone = All Access	enabled: cfg2 default zone: All Access or No Access	Clean merge. Enabled zone configuration and default zone mode from **Switch B** propagates to fabric.
Enabled zone configuration.	No enabled configuration. default zone = No Access	enabled: cfg2 default zone: All Access	Fabric segments because **Switch A** has a hidden zone configuration (No Access) activated and **Switch B** has an explicit zone configuration activated.
Enable zone configuration.	enabled: cfg1 default zone: No Access	No enabled configuration. default zone: No Access	Clean merge. Enabled zone configuration from **Switch A** propagates to fabric.
Enable zone configuration.	enabled: cfg1 default zone: All Access	No enabled configuration. default zone: No Access	Fabric segments. You can resolve the zone conflict by changing the default zone to No Access on **Switch A**.

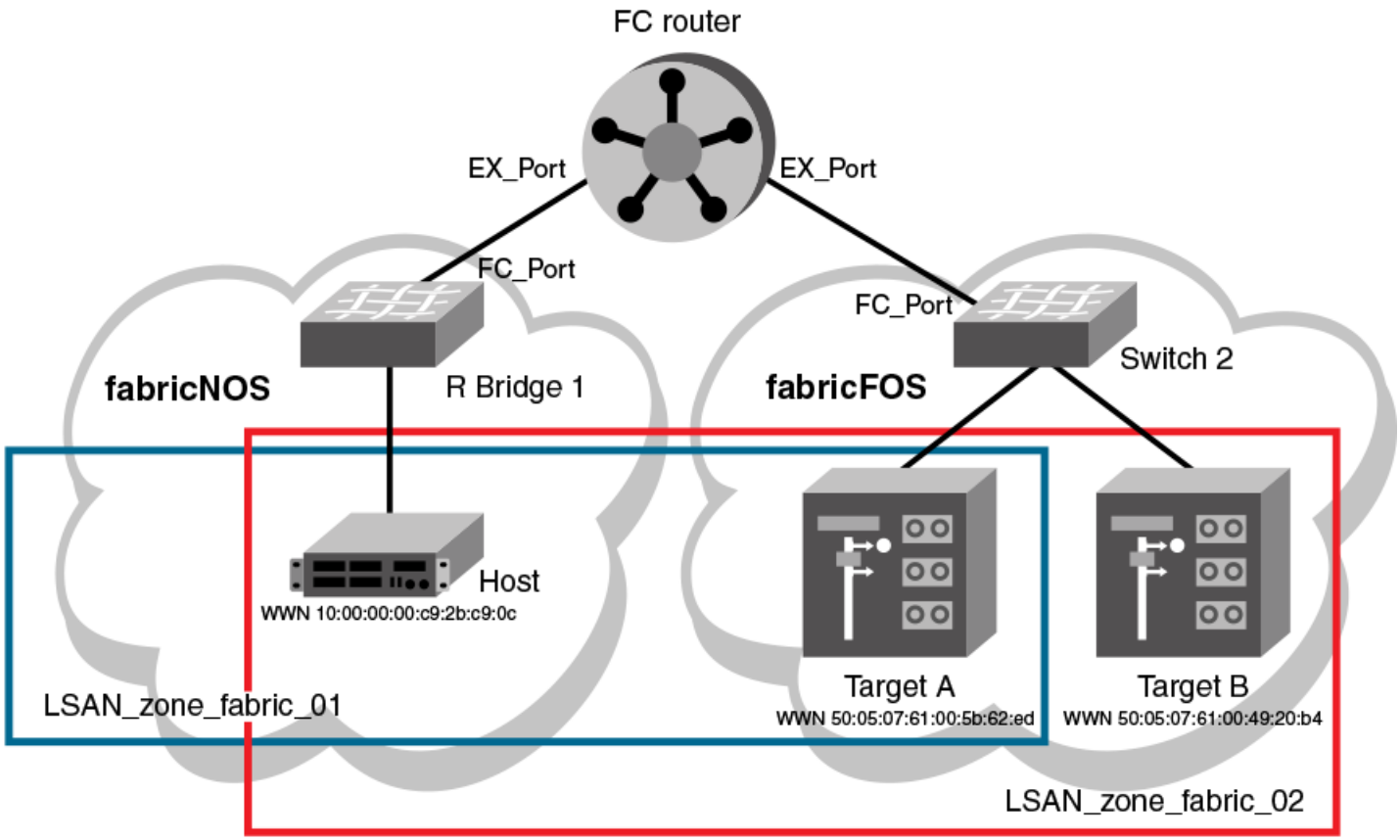
Configuring LSAN zones — device sharing example

The following example shows LSANs sharing devices in separate fabrics. The procedure illustrates the creation of two LSAN zones (called lsan_zone_fabric_02 and lsan_zone_fabric_01), which involve the following devices and connections:

- RBridge1 and the host in a Network OS fabric named fabric_01.
- Switch2, Target A, and Target B in a Fabric OS fabric named fabric_02.
- RBridge1 is connected by one of its FC_Ports to an EX_Port on the FC router.
- Switch2 is connected to the FC router using another EX_Port or VEX_Port.
- Host has WWN 10:00:00:00:c9:2b:c9:0c (connected to RBridge1).
- Target A has WWN 50:05:07:61:00:5b:62:ed (connected to switch2).
- Target B has WWN 50:05:07:61:00:49:20:b4 (connected to switch2).

The following illustration shows the connectivity.

FIGURE 26 LSAN zones example



The following example steps create this set of LSAN zones.

1. Obtain the host WWN in fabric_01:
   a) Log in to any switch in fabric_01.
   b) On the fabric_01 switch, enter the **show name-server detail** command to list the WWN of the host (10:00:00:00:c9:2b:c9:0c).

      NOTE
      The **show name-server detail** output displays both the port WWN and node WWN; the port WWN must be used for LSANs.

```
switch# show name-server detail
PID: 012100
Port Name: 10:00:00:00:c9:2b:c9:0c
Node Name: 20:00:00:00:c9:2b:c9:0c
SCR: 3
FC4s: FCP
PortSymb: [27] "Brocade-1020|2.3.0.0|localhost.localdomain|Red Hat
Enterprise Linux Server release 5.5"
NodeSymb: NULL
Fabric Port Name: 20:21:00:05:1E:CD:79:7A
Permanent Port Name: 10:00:00:00:c9:2b:c9:0c
Device type: Physical Initiator
Interface: Fcoe 1/1/9
Physical Interface: Te 1/0/9
Share Area: No
Redirect: No
```

2. Obtain the target WWNS in fabric_02:
   a) Log in as admin on switch2 in fabric_02.
   b) On fabric_02, enter the **nsShow** command to list Target A (50:05:07:61:00:5b:62:ed) and Target B (50:05:07:61:00:49:20:b4).

```
switch:admin> nsshow
{
Type Pid    COS  PortName                NodeName                TTL(sec)
NL   0508e8; 3;  50:05:07:61:00:5b:62:ed; 50:05:07:61:00:1b:62:ed; na
 FC4s: FCP [IBM   DNEF-309170   F90F]
 Fabric Port Name: 20:08:00:05:1e:34:11:e5
 Permanent Port Name: 50:05:07:61:00:5b:62:ed

NL   0508ef; 3;  50:05:07:61:00:49:20:b4; 50:05:07:61:00:09:20:b4; na
 FC4s: FCP [IBM   DNEF-309170   F90F]
 Fabric Port Name: 20:08:00:05:1e:34:11:e5
 Permanent Port Name: 50:05:07:61:00:49:20:b4
The Local Name Server has 2 entries }
```

3. Create an LSAN zone in the Network OS fabric (fabric_01)
4. In fabric_01, enter the **zoning defined-configuration zone** command to create the LSAN lsan_zone_fabric_01, and include the host.

```
switch# config terminal
switch(config)# zoning defined-configuration zone lsan_zone_fabric_01
switch(config-zone-lsan_zone_fabric_01)# member-entry 10:00:00:00:c9:2b:c9:0c
```

5. In fabric_01, add Target A to the LSAN.

```
switch(config-zone-lsan_zone_fabric_01)# member-entry 50:05:07:61:00:5b:62:ed
switch(config-zone-lsan_zone_fabric_01)# exit
```

6. In fabric_01, enter the **zoning defined-configuration cfg and zoning enabled-configuration cfg-name** commands to add and enable the LSAN configuration.

```
switch(config)# zoning defined-configuration cfg zone_cfg
switch(config-cfg-zone_cfg)# member-zone lsan_zone_fabric_01
switch(config-cfg-zone_cfg)# exit
switch(config)# zoning enabled-configuration cfg_name zone_cfg
```

Create an LSAN zone in the Fabric OS fabric (fabric_02)

7. On switch2 (fabric_02), enter the **zoneCreate** command to create the LSAN lsan_zone_fabric2, which includes the host (10:00:00:00:c9:2b:c9:0c), Target A (**50:05:07:61:00:5b:62:ed)** , and Target B (**50:05:07:61:00:49:20:b4)**.

```
switch:admin> zonecreate "lsan_zone_fabric_02", "10:00:00:00:c9:2b:c9:0c;
                                                 50:05:07:61:00:5b:62:ed;
                                                 50:05:07:61:00:49:20:b4"
```

8. On switch2 (fabric_02), enter the **cfgShow** command to verify that the zones are correct.

```
switch:admin> cfgshow
Defined configuration:
 zone: lsan_zone_fabric_02
        10:00:00:00:c9:2b:c9:0c;
        50:05:07:61:00:5b:62:ed;
        50:05:07:61:00:49:20:b4
Effective configuration:
 no configuration in effect
```

9. On switch2 (fabric_02), enter the **cfgAdd** and **cfgEnable** commands to create and enable the LSAN configuration.

```
switch:admin> cfgadd "zone_cfg", "lsan_zone_fabric_02"
switch:admin> cfgenable "zone_cfg"
You are about to enable a new zoning configuration.
This action will replace the old zoning configuration with the
current configuration selected.
Do you want to enable 'zone_cfg' configuration (yes, y, no, n): [no] y
zone config "zone_cfg" is in effect
Updating flash ...
```

Display the configuration on the FC router:

10. Log in as an admin and connect to the FC router.

11. On the FC router, enter the following commands to display information about the LSANs.

    The **lsanZoneShow -s** command shows the LSAN.

```
switch:admin> lsanzoneshow -s
Fabric ID: 2 Zone Name: lsan_zone_fabric_02
    10:00:00:00:c9:2b:c9:0c Imported
    50:05:07:61:00:5b:62:ed EXIST
    50:05:07:61:00:49:20:b4 EXIST
Fabric ID: 75 Zone Name: lsan_zone_fabric_01
    10:00:00:00:c9:2b:c9:0c EXIST
    50:05:07:61:00:5b:62:ed Imported
```

    The **fcrPhyDevShow** command shows the physical devices in the LSAN.

```
switch:admin> fcrphydevshow
    Device      WWN                     Physical
    Exists                              PID
    in Fabric
    ------------------------------------------
    75         10:00:00:00:c9:2b:c9:0c   c70000
     2         50:05:07:61:00:49:20:b4   0100ef
     2         50:05:07:61:00:5b:62:ed   0100e8
 Total devices displayed: 3
```

    The **fcrProxyDevShow** command shows the proxy devices in the LSAN.

```
switch:admin> fcrproxydevshow

Proxy      WWN                              Proxy Device  Physical State
Created                                     PID Exists    PID
in Fabric                                   in Fabric
-------------------------------------------------------------------------
75         50:05:07:61:00:5b:62:ed 01f001   2          0100e8  Imported
 2         10:00:00:00:c9:2b:c9:0c 02f000  75          c70000  Imported
Total devices displayed: 2
```

    On the FC router, the host and Target A are imported, because both are defined by lsan_zone_fabric_02 and lsan_zone_fabric_01. However, target B is defined by lsan_zone_fabric_02 and is not imported because lsan_zone_fabric_01 does not allow it.

Configuring Fibre Channel Ports

Fibre Channel ports overview

Fibre Channel (FC) ports provide the ability to connect a Brocade VCS Fabric cluster to a Fibre Channel switch in a Fabric OS network.

These connections can be regular or long distance. The following Network OS Fibre Channel port types are supported:

- E_Port
- F_Port
  - Supports Fibre Channel HBA and Fibre Channel target
  - Supports F_Port to FCoE port bidirectional traffic
  - Supports F_Port to E_Port bidirectional traffic

    NOTE
    You must enable **fcoeport default** for the interface for the Fibre Channel logins to be available to connect to F_Ports.

- Auto (G_Port) — This is the default.
- N_Port — For Access Gateways only. This port supports traffic to connect a VDX switch VF_Port to an FC fabric F_Port.

FC ports can connect to a FC switch in a Fabric OS network through two methods:

- Using an Inter-Switch Link (ISL) connection from an FC port on a VDX 6730 switch's to a FC router's EX_Port; this in turn connects to the FC switch in the Fabric OS network. The VDX FC ports are configured as E_Ports for this connection. Refer to Connecting to a FC Fabric through an FC Router on page 197.
- Using a direct connection from an FC port on a VDX 6720 switch's to a F_Port on a FC router in a Fabric OS network. The VDX FC ports are configured as N_Ports through the Access Gateway feature. Refer to Using Access Gateway on page 207.

Connecting to a FC Fabric through an FC Router

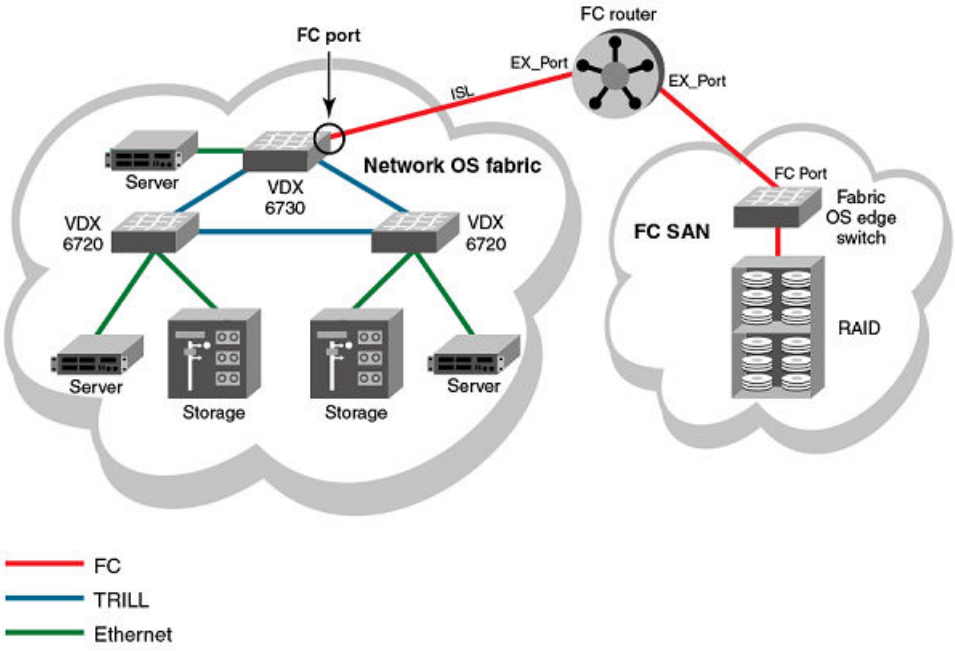
FC ports on VDX 6730 switches can provide a connection to a FC switch in the FC SAN.

The FC ports on the VDX 6730 switch can be configured as FC E_Ports to connect with EX_Ports on a FC router through Inter-Switch Links (ISL) links. In turn, EX_Ports on the FC router connect to F_Ports on the FC Fabric switch. These connections provide support for zoning across Network OS and Fabric OS fabric types, which can enable FCoE devices on the Brocade VCS Fabric cluster to access SAN storage and services. Refer to Fibre Channel ports overview on page 197 for information on how to create LSAN zones.

The following shows an FC connection between a Network OS fabric and Fibre Channel SAN.

NOTE
For details of Fibre Channel routing concepts, refer to the *Fabric OS Administrator's Guide*

FIGURE 27 FC connection between a Network OS fabric and a Fibre Channel SAN



The Brocade VDX 6730-32 and VDX 6730-76 switches are the only Network OS switches that support Fibre Channel ports. The Brocade VDX 6730-32 switch provides eight 8-Gbps Fibre Channel ports. The Brocade VDX 6730-76 provides sixteen 8-Gbps Fibre Channel ports.

Fibre Channel port configuration

Consider the topics discussed below when configuring Fibre Channel ports.

Using Fibre Channel commands

Network OS software provides the following high-level commands for managing Fibre Channel ports:

- **interface FibreChannel** - Global configuration mode command that allows you to enter the interface Fibre Channel configuration submode where you can enter commands to activate and deactivate a Fibre Channel port (**no shutdown** and **shutdown** commands) and to set port attributes (**desire-distance**, **fill-word**, **isl-r_rdy**, **long-distance**, **speed**, **trunk-enable**, and **vc-link-init** commands).
- **show running-config interface FibreChannel** - A privileged EXEC mode command that displays Fibre Channel port configuration information.
- **show interface FibreChannel** - A privileged EXEC mode command that displays hardware counters that monitor activity and status of a Fibre Channel port.

Activating and deactivating Fibre Channel ports

When VCS mode is enabled and an FCoE license is installed, all FC ports are activated by default. When enabling a switch for Access Gateway Mode, all FC ports are re-enabled as N_Ports.

Prerequisites for activating and deactivating Fibre Channel ports

An FCoE license must be installed on Brocade VDX 6730 and 6720 switches to allow Fibre Channel port activation. Brocade VCS Fabric mode must be enabled. Once the FCoE license is installed, all Fibre Channel ports are activated by default.

Access Gateway is a feature available only on VDX 6720 switches. When activated, all Fibre Channel ports are re-enabled as N_Ports.

Refer to the *Network OS Software Licensing Guide* for details about installing the FCoE license.

Enabling a Fibre Channel port

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Enter the **interface FibreChannel** *rbridge-id/slot/port* command for the Fibre Channel port you want to enable.

   A configuration submode prompt appears.
3. Enter the **no shutdown** command.

   The following example enables port 1 on RBridge 8.

```
switch# configure terminal

Entering configuration mode terminal
switch(config)# rbridge-id 8
switch(config-rbridge-id-8)# interface FibreChannel 8/0/1
switch(config-FibreChannel-8/0/1)# no shutdown
```

Disabling a Fibre Channel port

1. In privileged EXEC mode, enter the **configure terminal** command to enter the global configuration mode.
2. Enter the **interface FibreChannel** *rbridge-id/slot/port* command for the Fibre Channel port you want to disable.

   A configuration submode prompt appears.
3. Enter the**shutdown** command.

   The following example disables port 1 on routing bridge 8.

```
switch# configure terminal

Entering configuration mode terminal
switch(config)# interface FibreChannel 8/0/1
switch(conf-FibreChannel-8/0/1)# shutdown
```

Configuring and viewing Fibre Channel port attributes

This section introduces the options for configuring a variety of Fibre Channel port attributes and confirming the status of those attributes.

Using Fibre Channel port commands

Network OS v2.1.1 and later allows you to configure and display the following Fibre Channel port attributes for an E_Port by using the commands shown below:

- Port speed — Enter the interface Fibre Channel configuration submode **speed** command to set the speed of a Fibre Channel port.
- Fill word — Enter the interface Fibre Channel configuration submode **fill-word** command to configure the link initialization and fill word primitives for an 8-gbps Fibre Channel port.

- Long distance mode — Enter the interface Fibre Channel configuration submode **long-distance** command to configure the port for long-distance operations.
- VC link init — Enter the interface Fibre Channel configuration submode **vc-link-init** command to configure the fill word for long-distance operation.
- Desired distance — Enter the interface Fibre Channel configuration submode **desire-distance** command to configure manually the distance for a long-distance connection.
- Trunk port — Enter the interface Fibre Channel configuration submode **trunk-enable** command to configure the port for trunking.

  NOTE
  Port trunking is not supported in Access Gateway Mode.

- Buffer credit control — Enter the interface Fibre Channel configuration submode **isl-r_r-rdy** command to enable interswitch link receiver-ready (ISL R_RDY) mode on the port. Enter the interface Fibre Channel configuration submode **no isl-r_r-rdy** command to disable ISL R_RDY mode on the port. If ISL R_RDY is not set, then Inter-SwitchLink Virtual Channel ready (ISL VC_RDY) mode is set by default.

  ATTENTION
  Setting ISL R_RDY is not recommended.

The following Fibre Channel port attributes are not supported by Network OS 4.1.0:

AL_PA offset 13	F_Port buffers	NPIV capability
Compression	Fault Delay	NPIV PP Limit
Credit Recovery	FEC	Persistent Disable
CSCTL mode	Frame shooter port	Port Auto Disable
D-Port mode	Locked G_Port	QoS E_Port
Disabled E_Port	Locked L_Port	Rate limit
Encryption	LOS TOV enable	RSCN suppressed
EX_Port	Mirror Port	

Viewing Fibre Channel port attributes

To view the Fibre Channel port attributes for a single port, in privileged EXEC mode, enter the **show running-config interface FibreChannel** *rbridge-id/slot/port* command for the port you want to view. To view the Fibre Channel port attributes for all Fibre Channel ports in the fabric, enter the **show running-config interface FibreChannel** command without any additional parameters.

Whether you view attributes for a single port or for all ports, the settings for the **desire-distance**, **isl-r_rdy**, **trunk-enable**, and **shutdown** attributes are always displayed. The **speed**, **long-distance**, **vc-link-init**, and **fill-word** attributes are displayed only if they are set to nondefault values.

The following example displays the Fibre Channel port attributes for a single port. In this case, the **speed**, **long-distance**, and **vc-link-init** attributes appear because they have been set to values other than their default values.

```
switch# show running-config interface FibreChannel 8/0/1
interface FibreChannel 8/0/1
 speed 8gbps
 long-distance ld
 vc-link-init arb
 desire-distance 0
 no isl-r_rdy
```

```
 trunk-enable
 shutdown
```

The following example shows Fibre Channel attributes for all Fibre Channel ports. In this case, the **speed**, **long-distance**, **vc-link-init**, and **fill-word** attributes are set to their default values for all of the interfaces shown.

```
switch# show running-config interface FibreChannel
interface FibreChannel 3/0/1
 desire-distance 0
 no isl-r_rdy
 trunk-enable
 no shutdown
!
interface FibreChannel 3/0/2
 desire-distance 0
 no isl-r_rdy
 trunk-enable
 no shutdown
!
interface FibreChannel 3/0/3
 desire-distance 0
 no isl-r_rdy
 trunk-enable
 no shutdown
!
      (output truncated)
```

To view the setting of a single attribute on a specific port, regardless of whether the attribute is set to its default value, enter the **show running-config interface FibreChannel** *rbridge-id/slot/port* command.

The following example shows the setting of the speed attribute for port 66/0/1:

```
switch# show running-config interface FibreChannel 66/0/1 speed interface FibreChannel 66/0/1 speed auto
```

Setting Fibre Channel port speed

This procedure sets the ports speed to 1, 2, 4, or 8 Gbps, or to autonegotiate (the default value).

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Enter the **interface FibreChannel** *rbridge-id/slot/port* command for the port on which you want to set the speed.

   A configuration submode prompt appears.
3. Enter the **speed** command followed by the desired speed in Gbps.

   The following example sets the port speed to 4 Gbps.

   ```
   switch# configure terminal
   Entering configuration mode terminal
   switch(config)# interface FibreChannel 8/0/1
   switch(config-FibreChannel-8/0/1)# speed 4
   ```

Configuring Fibre Channel ports for long-distance operation

Configuring a port for long-distance operation reserves the appropriate number of full-size frame buffers for various long-distance modes. Be sure to observe preconditions for long distance operation as outlined in this section.

Long-distance operation overview

Use the **interface FibreChannel long-distance** command to support long-distance links and to allocate enough full-size frame buffers on a specific port. Changes made by this command are persistent across switch reboots and power cycles.

This command supports the following long-distance link modes:

- Normal mode (LO) — L0 is the normal (default) mode for a port. It configures the port as a regular port. A total of 20 full-size frame buffers are reserved for data traffic, regardless of the port operating speed. The maximum supported link distance is up to 5 km at 2 Gbps, up to 2 km at 4 Gbps, and up to 1 km at 8 Gbps.
- Extended mode (LE) — LE configures an E_Port distance greater than 5 km and up to 10 km. The baseline for the calculation is one credit per km at 2 Gbps, which yields the following values for 10 km:
  - 5 credits per port at 1 Gbps
  - 10 credits per port at 2 Gbps
  - 20 credits per port at 4 Gbps
  - 40 credits per port at 8 Gbps
- Dynamic Long-Distance mode (LD) — LD calculates buffer-to-buffer (BB) credits based on the distance measured during port initialization. Brocade switches use a proprietary algorithm to estimate distance across an ISL. The estimated distance is used to determine the BB credits required in LD extended link mode based on a maximum Fibre Channel payload size of 2,112. You can place an upper limit on the calculation by providing a desired distance value (by means of the **desire-distance** command). Network OS confines user entries to no larger than what it has estimated the distance to be. When the measured distance is more than the specified desired distance, the specified desired distance (the smaller value) is used in the calculation.
- Static Long-Distance mode (LS) — LS calculates a static number of BB credits based only on a user-defined desired distance value set using the **desire-distance** command. LS also assumes that all Fibre Channel payloads are 2,112 bytes. Specify LS to configure a static long-distance link with a fixed buffer allocation greater than 10 km. Up to a total of 1,452 full-size frame buffers are reserved for data traffic, depending on the specified desired-distance value.

Preconditions for long-distance operation

Before configuring an extended ISL, ensure that the ports on both ends of the ISL are operating at the same port speed and can be configured at the same distance level without compromising local switch performance.

Only qualified Brocade SFP transceivers are used. Only Brocade-branded or certain Brocade-qualified SFPs are supported.

Configuring a Fibre Channel port for long-distance operation

To configure a Fibre Channel port for long-distance operation, follow these steps:

1. In privileged EXEC mode, enter the **configure terminal** command to enter the global configuration mode.
2. Enter the **interface FibreChannel** *rbridge-id/slot/port* command for the Fibre Channel port you want to configure.

   A configuration submode prompt appears.
3. For 8 Gbps only, enter the **fill-word** command to set the fill word to the same value as for the remote port.
4. Enter the **long-distance** command to set the long distance mode.
5. For LD and LS modes only, enter the **desire-distance** command to set the desired distance.
6. For 8 Gbps only, enter the **vc-link-init** command to set the fill word for the long distance link to the same value as the fill word for the remote port.

7. On the Fabric OS end of the ISL, configure the Fibre Channel port with the same values set in step 3 and step 5 using the Fabric OS **portCfgFillWord** and **portCfgLongDistance** commands.

   The following example sets the long distance mode to LS for a distance of 100 km.

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# interface FibreChannel 8/0/1
switch(config-FibreChannel-8/0/1)# fill-word arbff-arbff
switch(config-FibreChannel-8/0/1)# long-distance ls
switch(config-FibreChannel-8/0/1)# desire-distance 100
switch(config-FibreChannel-8/0/1)# vc-link-init arb
switch(config-FibreChannel-8/0/1)# do show running-config interface FibreChannel 8/0/1
interface FibreChannel 8/0/1
 fill-word arbff-arbff
 long-distance ls
 vc-link-init arbff
 desire-distance 100
 no isl-r_rdy-mode
 no shutdown
```

Configuring a Fibre Channel port for trunking

A link can be configured to be part of a trunk group. Two or more links in a port group form a trunk group when they are configured for the same speed, the same distance level, and their link distances are nearly equal.

NOTE
Port trunking is not supported in Access Gateway Mode.

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Enter the **interface FibreChannel** *rbridge-id/slot/port* command for the desired port.

   A configuration submode prompt appears.
3. Enter the **trunk-enable** command.

   The following example configures the link attached to port 4 on RBridge 8 to be part of a trunk group.

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# rbridge-id 8
switch(config-rbridge-id-8)# interface FibreChannel 8/0/4
switch(config-FibreChannel-8/0/4)# trunk-enable
```

Monitoring Fibre Channel ports

To monitor a Fibre Channel port, in privileged EXEC mode, enter the **show interface FibreChannel** *rbridge-id/slot/port* command for the Fibre Channel port you want to monitor. The command output provides lots of information about the various hardware counters associated with the port.

This command has a basic version and a detail version. The basic version of the command provides general port information such as status, identification, and configuration information, along with interrupt statistics, link status counters, and so on, as shown in the following example:

```
switch# show interface FibreChannel 66/0/1

fibrechannel 66/0/1 is up (No_Light). Protocol state is down.
Pluggable media present
LineSpeed Actual:
PortSpeed:           N8Gbps
```

```
portDisableReason:   None
PortId:              427900
PortIfId:            4302303f
PortWwn:             20:79:00:05:33:67:26:78
Distance:            normal
Last clearing of show interface counters: 00:00:00
Interrupts:    0     Link_failure: 0     Frjt:     0
Unknown:       0     Loss_of_sync: 0     Fbsy:     0
Lli:           2     Loss_of_sig:  2
Proc_rqrd:     0     Protocol_err: 0
Timed_out:     0     Invalid_word: 0
Rx_flushed:    0     Invalid_crc:  0
Tx_unavail:    0     Delim_err:    0
Free_buffer:   0     Address_err:  0
Overrun:       0     Lr_in:        0
Suspended:     0     Lr_out:       0
Parity_err:    0     Ols_in:       0
2_parity_err:  0     Ols_out:      0
Rate info:
 Bandwidth:    8.00G
 Tx performance: 0 B/sec
 Rx performance: 0 B/sec
```

The detailed version of the command, illustrated below, tells you how much traffic has been transmitted or received, and how many times certain error conditions have occurred. Specifically, the **tim_txcrd_z** counters tell you how many times the port was unable to transmit frames because the transmit BB credit was zero. A number greater than zero indicates either that there is congestion on the port or that a device is affected by latency. A larger number indicates a greater problem. A sample is taken every 2.5 microseconds.

```
switch# show interface FibreChannel 66/0/1 detail

fibrechannel 66/0/1 is up. Protocol state is up (connected)
Pluggable media present
LineSpeed Actual:               400,800_MB/s
portSpeed:                      N8Gbps
portDisableReason:              None
portId                          423100
portIfId:                       43020026
portWwn:                        20:31:00:05:33:6f:27:57
Distance                        normal

Last clearing of show interface counters: 00:00:00

Rx Statistics:
  stat_wrx         118     4-byte words received
  stat_frx         4       Frames received
  stat_c2_frx      0       Class 2 frames received
  stat_c3_frx      0       Class 3 frames received
  stat_lc_rx       2       Link control frames received
  stat_mc_rx       0       Multicast frames received
Tx Statistics:
  stat_wtx         282     4-byte words transmitted
  stat_ftx         12      Frames transmitted
  stat_mc_tx       0       Multicast frames transmitted
  tim_txcrd_z      2881    Time  TX Credit   Zero (2.5Us ticks)
  tim_txcrd_z_vc 0- 3:     2881   0      0      0
  tim_txcrd_z_vc 4- 7:     0      0      0      0
  tim_txcrd_z_vc 8-11:     0      0      0      0
  tim_txcrd_z_vc 12-15:    0      0      0      0
Error Statistics:
  er_enc_in           0  Encoding errors inside of frames
  er_crc              0  Frames with CRC errors
  er_trunc            0  Frames shorter than minimum
  er_toolong          0  Frames longer than maximum
  er_bad_eof          0  Frames with bad end-of-frame
  er_enc_out          0  Encoding error outside of frames
  er_bad_os           1  Invalid ordered set
  er_rx_c3_timeout    0  Class 3 receive frames discarded due to timeout
  er_tx_c3_timeout    0  Class 3 transmit frames discarded due to timeout
  er_c3_dest_unreach  0  Class 3 frames discarded due to destination unreachable
  er_other_discard    0  Other discards
```

```
  er_type1_miss       0  frames with FTB type 1 miss
  er_type2_miss       0  frames with FTB type 2 miss
  er_type6_miss       0  frames with FTB type 6 miss
  er_zone_miss        0  frames with hard zoning miss
  er_lun_zone_miss    0  frames with LUN zoning miss
  er_crc_good_eof     0  Crc error with good eof
  er_inv_arb          0  Invalid ARB

Port Error Info:
  Loss_of_sync:1
  Loss_of_sig:2
  Frjt:0
  Fbsy:0

Buffer Information:
 Lx    Max/Resv   Buffer   Needed    Link       Remaining
 Mode  Buffers    Usage    Buffers   Distance   Buffers
=============================================================
 -     8          0        0         -          924

Rate info:
 Bandwidth:    8.00G
 Tx performance: 0 B/sec
 Rx performance: 0 B/sec
```

Using Access Gateway

Access Gateway basic concepts

Enable the Access Gateway (AG) feature on VDX 6730 platforms to configure FC ports as N_Ports and map specific VF ports to these N_Ports. This allows direct connection of hosts attached to the VF_Ports on the VDX switch with F_Ports on a Fibre Channel fabric edge switch instead of through ISL connections from a VDX 6730 to a Fibre Channel Router (FCR). These connections can be regular or long distance.

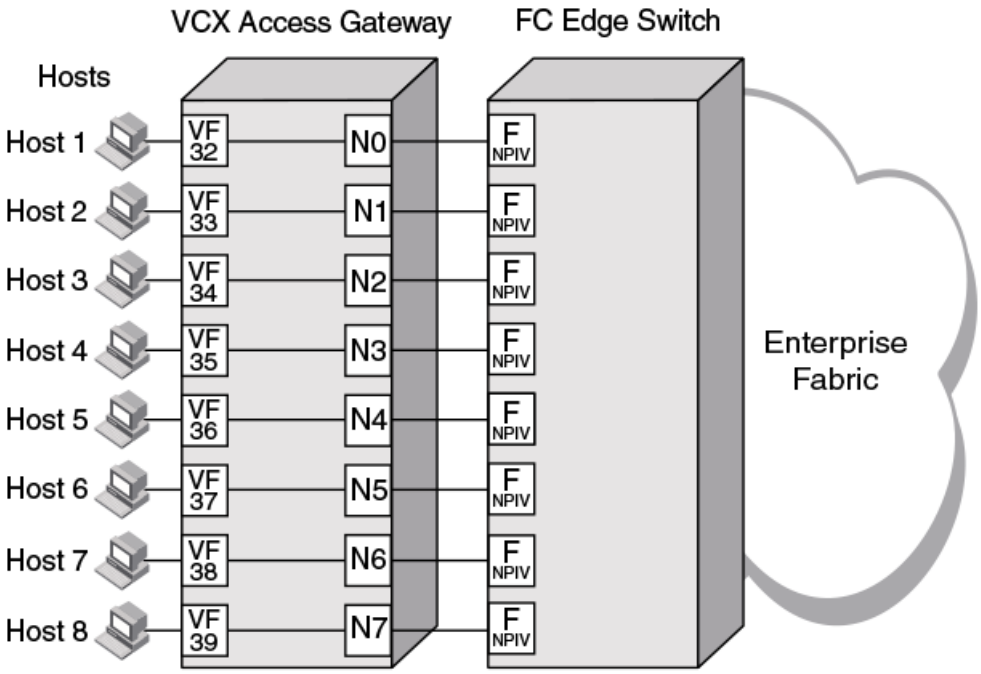
Through the use of N_Ports for direct connection to FC switches and VF_Port to N_Port mapping, Access Gateway provides the following benefits:

- As ISLs between VDX 6730 switches and FCRs utilize possibly limited domain IDs to identify switches, direct connection from VDX 6730 switch N_Ports to Fibre Channel switch F_Ports can resolve scalability issues as the number of Fibre Channel and VCS fabrics grow.
- Direct connection from VDX switch N_Ports to FC switch F_Ports allows greater interoperability with multivendor Fibre Channel fabrics as connection to these fabrics through an FCR is limited.
- The use of N_Ports instead of ISL connections to FCRs increases the number of device ports available for FCoE hosts and devices behind LAG-supported FSBs connected to the VDX switch VF_Ports. In addition, through use of N_Port ID Virtualization (NPIV), multiple FCoE initiators can access the SAN through the same physical port.

After you configure a Brocade VDX 6730 switch in AG mode, all FC Ports are enabled as N_Ports. These ports connect to F_Ports on the FC fabric. If the VDX switch in AG mode is connected to a FC switch, the connected N_Ports should come up automatically. Devices attached to VF_Ports come up when the **fcoeport default** command is executed on the individual switch interface port.

The following figure illustrates connection of eight hosts through an AG switch to a Fibre Channel fabric edge switch.

FIGURE 28 Hosts connecting to FC fabric through VDX Switch in AG mode

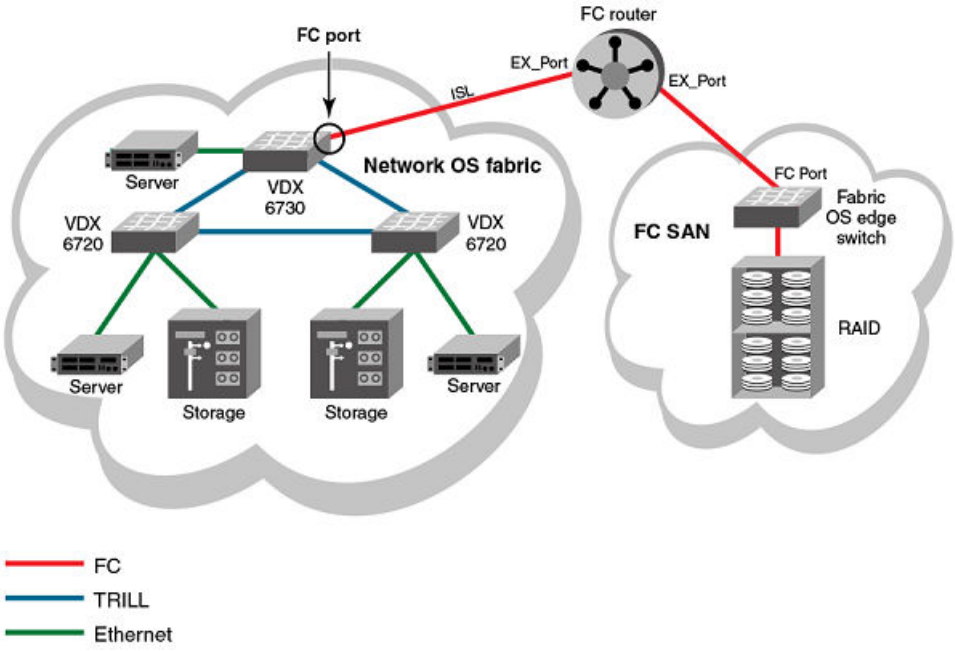


NOTE

An AG switch can connect to only one Fibre Channel SAN. Ports on this switch connecting to a second FC SAN are disabled. Multiple AG switches, each belonging to a different VCS cluster, can connect to the same SAN fabric.

The following figure illustrates an alternate connection of hosts (servers) to a FC fabric through a VDX 6730 Switch is not in Access Gateway mode. A VDX FC port, configured as an E_Port, connects to the FC SAN through an ISL connection to a FC router. For more information on configuring FC ports for an ISL and FC router connection, refer to Configuring Fibre Channel Ports on page 197.

FIGURE 29 Connecting Network OS fabric to FC fabric without AG mode



Switches in AG mode are logically transparent to the host and the fabric. Therefore, you can increase the number of hosts that have access to the fabric without increasing the number of switch domains. This simplifies configuration and management in a large fabric by reducing the number of domain IDs and ports.

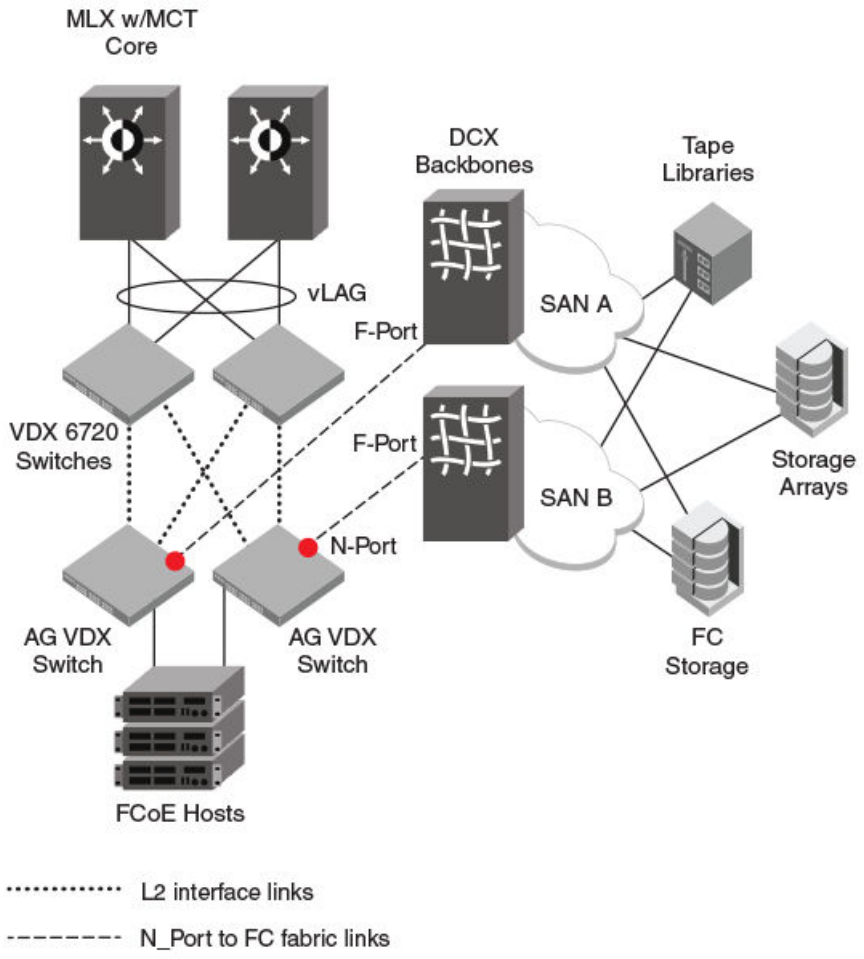
VCS mode must be enabled to enable Access Gateway on the switch. In addition, a FCoE license is required. For more information on this license, refer to the *Network OS Software Licensing Guide*.

While in AG mode, the switch functions both as a VCS and AG switch as follows:

- It supports N_Ports, VF_Ports, and L2 interfaces.
- It can connect devices to a VCS fabric through Ethernet ports. VCS fabric services run on Ethernet ports which function under the "native" VCS switch configuration.
- It can connect hosts to a Fibre Channel switch through VF_Ports mapped to N_Ports.

The following figure illustrates connection of FCoE hosts to two AG switches in a top-of-rack configuration. N_Ports on these switches connect to F_Ports on Brocade DCX Backbones in the FC SAN. In addition, L2 interfaces on these switches connect to other VDX switches in the VCS fabric cluster.

FIGURE 30 Using AG VDX switch for connecting FC and VCS fabrics



Access Gateway and native VCS modes

In this document, VCS "native" mode refers to a VDX switch enabled in VCS mode, whereas Access Gateway mode refers to a switch in VCS mode enabled for the Access Gateway feature.

In native VCS mode the switch can function as part of a VCS Fabric cluster, but cannot connect to a FC fabric through N_Ports. When enabled in AG mode, the VDX switch can still function as part of a VCS Fabric cluster, but can now connect directly with a FC "edge" fabric switch through F_Port to N_Port connections. VCS mode must be enabled before you can enable AG mode. As an option, you can enable VCS and AG mode with one command. All VCS and Network OS features are available to a switch in AG mode.

Enable AG mode using the **ag enable** command. Enabling VCS or AG mode initiates a system reboot. As an option, you can enable both VCS and AG mode using the **ag rbridge-id** *rbridge-id* **vcs-id** *vcs-id* **enable** command, which initiates only one system reboot.

Disable Access Gateway mode and return to VCS mode using **no ag enable** command. You can disable Access Gateway mode and VCS mode at the same time using the **no ag vcs enable** command. This enables the system for standalone mode.

For more information enabling and disabling AG mode, refer to Enabling Access Gateway mode on page 217 and Disabling Access Gateway mode on page 218.

Access Gateway in logical chassis cluster

Although operations of a VDX switch configured in Access Gateway mode are similar to a node configured in native VCS mode while in Logical Chassis Cluster mode, there are some unique considerations that you should be aware of.

Nodes in a logical chassis cluster are configured in Logical Chassis Cluster mode. In this mode, both the data and configuration paths are distributed to other nodes in the cluster. The entire cluster is configured from the principal node. For more information, refer to Logical chassis cluster mode on page 58 for more information.

Behavior and operations of an Access Gateway node configured in a logical chassis cluster, such as removing the node from or adding the node to the cluster, are similar to operations in other nodes in the cluster. Access Gateway does not have any global configuration, so the default configuration for the node in Access Gateway mode is similar to a cluster node in native VCS mode. Failover in the cluster, both controlled and uncontrolled, also occurs the same as for an AG switch.

There are two methods for adding an Access Gateway node to the cluster:

- You can enable Access Gateway on a standalone switch, then add the switch to the cluster. Before adding the switch, enable it for Access Gateway mode and configure Access Gateway features and policies through the Network OS AG commands.
- You can enable Access Gateway on a switch that is already a node in the cluster by just enabling AG on the switch. The switch will reboot and join the cluster enabled in AG mode.

Access Gateway ports

Access Gateway supports VF_Ports that connect host systems to the switch, L2 interface ports that connect the switch to the VCS Fabric cluster, and FC N_Ports that connect the switch to a FC fabric.

In order for hosts attached to VF_Ports on a VDX switch to connect with F_Ports on a FC switch, the VF_Ports must be mapped to VDX switch N_Ports. Enabling AG mode configures all FC ports as N_Ports and maps VF_Ports to the N_Ports in a sequential, round-robin fashion. This allows for even distribution of logins in a typical configuration where VF_Ports are sequentially allocated as ENodes log in. You can change this default mapping by mapping any VF_Port to an N_Port using Network OS commands as described in Configuring port mapping on page 224.

For details on default port mapping for supported VDX platforms, refer to Default port mapping on page 224.

The following ports are supported on a VDX switch in AG mode:

- N_Port — Node port that connects a switch in AG mode to the F_Port on the Fibre Channel switch. Port numbers are specific to the VDX Switch platform:
  - VDX 6730-76 — Valid N_Ports are 0–16
  - VDX 6730-32 — Valid N_Ports are 0–7

  NOTE
  In Network OS commands, N_Ports are designated by the format rbridge-id/port group/N_Port. Therefore, 5/0/1 designates RBridge 5 and that N_Port 1 resides in port group 0.

- VF_Ports — Virtual Fabric ports for connection of FCoE hosts and devices behind LAG-supported FSB devices. You can map these ports to specific N_Ports for connection to a Fibre Channel switch. Consider the following specifications:
  - By default, each switch is assigned 64 VF_Ports.
  - There is no limit the number of VF_Ports that you can map to an N_Port.
  - Up to 64 NPIV logins are allowed per VF_Port.

  Default port numbers are specific to the switch platform:
  - VDX 6730-76 — Valid VF_Ports are 75–139
  - VDX 6730-32 — Valid VF_Ports are 32–95

NOTE
In Network OS commands, VF_Ports are designated by the format domain/rbridge-id/VF_Port. For example, 1/2/26 designates that VF_Port 26 resides in domain 1 and RBridge 2.

- L2 interface ports — Ethernet TRILL ports that connect with other VDX switches in the Brocade VCS Fabric cluster. Port numbers are specific to the switch platform:
  - VDX 6730-76 — Valid TRILL ports are 16–75
  - VDX 6730-32 — Valid TRILL ports are 8–31

Since all VDX switch FC ports are enabled as N_Ports in Access Gateway mode, FC hosts or targets cannot directly attach to the AG switch. Once you enable Access Gateway mode, you can configure additional FC port attributes for the N_Ports as you would on non-AG switches. Port trunking is not supported, however. Refer to Configuring Fibre Channel Ports on page 197

Transitioning from native VCS to AG mode

Be aware of the following interface and port functions after enabling AG mode:

- The system reboots. Native VCS configuration is retained.
- CEE interfaces will be in a no-shutdown state.
- If FC ports are connected to FC switch F_Ports, the connected N_Port(s) should come up automatically. Devices connected to mapped VF_Ports should come up after the **fcoeport default** command is executed on the interface port.
- VDX switch Ethernet ports are under the native VCS switch configuration.
- For default VF_Port to N_Port mapping, VF_Ports are mapped to N_Ports sequentially in a round-robin fashion as ENodes log in. If you change mapping through the **map fport interface fcoe** *port* command, this mapping will be applied instead.
- VCS Fabric services will run on VCS ports and not under the Access Gateway dæmon.

Comparison of Access Gateway, ISL, and FC switch ports

A switch in Access Gateway (AG) mode uses VF_Ports and N_Ports to connect devices to the Fibre Channel (FC) switch. The connected FC switch connects to the AG switch N_Ports through F_Ports and presents a variety of ports for connection to FC fabric devices.

Access Gateway (AG) multiplexes host connections to the fabric. AG presents a VF_Port to a FCoE host and an N_Port to an edge Fibre Channel fabric switch. Multiple VF_Ports mapped to N_Ports provide multiple device ports for connection to the FC fabric.

Using N_Port ID Virtualization (NPIV), AG allows multiple FCoE initiators to access the SAN on the same physical port. This reduces the hardware requirements and management overhead of hosts to the SAN connections.

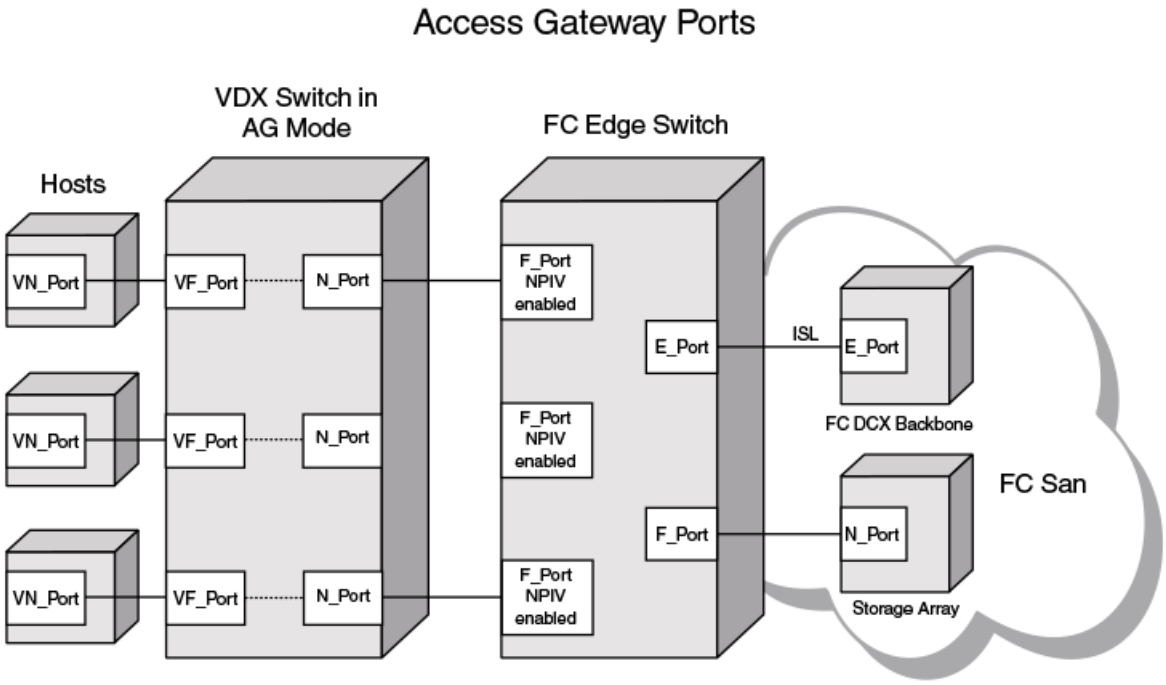
In contrast to the AG switch, the connected FC switch presents F_Ports (or FL_Ports) to storage devices hosts and presents E_Ports, VE_Ports, or EX_Ports to other switches in the fabric.

In contrast to the AG switch, the connected FC switch presents F_Ports (or FL_Ports) to storage devices hosts and presents E_Ports, VE_Ports, or EX_Ports to other switches in the fabric.

A non-AG VDX 6730 switch using an ISL connection between its FC E_Port and an EX_Port on an FCR, consumes domain ID resources that may impact scalability as VCS and FC fabrics grow. In addition, connection through a FCR may limit connection to multivendor FC fabrics. Finally, connection through an ISL provides limited device port connections to the FC fabric. For more information on configuring 6730 switch FC ports for connection to an FCR and FC fabric, refer to Configuring Fibre Channel Ports on page 197.

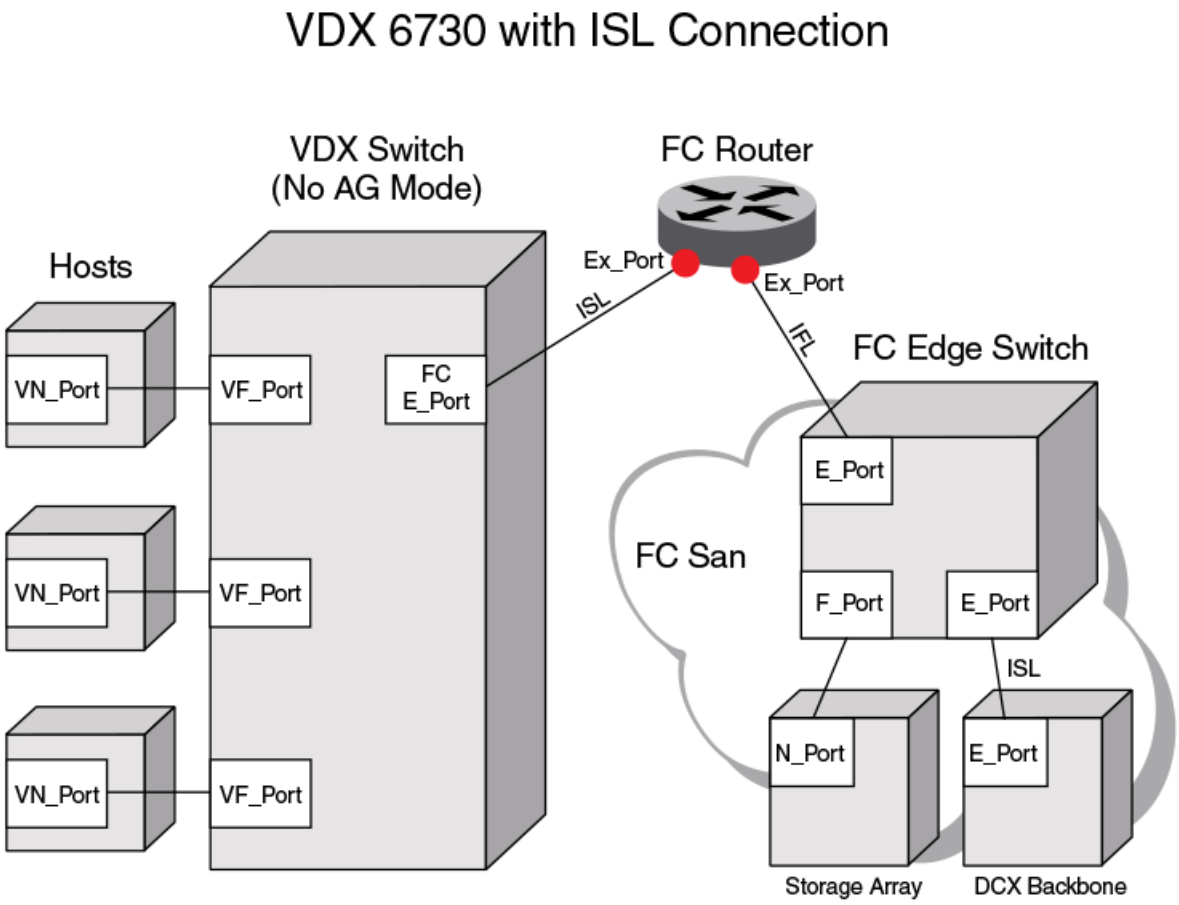
Refer to the following figure illustrating ports used for connecting hosts attached to an Access Gateway VDX Switch to a Fibre Channel switch.

FIGURE 31 Access Gateway and FC switch ports



The following figure illustrates the ports used for connecting hosts attached to a non-AG VDX 6730 switch to a Fibre Channel switch using an ISL connection.

FIGURE 32 VDX 6730 and FC switch ports



Access Gateway features, requirements and limitations

Although Access Gateway provides standard features for connection to Fibre Channel SANs, you can configure a number of optional features as well. There are also requirements and limitations that you should be aware of when using this feature in a VCS cluster and FC fabric environment.

Port grouping

The Port Grouping (PG) policy is enabled by default when AG is enabled. This allows you to group N_Ports into a port group. By default, any VF_Ports mapped to these N_Ports are also members of that port group. Port Grouping allows you to isolate specific hosts to specific FC fabric ports for performance, security, or other reasons.

Automatic Login Balancing (LB) and Modified Managed Fabric Name Monitoring (M-MFNM) modes are enabled by default when the PG policy is enabled.

- When LB mode is enabled and an N_Port goes offline, existing logins from VF_Ports are distributed to available N_Ports in the port group. If a new N_Port comes online, existing logins are not disturbed. LB mode can be disabled using Network OS commands.

- When LB mode is disabled, VF_Ports are not shared among N_Ports in the port group, as VF_Ports can only connect to N_Ports to which they are mapped. As a best practice to ensure device login, bind the ENode to a VF_Port and ensure that its mapped N_Port is online.
- M-MFNM mode ensures all N_Ports connect to the same FC fabric to prevent connections to multiple SANs. M-MFNM cannot be disabled as long as LB mode is enabled.

For more information on Port Grouping policy modes, refer to Port Grouping policy modes on page 230.

N_Port Monitoring for unreliable links

The N_Port monitoring for unreliable links feature monitors links from all N_Ports on the VDX switch to F_Ports on the FC fabric. If online and offline static change notifications (SCNs) exceed a set threshold during a specific time period, the link is considered unreliable, and the N_Port is taken offline. The VF_Ports mapped to the N_Port also go offline. If the N_Port is in a port group and Automatic Login Balancing is enabled, the VF_Ports mapped to the N_Port are distributed among available N_Ports in the same port group.

Additional features and functions

Following are additional features and functions of Access Gateway:

- Access Gateway enables VDX switch FC ports as N_Ports. Hosts attached to VDX switch VF_Ports can connect directly with F_Ports on a Fibre Channel fabric edge switch through these N_Ports.
- Instead of using ISL connections and possibly limited domain resources, the use of N_Ports increases the number of available device ports on the switch and can resolve scalability issues as the number of Fibre Channel and VCS Fabrics grow.
- Through the use of N_Port ID Virtualization (NPIV), multiple FCoE initiators can access the SAN through the same physical port.
- When enabling AG mode, VF_Ports are mapped to available N_Ports in a round-robin fashion as ENodes log in. However, you can re-map any VF_Port to switch N_Ports.
- Access Gateway can operate in both fabric cluster and logical chassis cluster modes.
- You can configure additional FC port attributes for the AG switch N_Ports as you would on non-AG switches. Port trunking is not supported, however. Refer to Configuring Fibre Channel Ports on page 197

Requirements

Following are VCS-related requirements for enabling Access Gateway mode.

- VCS mode and FCoE must be enabled to enable Access Gateway on the switch. A FCoE license is required.

Limitations

Following are limitations you should be aware of when using Access Gateway mode:

- AG is not supported in standalone mode.
- Port trunking is not supported on the AG switch N_Ports.
- Hosts connected to an Access Gateway switch cannot communicate with targets on the VCS Fabric.
- Only one VDX switch configured for Access Gateway can connect with one FC Fabric. Ports connected to a second FC fabric are disabled.
- Access Gateway can operate in both fabric cluster mode and logical chassis cluster modes. The AG configuration is not distributed in fabric cluster mode and is distributed in logical chassis cluster mode.

- You can only configure VF_Port to N_Port mapping for devices directly attached to VF_Ports and F_Ports on the connected FC switch. These mappings control device logins through appropriate N_Ports.
- Since all switch FC ports are configured as N_Ports when AG mode is enabled:
  - FC hosts or targets cannot be directly attached to the VDX switch.
  - The VDX AG switch cannot be connected to a Fabric OS Access Gateway in a Cascaded configuration.
- Access Gateway does not "bridge" the VCS and FC fabrics:
  - Hosts connected to VF_Ports mapped to Access Gateway N_Ports appear on the FC fabric only.
  - Device FC IDs are assigned by the FC fabric F_Ports connected to the Access Gateway N_Ports.
  - VF_Ports and N_Ports are under the Access Gateway dæmeon's configuration.
  - Fibre Channel OS components, such as management server, name server, and zoning are restricted on Network OS Access Gateways just as they are on Fabric OS Access Gateways. Refer to the *Fabric OS Access Gateway Administrator's Guide* for a complete list.
  - Although the **show fcoe login** command will display FCoE devices connected to the Access Gateway switch VF_Ports, these devices are in the FC fabric and cannot be detected by the VCS Fabric name server. Therefore, these devices cannot be zoned in a VCS Fabric.

FCoE and L2 support and limitations

The following functions are supported:

- The following functionality is supported for a configuration consisting of a vLAG from a host CNA to two Access Gateway switches or to an AG switch and a VCS Switch (L2 vLAG for top of rack split):
  - The vLAG links can carry L2 and L3 traffic.
  - VLAG support is identical to support in native VCS mode.
  - A separate FCoE device login is supported through each AG switch.
- The following functionality is supported for a configuration with a LAG from an FSB to an AG switch:
  - LAG specifics, such as number of links and contiguous vs. discontinuous, is identical to native VCS support.
  - Multiple LAGs can connect to the AG switch (one per FSB).
  - LAG carries L2 and L3 traffic.
  - Devices connected via an FSB LAG cannot talk to a Cisco SAN.
  - LAGs and direct attached devices are supported on the same AG switch.
- The following functionality is supported for VF_Ports and CEE interfaces:
  - VF_Ports are dynamically bound to Ethernet interfaces as in native VCS mode.
  - As in native VCS mode, all CEE interfaces with connected devices must be configured for FCoE.
  - The CEE interface will come up as an ISL ET port if it is connected to a peer ET port on another switch in the VCS Fabric.
  - As in native VCS mode, 64 VF_Ports are allocated by default.
  - A VF_Port an accept up to 64 NPIV logins.
  - As in native VCS mode, VF_Ports are dynamically allocated as devices come up.
  - As in native VCS mode, VF_Ports can be statically bound to ENodes.
  - VCS Fabric services run on VCS ports and not under Access Gateway.
  - As in native VCS mode, the number of VF_Ports allocated can be changed dynamically:
    - You can configure the maximum number of FCoE devices that can be logged into a switch by using the **fcoe_enodes** command.
    - Newly allocated VF_Ports are mapped to existing N_Ports sequentially in a round-robin fashion, which assigns all VF_Ports sequentially and evenly to the N_Ports.
    - Newly deallocated VF_Ports are removed from existing VF_Port to N_Port mappings.

Following are support limitations:

- If an interface is only handling L2 traffic, the corresponding VF_Port appears as disabled to AG.
- For vLAGs:
  - As in native VCS mode, a vLAG with FSB cannot support FCoE traffic. It can support L2 traffic only.
  - A vLAG from a host Converged Network Adapter (CNA) supports L2 and FCoE traffic.
- A single LAG/link is supported between one FSB and one AG switch. Subsequent LAG/links will be treated as a TRILL loop and disabled.
- LAG member VF_Ports cannot be mapped to individual N_Ports or N_Port groups.

Enabling Access Gateway mode

Enabling Access Gateway (AG) mode on a VDX switch allows FCoE hosts and devices behind LAG-supported FSBs connected to VF_Ports to connect to a FC fabric.

The FCoE license must be installed to enable AG mode. Refer to the *Network OS Software Licensing Guide* for more information.

Enabling AG mode enables VDX 6730 switch FC ports, configuring them as N_Ports. The N_Ports can connect directly to F_Ports on an edge FC switch. VF_Ports are mapped to N_Ports in a sequential, round-robin fashion as Enodes log in. You can change this default mapping using Network OS commands.

> NOTE
> Enabling AG mode is disruptive since the switch disables and reboots. If the switch is in standalone mode, you can enable VCS and AG mode simultaneously with a single reboot. If the switch is part of a logical cluster, you should back up the configurations before enabling AG mode.

Use the following procedure to enable Access Gateway mode.

1. Determine if the switch is in standalone or VCS mode by entering the **show vcs** command in privileged EXEC mode.
   If the state displays as disabled, the switch is in standalone mode. If the state displays VCS configuration data, the switch is in VCS mode.
2. Enable AG mode using one of the following steps:
   - If VCS is enabled, enable Access Gateway using the **ag enable** command as in the following example.

     ```
     switch# ag enable
     ```

   - If the switch is in standalone mode (VCS not enabled), enable VCS and AG mode using the **ag rbridge-id** *rbridge-id* **vcs-id** *vcs-id* **enable** command as in the following example.

     ```
     switch# ag rbridge-id 1 vcs-id 2000 enable
     ```

   The switch reboots and AG mode is enabled. Switch FC ports are automatically enabled as N_Ports and mapped to VF_Ports. The N_Ports and VF_Ports are allocated to the switch based on the switch model. Refer to Default port mapping on page 224 for more information.
3. You can configure additional FC port attributes for the N_Ports as you would on switches not in Access Gateway mode. Port trunking is not supported, however. Refer to Configuring Fibre Channel Ports on page 197

Disabling Access Gateway mode

Disabling Access Gateway (AG) mode returns the switch to native VCS mode. Disabling AG mode also removes all AG configuration, including port mapping and N_Port configuration.

Access Gateway mode must be enabled before you can disable it.

Use the following procedure to disable AG mode on the switch.

1. Display the current AG state and configuration by entering the **show ag rbridge-id** *rbridge-id* command in privileged EXEC mode.

   ```
   switch# show ag rbridge-id 1
   ```

   If Access Gateway configuration data displays, as shown in Display Access Gateway configuration data on page 218, AG is enabled.

   If "AG mode not set" displays as shown below, AG is not enabled.

   ```
   switch# show ag rbridge-id 2
   AG mode not set.
   ```

   For more information on displaying the current AG configuration on a switch or all AG switches in a VCS cluster using this command, refer to Display Access Gateway configuration data on page 218.
2. Disable AG mode or AG and VCS mode by entering one of the following commands while in privileged EXEC mode:
   - To disable AG mode only, enter **no ag enable**.

     ```
     switch# no ag enable
     ```

   - To disable AG and VCS mode, enter **no ag vcs enable**.

     ```
     switch# no ag vcs enable
     ```

Display Access Gateway configuration data

Use the **show running-config rbridge-id** *rbridge id* **ag** and **show ag rbridge-id** *rbridge-id* command to display Access Gateway configuration data.

To display AG configuration data, use the following methods:

- Use the **show running-config rbridge-id** *rbridge-id* **ag** command to display the configured N_Port to VF_Port mappings, port grouping information, and other parameters. This shows the factory-default configuration, unless parameters have been modified by the user.
- Use the **show ag rbridge-id** *rbridge-id* command to display the current and active status of AG configuration, such as the switch identification, number and type of ports, enabled policies, port grouping, and attached fabric details. This displays only ports that are currently online and current mappings. For example, this will show VF_Ports that have failed over to an N_Port if an N_Port that has gone offline.

NOTE

Display of current, active mapping, or configured mapping for a port group using the **show ag rbridge-id** *rbridge-id* and **show running-config rbridge-id** *rbridge-id* **ag** commands depend on the enabled or disabled state of Login Balancing mode. For more information, refer to Automatic Login Balancing Mode on page 230.

1. Make sure you are in Privileged EXEC mode and have a switch prompt such as the following.

```
switch#
```

2. Perform one of the following steps:
   - Enter the **show running-config rbridge-id** *rbridge-id* **ag** command as in the following example for RBridge 1.

     ```
     switch# show running-config rbridge-id 1 ag
     ```

   - Enter the **show ag rbridge-id** *rbridge-id* command as shown in the following example for RBridge 5.

     ```
     switch# show ag rbridge-id 5
     ```

   If Access Gateway is enabled, data such as the following displays for **show running-config rbridge-id** *rbridge-id* **ag**, as shown in the following example for RBridge 1:

```
switch# show running-config rbridge-id 1 ag
rbridge-id 1
 ag
  nport 1/0/1
   map fport interface Fcoe 1/1/1 1/1/9 1/1/17 1/1/25 1/1/33 1/1/41 1/1/49 1/1/57
  !
  nport 1/0/2
   map fport interface Fcoe 1/1/2 1/1/10 1/1/18 1/1/26 1/1/34 1/1/42 1/1/50 1/1/58
  !
  nport 1/0/3
   map fport interface Fcoe 1/1/3 1/1/11 1/1/19 1/1/27 1/1/35 1/1/43 1/1/51 1/1/59
  !
  nport 1/0/4
   map fport interface Fcoe 1/1/4 1/1/12 1/1/20 1/1/28 1/1/36 1/1/44 1/1/52 1/1/60
  !
  nport 1/0/5
   map fport interface Fcoe 1/1/5 1/1/13 1/1/21 1/1/29 1/1/37 1/1/45 1/1/53 1/1/61
  !
  nport 1/0/6
   map fport interface Fcoe 1/1/6 1/1/14 1/1/22 1/1/30 1/1/38 1/1/46 1/1/54 1/1/62
  !
  nport 1/0/7
   map fport interface Fcoe 1/1/7 1/1/15 1/1/23 1/1/31 1/1/39 1/1/47 1/1/55 1/1/63
  !
  nport 1/0/8
   map fport interface Fcoe 1/1/8 1/1/16 1/1/24 1/1/32 1/1/40 1/1/48 1/1/56 1/1/64
  !
  pg 0
   nport interface FibreChannel 1/0/1 1/0/2 1/0/3 1/0/4 1/0/5 1/0/6 1/0/7 1/0/8
   modes lb
   rename pg0
  !
  timeout fnm 120
  counter reliability 25
```

If Access Gateway is enabled, data such as the following displays for **show ag rbridge-id** *rbridge-id*, as shown in the following example for RBridge 5:

```
switch# show ag rbridge-id 5
RBridge-ID 5:
------------------------------------------------------------------------------
Name                  : sw0
NodeName              : 10:00:00:05:33:f4:78:04
Number of Ports       : 32
IP Address(es)        : 10.37.209.80
Firmware Version      : v4.1.0pgoel_pit02_nos4_1_10_10
Number of N_Ports(Fi) : 2
Number of VF_Ports    : 0
Policies Enabled      : pg
Persistent ALPA       : Disabled
Port Group information :
        PG_ID   PG_Name PG_Mode PG_Members
        ---------------------------------------------------------
        0        pg0     lb      5/0/1, 5/0/2, 5/0/3, 5/0/4,
                                 5/0/5, 5/0/6, 5/0/7, 5/0/8
```

```
        ------------------------------------------------------
Fabric Information :
        Attached Fabric Name            N_Ports(Fi)
        ------------------------------------------------------
        10:00:00:05:33:72:f5:5a         5/0/1, 5/0/2

N_Port(Fi) information :
        Port            PortID        Attached PWWN        IP_Addr         VF_Ports
        ------------------------------------------------------------------------------
        Fi 5/0/1       0x020200  20:02:00:05:33:72:f5:5a   10.37.209.86    None
        Fi 5/0/2       0x020300  20:03:00:05:33:72:f5:5a   10.37.209.86    None
        ------------------------------------------------------------------------------
VF_Port information :
        VF_Port   Eth_Port     PortID     Attached PWWN            N_Port(Fi)
        ------------------------------------------------------------------------------
        None
        ------------------------------------------------------------------------------
```

If AG is not enabled, "AG mode not set" displays as shown below:

```
switch# show ag rbridge-id 2
AG mode not set.
```

NOTE

You can also enter **show ag rbridge-id** *all* to display AG configuration data for all switches in the VCS cluster.

VF_Port to N_Port mapping

To connect hosts attached to VDX Switch VF_Ports to Fibre Channel switch F_Ports, the appropriate VF_Ports must be mapped to VDX Switch N_Ports. Although ports have a factory- default mapping based on the VDX platform, you can change mapping using Network OS commands.

Consider the following when mapping ports:

- You can map multiple VF_Ports to an N_Port. There is no limit to the number of VF_Ports that you can map to an N_Port.
- You can only configure VF_Port to N_Port mapping for devices directly attached to VF_Ports on the VDX switch and F_Ports on the connected FC switch. These mappings control device logins through appropriate N_Ports.
- Consider the N_Port and VF_Port ranges allowed for a VDX platform. Refer to Access Gateway ports on page 211.
- If an N_Port is removed from a port group enabled for Automatic Login Balancing mode and moved to another port group, the VF_Ports mapped to that N_Port remain with the N_Port. If an N_Port is moved from a port group not enabled for Automatic Login Balancing mode, the VF_Ports that are mapped to the N_Port move to the default Port Group 0.

This section presents the following topics:

Displaying port mapping

You can display current and configured VF_Port to N_Port mapping on a specific switch or on all switches enabled for Access Gateway in the VCS cluster.

Access Gateway and must be enabled for this command to succeed.

Display current, active VF_Port to N_Port mapping on a specific switch or on all switches enabled for Access Gateway in the VCS cluster using the **show ag map rbridge-id** *rbridge-id* command while in Privileged EXEC mode.

Display configured VF_Port to N_Port mapping on a switch using the **show running-config rbridge-id** *rbridge id* **ag** command.

1. Determine N_Port numbering for your switch model using the table in Default port mapping on page 224.
2. Perform one of the following steps while in privileged EXEC mode:
   - To display current, active, VF_Port mapping for a specific N_Port, enter **show ag map** *nport* **rbridge-id** *rbridge-id*.

     ```
     switch# show ag map rbridge-id 5/0/1 rbridge-id 5
     ```

   - To display current, active VF_Port mapping to all N_Ports on a switch, enter **show ag map rbridge-id** *rbridge-id*.

     ```
     switch# show ag map rbridge-id rbridge-id 5
     ```

   - To display VF_Port mapping to a N_Ports on all switches in the VCS cluster, enter **show ag map rbridge-id all**.

     ```
     switch# show ag map rbridge-id all
     ```

   - To display configured mapping on a switch, enter **show running-config rbridge-id** *rbridge id* **ag**.

     ```
     switch# show running-config rbridge-id 1 ag
     ```

Current and configured mapping display

Display of current, active mapping, or configured mapping for a port group using the **show ag map** and **show running-config rbridge-id** *rbridge id* **ag** commands depend on the enabled or disabled state of Login Balancing mode. For more information, refer to Automatic Login Balancing Mode on page 230.

The following is example output from the **show ag map rbridge-id** *rbridge-id* command, which shows current, active port mapping. The "Current_VF_Ports" column shows that there are no VF_Ports online.

```
switch# show ag map rbridge 5
RBridge-ID 5:
--------------------------------------------------
N_Port(Fi)    PG_ID  PG_Name  Current_VF_Ports
--------------------------------------------------
5/0/1         0      pg0      None
5/0/2         0      pg0      None
5/0/3         0      pg0      None
5/0/4         0      pg0      None
5/0/5         0      pg0      None
5/0/6         0      pg0      None
5/0/7         0      pg0      None
5/0/8         0      pg0      None
--------------------------------------------------
```

The following is example output from the **show running-config rbridge-id** *rbridge id* **ag** command to show configured port mapping. The output lists N_Port numbers on the switch, and then mapped VF_Ports following "map fport interface fcoe."

```
switch# show running-config rbridge-id 1 ag
rbridge-id 1
 ag
  nport 1/0/1
   map fport interface Fcoe 1/1/1 1/1/9 1/1/17 1/1/25 1/1/33 1/1/41 1/1/49 1/1/57
  !
  nport 1/0/2
   map fport interface Fcoe 1/1/2 1/1/10 1/1/18 1/1/26 1/1/34 1/1/42 1/1/50 1/1/58
  !
  nport 1/0/3
   map fport interface Fcoe 1/1/3 1/1/11 1/1/19 1/1/27 1/1/35 1/1/43 1/1/51 1/1/59
  !
  nport 1/0/4
   map fport interface Fcoe 1/1/4 1/1/12 1/1/20 1/1/28 1/1/36 1/1/44 1/1/52 1/1/60
  !
  nport 1/0/5
   map fport interface Fcoe 1/1/5 1/1/13 1/1/21 1/1/29 1/1/37 1/1/45 1/1/53 1/1/61
  !
  nport 1/0/6
   map fport interface Fcoe 1/1/6 1/1/14 1/1/22 1/1/30 1/1/38 1/1/46 1/1/54 1/1/62
  !
  nport 1/0/7
   map fport interface Fcoe 1/1/7 1/1/15 1/1/23 1/1/31 1/1/39 1/1/47 1/1/55 1/1/63
  !
  nport 1/0/8
   map fport interface Fcoe 1/1/8 1/1/16 1/1/24 1/1/32 1/1/40 1/1/48 1/1/56 1/1/64
  !
  pg 0
   nport interface FibreChannel 1/0/1 1/0/2 1/0/3 1/0/4 1/0/5 1/0/6 1/0/7 1/0/8
   modes lb
   rename pg0
  !
  timeout fnm 120
  counter reliability 25
```

Default port mapping

When Access Gateway is enabled for the switch, VF_Ports are mapped to available N_Ports in a round-robin fashion as Enodes log in. This distributes the VF_Ports evenly amount the N_Ports. You can modify this port mapping using Network OS commands.

The following table shows the factory-default ports assigned to supported VDX switches when AG mode is enabled. By default, 64 VF_Ports are assigned to the VDX 6730 switches. Each switch model has a set number of N_Ports available with specific port numbers.

Switch Model	Total ports	VF_Ports	N_Ports
VDX 6730-32	72	32-95	0-7
VDX 6730-76	80	76-139	0-15

You can modify this port mapping using instructions in Configuring port mapping on page 224

Display current and configured port mapping using instructions in Displaying port mapping on page 221.

Configuring port mapping

When operating in Access Gateway mode, you can specify routes that AG will use to direct traffic from the devices (hosts or targets) on its VF_Ports to the ports connected to the fabric using its N_Ports. The process of specifying routes is called "mapping." When AG is enabled on a switch, VF_Ports are assigned to available N_Ports in a round-robin fashion as ENodes log in. You can change this mapping using the following instructions.

Access Gateway mode must be enabled on the switch to map ports.

When operating in AG mode, you can specify routes that AG will use to direct traffic from the devices (hosts or targets) on its VF_Ports to the ports connected to the fabric using its N_Ports. The process of specifying routes is called "mapping." When enabling AG, VF_Ports are assigned to available N_Ports sequentially in a round-robin fashion as ENodes log in (default). You can change this mapping using the following instructions.
Use the **map fport interface fcoe** *port* command to map specific VF_Ports to a an N_Port to ensure that all traffic from these VF_Ports always goes through the same N_Port. You must enter this command while in N_Port configuration mode for a specific N_Port. All VF_Ports mapped to an N_Port in an N_Port group will be part of that port group.

Remember the following points when mapping ports:

- The range of valid VF_Ports and N_Ports is specific to the VDX platform. Refer to Access Gateway ports on page 211 for valid port numbers.
- Newly allocated VF_Ports are mapped to existing N_Ports in a round-robin fashion.
- Newly deallocated VF_Ports are removed from existing mappings.
- If the AG switch is connected to a FC switch, the connected N_Port and devices on the mapped VF_Ports should come online automatically.

Use the following steps to configure VF_Port to N_Port mapping:

> **NOTE**
> N_Ports are designated by the format rbridge-id/slot/N_Port, such as 3/0/4 for RBridge 3, slot 0, and N_Port 4. You must use this format to correctly identify the N_Port.

1. Perform steps under Displaying port mapping on page 221 to display current and configured port mapping.
2. Enter the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
```

3. Enter the **rbridge-id** *id* command to enter RBridge ID mode for the specific switch.

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

4. Enter the **ag** command to enter Access Gateway configuration mode.

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

5. Enter the **nport** *port* command for the N_Port where you want to change or set mapping to a VF_Port, where *nport* is the N_Port number in rbridge-id/slot/port format. This accesses the configuration mode for the N_Port.

```
switch(config-rbridge-id-2-ag)#
 nport interface FiberChannel 2/0/4
```

6. Perform one of the following steps:
   - To map a VF_Port to the N_Port, enter **map fport interface fcoe** *port* where *port* is the VF_Port in domain/rbridge-id/port format.

```
switch(config-rbridge-id-2-ag-nport-if-fi-
2/0/4)# map fport interface fcoe 1/2/26
```

   - To remove a VF_Port mapped to the N_Port, enter the **no map fport interface fcoe***port* command, where *port* is the VF_Port number in domain/rbridge-id/port format.

```
switch(config-rbridge-id-2-ag-nport-if-fi-
2/0/4)# no map fport interface fcoe 1/2/26
```

7. Return to privileged EXEC mode and enter the **show running-config rbridge-id** *rbridge id* **ag** command to verify configured VF_Port to N_Port mapping. Refer to Displaying port mapping on page 221 for more information.

```
switch# show running-config rbridge-id 2 ag
```

Port Grouping policy

The Port Grouping (PG) policy partitions the VF_Ports, host, target ports within an Access Gateway-enabled switch into independently operated groups. Port Grouping allows you to isolate specific hosts to specific fabric ports for performance, security, or other reasons.

Port Grouping policy is enabled by default when you enable Access Gateway mode and cannot be disabled.

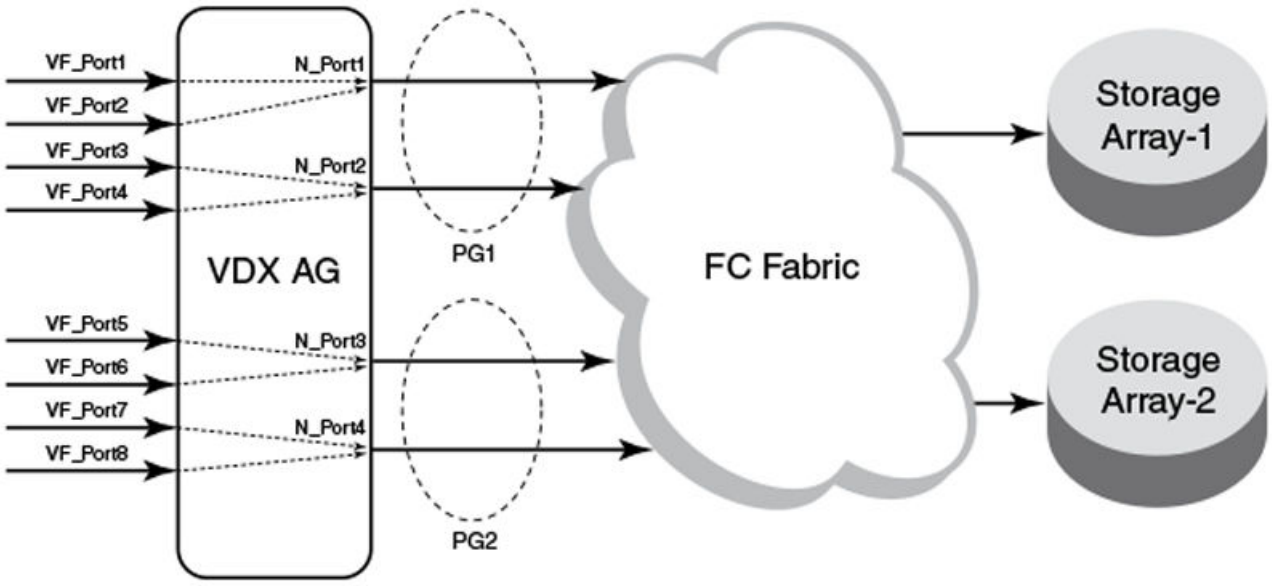
To create port groups, you group N_Ports under a specific port group ID. By default, any VF_Ports mapped to the N_Ports belonging to a port group will become members of that port group. All N_Ports in the group are shared by all VF_Ports mapped to those N_Ports. ENodes can log in as long as an online N_Port exists in the group.

> NOTE
> In Network OS commands, N_Ports are designated by the format rbridge-id/port group/N_Port. Therefore, 5/0/1 designates RBridge 5 and that N_Port 1 resides in port group 0.

When Access Gateway mode is enabled, a default port group 0 (pg 0) is created that contains all N_Ports on the switch. The maximum number of port groups that you can configure equals the number of N_Ports supported by the VDX platform minus 1 for pg 0. Therefore, since the VDX 6730-76 supports 16 N_Ports, it supports 15 port groups.

The following figure illustrates two port groups connecting VF_Ports to an FC fabric. Ports in PG 1 are connecting to one storage array, while ports in PG2 are connecting to a different storage array.

FIGURE 33 Port groups connecting to FC fabric



Following are considerations and limitations for the Port Grouping policy.

- An ENode can log in
- A port cannot be a member of more than one port group.
- The PG policy is enabled by default in when you enable AG mode. A default port group "0" (PG0) is created, which contains all N_Ports and mapped VF_Ports on the switch.
- If an N_Port is added to a port group or deleted from a port group, it maintains its original mapping configuration. If an N_Port is deleted from a port group, it is automatically added to port group 0.

Displaying port grouping information

Display information for N_Port groups configured on the switch or all switches in the VCS cluster enabled for Access Gateway mode.

Access Gateway must be enabled for this command to succeed.

Use the **show ag pg rbridge-id** *rbridge id* command while in while in Privileged EXEC mode to display information on N_Port groups configured on a switch. This information includes N_Ports and VF_Ports in the group and enabled PG modes.

1. Configure port groups using steps under Creating and removing port groups on page 227.

2. Perform one of the following steps while in Privileged EXEC mode:
   - To display the current information for port groups on a specific switch, enter **show ag pg rbridge-id** *rbridge-id*.

     ```
     switch# show ag pg rbridge-id 5
     ```

   - To display port grouping information for port groups on all Access Gateway switches in the VCS cluster, enter **show ag pg rbridge-id all**.

     ```
     switch# show ag pg rbridge-id all
     ```

   - To display current information on a specific port group (such as pg 11), enter **show ag pg** *pgid* **rbridge-id** *rbridge-id*.

     ```
     switch# show ag pg 11 rbridge-id 5
     ```

The following is an example of command output for RBridge 5:

```
switch# show ag pg rbridge-id 5
Rbridge-ID 5:
-------------------------------------------------------------------------------
PG_ID  PG_Name  PG_Mode  N_Ports(Fi)                    VF_Ports
-------------------------------------------------------------------------------
    0  pg0      lb       5/0/1, 5/0/2, 5/0/3, 5/0/4,    1/5/1, 1/5/2, 1/5/3, 1/5/4,
                         5/0/5, 5/0/6, 5/0/7, 5/0/8     1/5/5, 1/5/6, 1/5/7, 1/5/8,
                                                        1/5/9, 1/5/10, 1/5/11, 1/5/12,
                                                        1/5/13, 1/5/14, 1/5/15, 1/5/16,
                                                        1/5/17, 1/5/18, 1/5/19, 1/5/20,
                                                        1/5/21, 1/5/22, 1/5/23, 1/5/24,
                                                        1/5/25, 1/5/26, 1/5/27, 1/5/28,
                                                        1/5/29, 1/5/30, 1/5/31, 1/5/32,
                                                        1/5/33, 1/5/34, 1/5/35, 1/5/36,
                                                        1/5/37, 1/5/38, 1/5/39, 1/5/40,
                                                        1/5/41, 1/5/42, 1/5/43, 1/5/44,
                                                        1/5/45, 1/5/46, 1/5/47, 1/5/48,
                                                        1/5/49, 1/5/50, 1/5/51, 1/5/52,
                                                        1/5/53, 1/5/54, 1/5/55, 1/5/56,
                                                        1/5/57, 1/5/58, 1/5/59, 1/5/60,
                                                        1/5/61, 1/5/62, 1/5/63, 1/5/64
-------------------------------------------------------------------------------
```

Creating and removing port groups

You must create a port group with a unique ID before adding N_Ports to the group or enabling Port Grouping (PG) policy modes. Removing a port group removes all N_Ports, mapped VF_Ports, and associated PG modes.

Access Gateway must be enabled for this command to succeed.

When you enable Access Gateway mode, all ports belong to port group 0 (pg0). You can move ports to a separate port group by first creating a port group with a unique ID, and then adding N_Ports to that group. All VF_Ports mapped to added N_Ports also become members of the new group. Removing a port group removes all N_Ports, mapped VF_Ports, and associated PG modes.

Use the **pg** *pgid* command to configure a port group with a unique ID (pgid). The pgid is a number that cannot exceed the number of N_Ports allocated for the switch model, minus 1 for default pg 0. Therefore, for a VDX 6730-76 with 16 N_Ports, a valid pgid would be 1-15. Once configured, you can access the port group for configuration tasks, such as adding and removing N_Ports, enable port group modes, and renaming the group. Use the **no pg** *pgid* command to remove a port group. You must enter these commands while in Access Gateway (ag) configuration mode.

NOTE
Port Grouping policy is enabled by default when you enable Access Gateway mode.

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

```
switch# configure terminal
```

2. Enter the **rbridge-id** *id* command to enter RBridge ID mode for the specific switch.

```
switch(config)# rbridge-id 3
```

3. Enter the **ag** command to enter Access Gateway configuration mode.

```
switch(config-rbridge-id-3)# ag
```

4. Perform one of the following steps:
   - To create a port group, enter the **pg** *pgid* command. The port group ID (pgid) must not exceed 64 characters.

```
switch(config-rbridge-id-3-ag)# pg 1
```

   - To remove a port group, enter the **no pg** *pgid* command.

```
switch(config-rbridge-id-3-ag)# no pg 1
```

   Creating a port group with the **pg** *pgid* command enters the PG configuration mode for the port group ID (pgid) so that you can add N_Ports and perform other PG policy configuration.

```
switch(config-rbridge-id-3-ag-pg-1)#
```

5. Verify that the port group was created using the **show ag pg** *pgid* **rbridge-id** *rbridge-id* command from privileged EXEC configuration mode. Refer to Displaying port grouping information on page 226 for details.

Naming a port group

You can name or rename a port group and use this name in place of the port group ID.

Access Gateway and the PG policy must be enabled for this command to succeed.

Use the **rename** *pgid* command while in the configuration mode for a port group to change the port group name. The name cannot exceed 64 characters.

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

```
switch# configure terminal
```

2. Enter the **rbridge-id** *rbridge-id* command to enter RBridge ID configuration mode for the specific switch.

```
switch(config)# rbridge-id 3
```

3. Enter the **ag** command to enter Access Gateway configuration mode.

```
switch(config-rbridge-id-3)# ag
```

4. Enter the port group ID, such as pg 1, to enter configuration mode for the port group.

```
switch(config-rbridge-id-3-ag)# pg 1
```

5. Change the name of the port group using the **rename** *pgid* command. In the following example, port group is named pg-array24.

```
switch(config-rbridge-id-3-ag-pg-1)# rename pg-array24
```

   The port group name must not exceed 64 characters.

Adding and removing N_Ports in a port group

After creating a port group, you must add N_Ports to the group. You must delete N_Ports from a group if you want to move them to another port group or not include them in a port group.

Access Gateway and the PG policy must be enabled for this command to succeed.

Use the **nport interface Fibrechannel** *port* command while in command mode for a specific port group to add an N_Port to the group. Use the **no nport interface Fibrechannel** *port* command to remove an N_Port. Before you can add a port to a port group, you must remove it from the port group where it currently exists, unless the port is in port group 0 (pg 0). If you remove a port from a port group, it will default to port group 0. You cannot delete a port from port group 0.

NOTE
N_Ports are designated by the format rbridge-id/slot/N_Port, such as 3/0/4 for RBridge 3, slot 0, and N_Port 4. You must use this format to correctly identify the N_Port.

1. Determine the port group on the switch where the port is currently a member by entering the **show ag pg rbridge-id** *rbridge-id* while in the privileged EXEC command mode.

```
switch# show ag pg rbridge-id 3
```

2. Enter the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
```

3. Enter the **ag** command to enter Access Gateway command mode.

```
switch(config-rbridge-id-3)# ag
```

4. Enter the port group ID, such as pg 1, to enter configuration mode for the port group where the N_Port currently resides.

```
switch(config-rbridge-id-3-ag)# pg 1
```

5. Delete the N_Port from the group using the **no nport interface Fibrechannel** *port* command. In the following example, N_Port 3 is removed from port group 1.

   Before deleting the N_Port, all VF_Ports mapped to the N_Port should be remapped. If the port resides in port group 0 (pg 0), you do not need to remove it from the port group before adding it to a different port group and can skip to the next step.

```
switch(config-rbridge-id-3-ag-pg-1)# no nport interface Fibrechannel 3/0/3
```

   You can delete multiple N_Ports by listing the ports separated by spaces as in the following example.

```
no nport interface Fibrechannel 3/0/3 3/0/5
```

6. Enter the configuration mode for port group ID where you want to add the port, for example pg 2.

```
switch(config-rbridge-id-3-ag)# pg 2
```

7. Add the N_Port to the group using the **nport interface Fibrechannel** *port* command where *port* is a supported N_Port number for the switch in rbridge-id/slot/port format.

```
switch(config-rbridge-id-3-ag-pg-2)# nport interface Fibrechannel 3/0/3
```

   You can add multiple N_Ports by listing the ports separated by spaces. For example:

```
nport interface Fibrechannel 3/0/3 3/0/5
```

8. Verify that the ports were added or removed from the port groups using the **show ag pg rbridge-id** *rbridge-id* while in the privileged EXEC command mode.

```
show ag pg rbridge-id 3
```

   Refer to Displaying port grouping information on page 226 for details on this command.

Port Grouping policy modes

Port Grouping policy modes help manage VF_Port and N_Port operation when ports go offline or when all N_Ports in a group are not connected to the same FC fabric.

There are two Port Grouping policy modes that you can enable using Network OS commands:

- Login Balancing (LB) is enabled by default when you create a port group.
- Modified Managed Fabric Name Monitoring (M-MFNM) mode is enabled with LB mode. You cannot disable MFNM mode for a port group unless you disable LB mode.

Automatic Login Balancing Mode

Automatic Login Balancing (LB) mode works to distribute logins across all available N_Ports in a port group. It is enabled by default when a port group is created.

Consider the following for LB mode:

- When LB mode is disabled for a port group, the same configured VF_Port to N_Port mapping displays for the **show running-config ag** or **show ag** commands. This is because configured and active mapping are the same.
- When LB mode is enabled for a port group, the **show ag** command displays the current, active mapping because VF_Port to N_Port mapping is based on the current distributed load across all N_Ports. The **show running-config ag** command displays the configured mapping only.
- If LB mode is enabled for a port group and a new N_Port comes online, existing logins are undisturbed. If an N_Port is disabled, its existing logins are distributed to available ports to maintain a balanced N_Port-to-VF_Port ratio.
- LB can be disabled using Network OS commands. When LB mode is disabled, VF_Ports are not shared among N_Ports in the port group, but can only connect to N_Ports to which they are mapped. If an N_Port is disabled, ENodes logged into mapped VF_Ports log out. As a best practice to ensure device login, bind the ENode to a VF_Port and ensure that its mapped N_Port is online.
- LB mode is disruptive.
- If an N_Port is removed from a port group enabled for LB mode and moved to another port group, the VF_Ports mapped to that N_Port remain with the N_Port.

  This is not the case for port groups not enabled for LB mode. When you remove an N_Port from one of these port groups, the VF_Ports mapped to the N_Port move to the default Port Group 0 along with the N_Port. You can then move the N_Port to another group, but would need to re-map any VF_Ports to the N_Port.

- If an N_Port is in a port group and then Automatic Login Balancing is enabled, the VF_Ports mapped to the N_Port are distributed among online N_Ports in the same port group.
- You can disable or enable LB mode using the **no modes lb** or **modes lb** commands while in the port group configuration mode. Refer to Enabling and disabling Login Balancing mode on page 231.

Enabling and disabling Login Balancing mode

Although Login Balancing (LB) mode is enabled by default when you create a port group, you can disable and enable it using Network OS CLI commands.

Access Gateway and the PG policy must be enabled for this command to succeed.

Enable or disable LB mode using the **no modes LB** or **modes lb** commands while in the port group's configuration mode.

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

```
switch# configure terminal
```

2. Enter the **rbridge-id** *id* command to enter RBridge ID configuration mode for the specific switch.

```
switch(config)# rbridge-id 3
```

3. Enter the **ag** command to enter Access Gateway configuration mode.

```
switch(config-rbridge-id-3)# ag
```

4. Enter the port group ID, such as pg 8, to enter configuration mode for the port group.

```
switch(config-rbridge-id-3-ag)# pg 8
```

5. Perform one of the following steps:
   - To enable LB mode, enter **modes** *mode_name*.

```
switch(config-rbridge-id-3-ag-pg-8)# modes lb
```

   - To disable LB mode, enter **no modes** *mode_name*.

```
switch(config-rbridge-id-3-ag-pg-8)# no modes lb
```

Modified Managed Fabric Name Monitoring mode

Modified Managed Fabric Name Monitoring (M-MFNM) mode prevents connections from the AG VDX switch to multiple SANs to ensure that all N_Ports in a port group connect to the same FC fabric.

Modified Managed Fabric Name Monitoring (M-MFNM) mode is enabled with LB mode. It queries the FC fabric name for a default time out value of 120 seconds. If it detects an inconsistency, for example all the N_Ports within a port group are not physically connected to the same physical or virtual FC fabric, the following occurs:

- N_Ports are disabled to the fabric with the lower number of connected N_Ports.
- If more than one fabric has the same or the maximum number of ports connected, N_Ports are disabled to the fabric with the higher "fabric names" (WWN of the Principal Switch). Ports connected to the lowest "fabric name" stay online.

Consider the following about M-MFNM mode:

- M-MFNM mode is enabled by default when you enable LB mode. You cannot disable it unless you disable LB mode.

- You can change the default time out value (tov) for fabric name queries using the **timeout fnm** *value* when in ag configuration mode. Refer to Setting and displaying the fabric name monitoring TOV on page 232.

Setting and displaying the fabric name monitoring TOV

You can set the time out value (TOV) for M-MFNM queries of the fabric name to detect whether all N_Ports in a port group are physically connected to the same physical or virtual fabric.

Access Gateway and the PG policy must be enabled for this command to succeed.

Use the **timeout fnm** *value* command while in ag configuration mode to set time-out value (TOV) for M-MFNM queries of the fabric name. The valid range is 30 to 3600 seconds. The default value is 120 seconds.

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

```
switch# configure terminal
```

2. Enter the **rbridge-id** *id* command to enter RBridge ID configuration mode for the specific switch.

```
switch(config)# rbridge-id 3
```

3. Enter the **ag** command to enter Access Gateway configuration mode.

```
switch(config-rbridge-id-3)# ag
```

4. Enter the **timeout fnm** *value* command to change the time out value for fabric name queries.

```
switch(config-rbridge-id-3-ag)# timeout fnm 60
```

5. Enter timeout **timeout fnm** without a value to display the current M-MFNM timeout value.

```
switch(config-rbridge-id-3-ag)# timeout fnm
() (60)
```

N_Port monitoring for unreliable links

N_Port monitoring monitors links between N_Ports on the VDX switch configured in Access Gateway mode and F_Ports on the connected FC fabric. When links are considered unreliable, the N_Port is disabled.

Links from all N_Ports are monitored for the number of online and offline static change notifications (SCNs) that occur during a five-minute period. If the number of SCNs on a link exceeds a set threshold, the link is considered unreliable, and the port is taken offline. VF_Ports mapped to the N_Port also go offline. Once the number of SCNs drops below the set threshold, the port is deemed reliable again and the N_Port and mapped VF_Ports go back online.

The default threshold is 25 SCNs per 5 minutes. You can set from 10 to 100 SCNs per 5 minutes. Modify default threshold of SCNs counted in 5 minutes using the **counter reliability** *value* command while in ag command mode.

Setting and displaying the reliability counter for N_Port monitoring

You can set the reliability count of static change notifications (SCNs) counted during a five-minute period before the link between a N_Port on a VDX Switch in Access mode and an F_Port on a FC fabric is considered unreliable.

Access Gateway mode must be enabled for this procedure to succeed.

To set the reliability count, use the **counter reliability** *value* command while in ag configuration mode for the switch. The default value is 25 SCNs per 5 minutes. You can set from 10 to 100 SCNs per 5 minutes.

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

```
switch# configure terminal
```

2. Enter the **rbridge-id** *id* command to enter RBridge ID mode for the specific switch.

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

3. Enter the **ag** command to enter Access Gateway configuration mode.

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

4. Enter the **counter reliability** *value* command to change the counter value.

```
switch(config-rbridge-id-2-ag)# counter reliability 50
```

5. Enter the **counter reliability** command without a value to display the current reliability counter. In the following example, a counter value of 50 is returned.

```
switch(config-rbridge-id-2-ag)# counter reliability
() (50)
```

Using System Monitor and Threshold Monitor

System Monitor overview

System Monitor provides customizable monitoring thresholds, which allow you to monitor the health of each component of a switch. Whenever a switch component exceeds a configured threshold, System Monitor automatically provides notification by means of e-mail or RASLog messages, depending on the configuration.

Because of platform-specific values that vary from platform to platform, it was previously not possible to configure platform-specific thresholds through a global CLI command. In Network OS 4.0.0 and later, it is possible to monitor not only a stand-alone switch, but also individual switches in a management (or fabric) cluster. This is done in RBridge ID configuration mode, by addressing the RBridge ID of the selected switch. Both monitoring modes — logical chassis cluster and standalone — are illustrated in this chapter.

Threshold and notification configuration procedures are described in the following sections.

Monitored components

The following FRUs and temperature sensors are monitored on supported switches:

- **LineCard** —Displays the threshold for the line card.
- **MM** —Displays the threshold for the management module.
- **SFM** —Displays the threshold for the switch fabric module device.
- **cid-card** —Displays the threshold for the chassis ID card component.
- **compact-flash** —Displays the threshold for the compact flash device.
- **fan** —Configures fan settings.
- **power** —Configures power supply settings.
- **sfp** —Displays the threshold for the small form-factor pluggable (SFP) device.
- **temp**—Displays the threshold for the temperature sensor component.

NOTE
CID cards can be faulted and removed. The system continues to operate normally as long as one CID card is installed. If both CID cards are missing or faulted, the switch will not operate.

Monitored FRUs

System Monitor monitors the absolute state of the following FRUs:

- Fan
- Power supply

- CID card
- SFP
- Line card

Possible states for all monitored FRUs are removed, inserted, on, off, and faulty. A state of none indicates the switch is not configured. If the FRU is removed, inserted, or goes into a faulty state, System Monitor sends a RASLog message or an e-mail alert, depending on the configuration.

Based on the configured threshold, each component can be in a marginal state or a down state. If a component is in a marginal state or a down state, System Monitor generates a RASLog message to alert the user. It also generates a separate RASLog message for the overall health of the switch.

> **NOTE**
> For details about each RASLog message, refer to the "RAS System Messages" chapter of the *Network OS Message Reference*.

The following table lists the default threshold settings for components monitored by System Monitor on supported switches.

TABLE 37 Hardware platform default settings for supported switches

Platform	Hardware component	Default setting	Marginal thresholds	Down thresholds
Brocade VDX 6710	Power supply	2	1	2
	Temperature sensor	3	1	2
	Compact flash	1	1	0
	Fan	2	1	2
Brocade VDX 6720-24 single board 24-portswitch	Power supply	2	1	2
	Temperature sensor	3	1	2
	Compact flash	1	1	0
	Fan	2	1	2
Brocade VDX 6720-60 single board 60-portswitch	Power supply	2	1	2
	Temperature sensor	6	1	2
	Compact flash	1	1	0
	Fan	5	1	2
Brocade VDX 6730-32	Power supply	2	1	2
	Temperature sensor	3	1	2
	Compact flash	1	1	0
	Fan	2	1	2
Brocade VDX 6730-76	Power supply	2	1	2
	Temperature sensor	6	1	2
	Compact flash	1	1	0
	Fan	5	1	2
Brocade VDX 8770-4	Power supply	2	1	2
	Temperature sensor	3	1	2
	Compact flash	1	1	0
	Fan	2	1	2
Brocade VDX 8770-8	Power supply	3	6	7
	Temperature sensor	3	1	2
	Compact flash	1	1	0

TABLE 37 Hardware platform default settings for supported switches (continued)

Platform	Hardware component	Default setting	Marginal thresholds	Down thresholds
	Fan	4	1	2

Configuring System Monitor

TABLE 38 Hardware platform default settings for supported switches

Platform	Hardware component	Default setting	Marginal thresholds	Down thresholds
Brocade VDX 6710	Power supply	2	1	2
	Temperature sensor	3	1	2
	Compact flash	1	1	0
	Fan	2	1	2
Brocade VDX 6720-24 single board 24-portswitch	Power supply	2	1	2
	Temperature sensor	3	1	2
	Compact flash	1	1	0
	Fan	2	1	2
Brocade VDX 6720-60 single board 60-portswitch	Power supply	2	1	2
	Temperature sensor	6	1	2
	Compact flash	1	1	0
	Fan	5	1	2
Brocade VDX 6730-32	Power supply	2	1	2
	Temperature sensor	3	1	2
	Compact flash	1	1	0
	Fan	2	1	2
Brocade VDX 6730-76	Power supply	2	1	2
	Temperature sensor	6	1	2
	Compact flash	1	1	0
	Fan	5	1	2
Brocade VDX 8770-4	Power supply	2	1	2
	Temperature sensor	3	1	2
	Compact flash	1	1	0
	Fan	2	1	2
Brocade VDX 8770-8	Power supply	3	6	7
	Temperature sensor	3	1	2
	Compact flash	1	1	0
	Fan	4	1	2

The following are example basic configurations that illustrate various functions of the **system-monitor** command and related commands.

NOTE

For command details, refer to the *Network OS Command Reference*.

Setting system thresholds

Each component can be in one of two states, down or marginal, based on factory-defined or user-configured thresholds. (The default thresholds are listed in Configuring System Monitor on page 237.)

1. Issue the **configure terminal** command to enter global configuration mode.
2. Enter RBridge ID configuration mode, as in the following example.

```
switch(config)# rbridge-id 154
```

3. Change **down-threshold** and **marginal-threshold** values for the SFM.

```
switch(config-rbridge-id-154)# system-monitor sfm threshold down-threshold 3 marginal-threshold 2
```

NOTE
You can disable the monitoring of each component by setting **down-threshold** and **marginal-threshold** values to 0 (zero).

Setting state alerts and actions

System Monitor generates an alert when there is a change in the state from the default or defined threshold.

1. Issue the **configure terminal** command to enter global configuration mode.
2. Enter RBridge ID configuration mode (for RBridge ID 154 in this case).

```
switch(config)# rbridge-id 154
```

To enable a RASLog alert when the power supply is removed, enter the following command:

```
switch(config-rbridge-id-154)# system-monitor power alert state removed action raslog
```

NOTE
There are no alerts for MM, compact-flash, or temp. There are no alert actions for SFPs.

Configuring e-mail alerts

Use the **system-monitor-mail fru** command to configure e-mail threshold alerts for FRU, SFP, interface, and security monitoring. For an e-mail alert to function correctly, you must add the IP addresses and host names to the domain name server (DNS) in addition to configuring the domain name and name servers. A single email configuration is applicable for all switches in a logical chassis cluster. For complete information on the **system-monitor-mail relay host** command, refer to the *Network OS Command Reference*.

1. Issue the **configure terminal** command to enter global configuration mode.
2. Enter the following command to enable e-mail alerts and to configure the e-mail address.

```
switch(config)# system-monitor-mail fru enable email-id
```

Sendmail agent configuration

The following **system-monitor-mail relay host** commands allow the sendmail agent on the switch to resolve the domain name and forward all e-mail messages to a relay server.

- To create a mapping:

```
switch(config)# system-monitor-mail relay ip-address 1.2.3.4 domain-name domain_name1.brocade.com
```

- To delete the mapping:

```
switch(config)# no system-monitor-mail relay ip-address 1.2.3.4 domain-name domain_name1.brocade.com
```

- To change the domain name:

```
switch(config)# system-monitor-mail relay ip-address 1.2.3.4 domain-name domain_name2.brocade.com
```

  NOTE
  You must delete the first domain name before you can change it to a new domain name.

- To delete the domain name and return to the default:

```
switch(config)# no system-monitor-mail relay ip-address 1.2.3.4 domain-name domain_name2.brocade.com
```

Viewing system SFP optical monitoring defaults

You can view the optical monitoring default values by entering **show defaults threshold** followed by the SFP type.

The following example command will display the defaults for type 1GLR SFPs:

```
switch# show defaults threshold sfp type 1GLR
```

Displaying the switch health status

To display the health status of a switch, enter **show system monitor**.

```
switch# show system monitor
** System Monitor Switch Health Report **
RBridge 154     switch status            : MARGINAL
                Time of Report           : 2013-03-24 20:51:53
                Power supplies monitor   : MARGINAL
                Temperatures monitor     : HEALTHY
                Fans monitor             : HEALTHY
                Flash monitor            : HEALTHY
```

Threshold Monitor overview

The **threshold-monitor** commands allow you to monitor CPU and memory usage of the system, interface and SFP environmental status, and security status and be alerted when configured thresholds are exceeded. These commands are configured in RBridge ID configuration mode to support fabric cluster and logical chassis cluster topologies.

With the **policy** keyword (available for interface, SFP, and security monitoring), you can create your own custom policies that have nondefault thresholds, and apply them by means of the **apply** operand. This allows you to toggle between default settings and saved custom configuration settings and to apply actions and thresholds separately. For example, you can choose to use default threshold settings together with a customized subset of available actions, or you can modify some of the threshold settings and use the default action settings. You can also pause monitoring and actions by means of the **pause** keyword.

For detailed information on the variables and keywords (operands) of the **threshold-monitor** series of commands, refer to the *Network OS Command Reference*.

CPU and memory monitoring

When configuring CPU monitoring, specify a value in the 1-100 range. When the CPU usage exceeds the limit, a threshold monitor alert is triggered. The default CPU limit is 75 percent. With respect to memory, the limit specifies a usage limit as a percentage of available resources.

When used to configure memory or CPU threshold monitoring, the limit value must be greater than the low limit and smaller than the high limit. The alert provided is a RASLog message, with the following options configurable under the **raslog** option of the **threshold-monitor cpu** or the **threshold-monitor memory** commands:

high-limit Specifies an upper limit for memory usage as a percentage of available memory. This value must be greater than the value set by **limit**. When memory usage exceeds this limit, a RASLog CRITICAL message is sent. Valid values range from range from 0 through 80 percent.

limit Specifies the baseline memory usage limit as a percentage of available resources. When this value is exceeded, a RASLog WARNING message is sent. When the usage returns below the value set by **limit**, a RASLog INFO message is sent. Valid values range from 0 through 80 percent.

low-limit Specifies a lower limit for memory usage as percentage of available memory. This value must be smaller than the value set by **limit**. When memory usage exceeds or falls below this limit, a RASLog INFO message is sent.

poll Specifies the polling interval in seconds. Valid values range from 0 through 3600.

retry Specifies the number of polling retries before desired action is taken. Valid values range from 1 through 100.

NOTE

For CPU and memory thresholds, the low limit must be the lowest value and the high limit must be the highest value.

The table below lists the factory defaults for CPU and memory thresholds.

TABLE 39 Default values for CPU and memory threshold monitoring

Operand	Memory	CPU
low-limit	40%	N/A
limit	60%	75%
high-limit	70%	N/A
poll	120 seconds	120 seconds
retry	3	3

SFP monitoring

The SFP parameters that can be monitored are listed and described below.

TABLE 40 SFP parameter descriptions

SFP parameter	Description	Suggested SFP impact
Temperature	Measures the temperature of the SFP, in degrees Celsius.	High temperature suggests the SFP might be damaged.
Receive power (RXP)	Measures the amount of incoming laser, in µWatts.	Describes the condition of the SFP. If this parameter exceeds the threshold, the SFP is deteriorating.
Transmit power (TXP)	Measures the amount of outgoing laser power, in µWatts.	Describes the condition of the SFP. If this parameter exceeds the threshold, the SFP is deteriorating.
Current	Measures the amount of current supplied to the SFP transceiver.	Indicates hardware failures.
Voltage	Measures the amount of voltage supplied to the SFP.	A value higher than the threshold indicates the SFP is deteriorating.

SFP thresholds

You can customize SFP thresholds or actions by using the **threshold-monitor sfp** command, which enables you to perform the following tasks.

- Customize SFP configurations or accept SFP defaults.
- Manage the actions and thresholds for the Current, Voltage, RXP, TXP, and Temperature areas of the SFP.
- Suspend SFP monitoring.

If you do not provide the SFP type parameters, the default thresholds and actions are used. SFP types, monitoring areas, and default threshold values for the 16-Gbps and QSFP SFPs are detailed below.

TABLE 41 Factory thresholds for SFP types and monitoring areas

SfpType	Area	Default Value	
1 GSR	Temperature (C)	100	-40
	Voltage (mV)	3600	3000
	RXP (µW)	1122	8
	TXP (µW)	1000	60
	Current (mA)	12	2
1 GLR	Temperature (C)	90	-45
	Voltage (mV)	3700	2900
	RXP (µW)	501	6
	TXP (µW)	794	71
	Current (m)	45	1
10 GSR	Temperature (C)	90	-5
	Voltage (mVolt)	3600	3000
	RXP (µW)	1000	32
	TXP (µW)	794	251
	Current (mA)	11	4
10 GLR	Temperature (C)	88	-5

TABLE 41 Factory thresholds for SFP types and monitoring areas (continued)

SfpType	Area	Default Value	
	Voltage (mV)	3600	2970
	RXP (µW)	1995	16
	TXP (µW)	1585	158
	Current (mA)	85	15
10 GUSR	Temperature (C)	100	-5
	Voltage (mV)	3600	2970
	RXP (µW)	2000	32
	TXP (µW)	2000	126
	Current (mA)	11	3
QSFP	Temperature (C)	75	-5
	Voltage (mV)	3600	2970
	RXP (µW)	1995	40
	TXP (µW)	0	0
	Current (mA)	10	1

Threshold values

High and low threshold values are the values at which potential problems might occur. For example, in configuring a temperature threshold for SFPs, you can select the temperatures at which a potential problem can occur because of overheating or overcooling.

A combination of high and low threshold settings can cause the following actions to occur:

- Above high threshold — A default or user-configurable action is taken when the current value is above the high threshold.
- Below high threshold — A default or user-configurable action is taken when the current value is between the high and low threshold.
- Below low threshold — A default or user-configurable action is taken when the current value is below the low threshold.
- Above low threshold — monitoring is not supported for this value.

Security monitoring

You can monitor all attempts to breach your SAN security, helping you fine-tune your security measures. If there is a security breach, you can configure an email or RASLog alert to be sent. The following security areas are monitored:

- Telnet Violation, which occurs when a Telnet connection request reaches a secure switch from an unauthorized IP address.
- Login Violation, which occurs when a secure fabric detects a login failure.

The following table lists the factory defaults for security area settings.

TABLE 42 Security area default settings

Area	High threshold	Low threshold	Buffer	Timebase
Telnet Violation	2	1	0	Minute
Login Violation	2	1	0	Minute

Interface monitoring

You can set thresholds for error statistics on all external Gigabit Ethernet interfaces. When any monitored error crosses the configured high or low threshold, an alert can be generated or a problem interface can be isolated (refer to Port Fencing on page 243).

Interface error types

The following table describes the interface counters that can be monitored on external interfaces.

TABLE 43 Interface errors that can be monitored on external interfaces

Interface area	Description	Port Fencing support	Threshold defaults
MissingTerminationCharacter	Number of frames terminated by anything other than the Terminate character; this includes termination due to the Error character.	No	Low 12 Buffer 0 High 300
CRCAlignErrors	Total number of frames received that had a length (excluding framing bits but including Frame Check Sequence (FCS) octets) of between 64 and 1518 octets. The error indicates either a bad FCS with an integral number of octets (an FCS error) or a bad FCS with a non-integral number of octets (an alignment error).	No	Low 12 Buffer 0 High 300
IFG	Minimum-length interframe gap (IFG) between successive frames is violated. A typical IFG is 12 bytes.	Yes	Low 5 Buffer 0 High 100
SymbolErrors	An undefined (invalid) symbol received on the interface. Large symbol errors indicate a bad device, cable, or hardware.	No	Low 0 Buffer 0 High 5

NOTE

The default setting for above high threshold, above low threshold, below high threshold, and below low threshold actions is "[none]."

Port Fencing

A port that is consistently unstable can harm the responsiveness and stability of the entire fabric and diminish the ability of the management platform to control and monitor the switches within the fabric. *Port Fencing* is not enabled by default; it disables the interface if a user-defined high threshold is exceeded. When a port that has exceeded its user-defined high threshold is fenced by software, the port is placed in the "Disabled" state and held offline. After a port is disabled, user intervention is required for frame traffic to resume on the port.

NOTE

Port Fencing is supported for the "RX IFG Violated" error only.

Configuring Threshold Monitor

The following basic configurations illustrate various functions of the **threshold-monitor** commands.

NOTE
For CLI details, refer to the *Network OS Command Reference*

Viewing threshold status

To view the status of currently configured thresholds, enter the **show running-config threshold-monitor** command with the RBridge ID, as follows:

```
switch# show running-config rbridge-id rbridge_id threshold-monitor
```

NOTE
Default values are not displayed under the **show running-config threshold-monitor** command. Only custom values are displayed when a user applies a policy.

To display the default values of thresholds and alert options, enter the **show defaults threshold** command, as in the following example for interfaces.

```
switch# show defaults threshold interface type Ethernet

Type: GigE-Port
+--------+-----------------------+----------------------+------+-------+
|        |    High Threshold     |    Low Threshold     |Buffer|Time   |
|Area    |Value | Above  | Below |Value | Above | Below |Value |Base   |
|        |      | Action | Action|      | Action| Action|      |       |
+--------+------+--------+-------+------+-------+-------+------+-------+
|MTC     |  300 | none   | none  |    12| none  | none  |     0|minute |
+--------+------+--------+-------+------+-------+-------+------+-------+
|CRCAlign|  300 | none   | none  |    12| none  | none  |     0|minute |
+--------+------+--------+-------+------+-------+-------+------+-------+
|Symbol  |    5 | none   | none  |     0| none  | none  |     0|minute |
+--------+------+--------+-------+------+-------+-------+------+-------+
|IFG     |  100 | none   | none  |     5| none  | none  |     0|minute |
+--------+------+--------+-------+------+-------+-------+------+-------+
MTC - Missing Termination Character
```

CPU and memory threshold monitoring

NOTE
Support for the custom **policy** operand is not provided for CPU and memory threshold monitoring.

Configuring CPU monitoring thresholds and alerts

CPU monitoring allows you to set alerts for CPU usage.

1. Enter **configure terminal** to enter global configuration mode.

```
switch# configure terminal
switch(config)#
```

2. Enter **rbridge-id** *rbridge-id#* to change to RBridge ID configuration mode.

```
switch(config)# rbridge-id 154
switch(config-rbridge-id-154)#
```

3. Enter **threshold-monitor cpu ?** to view the available options:

```
switch(config-rbridge-id-154)# threshold-monitor cpu ?
```

The following example changes the thresholds from the default, adjusts polling and retry attempts, and causes a RASLog message to be sent when thresholds are exceeded.

```
switch(config-rbridge-id-154)# threshold-monitor cpu actions raslog limit 65 poll 60 retry 10
```

NOTE
This command does not support **low-limit** or **high-limit** under the **raslog** alert option.

Configuring memory monitoring thresholds and alerts

CPU monitoring allows you to set alerts for memory usage.

1. Enter **configure terminal** to enter global configuration mode.

```
switch# configure terminal
switch(config)#
```

2. Enter **rbridge-id** *rbridge-id#* to change to RBridge ID configuration mode.

```
switch(config)# rbridge-id 154
switch(config-rbridge-id-154)#
```

3. Enter **threshold-monitor memory ?** to view the available options.

```
switch(config-rbridge-id-154)# threshold-monitor memory ?
```

The following example changes the thresholds from the default and causes no message to be sent when thresholds are exceeded.

```
switch(config-rbridge-id-1)# threshold-monitor memory actions none high-limit 60 low-limit 40
```

Configuring SFP monitoring thresholds and alerts

The following is an example of configuring SFP monitoring.

1. Enter **configure terminal** to enter global configuration mode.

```
switch# configure terminal
switch(config)#
```

2. Enter **rbridge-id** *rbridge-id#* to change to RBridge ID configuration mode.

```
switch(config)# rbridge-id 154
switch(config-rbridge-id-154)#
```

3. Enter **threshold-monitor sfp** and create a custom policy.

```
switch(config-rbridge-id-154)# threshold-monitor sfp policy mypolicy type 1glr area temperature
alert above highthresh-action raslog email
```

NOTE
Refer also to Security monitoring on page 242 for more information.

4. Apply the policy.

```
switch(config-rbridge-id-154)# threshold-monitor sfp apply mypolicy
```

Security monitoring

Security monitoring allows you to set security threshold and alert options, including login-violation or telnet-violation alerts.

Viewing security defaults

To display the default values of security threshold and alert options, enter the **show defaults security area** command with the **login-violation** or **telnet-violation** options.

```
switch# show defaults security area login-violation
```

Configuring security monitoring

1. Issue the **configure terminal** command to enter global configuration mode.
2. Enter RBridge ID configuration mode, as in the following example.

```
switch(config)# rbridge-id 154
```

3. Enter the **threshold-monitor security** command to configure custom login-violation monitoring, as in the following example.

```
switch(config-rbridge-id-154)# threshold-monitor security
policy mypolicy area login-violation alert above highthresh-action
raslog below highthresh-action email lowthresh-action none
```

4. Apply the policy.

```
switch(config-rbridge-id-154)# threshold-monitor security apply mypolicy
```

Configuring interface monitoring

The following sections discuss how to view interface threshold defaults and configure interface monitoring.

Viewing interface threshold defaults

Use the following command to view interface threshold defaults.

```
switch# show defaults threshold interface type Ethernet
```

Refer to Viewing threshold status on page 244 for the results of this command.

Configuring interface monitoring

1. Issue the **configure terminal** command to enter global configuration mode.
2. Enter RBridge ID configuration mode (in this case, for RBridge ID 154).

```
switch(config)# rbridge-id 154
```

3. Enter the **threshold-monitor interface** command to configure custom interface monitoring, as in the following example.

```
switch(config-rbridge-id-154)# threshold-monitor interface policy mypolicy type ethernet area
missingterminationcharacter alert above lowthresh-action email
```

4. Apply the policy.

```
switch(config-rbridge-id-154)# threshold-monitor interface apply mypolicy
```

Pausing and continuing threshold monitoring

By default, threshold monitoring is enabled.

To disable monitoring of a particular type, enter the **threshold-monitor [cpu |interface | memory | security | sfp] pause** command.

To re-enable monitoring, enter the **no version** of the above command.

> NOTE
> Not all functions of this command can be disabled. Continue to enter **?** at each level of the command synopsis to confirm which functions can be disabled.

Using VMware vCenter

vCenter and Network OS integration overview

The VMware vCenter Server allows for the management of multiple ESX /ESXi servers and virtual machines (VMs) from different ESX servers through a single graphical user interface (GUI). It provides unified management of all the hosts and VMs in the data center, from a single console with an aggregate performance monitoring of clusters, hosts and VMs.

The VMware vCenter and Brocade Network OS integration supported in Brocade VCS Fabric mode and non-VCS (standalone switch) mode enables you to discover VMware ESX servers managed by a vCenter server. VMware's server hosts (ESX servers) are connected directly to the physical switches through the switch ports (edge ports in Brocade VCS Fabric mode). The server hosts implement a virtual switch (vSwitch), which is used to provide connections to the VMs. The fundamental requirement for the vCenter and Network OS integration is the IP-level management connectivity of the vCenter Server 4.0 version and later with the Brocade VDX switches.

NOTE
The Network OS integration with vCenter requires vCenter versions 4.0, 4.1, 5.1 or 5.5.

You can view virtual switches and virtual machines, their associated MAC addresses, and network policies using the Network OS command line interface (CLI). Refer to the *Network OS Command Reference* for details about the **vcenter** and **vnetwork** commands.

vCenter properties

The vCenter manages the VMware ESX/ESXi hosts. The vCenter user interface is provided through a vSphere client on the same management network as the vCenter, and virtual machines (VMs) are created using the vSphere client user interface. In addition to creating the VMs, the server administrator associates the VMs with distributed virtual switches, distributed virtual port groups, standard virtual switches (vSwitches) and standard port groups.

The vCenter automatically generates some of the VM properties (such as the MAC address), and some properties must be configured (such as the VLAN properties). Most of the VM configuration, including network policies, is done using the vCenter's vSphere user interface and is beyond the scope of this document.

For VMWare configuration information, visit the VMware documentation site.

vCenter guidelines and restrictions

Follow these guidelines and restrictions when configuring vCenter:

- Special characters in the port group names are replaced with the URL-encoded values.
- Standard port groups with the same name that reside in different ESX/ESXi hosts must have identical VLAN settings across all hosts.
- For all vCenter port groups, Network OS automatically creates a port profile with the following format: auto-*vcenter_name-datacenter_ID-port-group-name*. User editing of these auto port groups is not supported.
- Network OS supports vCenter discovery that is based on events.
- Network OS supports LLDP and QoS (IEEE 8021.p) for distributed virtual switches (dvSwitches).

- Network OS supports up to 750 port groups in the vCenter.
- CDP/LLDP-receiving interface ports must not have any conflicting configurations (such as switch port and FCoE port configurations) on the interface that prevent them from being in a port-profiled mode.
- Before configuring a vCenter in the fabric, remove all the manually created port profiles that have vCenter inventory MAC associations.
- For Network OS 4.0.0 versions, multiple data centers are supported, up to four data centers.
- Duplicate vCenter asset values are not supported, such as duplicate MAC addresses and duplicate Host names.

vCenter discovery

A Brocade VDX switch connected to VMware ESX/ESXi hosts and virtual machines must be aware of network policies in order to allow or disallow traffic; this requires a discovery process by the VDX switch. During VDX switch configuration, relevant vCenters that exist in its environment and the discovery of virtual assets from the vCenter occurs in the following circumstances:

- When a switch boots up
- When a new vCenter is configured on the VDX switch and activated (activation turns on the timer processing, set to 30-minute intervals)
- When the discovery is explicitly initiated with the CLI

The following assets are discovered from the vCenter:

- Hosts and data centers associated with the vCenter
- Virtual machines (VMs) that have been created on the hosts
- VMware distributed virtual port groups (dvPortGroups)
- Standard port groups, with QoS priority associated with a dvPortGroup
- Standard virtual switches
- Distributed virtual switches

vCenter configuration

Configuring vCenter consists of three basic steps performed in this order:

1. Enabling VMware vSphere QoS.
2. Enabling CDP/LLDP on switches.
3. Adding and activating the vCenter.

These steps and postconfiguration steps are discussed in this section.

Step 1: Enabling QoS

You must edit the network resource pool settings and set QoS priorities. Refer to the latest VMware vSphere Networking documentation.

Step 2: Enabling CDP/LLDP

In order for an Ethernet Fabric to detect the ESX/ESXi hosts, you must first enable Cisco Discovery Protocol (CDP) and Link Layer Discovery Protocol (LLDP) on all the virtual switches (vSwitches) and distributed vSwitches (dvSwitches) in the vCenter Inventory.

For more information, refer to the VMware KB article 1003885.

Enabling CDP/LLDP on vSwitches

Complete the following steps to enable CDP/LLDP on virtual switches (vSwitches).

1. Login as root to the ESX/ESXi Host.
2. Use the following command to verify the current CDP/LLDP settings.

```
[root@server root]# esxcfg-vswitch -b vSwitch1
```

3. Use the following command to enable CDP/LLDP for a given virtual switch. Possible values here are **advertise** or **both**.

```
[root@server root]# esxcfg-vswitch -B both vSwitch1
```

Enabling CDP/LLDP on dvSwitches

Complete the following steps to enable CDP on distributed virtual switches (dvSwitches).

1. Connect to the vCenter server by using the vSphere Client.
2. On the vCenter Server home page, click **Networking**.
3. Right-click the distributed virtual switches (dvSwitches) and click **Edit Settings**.
4. Select **Advanced** under **Properties**.
5. Use the check box and the drop-down list to change the CDP/LLDP settings.

Step 3: Adding and Activating the vCenter

After CDP is enabled on all the vSwitches and dvSwitches in the vCenter, configuration on the Network OS side is a two-step process, consisting of adding the vCenter and activating the vCenter.

Adding the vCenter

You must add the vCenter before initiating any discovery transactions. To authenticate with a specific vCenter, you must first configure the URL, login, and password properties on the VDX switch.

NOTE
By default, the vCenter server accepts only HTTPS connection requests.

1. Enter the **vcenter** command with the name, URL, user name, and password of the vCenter.

```
switch(config)# vcenter myvcenter url https://10.2.2.2 username user password pass
```

2. An invalid state or condition of a vCenter can cause the deletion of all auto-port-profiles in a system. To prevent this from happening, configure the **ignore-delete-all-response** operand of the **vcenter** command to ignore the “delete-all” responses from the vCenter.

```
switch# vcenter MYVC discover ignore-delete-all-response 5
```

Activating the vCenter

After adding the vCenter, you must activate the configured vCenter instance.

NOTE
In VCS mode, you can configure the vCenter by using any node. Discovery is initiated by the primary node.

1. Enter the **config** command.
2. Enter the **vcenter** command to activate the vCenter.

```
switch(config)# vcenter myvcenter activate
```

Immediately following first-time vCenter activation, the Network OS starts the virtual asset discovery process. Use the **show vnetwork vcenter status** command to display the vnetwork status, as in the following example.

```
switch# show vnetwork vcenter status
vCenter          Start               Elapsed (sec)    Status
================ =================== ================ =============
myvcenter        2011-09-07 14:08:42  10               In progress
```

When the discovery process completes, the status displays as "Success." Network OS has performed all the necessary configurations needed for the vCenter Server, and is now ready for CDP transmissions from the virtual switches to identify which ESX/ESXi host is connected to which physical interface in the Ethernet Fabric.

Discovery timer interval

By default, Network OS queries the vCenter updates every thirty minutes. If any virtual assets are modified (for example, adding or deleting virtual machines (VMs), or changing VLANs), Network OS detects those changes and automatically reconfigures the Ethernet Fabric during the next periodic rediscovery attempt.

Use the **vcenter interval** command to manually change the default timer interval value to suit the individual environment needs.

```
switch(config)# vcenter myvcenter interval ?
Possible completions:
 <NUMBER:0-1440>  Timer Interval in Minutes (default = 30)
```

NOTE
Best practice is to keep the discovery timer interval value at the default (30). A value of 0 disables the periodic vCenter discovery.

User-triggered vCenter discovery

The discovery of virtual assets from the vCenter occurs during one of the following circumstances:

- When a switch boots up.
- When a new vCenter is configured on the VDX switch and activated (activation turns on the timer processing, set to 180-second intervals.)
- When the discovery is explicitly initiated with the CLI.

To explicitly initate vCenter discovery, perform the following task in global configuration mode.

1. An invalid state or condition of a vCenter can cause the deletion of all auto-port-profiles in a system. To prevent this from happening, configure the **ignore-delete-all-response** operand of the **vcenter** command to ignore the “delete-all” responses from the vCenter.

```
switch(config)# vcenter MYVC discover ignore-delete-all-response 5
```

2. Return to privileged EXEC mode with the **exit** command.

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

3. Use the **vnetwork vcenter** command to trigger a vCenter discovery manually.

```
switch# vnetwork vcenter myvcenter discover
```

Viewing the discovered virtual assets

Enter one of the following **show vnetwork** asset commands:

```
switch# show vnetwork dvpgs datacenter
 datacenter_name
 vcenter
 vcenter_name
switch# show vnetwork dvs datacenter
 datacenter_name
 vcenter
 vcenter_name
switch# show vnetwork hosts datacenter
 datacenter_name
 vcenter
 vcenter_name
switch# show vnetwork pgs datacenter
 datacenter_name
 vcenter
 vcenter_name
switch# show vnetwork vcenter status datacenter
 datacenter_name
    vcenter
 vcenter_name
switch# show vnetwork vmpolicy
 datacenter
 datacenter_name
 vcenter
 vcenter_name
switch# show vnetwork vms datacenter
 datacenter_name
 vcenter
 vcenter_name
switch# show vnetwork vss datacenter
 datacenter_name
 vcenter
 vcenter_name
```

where:

- **dvpgs** — Displays discovered distributed virtual port groups.
- **dvs** — Displays discovered distributed virtual switches.
- **hosts** — Displays discovered hosts.
- **pgs** — Displays discovered standard port groups.
- **vcenter status** — Displays configured vCenter status.
- **vmpolicy** — Displays the following network policies on the Brocade VDX switch: associated media access control (MAC) address, virtual machine, (dv) port group, and the associated port profile.
- **vms** — Displays discovered virtual machines (VMs).
- **vss** — Displays discovered standard virtual switches.

Refer to the *Network OS Command Reference* for detailed information about the **show vnetwork** commands.

Configuring Remote Monitoring

RMON overview

Remote monitoring (RMON) is an Internet Engineering Task Force (IETF) standard monitoring specification that allows various network agents and console systems to exchange network monitoring data. The RMON specification defines a set of statistics and functions that can be exchanged between RMON-compliant console managers and network probes. As such, RMON provides you with comprehensive network-fault diagnosis, planning, and performance-tuning information.

Configuring and Managing RMON

Both alarms and events are configurable RMON parameters.

- Alarms allow you to monitor a specific management information base (MIB) object for a specified interval, triggers an alarm at a specified value (rising threshold), and resets the alarm at another value (falling threshold). Alarms are paired with events; the alarm triggers an event, which can generate a log entry or an SNMP trap.
- Events determine the action to take when an event is triggered by an alarm. The action can be to generate a log entry, an SNMP trap, or both. You must define the events before an alarm can be configured. If you do not configure the RMON event first, you will receive an error when you configure the alarm settings.

By default, no RMON alarms and events are configured and RMON collection statistics are not enabled.

Configuring RMON events

You can add or remove an event in the RMON event table that is associated with an RMON alarm number.

To configure RMON events, perform the following steps from privileged EXEC mode.

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

```
switch# configure terminal
```

2. Configure the RMON event.

```
switch(config)# rmon event 27 description Rising_Threshold log owner    john_smith trap syslog
```

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
```

Configuring RMON Ethernet group statistics collection

You can collect RMON Ethernet group statistics on an interface. RMON alarms and events must be configured for you to display collection statistics. By default, RMON Ethernet group statistics are not enabled.

To collect RMON Ethernet group statistics on an interface, perform the following steps from privileged EXEC mode.

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

```
switch# configure terminal
```

2. Enter the **interface** command to specify the Data Center Bridging (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. Enable the DCB interface.

```
switch(conf-if-te-0/1)# no shutdown
```

4. Configure RMON Ethernet group statistics on the interface.

```
switch(conf-if-te-0/1)# rmon collection stats 200 owner john_smith
```

5. Return to privileged EXEC mode.

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

6. Enter the **copy** command to save the running-config file to the startup-config file.

```
switch# copy running-config startup-config
```

Configuring RMON alarm settings

To configure RMON alarms and events, perform the following steps from privileged EXEC mode.

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

```
switch# configure terminal
```

2. Configure the RMON alarms.

   Example of an alarm that tests every sample for a rising threshold

```
switch(config)# rmon alarm 5 1.3.6.1.2.1.16.1.1.1.5.65535 interval 30
                        absolute rising-threshold 95 event 27 owner john_smith
```

   Example of an alarm that tests the delta between samples for a falling threshold

```
switch(config)# rmon alarm 5 1.3.6.1.2.1.16.1.1.1.5.65535 interval 10 delta
                        falling-threshold 65 event 42 owner john_smith
```

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
```

5. To view configured alarms, use the **show running-config rmon alarm** command.

Section II: Network OS Security Configuration

Managing User Accounts

Understanding and managing user accounts

A user account allows authorized user access to the switch CLI. A user account must be assigned a role to specify the account's access privileges. A user account can be disabled at any point, preventing the user from logging in to the switch. A user can only be unlocked when the account is auto-locked because the user exceeded the configured threshold for failed login attempts. Only an administrator can create, change, unlock, or delete user accounts.

All modules that pertain to security, for example, user and user roles, role-based access control (RBAC), and password attributes (for example, encryption), are globally configurable data entities. This means that if a switch is in logical chassis cluster mode, all switches in the cluster have a common configuration for all the above-mentioned entities.

Default accounts in the local switch user database

Network OS comes with two predefined user accounts that are part of the factory-default settings. Brocade recommends that you change the password for all default accounts during the initial installation and configuration for each switch.

The default user accounts are "admin" and "user," and these accounts are associated with the corresponding admin" and "user" roles in the switch-local user database. Only the "admin" and "user" users can access the CLI and, except for the account password, no other attributes can be changed for the default users "admin" and "user."

By default, all account information is stored in the switch-local user database. User authentication and tracking of logins to the switch is local by default.

NOTE

The maximum number of user accounts, including the default accounts, is 64. The maximum number of roles, including the default roles is 64. For any environment requiring more than 64 users, you should adopt an authentication, authorization, and accounting (AAA) service for user management. Refer to Managing User Accounts on page 261 for more information. The maximum number of active Telnet or CLI sessions supported per switch is 32.

User account attributes

The following table summarizes the available user account attributes.

TABLE 44 User account attributes

Parameter	Description
name	The name of the account. The user account name is case-sensitive, must not exceed 40 characters, and must begin with a letter. The text string can contain letters, numbers, underscore (__), and periods (.). If the user name specified already exists, the **username** command modifies the existing role.
role	The role assigned to the user defines the RBAC access privileges for the account.

TABLE 44 User account attributes (continued)

Parameter	Description
password	The account password must satisfy all currently enforced password rules. Refer to the section Password policies overview on page 265 for more information.
encryption-level	The password encryption level. You can choose to encrypt the password (7) or leave it in clear text (0). If you do not specify an encryption level, the default, clear text (0), is the default.
desc	A description of the account. The description can be up to 64 characters long, and can include any printable ASCII character, except for the following characters: single quotation marks ('), double quotation marks("), exclamation point (!), colon (:), and semi-colon (;). If the description contains spaces. you must enclose the text in double quotation marks.
enable true | false	Indicates whether the account is enabled or disabled. A user whose account is disabled cannot log in. The default account status is enabled.

Configuring user accounts

When you create a user account you must specify three mandatory attributes: an account login name, a role, and a password. The remaining attributes are optional.

Creating a user account

The following example creates a new user account with the minimally required attributes: name, role, and password. The account name "brcdUser" has the default user privilege of accessing commands in privileged EXEC mode

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.
2. Enter **username** command with the specified parameters.

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# username brcdUser role user password welcome
Displaying user account information
The user account information is saved in switch configuration file.
```

Examples

Use the **show running-config username** command in privileged EXEC mode to display all configured users.

```
switch# show running-config username
username admin password "BwrsDbB+tABWGWpINOVKoQ==\n" encryption-level 7 role admin desc Administrator
username user password "BwrsDbB+tABWGWpINOVKoQ==\n" encryption-level 7 role user desc User
```

Use the **show running-config username** *username* command in privileged EXEC mode to display a single user.

```
switch# show running-config username admin
username admin password "BwrsDbB+tABWGWpINOVKoQ==\n" encryption-level 7 role admin desc Administrator
```

Use the **show running-config username** *username* **enable** command in privileged EXEC mode to display whether the account is enabled or disabled.

```
switch# show running-config username admin enable
username admin enable true
```

Modifying an existing user account

The syntax for the account *create* and *modify* operations is essentially the same. The difference is that there are no mandatory parameters for modifying an existing account. The system internally recognizes whether a new account is created or an existing account is modified by checking whether the user account is already present in the configuration database.

The following example adds a description to the previously created "brcdUser" account.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.
2. Enter the **username** command with the specified parameters.

```
switch# configure terminal l
Entering configuration mode terminal
switch(config)# username brcdUser
switch(config-username-brcdUser)# desc "Brocade guest account"
```

Disabling a user account

You can disable a user account by setting the **enable** parameter to **false**. All active login sessions for a user are terminated when a user account is disabled.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.
2. Enter **username** command with the specified parameters.

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# username testUser enable false
```

Deleting a user account

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.
2. Enter the **no username** command.

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# no username testUser
```

All active login sessions for a user are terminated when a user account is deleted.

Unlocking a user account

A user account is automatically locked by the system when the configured threshold for repeated failed login attempts has been reached. The account lockout threshold is a configurable parameter. Refer to Account lockout policy on page 266 for more information.

If a user account is locked out of a switch, that same user can still try to log in on another switch in the cluster. However, the unlocking is done on the given RBridge IDs, irrespective of whether the user is not locked or not on one or more switches.

The following procedure shows the commands used to unlock a user account.

NOTE
The **username** and **no username** commands are global configuration commands, but the **unlock username** command is a privileged EXEC command.

1. Enter the **show users** command in privileged EXEC mode to display currently active sessions and locked out users.
2. Enter the **unlock username** command in privileged EXEC mode to unlock the locked user account.

3. Verify that the user account has been unlocked. The **show users** command should display "no locked users".

```
switch# show users
**USER SESSIONS**
RBridge
ID  Username    Host Ip       Device   Time Logged In
2   user        10.70.4.105   vty/0    2012-04-30 01:59:35
1   user        10.70.4.105   vty/0    2012-04-30 01:57:41
1   admin       10.70.4.105   vty/2    2012-04-30 01:58:41
1   user        10.70.4.105   vty/3    2012-09-30 02:04:42
**LOCKED USERS**
RBridge
ID   username
1    testUser
switch#  unlock username testUser
Result: Unlocking the user account is successful
switch#  show users
**USER SESSIONS**
RBridge
ID  Username    Host Ip       Device   Time Logged In
2   user        10.70.4.105   vty/0    2012-04-30 01:59:35
1   user        10.70.4.105   vty/0    2012-04-30 01:57:41
1   admin       10.70.4.105   vty/2    2012-04-30 01:58:41
1   user        10.70.4.105   vty/3    2012-09-30 02:04:42
**LOCKED USERS**
RBridge
ID   username
no locked users
```

Configuring a user alias

You can specify a global alias and user alias for the switch by using the **alias** command. The **alias** command operates in two slightly different ways, depending on which configuration mode you are using; global alias or user-level alias. The global alias is accessible by all users. The user-level alias is accessible only when the respective user logs in.

To set a global alias and a user alias, perform the following task in global configuration mode.

1. Enter alias configuration mode.

```
switch(config)# alias-config
```

2. Set the global user-alias for the switch.

```
switch(config-alias-config)# alias redwood engineering
```

3. Enter user configuration mode.

```
switch(config-alias-config)# user john smith
```

4. Set the user-level alias.

```
switch(config-alias-config-user)# alias manager engineering
```

Understanding and managing password policies

Password policies overview

Password policies define and enforce a set of rules that make passwords more secure by subjecting all new passwords to global restrictions. The password policies described in this section apply to the switch-local user database only. Configured password policies (and all user account attribute and password state information) are synchronized across management modules and remain unchanged after an HA failover.

In logical chassis cluster mode, the configuration is applied to all the nodes in the cluster.

The following three subsections detail the configurable password policies.

Password strength policy

The following table lists configurable password policy parameters.

TABLE 45 Password policy parameters

Parameter	Description
character-restriction lower	Specifies the minimum number of lowercase alphabetic characters that must occur in the password. The maximum value must be less than or equal to the minimum length value. The default value is zero, which means there is no restriction of lowercase characters.
character-restriction upper	Specifies the minimum number of uppercase alphabetic characters that must occur in the password. The maximum value must be less than or equal to the Minimum Length value. The default value is zero, which means there is no restriction of uppercase characters.
character-restriction numeric	Specifies the minimum number of numeric characters that must occur in the password. The maximum value must be less than or equal to the Minimum Length value. The default value is zero, which means there is no restriction of numeric characters.
character-restriction special-char	Specifies the minimum number of punctuation characters that must occur in the password. All printable, non-alphanumeric punctuation characters except the colon (:) are allowed. The value must be less than or equal to the Minimum Length value. The default value is zero, which means there is no restriction of punctuation characters. Characters added after an exclamation point are dropped. For example, if you use the password "first!second", the password will become "first!" Special characters, such as backslash (\) and question mark (?), are not counted as characters in a password unless the password is specified within quotes.
min-length	Specifies the minimum length of the password. Passwords must be from 8 through 32 characters in length. The default value is 8. The total of the previous four parameters (lowercase, uppercase, digits, and punctuation) must be less than or equal to the Minimum Length value.
max-retry	Specifies the number of failed password logins permitted before a user is locked out. The lockout threshold can range from 0 through 16. The default value is 0. When a password fails more than one of the strength attributes, an error is reported for only one of the attributes at a time.

NOTE

Passwords can have a maximum of 40 characters.

Password encryption policy

Network OS supports encrypting the passwords of all existing user accounts by enabling password encryption at the switch level. By default, the encryption service is disabled and passwords are stored in clear text. Use the **no service password-encryption** command to enable or disable password encryption. The following rules apply to password encryption:

- When you enable password encryption, all existing clear-text passwords will be encrypted, and any password that are added subsequently in clear-text are stored in encrypted format

  In the following example, the testuser account password is created in clear text after password encryption has been enabled. The global encryption policy overrides command-level encryption settings The password is stored as encrypted.

```
switch(config)# service password-encryption

switch(config)# do show running-config service password-encryption
service password-encryption

switch(config)# username testuser role testrole desc "Test User" encryption-level 0 password hellothere

switch(config)# do show running-config username
username admin password "BwrsDbB+tABWGWpINOVKoQ==\n" encryptionlevel 7 role admin desc Administrator
username testuser password "cONW1RQ0nTV9Az42/9uCQg==\n" encryption-level 7 role testrole desc "Test User"
username user password "BwrsDbB+tABWGWpINOVKoQ==\n" encryptionlevel 7 role user desc User
```

- When you disable the password encryption service, any new passwords added in clear text will be stored as clear text on the switch. Existing encrypted passwords remain encrypted.

  In the following example, the testuser account password is stored in clear text after password encryption has been disabled. The default accounts, "user" and admin" remain encrypted.

```
switch(config)# no service password-encryption

switch(config)# do show running-config service password-encryption no service password-encryption

switch(config)# username testuser role testrole desc "Test User" encryption-level 0 password hellothere enable
true

switch(config)# do show running-config username
username admin password "BwrsDbB+tABWGWpINOVKoQ==\n" encryptionlevel 7 role admin desc Administrator
username testuser password hellothere encryption-level 0 role testrole desc "Test User"
username user password "BwrsDbB+tABWGWpINOVKoQ==\n" encryptionlevel 7 role user desc User
```

Account lockout policy

The account lockout policy disables a user account when the user exceeds a configurable number of failed login attempts. A user whose account has been locked cannot log in. SSH login attempts that use locked user credentials are denied without the user being notified of the reason for denial.

The account remains locked until explicit administrative action is taken to unlock the account. A user account cannot be locked manually. An account that is not locked cannot be unlocked.

Failed login attempts are tracked on the local switch only. in VCS mode, the user account is locked only on the switch where the lockout occurred; the same user can still try to log in on another switch in the VCS fabric.

The account lockout policy is enforced across all user accounts except for the root account and accounts with the admin role.

Denial of service implications

The account lockout mechanism may be used to create a denial of service (DOS) condition when a user repeatedly attempts to log in to an account by using an incorrect password. Selected privileged accounts, such as root and admin, are exempted from the account lockout policy to prevent these accounts from being locked out by a DOS attack. However these privileged accounts may then become the target of password-guessing attacks.

ATTENTION

Brocade advises that you periodically examine the Security Audit logs to determine if such attacks are attempted. Refer to Logging and analyzing security events on page 276.

Password interaction with remote AAA servers

The password policies apply to local switch authentication only. External AAA servers such as RADIUS, TACACS+, or LDAP provide server-specific password-enforcement mechanisms. The Network OS password management commands operate on the switch-local password database only, even when the switch is configured to use an external AAA service for authentication. When so configured, authentication through remote servers is applied to login only.

When remote AAA server authentication is enabled, an administrator can still perform user and password management functions on the local password database.

For more information on remote AAA server authentication, refer to Managing User Accounts on page 261.

Configuring password policies

Use the **password-attributes** command with specified parameters to define or modify existing password policies.

Configuring the account lockout threshold

You can configure the lockout threshold with the **password-attributes max-retry** *maxretry* command. The value of the *maxretry* specifies the number of times a user can attempt to log in with an incorrect password before the account is locked. The number of failed login attempts is counted from the last successful login. The *maxretry* can be set to a value from 0 through 16. A value of 0 disables the lockout mechanism (default).

The following example sets the lockout threshold to 5.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.
2. Enter the password-attributes command with the specified parameter.

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# password-attributes max-retry 4
```

When a user account is locked, it can be unlocked using the procedure described in Unlocking a user account on page 263.

Creating a password policy

The following example defines a password policy that places restrictions on minimum length and enforces character restrictions and account lockout.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

2. Enter the **password-attributes** command with the specified parameters.

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# password-attributes min-length 8 max-retry 4 character-restriction lower 2 upper 1
numeric 1 special-char 1
```

Restoring the default password policy

Entering the **no** form of the **password-attributes** command resets all password attributes to their default values. If you specify a specific attribute, only that attribute is reset to the default. If you enter **no password-attributes** without operands, all password attributes are reset to their default values.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.
2. Enter the **password-attributes** command with the specified parameters.

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# no password-attributes min-length
switch(config)# password-attributes max-retry 4
switch(config)# no password-attributes numeric
```

Displaying password attributes

To display configured password attributes, switch to privileged EXEC mode and enter **show running-config password-attributes**.

```
switch(config)# password-attributes max-retry 4

switch(config)# password-attributes character-restriction lower 2

switch(config)# password-attributes character-restriction upper 1 numeric 1 special-char 1

switch(config)# exit

switch# show running-config password-attributes
password-attributes max-retry 4
password-attributes character-restriction upper 1
password-attributes character-restriction lower 2
password-attributes character-restriction numeric 1
password-attributes character-restriction special-char 1

switch# configure terminal

switch(config)# no password-attributes character-restriction lower

switch(config)# no password-attributes character-restriction upper

switch(config)# exit

switch# show running-config password-attributes
password-attributes max-retry 4
password-attributes character-restriction numeric 1
password-attributes character-restriction special-char 1

switch# configure terminal

switch(config)# no password-attributes special-char

switch(config)# exit

switch# show running-config password-attributes
% No entries found.
```

Understanding and managing role-based access control (RBAC)

Network OS uses role-based access control (RBAC) as the authorization mechanism. You can create roles dynamically and associate them with rules to define the permissions applicable to a particular role. Every user account must be associated with a role, and only a single role can be associated with any given account.

RBAC specifies access rights to resources. When a user executes a command, privileges are evaluated to determine access to the command based on the role of the user.

In logical chassis cluster mode, the configuration is applied to all nodes in the cluster.

Default roles

All Brocade VDX switches support two default roles, "user" and "admin." You cannot modify the attributes of default roles; however, you can assign the default roles to non-default user accounts. The default roles have the following access privileges:

- The user role has limited privileges that are restricted to executing show commands in privileged EXEC mode, as well as the following operational commands: **ping**, **ssh**, **telnet**, and **traceroute**. User accounts associated with the user role cannot access configuration commands that are available only in global configuration mode.
- The admin role has the highest privileges. All commands available in privileged EXEC mode and in global configuration mode are accessible to the user associated with the admin role.

With a new switch, only the admin user account has access to perform user and role management operations. The admin user can create any roles and configure those roles for access to user and role management operations.

User-defined roles

In addition to the default roles, Network OS supports the creation of user-defined roles. A user-defined role starts from a basic set of privileges which are then refined by adding special rules. When you have created a role, you can assign a name to the role and then associate the role to one or more user accounts.

The following tools are available for managing user-defined roles:

- The **role** command defines new roles and deletes user-defined roles.
- The **rule** command allows you to specify access rules for specific operations and assign these rules to a given role.
- The **username** command associates a given user-defined role with a specific user account.

A user-defined role has a mandatory name and an optional description, as shown in the following table.

TABLE 46 Role attributes

Parameter	Description
name	The role name must be unique, begin with a letter, and can contain alphanumeric characters and underscores. The length of the role name should be between 4 and 32 characters. The name cannot be same as that of an existing user, an existing default role, or an existing user-defined role.
desc	An optional description of the role. The description can be up to 64 characters and can include any printable ASCII character, except for the following characters: single quotation marks (‘), double quotation marks(“), exclamation point (!), colon (:), and semi-colon (;). If the description

TABLE 46 Role attributes (continued)

Parameter	Description
	contains spaces, you must enclose the text in double quotation marks. if the description contains spaces

The operation of creating a role must satisfy the following criteria to succeed:

- The maximum number of roles supported on a chassis is 64.
- The command must be run from an account authorized for the operation.
- The **role** command is available in global configuration mode.
- If the role specified already exists, the **role** command modifies the existing role.

Displaying a role

In privileged EXEC mode, enter the **show running-config role** command.

```
switch# show running-config role
role name VLANAdmin desc "Manages security CLIs"
role name NetworkAdmin desc "Manages Network CLIs"
role name ClusterAdmin desc "Manages Cluster CLIs"
```

Creating or modifying a role

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter the **role** command with the specified parameters.

```
switch(config)# role name VLANAdmin desc "Manages security CLIs"
```

Deleting a role

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter the **no role** command with the specified parameters.

```
switch(config)# no role name VLANAdmin
```

Commonly used roles

The following examples illustrate the creation and configuration of two frequently-used administrative roles and accounts: Brocade VCS Fabric security administrator, and FCoE Fabric administrator.

Creating a VCS Fabric security administrator role and account

The following steps create and configure a typical Brocade VCS Fabric security administrator role.

1. Create a role for a Brocade VCS Fabric security administrator.

```
switch(config)# role name NetworkSecurityAdmin desc "Manages security CLIs"
```

2. Create a user account associated with the newly created role.

```
switch(config)# username SecAdminUser role NetworkSecurityAdmin password testpassword
```

3. Create the rules to specify the RBAC permissions for the NetworkSecurityAdmin role.

```
switch(config)# rule 30 action accept operation read-write role NetworkSecurityAdmin command role
switch(config-rule-30)# exit
switch(config)# rule 31 action accept operation read-write role NetworkSecurityAdmin command rule
switch(config-rule-31)# exit
switch(config)# rule 32 action accept operation read-write role NetworkSecurityAdmin command username
switch(config-rule-32)# exit
switch(config)# rule 33 action accept operation read-write role    NetworkSecurityAdmin command aaa
switch(config-rule-33)# exit
switch(config)# rule 34 action accept operation read-write role    NetworkSecurityAdmin command
radius-server
switch(config-rule-34)# exit
switch(config)# rule 35 action accept operation read-write role    NetworkSecurityAdmin command
config
switch(config-rule-35)# exit
```

The SecAdminUser account has been granted operational access to the configuration-level commands **role**, **rule**, **username**, **aaa**, and **radius-server**. Any account associated with the NetworkSecurityAdmin role can now create and modify user accounts, manage roles, and define rules. In addition, the role permits configuring a RADIUS server and set the login sequence.

Creating a FCoE administrator role and account

The following steps create and configure a typical FCoE administrator role.

1. Create an FCoE administrator role.

```
switch(config)# role name FCOEAdmin desc "Manages FCOE"
```

2. Create an FCoE admin user account.

```
switch(config)# username FCOEAdmUser role FCOEAdmin password testpassword
```

3. Create the rules defining the access permissions for the FCoE administrator role.

```
switch(config)# rule 40 action accept operation read-write role FCOEAdmin    command interface fcoe
```

The FCOEAdmUser account that is associated with the FCoEAdmin role can now perform the FCoE operations.

Understanding and managing command access rules

Command authorization is defined in terms of an ordered set of rules that are associated with a role. Rules define and restrict a role to access modes (*read-only* or *read-write* access), and beyond that can define permit or reject on specified command groups or individual commands. You can associate multiple rules with a given user-defined role, but you can associate only one role with any given user account.

To specify a rule, you must specify at least three mandatory attributes: a rule index number, the role to which the rule should apply, and the command that is defined by the rule. The following table describes the rule attribute details.

TABLE 47 Command access rule attributes

Parameter	Description
index	A numeric identifier of the rule in the range between 1 and 512.
role	The name of the role for which the rule is defined.
command	The command for which access is defined.
operation	Optional. Defines the general access mode granted by the rule. Access can be **read-only** or **read-write** (default).
action	Optional. A modifier restricting the general access mode. The specified access is either accepted (**accept**) or rejected (**reject**). The default value is **reject** .

Specifying rule commands with multiple options

Commands consisting of multiple words indicating command hierarchy are separated by a space, as shown in the following examples.

```
switch(config)# rule 70 action accept operation read-write role NetworkAdmin command copy running-config
switch(config)# rule 71 action accept operation read-write role NetworkAdmin command interface management
switch(config)# rule 72 action accept operation read-write role NetworkAdmin command clear logging
```

NOTE

Rules cannot be added for commands that are not at the top level of the command hierarchy. For a list of eligible commands, type the help function (**?**) at the command prompt.

Verifying rules for configuration commands

You can display configuration data for a particular command by using the **show running-config** command. By default, every role can access all the **show running-config** commands. For the nondefault roles, even the permission to access the **show running-config** commands can be modified by the authorized user (admin). The user must have the read-write permission for the **configure terminal** command to execute any of the configuration commands.

The following rules govern configuration commands:

- If a role has a rule with a *read-write* operation and the **accept** action for a configuration command, the user associated with this role can execute the command and read the configuration data.
- If a role has a rule with a **read-only** operation and the **accept** action for a configuration command, the user associated with this role can only read the configuration data of the command.
- If a role has a rule with a **read-only** or **read-write** operation and the **reject** action for a configuration command, the user associated with this role cannot execute the command and can read the configuration data of the command.

Configuring rules for operational commands

Rules can be created for the specified operational commands. By default, every role can display all the operational commands but cannot execute them. The show commands can be accessed by all the roles.

The following rules govern operational commands:

- If a role has a rule with a **read-write** operation and the **accept** action for an operational command, the user associated with this role can execute the command.

- If a role has a rule with a **read-only** operation and the **accept** action for an operational command, the user associated with this role can access but cannot execute the command.
- If a role has a rule with a **read-only** or **read-write** operation and the **reject** action for an operational command, the user associated with this role can neither access nor execute the command.

Configuring rules for interface key-based commands

By default, every role has the permission to read the configuration data related to all the instances of the interfaces using the **show running-config interface** *interface_name rbridge-id/slot/port* command.

Rules can be created for a specific instance of the interface-related configuration commands.

The following rules govern interface key-based commands:

- If a role has a rule with a **read-write** operation and the **accept** action for only a particular instance of the interface, the user associated with this role can only modify the attributes of that instance.
- If a role has a rule with a **read-only** operation and the **accept** action for only a particular instance of the interface, the user associated with this role can only read (using the **show running-config** command) the data related to that instance of the interface.
- If a role has a rule with a **read-write** operation and the **reject** action for only a particular instance of the interface, the user associated with this role cannot execute and read the configuration data for that interface instance.

  In the following example, the rules are applicable only to a particular instance of the specified interface.

```
switch(config)# rule 60 action accept operation read-write role NetworkAdmin command interface
tengigabitethernet 1/0/4
switch(config)# rule 65 action accept operation read-write role NetworkAdmin    command interface
fcoe 1/0/4
switch(config)# rule 68 role NetworkAdmin action reject command interface    fortygigabitethernet
1/2/4
```

- If a role has a rule with a **read-only** or **read-write** operation and the **reject** action for an interface or an instance of the interface, the user associated with this role cannot perform **clear** and **show** operations related to those interfaces or interface instances. To perform **clear** and **show** operations, the user's role must have at least **read-only** and the **accept** permission. By default, every role has the **read-only** and **accept** permission for all interface instances.

  In the following example, the user associated with the NetworkAdmin role cannot perform **clear** and **show** operations related to all **tengigabitethernet** instances.

```
switch(config)# rule 30 action accept operation read-write role NetworkAdmin    command interface
tengigabitethernet
```

- If a role has a rule with **read-only** or **read-write** operation, and the **reject** action for an interface **tengigabitethernet** and **fcoe** instances, the user associated with this role cannot perform **clear** and **show** operations related to those instances. To perform **clear** and **show** operations related to **interface tengigabitethernet** and **fcoe** instances, the user's role should have at least **read-only** and **accept** permission. By default, every role has the **read-onlyaccept** permission for all interface instances.

  In the following example, the user associated with the NetworkAdmin role cannot perform some of the **clear** and **show** operations related to all **tengigabitethernet** instances.

```
switch(config)# rule 30 role NetworkAdmin action reject command interface    tengigabitethernet
```

- A rule created with the **no-operation** command does not enforce any authorization rules. Instead, the **no-operation** instance can be considered as a placeholder for a valid command that will be added later. For example:

```
switch(config)# rule 75 action reject operation read-write role NetworkAdmin    command no-operation
switch(config)# rule 75 command firmware
```

- The **dot1x** option under the **interface** instance submode can only be configured if the role has the **read-write** and **accept** permissions for both the **dot1x** command and **interface te** instances.

  In the following example, the user associated with the CfgAdmin role can access and execute the **dot1x** command in the specified **tengigabitethernet** instance.

```
switch(config)# rule 16 action accept operation read-write role cfgadmin    command interface
tengigabitethernet
switch(config)# rule 17 action accept operation read-write role cfgadmin    command dot1x
```

- To execute the **no vlan** and **no spanning-tree** commands under the submode of **interface tengigabitethernet** instances, a user must have **read-write** and **accept** permissions for both the **vlan** and the **protocol spanning-tree** commands. If a user has **read-write** and **accept** permissions for the **vlan** and **spanning-tree** commands and **read-write** and **accept** permissions for at least one interface instance, the user can perform the **no vlan** and **no spanning-tree** operations on the other **interface** instances for which the user has only default permissions (**read-only** and **accept**).

Configuring a placeholder rule

A rule created with the **no-operation** command does not enforce any authorization rules. Instead, you can use the **no-operation** instance as a placeholder for a valid command that is added later, as shown in the following example.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter the **rule** command with the specified parameters and the **no-operation** keyword as a placeholder.

```
switch(config)# rule 75 action reject operation read-write role NetworkAdmin command no-operation
```

3. Enter the **rule** command with the specified command to replace the placeholder.

```
switch(config)# rule 75 command firmware
```

Configuring rule processing

When a user executes a command, rules are searched in ascending order by index for a match and the action of the first matching rule is applied. If none of the rules match, command execution is blocked. If there are conflicting permissions for a role in different indices, the rule with lowest index number is applied.

As an exception, when a match is found for a rule with the **read-only** operation and the **accept** action, the system seeks to determine whether there are any rules with the **read-write** operation and the **accept** action. If such rules are found, the rule with the **read-write** permission is applied.

In the following example, two rules with action accept are present and rule 11 is applied.

```
switch(config)# rule 9 operation read-only action accept role NetworkAdmin command aaa
switch(config)# rule 11 operation read-write action accept role NetworkAdmin command aaa
```

Adding a rule

You add a rule to a role by entering the **rule** command with appropriate options. Any updates to the authorization rules will not apply to the active sessions of the users. The changes are applied only when users log out from the current session and log in to a new session.

The following example creates the rules that authorize the security administrator role to create and manage user accounts:

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Create a rule specifying read-write access to the global configuration mode.

```
switch(config)# rule 150 action accept operation read-write role SecAdminUser    command config
```

3. Create a second rule specifying read-write access to the **username** command. Enter the **rule** command with the specified parameters.

```
switch(config)# rule 155 action accept operation read-write role SecAdminUser command username
```

4. After creating the rules, the user of the SecAdminUser account can log in to the switch and create or modify the user accounts by using the **username** command.

```
switch login: SecAdminUser
Password:******
Welcome to the ConfD CLI
SecAdminUser connected from 127.0.0.1 using console on switch

switch# configure terminal
Entering configuration mode terminal
Current configuration users:
admin console (cli from 127.0.0.1) on since 2010-08-16 18:35:05 terminal mode

switch(config)# username testuser role user password (<string>): ********
```

Changing a rule

The following example changes the previously created rule (index number 155) so that the command **username** is replaced by **role**.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter the **rule** command, specifying an existing rule (index 155) and changing the **command** attribute to the **role** command.

```
switch(config)# rule 155 command role
```

After changing rule 155, SecAdminUser can log in to the switch and execute the **role** command and not the **username** command.

```
switch# login SecAdminUser
switch# Password: ***********
Welcome to the ConfD CLI
SecAdminUser connected from 127.0.0.1 using console on sw0
switch# configure terminal
Entering configuration mode terminal
Current configuration users:
admin console (cli from 127.0.0.1) on since 2010-08-16 18:35:05 terminal mode
switch(config)# role name NetworkAdmin
```

Deleting a rule

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter the **no rule** command followed by the index number of the rule you wish to delete.

```
switch(config)# no rule 155
```

After rule 155 is deleted, the SecAdminUser can no longer access the **role** command.

Displaying a rule

Enter the **show running-config rule** command in privileged EXEC mode to display all configured rules. You can modify the output by using the command and specifying additional parameters.

```
switch# show running-config rule
rule 30 action accept operation read-write role NetworkSecurityAdmin rule 30 command role
rule 31 action accept operation read-write role NetworkSecurityAdmin rule 31 command rule
rule 32 action accept operation read-write role NetworkSecurityAdmin rule 32 command username
rule 33 action accept operation read-write role NetworkSecurityAdmin rule 33 command aaa
rule 34 action accept operation read-write role NetworkSecurityAdmin rule 34 command radius-server
rule 35 action accept operation read-write role NetworkSecurityAdmin rule 35 command configure
rule 40 action accept operation read-write role FCOEAdmin rule 40 command "interface fcoe"
```

Logging and analyzing security events

Security event logging utilizes the RASLog audit infrastructure to record security-related audit events. Any user-initiated security event generates an auditable event. Audited events are generated for all Management interfaces. In Brocade VCS Fabric mode, for cluster-wide events, the audit is generated on all switches of the cluster.

Refer to the *Network OS Message Reference* for information on how to configure, monitor, and analyze security audit logging.

Configuring External Server Authentication

Understanding and configuring remote server authentication

Remote server authentication overview

Network OS supports various protocols to provide external Authentication, Authorization, and Accounting (AAA) services for Brocade devices. Supported protocols include the following:

- RADIUS — Remote authentication dial-in user service
- LDAP/AD — Lightweight directory access protocol using Microsoft Active Directory (AD) in Windows
- TACACS+ — Terminal access controller access-control system plus

When configured to use a remote AAA service, the switch acts as a network access server client. The switch sends all authentication, authorization, and accounting (AAA) service requests to the remote RADIUS, LDAP, or TACACS+ server. The remote AAA server receives the request, validates the request, and sends a response back to the switch.

The supported management access channels that integrate with RADIUS, TACACS+, or LDAP include serial port, Telnet, or SSH.

When configured to use a remote RADIUS, TACACS+, or LDAP server for authentication, a switch becomes a RADIUS, TACACS+, or LDAP client. In either of these configurations, authentication records are stored in the remote host server database. Login and logout account name, assigned permissions, and time-accounting records are also stored on the AAA server for each user.

Brocade recommends that you configure at least two remote AAA servers to provide redundancy in the event of failure. For each of the supported AAA protocols, you can configure up to five external servers on the switch. Each switch maintains its own server configuration.

Login authentication mode

The authentication mode is defined as the order in which AAA services are used on the switch for user authentication during the login process. Network OS supports two sources of authentication: primary and secondary. The secondary source of authentication is used in the event of primary source failover and is optional for configuration. You can configure four possible sources for authentication:

- Local — Use the default switch-local database (default)
- RADIUS — Use an external RADIUS server
- LDAP — Use an external LDAP server
- TACACS+ — Use an external TACACS+ server

By default, external AAA services are disabled, and AAA services default to the switch-local user database. Any environment requiring more than 64 users should adopt AAA servers for user management.

When the authentication, authorization, and accounting (AAA) mode is changed, an appropriate message is broadcast to all logged-in users, and the active login sessions end. If the primary source is set to an external AAA service (RADIUS, LDAP, or TACACS+) and the secondary source is not configured, the following events occur:

- For Telnet-based and SSH connections-based logins, the login authentication fails if none of the configured (primary source) AAA servers respond or if an AAA server rejects the login.
- For a serial port (console) connection-based login, if a user's login fails for any reason with the primary source, failover occurs and the same user credentials are used for login through the local source. This failover is not explicit.
- If the primary source is set to an external AAA service, and the secondary source is configured to be local (for example, by means of the **aaa authentication login radius local** command), then, if login fails through the primary source either because none of the configured servers is responding or the login is rejected by a server, failover occurs and authentication occurs again through the secondary source (local) for releases earlier than Network OS 4.0.

In Network OS 4.0 and later, when **local** is specified as the secondary authentication service, failover to local does not occur if login is rejected by a server. In addition, when the authentication service is changed, the user sessions are not logged out. If a user wants to log out all connected user sessions, the **clear sessions** command should be used.

- In Network OS 4.0 and later, when **local** is specified as the secondary authentication service, local authentication is tried only when the primary AAA authentication service (TACACS+/Radius/LDAP) is either unreachable or not available. Local authentication will not be attempted if authentication with the primary service fails.
- In Network OS 4.0 and later, you can specify to use the local switch database if prior authentication methods on a RADIUS or TACACS+ server are not active or if authentication fails. To specify this option, use the **local-auth-failback** command. In the following example, the local switch database will be used if the RADIUS server is unavailable.

```
switch(config)# aaa authentication login radius local-auth-fallback
```

Conditions for conformance

- If the first source is specified as **default**, do not specify a second source. A second source signals a request to set the login authentication mode to its default value, which is **local**. If the first source is **local**, the second source cannot be set to any value, because the failover will never occur.
- The source of authentication (except **local**) and the corresponding server type configuration are dependent on each other. Therefore, at least one server should be configured before that server type can be specified as a source.
- If the source is configured to be a server type, you cannot delete a server of that type if it is the only server in the list. For example, if there are no entries in the TACACS+ server list, the authentication mode cannot be set to **tacacs+** or **tacacs+ local**. Similarly, when the authentication mode is **radius** or **radius local**, a RADIUS server cannot be deleted if it is the only one in the list.

Configuring remote server authentication

This section introduces the basics of configuring remote server authentication using RADIUS and TACACS+.

- Understanding and configuring RADIUS on page 280
- Understanding and configuring TACACS+ on page 286
- Understanding and configuring LDAP on page 294

Setting and verifying the login authentication mode

The following procedure configures TACACS+ as the primary source of authentication and the switch-local user database as the secondary source.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter the **aaa authentication login** command with the specified parameters.

```
switch(config)# aaa authentication login tacacs+ local

Broadcast message from root (pts/0) Tue Apr 5 16:34:12 2011...
AAA Server Configuration Change: all accounts will be logged out
```

3. Enter the **do show running-config aaa** command to display the configuration.

```
switch(config)# do
 show running-config aaa
aaa authentication login tacacs+ local
```

4. Log in to the switch using an account with TACACS+-only credentials to verify that TACACS+ is being used to authenticate the user.

Resetting the login authentication mode

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter the **no aaa authentication login** command to remove the configured authentication sequence and to restore the default value (Local only).

```
switch(config)# no aaa authentication login
```

3. Verify the configuration with the **do show running-config aaa** command.

```
switch(config)# do show running-config aaa
aaa authentication login local
```

4. Log in to the switch using an account with TACACS+-only credentials. The login should fail with an "access denied" error.
5. Log in to the switch using an account with local-only credentials. The login should succeed.

Changing the login authentication mode

You can set the authentication mode with the **aaa authentication login** command, but you cannot change or delete an existing authentication mode with the same command. You can only reset the configuration to the default value using the **no aaa authentication login** command and then reconfigure the authentication sequence to the correct value.

1. In privileged EXEC mode, use the configure terminal command to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter the **no aaa authentication login** command to reset the configuration to the default value.

```
switch(config)# no aaa authentication login tacacs+ local
```

3. Enter the **aaa authentication login** command and specify the desired authentication mode.

```
switch(config)# aaa authentication login radius local
Broadcast message from root (pts/0) Tue Apr 5 16:34:12 2011...
AAA Server Configuration Change: all accounts will be logged out
```

4. Verify the configuration with the **do show running-config aaa** command.

```
switch(config)# do show running-config aaa
aaa authentication login radius local
```

5. Log in to the switch using an account with TACACS+ credentials. The login should fail with an "access denied" error.
6. Log in to the switch using an account with RADIUS credentials. The login should succeed.

Understanding and configuring RADIUS

The remote authentication dial-in user service (RADIUS) protocol manages authentication, authorization, and accounting (AAA) services centrally. The supported management access channels that integrate with RADIUS are serial port, Telnet, and SSH.

If you are in logical chassis cluster mode, the configuration is applied to all nodes in the cluster.

Authentication and accounting

When a Brocade switch is configured with a set of RADIUS servers to be used for authentication, the switch also sends accounting data to the RADIUS server implicitly. The only accounting events supported on Brocade VDX switches configured to use RADUS are successful login and logout of the RADIUS user.

During the user authentication process, the switch sends its IP address. When the switch also has a Virtual IP address (in Brocade VCS Fabric mode), it still sends only its unique IP address to the RADIUS server.

> NOTE
> If the RADIUS server is not configured to support accounting, the accounting events sent by the switch to the server are dropped.

Authorization

User authorization through the RADIUS protocol is not supported. The access control of RADIUS users is enforced by the Brocade role-based access control (RBAC) protocol at the switch level. A RADIUS user should therefore be assigned a role that is present on the switch using the Vendor Specific Attribute (VSA) *Brocade-Auth-Role* . After the successful authentication of the RADIUS user, the role of the user configured on the server is obtained. If the role cannot be obtained or if the obtained role is not present on the switch, the user will assigned "user" role and a session is granted to the user with "user" authorization.

Account password changes

All existing mechanisms for managing switch-local user accounts and passwords remain functional when the switch is configured to use RADIUS. Changes made to the switch-local database do not propagate to the RADIUS server, nor do the changes affect any account on the RADIUS server; therefore, changes to a RADIUS user password must be done on the RADIUS server.

RADIUS authentication through management interfaces

You can access the switch through Telnet or SSH from either the Management interface or the data ports (TE interface or in-band). The switch goes through the same RADIUS-based authentication with either access method.

Configuring server side RADIUS support

With RADIUS servers, you should set up user accounts by their true network-wide identity, rather than by the account names created on a Brocade switch. Along with each account name, you must assign appropriate switch access roles. A user account can exist on a RADIUS server with the same name as a user on the switch at the same time.

When logging in to a switch configured with RADIUS, users enter their assigned RADIUS account names and passwords when prompted. Once the RADIUS server authenticates a user, it responds with the assigned switch role and information associated with the user account information using a Brocade Vendor-Specific Attribute (VSA). An Authentication-Accept response without the role assignment automatically grants the "user" role.

NOTE
RADIUS requires that you configure both the client and the server.

Configuring a RADIUS server with Linux

FreeRADIUS is an open source RADIUS server that runs on Linux (all versions), FreeBSD, NetBSD, and Solaris. Download the package from www.freeradius.org and follow the installation instructions at the FreeRADIUS website.

You will need the following information to configure Brocade-specific attributes. Refer to the RADIUS product documentation for information on configuring and starting up a RADIUS server.

Adding the Brocade attribute to the RADIUS server configuration

For the configuration on a Linux FreeRadius server, define the values outlined in the following table in a vendor dictionary file named dictionary.brocade.

TABLE 48 dictionary.brocade file entries

Include	Key	Value
VENDOR	Brocade	1588
ATTRIBUTE	Brocade-Auth-Role	1 string Brocade

1. Create and save the file `$PREFIX/etc/raddb/dictionary.brocade` with the following information:

```
#
# dictionary.brocade
#
VENDOR Brocade 1588
#
# attributes
#
ATTRIBUTE         Brocade-Auth-Role          1      string      Brocade.
```

2. Open the master dictionary file `$PREFIX/etc/raddb/dictionary` in a text editor and add the line:

```
$INCLUDE dictionary.brocade
```

   The file `dictionary.brocade` is located in the RADIUS master configuration directory and loaded for use by the RADIUS server.

Configuring a Brocade user account

When you use network information service (NIS) for authentication, the only way to enable authentication with the password file is to force the Brocade switch to authenticate using password authentication protocol (PAP); this requires the setting the **pap** option with the **radius-server host** command.

1. Open the `$PREFIX/etc/raddb/users` file in a text editor.
2. Add the user name and associated the permissions.

   The user must log in using the permissions specified with Brocade-Auth-Role.

   The following example configures an account called "jsmith" with admin permissions and a password "jspassword".

```
jsmith    Auth-Type := Local,
                  User-Password == "jspassword",
                  Brocade-Auth-Role = "admin"
```

   NOTE
   You must use double quotation marks around the password and role.

Configuring RADIUS server support with a Windows server

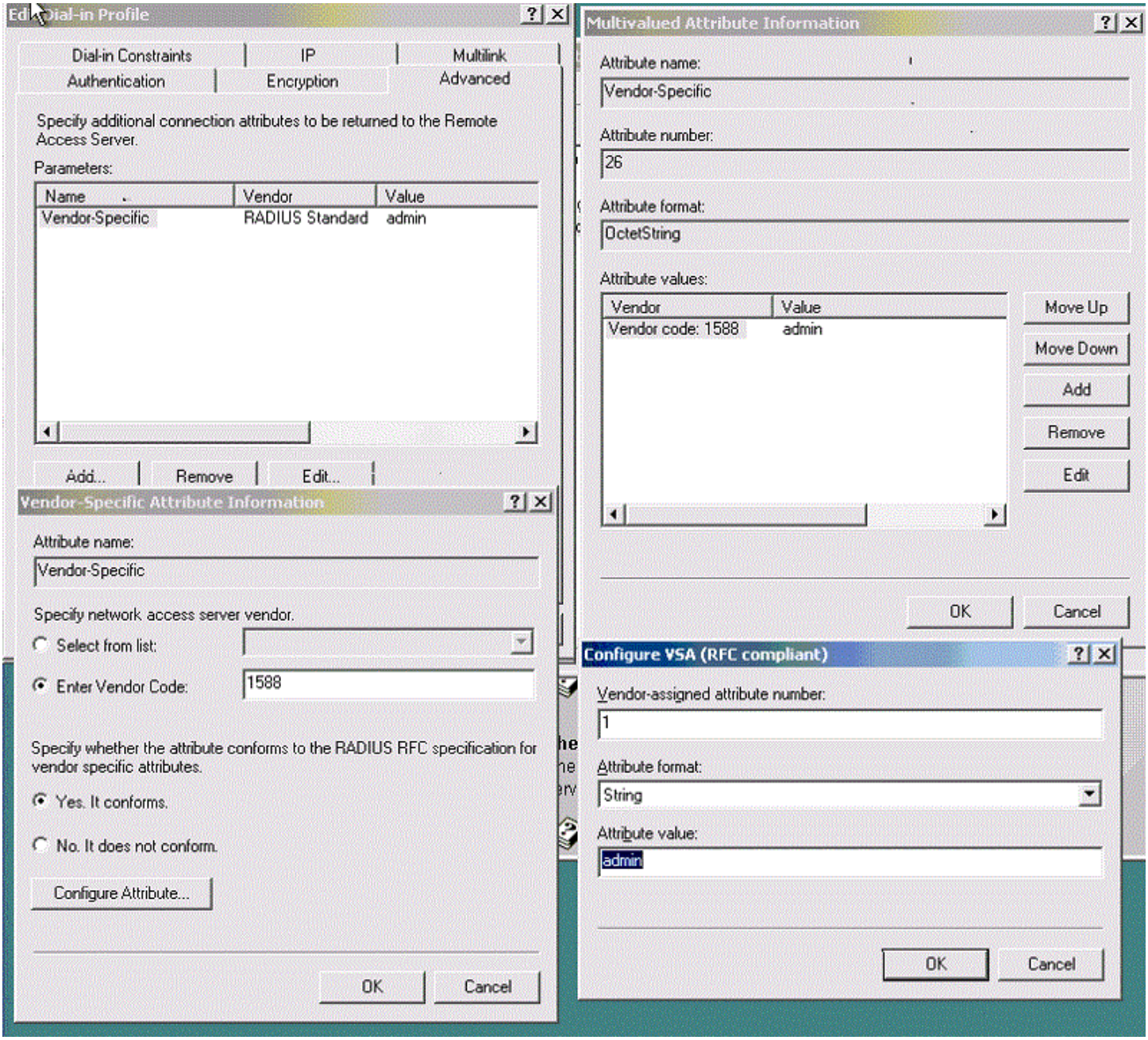
Step-by-step instructions for installing and configuring Internet Authentication Service (IAS) with Microsoft Windows server 2008 (or earlier versions, Windows 2003 or 2000) can be obtained from www.microsoft.com or your Microsoft documentation. Confer with your system or network administrator prior to configuration for any special needs your network environment may have.

Use the following information to configure the Internet Authentication Service for a Brocade switch. This is not a complete presentation of steps.

1. In the New RADIUS Client window, choose **RADIUS Standard** from the **Client-Vendor** menu.
2. Configure the Dial-in Profile window as follows:
   a) Select the **Advanced** tab.
   b) Scroll to the bottom of the RADIUS Standard list, select **Vendor-Specific** , and click **Add**.
   The Multivalued Attribute Information dialog appears.
   c) Click **Add** in the Multivalued Attribute Information window.
   The Vendor-Specific Attribute Information dialog appears.
   d) Enter the Brocade vendor code value of **1588**.
   e) Select the **Yes. It conforms.** radio button and then click **Configure Attribute**.
   The Configure VSA (RFC compliant) dialog appears.
   f) In the Configure VSA (RFC compliant) window, enter the following values and click **OK**.
      - Vendor-assigned attribute number — Enter the value **1**.
      - Attribute format — Enter the value **String**.

   The RADIUS server is now configured.

FIGURE 34 Windows server VSA configuration



Configuring client side RADIUS support

Each Brocade switch client must be individually configured to use RADIUS servers. You use the **radius-server** command to specify the server IP address, authentication protocols, and other parameters. You can configure a maximum of 5 RADIUS servers on a Brocade switch for AAA service.

NOTE
RADIUS requires that you configure both the client and the server.

The following table describes the parameters associated with a RADIUS server that is configured on the switch.

TABLE 49 RADIUS server parameters

Parameter	Description
host	IP address (IPv4 or IPv6) or host name of the RADIUS server. Host name requires prior DNS configuration. The maximum supported length for the host name is 40 characters.
auth-port	The user datagram protocol (UDP) port used to connect the RADIUS server for authentication. The port range is 0 through 65535; the default port is 1812.
protocol	The authentication protocol to be used. Options include CHAP, PAP, and PEAP. The default protocol is CHAP. IPv6 hosts are not supported if PEAP is the configured protocol.
key	The shared secret between the switch and the RADIUS server. The default value is "sharedsecret." The key cannot contain spaces and must be from 8 through 40 characters in length. Empty keys are not supported.
retries	The number of attempts permitted to connect to a RADIUS server. The range is 0 through 100, and the default value is 5.
timeout	Time to wait for a server to respond. The range is 1 through 60 seconds. The default value is 5 seconds.
encryption-level	Whether the encryption key should be stored in clear-text or in encrypted format. Default is 7 (encrypted). Possible values are 0 or 7, where 0 represents store the key in clear-text format and 7 represents encrypted format.

NOTE
If you do not configure the **key** attribute, the authentication session will not be encrypted. The value of the **key** attribute must match the value configured in the RADIUS configuration file; otherwise, the communication between the server and the switch fails.

Refer also to:

- Adding a RADIUS server to the client server list on page 284
- Modifying the client-side RADIUS server configuration on page 285
- Configuring the client to use RADIUS for login authentication on page 286

Adding a RADIUS server to the client server list

You must configure the Domain Name System (DNS) server on the switch prior to adding the RADIUS server with a domain name or a host name. Without the DNS server, name resolution of the RADIUS server fails and therefore the add operation fails. Use the **ip dns** command to configure the DNS server.

NOTE
When a list of servers is configured on the switch, failover from one server to another server happens only if a RADIUS server fails to respond; it does not happen when user authentication fails.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter **radius-server** command with the specified parameters.

```
switch(config)# radius-server host 10.38.37.180 protocol pap key "new#virgo*secret" timeout 10
```

   Once you run this command, you are placed into the AAA server configuration submode where you can specify additional parameters.

3. Enter the **exit** command to return to global configuration mode.

```
switch(config-host-10.38.37.180)# exit
```

4. Enter the **do show running-config radius-server host** *host_IP* command to verify the configuration.

```
switch# show running-config radius-server host 10.38.37.180
radius-server host 10.38.37.180
protocol  pap
key        "new# virgo*secret"
timeout    10
```

Modifying the client-side RADIUS server configuration

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter **radius-server host** command with the help option (**?**) to display the configured RADIUS servers.

```
switch(config)# radius-server ?
Possible completions:
<hostname: IP Address or Hostname of this RADIUS server>
10.38.37.180
10.24.65.6
```

3. Enter the **radius-server host** command with the IP address of the server you want to modify.

```
switch(config)# radius-server host 10.38.37.180
```

   After you run this command you are placed into the radius-server configuration sub-mode where you can specify the parameters you want to modify.

4. Enter the parameters and values you want to change.

```
switch(config-host-10.38.37.180 )# key "changedsec"
switch(config-host-10.38.37.180 )# timeout 3
```

5. Enter the **do show running-config radius-server** command to verify the configuration.

   NOTE
   This command does not display default values.

```
switch(config)# do show running-config radius-server host 10.24.65.6
radius-server host 10.24.65.6
protocol  pap
key        changedsec
timeout    3
```

   NOTE
   The **no radius-server host** command removes the server configuration from the list of configured RADIUS servers. When used with a specified parameter, the command sets the default value of that parameter.

Configuring the client to use RADIUS for login authentication

After you configured the client-side RADIUS server list, you must set the authentication mode so that RADIUS is used as the primary source of authentication. Refer to Login authentication mode on page 277 for information on how to configure the login authentication mode.

Understanding and configuring TACACS+

The Terminal Access Controller Access-Control System Plus (TACACS+) is an AAA server protocol that uses a centralized authentication server and multiple network access servers or clients. With TACACS+ support, management of Brocade switches seamlessly integrates into these environments. Once configured to use TACACS+, a Brocade switch becomes a network access server.

If you are in logical chassis cluster mode, the configuration is applied to all nodes in the cluster.

TACACS+ authorization

The TACACS+ server is used only for authentication and accounting. Authorization is enforced by the Brocade role-based access control (RBAC) protocol at the switch level. The same role should be assigned to a user configured on the TACACS+ server and configured on the switch. If the switch fails to get the user's role from the TACACS+ server after successful authentication, or if the role does not match any of the roles present on the switch, the **user** role is assigned by default. Thereafter, the role obtained from the TACACS+ server (or the defaulted role) is used for RBAC.

TACACS+ authentication through management interfaces

You can access the switch through the serial port, or through Telnet or SSH from either the management interface or the data ports (TE interface or in-band). The switch goes through the same TACACS+-based authentication with either access method.

Supported TACACS+ packages and protocols

Brocade supports the following TACACS+ packages for running the TACACS+ daemon on remote AAA servers.

- Free TACACS+ daemon (tacacs-plus 4.0.4.23-3). You can download this package from www.shrubbery.net/tac_plus.
- ACS 5.3
- ACS 4.2

The TACACS+ protocol v1.78 is used for AAA services between the Brocade switch client and the TACACS+ server.

The authentication protocols supported for user authentication are Password Authentication Protocol (PAP) and Challenge Handshake Authentication Protocol (CHAP).

TACACS+ configuration components

Configuring TACACS+ requires configuring TACACS+ support on the client (including optional accounting), as well as configuring TACACS+ on the server. Support for mixed environments may also be required.

Configuring the client for TACACS+ support

Each Brocade switch client must be individually configured to use TACACS+ servers. You use the **tacacs-server** command to specify the server IP address, authentication protocols, and other parameters. You can configure a maximum of five TACACS+ servers on a Brocade switch for AAA service.

The parameters in the following table are associated with a TACACS+ server that is configured on the switch.

TABLE 50 TACACS+ server parameters

Parameter	Description
host	IP address (IPv4 or IPv6) or domain/host name of the TACACS+ server. Host name requires prior DNS configuration. The maximum supported length for the host name is 40 characters.
port	The TCP port used to connect the TACACS+ server for authentication. The port range is 1 through 65535; the default port is 49.
protocol	The authentication protocol to be used. Options include CHAP and PAP. The default protocol is CHAP.
key	The shared secret between the switch and the TACACS+ server. The default value is "sharedsecret." The key cannot contain spaces and must be from 8 through 40 characters in length. Empty keys are not supported.
retries	The number of attempts permitted to connect to a TACACS+ server. The range is 0 through 100, and the default value is 5.
timeout	The maximum amount of time to wait for a server to respond. Options are from 1 through 60 seconds, and the default value is 5 seconds.
encryption-level	Whether the encryption key should be stored in clear-text or in encrypted format. Default is 7 (encrypted). Possible values are 0 or 7, where 0 represents store the key in clear-text format and 7 represents encrypted format.

NOTE

If you do not configure the **key** attribute, the authentication session will not be encrypted. The value of **key** must match with the value configured in the TACACS+ configuration file; otherwise, the communication between the server and the switch fails.

Refer also to:

- Adding a TACACS+ server to the client server list on page 287
- Modifying the client-side TACACS+ server configuration on page 288
- Configuring the client to use TACACS+ for login authentication on page 289
- Configuring TACACS+ accounting on the client side on page 289

Adding a TACACS+ server to the client server list

You must configure the Domain Name System (DNS) server on the switch prior to adding the TACACS+ server with a domain name or a host name. Without the DNS server, name resolution of the TACACS+ server fails and therefore the add operation fails. Use the **ip dns** command to configure the DNS server.

NOTE

When a list of servers is configured, failover from one server to another server happens only if a TACACS+ server fails to respond; it does not happen when user authentication fails.

The following procedure adds a TACACS+ server host in IPv6 format.

1. In the privileged EXEC mode, enter **configure terminal** to enter the global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter **tacacs-server** and specify the server IP address.

```
switch(config)# tacacs-server host fec0:60:69bc:94:211:25ff:fec4:6010
```

   Upon execution of the command you are placed into the tacacs-server configuration sub-mode where you can specify additional parameters.

3. Specify the additional parameters.
   This example specifies the CHAP protocol key.

```
switch(config-tacacs-server-fec0:60:69bc:94:211:25ff:fec4:6010)# protocol chap key
"new#hercules*secret"
switch(config-tacacs-server-fec0:60:69bc:94:211:25ff:fec4:6010)# exit
switch(config)# do show running-config tacacs-server fec0:60:69bc:94:211:25ff:fec4:6010
tacacs-server host fec0:60:69bc:94:211:25ff:fec4:6010 key new# Hercules*secret
```

4. Enter **exit** to return to the global configuration mode.

```
switch(config-tacacs-server-fec0:60:69bc:94:211:25ff:fec4:6010)# exit
```

5. Enter **do show running-config tacacs-server host** *server_address* to verify the configuration.

```
switch(config)# do show running-config tacacs-server fec0:60:69bc:94:211:25ff:fec4:6010
tacacs-server host fec0:60:69bc:94:211:25ff:fec4:6010
key new# Hercules*secret
```

Modifying the client-side TACACS+ server configuration

1. In privileged EXEC mode, enter **configure terminal** to change to global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter **tacacs-server host** with the help option (**?**) to display the configured server IP addresses.

```
switch(config)# tacacs-server host ?
fec0:60:69bc:94:211:25ff:fec4:6010
```

3. Enter **tacacs-server host** followed by the address of the server you wish to modify.

```
switch(config)# tacacs-server host fec0:60:69bc:94:211:25ff:fec4:6010
```

   Upon execution of the command you are placed into the tacacs-server configuration sub-mode where you can specify the parameters you want to modify.

4. Specify the additional parameters.

```
switch(config-tacacs-server-fec0:60:69bc:94:211:25ff:fec4:6010)# key "changedsec" retries 100
```

5. Enter **exit** to return to the global configuration mode.

```
switch(config-tacacs-server-fec0:60:69bc:94:211:25ff:fec4:6010)# exit
```

6. Enter **do show running-config tacacs-server host** *server_address* to verify the configuration.

   This command does not display default values.

```
switch(config)# do show running-config tacacs-server fec0:60:69bc:94:211:25ff:fec4:6010
tacacs-server host fec0:60:69bc:94:211:25ff:fec4:6010
key       changedesc
retries   100!
```

   The **no tacacs-server host** command removes the server configuration from the list of configured RADIUS servers. If the tacacs-server being deleted is the last one in the list and authentication mode is set to **tacacs+**, deletion of the server from the switch configuration is denied. When used with a specified parameter, the command sets the default value of that parameter.

Configuring the client to use TACACS+ for login authentication

After you configured the client-side TACACS+ server list, you must set the authentication mode so that TACACS+ is used as the primary source of authentication. refer to the section Login authentication mode on page 277 for information on how to configure the login authentication mode.

Configuring TACACS+ accounting on the client side

Once the fundamentals of TACACS+ authentication support are configured on the client, a variety of options are available for tracking user activity.

Client-side TACACS+ accounting overview

The TACACS+ protocol supports accounting as a function distinctly separate from authentication. You can use TACACS+ for authentication only, for accounting only, or for both. With a TACACS+ server you can track user logins and the commands users execute during a login session by enabling login accounting, command accounting, or both.

If you are in logical chassis cluster mode, the configuration is applied to all nodes in the cluster.

- When **login accounting** is enabled, the switch sends a TACACS+ start accounting packet with relevant attributes to the configured TACACS+ server when the user logs in, and a stop accounting packet when the session terminates.
- When **command accounting** is enabled, the switch sends a TACACS+ stop accounting packet to the server when the command execution completes. No TACACS+ start accounting packet is sent for command accounting. Most configuration commands, show commands and non-configuration commands such as firmware download will be tracked. Commands received through the NetConf interface will also be tracked. For a listing of commands that are not accounted for, refer to TACACS+ Accounting Exceptions on page 745.

If a TACACS+ server is used for both authentication and accounting, the switch first attempts to connect to the TACACS+ server that was successfully used for authentication when sending accounting packets to the server. If the TACACS+ server cannot be reached, the switch attempts to send the packets to the next server on the list. Note that there is no fail back in this case. When the first TACACS+ server becomes reachable again, the accounting packets continue to be sent to the second TACACS+ server.

If authentication is performed through some other mechanism, such as the switch-local database, a RADIUS, or an LDAP server, the switch will attempt to send the accounting packets to the first configured TACACS+ server. If that server is unreachable, the switch will attempt to send the accounting packets to subsequent servers in the order in which they are configured.

Conditions for conformance

- Only login and command accounting is supported. System event accounting is not supported.

- You can use a TACACS+ server for accounting regardless of whether authentication is performed through RADIUS, LDAP, TACACS+, or the switch-local user database. The only precondition is the presence of one or more TACACS+ servers configured on the switch.
- No accounting can be performed if authentication fails.
- In command accounting, commands with partial timestamp cannot be logged. For example, a **firmware download** command issued with the reboot option will not be accounted for, because there is no timestamp available for completion of this command.

Firmware downgrade considerations

Before downgrading to a version that does not support TACACS+ accounting, you must disable both login and command accounting or the firmware download will fail with an appropriate error message.

Configuring TACACS+ accounting on the client

By default, accounting is disabled on the TACACS+ client (the switch) and you must explicitly enable the feature. Enabling command accounting and login accounting on the TACACS+ client are two distinct operations. To enable login or command accounting, at least one TACACS+ server must be configured. Similarly, if either login or command accounting is enabled, you cannot remove a TACACS+ server, if it is the only server in the list.

Enabling login accounting

The following procedure enables login accounting on a switch where accounting is disabled.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter the **aaa accounting default exec start-stop tacacs+** command to enable login accounting.

```
switch(config)# aaa accounting exec default start-stop tacacs+
```

3. Enter the **do show running-config aaa** accounting command to verify the configuration.

```
switch(config)# do show running-config aaa accounting
aaa accounting exec default start-stop tacacs+
aaa accounting commands default start-stop tacacs+
```

Enabling command accounting

The following procedure enables login accounting on a switch where login accounting is enabled and command accounting is disabled.

1. In privileged EXEC mode, enter **configure terminal** to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter **aaa accounting default command start-stop tacacs+** to enable command accounting.

```
switch(config)# aaa accounting command default start-stop tacacs+
```

3. Enter **exit** to return to privileged EXEC mode.

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

4. Enter **do show running-config aaa accounting** to verify the configuration.

```
switch# show running-config aaa accounting
aaa accounting exec default start-stop none
aaa accounting commands default start-stop tacacs+
```

Disabling accounting

You have two options to disable accounting, either by using the **aaa accounting** command, with the none option or by using the **no** form of the command. Both variants are functionally equivalent. You must perform the disable operation separately for login accounting and for command accounting. The operation is performed in the global configuration mode.

This example shows two ways of disabling **command** accounting. The commands are executed in the global configuration mode.

```
switch(config)# aaa accounting commands default start-stop none
switch(config)# no aaa accounting commands default start-stop
```

This example shows two ways of disabling **login** accounting.

```
switch(config)# aaa accounting exec default start-stop none
switch(config)# no aaa accounting exec default start-stop
```

Viewing the TACACS+ accounting logs

The following excerpts from TACACS+ accounting logs exemplify typical success and failure cases for command and login accounting. These examples were taken from the free TACACS+ server. The order of the attributes may vary depending on the server package, but the values are the same. The location of the accounting logs depend on the server configuration.

Example: Command accounting

The following example record shows the successful execution of the **username** command by the admin user.

```
<102> 2012-04-09 15:21:43 4/9/2012 3:21:43 PM NAS_IP=10.17.37.150 Port=0 rem_addr=Console User=admin
Flags=Stop task_id=1 timezone=Etc/GMT+0 service=shell priv-lvl=0 Cmd=username Stop_time=Mon Apr 9 09:43:56
2012
 Status=Succeeded
```

The following record shows the failed execution of the **radius-server** command by the admin user due to an invalid host name or server IP address.

```
<102> 2012-04-09 14:19:42 4/9/2012 2:19:42 PM NAS_IP=10.17.37.150 Port=0 rem_addr=Console User=admin
Flags=Stop task_id=1 timezone=Etc/GMT+0 service=shell priv-lvl=0 Cmd=radius-server Stop_time=Mon Apr 9
08:41:56 2012
 Status=%% Error: Invalid host name or IP address
```

Example: Login (EXEC) accounting

The following example record shows the successful login of the trial user.

```
<102> 2012-05-14 11:47:49 5/14/2012 11:47:49 AM NAS_IP=10.17.46.42 Port=/dev/ttyS0 rem_addr=Console
User=trial Flags=Start task_id=1 timezone=Asia/Kolkata service=shell
```

Example: The following example record shows the successful logout of the trial user.

```
<102>2012-05-14 11:49:52 5/14/2012 11:49:52 AM NAS_IP=10.17.46.42 Port=/dev/ttyS0 rem_addr=console
User=trial Flags=Stop task_id=1 timezone=Asia/Kolkata service=shell elapsed_time=123 reason=admin reset
```

Configuring TACACS+ on the server side

Step-by-step instructions for installing and configuring can be obtained from www.cisco.com. Confer with your system or network administrator prior to configuration for any special needs your network environment may have.

Server-side user account administration overview

With TACACS+ servers, you should set up user accounts by their true network-wide identity, rather than by the account names created on a Brocade switch. Along with each account name, you must assign appropriate switch access roles. A user account can exist on TACACS+ server with the same name as a user on the switch at the same time.

When logging in to a switch configured with a TACACS+ server, users enter their assigned TACACS+ account names and passwords when prompted. Once the TACACS+ server authenticates a user, it responds with the assigned switch role and information associated with the user account information using a Brocade Vendor-Specific Attribute (VSA). An Authentication-Accept response without the role assignment automatically grants the "user" role.

User accounts, protocols passwords, and related settings are configured by editing the server configuration files. The following configuration examples are based on the documentation provided by Cisco for its TACACS+ daemon users.

Establishing a server-side user account

The following example assigns the user "Mary" the Brocade role of "vlanadmin" and different passwords depending on whether the CHAP or the PAP protocol is used. In the following example, the brcd-role attribute is mandatory, which works in a Brocade-only environment. In a mixed vendor environment, the brcd-role attribute most be set to optional. Refer to Configuring TACACS+ for a mixed vendor environment on page 293 for more information.

```
user = Mary {
chap = cleartext "chap password"
pap = cleartext "pap password"
service = exec {
brcd-role = vlanadmin;
}
}
```

The following example assigns the user "Agnes" a single password for all types of login authentication.

```
user = Agnes {
global = cleartext "Agnes global password"
}
```

Alternatively, a user can be authenticated using the /etc/passwd file. Configure the account as shown in the following example.

```
user = fred {
login = file /etc/passwd
}
```

Changing a server-side TACACS+ account password

Changing a TACACS+ user password is done on the server by editing the TACACS+ server configuration file.

Defining a server-side TACACS+ group

A TACACS+ group or role can contain the same attributes as the users. By inference, all the attributes of a group can be assigned to any user to whom the group is assigned. The TACACS+ group, while functionally similar to the Brocade role concept, has no relation with the value of "brcd-role" attribute.

The following example defines a TACACS+ group.

```
group = admin {
# group admin has a cleartext password which all members share
# unless they have their own password defined
chap = cleartext "my$parent$chap$password"
}
```

The following example assigns the user "Brocade" with the group "admin".

```
user = Brocade {
member = admin
pap = cleartext "pap password"
}
```

Setting a server-side account expiration date

You can set an expiration date for an account by using the "expires" attribute in the TACACS+ server configuration file. The expiration date has the format "*MMM DD YYYY* "

```
user = Brocade {
member = admin
expires = "Jan 1 2011"
pap = cleartext "pap password"
}
```

Configuring a TACACS+ server key

The TACACS+ server key is the shared secret used to secure the messages exchanged between the Brocade switch and the TACACS+ server. The TACACS+ server key must be configured on both the TACACS+ server and the client Brocade switch. Only one key is defined per server in the TACACS+ server configuration file. The key is defined as follows:

```
key = "vcs shared secret"
```

Configuring TACACS+ for a mixed vendor environment

Network OS uses Role Based Access Control (RBAC) to authorize access to system objects by authenticated users. In AAA environments users may need to be authorized across Brocade and non-Brocade platforms. You can use TACACS+ to provide centralized AAA services to multiple network access servers or clients. To use TACACS+ services in multi-vendor environments, you must configure the Attribute-Value Pair (AVP) argument to be optional as shown in the example.

```
brcd-role*admin
```

The Network OS device sends the optional argument 'brcd-role' in the authorization request to the TACACS+ service. Most TACACS+ servers are programmed to return the same argument in response to the authorization request, If 'brcd-role' is configured as an optional argument, it is sent in the authorization request and Network OS users are able to successfully authorize with all TACACS+ services in a mixed-vendor environment.

Example: Configuring optional arguments in tac_plus

The following is a specific example for tac_plus package. Syntax for other packages may differ.

In the example, the mandatory attribute priv-lvl=15 is set to allow Cisco to authenticate. The optional brcd-role = admin argument is added to the tac_plus.conf file and allows Brocade VDX switches to authenticate.

The following example configures a user with the optional attribute value pair, brcd-role = admin. A Brocade user must match both the *username* and *usergroup* to authenticate successfully.

```
user = <username> {
    default service = permit
    service = exec {
     priv-lvl=15
  optional brcd-role = admin
  }
}
```

or

```
group = <usergroup> {
    default service = permit
    service = exec {
     priv-lvl=15
     optional brcd-role = admin
  }
}
user = <username> {
   Member = <usergroup>
}
```

Understanding and configuring LDAP

Lightweight Directory Access Protocol (LDAP) is an open-source protocol for accessing distributed directory services that act in accordance with X.500 data and service models. The LDAP protocol assumes that one or more servers jointly provide access to a Directory Information Tree (DIT) where data is stored and organized as entries in a hierarchical fashion. Each entry has a name called the distinguished name that uniquely identifies it.

The LDAP protocol can also be used for centralized authentication through directory service.

Active Directory (AD) is a directory service which supports a number of standardized protocols such as LDAP, Kerberos authentication, and DNS, to provide various network services. AD uses a structured data store as the basis for a logical, hierarchical organization of directory information. AD includes user profiles and groups as the part of directory information, so it can be used as a centralized database for authenticating the third-party resources.

If you are in logical chassis cluster mode, the configuration is applied to all nodes in the cluster.

User authentication

A Brocade switch can be configured as an LDAP client for authentication with an Active Directory (AD) server, supporting authentication with a clear text password over the Transport Layer Security (TLS) channel. Optionally, it supports server authentication during the TLS handshake. Only the user principal name from the AD server is supported for LDAP authentication on the Brocade switch. The Common Name-based authentication is not supported. When you log in from the switch, the complete user principal name, including domain, should be entered (for example, "testuser@sec.example.com").

LDAP supports alternative user principal names, such as:

- username
- username@AD.com
- username@ADsuffix.com
- username@newUPN.com

Network OS supports LDAP authentication with the following AD servers:

- Windows 2000
- Windows 2003
- Windows 2008 AD

A Brocade switch configured to perform LDAP-based authentication supports its access through a serial port, Telnet, and SSH. These access channels require that you know the switch IP address or name to connect to the switches.

A maximum of five AD servers can be configured on a Brocade switch.

If you are in logical chassis cluster mode, all LDAP server and map role configurations (except "show certutil" and "certutil") are applied to all switches in the cluster.

Server authentication

As a part of user authentication using LDAP, the Brocade switch can be configured to support server certificate authentication. To enable server authentication (server certificate verification), follow these guidelines:

- While configuring the LDAP server, the Fully Qualified Domain Name (FQDN) of the AD server should be added as the host parameter, instead of the IP address. A FQDN is needed to validate the server identity as mentioned in the common name of the server certificate.
- The DNS server must be configured on the switch prior to adding AD server with a domain name or a hostname. Without a DNS server, the name resolution of the server fails, and then the add operation fails. Use the **ip dns** command to configure DNS.
- The CA certificate of the AD server's certificate should be installed on the switch. Currently, only PEM-formatted CA certificates can be imported into the switch.

If more than one server is configured and an LDAP CA certificate is imported for one server on the switch, the switch performs the server certificate verification on all servers. Thus, either CA certificates for all servers should be imported, or CA certificates should not be imported for any of the servers. After the CA certificate is imported, it is retained even if the switch is set back to its default configuration. If the CA certificate is not required, you should explicitly delete it.

Server authorization

The Active Directory (AD) server is used only for authentication. Command authorization of the AD users is not supported in the AD server. Instead, the access control of AD users is enforced locally by role-based access control (RBAC) on the switch.

A user on an AD server should be assigned a nonprimary group, and that group name should be either matched or mapped to one of the existing roles on the switch; otherwise, authentication will fail. After successful authentication, the switch receives the nonprimary group of the user from the AD server and finds the corresponding user role for the group based on the matched or mapped roles.

If the switch fails to get the group from the AD server, or the LDAP user is not a member of any matching AD group, the user authentication fails. Groups that match with the existing switch roles have higher priority than the groups that are mapped with the switch roles. Thereafter, the role obtained from AD server (or default role) is used for RBAC.

If multiple nonprimary groups are associated to the AD user, only one of the groups should be mapped or matched to the switch role. If multiple AD groups of AD users are mapped or matched to the switch roles, authentication of the user is successful, but there is no guarantee as to which role the AD user gets among those multiple roles. After successful authentication, the switch gets the nonprimary group of the user from the AD server and finds the corresponding user role for group based on the matched or mapped roles. Thereafter, the role obtained from the AD server (or default role) will be used for RBAC.

A maximum 16 AD groups can be mapped to the switch roles.

FIPS compliance

To support FIPS compliance, the CA certificate of the AD server's certificate should be installed on the switch, and the FIPS-compliant TLS ciphers for LDAP should be used.

Configuring LDAP

Configuring support for LDAP requires configuring both the client and the server. This section presents the following major tasks, sorted by client-side and server-side activities:

Client-side tasks:

- Configuring an Active Directory server on the client side on page 296
- Configuring Active Directory groups on the client side on page 301
- Clearing sessions on the client side on page 302

Server-side tasks:

- Configuring an Active Directory server on the client side on page 296

Importing an LDAP CA certificate

The following example imports the LDAP CA certificate from a remote server to a Brocade switch using secure copy (SCP).

1. In privileged EXEC mode, enter **configure terminal** to change to global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter **certutil import ldapca** with the specified parameters.

```
switch# certutil import ldapca directory /usr/ldapcacert file cacert.pem protocol SCP host
10.23.24.56 user admin password *****
```

3. Verify the import by entering **show cert-util ldapcacert**.

```
switch# show cert-util ldapcacert
List of ldap ca certificate files:
swLdapca.pem
```

Deleting LDAP CA certificates

The **no certutil ldapca** command deletes the LDAP CA certificates of all Active Directory servers. You must confirm that you want to delete the certificates.

```
switch# no certutil ldapca
Do you want to delete LDAP CA certificate? [y/n]:y
```

Configuring an Active Directory server on the client side

Each Brocade switch client must be individually configured to use Active Directory servers. You use the **ldap-server** command to specify the host server, authentication protocols, and other parameters. You can configure a maximum of five Active Directory servers on a Brocade switch for AAA service.

The parameters in the following table are associated with an Active Directory server that is configured on the switch.

TABLE 51 Active Directory parameters

Parameter	Description
host	IP address (v4) or Fully Qualified Domain name of the AD server. IPv6 is supported for Windows 2008 AD server only. The maximum supported length for the host name is 40 characters.
port	TCP port used to connect the AD server for authentication. The valid port range is 1024 through 65535. The default port is 389.
timeout	Time to wait for a server to respond. The range is 1 through 60 seconds. The default value is 5 seconds.
retries	Number of unsuccessful attempts to be made to connect to an AD server before quitting. The valid range is 1 through 100. The default value is 5.
domain	Base domain name

A maximum of five LDAP/AD servers can be configured on a Brocade switch for authentication service.

Adding an LDAP server to the client server list

The following procedure configures an LDAP server on an ADAP client (Brocade switch).

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Use the **ldap-server-host** command to set the parameters for the LDAP server.

   This command places you into the ldap-server configuration submode where you can modify the server default settings.

```
switch(config)# ldap-server host 10.24.65.6 basedn sec.brocade.com port 3890
switch(config-ldap-server-10.24.65.6)#
```

3. Modify any settings, such as the domain name or retry limit, in this configuration mode (refer to the preceding table).

```
switch(config-ldap-server 10.24.65.6)# basedn security.brocade.com
switch(config-ldap-server 10.24.65.6)# timeout 8
switch(config-host-10.24.65.6)# retries 3
```

4. Confirm the LDAP settings with the **do show** command.

   Attributes holding default values are not displayed.

```
switch(config-ldap-server-10.24.65.6)# do show running-config ldap-server host 10.24.65.6

ldap-server host 10.24.65.6
port      3890
basedn    security.brocade.com
retries   3
timeout   8
!
```

5. Use the **exit** command to return to the global configuration mode.

```
switch(config-ldap-server-10.24.65.6)# exit
```

6. Use the **no ldap-server** command to set an attribute back to the default value.

```
switch(config)# no ldap-server host 10.24.65.6 retries
```

Changing LDAP server parameters

Changing an LDAP server follows the same procedure as that noted for adding an LDAP server to the client server list. Enter the host IP address or host name, then enter the new values as required. Refer to Adding an LDAP server to the client server list on page 297.

```
switch# configure terminal
Entering configuration mode terminal
switch(config)# ldap-server host 10.24.65.6
switch(config-host-10.24.65.6)# domain security.brocade.com
```

Removing an LDAP server

The following example deletes an LDAP server entry from the switch LDAP server list.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode

```
switch# configure terminal
Entering configuration mode terminal
```

2. Use the **no ldap-server** command to delete the LDAP server.

```
switch(config)# no ldap-server host 10.24.65.6
```

Importing an LDAP CA certificate

This procedure imports the LDAP CA certificate from the remote host to the switch.

1. Connect to the switch and log in using an account with admin role permissions.
2. In privileged EXEC mode, enter the **certutil import ldapca** command. Include the full path to the certificate on the host, specify SCP as the protocol, and include the IP address of the host.

Standalone mode

```
switch# certutil import ldapca directory /usr/ldapcacert/ file cacert.pem protocol SCP host 10.23.24.56
user jane password
password: ****
```

Logical chassis cluster mode

```
switch# certutil import ldapca directory /usr/ldapcacert/ file cacert.pem protocol SCP host 10.23.24.56
user jane password rbridge-id 3
password: ****
```

Deleting an LDAP CA certificate

This procedure deletes the LDAP CA certificates of all attached Microsoft Active Directory servers from the switch.

1. Connect to the switch and log in using an account with admin role permissions.
2. In privileged EXEC mode, enter the **no certutil ldapca** command.

```
switch# no certutil ldapca
Do you want to delete LDAP CA certificate? [y/n]:y
```

3. Enter **Y** to confirm that you want to delete the LDAP CA certificates.

Verifying LDAP CA certificates

To test whether an LDAP CA certificate has been imported on the switch, in privileged EXEC mode, enter the **no certutil ldapca** command and examine the message returned by the system. The command returns an error if there is no LDAP CA certificate on the switch. If an LDAP CA certificate exists on the switch, you are prompted to delete it. Enter **no** to retain the certificate.

When no LDAP CA certificate is present

```
switch# no certutil ldapcacert
% Error: LDAP CA certificate does not exist.
```

When an LDAP CA certificate exists on the switch

```
switch# no certutil ldapcacert
List of swLdapca.pem files:
swLdapca.pem
```

Viewing the LDAP CA certificate

The following procedure allows you to view the LDAP CA certificate that has been imported on the switch.

1. Connect to the switch and log in using an account with admin role permissions.
2. In privileged EXEC mode, enter the **certutil import syslogca** command. Include the full path to the certificate on the host, specify SCP as the protocol, and include the IP address of the host.

Standalone mode

To view the output in standalone mode, enter **show cert-util ldapcacert** with no options.

```
switch# show cert-util ldapcacert
```

Logical chassis cluster mode

To view the output in logical chassis cluster mode, enter **show cert-util ldapcacert** followed by the desired RBridge ID. This example displays the certificate for rbridge-id 3.

```
switch# show cert-util syslogcacert rbridge-id 3
```

Importing a syslog CA certificate

The following procedure imports the syslog CA certificate from the remote host to the switch.

1. Connect to the switch and log in using an account with admin role permissions.
2. In privileged EXEC mode, enter the **certutil import syslogca** command. Include the full path to the certificate on the host, specify SCP as the protocol, and include the IP address of the host.

Standalone mode

```
switch# certutil import ldapca directory /usr/ldapcacert/ file cacert.pem protocol SCP host 10.23.24.56
user jane password
password: ****
```

Logical chassis cluster mode

```
switch# certutil import syslogca directory /usr/ldapcacert/ file cacert.pem protocol SCP host 10.23.24.56
user jane password rbridge-id 3
password: ****
```

Deleting a syslog CA certificate

The following procedure deletes the syslog CA certificates of all attached Active Directory servers from the switch.

1. Connect to the switch and log in using an account with admin role permissions.
2. In Privileged EXEC mode, enter the **no certutil syslogca** command. You will be prompted to confirm that you want to delete the syslogca certificates.

Standalone mode

This example deletes all the syslogca certificates.

```
switch# no certutil syslogca
Do you want to delete syslogca certificate? [y/n]:y
Warning: All the syslogca CA certificates are deleted.
```

Logical chassis cluster mode

This example deletes the syslogca certificates for rbridge-id 3 only.

```
switch# no certutil syslogca rbridge-id 3
Do you want to delete syslogca certificate? [y/n]:y
Warning: All the syslog CA certificates are deleted.
```

Verifying syslog CA certificates

To test whether a syslogCA certificate has been imported on the switch, in privileged EXEC mode, enter the **no certutil syslogca** command and examine the message returned by the system. The command returns an error if there is no syslog CA certificate on the switch. If a syslog CA certificate exists on the switch, you are prompted to delete it. Enter **no** to retain the certificate.

When no syslog CA certificate is present

```
switch# no certutil syslogcacert
% Error: syslog CA certificate does not exist.
```

When a syslog CA certificate exists on the switch

```
switch# no certutil syslogcacert
Do you want to delete syslog CA certificate? [y/n]:n
```

Viewing the syslog CA certificate

The following procedure allows you to view the syslog CA certificate that has been imported on the switch.

1. Connect to the switch and log in using an account with admin role permissions.
2. In privileged EXEC mode, enter the **show cert-util syslogcacert** command.

Standalone mode

This example displays all syslog CA certificates.

```
switch# show cert-util syslogcacert
```

Logical chassis cluster mode

This example displays the syslog CA certificates for rbridge-id 3 only.

```
switch# show cert-util syslogcacert rbridge-id 3
```

Configuring Active Directory groups on the client side

An Active Directory (AD) group defines access permissions for the LDAP server similar to Brocade roles. You can map an Active Directory group to a Brocade role with the **ldap-server map-role** command. The command confers all access privileges defined by the Active directory group to the Brocade role to which it is mapped.

A user on an AD server should be assigned a nonprimary group, and that group name should be either matched or mapped to one of the existing roles on the switch.

After successful authentication, the user is assigned a role from a nonprimary group (defined on the AD server) based on the matched or mapped switch role.

A user logging in to the switch that is configured to use LDAP and has a valid LDAP user name and password will be assigned LDAP user privileges if the user is not assigned with any nonprimary group.

Mapping an Active Directory group to a switch role

In the following example, a Brocade user with the admin role inherits all privileges associated with the Active Directory (AD) Administrator group.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
switch# config terminal
Entering configuration mode terminal
```

2. Use the **ldap-server** command to set the group information.

   A maximum of 16 AD groups can be mapped to the switch roles.

```
switch(config)# ldap-server maprole group Administrator role admin
```

Removing the mapping of an Active Directory to a switch role

The following example removes the mapping between the Brocade admin role and the Active Directory (AD) Administrator group. A Brocade user with the admin role can no longer perform the operations associated with the AD Administrator group.

To unmap an AD group to a switch role, perform the following steps from privileged EXEC mode.

1. Use the **configure terminal** command to enter global configuration mode.

```
switch# config terminal
Entering configuration mode terminal
```

2. Use the **no ldap-server** command to set the group information.

```
switch(config)# no ldap-server maprole group Administrator
```

Configuring the client to use LDAP/AD for login authentication

After you configured the switch LDAP server list, you must set the authentication mode so that ALDAP is used as the primary source of authentication. refer to Login authentication mode on page 277 for information on how to configure the login authentication mode.

Clearing sessions on the client side

In Network OS 4.0 and later, you can use the **clear sessions** command to log out user sessions that are connected to a switch. This command is not distributed across a cluster. If you are in VCS mode, you must use the RBridge ID of the node to log out the users connected to the individual nodes.

In standalone mode:

```
switch# clear sessions
This operation will logout all the user sessions. Do you want to continue (yes/no)?: y
```

In VCS mode:

```
switch# clear sessions rbridge-id 3
This operation will logout all the user sessions. Do you want to continue (yes/no)?: y
```

Configuring an Active Directory server on the client side

The following high-level overview of server-side configuration for LDAP/AD servers indicates the steps needed to set up a user account. This overview is provided for your convenience only. All instructions involving Microsoft Active Directory can be obtained from www.microsoft.com or from your Microsoft documentation. Confer with your system or network administrator prior to configuration for any special needs your network environment may have.

Creating a user account on an LDAP/AD server

1. Create a user on the Microsoft Active Directory server.
2. Create a group. The group should either match with the user's Brocade switch role or you can map the role to the Brocade switch role with the **ldap-server maprole** command.
3. Associate the user with the group by adding the user to the group.
   The user account configuration is complete.

Verifying the user account on the switch

1. Log in to the switch as a user with admin privileges.
2. Verify that the LDAP/AD server has an entry in the switch LDAP server list.

   ```
   switch# show running-config ldap-server
   ```

3. In global configuration mode, set the login authentication mode on the switch to use LDAP only and verify the change.

   ```
   switch# configure terminal
   Entering configuration mode terminal
   switch(config)# no aaa authentication login
   switch(config)# aaa authentication login ldap
   switch(config)# do
    show running-config aaa
   aaa authentication login ldap
   ```

4. Log in to the switch using an account with valid LDAP/AD only credentials to verify that LDAP/AD is being used to authenticate the user.
5. Log in to the switch using an account with switch-local only credentials. The login should fail with an access denied message.

Configuring LDAP users on an AD server

1. Create a user.
   a) Go to **Programs** > **Administrative Tools** > **Active directory Users and Computers**.
   b) Add a user by completing the dialog shown in the following figure.
   c) Save the account information.
   d) From a command prompt, log in using the new user name and enter a password when prompted.
2. Create a group.
   a) Go to **Programs** > **Administrative Tools** > **Active directory Users and Computers**.
   b) Add a new group.
   c) Save the group information.
3. Assign the group to the user.
   a) Click on the user name.
   b) From the **Properties** dialog, click the **Member Of** tab and update the field with the group name. This group should either match the switch role or it must be mapped with the switch role on the Brocade switch. In this instance, Domain Users is the primary group and therefore should not be mapped with the switch role.

Configuring Fabric Authentication

Fabric authentication overview

When you connect a Brocade VCS Fabric to a Fabric OS fabric, the Network OS Fibre Channel E_Ports on the Brocade VDX 6730 connect through Inter-Switch Links (ISLs) to EX_Ports on an FC router, which in turn connects to the Fabric OS network as shown in Fibre Channel ports overview on page 197.

To ensure that no unauthorized devices can access the fabric, Network OS provides support for security policies and protocols capable of authenticating Network OS (E_Ports) to the EX_Ports on the FC router (FCR) that provides access to the SAN storage and services.

DH-CHAP

Network OS uses the Diffie-Hellman Challenge Handshake Authentication Protocol (DH-CHAP) to control access between devices. DH-CHAP is a password-based, key exchange authentication protocol that negotiates hash algorithms and Diffie Hellman (DH) groups before performing authentication. It supports both MD5 and SHA-1 hash algorithm-based authentication.

The Fibre Channel Security Protocol (FC-SP) defines the DH groups supported in the DH-CHAP protocol. Following current FC-SP standards, Network OS supports the following DH groups:

- 00 - DH Null option
- 01 - 1024 bit key
- 02 - 1280 bit key
- 03 - 1536 bit key
- 04 - 2048 bit key

To configure DH-CHAP authentication between Network OS switches (E_Ports) and FC routers (EX_Ports) you must apply a matching configuration to both sides of the connection. Each device must be configured locally.

NOTE
The Brocade VDX 6730-32 and VDX 6730-76 are the only platforms that can connect to an FC router providing access to a SAN network of Fabric OS switches.

Shared secret keys

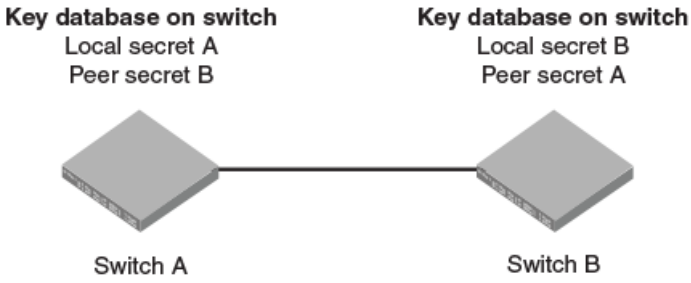
When you configure device ports for DH-CHAP authentication, you define a pair of shared secrets known to both devices as a secret key pair. A key pair consists of a local secret and a peer secret. The local secret uniquely identifies the local device. The peer secret uniquely identifies the entity to which the local device may authenticate. Every device may share a secret key pair with any other device or host in a fabric.

Shared secret keys have the following characteristics:

- The shared secrets must be configured locally on every device.
- If shared secrets are not set up for a link, authentication fails. The "Authentication Failed" error is reported for the port.

- The minimum length of a shared secret is 8 bytes and the maximum 40 bytes.

FIGURE 35 DH-CHAP authentication



The preceding figure illustrates how the secrets are configured. Assume two devices, A and B. Each device has a local secret (local secret A and local secret B), and a matching peer secret (peer secret A and peer secret B). If device B wants to shake hands with A, it will use A's local secret (B's peer secret A) to send the information. In doing so, A authenticates B by confirming its identity through the exchange of matching secret pairs. Conversely, B authenticates A when A sends information to B using B's local secret (A's peer secret B).

On the FC router, the authentication configuration for EX_Ports is set to fixed default values and cannot be changed. The Fabric OS **authutil** command is applicable only to the E_Ports on the FC router, not to EX_Ports. The following table shows the default authentication configuration for EX_Ports:

TABLE 52 Default EX_Port configuration

Operand	Value
Auth-type	DHCHAP
Auth-Policy	PASSIVE
Auth-Group	* (0, 1, 2, 3, 4)
Auth-Hash	msd5, sha1

Switch connection control (SCC) policy

The Switch Connection Control (SCC) policy controls access between neighboring devices. The policy defines and restricts which devices can join the fabric. Each time an E_Port-to-EX_Port connection is attempted, the devices are checked against the policy and the connection is either accepted or rejected depending on whether the connecting device is listed in the policy. The policy is named SCC_POLICY and accepts members listed as world wide names (WWNs).

A device configured with an active SCC policy reviews its database whenever a neighboring device tries to establish a connection. If the WWN of the connecting device is found in the SCC active policy database, the connecting device is allowed to join the fabric. If the neighboring device is not specified in the SCC policy active list, both devices are segmented.

By default, any device is allowed to join the fabric; the SCC policy is not enforced until it is created and activated. Creating a policy without any entries blocks access from all devices. The local switch is not required to be included in a switch-local SCC policy.

SCC policy commands are not distributed across the cluster. The RBridge ID of the node should be used to configure policy configurations.

NOTE
The configuration is applicable only to E_Ports on the Brocade VDX 6730 platforms. All configurations are local to the switch and are not automatically distributed across the fabric

Port security

Port security can be used to prevent administrators or malicious users from being able to change the MAC address of a virtual machine (VM) in a data center environment. This is especially helpful in virtual desktop infrastructure (VDI) environments, where users might have full administrative control of the VM and can change the MAC address of a virtual network interface card (vNIC). Here port security can be used to provide more control over the behavior of VMs.

The secured ports can be categorized as either trusted or untrusted. The administrator can apply policies appropriate to those categories to protect against various types of attacks.

Port security features can be turned on to obtain the most robust port-security level that is appropriate. Basic port-security features are enabled in the switch's default configuration. Additional features can be enabled with minimal configuration steps.

The following MAC port-security features enhance security at Layer 2:

- *MAC address limiting*: This restricts input to an interface by limiting and identifying the MAC addresses of workstations that are allowed to access the port. When secure MAC addresses are assigned to a secure port, the port does not forward packets with source addresses outside the group of defined addresses.
- *OUI-based port security*: If an administrator knows which types of systems are connecting to the network, it is possible to configure an Organizationally Unique Identifier (OUI) on a secure port to ensure that only traffic coming from devices that are part of the configured OUI is forwarded.
- *Port security with sticky MAC addresses*: Using sticky MAC addresses is similar to using static secure MAC addresses, but sticky MAC addresses are learned dynamically. These addresses are retained when a link goes down.

Default configurations

Port security is disabled by default. The following table summarizes default port-security configurations that are applied to an interface when it is made a secure port.

TABLE 53 Default configurations for port security

Feature	Default configuration
Max. number of secure MAC addresses	8192
Violation mode	Shutdown
Shutdown time (minutes)	0

Port security configuration commands

Port security is enabled on an interface by means of a series of **switchport** commands. For configuration examples, refer to Configuring port security on page 316.

The following summarizes the configuration commands. For command details, refer to the *Network OS Command Reference*

Command	Description
switchport port-security	Enables or disables port security on an interface port.
switchport port-security mac-address	Configures the MAC address option for port security on an interface port.
switchport port-security max	Configures the maximum number of MAC addresses used for port security on an interface port.
switchport port-security oui	Configures an Organizationally Unique Identifier (OUI) MAC address for port security on an interface port.
switchport port-security shutdown-time	Configures the shutdown-time option for port security on an interface port.
switchport port-security sticky	Converts dynamic MAC addresses to sticky secure MAC addresses.

Command	Description
switchport port-security violation	Configures the violation response options for port security on an interface.

Port security troubleshooting commands

The following **show** commands are useful in troubleshooting port security.

Command	Description
show ip interface brief	Displays port-security status when the port-security feature is applied.
show port-security	Displays the configuration information related to port-security.
show port-security addresses	Displays the configuration information related to port-security addresses.
show port-security interface	Displays the configuration information related to port-security interfaces.
show port-security oui interface	Displays the configuration information related to port-security for Organizationally Unique Identifier (OUI) interfaces.
show port-security sticky interface	Displays the configuration information related to port-security for a sticky interface

Port security guidelines and restrictions

Note the following guidelines and restrictions for configuring port security:

- A port mode change is not allowed when port security is enabled on the interface.
- Organizationally Unique Identifier (OUI)-based port security is not supported on the Brocade VDX 6710 and VDX 6720 platforms.
- A maximum of 4 OUIs are allowed per secure port. A maximum of 20 secure ports are allowed to enable OUI-based port security.
- Static secure MAC addresses are not supported for OUI-based port security.
- When the user tries to configure the first OUI IPv4 address on a secure port, traffic is flooded until all entries are programmed in the hardware.
- If a port-security-based change occurs when a port is shut down, the shutdown timer is not triggered. Consequently, the user must restore the full functionality of the port.
- When port security causes a port to be shut down and the user manually changes the shutdown time, the shutdown timer is reset and the timer starts with the new shutdown time.
- A secure port cannot be a destination port for Switch Port Analyzer (SPAN) purposes, because the port cannot be a Layer 2 port.
- Port security configurations are not allowed on member interfaces of a link aggregation group (LAG). They are allowed on the LAG interface, however, as they are in other Layer 2 configurations.
- Static MAC addresses cannot be configured on a secure port. They must be configured as secure MAC addresses on the secure port.
- Access control lists (ACLs) take precedence over the port security feature.

Understanding fabric authentication

This section presents a brief overview of SSH server key exchange, configuring an authentication policy and device authentication, and configuring SCC policy sets.

Configuring SSH server key exchange

The SSH server key-exchange specifies the method used for generating one-time session keys for encryption and authentication with the SSH server. Currently, you can configure the SSH server key-exchange method to DH Group 14.

If you are in logical chassis cluster mode, the command is not distributed across the cluster. The RBridge ID of the node should be used to configure service on individual nodes.

When the SSH server key exchange method is configured to DH Group 14, SSH connection from a remote SSH client is allowed only if the key-exchange method at the client end is also configured to DH Group 14.

By default, SSH server key-exchange is not configured as DH Group 14. Enter **no ssh server key-exchange dh-group-14** to restore SSH server key-exchange to the default value.

Configuring an authentication policy

The switch authentication (AUTH) policy initiates DH-CHAP authentication on all E_Ports. This policy is persistent across reboots, which means authentication will be initiated automatically on ports or switches brought online if the policy is active. You must configure the AUTH policy on all connected fabric entities.

If you are in logical chassis cluster mode, this command is *not* distributed across the cluster. The RBridge ID of the node should be used to configure protocol and policy configurations.

By default the policy is set to PASSIVE and you can change the policy. All changes to the AUTH policy take effect during the next authentication request. This includes starting authentication on all E_Ports on the local switch if the policy is changed to ON or ACTIVE, and clearing the authentication requirement if the policy is changed to OFF.

Authentication policy configuration is not distributed across the cluster. The RBridge ID of the node should be used to configure protocol and policy configurations.

You can set the authentication policy to any of the values listed in the following table. The remaining attributes are optional.

TABLE 54 User account attributes

Setting	Description
ON	Strict authentication is enforced on all E_Ports. During switch initialization, authentication is initiated on all E_Ports automatically. The authentication handshaking is completed before the switches exchange the fabric parameters (EFP) for E_Port bring-up. If the connecting switch does not support the authentication or the policy is turned off, all ports are disabled and the ISL goes down.
ACTIVE	A switch with an ACTIVE policy is more tolerant and can connect to a device with any type of policy. During switch initialization, authentication is initiated on all E_Ports, but the port is not disabled if the connecting switch does not support authentication, or if the authentication policy is turned off.
PASSIVE (default)	The switch does not initiate authentication, but participates in authentication if the connecting switch initiates authentication. The switch does not start authentication on E_Ports, but accepts the incoming authentication requests, and will not be disabled if the connecting switch does not support authentication or the policy is turned off.
OFF	The switch does not support authentication, and rejects any authentication negotiation request from a neighbor switch or device. A switch with the policy set to OFF should not be connected to a switch with a policy set to ON. A policy set to ON policy is strict and disables the port if a peer rejects the authentication. DH CHAP shared secrets must be configured

TABLE 54 User account attributes (continued)

Setting	Description
	on both sides of the connection before you can change the policy from an OFF state to an ON state.

The behavior of the policy between two adjacent switches is defined as follows:

- If the policy is ON or ACTIVE, the switch sends an Authentication Negotiation request to the connecting device.
- If the connecting device does not support authentication or the policy is OFF, the request is rejected.
- Once the authentication negotiation succeeds, the DH-CHAP authentication is initiated. If DH-CHAP authentication fails, the port is disabled, regardless of the policy settings.

The policy defines the responses of the host if the connecting switch does not support authentication. By default, the policy is set to PASSIVE and you can change the policy with the **fcsp auth** command. This includes starting authentication on all E_Ports if the policy is changed to ON or ACTIVE, and clearing the authentication if the policy is changed to OFF. Before enabling the policy, you must install the DH-CHAP shared secrets. Refer to Configuring DH-CHAP shared secrets on page 310.

Configuring DH-CHAP shared secrets

To configure the DH-CHAP shared secrets, execute the **fcsp auth-secret** command in privileged EXEC mode. Provide the following information as shown in the example:

- The world wide name (WWN) of the peer.
- The secret of the peer that authenticates the peer to the local switch.
- The local secret that authenticates the local switch to the peer.

  NOTE
  Only the following non-alphanumeric characters are valid for the secret key:@ $ % ^ & * ( ) _ + - < > { } [ ] ; ' :

```
switch# fcsp auth-secret dh-chap node 10:00:00:05:1e:7a:c3:00 peer-secret    12345678 local-secret 87654321
Shared secret is configured successfully.
```

To display the device (WWN) for which the shared secret is configured, use the **show fcsp auth-secret dh-chap** command in privileged EXEC mode.

```
switch# show fcsp auth-secret dh-chap 10:00:00:05:1e:7a:c3:00
```

To remove the shared secrets, use the **no fcsp auth-secret** command in privileged EXEC mode.

```
switch# no fcsp auth-secret dh-chap node 10:00:00:05:1e:7a:c3:00
Shared secret successfully removed
```

Setting up secret keys

Setting up secret keys can quickly become an administrative challenge as your fabric size increases. As a minimum, key pairs need to be installed on all connected fabric entities. However, when connections change, you must install new key pairs to accommodate these changes. If you anticipate this situation, you may install key pairs for all possible connections up front, thus enabling links to change arbitrarily while still maintaining a valid key pair for any new connection.

Setting the authentication policy parameters

The following procedure configures an authentication policy auth-type DH-CHAP (only option), a DH group of 2, and a hash type of md5. The switch policy is set to OFF until you are ready to explicitly activate the policy.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter the **fcsp auth** command with the specified parameters.

```
switch(config)# fcsp auth auth-type dh-chap hash md5 group 2 switch policy off
```

3. Enter the **do show running-config fcsp auth** command to verify the configuration.

```
switch(config)# do show running-config fcsp auth
fcsp auth group 2
fcsp auth hash md5
fcsp auth policy switch off
```

Activating the authentication policy

1. In privileged EXEC mode, issue the **configure terminal** command to enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
```

2. Enter the **fcsp auth policy active** command to change the policy state from OFF to ON.

```
switch(config)# fcsp auth auth-type switch policy on
```

3. Enter the **do show running-config fcsp auth** command to verify the configuration.

```
switch(config)# do show running-config fcsp auth
fcsp auth group 2
fcsp auth hash md5
fcsp auth policy switch on
```

Configuring a Brocade VDX 6730 to access a SAN fabric

Configuring a Brocade VDX 6730 switch to access a SAN fabric connected through an FC Router involves the following steps:

1. Configure the matching shared secret pairs on the VDX 6730 and on the FC router.
2. Configure the authentication policy on the VDX 6730 switch (The FC router configuration is fixed).
3. Activate the authentication policy.

Configuring defined and active SCC policy sets

The Switch Connection Control (SCC) policy maintains two versions, active, and defined, and creating a policy includes two distinct operations:

1. Creating the defined SCC policy set.

2. Activating the SCC policy.

The defined policy includes a list of WWN members and it is configurable. You can create the SCC policy and its members using a single command, **secpolicy defined-policy SCC_POLICY**. Or you can create the SCC policy first and add the members later. You can modify the defined policy at any time thereafter.

When you create the SCC policy and its defined member set, it remains inactive until you explicitly activate the policy with the **secpolicy activate** command. The SCC policy is enforced on the E_Ports only after you activate the policy. When the policy is active, only the members included in the activated policy can communicate with each other. If you add additional devices to the defined policy, they remain inactive and access is blocked until you active the defined policy again.

Follow these guidelines and restrictions when configuring SCC policy:

- During the configuration replay operation, the defined and active policies are replayed and the E_Ports are enabled or disabled based on the SCC policy entries in the active policy list.

  During a configuration replay operation, if an E_Port is already disabled due to a violation, it will not come online even if the WWN entry is found in the active policy list. You must explicitly bring up the E_Port to enforce the active policy.
- During execution of the **copy file running-config** command, only the defined policy in the switch is updated with the config file entries; the active policy entries remain unchanged. In this case, you must use the **secpolicy activate** command to activate the defined policy list.
- If an empty policy is created and activated, but not saved, all Fibre Channel (FC) E_Ports will be in the disabled state after a reboot.
- Network OS requires that you invoke the **shutdown** command, followed by the **no shutdown** command to bring up the E_Port. Invoking the **no shutdown** command alone does not enable the port.

Creating a defined SCC policy

The following procedure creates a Switch Connection Control (SCC) policy, adds two members, and verifies the configuration.

1. In privileged EXEC mode, issue the **configure terminal** command to enter global configuration mode.
2. Enter the secpolicy **defined-policy SCC_POLICY** command.

   This command places you into the defined SCC configuration mode where you can add policy member WWNs.
3. Specify a policy member with the **member-entry** *WWN* command.
4. Specify a second policy member with the **member-entry** *WWN* command.
5. Exit the defined SCC configuration mode.
6. Enter the **do show running-config secpolicy defined-policy** command to verify the configuration.

Creating an SCC policy in Standalone mode

This example creates an SCC policy in Standalone mode:

```
switch# configure terminal
Entering configuration mode terminal

switch(config)# secpolicy defined-policy SCC_POLICY

switch(config-defined-policy-SCC_POLICY)# member-entry 10:00:00:05:1e:00:69:00

switch(config-defined-policy-SCC_POLICY)# member-entry 10:00:00:08:2f:00:79:00

switch(config-defined-policy-SCC_POLICY)# exit

switch(config)# do show running-config secpolicy defined-policy
secpolicy defined-policy SCC_POLICY
 member-entry 10:00:00:05:1e:00:69:00
 !
 member-entry 10:00:00:08:2f:00:79:00
```

Creating an SCC policy in VCS mode

This example creates an SCC policy in VCS mode:

```
switch# config
Entering configuration mode terminal

switch(config)# rbridge-id 3

switch(config-rbridge-id-3)# secpolicy defined-policy SCC_POLICY

switch(config-defined-policy-SCC_POLICY)# exit

switch(config)#
```

Creating an SCC policy and adding members into the defined policy set in VCS mode

This VCS mode example creates a SCC policy and adds members into the defined policy set

```
switch# config
Entering configuration mode terminal

switch(config)# rbridge-id 3

switch(config-rbridge-id-3)# secpolicy defined-policy SCC_POLICY member-entry 10:00:00:05:1e:00:69:00

switch(config-member-entry-10:00:00:05:1e:00:69:00)# exit

switch(config-defined-policy-SCC_POLICY)# exit

switch(config-rbridge-id-3)# exit
```

Modifying the SCC policy

The same command sequence that creates the Switch Connection Control (SCC) policy adds additional members. The defined SCC member entries are cumulative. Use the **no member-entry** command to remove members from the policy.

The following examples adds a member and subsequently removes the same added member:

Standalone mode example

```
switch# configure terminal
Entering configuration mode terminal

switch(config)# secpolicy defined-policy SCC_POLICY
```

```
switch(config-defined-policy-SCC_POLICY)# member-entry 22:22:22:22:22:22:22:22

switch(config-defined-policy-SCC_POLICY)# no member-entry 22:22:22:22:22:22:22:22

switch(config-defined-policy-SCC_POLICY)# exit

switch(config)# do show running-config secpolicy defined-policy
secpolicy defined-policy SCC_POLICY
 member-entry 10:00:00:05:1e:00:69:00
 !
 member-entry 10:00:00:08:2f:00:79:00
```

VCS mode example

```
switch# config
Entering configuration mode terminal

switch(config)# rbridge-id 3

switch(config-rbridge-id-3)# secpolicy defined-policy SCC_POLICY

switch(config-defined-policy-SCC_POLICY)# member-entry 10:00:00:05:1e:00:69:00

switch(config-defined-policy-SCC_POLICY)# no member-entry 10:00:00:05:1e:00:69:00

switch(config-defined-policy-SCC_POLICY)# exit

switch(config)# do show running-config secpolicy defined-policy
secpolicy defined-policy SCC_POLICY
 member-entry 10:00:00:05:1e:00:69:00
 !
 member-entry 10:00:00:08:2f:00:79:00
```

Activating the SCC policy

1. Define the SCC policy as shown in section Creating a defined SCC policy on page 312.
2. Enter the **secpolicy activate** command in privileged EXEC mode.
3. Enter the **do show running-config secpolicy active -policy** command to verify the configuration.

Standalone mode example

```
switch# secpolicy activate

switch# do show running-config secpolicy active-policy
secpolicy active-policy SCC_POLICY
 member-entry 10:00:00:05:1e:00:69:00
 !
 member-entry 10:00:00:08:2f:00:79:00
```

VCS mode example

```
switch# secpolicy activate rbridge-id 3

switch# do show running-config rbridge-id 3 secpolicy defined-policy rbridge-id 3
secpolicy defined-policy SCC_POLICY
 member-entry aa:aa:aa:aa:aa:aa:aa:aa
 !
 member-entry bb:bb:bb:bb:bb:bb:bb:bb
 !
 member-entry cc:cc:cc:cc:cc:cc:cc:cc
 !
!
```

Removing the SCC Policy

1. In privileged EXEC mode, issue the **configure terminal** command to enter global configuration mode.
2. Enter the **no secpolicydefined-policy SCC_POLICY** command.
3. Exit global configuration mode.
4. Activate the SCC policy to save the defined policy configuration to the active configuration.
5. Enter the **do show running-config secpolicy active-policy** command to verify that the policy is empty.

Removing an entry from the policy list in standalone mode

```
switch# config
Entering configuration mode terminal

switch(config)# no secpolicy defined-policy SCC_POLICY member-entry 10:00:00:05:1e:00:69:00

switch(config)# exit

switch# secpolicy activate

switch# do show running-config secpolicy active-policy
% No entries found.
```

Removing the SCC_POLICY entry in standalone mode

```
switch# config
Entering configuration mode terminal

switch(config)# no secpolicy defined-policy SCC_POLICY

switch(config)# exit

switch# secpolicy activate

switch# do show running-config secpolicy active-policy
% No entries found.
```

Removing an entry from the policy list of rbridge-id 3 in VCS mode

```
switch# config
Entering configuration mode terminal

switch(config)# rbridge-id 3

switch(config-rbridge-id-3)# no secpolicy defined-policy SCC_POLICY member-entry 10:00:00:05:1e:00:69:01

switch(config)# exit

switch# do show running-config secpolicy active-policy
% No entries found.
```

Removing the SCC_POLICY entry of rbridge-id 3 in VCS mode

```
switch# config
Entering configuration mode terminal

switch(config)# rbridge-id 3

switch(config-rbridge-id-3)# no secpolicy defined-policy SCC_POLICY

switch(config)# exit

switch# do show running-config secpolicy active-policy
% No entries found.
```

Configuring port security

The following section covers how to configure port security for access and trunk ports, set port-security MAC address limits and shutdown time, set up OUI-based port security, and configure port security with sticky MAC addresses.

Refer also to Port security on page 307.

Configuring port security on an access port

To enable port security on an access port, do the following in global configuration mode.

1. Enable interface subconfiguration mode for the interface you want to modify.

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

2. Put the interface in Layer 2 mode by using the **switchport** command.

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

3. Enable switchport security by using the **switchport port-security** command.

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

Configuring port security on a trunk port

To enable port security on a trunk port, do the following in global configuration mode.

1. Enable interface subconfiguration mode for the interface you want to modify.

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

2. Put the interface in Layer 2 mode by using the **switchport** command.

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

3. Set the mode of the interface to trunk.

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

4. Set the VLANs that will transmit and receive through the Layer 2 interface.

```
switch(conf-if-te-1/0)# switchport trunk allowed vlan add 100
```

5. Enable switchport security by using the **switchport port-security** command.

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

Configuring port-security MAC address limits

To configure the MAC address option for port security on an interface port, do the following in global configuration mode.

1. Enable interface subconfiguration mode for the interface you want to modify.

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

2. Put the interface in Layer 2 mode by using the **switchport** command.

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

3. Set the MAC address and VLAN ID for the interface.

```
switch(conf-if-te-1/0)# switchport port-security mac-address 1000.2000.3000 vlan 100
```

Configuring port-security shutdown time

You can configure two responses to a violation of port security: **restrict** and **shutdown**.

- The **restrict** option drops packets that have unknown source addresses until you remove a sufficient number of secure MAC addresses until this value is below that set by the **switchport port-security max** command.
- The **shutdown** option puts the interface in the error-disabled state immediately for a predetermined amount of time.

To configure the port-security shutdown time for an interface port, do the following in global configuration mode.

1. Enable interface subconfiguration mode for the interface you want to modify.

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

2. Put the interface in Layer 2 mode by using the **switchport** command.

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

3. Set the violation response option to shutdown.

```
switch(conf-if-te-1/0)# switchport port-security violation shutdown
```

4. Set the shutdown time, in minutes.

```
switch(conf-if-te-1/0)# switchport port-security shutdown-time 10
```

Configuring OUI-based port security

If you know which types of systems are connected to your network, use this security feature to configure an Organizationally Unique Identifier (OUI) MAC address on a secure port. This ensures that only traffic from a known OUI MAC address is forwarded.

To configure OUI-based port security, do the following in global configuration mode.

1. Enable interface subconfiguration mode for the interface you want to modify.

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

2. Put the interface in Layer 2 mode by using the **switchport** command.

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

3. Configure a permitted OUI MAC address by using the **switchport port-security oui** command.

```
switch(conf-if-te-1/0)# switchport port-security oui 2000.3000.4000
```

Configuring port security with sticky MAC addresses

You can configure an interface to convert dynamic MAC addresses to sticky secure MAC addresses and add them to the running-config by enabling sticky learning. This converts all dynamic secure MAC addresses, including those learned dynamically before sticky learning was enabled, to sticky secure MAC addresses.

To configure sticky MAC addresses on a secure port, do the following in global configuration mode.

1. Enable interface subconfiguration mode for the interface you want to modify.

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

2. Put the interface in Layer 2 mode by using the **switchport** command.

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

3. Enable switchport security by using the **switchport port-security** command.

```
switch(conf-if-te-1/0)# switchport port-security oui 2000.3000.4000
```

4. Configure the sticky option.

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

Section III: Network OS Layer 2 Switch Features

Administering Edge-Loop Detection

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.

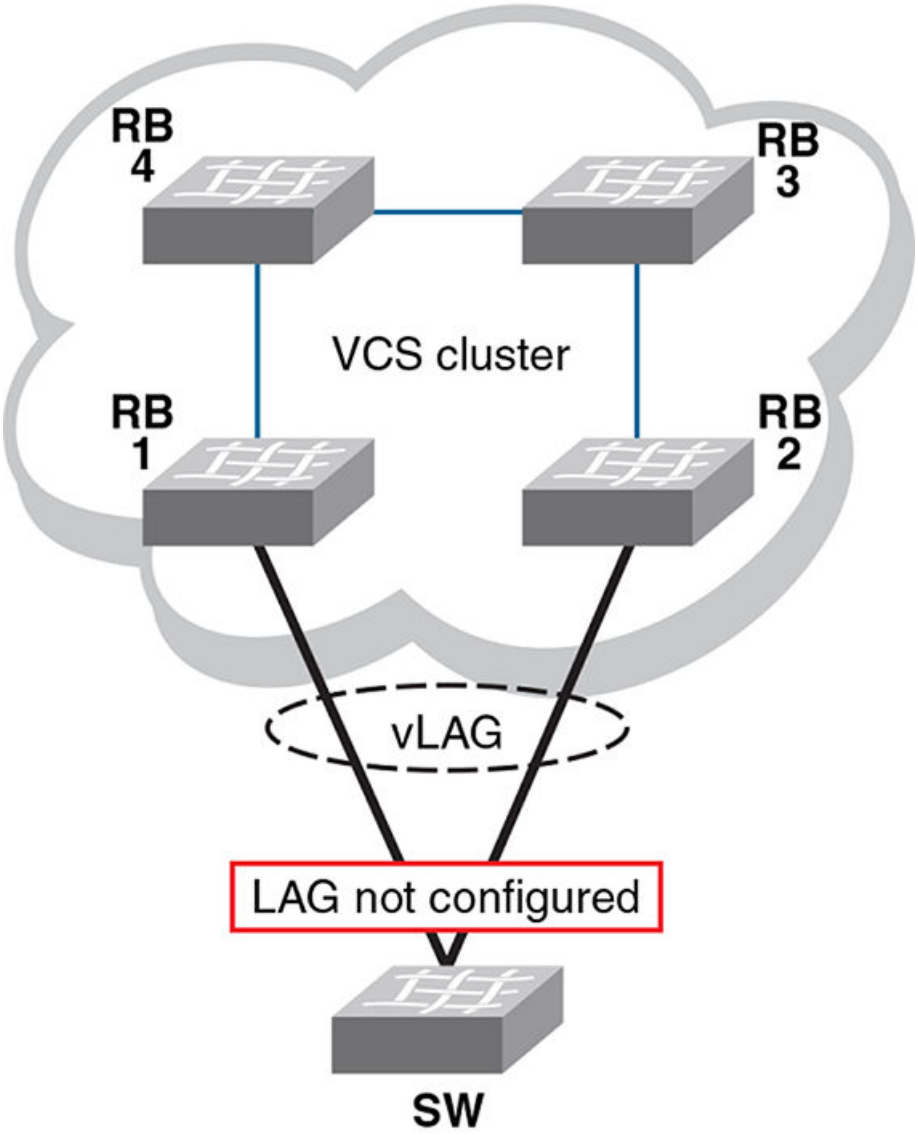
ELD is configured and enabled on Brocade VCS Fabric clusters. Any topology that includes one or more Brocade VCS Fabric clusters use ELD to detect Layer 2 loops and prevent broadcast storms. Standalone switches can be included in such a cluster, but loop detection takes place on the Brocade VCS Fabric 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.

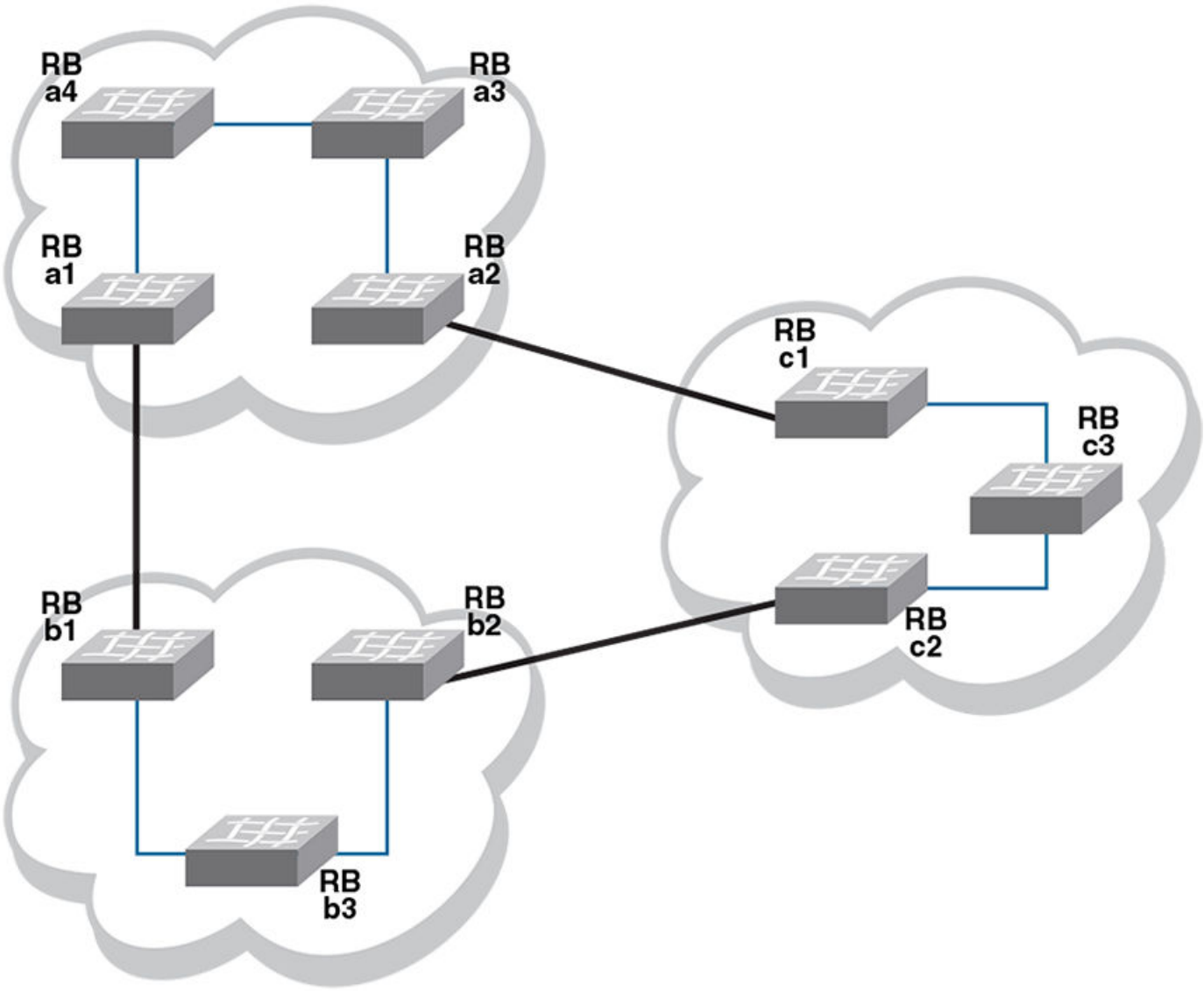
The following figure shows an example of a misconfiguration between a Brocade VCS Fabric cluster and a standalone switch that could cause a Layer 2 loop. In this case, a VLAG is configured on the edge devices of the Brocade VCS Fabric cluster for the two ISLs that connect the Brocade VCS Fabric cluster 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 36 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 37 Interconnected Brocade VCS Fabric clusters cause loop



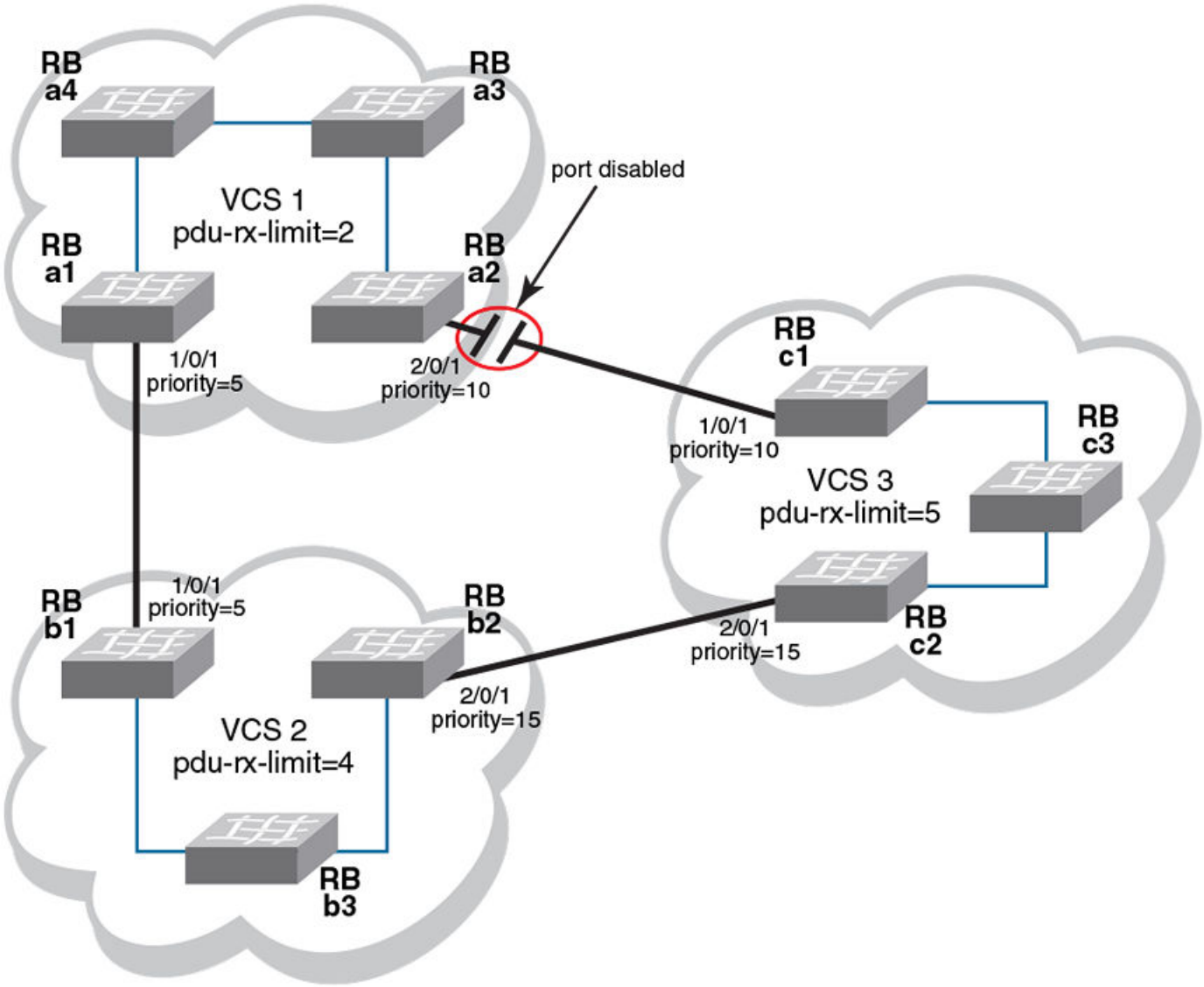
How ELD detects loops

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 321, but with ELD enabled on each edge port, and with port priorities and receive limits assigned.

FIGURE 38 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 shutdown by ELD is part of a LAG, all member ports of the LAG are also shutdown. If the port being shutdown is part of a vLAG, all member ports of the vLAG on that RBridge are also shutdown.

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 L2 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 timer 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. We recommend setting 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 **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* operand must be a value in the range1 through 5. The default value is 1.

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

4. Enter the **hello-interval** *number* command to set the interval between PDUs.

   The *number* operand has a unit of 1 millisecond (ms). It must be in the range from 100 ms to 5000ms . The default value is 1000 ms.

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

5. Enter the **edge-loop-detection shutdown-time** *number* command to set the number of minutes after which the shutdown port is re-enabled.

   The *number* value 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)# edge-loop-detection shutdown-time 1440
   ```

   The *number* value 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.

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) then 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 shutdown 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

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 335). 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 443.

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.

Auto Migrating Port Profile (AMPP) support for a mirrored port provides the support needed to make the mirrored port as profiled-port, and the reverse as well. This does not allow configuring the destination port as the profiled port, or the reverse. SPAN allows the capability to mirror the traffic learnt on the profiled port.

For complete information on SPAN, refer to Configuring Switched Port Analyzer on page 545.

AMPP scalability

The following table describes the Auto Migrating Port Profile (AMPP) scalability values supported by Network OS 4.0.0.

TABLE 55 AMPP scalability values

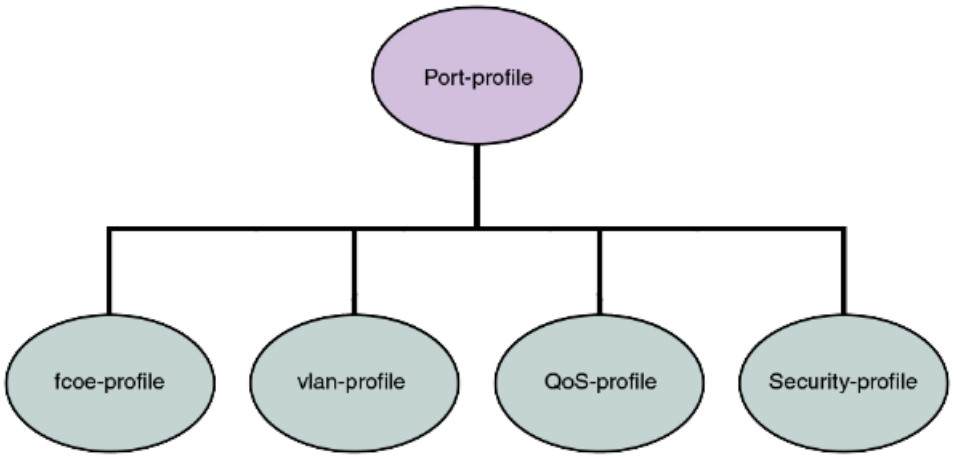
Metric	Logical chassis mode	Fabric cluster mode
Number of profiles	750	750
Number of VLANs in port-profiles	2000	2000
QoS profile	1 cee-map 1 mutation-map	1 cee-map 1 cos-mutation-map
Number of ACLs in security profiles	Same as Layer 2 ACL	Same as Layer 2 ACL
Number of MAC associations	8000 (4000 for Brocade VDX 6710.)	8000 (4000 for Brocade VDX 6710.)

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 750 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 39 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, except on the Brocade VDX 6730.

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 335 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 56 AMPP behavior and failure descriptions

AMPP event	Applicable behavior and failures
Create port-profile	• 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).
Activate port-profile	• 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. • If all the dependency validations succeed, the port-profile is in the ACTIVE state and is ready for association. • A vlan-profile is mandatory for all port-profiles.
De-activate port-profile	• This event removes the applied port-profile configuration from all the profiled-ports. • De-activation is allowed even if there are MAC addresses associated with the port-profile.
Modify port-profile	• Port-profile can be edited only in the pre-activation stage. • The port-profile is set to the INACTIVE state if any conflicting attributes are configured, or some dependent configuration is not completed. • Port-profile state is set as INACTIVE and any attempt to associate the port-profile to a MAC address may not be allowed.
Associate MAC addresses to a port-profile	• If the MAC is already associated with a port-profile, the port-profile to MAC association fails. • 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.
De-associate MAC addresses from a port-profile	• If mapping exists, all the policies configured for a specific MAC address are removed from that port or switch.

TABLE 56 AMPP behavior and failure descriptions (continued)

AMPP event	Applicable behavior and failures
Deleting a port-profile	• An IN USE error is generated if the port-profile is in an activated state. AMPP forces you to de-activate the profile before deleting. • If the port-profile is in an inactive state, then deletion of profile removes all the MAC associations as well.
Modifying port-profile content when in an associated state	• An IN USE error is generated if the port-profile is already activated.
Moving the VM MAC and notifying the fabric	• All policies associated to the port-profile ID are mapped on the MAC address and applied to the new port in the fabric.
Unused port-profile	• You must manually remove the port-profile to MAC associations.

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 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 vm1-port-profile
switch(config-port-profile-vm1-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 vm1-port-profile activate
```

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

```
switch(config)# port-profile vm1-port-profile static 0050.56bf.0001
switch(config)# port-profile vm1-port-profile static 0050.56bf.0002
switch(config)# port-profile vm1-port-profile static 0050.56bf.0003
switch(config)# port-profile vm1-port-profile static 0050.56bf.0004
switch(config)# port-profile vm1-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 vm1-port-profile activate
```

2. Enter VLAN profile configuration mode.

```
switch(config)# port-profile vm1-port-profile
switch(config-port-profile-vm1-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 vm1-port-profile activate
```

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

```
switch(config)# port-profile vm1-port-profile static 0050.56bf.0001
switch(config)# port-profile vm1-port-profile static 0050.56bf.0002
switch(config)# port-profile vm1-port-profile static 0050.56bf.0003
switch(config)# port-profile vm1-port-profile static 0050.56bf.0004
switch(config)# port-profile vm1-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 341 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 vm1-port-profile activate
```

2. Enter QoS profile mode.

```
switch(config)# port-profile vm1-port-profile
switch(config-port-profile-vm1-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 vm1-cos2cos-map
```

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

```
switch(config-qos-profile)# qos cos-traffic-class vm1-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 vm1-port-profile activate
```

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

```
switch(config)# port-profile vm1-port-profile static 0050.56bf.0001
switch(config)# port-profile vm1-port-profile static 0050.56bf.0002
switch(config)# port-profile vm1-port-profile static 0050.56bf.0003
switch(config)# port-profile vm1-port-profile static 0050.56bf.0004
switch(config)# port-profile vm1-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 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 vm1-port-profile activate
```

2. Enter security profile configuration mode.

```
switch(config)# port-profile vm1-port-profile
switch(config-pp)# security-profile
switch(config-pp-security)#
```

3. Modify the ACL security attributes. Refer to Configuring ACLs on page 467 for details.
4. Apply the ACL to the security profile.

```
switch(config-pp-security)# mac access-group vm1-acl in
```

5. Exit security profile configuration mode.

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

6. Activate the profile.

```
switch(config)# port-profile vm1-port-profile activate
```

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

```
switch(config)# port-profile vm1-port-profile static 0050.56bf.0001
switch(config)# port-profile vm1-port-profile static 0050.56bf.0002
switch(config)# port-profile vm1-port-profile static 0050.56bf.0003
switch(config)# port-profile vm1-port-profile static 0050.56bf.0004
switch(config)# port-profile vm1-port-profile static 0050.56bf.0005
```

8. 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
```

9. 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 vm1-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 vm1-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 vm1-port-profile activate
```

3. Enter port-profile mode.

```
switch(conf-vm1-port-profile)# port-profile vm1-port-profile
```

4. Use the following to delete sub-profiles.
   - To delete a vlan sub-profile:

```
switch(conf-vm1-port-profile)# no vlan-profile
```

   - To delete a security sub-profile:

```
switch(conf-vm1-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-vm1-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
```

3. 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
```

4. 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
```

5. 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

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:

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

FCoE terminology

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

TABLE 57 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 57 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.

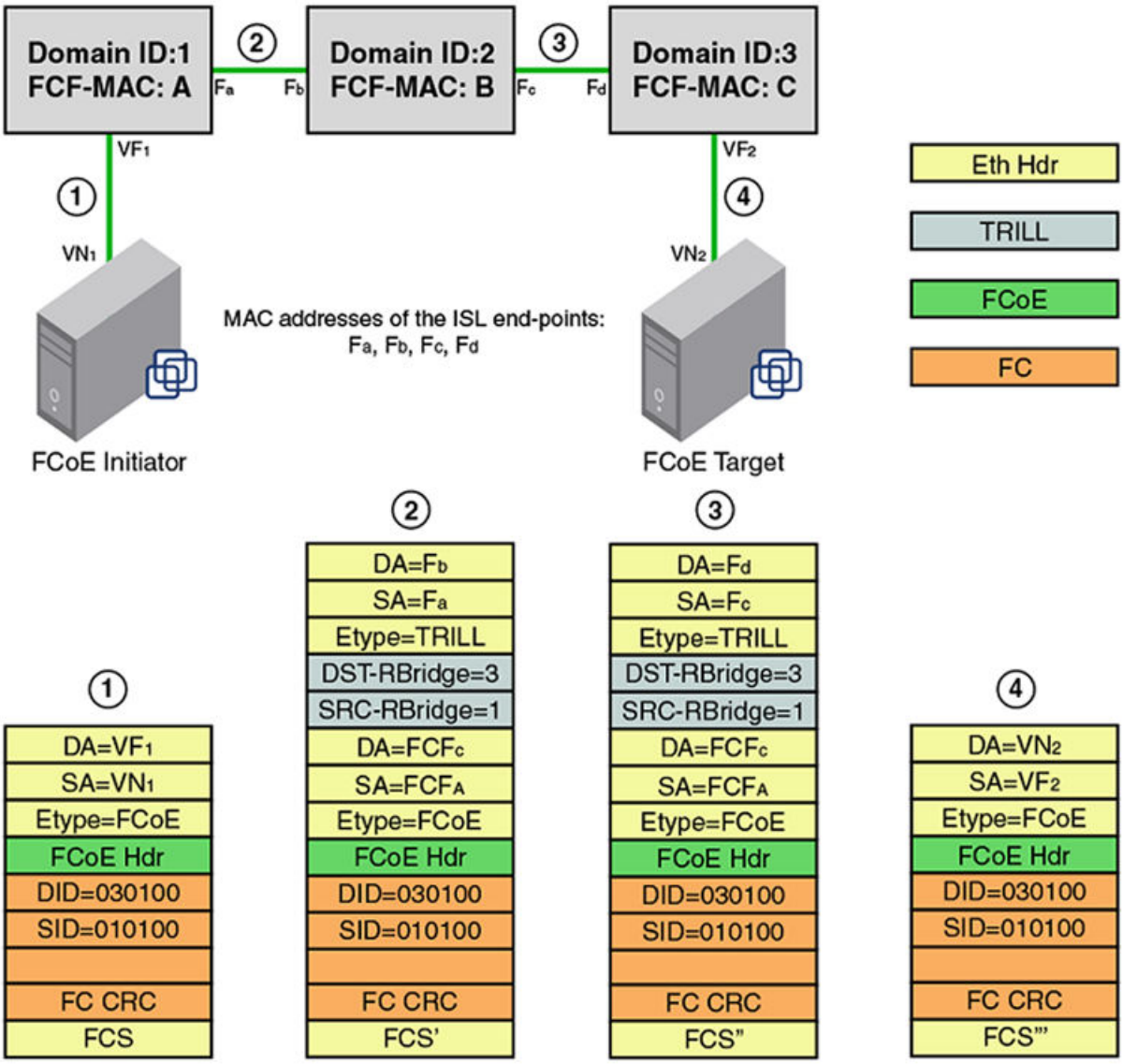
The following figure illustrates this process. Assume that VN1 (an FCoE initiator) is trying to access VN2 (an FCoE target).

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 40 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 is 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.

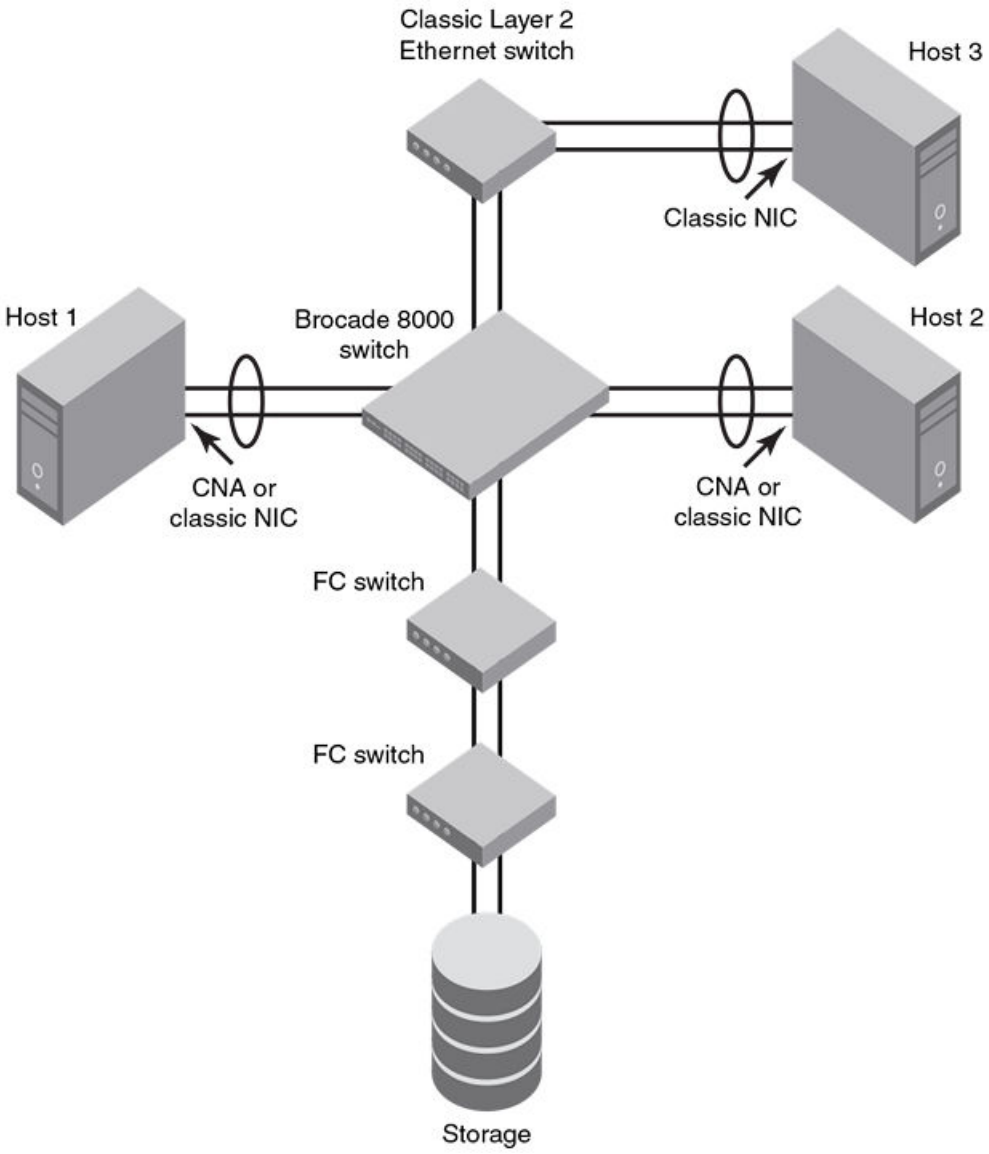
NOTE

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 figure below). 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 41 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 411.

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 359.

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 381.

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 477.

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 in global configuration mode is supported *only* on the Brocade VDX 6710, VDX 6720, and VDX 6730. 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 477.

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 Configuring ACLs on page 467.

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 455.

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 443.

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 491.

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* for the latest release.

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
   ```

5. 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     FCoE-Enodes
================================================================================
default      1002[D]  128[D]  3[D]  0xefc00[D]  8000[D]  Enabled[D]  64 [D]
Total number of Fabric Maps = 1
```

6. Repeat this procedure for any additional interfaces.

Assigning an FCoE map onto a LAG member

The **fcoeport default** is a command under interface configuration mode used 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.

1. 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)#
```

2. Activate the channel-group mode.

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

3. Set the LACP timeout to long.

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

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

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

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

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

6. 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
```

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

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

8. 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 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 example below.

```
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 58 Number of FCoE ports per platform

Platform	Number of FCoE ports
Brocade VDX 6740	1000

TABLE 58 Number of FCoE ports per platform (continued)

Platform	Number of FCoE ports
Brocade VDX 6740T	1000
Brocade VDX 6740T-1G	1000
Brocade VDX 6720-24	1000
Brocade VDX 6720-60	1000
Brocade VDX 6710	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.

Command	Description

show fcoe fabric-map	Displays VLAN and fabric-map state, among other items
show vlan brief	Displays VLANs that are configured, provisioned, and unprovisioned, among other items

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

Configuring 802.1Q VLANs

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 381.

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 364 for details).

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

Ingress VLAN filtering

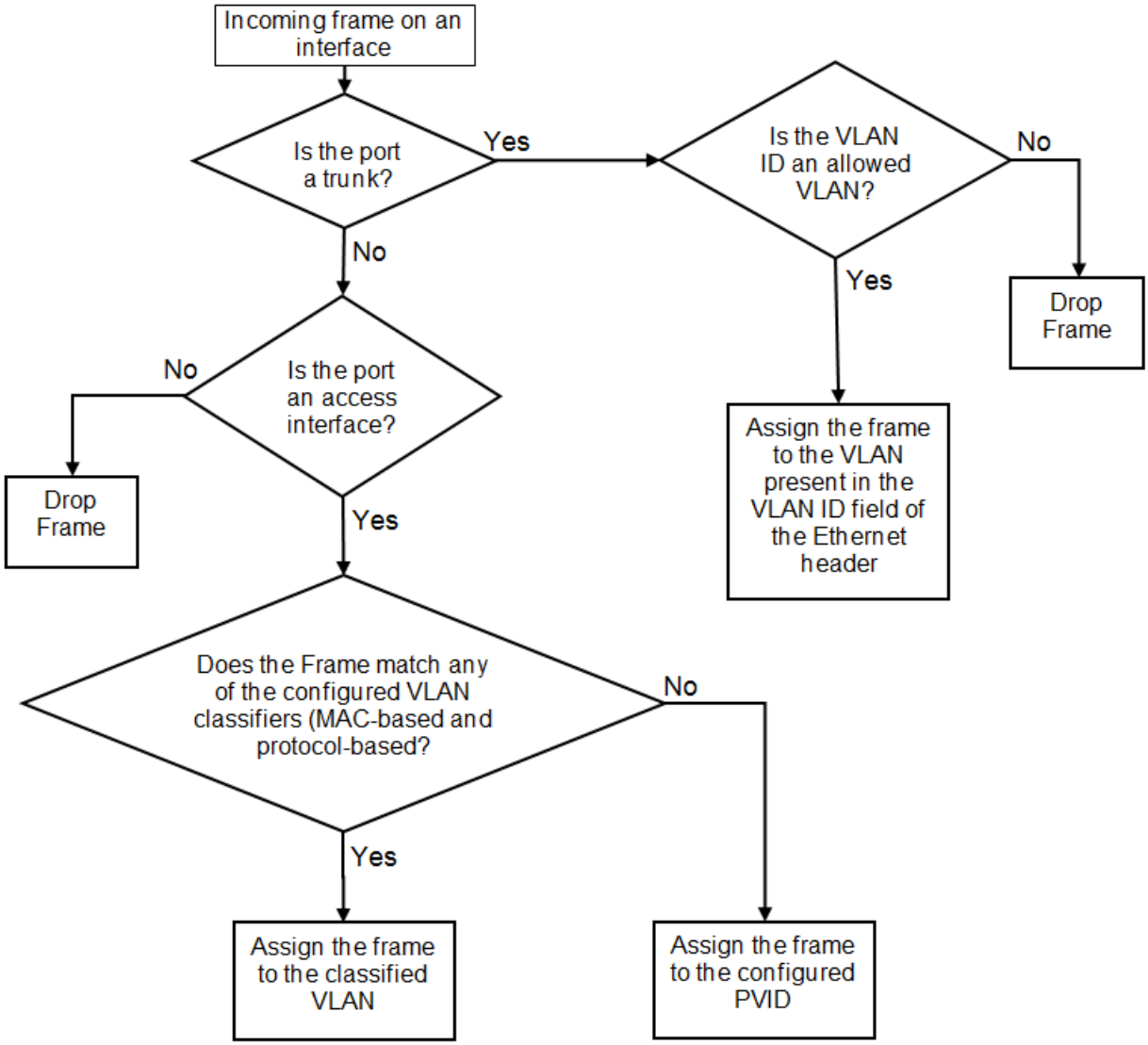
A frame arriving at Brocade VDX hardware is either associated with a specific port or with a VLAN, based on whether the frame is tagged or untagged. The association rules are as follows:

- 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 42 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 344.

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 59 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 disabled by default in standalone mode, but 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 DCB interface type and slot/port number.

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

```
switch(config)# interface tengigabitethernet 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 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 has the format: switch(config-if-gi-22/0/1)#.

```
switch(config)# interface tengigabitethernet 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 **configure terminal** 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 the spanning tree protocol 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 **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 0/1
   ```

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. For example

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

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

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

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

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

4. 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 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 0/19
   ```

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

   ```
   switch(conf-if-te-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/receive through the DCB interface

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

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

Allowing all VLANs to transmit/receive through the DCB interface

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

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

Excluding a VLAN from the DCB interface

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

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

Blocking all VLANs from the DCB interface

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

```
switch(conf-if-te-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 367).

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

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 344.

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 **configure terminal** 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 **configure terminal** 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 0/1 vlan 100
   ```

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 table below.

TABLE 60 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. Configure the secondary VLAN (community).

```
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 secondary VLAN with the primary VLAN. The list can contain one isolated VLAN and multiple community VLAN.

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

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 0/1
```

2. Mark the interface as a switch port.

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

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

   Configuring a tagged PVLAN host port.

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

   Configuring a tagged PVLAN host port.

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

4. Configure the interface as a PVLAN host port that is untagged.

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

5. Associate the interface with a PVLAN.

```
switch(conf-if-te-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.

   NOTE

   Multiple PVLAN pairs can be specified using this 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.

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

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

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

6. Configures 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 100
```

Displaying PVLAN information

To display private VLAN information, use the **show vlan private-vlan** command.

Configuring a VXLAN Gateway

Introduction to VXLAN Gateway

Virtual Extensible LAN (VXLAN) is an overlay network to extend L2 domains over L3 networks. The overlay network supports elastic compute architectures. VXLAN enables 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 IDs to 16 million. The VXLAN segment ID in each frame differentiates individual logical networks, allowing millions of isolated Layer 2 VXLAN networks to co-exist on a common Layer 3 infrastructure. As with VLANs, only virtual machines within the same logical network can communicate with each other.

Not all devices and servers, however, are capable of sending or receiving VXLAN traffic. A device called a VXLAN 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 (VCS) and other switches and devices behind the VCS.

The VXLAN-aware world consists of virtual networks that are managed by a third-party system known as the NSX Controller. The NSX Controller is a highly available distributed system that manages all network components and connections in a virtual network.

The VXLAN gateway must communicate with NSX controller to create tunnels with VXLAN-aware end devices. The NSX controller function can comprise a cluster of controllers.

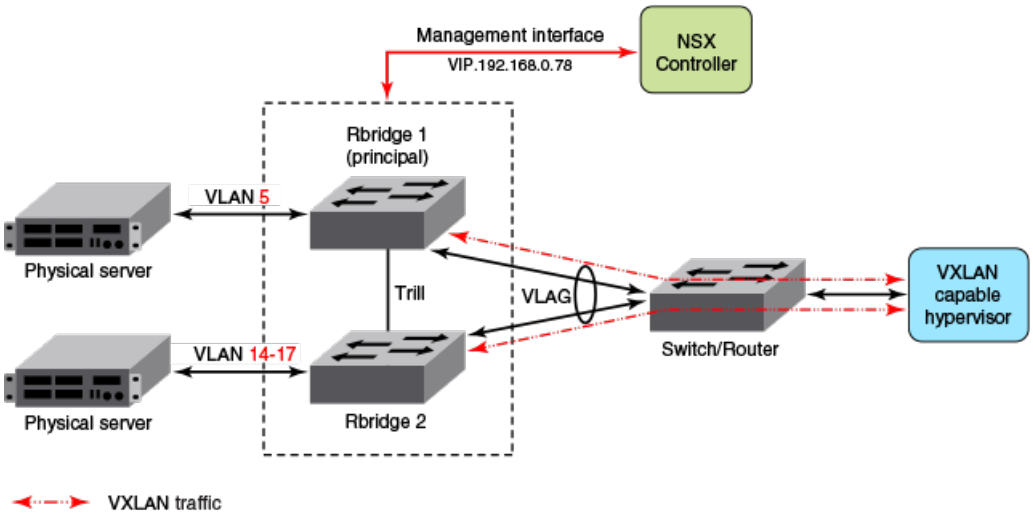
VXLAN tunnel endpoints

VXLAN creates large-scale, isolated virtual L2 networks for virtualized and multi-tenant environments by encapsulating frames in VXLAN packets. Frame encapsulation is performed by an VXLAN tunnel endpoint (VTEP). A VTEP originates and/or terminates VXLAN tunnels.

High-level communication in a VXLAN environment

The following illustration provides a basic view of the interaction of components in a VXLAN environment.

FIGURE 43 High-level communication for VXLAN gateway



VXLAN gateways must be part of a two-node virtual switching cluster. In the example shown in Figure 1, RBridge 1 and RBridge 2 make up the two-node cluster. These two RBridges combine to form the VXLAN gateway.

The current principal switch of the VXLAN 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).

VXLAN gateways are supported only on the Brocade VDX 6740, 6740T, and 6740T-1G.

> NOTE
> VXLAN gateways must be in logical chassis cluster mode. This allows the VCS to present itself as a single device to the NSX Controller.

Coordination of activities

Be sure to coordinate your activities with the administrators of the virtual network and NSX Controller to help ensure a successful setup.

Provide the NSX administrator with an inventory of switches, ports and VLANs in your VCS cluster.

The NSX administrator creates the virtual network, assigns a VXLAN Network Identifier (VNI) to this network, and selects ports which are to be attached to this virtual network. If ports on the VCS are selected, the NSX controller pushes network information to the VCS. 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 would not have the knowledge of MAC addresses in the L2 network behind the VCS at this time.

VXLAN Gateway configuration steps

Be sure you do the "Prequisite steps" before you configure the VXLAN gateway. The prerequisite steps demonstrate how to configure the RBridges as part of a virtual-router-redundancy-protocol extended group, which is a requirement for a VXLAN gateway. Also, you must configure the identical VE and VRRP-E group on all the Rbridges for the VXLAN gateway.

Prerequisite steps

The steps that follow show example VRRP-Extended group configuration for the RBridges shown in Figure 1. Perform all the following steps on the principal switch (Rbridge 1 in Figure 43 on page 374).

NOTE
When the VTEP is using the VRRP-Extended address of a Ve interface on a VLAN, then for all L2 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-Extended (active-active) with the same VRID and same virtual-mac address.

1. Enter global configuration mode:

```
switch# configure
```

2. Enter Rbridge ID configuration mode for the first RBridge in your logical chassis cluster (this example will use the Rbridge ID of 1 for RBridge 1 in Figure 1):

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

3. Enable the VRRP-Extended protocol for this Rbridge:

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

4. Enter the **interface ve** command to configure a virtual ethernet interface that corresponds to an already created vlan. This example will use ve 10:
5. Enter the IP address for RBridge 1 for this Ve interface (for example, 60.60.60.3/24):

```
switch(config-Ve-10)# ip address 60.60.60.3/24
```

6. Run the **no shutdown** command to enable the interface:

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

7. Run the **vrrp-extended group** command for the group ID (100 in this example) of the virtual-router-extended group:

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

8. Enter the following **virtual-mac address** command:

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

9. Enter the virtual ip address of the virtual-router-extended group, as in the following example:

```
switch(config-vrrp-extended-group-100)# virtual-ip 60.60.60.230
```

10. Enable short-path forwarding on the virtual router:

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

11. Enter the end command to exit configuration mode.
12. Enter global configuration mode:

```
switch# configure
```

13. Enter Rbridge ID configuration mode for the other RBridge in your logical chassis cluster (this example will use the Rbridge ID of 2 for RBridge 2 in Figure 1):

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

14. Enable the VRRP-Extended protocol for this Rbridge:

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

15. Enter the same **interface ve** command you entered for the first RBridge:

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

16. Enter the IP address for RBridge 2 for this Ve interface (for example, 60.60.60.4/24):

```
switch(config-Ve-10)# ip address 60.60.60.4/24
```

17. Run the **no shutdown** command to enable the interface:

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

18. Run the vrrp-extended group command for the group ID of the virtual-router-extended group:

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

19. Enter the following **virtual-mac address** command:

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

20. Enter the virtual ip address of the virtual-router-extended group, as in the following example:

```
switch(config-vrrp-extended-group-100)# virtual-ip 60.60.60.230
```

21. Enable short-path forwarding on the virtual router:

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

VXLAN gateway configuration example

The following steps illustrate how to configure a VXLAN gateway and point it to the NSX controller. This procedure uses data shown in Figure 43 on page 374.

Perform all the following steps on the principal switch (Rbridge 1 in Figure 43 on page 374):

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 are for creating a virtual tunnel endpoint:
   a) Enter global configuration mode, then run the **overlay-gateway name** command (gateway1 is used as an example name; this can be any name of your choice):

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

   b) Run the **attach rbridge-id** command to attach existing RBridge IDs to this VXLAN gateway instance. You can specify a range of RBridge IDs (as shown below):

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

   c) Run the **ip interface Ve** *veid* **vrrp-extended-group** *group-ID* command to set the IP address of the VXLAN gateway, as shown in this example:

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

   The command accepts the VE interface ID and VRPP-E group ID, then sets the VXLAN gateway IP address as identical to the already configured Virtual Redundancy Router Protocol-Extended (VRRP-E) virtual IP address. Tunnels that form use this IP address as the source IP address for outgoing packets.

   d) Run the attach vlan vlan_ID command to export specified VLANs (these are VLANs than can be mapped to VXLAN domains), as shown in the example below:

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

   All the MAC addresses that the VXLAN 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.

   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: You can run 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/remove 1-10
```

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

   f) Optional: If you have created a SPAN destination outside of the VXLAN gateway (as a monitor session), you can run the monitor session command to monitor sessions traffic, as shown in the following example:

```
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) Run the **activate** command to activate this gateway instance:

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

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

h) Return to Privileged EXEC mode by running the **end** command:

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

2. NOTE
Certificate generation is a one-time-only action.

Generate the security certificate for the VXLAN gateway by running the **nsx-controllerclient-cert generate** command:

```
sw0# nsx-controller client-cert generate
```

3. Display the certificate by running the **show nsx-controller client-cert** command in Privileged EXEC mode, then provide the certificate to the NSX administrator.
4. The following substeps are for configuring the management interface (depicted by the red line in Figure 43 on page 374), which allows communication between the VXLAN gateway and the NSX controller:
   a) Enter global configuration mode by running the **configure** command.

```
sw0# configure
```

   b) Run the **vcs virtual ip address** command:

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

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

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

   d) Run the **ip address** command to set the IP address of the controller, 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, run the following command:

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

   f) Run 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

Most of the VXLAN-gateway-related commands were used in the configuration example in the section VXLAN Gateway configuration steps on page 375. For complete information on the those commands as well as other VXLAN gateway commands and commands related to nsx-controller, refer to the *Network OS Command Reference.*

Some additional commands you may want to use include the following:

- **show nsx controller**—Displays connection status for the NSX controller. Includes an option to display the gateway certificate that is needed for NSX "transport node" configuration.

- **show overlay-gateway**—Displays status and statistics for the VXLAN gateway instance.
- **clear overlay-gateway**—Clears counters for the specified gateway.
- **show tunnel**—Displays statistics for tunnels.

Configuring Virtual Fabrics

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 approximately16 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 385.

For example topologies and detailed discussion, refer to Virtual Fabrics configuration overview on page 385.

Virtual Fabrics considerations and limitations

FGL limitations

Network OS 4.1.0 supports pre-IETF standard Fine-Grained Labeling (FGLs) on ISLs. IETF defines the Ethertype for inner and outer labels as 0x893B. The outer and inner Ethertypes 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 and vCenter orchestration

Network OS 4.1.0 does not support the use of VFs to extend a VCS fabric to another VCS fabric, or to orchestrate multiple vCenters.

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. RBridges 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 RBridges running in logical chassis cluster mode.

In earlier releases, every 802.1Q VLAN had to be configured on every RBridge. This configuration had to be applied to every RBridge, even when that RBridge serves as a transit and did not terminate the VLAN. This is because the RBridge 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 RBridges. A transit RBridge 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 RBridge.

Mixed fabric interoperability

Releases prior to Network OS 4.1.0 can support only 802.1Q VLAN configurations. However, although Network OS 4.1.0 can support both 802.1Q VLANs and VFs, CLI support for a given VF configuration depends on the participating RBridge's capability. This is because the Brocade VDX 6720 series and VDX 6730 series can support only 802.1Q VLAN configurations, whereas the Brocade VDX 6740 series and VDX 8770 series can support any VF configuration.

A VCS Fabric can be in one of three states, which are determined from the participating RBridge's capability and the VF state of the fabric. The VF state can change when an RBridge joins or leaves the fabric. VF configurations are supported only when a fabric is in the VF-enabled state, as summarized below.

- VF-incapable: Fabric has mixed platforms (VDX 6720, 6730, 6740, 8770) or mixed releases (Network OS 4.1.0 and earlier). Support is for 802.1Q VLANs only.
- VF-capable: Fabric has VDX 6740 and 8770 RBridges all with Network OS 4.1.0. By default, support is for 802.1Q VLANs only. Use the **vcs virtual-fabric enable** command to bring fabric to the VF-enabled state and support VFs.
- VF-enabled: Fabric is enabled to support VF configuration. In this state, pre-Network OS 4.1.0 RBridges and VDX 6720 and VDX 6730 RBridges cannot join the fabric.

The following summarizes VF states by platform and release:

Switch/platform joining fabric	VF-incapable fabric	VF-capable fabric	VF-enabled fabric
VDX 6720/6730	Yes	Yes	No
Pre-4.1.0 VDX 6740/8770	Yes	Yes	No
4.1.0 VDX 6740/8770	Yes	Yes	Yes

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 RBridges 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 RBridges in the fabric. Each RBridge 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-config, the RBridge will not able to join a VF-enabled fabric upon reboot. Although the RBridge may form ISLs with a neighbor RBridge at the link level, the RBridge will be segmented from the VF-enabled cluster because of a capability mismatch.

In order for the RBridge to join a VF-enabled cluster, the procedures described in Upgrading and downgrading firmware with Virtual Fabrics on page 409 must apply to the segmented RBridge. At the end of the procedures, the segmented RBridge will also be in the VF-enabled state. All segmented ISLs on the RBridge 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 RBridges in the fabric. If there are 100K VLANs in the data center, this implies that as RBridge will receive all those configuration, even though the RBridge could support a maximum of 8K (8192) VLANs. The processing of VLAN configurations for classified VLANs that are not actually provisioned in the RBridge 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 61 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 RBridge. 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 RBridge 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 RBridge. 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 RBridge 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

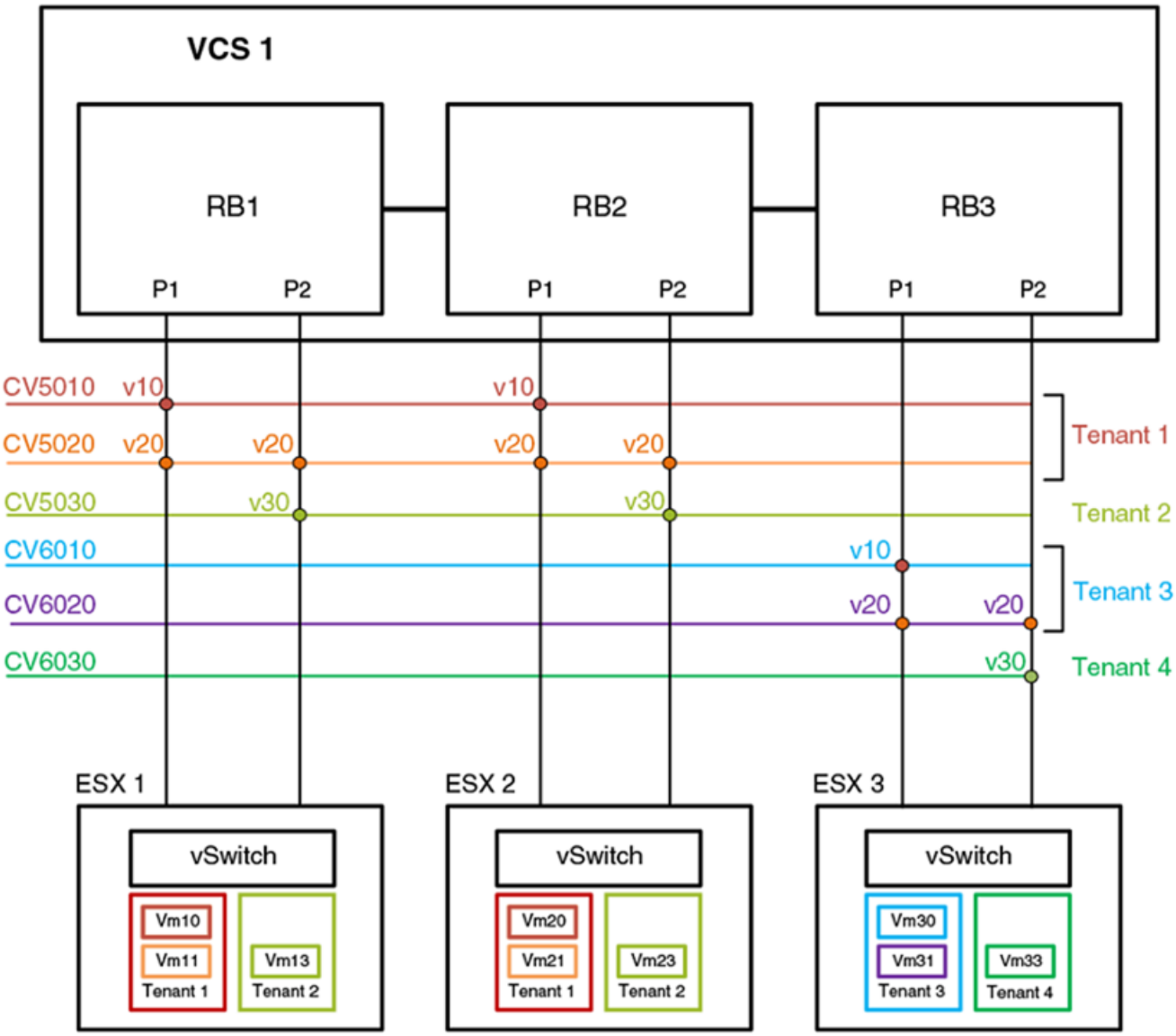
The Brocade VDX 6740 series RBridge supports a total of 6096 (4096 + 2000) VLANs, 4096 of which must be 802.1Q VLANs. The other 2000 VLANs can be configured as service VFs, assuming that the VLAN is configured on a single port. This limitation comes from the VPN table size on this platform.

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 below, 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.

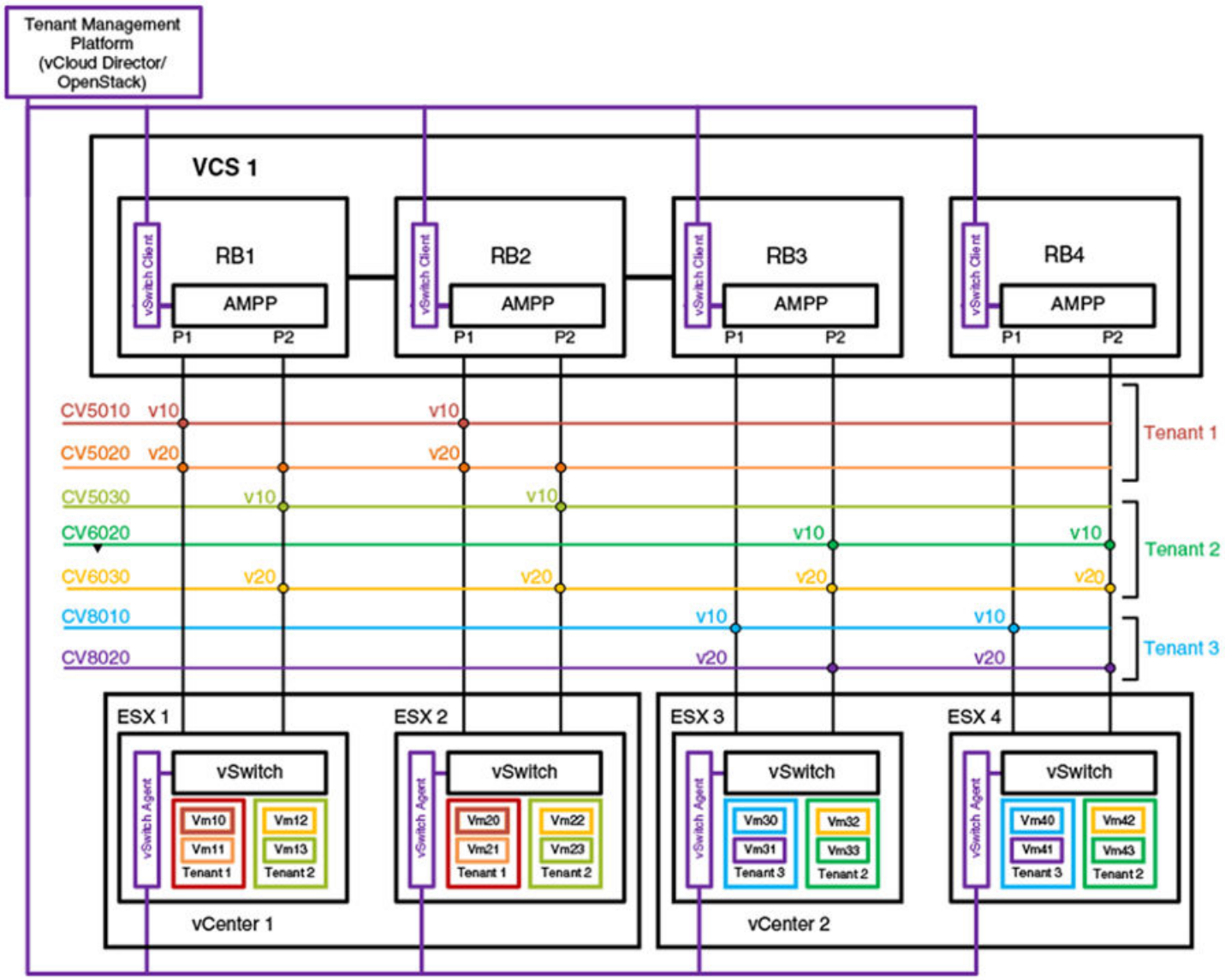
FIGURE 44 VLAN virtualization



Virtual data center deployment

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

FIGURE 45 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 above 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.)

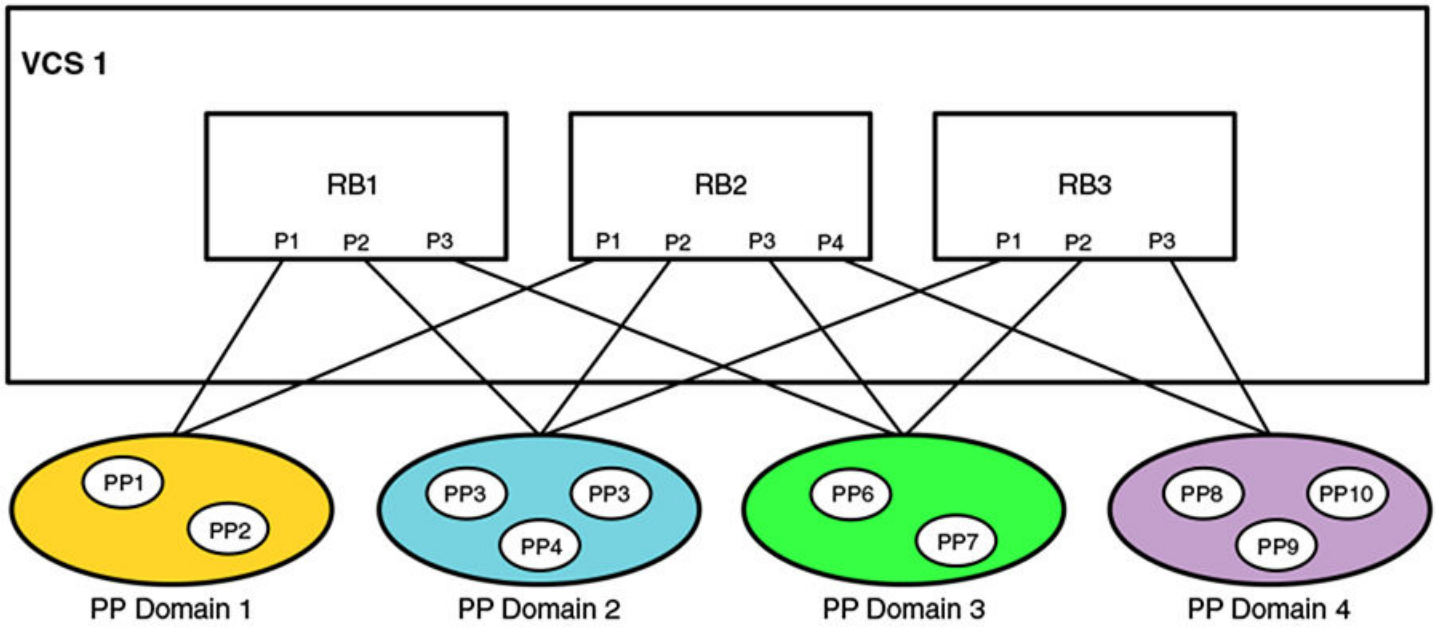
AMPP provisioning with service VFs

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 46 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 PP 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 PP 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 PP domain.
    a. Overlapping VF VLANs
        a. **switchport trunk allow vlan add 8000 ctag 80**
        b. **switchport trunk allow vlan add 8000 ctag 800**
    b. Overlapping C-TAG:
        a. **switchport trunk allow vlan add 5000 ctag 10**
        b. **switchport trunk allow vlan add 6000 ctag 10**
    c. Overlapping MAC address across all profiles in the same domain:
        a. **switchport access vlan 8002 mac 2.2.2**
        b. **switchport access vlan 8003 mac 2.2.2**
    d. Conflicting access and trunk service VF configurations:
        a. **switchport access vlan 8000 mac 2.2.2**
        b. **switchport trunk vlan add 8000 ctag 20**
7. The following configuration can be present on only one PP 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 new port-profile named UpgradedVlanProfile is automatically created. This profile has the single VLAN profile that represents the results of the **switchport trunk allow vlan all** command. This is the configuration that is present in the default port-profile prior to Network OS 4.1.1.
- 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 mentioned above.

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, 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 default port-profile domain.
- The user is allowed to edit the default port-profile domain.
- The user is not allowed to delete the default-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.

TABLE 62 Configuration status before and after upgrade

Network OS 4.0.0	Network OS 4.1.1
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 !	port-profile default allow non-profiled-macs vlan-profile switchport switchport mode trunk switchport trunk native-vlan 1 ! fcoe-profile fcoeport default ! restrict-flooding

TABLE 62 Configuration status before and after upgrade (continued)

Network OS 4.0.0	Network OS 4.1.1
restrict-flooding ! port-profile pp1 vlan-profile switchport switchport mode trunk switchport trunk allowed vlan add 11 ! ! port-profile pp2 vlan-profile switchport switchport mode trunk switchport trunk allowed vlan add 12 ! !	! ! port-profile pp1 vlan-profile switchport switchport mode trunk switchport trunk allowed vlan add 11 switchport trunk allowed vlan add 5000 ctag 50 ! ! port-profile pp2 vlan-profile switchport switchport mode trunk switchport trunk allowed vlan add 12 switchport trunk allowed vlan add 6000 ctag 60 ! ! 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 !

Association of multiple port-profiles with an interface

The **port-profile-port** command allows a user to associate a profiled-port to a single port-profile or to a port-profile domain that contains multiple port-profiles. The result is that all VLANs specified therein are configured onto the port.

When the **domain** keyword is not used, the default is to apply only the 802.1Q VLANs that exist in any port-profile that is configured on the switch. This is shown the following example.

```
switch(config)# int te 2/0/1
switch(config-int-te-2/0/1)# port-profile-port domain vDC1
```

STP with service VFs

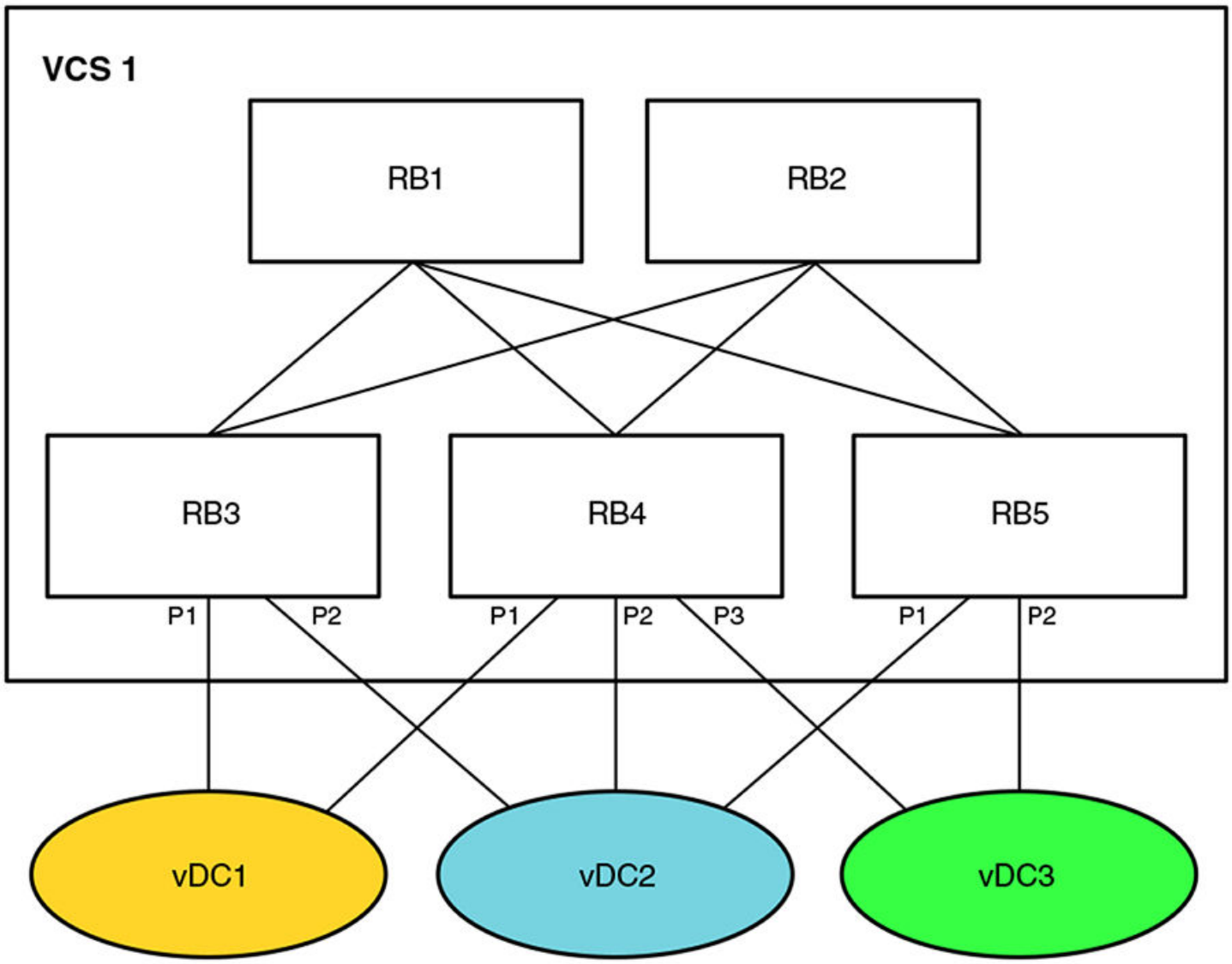
Spanning Tree Protocol (xSTP) is configured on a switch port as in previous releases. However, the user is responsible for configuring xSTP correctly. The user must ensure that VLAN configurations and VLAN-to-instance mappings are consistent across switch ports, and must understand whether RSTP or MSTP 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 47 STP-with-service-VFs topology



STP-with-service-VFs configuration rules

It is 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 RBridges in a given VRF instance.

Transport VFs

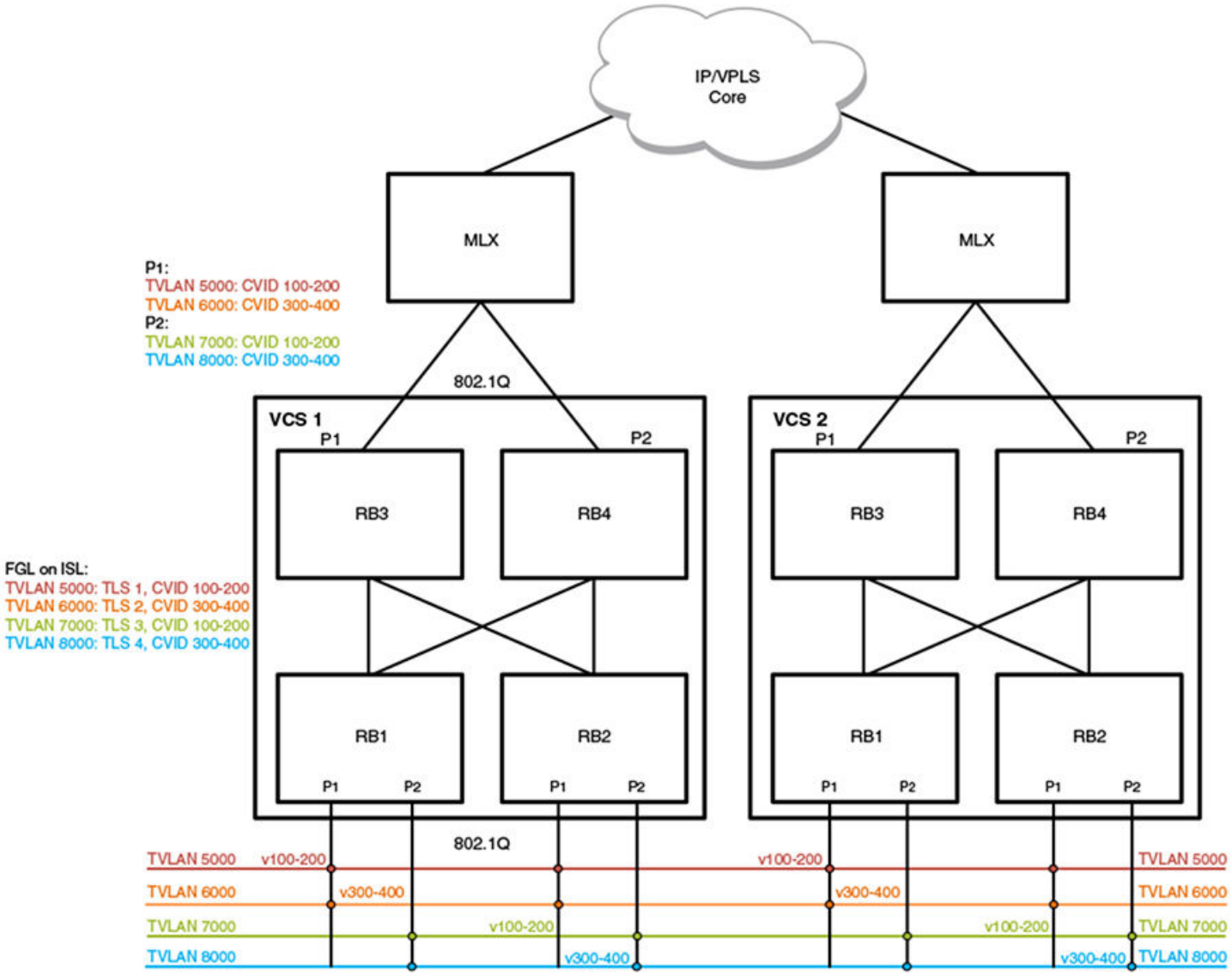
Transport service enables a cloud provider to offer service applicability on a VLAN group level, rather than at a per-individual tenant VLAN level.

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 48 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** *tlsid* 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.

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 below.

TABLE 63 802.1Q 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	**switchport trunk native vlan** *vid*, **switchport trunk tag native-vlan**, AND **dot1q tag native**
Untagged and tagged	Yes	No	**switchport trunk native vlan** *vid*, **no switchport trunk tag native-vlan**, OR **no dot1q tag native**

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 64 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	**switchport trunk native vlan** *vid*, **no switchport trunk tag native-vlan**
Tagged only	N/A	Yes	**switchport trunk native vlan** *vid* **ctag** *cvid*, **switchport trunk tag native-vlan**
Untagged and tagged	Yes	No	**switchport trunk native vlan** *vid* **ctag** *cvid*, **no switchport trunk tag native-vlan**

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-5/01)# 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-5/01)# 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-5/01)# switchport trunk native-vlan 7000
ERROR: interface is not configured to accept untagged packet
(config-if-te-5/01)# no switchport trunk tag native-vlan
(config-if-te-5/01)# 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 below.

TABLE 65 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	**switchport mode trunk-no-default-native**
Untagged only	Yes	N/A	**switchport trunk native-vlan-untagged** *vid*
Tagged only	N/A	Yes	Use regular VLAN classification: **switchport trunk allow vlan add** *vid* [**ctag** *cvid*]
Untagged and tagged	Yes	Yes	**switchport trunk native-vlan-xtagged** *vid* [**ctag** *cvid*] [**ctag** *cvid*] **egress** [**untagged**	**tagged**	**any**]

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-xtgagged** *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-it-te-5/0/1)# switchport trunk tag-native
    ERROR: Port mode not set to trunk
switch(config-it-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 381.

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* 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(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 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(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 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 395.

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
```

2. In VLAN configuration mode, use the **private-vlan** command 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
```

3. 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

1. 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
```

2. 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
```

3. 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
```

4. 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
```

5. Configure the isolated PVLAN on the access port.

```
switch(config)# interface te 1/1/2
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 6000
```

6. Configure the community PVLAN on the 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 allowed vlan add 7000 ctag 10
switch(conf-if-te-1/0/3)# switchport private-vlan host-association 5000 7000
```

7. 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
```

8. Configure the PVLAN trunk port.

```
switch(config)# interface te 1/4/1
switch(conf-if-te-1/4/1)# switchport private-vlan trunk allowed vlan add 5000 ctag 10
switch(conf-if-te-1/4/1)# switchport private-vlan trunk allowed vlan add 6000 ctag 20
switch(conf-if-te-1/4/1)# switchport private-vlan trunk allowed vlan add 7000 ctag 30
switch(conf-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(conf-if-te-1/4/1)# switchport trunk allowed vlan add 5000 ctag 10
switch(conf-if-te-1/4/1)# switchport trunk allowed vlan add 6000 ctag 10
switch(conf-if-te-1/4/1)# switchport trunk allowed vlan add 6000 ctag 10
switch(conf-if-te-1/4/1)# switchport private-vlan association trunk 5000 6000
switch(conf-if-te-1/4/1)# switchport private-vlan association trunk 5000 7000
```

The following configures non-PVLAN VFs.

```
switch(conf-if-te-1/4/1)# switchport private-vlan trunk allowed vlan add 400
switch(conf-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(conf-if-te-1/0/1)# switchport mode private-vlan trunk promiscuous
switch(conf-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(conf-if-te-1/0/2)# switchport mode private-vlan trunk host
switch(conf-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(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
```

- 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
```

3. 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.

4. 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
```

5. 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.

6. 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 395.

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 RBridges in that VRF instance. Virtual Router Redundancy Protocol (VRRP) provides high availability.
Do the following to configure Layer 3 service VF features.

1. 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(conf-if-te-3/1/1)# switchport
switch(conf-if-te-3/1/1)# switchport mode trunk
switch(conf-if-te-3/1/1)# switchport trunk allowed vlan add 5000 ctag 50
```

2. Enable VRF and VRRP on an RBridge.

```
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
```

Upgrading and downgrading firmware with Virtual Fabrics

Refer to Virtual Fabrics upgrade and downgrade considerations on page 383 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*.

Command	Description
show vlan brief	Displays all classified VLANs that are configured, provisioned (active) or unprovisioned (inactive).
show port profile	Displays the AMPP port-profile configuration information.
show overlapping-vlan-resource usage	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.
show virtual-fabric status	Displays the status of the Virtual Fabric: VF-capable, VF-incapable, or VF-enabled.

Configuring STP-Type Protocols

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.

> NOTE
> All Brocade VDX switches that are operating in standalone mode need to have some version of xSTP configured in order to avoid VLAN looping issues.

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 432.
- *Port fast BPDU guard* and *BPDU filter* — Refer to Enabling port fast (DCB) on page 434.

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 TurboIron. 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 66 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 based on the above attributes. 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 STP/RSTP/MSTP switches in standalone 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.
- 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.
- To eliminate the need for standalone mode in order to be able to run xSTP.

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. The xSTP protocol is running between VCS and standalone nodes. Each VCS has a unique RBridge ID and Priority. DiST can be enabled on VCS edge ports connecting to other VCS nodes or standalone 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 412.

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 67 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 68 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 69 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 424.

```
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 425. 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 434.

   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 non-trunking mode.

```
switch(config)# interface tengigabitethernet 0/10
switch(conf-if-te-0/10)# spanning-tree portfast
switch(conf-if-te-0/10)# exit
switch(config)# interface tengigabitethernet 0/11
switch(conf-if-te-0/11)# spanning-tree portfast
switch(conf-if-te-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 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 432.

   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-0/12)# end
```

9. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
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 416.

Configuring RSTP

The basic process for configuring RSTP is as follows.

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

```
switch# configure terminal
```

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 424.

```
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 425. 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 426.

```
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 426.

```
switch(conf-stp)# max-age 25
```

6. Enable the **error disable timeout timer** value. For more details, refer to Enabling the error disable timeout timer on page 428.

```
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 428.

```
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 429.

```
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 427.

```
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 434.

    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 0/10
switch(conf-if-te-0/10)# spanning-tree portfast
switch(conf-if-te-0/10)# exit
switch(config)# interface tengigabitethernet 0/11
switch(conf-if-te-0/11)# spanning-tree portfast
switch(conf-if-te-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 435.

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 432.

    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** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

Configuring MSTP

The basic process for configuring MSTP is as follows.

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

```
switch# configure terminal
```

2. Enable MSTP by using the global **protocol spanning-tree** command. Refer to Enabling STP, RSTP, MSTP, PVST+ or R-PVST+ on page 424 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 423 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 423 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 422 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 422 for more details.

```
switch(config-mstp)# max-hops 25
```

7. Return to privileged EXEC mode.

```
switch(config)# end
```

8. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

For more information on MSTP, refer to Configuring and managing STP and STP variants on page 416.

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

This 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 **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Enter the **protocol** command to enable MSTP.

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

3. Enter the **cisco-interoperability enable** command to enable interoperability with certain legacy Cisco switches.

```
switch(config-mstp)# cisco-interoperability enable
```

To disable interoperability with certain legacy Cisco switches, perform the following steps from privileged EXEC mode.

4. Enter the **configure terminal** command to access global configuration mode.
5. Enter the **protocol** command to enable MSTP.

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

6. Disable interoperability with certain legacy Cisco switches.

```
switch(config-mstp)# cisco-interoperability 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 **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

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** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

Specifying the maximum number of hops for a BPDU (MSTP)

In MSTP mode, use this 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 **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Enter the **protocol** command to enable MSTP.

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

3. Enter the **max-hops** command to configure the maximum number of hops for a BPDU in an MSTP region.

```
switch(config-mstp)# max-hops hop_count
```

4. Return to privileged EXEC mode.

```
switch(config-mstp)# end
```

5. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

Specifying a name for an MSTP region

In MSTP mode, use this 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 **configure terminal** command to access global configuration mode.

```
switch# configure terminal
```

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** command to save the `running-config` file to the `startup-config` file.

```
switch# copy running-config startup-config
```

Specifying a revision number for MSTP configuration

In MSTP mode, use this 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 **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Enter the **protocol** 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** command to save the *running-config* file to the *startup-config* file.

```
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 rpvst** commands. Refer to the *Network OS Command Reference* for details.

> NOTE
> Before proceeding, refer to PVST+ and R-PVST+ guidelines and restrictions on page 415.

For example, the script below sets up PVST+ for VLAN 10:

```
switch(config)# protocol spanning-tree pvst
switch(conf-pvst)# bridge-priority 4096
switch(conf-pvst)# forward-delay 4
switch(conf-pvst)# hello-time 2
switch(conf-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 **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

2. Enter the **protocol** command to enable STP, RSTP, MSTP, PVST+, or R-PVST+.

```
switch(config)# protocol spanning-tree mode_name
```

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 **configure terminal** command to access global configuration mode.

```
switch# configure terminal
```

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

```
switch# configure terminal
```

2. Enter the **shutdown** command to globally shutdown STP, RSTP, MSTP, PVST+, or R-PVST+. The **shutdown** command below 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 (**BPDU**s) 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.

> NOTE
> On the Brocade VDX 8770, the VLAN value can be 1 through 4086. VLAN IDs 4087 through 4094 are internally reserved VLAN IDs. On all other Brocade VDX switches, the VLAN value can be 1 through 3962, as 3963 through 4094 are reserved.

To specify the bridge priority, 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 **protocol** 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*(forward_delay - 1)≥ max_age ≥ 2*(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.

NOTE
On the Brocade VDX 8770, the VLAN value can be 1 through 4086. VLAN IDs 4087 through 4094 are internally-reserved VLAN IDs. On all other Brocade VDX switches, the VLAN value can be 1 through 3962, as 3963 through 4094 are reserved.

To specify the bridge forward delay, 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 **protocol** 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*(forward_delay - 1) ≥ max_age ≥ 2*(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.

NOTE
On the Brocade VDX 8770, the VLAN value can be 1 through 4086. VLAN IDs 4087 through 4094 are internally reserved VLAN IDs. On all other Brocade VDX switches, the VLAN value can be 1 through 3962, as 3963 through 4094 are reserved.

To specify the bridge maximum aging time, 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 **protocol** 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. 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 **max-age** to be greater than the hello time. The following relationship should be kept:

```
2*(forward_delay - 1) ≥ max_age ≥ 2*(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.

> NOTE
> On the Brocade VDX 8770, the VLAN value can be 1 through 4086. VLAN IDs 4087 through 4094 are internally-reserved VLAN IDs. On all other Brocade VDX switches, the VLAN value can be 1 through 3962, as 3963 through 4094 are reserved.

To specify the bridge hello time, 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 **protocol** 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. 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** command to save the *running-config* file to the *startup-config* file.

```
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 428.

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 **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

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

```
switch# configure terminal
```

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

```
switch# configure terminal
```

2. Enter the **protocol** command to enable STP, RSTP, MSTP, PVST+, or R-PVST+.

```
switch(config)# protocol spanning-tree stp
```

3. Specify the port-channel path cost.

```
switch(conf-stp)# port-channel path-cost custom
```

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
```

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 **configure terminal** command to change to global configuration mode.

```
switch# configure terminal
```

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** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

Clearing spanning tree counters

In privileged EXEC mode, use this command to clear spanning tree counters on all interfaces or on the specified interface.

To clear spanning tree counters, perform the following steps from privileged EXEC mode.

1. Use the **clear** command to restart the protocol migration process on all the interfaces.

```
switch# clear spanning-tree counter
```

2. Use the **clear** command to restart the protocol migration process associated with a specific port-channel or DCB port interface.

```
switch# clear spanning-tree counter interface tengigabitethernet 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 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. 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 automatic edge detection (DCB)

From the DCB interface, use this command to automatically identify the edge port. 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 **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. 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.

```
switch(conf-if-te-0/1)# no shutdown
```

4. Enter the **spanning-tree** command to enable automatic edge detection on the DCB interface.

```
switch(conf-if-te-0/1)# spanning-tree autoedge
```

Configuring the path cost (DCB)

From the DCB interface, use this 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.

On the Brocade VDX 8770, the VLAN value can be 1 through 4086. VLAN IDs 4087 through 4094 are internally-reserved VLAN IDs. On all other Brocade VDX switches, the VLAN value can be 1 through 3962, as 3963 through 4094 are reserved.

To configure the path cost for spanning tree calculations on the DCB 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* 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)#.

```
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** command to configure the path cost for spanning tree calculations on the DCB interface.

```
switch(conf-if-te-0/1)# spanning-tree cost 10000
```

5. Enter the **spanning-tree** command to configure the path cost for spanning tree calculations on the DCB interface.

```
switch(conf-if-te-0/1)# spanning-tree cost 10000 vlan 10
```

6. Return to privileged EXEC mode.

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

7. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

Enabling a port (interface) as an edge port (DCB)

From the DCB interface, use this command to enable the port as an edge port to allow the port to quickly transition to the forwarding state.

NOTE
This command is only for RSTP and MSTP. Use the **spanning-tree portfast** command for STP (refer to Enabling port fast (DCB) on page 434).

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 **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. 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.

   ```
   switch(conf-if-te-0/1)# no shutdown
   ```

4. Enter the **spanning-tree** command to enable the DCB interface as an edge port.

   ```
   switch(conf-if-te-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.

On the Brocade VDX 8770, the VLAN value can be 1 through 4086. VLAN IDs 4087 through 4094 are internally reserved VLAN IDs. On all other Brocade VDX switches, the VLAN value can be 1 through 3962, as 3963 through 4094 are reserved.

To enable guard root on a DCB 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* 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 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** command to enable guard root on a DCB interface.

   ```
   switch(conf-if-te-0/1)# spanning-tree guard root
   ```

5. Enter the **spanning-tree** command to enable guard root for a specific VLAN.

   ```
   switch(conf-if-te-0/1)# spanning-tree guard root vlan 10
   ```

Specifying the STP hello time (DCB)

From the DCB interface, use this command to set the time interval between BPDUs sent by the root switch. Changing the hello time affects all spanning tree instances.

The **max-age** setting must be greater than the **hello-time** setting (refer to Specifying the bridge maximum aging time on page 426). The range 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.

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. 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.

   ```
   switch(conf-if-te-0/1)# no shutdown
   ```

4. Enter the **spanning-tree** command to specify the hello time on a DCB interface.

   ```
   switch(conf-if-te-0/1)# spanning-tree hello-time 5
   ```

5. Return to privileged EXEC mode.

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

6. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

   ```
   switch# copy running-config startup-config
   ```

Specifying restrictions for an MSTP instance (DCB)

From the DCB interface, use this 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.

1. Enter the **configure terminal** command to access global configuration mode from privileged EXEC 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 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** command to specify the restrictions for an MSTP instance on a DCB interface.

   ```
   switch(conf-if-te-0/1)# spanning-tree instance 5 restricted-tcn
   ```

5. Return to privileged EXEC mode.

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

6. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

   ```
   switch# copy running-config startup-config
   ```

Specifying a link type (DCB)

From the DCB interface, use this 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 **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. The prompt for these ports is in the following 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** command to specify the link type on the DCB interface.

   ```
   switch(conf-if-te-0/1)# spanning-tree link-type shared
   ```

Enabling port fast (DCB)

From the DCB interface, use this 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 bpdu-guard** 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 portfast 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 432).

To enable on the DCB interface for STP, 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 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 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** 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 this 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.

On the Brocade VDX 8770, the VLAN value can be from 1 through 4086. VLAN IDs 4087 through 4094 are internally reserved VLAN IDs. On all other Brocade VDX switches, the VLAN value can be from 1 through 3962, as 3963 through 4094 are reserved.

To specify the port priority on the DCB 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 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 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** command to specify the port priority on the DCB interface.

   ```
   switch(conf-if-te-0/1)# spanning-tree priority 32
   ```

5. Optional: Enter the **spanning-tree** command to specify the port priority for a specific VLAN.

```
switch(conf-if-te-0/1)# spanning-tree priority 32 vlan 10
```

Restricting the port from becoming a root port (DCB)

From the DCB interface, use this procedure 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 **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. The prompt for these ports is in the following 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** command to restrict the DCB interface from becoming a root port.

```
switch(conf-if-te-0/1)# spanning-tree restricted-role
```

Restricting the topology change notification (DCB)

From the DCB interface, use this command to restrict the topology change notification BPDUs sent on the interface. By default, the restriction is disabled. This procedure affects MSTP only.

To restrict the topology change notification BPDUs sent on the DCB 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 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 0/1
```

3. Enter the **no shutdown** command to enable the DCB interface.

```
switch(conf-if-te-0/1)# no shutdown
```

4. Enter the **spanning-tree** command to restrict the topology change notification BPDUs sent on the DCB interface.

```
switch(conf-if-te-0/1)# spanning-tree restricted-tcn
```

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 **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, 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 0/1
   ```

3. Enter the **no shutdown** command to enable the DCB interface.

   ```
   switch(conf-if-te-0/1)# no shutdown
   ```

4. Enter the **spanning-tree** command to enable spanning tree on the DCB interface.

   ```
   switch(conf-if-te-0/1)# no spanning-tree shutdown
   ```

Disabling spanning tree (DCB)

From the DCB interface, use this command to disable spanning tree on the DCB interface. By default, spanning tree is disabled.

To disable spanning tree on the DCB 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 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 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** command to enable spanning tree on the DCB interface.

   ```
   switch(conf-if-te-0/1)# spanning-tree shutdown
   ```

Configuring DiST

With respect to Distributed STP (DiST), the CLI commands to configure xSTP in the VCS mode are exactly the same as the CLI commands in standalone mode. By default, all the ports are spanning tree disabled. 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 416.

The following table describes the behavior of interface based on global and interface level configuration. By default, spanning tree is disabled at the global and interface configuration levels.

TABLE 70 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

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

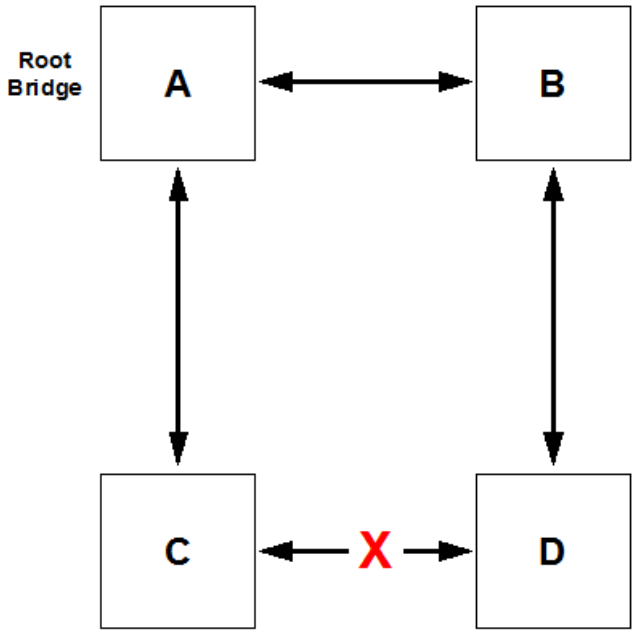
Note the following requirements for UniDirectional Link Detection:

- 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.
- UDLD works in standalone mode or VCS mode. 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 49 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 439.

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
```

2. To enable the UDLD protocol, as well as to enter protocol UDLD configuration mode, enter the **protocol udld** command.

```
switch(config)# protocol udld
```

3. (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
```

4. 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
```

5. 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
```

6. 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.

Other UDLD-related commands

Among additional UDLD commands that you can use are the following:

- **clear udld statistics** —Clears either all unidirectional link detection (UDLD) protocol statistics or clears the statistics on a specified port.
- **show udld** — Shows global UDLD information.
- **show udld interface** — Shows UDLD information for one or all ports.
- **show udld statistics** — Shows either all UDLD statistics or shows 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

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 (LACPDUs) 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 LACPDUs.

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. For example, the Brocade VDX 6720-24 has two port groups: te0/1 to te0/12 and te0/13 to te0/24. All of the member links should be members of either groups 1 to 12 or groups 13 to 24, but not both.
- 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 444 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.

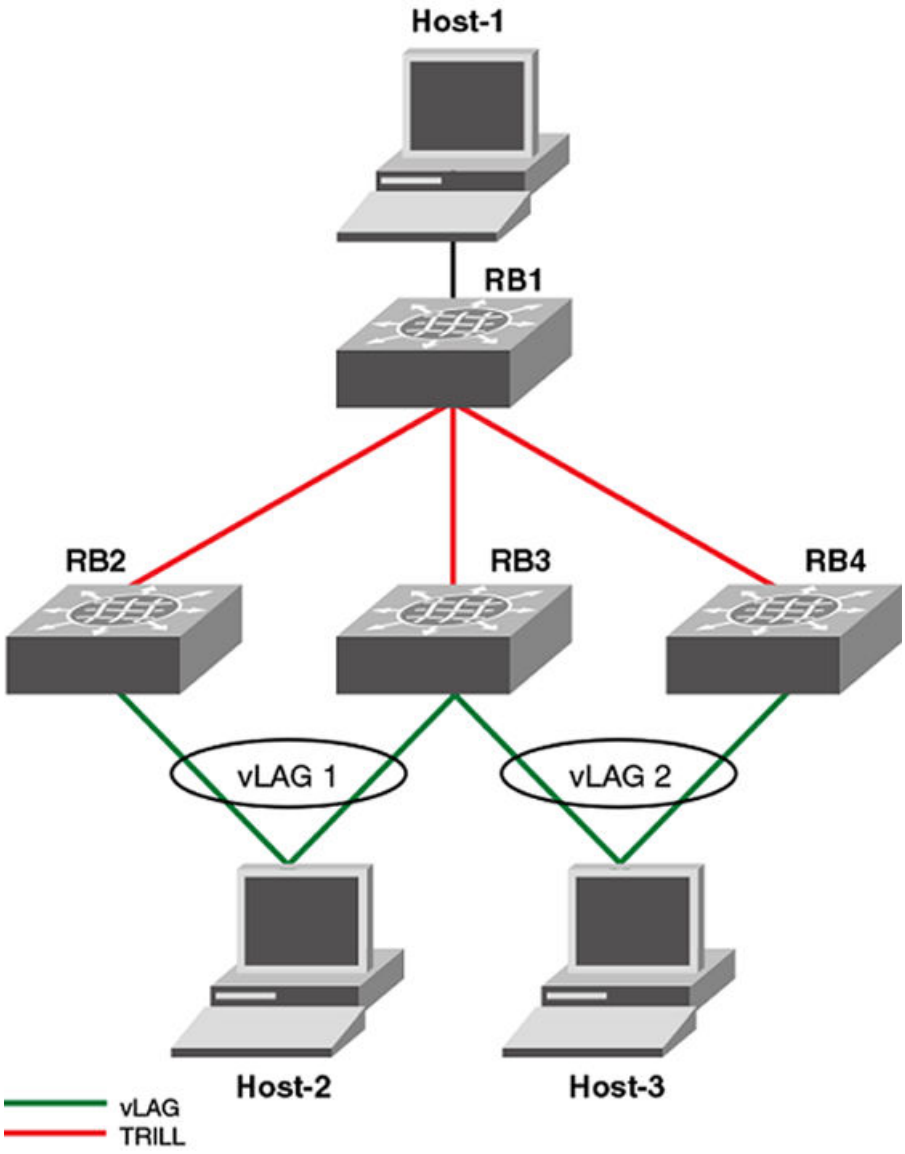
In a case where connectivity between nodes is lost because of a fabric split (as opposed to one of members going down), there will be duplication of multicast/broadcast packets. Brocade recommends that you build redundancy in the fabric so that individual links are not single points of failure.

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 50 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 448 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 446.

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
```

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 71 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 72 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            LACPDUs               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 LACPDUs are being received and transmitted on both ends of the link and that there are no error PDUs. 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 LACPDUs are being received and transmitted on both ends of the link and there are no error PDUs. 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

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 457
- Priority Flow Control on page 457

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 73 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 458.

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 74 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 458.

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

By default, For a switch in standalone mode only "dcbx-tlv" is advertised. 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 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
```

8. Set the iSCSI priority bits for the interface.

```
switch(conf-if-te-0/1)# lldp iscsi-priority 4
```

9. 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.

1. 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
```

2. Apply an LLDP profile to the interface.

```
switch(conf-if-te-0/10)# lldp profile network_standard
```

3. Return to privileged EXEC mode.

```
switch(conf-if-te-0/10)# end
```

4. 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.

1. Use the **show lldp** command to display LLDP general information.

```
switch# show lldp
```

2. 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
```

3. 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.

1. Use the **clear** command to clear LLDP neighbor information.

```
switch# clear lldp neighbors interface tengigabitethernet 0/1
```

2. Use the **clear** command to clear LLDP statistics.

```
switch# clear lldp statistics interface tengigabitethernet 0/1
```

Configuring ACLs

ACL overview

NOTE

In the Brocade Network OS 4.0.0 release, both Ingress Layer 2 MAC access control lists (ACLs) and Layer 3 IP ACLs are supported. With the introduction of Network OS 4.0.0 extended IP ACLs support IPv6 to access the switch or cluster from the management plane; however, management plane ACLs do not support the use of remarks.

ACLs filter traffic for the Brocade VDX hardware platforms and permit or deny frames on ingress interfaces that have the ACLs applied to them. You can apply ACLs on the three kinds of Layer 2 interfaces that Brocade Network OS 4.0.0 supports: physical 1-, 10-, and 4-gigabit Ethernet, VLAN, and port-channel (both static and dynamic LAGs), and Layer 3 IP virtual interfaces.

Each ACL is a unique collection of "permit" and "deny" statements (rules) that apply to frames. When a frame is received on an interface, the switch compares the fields in the frame against any ACLs applied to the interface to verify that the frame has the required permissions to be forwarded. The switch compares the frame sequentially against each rule in the ACL, and either forwards the frame or drops the frame.

The switch examines ACLs associated with options configured on a given interface. As frames enter the switch on an interface, ACLs associated with all inbound options configured on that interface are examined.

ACL benefits

The primary benefits of ACLs are as follows:

- Provide a measure of security.
- Save network resources by reducing traffic.
- Block unwanted traffic or users.
- Reduce the chance of denial of service (DOS) attacks.

There are two types of ACLs:

- *Standard ACLs* — Permit and deny traffic according to the source MAC address in the incoming frame. Use standard MAC ACLs if you only need to filter traffic based on source addresses.
- *Extended ACLs* — Permit and deny traffic according to the source and destination MAC addresses in the incoming frame, as well as EtherType.

MAC ACLs are supported on the following interface types:

- Physical interfaces
- Logical interfaces (LAGs)
- VLANs

IP ACLs are supported on the following interface types:

- Logical interfaces (LAGs)
- VLANs

IP ACLs

The IP ACLs control access to the switch. The policies do not control the egress and outbound management traffic initiated from the switch. The IP ACLs support both IPv4 and IPv6 simultaneously.

An IP ACL is a set of rules that are applied to the interface as a packet filtering firewall. Each rule defines whether traffic of a combination of source and destination IP address, protocol, or port, is to be denied or permitted.

Each ACL must have a unique name, but there is no limit to the number of ACLs to be defined. An ACL can contain rules for only one version of IP (either IPv4 or IPv6). Only one ACL by the version of IP can be active on the interface at a time. In other words, one ACL for IPv4 addresses and one ACL for IPv6 address on the interface for packet filtering can be active at the same time.

For filtering the traffic, each rule of the ACL applied to the interface is checked in the ascending order of their sequence numbers. A maximum of 2048 rules can be added to an access list. When the ACL is applied to an interface, only the 256 lowest-numbered rules are applied. If an ACL does not contain any rules and is applied to the interface, it becomes "no-op" and all ingress traffic is denied through the interface. For Layer 2 ACL, if there are no rules applied to the interface then the action is permitted through that interface. But in Layer 3 ACL or IP ACL, it is denied.

After an IP ACL rule is created, it is not possible to modify any of its options.

The default configuration of the switch consists of two ACLs; one IPv4 ACL and one IPv6 ACL is applied to the interface.

There are two types of IP access lists:

- *Standard* — Contains rules for only the source IP address. The rules are applicable to all ports of that source IP address.
- *Extended* — Contains rules for a combination of IP protocol, source IP address, destination IP address, source port, and destination port.

  NOTE
  If an IP ACL is applied to a VE interface, routed-traffic and VLAN-switched traffic is filtered by the ACL, regardless if the VE interface is in the “shutdown” or “no shutdown” state.

IP ACL parameters

The following lists the parameters and their definitions for IP ACLs.

NOTE
For Network OS 3.0 and later, on the Brocade VDX 67xx series, the only supported parameter for Extended IP ACL rules is the **eq** parameter.

TABLE 75 IP ACL parameters

ACL / Rule type	IP ACL parameter	IP ACL parameter definition
Standard IP ACL	name	The name of the standard IP ACL. The name must begin with a-z, A-Z, or 0-9. Underscores and hyphens are also accepted except as the first character. The ACL name must be unique among all ACL types (L2/L3) and cannot contain more than 63 characters.
Standard IP ACL rule	seq	The sequence number of the rule. The number must be from 0 through 4294967290. A rule without a sequence number is allocated one. The allocated sequence can be changed by the user using the **resequence** command.
	permit/deny	Specifies whether to permit or deny traffic for the combination specified in the rule.

TABLE 75 IP ACL parameters (continued)

ACL / Rule type	IP ACL parameter	IP ACL parameter definition
	any/host	The IP address of the host from which ingress traffic must be filtered.
Extended IP ACL	name	The name of the extended IP Access Control List. The name must begin with a-z, A-Z, or 0-9. Underscores and hyphens are also accepted except as the first character. The ACL name must be unique among all ACL types (L2/L3) and cannot contain more than 63 characters.
Extended IP ACL Rule	seq	The sequence number of the rule. The number must be from 0 through 65535. A rule without a sequence number is allocated one. The allocated sequence can be changed by the user using the **resequence** command.
permit/deny		Specifies whether to permit or deny traffic for the combination specified in the rule.
protocol		Indicates the type of IP packet to be filtered.
any/host		The IP address of the host from which inbound traffic must be filtered.
any		The IP address of the host to which egress or control of outbound traffic must be blocked. Because the egress and outbound traffic is blocked, the destination address is always "any" (which also covers the Virtual IP address of a host).
port-number		Indicates the source or destination port for which the filter is applicable. This is applicable for both UDP and TCP. The number is from 0 through 65535.
range		If there is more than one destination port that must be filtered through the ACL rule, use the range parameter to specify the starting port and end port.
eq		If there is only one destination port that must be filtered through the ACL rule, use the eq parameter.
dscp value		Compares the specified value against the DSCP value of the received packet. The range of valid values is from 0 through 63.
ack, fin, rst, sync, urg, psh		Any combination of the TCP flags may be specified.
log		Packets matching the filter is sent to the CPU and a corresponding log entry is generated. The optional log parameter enables the logging mechanism. This option is only available with permit and deny.
hard drop		Overrides the trap behavior for control frames and data frames such as echo request (ping).

Default ACLs

When none of the policies is enforced on the switch, these default ACL rules are effective in Network OS:

- seq 0 permit tcp any any eq 22

- seq 1 permit tcp any any eq 23
- seq 2 permit tcp any any eq 897
- seq 3 permit tcp any any eq 898
- seq 4 permit tcp any any eq 111
- seq 5 permit tcp any any eq 80
- seq 6 permit tcp any any eq 443
- seq 7 permit udp any any eq 161
- seq 8 permit udp any any eq 111
- seq 9 permit tcp any any eq 123
- seq 10 permit tcp any any range 600 65535
- seq 11 permit udp any any range 600 65535

Configuring and managing ACLs

The following sections discuss working with the Access Control Lists (ACLs) on Brocade devices.

Understanding ACL configuration guidelines and restrictions

Follow these Access Control List (ACL) configuration guidelines and restrictions when configuring ACLs:

- The order of the rules in an ACL is critical. The first rule that matches the traffic stops further processing of the frames.
- Standard ACLs and extended ACLs cannot have the same name.
- Applying a permit or deny UDP ACL to the management interface enacts an implicit deny for TCP; however, ping will succeed.
- Applying a permit or deny ACL for a specific UDP port enacts an implicit deny for all other UDP ports.
- Applying a permit or deny ACL for a specific TCP port enacts an implicit deny for all other TCP ports.
- There is a default "permit" rule added at the end of the rules list of a Layer 2 (L2) ACL. This implicit rule permits all L2 streams that do not match any of the configured rules in the sequence list associated with the ACL.
- The default action of "permit any" is inserted at the end of a bounded L2 ACL. This default rule is not exposed to the user.
- There is a default "deny" rule added at the end of the rule list of a Layer 3 (L3) ACL.
- The default action of "deny any" is inserted at the end of a bounded L3 ACL. This default rule is not exposed to the user.
- Applying a hard-drop ACL in place of a permit or deny ACL enables packets to be dropped and overrides the control packet trap entries, but does not override the permit entry that occurs before the rule in the ACL.
- You cannot delete an ACL if it is applied to an interface.
- ACLs in a route-map are not used by the Open Shortest Path First (OSPF) or Border Gateway Protocol (BGP) protocols.
- Existing ACL rules cannot be updated with new optional elements, like **count** and **log**. You must delete the rule and recreate it with the additional elements.

The Brocade VDX 6710, VDX 6720, and VDX 6730 do not support the following:

- Egress ACLs
- MAC masks (except FFFF.FFFF.FFFF)
- IP address mask of noncontiguous addresses with variable LSBs
- Operators except “eq” (equal) for TCP or UDP port ranges

- TCP flags PUSH and URG

For example, the wildcard mask 0.0.255.255 is supported, while 255.0.0.0, 0.255.0.255 is not. Only IP addresses and MASKs which can be represented in CIDR format are supported.

Creating a standard MAC ACL and adding rules

The following items should be kept in mind when creating standard MAC ACLs and adding rules to them.

- You can use the **resequence** command to change the sequence numbers assigned to the rules in a MAC ACL. For detailed information, refer to Reordering the sequence numbers in a MAC ACL on page 474.
- A MAC ACL does not take effect until it is applied to a Layer 2 interface. Refer to Applying a MAC ACL to a DCB interface on page 472 and Applying a MAC ACL to a VLAN interface on page 473.
- Certain invalid characters(such as "[]\.@#+*()={}" etc.) were allowed in earlier versions (Network OS 2.x) as part of ACL names. The ability to use these characters in ACL names was discontinued in Network OS 3.0.0. As part of the upgrade to Network OS 3.x releases, a script removes these invalid characters, which can result in ACL names not being unique. An ID is appended at the end of each ACL to make certain that each ACL name is unique.(-m <acl_num> for MAC ACL names, and -i <acl_num> for IP ACL names). The update script ensures the same changes for the ACL names everywhere (such as updating the ACL names on the interfaces where the ACL rules are applied) so functionality is not affected.
- If an ACL is set up to deny a specific host or range (for example: "seq 2 deny host 10.9.106.120"), the VDX still responds to the **ping** command unless the hard drop option is added (such as `seq 20 hard-drop icmp any any`).

To create a standard MAC ACL and add rules, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Create a standard MAC ACL and enter ACL configuration mode.

   In this example, the name of the standard MAC ACL is "test_01."

   ```
   switch(config)# mac access-list standard test_01
   switch(conf-macl-std)#
   ```

3. Enter the **deny** command to create a rule in the MAC ACL to drop traffic with the source MAC address.

   ```
   switch(conf-macl-std)# deny 0022.3333.4444 count
   ```

4. Enter the **permit** command to create a rule in the MAC ACL to permit traffic with the source MAC address.

   ```
   switch(conf-macl-std)# permit 0022.5555.3333 count
   ```

5. Use the **seq** command to create MAC ACL rules in a specific sequence.

   ```
   switch(conf-macl-std)# seq 100 deny 0011.2222.3333 count
   switch(conf-macl-std)# seq 1000 permit 0022.1111.2222 count
   ```

6. Return to privileged EXEC mode.

   ```
   switch(conf-macl-std)# end
   ```

7. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

   ```
   switch# copy running-config startup-config
   ```

Creating an extended MAC ACL and adding rules

The following items should be kept in mind when creating extended MAC ACLs and adding rules to them.

- You can use the **resequence** command to change the sequence numbers assigned to the rules in a MAC ACL. For detailed information, refer to Reordering the sequence numbers in a MAC ACL on page 474.
- The MAC ACL name length is limited to 64 characters. A MAC ACL does not take effect until it is applied to a Layer 2 interface. Refer to Applying a MAC ACL to a DCB interface on page 472 and Applying a MAC ACL to a VLAN interface on page 473.
- Certain invalid characters(such as "[]\.@#+*()={}" etc.) were allowed in earlier versions (Network OS 2.x) as part of ACL names. The ability to use these characters in ACL names was discontinued in Network OS 3.0.0. As part of the upgrade to Network OS 3.x releases, a script removes these invalid characters, which can result in ACL names not being unique. An ID is appended at the end of each ACL to make certain that each ACL name is unique.(-m <acl_num> for MAC ACL names and -i <acl_num> for IP ACL names). The update script ensures the same changes for the ACL names everywhere (such as updating the ACL names on the interfaces where the ACL rules are applied) so functionality is not affected.
- If an ACL is set up to deny a specific host or range (for example: "seq 2 deny host 10.9.106.120"), the VDX still responds to ping unless the hard drop option is added (such as `seq 20 hard-drop icmp any any`).

To create an extended MAC ACL and add rules, run the following steps in privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Create an extended MAC ACL and enter ACL configuration mode.

```
switch(config)# mac access-list extended test_02
```

3. Create a rule in the MAC ACL to **permit** traffic with the source MAC address and the destination MAC address.

```
switch(conf-macl-ext)# permit 0022.3333.4444 0022.3333.5555
```

4. Use the **seq** command to insert the rule anywhere in the MAC ACL.

```
switch(conf-macl-ext)# seq 5 permit 0022.3333.4444 0022.3333.5555
```

5. Return to privileged EXEC mode.

```
switch(conf-macl-ext)# end
```

6. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

Applying a MAC ACL to a DCB interface

Ensure that the ACL you want to apply exists and is configured to filter traffic in the manner you need for this DCB interface. An ACL does not take effect until it is expressly applied to an interface using the **access-group** command. Frames can be filtered as they enter an interface (ingress direction).

> NOTE
> The DCB interface must be configured as a Layer 2 switch port before an ACL can be applied as an access-group to the interface.

To apply a MAC ACL to a DCB 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, VDX 6740-series, and VDX 8770-series platforms. The prompt for these ports is in the following example format:

   ```
   switch(config)# interface tengigabitethernet 0/1
   switch(config-if-gi-22/0/1)#
   ```

3. Enter the **switchport** command to configure the interface as a Layer 2 switch port.
4. Enter the **mac-access-group** command to specify the MAC ACL that is to be applied to the Layer 2 DCB interface in the ingress direction.

   ```
   switch(conf-if-te-0/1)# mac access-group test_02 in
   ```

Applying a MAC ACL to a VLAN interface

Ensure that the ACL that you want to apply exists and is configured to filter traffic in the manner that you need for this VLAN interface. An ACL does not take effect until it is expressly applied to an interface using the **access-group** command. Frames can be filtered as they enter an interface (ingress direction).

To apply a MAC ACL to 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** command to apply the MAC ACL to the VLAN interface.

   ```
   switch(config)# interface vlan 50
   ```

3. Enter the **mac access-group** command to specify the MAC ACL that is to be applied to the VLAN interface in the ingress direction.

   ```
   switch(config-Vlan-50)# mac access-group test_02 in
   ```

Modifying MAC ACL rules

You cannot modify the existing rules of a MAC ACL. However, you can remove the rule and then recreate it with the desired changes.

If you need to add more rules between existing rules than the current sequence numbering allows, you can use the **resequence** command to reassign sequence numbers. For detailed information, refer to Reordering the sequence numbers in a MAC ACL on page 474.

Use a sequence number to specify the rule you wish to modify. Without a sequence number, a new rule is added to the end of the list, and existing rules are unchanged.

NOTE

Using the **permit** and **deny** keywords, you can create many different rules. The examples in this section provide the basic knowledge needed to modify MAC ACLs. This example assumes that "test_02" contains an existing rule number 100 with the "deny any any" options.

To modify a MAC ACL, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter the **mac** command to specify the ACL called test_02 for modification.

   ```
   switch(config)# mac access-list extended test_02
   ```

3. Enter the **no seq** command to delete the existing rule 100.

```
switch (conf-macl-ext)# no seq 100
```

-or-

Enter the **seq** command to recreate rule number 100 by recreating it with new parameters.

```
switch(conf-macl-ext)# seq 100 permit any any
```

Removing a MAC ACL

A MAC ACL cannot be removed from the system unless the access-group applying the MAC ACL to a DCB or a VLAN interface is first removed.

To remove a MAC ACL, perform the following steps from privileged EXEC mode.

1. Enter the **configure terminal** command to access global configuration mode.
2. Enter the **mac** command to specify and delete the ACL that you want to remove. In this example, the extended MAC ACL name is "test_02."

```
switch(config)# no mac access-list extended test_02
```

Reordering the sequence numbers in a MAC ACL

You can reorder the sequence numbers assigned to rules in a MAC ACL. Reordering the sequence numbers is useful when you need to insert rules into an ACL and there are not enough available sequence numbers. The default initial sequence number is 10 and the default increment is 10 for both standard and extended MAC ACLs.

The first rule receives the number specified by the starting-sequence number that you specify. Each subsequent rule receives a number larger than the preceding rule. The difference in numbers is determined by the increment number that you specify. The starting-sequence number and the increment number must range from 1 through 65535.

For example, in the task listed below the **resequence** command assigns a sequence number of 50 to the rule named test_02. The second rule has a sequence number of 55, and the third rule a has a sequence number of 60. The example is using IPv4.

```
switch# resequence ip access-list mac test_02 50 5
```

Creating a standard IP ACL

To create a standard IP ACL, perform the following steps in global configuration mode.

1. Use the **ip access-list standard** command to enter the configuration mode.

```
switch(config)# ip access-list standard stdACL3
```

2. Use the **seq** command to enter the rules for the ACL. You can enter multiple rules.

```
switch(config-ip-std)# seq 5 permit host 10.20.33.4
switch(config-ip-std)# seq 15 deny any
```

3. Use the **exit** command to return to global configuration mode. Your changes are automatically saved.

```
switch(config-ip-std)# exit
switch(config)#
```

Creating an extended IP ACL

To create an extended IP ACL, perform the following steps in global configuration mode.

1. Use the **ip access-list extended** command to enter the configuration mode.

```
switch(config)# ip access-list extended extdACL5
```

2. Use the **seq** command to enter the rules for the ACL. You can enter multiple rules.

```
switch(config-ip-ext)# seq 5 deny tcp host 10.24.26.145 any eq 23
switch(config-ip-ext)# seq 7 deny tcp any any eq 80
switch(config-ip-ext)# seq 10 deny udp any any range 10 25
switch(config-ip-ext)# seq 15 permit tcp any any
```

3. Use the **exit** command to return to global configuration mode. Your changes are automatically saved.

```
switch(config-ip-ext)# exit
```

Applying a Layer 3 ACL to a management interface

Use this procedure for applying a Layer 3 ACL to a management interface, using the **access-group** command.

NOTE
In virtual cluster switching (VCS) mode, you can apply an ACL to any cluster node, specifying its RBridge ID and port.

NOTE
If an explicit "deny ip any any" IP rule is applied to the management interface, that IP rule has priority over any TCP or UDP rules. Any incoming TCP packets that match that IP rule are dropped because the TCP packet has an IP header.

1. Enter **configure** to access global configuration mode.

```
switch# configure
```

2. Use the **interface management** command to enter configuration mode for the management interface, specifying RBridge ID/port.

```
switch(config)# interface management 3/1
```

3. To apply an IPv4 ACL to the management interface, use the **ip access-group** command.

```
switch(config-Management-3/1)# ip access-group stdACL3 in
```

4. To apply an IPv6 ACL to the management interface, use the **ipv6 access-group** command.

```
switch(config-Management-3/1)# ipv6 access-group stdV6ACL1 in
```

5. Use the **exit** command to return to global configuration mode. Your changes are automatically saved.

```
switch(config-Management-3/1)# exit
```

Binding an ACL in standalone mode or fabric cluster mode

In standalone or fabric cluster mode, an ACL can be applied to any node present in the cluster by specifying its RBridge ID. One ACL per IPv4 and one ACL per IPv6 can be applied to the management interface. Applying a new ACL replaces the ACL that was previously applied. The **no** command form removes an ACL from the interface. Removing the active ACL results in default behavior of "permit any."

You can bind an IP ACL in the ingress direction for the management interface, and you are not required to create an ACL before binding it to the management interface.

On a management interface, the default action of "permit any" is inserted at the end of an ACL that has been bound.

To bind an ACL to a management interface, perform the following steps from privileged EXEC mode.

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

```
switch# configure terminal
```

2. Enter **interface management** followed by the *rbridge-id/port*, the IP version, the access-group name for the ACL you want to bind, and the binding direction (ingress or egress).

```
switch(config)# interface management 1/0
switch(config-Management-1/0)# ip access-group stdACL3 in
switch(config-Management-1/0)# ipv6 access-group stdV6ACL1 in
switch(config-Management-1/0)# exit
```

NOTE

Before downgrading firmware, you must unbind any ACLs on the management interface, or the downgrade will be blocked.

Displaying the IP ACL configuration

To display the IP ACL configuration, use the **show running-config ip access-list** command in privileged EXEC mode.

```
switch# show running-config ip access-list
ip access-list standard stdACL3
 seq 5 permit host 10.20.33.4
 seq 7 permit any
!
ip access-list extended extdACL5
 seq 5 deny tcp host 10.24.26.145 any eq 23
 seq 7 deny tcp any any eq 80
 seq 10 deny udp any any range 10 25
 seq 15 permit tcpp any any
```

Configuring QoS

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 478 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 478 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 478 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 481 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 482 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.

In standalone mode:

- All incoming priority 7 tagged packets are counted in queue 7 (TC7).
- Untagged control frames are counted in queue 7 (TC7).

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.

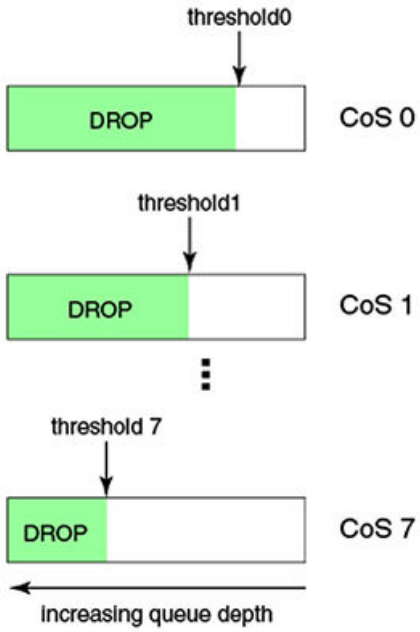
NOTE
You cannot configure CoS thresholds and multicast tail drop on Brocade VDX 8770-4 and VDX 8770-8 platforms. Random Early Discard (RED) is supported only on Brocade VDX 6740, VDX 8770-4 and VDX 8770-8 platforms.

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 51 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.

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%)

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.

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 76 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 Brocade VDX 8770-4 and 8770-8 platforms. For these products, refer to BUM storm control on page 482.

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.

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. This command is not supported on the Brocade VDX 6710, VDX 6720, and VDX 6730.

Scheduling

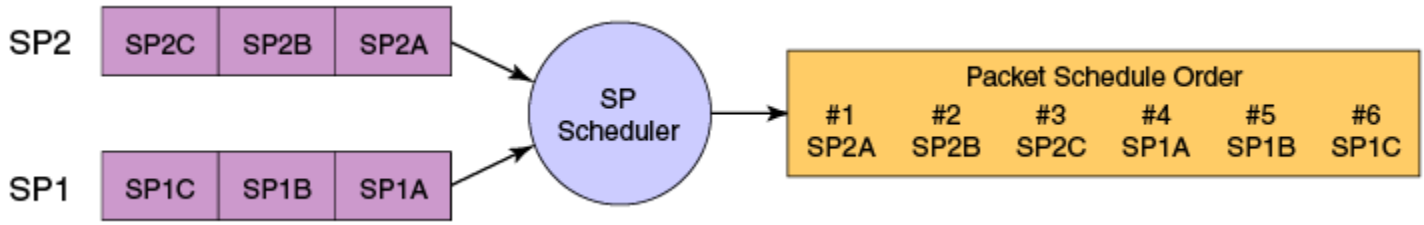
Scheduling arbitrates among multiple queues waiting to transmit a frame. The Brocade switch supports both Strict Priority (SP) and Deficit Weighted Round Robin (DWRR) scheduling algorithms. Also supported is the flexible selection of the number of traffic classes using SP-to-DWRR. When there are multiple 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 52 Strict priority schedule — two queues

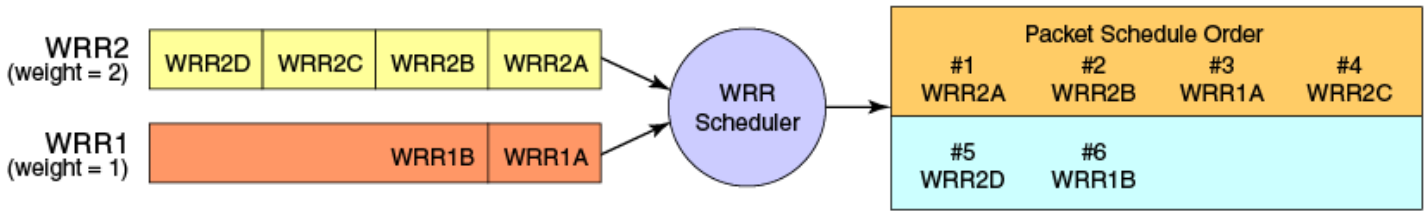


Weighted Round Robin scheduling

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 53 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 77 Supported scheduling configurations

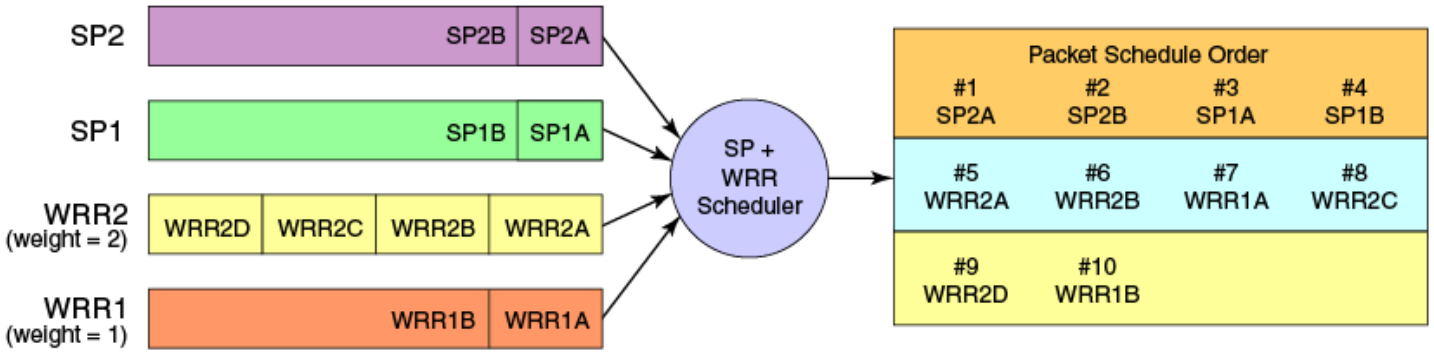
Traffic Class	SP0	SP1	SP2	SP3	SP4	SP5	SP6	SP8
7	WRR8	SP1	SP2	SP3	SP4	SP5	SP6	SP8

TABLE 77 Supported scheduling configurations (continued)

Traffic Class	SP0	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 54 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 78 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 79 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 80 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. Default maps occur when DSCP trust is enabled in standalone 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. This feature is supported only on Brocade VDX 8770-4, VDX 8770-8, and later models.

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 487). 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 487). 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 40000-40000000000 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 1250-5000000000 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 0-40000000000 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 1250-5000000000 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** *trafficlass*.

  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 *trafficlass* 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 *trafficlass* variable. Acceptable values for *trafficlass* 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.

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.

Policer behavior for control packets

Port-based Policer behavior for Layer 2 and Layer 3 control packets is shown in the table below.

TABLE 81 Policer behavior for L2 and L3 control packets

Protocol	Ingress Policer	Egress Policer
LLDP	Enabled if protocol is not enabled and disabled if protocol is enabled.	Disabled
LACP	Enabled if protocol is not enabled and disabled if protocol is enabled.	Disabled

TABLE 81 Policer behavior for L2 and L3 control packets (continued)

Protocol	Ingress Policer	Egress Policer
STP	Enabled if protocol is not enabled and disabled if protocol is enabled.	Disabled
DOT1X	Enabled if protocol is not enabled and disabled if protocol is enabled.	Disabled
PIM	Disabled	Enabled
OSPF	Disabled	Enabled
IGMP	Disabled	Enabled
VRRP/VRRP-E	Disabled	Enabled

When a Layer 2 control protocol is not enabled on an interface, packets are dropped during ingress and are subjected to ingress policing. Layer 3 control packets, irrespective of whether they are protocol-enabled or not, will not be subject to ingress and egress policing.

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 478.

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 82 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)

TABLE 82 Default priority value of untrusted interfaces (continued)

Incoming CoS	User Priority
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 83 IEEE 802.1Q default priority mapping

Incoming CoS	User Priority
0	0
1	1
2	2
3	3
4	4
5	5
6	6
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.

   For Standalone mode:

   ```
   switch(conf-if-te-2/1/2)# qos trust cos
   ```

   For VCS mode:

   ```
   switch(conf-if-te-2/1/2)# qos dscp-cos test
   switch(conf-if-te-2/1/2)# qos dscp-traffic-class test
   ```

   NOTE

   To deactivate CoS trust from an interface, enter **no qos trust cos**

4. Return to privileged EXEC mode.

   ```
   switch(conf-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 cos
```

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 84 Default DSCP priority mapping

DSCP Values	User Priority
0-7	0
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 486.

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.

For Standalone mode:

```
switch(conf-if-te-2/1/2)# qos trust dscp
```

For VCS mode:

```
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
```

6. 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 486.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. 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
```

3. 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. Activate or apply changes made to the DSCP-to-CoS mutation map. 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. Specify the DSCP trust mode for incoming traffic.

   Use this command to specify the interface ingress DSCP trust mode, which controls user priority mapping of incoming traffic. The untrusted mode will not classify packets based on DSCP. The DSCP trust mode classifies packets based on the incoming DSCP value. If the incoming packet is priority tagged, fallback is to classify packets based on the CoS value.

   ```
   switch(conf-if-te-1/1/2)# qos trust dscp
   ```

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 499.

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 478.

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 85 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 86 Default user priority for multicast traffic class mapping

User Priority	Traffic class
0	1
1	0
2	2
3	3
4	4
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.

Mapping a CoS to a traffic class

To map a CoS to a traffic-class, perform the following steps from privileged EXEC mode.

NOTE
Creating a CoS-to-traffic-class map is available only in standalone mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Create the mapping by specifying a name and the mapping.

```
switch(config)# qos map cos-traffic-class test 1 0 2 3 4 5 6 7
```

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
```

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 DSCP-to-traffic-class maps

Consider the topics discussed below when configuring the DSCP-to-traffic-class mappings.

Mapping DSCP to-traffic class

Ingress DSCP values can be used to classify traffic for the ingress interface into a specific traffic class by means of a DSCP-to-Traffic class-map. To map a DSCP-to-Traffic-Class, perform the following steps from privileged EXEC mode.

NOTE
The restrictions for using this feature in VCS mode are discussed in Restrictions for Layer 3 features in VCS mode on page 486.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Create the DSCP-Traffic-Class mapping by specifying a map name. The following command uses "test" as the map name and places the system in **dscp-traffic-class** mode so that you can configure mapping for the map that you created.

```
switch(config)# qos map dscp-traffic-class test
```

3. Once the system is in dscp-traffic-class mode for the configured map (in this case dscp-traffic-class-test), you can map DSCP values to traffic classes by using the **mark** command as in the following examples:

```
switch(dscp-traffic-class-test)# mark 1,3,5,7 to 3
switch(dscp-traffic-class-test)# mark 11,13,15,17 to 5
switch(dscp-traffic-class-test)# mark 12,14,16,18 to 6
switch(dscp-traffic-class-test)# mark 2,4,6,8 to 7
```

This sets the following:

- DSCP values 1, 3, 5, and 7 are mapped to traffic class 3.
- DSCP values 11, 13, 15, and 17 are mapped to traffic class 5.
- DSCP values 12, 14, 16, and 18 are mapped to traffic class 6.
- DSCP values 2, 4, 6, and 8 are mapped to traffic class 7.

4. Return to privileged EXEC mode:

```
switch(dscp-traffic-class-test)# end
```

5. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

Applying the DSCP-to-traffic-class mapping to an interface

To activate a DSCP-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 1/1/2
```

3. Activate the DSCP-to-Traffic-Class mapping. In this case, "test" is the map name.

```
switch(conf-if-te-1/1/2)# qos dscp-traffic-class test
```

   NOTE
   To deactivate a DSCP-to-Traffic-Class map from an interface, enter **no qos dscp-traffic-class** *name*.

4. Return to privileged EXEC mode.

```
switch(conf-if-te-1/1/2)# 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 DSCP-to-Traffic-Class mapping

To verify a DSCP-to-Traffic-Class mapping, you can use one or both of the following options from global configuration mode.

- Verify the DSCP-Traffic-Class mapping for specific map by using the **do show qos maps dscp-traffic-class** command and specifying a map name.

```
switch(config)# do show qos maps dscp-traffic-class test
```

- Verify all DSCP-Traffic-Class mapping with the just the **do show qos maps** command with the `dscp-traffic-class` parameter *only*.

```
switch(config)# do show qos maps dscp-traffic-class
```

.

- Verify DSCP-to-Traffic-Class mapping for an interface by using the **show qos interface** command and specifying the interface.

```
switch(config)# show qos interface te 1/1/2
```

Configuring congestion control

Refer also to Congestion control on page 478.

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.

- Up to four RED profiles can be applied to each port group. On the 48 x 10G line card, the port groups consist of ports 1–8, 9–16, 17–24, 25–32, 33–40, and 41–48. On the 12x40G line card, the port groups consist of ports 1–2, 3–4, 5–6, 7–8, 9–10, and 11–12.
- 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, and 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 CoS priority to an RED profile on an interface

To map a CoS priority value for a port to the RED profile created under Understanding RED profiles on page 504, 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 CoS priority 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 cos 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
```

Examine the applied RED profiles for an interface by using the **show qos interface** *interface-name* command. This will display 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
```

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 480. The Ethernet Pause option is available only in standalone mode.

Enabling Ethernet Pause

To enable Ethernet Pause, 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 3/0/2
   ```

3. Enable Ethernet Pause on the interface for both TX and RX traffic.

   ```
   switch(conf-if-te-3/0/2)# qos flowcontrol tx on rx on
   ```

   NOTE
   To deactivate Ethernet pause on an interface, enter **no qos flowcontrol**

4. Return to privileged EXEC mode.

   ```
   switch(conf-if-te-3/0/2)# end
   ```

5. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

   ```
   switch# copy running-config startup-config
   ```

6. Verify the Ethernet Pause with the **show qos flowcontrol** command.

   ```
   switch# show qos flowcontrol interface all 3/0/2
   ```

Enabling an Ethernet PFC

To enable Ethernet PFC, 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 1/1/2
   ```

3. Enable an Ethernet PFC on the interface.

   ```
   switch(conf-if-te-1/1/2)# qos flowcontrol pfc 3 tx on rx on
   ```

4. Return to privileged EXEC mode.

   ```
   switch(conf-if-te-1/1/2)# end
   ```

5. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

   ```
   switch# copy running-config startup-config
   ```

   NOTE
   To disable Ethernet PFC from an interface, enter **no qos flowcontrol pfc** *cos value*

Configuring rate limiting

Refer also to Multicast rate limiting on page 481.

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 482.

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
```

4. 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 482.

Scheduling the QoS queue

To specify the schedule used, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. 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
```

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
```

Scheduling the QoS multicast queue

To schedule the QoS multicast queue, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. 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
```

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 DCB QoS

Refer also to Data Center Bridging QoS on page 485.

Creating a DCB map

To create a DCB map, perform the following steps from privileged EXEC mode.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Select the DCB map by using the **cee-map** command.

   The only map name allowed is "default."

```
switch(config)# cee-map default
```

3. Return to privileged EXEC mode.

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

4. 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.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. 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
```

3. Define the DCB map for PGID 0.

```
switch(config-cee-map-default)# priority-group-table 0 weight 50 pfc on
```

4. Define the DCB map for PGID 1.

```
switch(config-cee-map-default)# priority-group-table 1 weight 50 pfc off
```

5. Return to privileged EXEC mode.

```
switch(config-cee-map-default)# end
```

6. 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.

1. Enter global configuration mode.

```
switch# configure terminal
```

2. 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 486.

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
```

Configuring policer functions

Consider the topics discussed below when configuring the policer functions.

Configuring port-based policer functions

Refer to Port-based Policer on page 487.

To configure port-based **policer** functions, do the following while in switch global configuration mode and using policer CLI commands and parameters:

1. Configure a class map to classify traffic according to traffic properties that you will configure with the policing parameters while adding the class map to a policy-map. Refer to Configuring a policer class map on page 512.
2. Configure a police priority-map to add color-based priority mapping. Refer to Configuring a policer priority-map on page 513. This is an optional step. If you do not define priority mapping for a color, the map defaults to priorities 0, 1, 2, 3, 4, 5, 6, and 7 (in other words, nothing is modified).
3. Configure a policy-map to associate QoS and policing parameters to traffic belonging to specific classification maps. Each policy-map can contain only one classification map. Refer to Configuring the policer policy-map on page 514.
4. Bind the policy-map to a specific interface using the **service-policy** command. Refer to Binding the policy-map to an interface on page 518.

   For additional information refer to Configuring policer functions on page 511.

Configuring a policer class map

The classification map or *class map* classifies traffic based on match criteria that you configure using the with the **class-map** command. If traffic matches the criteria, it belongs to the class. Currently, the only match criterion is match any. With the match any criterion, traffic with any MAC address, IP address, VLAN ID, IP precedence, Access Control List (ACL) security, or other identification belongs to the class.

When you add the class map to a policy-map, the traffic belonging to the class is subject to actions of the QoS and Policer parameters configured for the class-map in the policy-map. For more information on these parameters, refer to Policing parameters on page 487.

To configure a class map, use the following steps:

1. Enter global configuration mode.

```
switch# configure terminal
```

2. Create an access-list (either MAC or IP) to define the traffic.

```
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 class-1
```

   The name for the class map (in this case default) can be a character string up to 64 characters.

   NOTE
   The "default" 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-list mac acl 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 map class-map** *name* command while in global configuration mode to remove the classification map.

Configuring a policer priority-map

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 will re-mark 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 reserved as a 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-policepmap)# 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-policepmap)# exceed 3 3 3 3 4 5 6 7
```

4. Exit the police priority-map configuration mode.

```
switch (config-policepmap)# exit
```

5. Return to privileged EXEC mode.

```
switch(config)# end
```

6. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

   To delete color-based CoS mapping, use the **no** keyword as shown in the following examples:

   - To delete the conform color, use the following example:

```
switch(config-policepmap)# no conform
```

   - To delete the exceed color, use the following example:

```
switch(config-policpmap)# no exceed
```

   - To delete an entire police priority-map, use the following example:

```
switch(config)# no police-priority-map name
```

Configuring the policer policy-map

Configure a rate-limit policy-map to associate QoS and policing parameters with traffic belonging to a specific **classification map**. A **policy-map** can only contain one classification map. You can apply one policy-map per interface per traffic direction (inbound and outbound) by using the **service-policy** command.

To configure a policy-map, add a classification map, and configure QoS and 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 policymap1
```

   The name for the policy-map (in this case policymap1) can be a character string up to 64 characters.

   To delete a policy-map, use the **no** keyword as in the following example.

```
switch(config)# no policy-map policymap1
```

3. 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 policer class map on page 512).

```
switch(config-policymap)# class default
```

4. 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-class)# 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 a class map. All other parameters are optional. Note that the parameter for set-priority (pmap1) includes the name for the created priority-map (refer to Configuring a policer priority-map on page 513). For details on setting QoS and policing parameters, refer to Policing parameters on page 487.

   To delete the mandatory CIR parameter, you must delete all Policer parameters while in the policy-map class configuration mode as in the following example:

```
switch(config-policymap-class)# no police
```

   To delete any optional parameter, use the **no** keyword while in the policy-map class police configuration mode. The following example removes the EBS setting.

```
switch(config-policymap-class-police)# no ebs
```

5. Exit the policy class map configuration mode.

```
switch(config-policymap-class)# exit
```

6. Exit the policy-map configuration mode.

```
switch(config-policymap)# exit
```

7. Return to privileged EXEC mode.

```
switch(config)# end
```

8. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

Configuring parameters for a class map (policy-class-map Policer mode)

You can configure QoS and policing parameters when configuring a class map in the policy-class-map configuration mode as shown in the preceding procedure, or you can create or modify parameters for a class map in the policy-class-map policer attributes mode, as shown in the following example. Using the **policy-class-map** policer mode is a convenience for adding or modifying single or multiple attributes for a policy.

1. Enter the **configure terminal** command to change to 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 policymap2
```

   The name for the priority-map (in this case policymap2) can be a character string up to 64 characters.

   To delete a policy-map, use the **no** keyword as in the following example.

```
switch(config)# no policy-map policymap2
```

3. Configure a class map in the policy-map by providing the class map name. This enables policy-class-map configuration mode.

```
switch(config-policymap)# class default
```

NOTE
To configure a class map in the policy-map you must create the class map first using the **class-map** command while in global configuration mode. Refer to Configuring a policer class map on page 512.

4. Provide a policing parameter for the class map. This enables policy-class-map policer configuration mode.

```
switch(config-policymap-class)# police cir 4000000
```

5. Enter another parameter as applicable.

```
(config-policymap-class-police)# cbs 50000
```

6. Enter additional parameters as applicable.

```
switch(config-policymap-class-police)# eir 800000 ebs 400000 conform-set-tc 3 exceed-set-prec 4
```

7. Exit the policy-class-map Policer configuration mode.

```
switch(config-policymap-class-police)# exit
```

8. Exit the policy-class-map configuration mode.

```
switch (config-policymap-class)# exit
```

9. Exit the policy-map configuration mode.

```
switch(config-policymap)# exit
```

10. Return to privileged EXEC mode.

```
switch(config)# end
```

11. Enter the **copy** command to save the *running-config* file to the *startup-config* file.

```
switch# copy running-config startup-config
```

Attaching the mutation to the class

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
```

3. 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:
   - cos-mutation
   - cos-traffic-class
   - dscp-mutation
   - dscp-cos
   - dscp-traffic-class

```
switch(config-policyclass)# cos-mutation plsmap
```

Attaching the port-shaper to the class

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.

1. Select the policy map.

```
switch(config)# policy-map p1
```

2. Select the class.

```
switch(config-policymap)# class class-default
```

3. Specify the shaping rate for the port.

```
switch(config-policyclass)# port-shape 3000
```

Attaching the scheduler to the class

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.

1. Select the policy map.

```
switch(config)# policy-map p1
```

2. Select the class.

```
switch(config-policymap)# class class-default
```

3. Specify the scheduling attributes. For complete information, refer to the *Network OS Command Reference*.

```
switch(config-policyclass)# scheduler 3 31000 32000 33000 dwrr 20 20 20 10 10
```

Attaching the priority mapping table to the CEE map

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
```

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 egress traffic on the interface. The following associates binds policymap1 to outbound traffic on the interface.

```
switch(config-if-te-1/1/2)# service-policy out policymap1
```

You can unbind the policy-map by using the **no** keyword.

```
switch(config-if-te-1/1/2)# no service-policy out
```

4. Bind a policy-map to inbound traffic on the interface. The following associates binds policymap1 to inbound traffic on the interface.

```
switch(config-if-te-1/1/2)# service-policy in policymap1
```

   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 a class map is not associated with the policy-map.
- If policy-map is bound to an interface and the policy-map does not have mandatory Policer attributes, then traffic coming on that interface will be treated as conformed traffic. Packets on that interface will be marked as green and color based actions such as DSCP, CoS mapping and so on will not be applied.

Displaying policing settings and policy-maps

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** without identifying an interface and specify inbound or outbound 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)
```

```
sw0(conf-if-te-5/1/33)#
switch(conf-if-te-5/1/33)# do show policy-map detail pmap1
Policy-Map pmap1
    Class default
      Police cir 43454
Bound To: te 5/1/33(in), te 5/1/33(out)
```

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 policy-map
policy-map pmap1
 class default
  police cir 43454
switch(conf-if-te-5/1/33)# do sh ru int te 5/1/33
interface TenGigabitEthernet 5/1/33
 service-policy in pmap1
 service-policy out pmap1
 fabric isl enable
 fabric trunk enable
 no shutdown
```

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
```

Displaying police-priority-maps

The following example displays the running configured police priority-map name and mapping of CoS values for conform and exceed color priorities by means of the **show running-config police-priority-map** command.

```
switch# show running-config police-priority-map
police-priority-map prio_map1
 conform 3 3 3 5 6 1 1 1
 exceed 2 2 2 1 1 1 1 2
```

Auto QoS

Auto QoS automatically classifies traffic based on either a source or a destination IPv4 address. IPv6 addressing is not supported. 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 523.

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 multitenacy (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 525 and Removing NAS server IP addresses for Auto QoS on page 525 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 eAnvil-based platforms (VDX 6710, VDX 6720, and VDX 6730 switches, and VDX 6700 platforms, except the VDX 6740-series), 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 only supports IPv4 addressing.
- 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.
- 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.
- You cannot change the traffic class for NAS-classified traffic; it is always assigned to traffic-class TC5.
- 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 minimum bandwidth guarantee of 20% through their CEE map.
- The bandwidth available for Auto QoS traffic (20%) is fixed and cannot be modified. The following error is shown if you attempt to change the value.

```
switch(config-cee-map-default)# priority-group-table 2 weight 30 pfc off
switch(config-cee-map-default)# priority-group-table 3 weight 30 pfc off

%Error: PGID 3 cannot be modified when 'nas auto-qos' is configured
```

- 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 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   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 20

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 a CoS of 2 and DSCP of 0 (defaults) 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 802.1x Port Authentication

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 529, 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(conf-if-te-1/12)# dot1x authentication
   ```

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 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 **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(conf-if-te-1/12)# dot1x authentication
```

4. Change the port authentication mode to **auto**, **force-authorized** or **force-unauthorized**.

```
switch(conf-if-te-1/12)# dot1x port-control keyword
```

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
```

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(conf-if-te-1/12)# dot1x reauthenticate
```

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 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 authentication
```

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

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 87 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 **if_counters** and **Ethernet** 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. Each ASIC supports eight front-user ports on the 48x10G and 48x1G line cards, and supports two front-user ports on the 12x48G Line card.
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 topics discussed below 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 540.

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 540.

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
```

7. 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
```

8. 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 539.

1. 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
```

2. Configure the sFlow polling interval.

```
switch(conf-if-te-0/16)# sflow polling interval 35
```

3. Use the **sflow enable** command to enable sFlow on the interface.

```
switch(conf-if-te-0/16)# sflow enable
```

4. 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 538.

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 "policy1."

```
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 Switched Port Analyzer

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 topics discussed below 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.

SPAN in logical chassis cluster guidelines and limitations

In addition to the standard SPAN limitations, note the following guidelines and limitations for SPAN in logical chassis cluster:

- The Brocade VDX 6720 is not supported as SPAN source node in logical chassis cluster but it can act as a destination node.
- The Brocade VDX 6740, VDX 6740T, VDX 6740T-1G, and VDX 6730 are supported as both source and destination nodes for SPAN in logical chassis cluster.
- SPAN in logical chassis cluster supports up to 512 sessions.
- For SPAN with the destination port residing on a remote node, the **show span path session** *session-number* command shows the path taken by the mirrored packets in the cluster.

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.

Limitations for mirroring across RSPAN

Network OS 4.0.0 and later use Inter-Switch Links (ISLs) to mirror packets across RBridges to reach the destination. All the SPAN standalone commands function for RBridges with the following exceptions:

- The source port cannot be a Brocade VDX 6720-60 or VDX 6720-24 port.
- If there is congestion at the ingress span queue resulting from bandwidth-related backpressure at the ISL, the SPAN mirrored packets will be dropped and traffic will be lost.
- FCoE mirroring is not supported.
- TRILL ports cannot be destination ports.
- A TRILL port can be a source port, but its mirroring is restricted to the local node only.
- 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.
- Ethernet Pause frames are not mirrored across RBridges.

Configuring SPAN

Refer also to Standard SPAN guidelines and limitations on page 545.

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. The source and destination ports must be in the same port group for the Brocade VDX 6720-60.

```
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`.

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.

Configuring egress SPAN

To configure SPAN for outgoing 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 **tx** parameter for transmitted packets.

   The destination port is always an external port. The source and destination ports must be in the same port group for the Brocade VDX 6720-60.

```
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`.

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.

Configuring bidirectional SPAN

To configure SPAN for packets traveling in both directions, 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 **both** parameter for all packets.

   The destination port is always an external port. The source and destination ports must be in the same port group for the Brocade VDX 6720-60.

```
switch(config-session-1)# source tengigabitethernet 1/0/15 destination tengigabitethernet 1/0/18
direction both
```

   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`.

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** keyword.

```
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 SPAN in a logical chassis cluster

Refer also to SPAN in logical chassis cluster guidelines and limitations on page 546.

The **source** command controls the source and destination switches in the logical chassis cluster by the interface designation. The source and destination port can be anywhere in the logical chassis cluster. In this example, the source is set as the third switch in the logical chassis cluster by the *3/0/15* value. However the destination is set to the fifth switch in the logical chassis cluster by the *5/0/18* value.

```
switch(config-session-1)# source tengigabitethernet 3/0/15 destination tengigabitethernet 5/0/18 direction
tx
```

This configuration rule applies to **ingress**, **egress**, and **both** directions of SPAN. Otherwise, configure SPAN as you would in standalone mode. Refer to Switched Port Analyzer protocol overview on page 545.

The **show monitor** and **show span path** commands display the source and destination switches, as shown in this example:

```
switch# show span path session 1
Session                         :1
Path                            :Te 1/0/10 -> Te 3/0/15 (ISL-exit port) -> Te 5/0/18

switch# show monitor
Session                         :1
Description                     :Test monitor session
State                           :Enabled
Source interface                :Te 3/0/15 (Up)
Destination interface           :Te 5/0/18 (Up)
Direction                       :Rx
```

Configuring RSPAN

Refer also to RSPAN guidelines and limitations on page 546.

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
```

Configuring SFP Breakout Mode

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 555). 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 88 Platforms supporting breakout

Platform	Port configuration	QSFP ports
VDX 6740 VDX 6740T VDX 6740T-1G	48 10G plus 4 40G VDX 6740T-1G ports can be upgraded from to 10G with Port Upgrade license.	4 (with 40GbE Port Upgrade license)

TABLE 88 Platforms supporting breakout (continued)

Platform	Port configuration	QSFP ports
VDX 8770-4 VDX 8770-8	12x 40G and 27x40G	12 (12x40G) and 27 (27x40G)

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 89 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

TABLE 89 SFP breakout values (continued)

SFP # (rbridge/slot/port)	SFP type	Interface name	
			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 553.

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. (This applies to standalone and fabric cluster modes.)
    a) If you are in standalone mode or fabric cluster mode, you must 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                      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 1/2/11      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 breakout mode for a standalone switch

Static configuration supports certain line cards whereby the SFP mode change must be done in the line-card power off state to facilitate the re-allocation of line-card-wide ASIC resources among the new set of interfaces.

For the Brocade VDX 6740 series platforms, the SFP interfaces must be in the shutdown state before the configuration is allowed.

Perform the following configuration procedure for each SFP.

1. Shut down all interfaces that exist on this SFP.
   a) To *disable* breakout, four Te (10Gbps) interfaces are shut down on the Quad SFP (QSFP).
   b) To *enable* breakout, a single Fo (40Gbps) interface is shut down on the QSFP.
2. Apply the SFP breakout command to the target port(s).
   a) Existing interface(s) under the old mode, along with the associated configurations, are removed from the DCM database. If the target is a QSFP, disabling breakout mode results in deleting four Te (10 Gbps) interfaces and enabling breakout results in deleting a single Fo (40 Gbps) interface. The configuration of nontargeted interfaces is not affected.
   b) SFP breakout mode is updated in the DCM database.
3. After all SFPs are configured, copy the *running-config* file to the *startup-config* file. (This applies to standalone and fabric cluster modes.)
   a) If you are in standalone mode or fabric cluster mode, you must save the *running-config* file to the *startup-config* file. The SFP configuration must be saved in the startup database, which is used after you reboot the switch.
   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. Reboot the switch
   a) The Brocade VDX 6740, 6740T, and 6740T-1G create interfaces corresponding to the SFP breakout mode of each port. For a 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 as if the system were booting up for the first time. Unaffected interfaces retain their original configurations before the switch reboot is applied.

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(conf-if-fo-48/0/49)# shut

switch(conf-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                        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)#
```

Section IV: Network OS Layer 3 Routing Features

Configuring In-Band Management

In-band management overview

In-band management on the Brocade VDX switches allows you to manage devices through Layer 3-enabled front-end Ethernet ports. An in-band management interface is relatively easy to configure and the most cost-effective management solution, because management traffic and data traffic use the same physical port (a design principle referred to as "fate-sharing"). Therefore, no special infrastructure is required to support management traffic. The downside is that any problem in the data network can potentially cause loss of connectivity, and thus loss of management function, to the managed devices. Therefore, it is highly recommended that you configure a dedicated serial connection for any device in your network as an out-of-band fallback solution in the event in-band management becomes unavailable.

In-band management facilitates management tasks such as downloading firmware, SNMP polling, SNMP traps, troubleshooting, and configuration when an out-of-band management interface is not available. The table below lists some of the applications you can use with in-band management. The application listing is not meant to be exhaustive.

TABLE 90 Supported applications for in-band management

Application	Description
FWDL	Download firmware from an external server to a remote device using FTP or SCP.
SCP	Transfer files by using the Secure Copy Protocol.
SSH	Connect to a device through the Secure Shell application.
SNMP	Manage devices through the Simple Network Management Protocol.
Telnet	Connect to a device by using Telnet.

In-band management prerequisites

The management station must be able to acquire an IP address and the routes to the management network. You can configure the management station to use a static IP address or to acquire an IP address dynamically or through protocols such as DHCP. A default gateway can be used to forward all the packets from the management station to the management network. Refer to Configuring Ethernet management interfaces on page 69.

In addition, you must configure IP routes and subnets. The front-end Ethernet port that you configure for management access acts as a router with IP forwarding implemented to allow communication with the target device. If the management station and the managed devices are in separate subnets, it is necessary to configure IP routes throughout the network to allow the communication to take place. You can configure the management interface to use either dynamic routing protocols, such as Open Shortest Path First (OSPF), or static routing.

- To configure the in-band management interface to use static routing, refer to Configuring static routes on page 577.
- To configure the in-band management interface to use dynamic routing, refer to Configuring OSPF on page 607.

On switches running Network OS 3.0.0 and later, in-band management is supported in VCS-enabled mode to manage devices through a Layer 2 or Layer 3 network. In standalone mode, a management station may be directly connected to another node in standalone mode. On switches running firmware prior to Network OS 3.0.0, in-band management is supported only in standalone mode.

NOTE
Standalone mode is not supported on the Brocade VDX 8770 switches.

In-band management does not require any special configuration commands. Because management traffic rides over the existing IP routing infrastructure, the commands needed to configure an in-band management interface are the same you would use to configure IP interfaces supported by static or dynamic routing protocols to provide connectivity to target devices.

In-band management supported interfaces

In-band management is supported on the interfaces shown in the table below. Refer to the **interface** command documentation in the *Network OS Command Reference* for more information on the configuration options available for each of these interfaces.

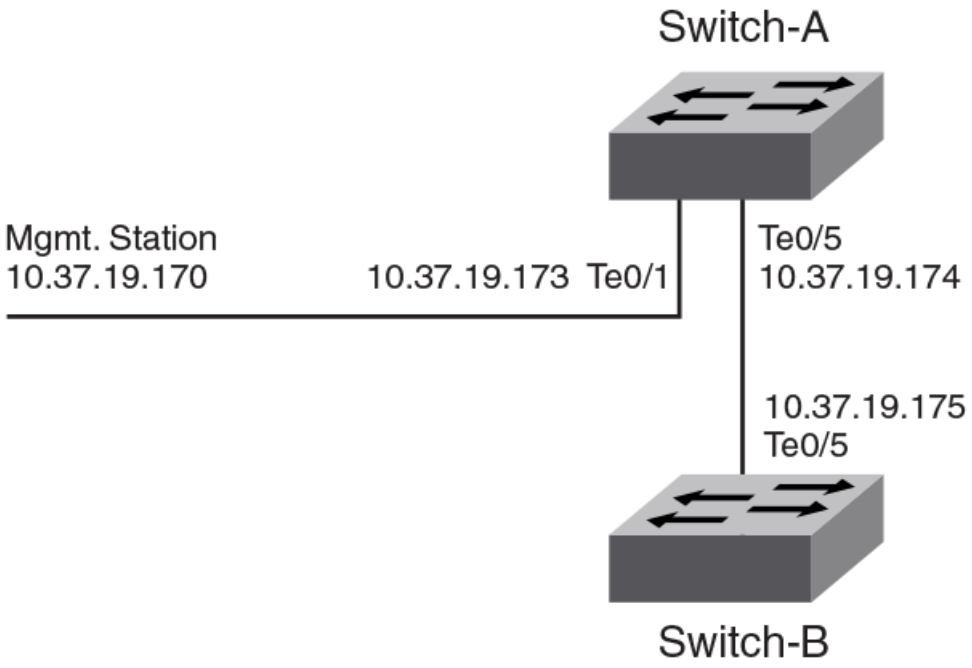
TABLE 91 Ports configurable for in-band management

Interface	Addressing	Description
Management (Ma)	rbridge-id/slot	Management interface
GigabitEthernet (Gi)	rbridge-id/slot/port	1-GbE physical interface
TenGigabitEthernet (Te)	rbridge-id/slot/port	10-GbE physical interface
FortyGigabitEthernet (Fo)	rbridge-id/slot/port	40-GbE physical interface
Port-channel (Po)	interface-id (IP or Po in standalone mode only)	Port Channel interface
Virtual Ethernet (Ve)	interface-id (corresponding VLAN ID)	Virtual Ethernet Interface

NOTE
A virtual Ethernet (Ve) interface is a logical port associated with a Layer 3 Virtual LAN (VLAN) configured on a Layer 3 switch. You can configure routing parameters on the virtual interface to enable the Layer 3 switch to route protocol traffic from one Layer 3 VLAN to the other, without using an external router. A corresponding VLAN must be configured before you can configure the Ve interface.

Configuring an in-band management interface in standalone mode

The figure below shows the configuration of an in-band management interface in standalone mode. In this example, the management station IP address and Ethernet port interface IP addresses for Switch-A and Switch-B are all in the same subnet, and therefore, no routing protocols are needed for the management station to connect to Switch-B through Switch-A. The management station (a server or workstation) connects to the physically attached Switch-A, and switch-A can connect to the physically connected Switch-B.



A management station with a networked device in standalone mode.

The configuration shown in this figure supports the following operations:

- Connecting from the management station to Switch-A through an SSH or Telnet session.
- Transferring files between the management station and Switch-A using secure copy (SCP) or FTP.
- Transferring files between Switch-A and Switch-B using secure copy (SCP).
- Using any of the applications in the table shown in the section In-band management overview on page 563 between Switch-A and Switch-B.

The following procedure configures the in-band management interface shown in the figure above.

1. Connect to the switch through the serial console or the management interface if available.
2. Issue the **configure terminal** command to enter global configuration mode.
3. Enter the **interface** command followed by the interface type you want to configure.

   For a standalone in-band management interface, only a physical user port (1 GbE, 10 GbE, or 40 GbE) needs to be configured with IP addresses. There is no need to configure either a VLAN or a Ve interface.
4. Enter the **ip address IPv4_address /prefix_length** command to set the IPv4 address for the interface.

   NOTE
   You must configure a primary IP address only. Secondary IP addresses are not supported.
5. Enter the **ip mtu** command to set the interface IP Maximum Transmission Unit (MTU) in bytes.
6. Enter the **arp-ageing-timeout** command to configure the interface timeout parameter (in minutes) for the Address Resolution Protocol (ARP).

   The default timeout value is 4 hours.
7. Clear the ARP cache by using the **do clear-arp-cache** command with the **no-refresh** option to delete unused ARP entries.

8. Configure a proxy ARP per interface by using the **ip proxy-arp** command.
9. Display the configuration by using the **show ip interface** command.

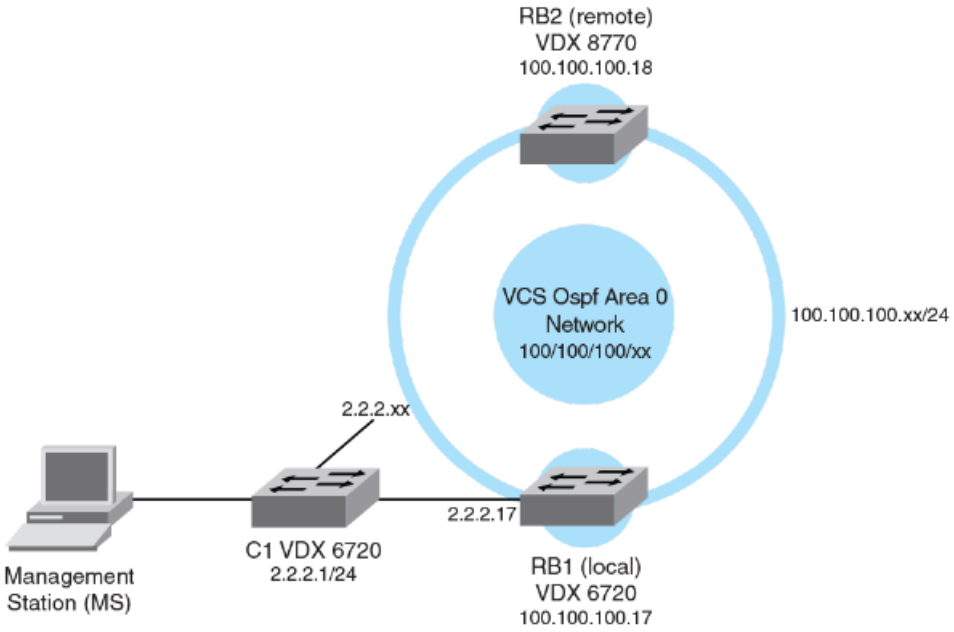
```
switch# configure terminal
Entering configuration mode terminal

switch(config)# interface TenGigabitEthernet 1/0/1

switch(conf-if-te-10/1)# no shutdown

switch(conf-if-te-1/0/1)# ip address 10.37.19.170/24

switch(conf-if-te-1/0/1)# ip mtu 1200

switch(conf-if-te-1/0/1)# arp-ageing-timeout 300

switch(conf-if-te-1/0/1)# do clear-arp-cache no-refresh

switch(conf-if-te-1/0/1)# ip proxy-arp

switch(conf-if-te-1/0/1)# exit

switch# show ip interface TenGigabitEthernet 1/0/1
TenGigabitEthernet 10/1 is up protocol is up
Primary Internet Address is 10.37.19.170/24 broadcast is 10.37.19.255
IP MTU is 1200
Proxy Arp is Enabled
ICMP unreachables are always sent
ICMP mask replies are never sent
IP fast switching is enabled
```

Configuring an in-band management interface using OSPF

The figure below shows the configuration of an in-band management interface connected to a VCS fabric through OSPF.

- In this scenario, a Brocade VDX 6720 (RB1 local), is connected to a Brocade VDX 8770 switch (RB2) in a VCS fabric through fabric ports.
- Another Brocade VDX 6720 switch (C1) is connected to a VCS fabric member (RB1) through the front panel port in RB1.
- OSPF is configured between RB1 and RB2 for Layer 3 forwarding, and to export and exchange routes.
- A management station (MS) is connected to C1 through a Telnet or SSH session.
- In a standalone configuration (Configuring an in-band management interface in standalone mode on page 564) C1 and RB1 are in standalone mode. The management station connects to RB1 through C1 using physical front-panel port connections.
- In VCS mode (Configuring a management connection in VCS fabric cluster mode on page 569), the management station connects to RB2 through C1 using OSPF and dynamic route distribution in a VCS fabric.

FIGURE 55 In-band management in a VCS fabric with dynamic routes (OSPF)



Basic configuration for a standalone in-band management

The following configuration establishes a basic in-band management connection from the management station to RBridge ID 1 (RB1) through C1. For the purpose of this example, C1 and RB1 operate in standalone mode (VCS mode is disabled). This example also illustrates the use of a VLAN to establish a connection.

1. Configure the front-end Ethernet port on RB1 through a serial connection.
   a) Connect to RB1 using the serial console.
   b) Issue the **configure terminal** command to enter global configuration mode.
   c) Configure a front-end Ethernet port by using the **interface vlan** *vlan_id* command.
   d) Issue the **rbridge-id** *rbridge-id* command to enter RBridge ID configuration mode.
   e) Enter the **interface ve** *ve_id* command to configure the virtual Ethernet interface (Ve).

      The Ve ID must correspond to the existing VLAN ID.
   f) Enter the IP address of the interface.
   g) Enter the **no shutdown** command to enable the interface.
   h) Enter the **do show vcs** command to verify that RB1 is in standalone mode and not a part of a VCS fabric.

```
RB1# configure terminal
Entering configuration mode terminal.

RB1(config)# interface vlan 2

RB1(config)# rbridge-id 1

RB1(config-rbridge-id-1)# interface ve 2

RB1(config-Ve-2)# ip address 2.2.2.17/24

RB1(config-Ve-2)# no shutdown

RB1(config--Ve2)# exit

RB1(config)# do show vcs
state   : Disabled
```

2. C1 is a management station and automatically Telnets into node RB1.

3. Verify that the in-band management connection between the management station to C1, and between C1and RB1 (standalone test).
   a) Connect to C1 through the management interface by using an SSH session.
   b) On C1, establish a Telnet connection from C1 to RB1.

```
C1# telnet 2.2.2.17/24
Trying 2.2.2.17...
Connected to 2.2.17.24.
Escape character is '^]'.
```

   You are now logged in to RB1 (note the prompt change).
   c) Verify the Telnet notification on RB1.

```
RB1# 1970/01/01-02:16:27, [SEC-1203], 13406, M1, INFO, RB1, Login information: Login successful
via TELNET/SSH/RSH. IP Addr: 2.2.17.24
```

   d) Through the Telnet in-band management connection from C1, verify that RB1 is in standalone mode.

```
RB1# show vcs
state   : Disabled
```

   You can now perform in-band management functions on RB1 through the management interface SSH connection to C1, such as downloading firmware or managing SNMP.

Configuring a management connection in VCS fabric cluster mode

The following configuration establishes an in-band management connection from a management station (MS) to C1, and from C1 to RB1 and RB2. RB1 is the local switch, RB2 is the remote switch. Both switches operate in VCS-enabled mode.

1. Set up an OSPF network (area 0) on RB1 to enable dynamic routing by using the following procedure.
   a) Connect to RB1 by using a serial connection.
   b) Issue the **configure terminal** command to enter global configuration mode.
   c) Enter the **interface vlan** command to configure a VLAN on RB1.

```
RB1# configure terminal
Entering configuration mode terminal.
RB1(config)# interface vlan 100
```

   d) Issue the **rbridge-id** *rbridge-id* command to enter RBridge ID configuration mode.
   e) Configure OSPF by using the **router ospf** command followed by the **area** command. Enter `0` to configure OSPF area 0.
   f) Enter the **exit** command to return to RBridge ID configuration mode.

```
RB1(config-Vlan-100)# rbridge-id 17
RB1(config-rbridge-id-17)# router ospf
RB1(conf-ospf-router)# area 0
RB1(conf-ospf-router)# exit
RB1(config-rbridge-id-17)#
```

   g) Configure a virtual Ethernet interface for the VLAN and assign the IP address for RB1.
   h) Set OSPF area 0 with the **ip ospf area** command.
   i) Enter the **no shutdown** command to enable the interface.

```
RB1(config-rbridge-id-17)# interface ve 100
RB1(config-Ve-100)# ip address 100.100.100.17/24
RB1(config-Ve-100)# ip ospf area 0
RB1(config-Ve-100)# no shutdown
```

2. Set up an OSPF network (area 0) on RB2 to enable dynamic routing. The configuration steps mirror the configuration on RB1.

   NOTE
   If you are configuring this in a logical chassis cluster mode, you do not configure the VLAN again on RB2 because RB1 (the principal node) would distribute the configuration to all nodes in the logical chassis cluster.

   a) Connect to RB2 by using a serial connection.
   b) Enter the **configure terminal** command to enter global configuration mode.
   c) Enter the **interface vlan** command to configure a VLAN on RB2.

```
RB2# configure terminal
Entering configuration mode terminal.
RB2(config)# interface vlan 100
```

   d) Enter the **rbridge-id** *rbridge-id* command to enter RBridge ID configuration mode.
   e) Configure OSPF by using the **router ospf** command followed by the **area** command. Enter `0` to configure OSPF area 0.
   f) Enter the **exit** command to return to RBridge ID configuration mode.

```
RB2(config-Vlan-100)# rbridge-id 18
RB2(config-rbridge-id-18)# router ospf
RB2(conf-ospf-router)# area 0
RB2(conf-ospf-router)# exit
RB2(config-rbridge-id-18)#
```

   g) Configure the virtual Ethernet interface for the VLAN and assign the IP address for RB2.
   h) Set OSPF area 0 with the **ip ospf area** command.
   i) Enter the **no shutdown** command to enable the interface.

```
RB2(config-rbridge-id-18)# interface ve 100
RB2(config-Ve-100)# ip address 100.100.100.18/24
RB2(config-Ve-100)# ip ospf area 0
RB1(config-Ve-100)# no shutdown
```

3. Verify the OSPF configuration in the VCS fabric.
   a) On RB2, verify adjacency between RB1 and RB2. RB2 is displayed as a neighbor.

```
RB2(config-Ve-100)# do show ip ospf neighbor
Port   Address        Pri State    Neigh Address  Neigh ID       Ev Opt Cnt
Ve 100 100.100.100.18 1   FULL/BDR 100.100.100.17 100.100.100.17 6  2   0
```

   b) On RB2, verify the IP routes between RB1 and RB2.

```
RB2(config-Ve-100)# do show ip route
Total number of IP routes: 2
Type Codes-B:BGP D:Connected I:ISIS O:OSPF R:RIP S:Static; Cost-Dist/Metric
BGP Codes - i:iBGP e:eBGP
ISIS Codes - L1:Level-1 L2:Level-2
OSPF Codes - i:Inter Area 1:External Type 1 2:External Type 2 s:Sham Link
  Destination      Gateway        Port   Cost    Type Uptime
1 2.2.2.0/24       100.100.100.17 Ve 100 110/10  O2   0m14s
2 100.100.100.0/24 DIRECT         Ve 100 0/0     D    5m2s
```

   c) On RB1, distribute the routes between RB1 and RB2 as shown here:

```
RB1# configure terminal
Entering configuration mode terminal.
RB1(config)# rbridge-id 17
RB1(config-rbridge-id-17)# router ospf
RB1(conf-ospf-router)# redistribute connected
RB1(conf-ospf-router)# exit
RB1(config)#
```

   d) Verify the VCS fabric configuration on RB1.

```
RB1(config)# do show vcs
Config Mode  : Local-Only
VCS ID       : 2
Total Number of Nodes   : 2
Rbridge-Id  WWN                       Management IP Status HostName
-----------------------------------------------------------------------
17          10:00:00:05:33:77:31:9C* 10.24.73.80   Online RB1
18         >10:00:00:05:33:77:23:6C  10.24.73.85   Online RB2
```

   e) Verify the VCS fabric configuration on RB2.

```
RB2# show vcs
Config Mode  : Local-Only
VCS ID       : 2
Total Number of Nodes   : 2
Rbridge-Id  WWN                       Management IP Status HostName
-----------------------------------------------------------------------
17          10:00:00:05:33:77:31:9C* 10.24.73.80   Online RB1
18         >10:00:00:05:33:77:23:6C  10.24.73.85   Online RB2
```

4. Verify the in-band management connection to RB1 and RB2.
   a) Connect to C1 from the management station using an SSH connection.
   b) On C1, verify connectivity to RB1 (local test) by issuing the **ping** command to the front-end Ethernet interface (Ve port) IP address for RB1.

```
C1# ping 2.2.2.17
PING 2.2.2.17 (2.2.2.17): 56 data bytes
64 bytes from 2.2.2.17: icmp_seq=0 ttl=64 time=8.206 ms
64 bytes from 2.2.2.17: icmp_seq=1 ttl=64 time=7.126 ms
--- 2.2.2.17 ping statistics ---
```

   c) From C1, verify connectivity to RB2 (remote test) by issuing the **ping** command to the front-end Ethernet interface (VE port) IP address for RB2.

```
C1# ping 100.100.100.18
PING 100.100.100.18 (100.100.100.18): 56 data bytes
64 bytes from 100.100.100.18: icmp_seq=0 ttl=63 time=21.239 ms
64 bytes from 100.100.100.18: icmp_seq=1 ttl=63 time=19.889 ms
--- 100.100.100.18 ping statistics ---
```

   d) From C1, establish a Telnet connection to RB1 by issuing the **telnet** command to the front-end Ethernet interface (Ve port) IP address for RB1.

      This test verifies the in-band management interface between C1 and the local RBridge, RB1. If the test succeeds, you can perform management functions on RB1 through C1.

```
C1# telnet 2.2.2.17
Trying 2.2.2.17...
Connected to 2.2.2.17
Escape character is '^]'.
```

   e) Verify the Telnet RASLog notification on RB1 through C1.

      The RASLog message displays on the console.

```
RB1# 2012/05/10-17:31:09, [SEC-1203], 312942, M1, INFO, C1, Login information: Login successful
via TELNET/SSH/RSH. IP Addr: 2.2.2.1
```

   f) Verify the VCS fabric configuration on RB1 through C1.

      The output is identical to the output generated in step 3d. The difference is that you are now connected to RB1 through the in-band management interface.

```
RB1# show vcs
Config Mode  : Local-Only
VCS ID       : 2
Total Number of Nodes   : 2
Rbridge-Id  WWN                     Management IP  Status HostName
-----------------------------------------------------------------
17         10:00:00:05:33:77:31:9C* 10.24.73.80    Online RB1
18        >10:00:00:05:33:77:23:6C  10.24.73.85    Online RB2
```

   g) From C1, establish a Telnet connection to RB2 by issuing the **telnet** command to the front-end Ethernet interface (VE port) IP address for RB2.

      This test verifies the in-band management interface between C1 and the remote RBridge, RB2. If the test succeeds, you can perform management functions on RB2 through C1.

```
C1# telnet 100.100.100.18
Trying 100.100.100.18...
Connected to 100.100.100.18.
Escape character is '^]'.
```

h) Verify the Telnet RASLog notification on RB2 through C1.

The RASLog message displays on the console.

```
RB2# 2012/05/10-17:31:09, [SEC-1203], 312942, M1, INFO, C1, Login information: Login successful
via TELNET/SSH/RSH. IP Addr: 2.2.2.1
```

i) Verify the VCS fabric configuration on RB2 through C1.

The output is identical to the output generated in step 3d. The difference is that you are now connected to RB2 through the in-band management interface.

```
RB2# show vcs
Config Mode  : Local-Only
VCS ID       : 2
Total Number of Nodes   : 2
Rbridge-Id  WWN                       Management IP Status HostName
-----------------------------------------------------------------------
17          10:00:00:05:33:77:31:9C* 10.24.73.80   Online RB1
18         >10:00:00:05:33:77:23:6C  10.24.73.85   Online RB2
```

If all verification steps produce the desired results, the configuration is successful, and you can use the management interface on C1 to perform management functions on both the local (RB1) and the remote (RB2) switch.

For more information on IP address configuration in the VCS fabric, refer to Configuring VCS virtual IP addresses on page 150.

IP Route Policy

IP route policy overview

IP route policy controls how routes or IP subnets are transported from one subsystem to another subsystem. The IP route policy may perform "permit" or "deny" actions so that matched routes may be allowed or denied to the target subsystem accordingly. Additionally, IP route policy may also be used for modify the characteristics of a matched route and IP subnet pair.

Two types of IP route policies are supported, *prefix-list* and *route-map*, as discussed in the following sections

IP prefix lists

An IP prefix list is identified by its name. Each IP prefix list may consist of one or more instances. The following is an example of IP prefix list,

```
switch# ip prefix-list test 1 deny 1.2.0.0/16 ge 17 le 30
switch# ip prefix-list test 2 permit 1.1.0.0/16
```

A matching condition of a prefix-list instance contains two portions: (1) an IP subnet prefix and(2) an optional prefix (mask) length, where **ge** (greater than or equal to) is the lower limit of the mask length, and **le** (less than or equal to) is the upper limit of the mask length. If no **ge** or **le** is given in an instance, the exact match of subnet prefix length is needed.

In the example above, a route is considered a match for instance 1 if this route is inside subnet 1.2.0.0/16 *and* whose mask length is between 17 and 30. That is, route 1.2.1.0/24 matches but route 1.2.1.1/32 does not match because of the difference in mask length.

Similar to a route map, when finding a match, each prefix-list instance is looked at in the order specified by its instance ID. The look-up terminates at the first match. A route that does not find a match in the prefix list is denied.

At present, a prefix list is not used by itself. The IP prefix list can be used as part of route-map **match** clauses. In this context, **permit** means “match” this pattern, and **deny** means “do not match this pattern”.

Route maps

A route map is identified by its name. Each route map may consist of one or more instances. Each route map instance may contain zero or more **match** clauses, and zero or more **set** clauses.

At present, a route map instance represents the largest granularity of configuration. That is, the end user is required to add *and* delete route maps by means of its instance. For example, when removing a route map, an end user is required to remove this route-map in all of its instances. A route map instance may contain more than one match condition. The overall matching condition of the instance is true only if all matching conditions are met. The following is an example of a route map:

```
switch# route-map test deny 1 match interface te 0/1
switch# route-map test permit 2 match ip next-hop prefix-list pre-test set tag 5000
```

In the example above, **route-map test** comprises of two instances: instance 1 denies entry for any routes whose next-hop interface is te 0/1, and instance 2 allows entry for routes whose next-hop address matches the IP subnets specified by **prefix-list pre-test** (the prefix-list instance is not shown). Additionally, each matched route has its tag set to 5000.

NOTE
The maximum number of OSPF networks that can be advertised and processed in a single area in a router is limited to 600.

A route map instance does not need to contain a matching condition; its existence implies that the matching condition for this instance is true.

A route map instance may contain more than one set clause. All **set** clauses are applied to the **match** routes when applicable.

When a route map is applied, each instance is looked at in the order specified by the instance ID. If there is a match, the instance's action are applied, and its **set** clauses are applied if the action is permitted. The search terminates at the first match. A route that does not find a match in a route map is denied.

Configuring IP route policy

Similar to ACLs, a route map and IP prefix list need to be applied for a specified policy to take effect. The following example applies a route-map to the redistribution of static routes into an OSPF domain. (For complete information on these commands, refer to the *Network OS Command Reference*.)

To set an IP route policy, perform the following steps in privileged EXEC mode.

1. Enter the **router ospf (or router bgp)** command to enable the appropriate Layer 3 protocol. This example uses OSPF and creates the route map instance "test."

```
switch# router ospf redistribute static route-map test area 0
```

2. Enter the **ip route** command to create the prefix for a static route.

```
switch# ip route 11.11.11.0/24 2.2.2.1
```

3. Enter the **ip route** command to create the next hop in the static route. Repeat as needed.

```
switch# ip route 11.11.11.0/24 2.2.2.2
```

4. Enter the **route-map** command to create the route map and prefix list instance.

```
switch# route-map test permit 1 match ip address prefix-list pretest
```

5. Enter the **ip prefix-list** command to configure the IP prefix list instance.

```
switch# ip prefix-list pretest 2 permit 1.1.1.0/24
```

In the example above, when the **route-map test** *permit 1* command executes, only the static route 1.1.1.0/24 is exported into the OSPF domain, because there are no matching rules in **pretest** for route 11.11.11.0/24. The default action of **pretest** is **deny** (there is no match); therefore, the route 11.11.11.0/24 is not exported into the OSPF domain.

You can configure the router to permit or deny specific IP addresses explicitly. The router permits all IP addresses by default. If you want **permit** to remain the default behavior, define individual filters to deny specific IP addresses. If you want to change the default behavior to **deny**, define individual filters to permit specific IP addresses. Once you define a filter, the default action for addresses that do not match a filter is **deny**. To change the default action to **permit**, configure the last filter as **permit any any**.

Configuring IP Route Management

IP route management overview

IP route management is the term used to refer to software that manages routes and next hops from different sources in a routing table, from which the Brocade device selects the best routes for forwarding IP packets. This route management software gets activated automatically at system bootup and does not require preconfiguration.

IP route management runs on all platforms configured for Layer 3 and does the following:

- Maintains routes submitted by other protocols.
- Supports route redistribution.
- Supports router identification.
- Selects and synchronizes routes to the forwarding information base (FIB).
- Synchronizes the Layer 3 interface to the FIB.
- Supports the following Layer 3 interfaces: virtual ethernet (Ve), router port, loopback, and management.

NOTE
IP route management supports both IPv4 and IPv6 routes.

How IP route management determines best route

The sources of routes that are added into IP route management are the following:

- Dynamic routes from routing protocols. Open Shortest Path First (OSPF) and Border Gateway Protocol (BGP) are both supported.
- Static configured routes: You can add routes directly to the route table. When you add a route to the IP route table, you are creating a static IP route.
- Directly connected routes from interface configuration: When you add an IP interface, the Brocade device automatically creates a route for the network.

Administrative distance can be configured for route types other than connected routes. IP route management prefers routes with lower administrative distances.

Configuring static routes

You can add a static route to IP route management by using the **ip route** commands in RBridge ID configuration mode. With these commands, you can specify either the next-hop gateway or the egress interface for the route.

NOTE
To make these same commands work in standalone mode, omit the **rbridge-id** command. For detailed information, refer to the *Network OS Command Reference*.

Specifying the next-hop gateway

To configure a static route to network 10.95.7.0/24, using 10.95.6.157 as the next-hop gateway, use the **ip route** command in RBridge ID configuration mode, as shown in this example:

```
switch (config)# rbridge-id 30
switch (config-rbridge-id-30)# ip route 10.95.7.0/24 10.95.6.157
```

Specifying the egress interface

To configure a static IP route with an IPv4 address on a 10-gigabit Ethernet port, enter an **ip route** command such as the following.

```
switch (config)# rbridge-id 30
switch (config-rbridge-id-30)# ip route 192.128.2.0/24 te 101/4/1
```

The command configures a static IP route for destination network 192.128.2.0/24. Because an Ethernet port is specified instead of a gateway IP address as the next hop, the Brocade device forwards traffic for network 192.128.2.0/24 to the 10-gigabit Ethernet port 101/4/1.

This example is the same command using IPv6.

```
switch (config)# rbridge-id 30
switch (config-rbridge-id-30)# ipv6 route fe80::21b:edff:fe0b:3c00/64 te 101/4/1
```

Configuring the default route

A default route is configured with an all-zero prefix/netmask (for example, 0.0.0.0/0). The default route is an example of a special static route with a destination prefix of zero. All traffic that does not have other matching routes is forwarded to the default route.

Once the maximum number of routes are installed in the IP route table and if you delete some of those routes, the **clear ip route all** command needs to be executed for the routes to be refreshed, so that previously uninstalled routes can be re-installed up to the maximum limit.

The same gateway for the default route is updated on the management interface, on both management modules MMs).

The first configured management-port default route entry becomes the gateway on the management interface. Any other default routes configured later do not change the management interface gateway value. When multiple such entries exist, and you remove them one by one, the last entry is updated as the gateway.

To configure a default route with a next hop address of 10.95.6.157, enter the following **ip route** command.

```
switch(config)# rbridge-id 30
switch(config-rbridge-id-30)# ip route 0.0.0.0/0 10.95.6.157
```

Using additional IP routing commands

Refer to the *Network OS Command Reference* for more information about using additional IP routing-related commands. The following examples are just a few among a range of command options:

- The **ip route** command offers an option that allow you to specify a tag value of a route for route filtering with a route map. The command also offers an option for specifying a cost metric.
- The **ip load-sharing** command can be used to balance IP traffic across up to eight equal paths.
- The **ip route next-hop ospf** command allows a Brocade device to use routes learned from OSPF to resolve a configured static route.

- The **ip route next-hop bgp** command allows a Brocade device to use routes learned from BGP to resolve a configured static route.
- The **ip route next-hop-recursion** command allows a Brocade device to resolve a route by using as many as 10 recursive-level lookups of other routes.

Configuring PBR

Policy-Based Routing

Policy-Based Routing (PBR) allows you to use ACLs and route maps to selectively modify and route IP packets in hardware.

(PBR) allows you to use ACLs and route maps to selectively modify and route IP packets in hardware. Basically, the ACLs classify the traffic and route maps that match on the ACLs set routing attributes for the traffic.

A PBR policy specifies the next hop for traffic that matches the policy:

- For standard ACLs with PBR, you can route IP packets based on their source IP address.
- For extended ACLs with PBR, you can route IP packets based on all of the matching criteria in the extended ACL.

To configure PBR, you define the policies using IP ACLs and route maps, then enable PBR on individual interfaces. The platform programs the ACLs on the interfaces, and routes traffic that matches the ACLs according to the instructions provided by the "set" statements in the route map entry.

Currently, the following platforms support PBR:

- VDX 8770
- VDX 6740

You can configure the Brocade device to perform the following types of PBR based on a packet's Layer 3 and Layer 4 information:

- Select the next-hop gateway.
- Send the packet to the null interface (null0) to drop the packets.

Using PBR, you can define a set of classifications that, when met, cause a packet to be forwarded to a predetermined next-hop interface, bypassing the path determined by normal routing. You can define multiple match and next-hop specifications on the same interface. The configuration of a set of match criteria and corresponding routing information (for example next hops and DSCP values) is referred to as a stanza.

You can create multiple stanzas within a route-map configuration and assign the stanza an "Instance_ID" that controls the program positioning within the route map. Furthermore, when the route map is created, you specify a deny or permit construct for the stanza. In addition, the ACL used for the "match" criteria also contains a deny or permit construct.

The deny or permit nomenclature has a different meaning within the context of the PBR operation than it does within the normal context of user-applied ACLs (where deny and permit are directly correlated to the forwarding actions of forward and drop). The following table lists the behavior between the permit and deny actions specified at the route-map level, in conjunction with the permit and deny actions specified at the ACL rule level.

Route-map level permit and deny actions	ACL clause permit and deny actions	Resulting Ternary Content Addressable Memory (TCAM) action
Permit	Permit	The "set" statement of the route-map entry is applied.
Permit	Deny	The packet is "passed" and routed normally. The contents of the "set" command are not applied. A rule is programmed in the TCAM as a "permit" with no result

Route-map level permit and deny actions	ACL clause permit and deny actions	Resulting Ternary Content Addressable Memory (TCAM) action
		actions preventing any further statements of the route-map ACL from being applied.
Deny	Permit	The packet is "passed" and routed normally. There should be no "set" commands following the "match" command of a deny route-map stanza. A rule is programmed in the TCAM as a "permit" with no result actions preventing any further statements of the route-map ACL from being applied.
Deny	Deny	No TCAM entry is provisioned; no other route-map ACL entries will be compared against. If no subsequent matches are made, the packet is forwarded as normal.

Notes:

- Ternary Content Addressable Memory is high-speed hardware memory.
- Consider the permit and deny keywords as allowing the specified match content as either being permitted to or denied from using the defined "set criteria" of the route map. The permit and deny keywords do not correlate to the forwarding action of forward and drop as they do in the ACL application.
- PBR route maps may only be applied to Layer 3 (L3) interfaces. Application of a route map to a non-L3 interface results in the configuration being rejected.
- Deletion of a route map or deletion of an ACL used in the route map "match" is not allowed when the route map is actively bound to an interface. Attempts to delete an active route map or associated ACL is rejected, and an error and log will be generated.
- The "set" commands are only available within the context of a "permit" stanza. The CLI should not allow the use of a "set" command within a PBR "deny" stanza.

Policy-Based Routing behavior

Policy-Based Routing (PBR) next-hop behavior selects the first live next-hop specified in the policy that is "UP". If none of the policy's direct routes or next hops is available, the packets are forwarded as per the routing table. The order in which the next hop addresses are listed in the route map is an implicit preference for next hop selection.

When a PBR policy has multiple next hops to a destination, the PBR selects the first live next-hop specified in the policy that is "UP". If none of the policy's direct routes or next hops is available, the packets are forwarded as per the routing table. The order in which the next hop addresses are listed in the route map is an implicit preference for next hop selection.

For example, if you enter the next hop addresses A, B, and C (in that order), and all paths are reachable, then A is the preferred selection. If A is not reachable, the next hop is B. If the path to A becomes reachable, the next hop logic will switch to next-hop A.

PBR does not have implicit "deny ip any any" ACL rule entry, as used in ACLs, to ensure that for route maps that use multiple ACLs (stanzas), the traffic is compared to all ACLs. However, if an explicit "deny ip any any" is configured, traffic matching this clause is routed normally using L3 paths and is not compared to any ACL clauses that follow the clause.

The set clauses are evaluated in the following order:

1. Set clauses where the next hop is specified.
2. Set interface NULL0.

The order in which you enter the "set ip next-hop" commands determines the order preference. If no next-hops are reachable, the egress interface is selected based on the order of interface configuration. The set interface NULL0 clause — regardless of which position it was entered — is always placed as the last selection in the list.

For example if you enter the order shown below, the PBR logic will treat 3.3.3.5 as its first choice. If 3.3.3.5 is unavailable, the PBR logic will determine if 4.4.4.4 is available. NULL0 is recognized only if 3.3.3.5 and 4.4.4.4 are both unavailable.

```
route-map foo permit 20
   match ip address acl Vincent
   set ip next-hop 3.3.3.5
   set ip interface NULL0
   set ip next-hop 4.4.4.4
```

NOTE

If a PBR route map is applied to an interface that is actively participating in a control protocol, and the ACL specified in the route map also matches the control protocol traffic, the control protocol traffic is trapped to the local processor and is not forwarded according to the route map.

Policy-Based Routing with differing next hops

In this example, traffic is routed from different sources to different places (next hops). Packets arriving from source 1.1.1.1 are sent to the VRF pulp_fiction's next hop at 3.3.3.3; packets arriving from source 2.2.2.2 are sent to the VRF pulp_fiction's next hop at 3.3.3.5. If next hop 3.3.3.5 is not available, then the packet is sent to the next hop 4.4.4.4.

1. Configure the ACLs.

```
sw0(config)# ip access-list standard Jules
sw0(conf-ipacl-std)# permit ip 1.1.1.1

sw0(config)# ip access-list standard Vincent
sw0(conf-ipacl-std)# permit ip 2.2.2.2
```

2. Create the first stanza of the route map. (The example is using a route-map named pulp_fiction.)

```
sw0(config)# route-map pulp_fiction permit 10
sw0(config-routemap pulp_fiction)# match ip address acl Jules
sw0(config-routemap pulp_fiction)# set ip vrf pulp_fiction next-hop 3.3.3.3
```

3. Create the second stanza of the route-map (in this example well define a route-map named pulp_fiction.)

```
sw0(config)# route-map pulp_fiction permit 20
sw0(config-routemap pulp_fiction)# match ip address acl Vincent
sw0(config-routemap pulp_fiction)# set ip vrf pulp_fiction next-hop 3.3.3.5
sw0(config-routemap pulp_fiction)# set ip next-hop 4.4.4.4
```

4. Bind the route map to the desired interface.

```
sw0(config)# interface TenGigabitEthernet 4/1
sw0(conf-if-te-4/1)# ip policy route-map pulp_fiction
```

5. View the route map configuration contents.

```
sw0# show running-config route-map pulp-fiction
route-map pulp-fiction permit 10
 match ip address acl Jules
  set ip vrf pulp_fiction next-hop 3.3.3.3
!
route-map pulp-fiction permit 20
 match ip address acl Vincent
 set ip vrf pulp_fiction next-hop 3.3.3.5
 set ip next-hop 4.4.4.4
!
```

6. View the route map application.

```
sw0# show route-map pulp-fiction
Interface TenGigabitEthernet 3/3
  route-map pulp-fiction permit 10
    match ip address acl Jules       (Active)
    set ip vrf pulp_fiction next-hop 3.3.3.3
    Policy routing matches: 0 packets; 0 bytes

  route-map pulp-fiction permit 20
    match ip address acl Vincent     (Active)
    set ip vrf pulp_fiction next-hop 3.3.3.5  (selected)
    set ip next-hop 4.4.4.4
    Policy routing matches: 0 packets; 0 bytes
```

NOTE

For the first stanza (10) created in step 2, the absence of the keyword selected indicates that the none of the next hops in the list is being used; the packet is being routed by the standard routing mechanism.

Policy-Based Routing uses of NULL0

NULL0 is a mechanism used to drop packets in policy-based routing.

NULL0 is a mechanism used to drop packets in policy-based routing. If the NULL0 interface is specified within a stanza and the stanza also contains a “match ACL” statement, only traffic meeting the match criteria within the ACL is forwarded to the NULL0 interface. If the NULL0 interface is specified within a stanza that does not contain a “match” statement, the match criteria is implicitly “match any.”

Examples of using NULL0 include:

- NULL0 in conjunction with a “match” statement.
- NULL0 as a default action of a route map.

Policy-Based Routing and NULL0 with match statements

NULL0 is a mechanism used to drop packets in the Policy-Based Routing (PBR). If the NULL0 interface is specified within a stanza and the stanza also contains a “match ACL” statement, only traffic meeting the match criteria within the ACL is forwarded to the NULL0 interface. If the NULL0 interface is specified within a stanza that does not contain a “match” statement, the match criteria is implicitly “match any.”

In this example, the use of the NULL0 interface is only applicable to frames that meet the match criteria defined in the created ACL, or implicit "permit any" when no explicit match statement is listed for the stanza.

1. Configure the ACLs.

```
sw0(config)# ip access-list standard Jules
sw0(conf-ipacl-std)# permit ip 1.1.1.1
sw0(conf-ipacl-std)# deny ip 11.11.11.11
sw0(config)# ip access-list standard Vincent
sw0(conf-ipacl-std)# permit ip 2.2.2.2
```

2. Create the first stanza of the route map. (The example is using a route-map named pulp_fiction.)

```
sw0(config)# route-map pulp_fiction permit 10
sw0(config-routemap pulp_fiction)# match ip address acl Jules
sw0(config-routemap pulp_fiction)# set ip vrf pulp_fiction next-hop 3.3.3.3
sw0(config-routemap pulp_fiction)# set ip interface NULL0
```

3. Create the second stanza of the route map. (The example is using a route map named pulp_fiction.)

```
sw0(config)# route-map pulp_fiction permit 20
sw0(config-routemap pulp_fiction)# match ip address acl Vincent
sw0(config-routemap pulp_fiction)# set ip vrf pulp_fiction next-hop 3.3.3.5
sw0(config-routemap pulp_fiction)# set ip next-hop 4.4.4.4
```

Based on the above configuration, when address 1.1.1.1 is received, it matches stanza 10:

- If the next hop 3.3.3.3 is selected, the packet is forwarded to 3.3.3.3.
- If 3.3.3.3 is not selected by the PBR logic, the packet is sent to the next specified next-hop, which is the NULL0 interface, resulting in the traffic being dropped.
- If address 11.11.11.11 is received, since it matches the deny case of the ACL, it is denied from using the next hops specified in the route map and is forwarded according to the standard logic.
- If address 12.12.12.12 is received, because it meets none of the specified match criteria in either of the two stanzas, it basically falls off the end of the route map and reverts to using the standard routing logic.

Policy-Based Routing and NULL0 as route map default action

This example shows the use of the NULL0 interface.

In this example, the use of the NULL0 interface is only applicable to frames that meet the match criteria defined in the created ACL.

1. Configure the ACLs.

```
sw0(config)# ip access-list standard Jules
sw0(conf-ipacl-std)# permit ip 1.1.1.1
sw0(conf-ipacl-std)# deny ip 11.11.11.11
sw0(config)# ip access-list standard Vincent
sw0(conf-ipacl-std)# permit ip 2.2.2.2
```

2. Create the first stanza of the route map. (The example is using a route-map named pulp_fiction.)

```
sw0(config)# route-map pulp_fiction permit 10
sw0(config-routemap pulp_fiction)# match ip address acl Jules
sw0(config-routemap pulp_fiction)# set ip vrf pulp_fiction next-hop 3.3.3.3
sw0(config-routemap pulp_fiction)# set ip interface NULL0
```

3. Create the second stanza of the route map. (The example is using a route-map named pulp_fiction.)

```
sw0(config)# route-map pulp_fiction permit 20
sw0(config-routemap pulp_fiction)# match ip address acl Vincent
sw0(config-routemap pulp_fiction)# set ip vrf pulp_fiction next-hop 3.3.3.5
sw0(config-routemap pulp_fiction)# set ip next-hop 4.4.4.4
```

4. Create the third stanza, which provides the default action of the route map.

```
sw0(config)# route-map pulp_fiction permit 30
sw0(config-routemap pulp_fiction)#
sw0(config-routemap pulp_fiction)# set ip interface NULL0
```

The above configuration introduces a third stanza that defines the routing desired for all frames that do not meet any of the match criteria defined by the route map.

Based on the above configuration, when address 1.1.1.1 is received, it matches stanza 10:

- If the next hop 3.3.3.3 is selected, the packet is forwarded to 3.3.3.3.
- If 3.3.3.3 is not selected by the PBR logic, the packet is sent to the next specified next-hop, which is the NULL0 interface, resulting in the traffic being dropped.
- If address 11.11.11.11 is received, since it matches the deny case of the ACL, it is denied from using the next hops specified in the route map and will be forwarded according to the standard logic.
- If address 12.12.12.12 is received, because it meets none of the specified match criteria in either of the first two stanzas, it reaches the third stanza. Since a no “match” statement is specified, it is an implicit “match any.” The address 12.12.12.12 is forwarded to the NULL0 interface where it is dropped.

Providing the default stanza enables a mechanism whereby if any packet is received that does not meet the match criteria set by the route map, the traffic is dropped.

Configuring PIM

PIM overview

The Protocol Independent Multicast (PIM) protocol is a family of IP multicast protocols. PIM does not rely on any particular routing protocol for creating its network topology state. Instead, PIM uses routing information supplied by other traditional routing protocols such as the Routing Information Protocol, Open Shortest Path First, Border Gateway Protocol, and Multicast Source Discovery Protocol.

PIM messages are sent encapsulated in an IP packet with the IP protocol field set to 103. Depending on the type of message, the packet is either sent to the PIM All-Router-Multicast address (224.0.0.13) or sent as unicast to a specific host.

As with IP multicast, the main use case of PIM is for the source to be able to send the same information to multiple receivers by using a single stream of traffic. This helps minimize the processing load on the source as it needs to maintain only one session irrespective of the number of actual receivers. It also minimizes the load on the IP network since the packets are sent only on links which lead to an interested receiver.

Several types of PIM exist, but in this release Brocade supports only PIM Sparse Mode (PIM-SM). PIM-SM explicitly builds unidirectional shared trees rooted at a rendezvous point (RP) per group, and optionally creates shortest-path trees per source.

Important notes

- PIM can be enabled on the Brocade VDX 6740 and VDX 8770 series platforms only.
- PIM-SM can be used in VCS mode only.

PIM Sparse Mode

PIM-SM (Sparse Mode) is the most commonly deployed flavor of PIM. PIM-SM is most effective in large networks sparsely populated with hosts interested in multicast traffic. It is assumed that most hosts within a network are not interested in all multicast data streams.

PIM Sparse devices are organized into domains. A PIM Sparse domain is a contiguous set of devices that all implement PIM and are configured to operate within a common boundary.

PIM-SM creates unidirectional shared trees which are rooted at a common node in the network called the rendezvous point (RP). The RP acts as the messenger between the source and the interested hosts or routers.

There are various ways of identifying an RP within a network. It can either be statically configured per PIM router or configured using Bootstrap Router (BSR). Within a network, the RP should always be upstream compared to the destination hosts.

Once the RP has been identified, each interested host and/or router sends join messages to the RP for the group that they are interested in. To reduce incoming join messages to a RP, the local network selects one of its upstream routers as the designated router (DR). All hosts below a DR send IGMP join messages to the DR. The DR sends only one join message to the RP on behalf of all its interested hosts.

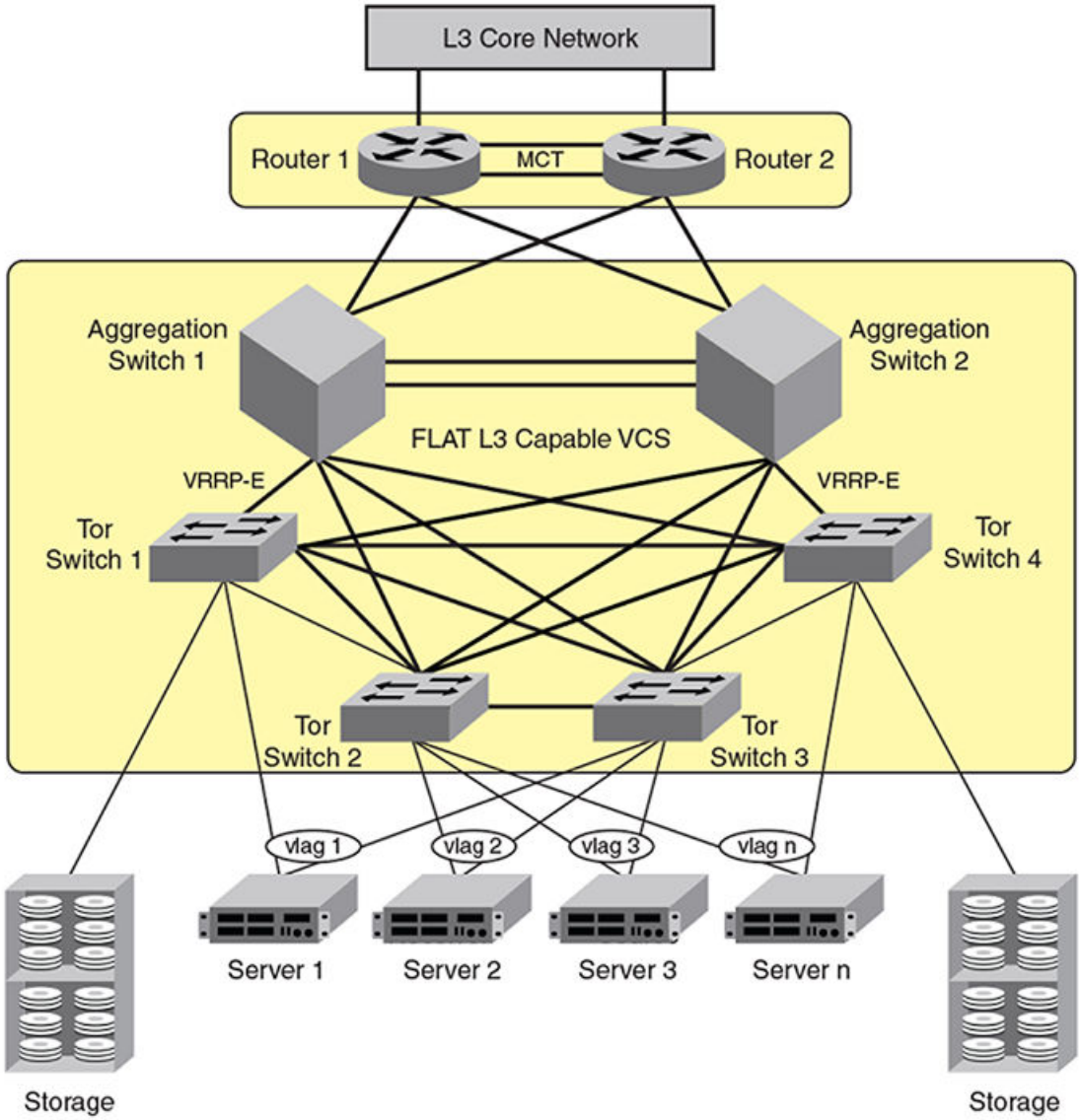
PIM-SM also provides the option of creating a source-based tree rooted at a router adjacent to the tree. This provides the destination hosts with an option of switching from the shared tree to the source-based tree if this is a shorter path between the source and the destination.

PIM topologies

This section shows diagrams of two supported PIM topologies.

The figure below shows the components for a single-VCS PIM topology.

FIGURE 56 Single VCS deployment



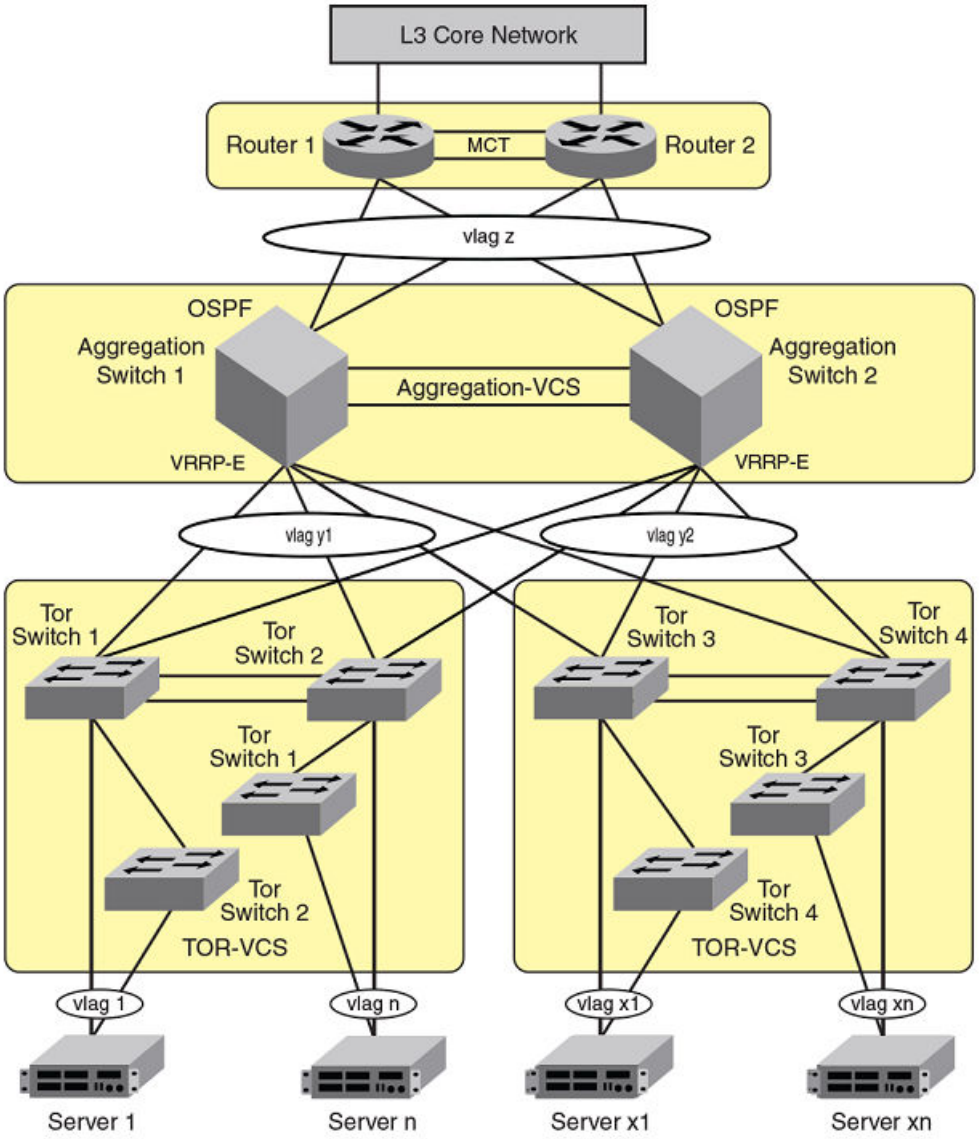
The following requirements apply to the single-VCS deployment depicted in the figure above:

- Top of rack switches can be Brocade VDX 6710, VDX 6720, VDX 6730, VDX 6740, VDX 6740T, VDX 6740T-1G, or VDX 8770 models. However, top of rack switches are typically only Layer 2-capable when used in this context as part of a PIM environment, and PIM can be enabled on the Brocade VDX 8770 and VDX 6740 models only.
- Top of rack switches must have IGMP-snooping enabled.
- Aggregation-layer switches must be Brocade VDX 8770 or VDX 6740 models only.
- Aggregation-layer switches can be PIM-enabled.
- L3 (VRRP-E and OSPF) can be configured on all interfaces with L3 connectivity to the data-center core.
- IGMP snooping must be enabled on the aggregation-layer switches.

- PIM DR-priority is configured on ve interfaces of all PIM-capable aggregation routers to optimize load-sharing abilities within the aggregation.

The figure below shows the components for a two-tier VCS PIM topology.

FIGURE 57 Two-tier VCS deployment



The following requirements apply to the two-tier-VCS deployment depicted in the figure above:

- Top of rack switches can be Brocade VDX 6710, VDX 6720, VDX 6730, or VDX 8770 models. However, Top of rack switches are typically only L2-capable when used in this context as part of a PIM environment, and PIM can be enabled on the Brocade VDX 8770 or VDX 6740 models only.
- Top of rack VCS are typically only L2 capable.
- Top of rack switches must have IGMP-snooping enabled.
- Aggregation-layer VCS must be VDX 8770 or VDX 6740 models only.

- Aggregation-layer switches can be PIM-enabled.
- L3 (VRRP-E and OSPF) can be configured on all interfaces with L3 connectivity to the data-center core.
- IGMP snooping must be enabled on the aggregation-layer switches.
- PIM can be enabled on all Brocade VDX 8770 or VDX 6740 models where VRRP-E is enabled.
- PIM DR-priority is configured on ve interfaces of all PIM-capable aggregation routers to optimize load-sharing abilities within the aggregation.

PIM Sparse device types

Devices that are configured with PIM Sparse interfaces also can be configured to fill one or more of the following roles:

- PIM multicast border router (PMBR) — A PIM device that has interfaces within the PIM domain and other interface outside the PIM domain. PBMRs connect the PIM domain to the Internet.
- Bootstrap router (BSR) — A router that distributes rendezvous point (RP) information to the other PIM Sparse devices within the domain. Each PIM Sparse domain has one active BSR. For redundancy, you can configure ports on multiple devices as candidate BSRs. The PIM Sparse protocol uses an election process to select one of the candidate BSRs as the BSR for the domain. The BSR with the highest BSR priority (a user-configurable parameter) is elected. If the priorities result in a tie, then the candidate BSR interface with the highest IP address is elected.

  The BSR must be configured as part of the L3 core network.
- Rendezvous point (RP) — The meeting point for PIM Sparse sources and receivers. A PIM Sparse domain can have multiple RPs, but each PIM Sparse multicast group address can have only one active RP. PIM Sparse devices learn the addresses of RPs and the groups for which they are responsible from messages that the BSR sends to each of the PIM Sparse devices.

  The RP must be configured as part of the L3 core network.

  NOTE
  Brocade recommends that you configure the same ports as candidate BSRs and RPs.

- PIM designated router (DR) — Once the RP has been identified, each interested host and/or router sends join messages to the RP for the group that they are interested in. The local network selects one of its upstream routers as the designated router (DR). All hosts below a DR send IGMP join messages to the DR. The DR in turn sends only one join message to the RP on behalf of all its interested hosts. The RP receives the first few packets of the multicast stream, encapsulated in the PIM register message, from the source hosts. These messages are sent as a unicast to the RP. The RP de-encapsulates these packets and forwards them to the respective DRs.

  NOTE
  DR election is based first on the router with the highest configured DR priority for an interface (if DR priority has been configured), and based next on the router with the highest IP address. To configure DR priority, use the **ip pim dr-priority** command. For more information about this command, refer to *Network OS Command Reference*.

PIM prerequisites

PIM requires the following to function properly:

- The system should support receiving and transmitting unicast as well as multicast packets.
- A Routing Information Base (RIB) must be accessible for obtaining routing information.

- An IPC mechanism must be available.
- A timer mechanism must be available.
- An IGMP module should be available for correct operation of PIM when working as a DR.

PIM standards conformity

The table below lists the level of Brocade conformity for various PIM-related RFCs.

TABLE 92 PIM RFCs supported

Standard	Level (Y/N/Partial)	Notes
RFC 4601	Y	PIM-SM Protocol Specification
RFC 3973	N	PIM-DM Protocol Specification
RFC 5059	Partial	BSR mechanism for PIM supported
RFC 5060	Partial	PIM MIB supported
RFC 5240	N	BSR MIB
RFC 4610	N	Anycast-RP
RFC 3618	N	MSDP

PIM limitations

In this release, PIM can be enabled on Brocade VX 6740 and VDX 8770 series platforms only. Also, only PIM Sparse Mode (PIM-SM) is supported at this time.

Static RP is not supported within the VCS cluster.

All PIM-enabled aggregation layer devices should have a direct Layer 3 connection to RP.

The following PIM features are not supported in this release:

- Non-stop routing (NSR)
- IP version 6
- VRF
- Prefix list
- Configuring the switch as the BSR candidate. However, the switch will be able to receive and process the BSR messages from other routers.
- Configuring the switch as the RP candidate.

PIM supportability

This release of Network OS includes the following PIM support:

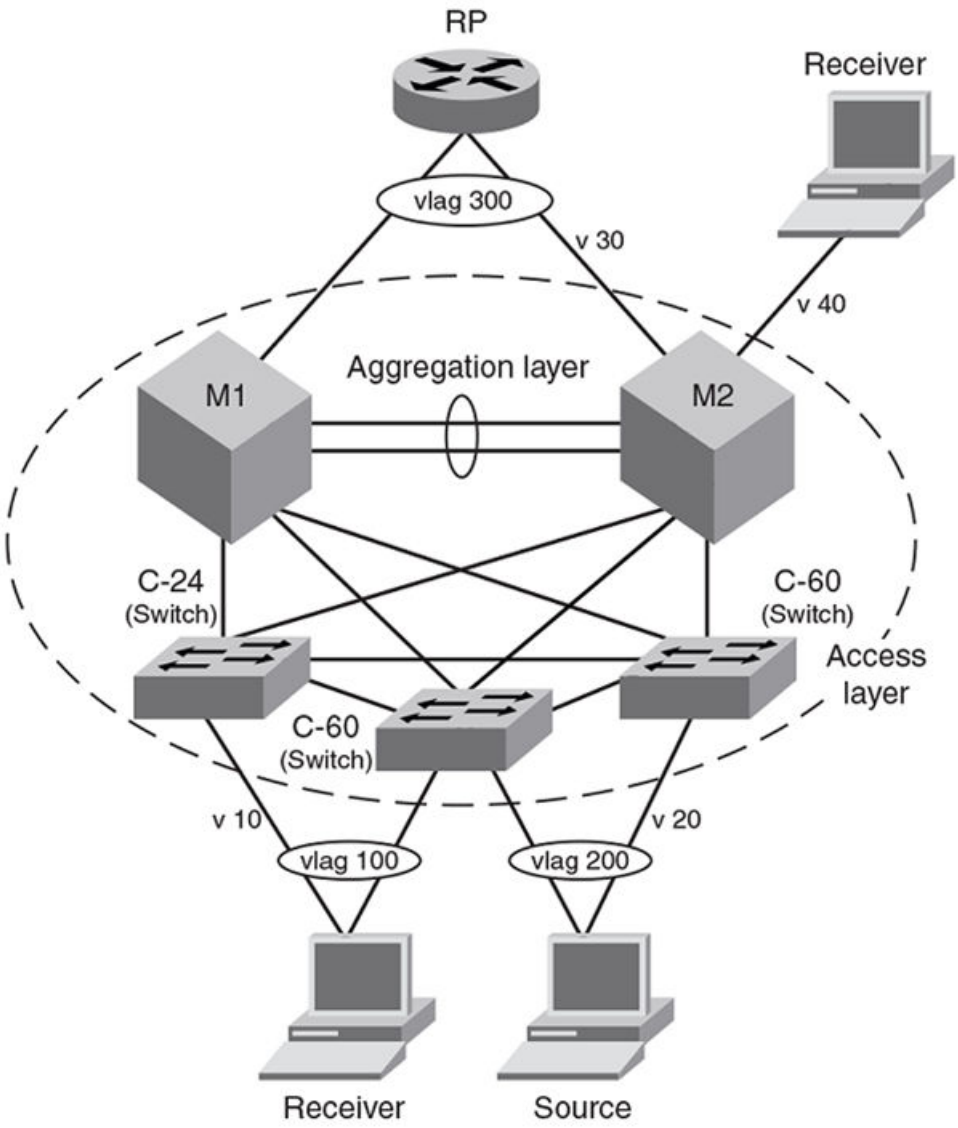
- 32 virtual interfaces. The virtual interfaces can be either Layer 3 VLAN or router ports
- 32 output interfaces
- 4,000 Layer 3 multicast group IDs
- 2,000 (S,G) forwarding entries

- 256 (*, G) forwarding entries
- A learning rate of 32 routes per second

Configuring PIM

This section shows you an example PIM Sparse deployment and configuration, based on the figure below.

FIGURE 58 Example deployment using single VCS



PIM configuration prerequisites

- VLAGs must belong to PIM-enabled VLANs. For more information, refer to Configuring Link Aggregation on page 443.
- Set up your VLAGs before performing any PIM-specific configuration.

- Make sure the rendezvous point (RP) is configured. This should be a third-party box for dynamic RP functionality, or either the Brocade VDX 8770 or the VDX 6740 series platforms for static RP functionality.
- Make sure the bootstrap router (BSR), if applicable to your setup, is configured. The BSR can be any third-party box that supports PIM, BSR and rendezvous point (RP) functionality. If you are using a Brocade MLX switch as the bootstrap router, refer to the *Brocade MLX Series and NetIron Family Configuration Guide* for more information.

Configuring PIM Sparse

NOTE
If you are statically configuring the RP per PIM router, use the **router pim** and **rp-addr** commands, as described in the *Network OS Command Reference*

Refer to the example figure for a deployment using a single VCS in Configuring PIM on page 593

- M1 and M2 must be Brocade VDX 8770 or VDX 6740 switches.
- M1 is the designated router (DR) for virtual LAN 10 (labeled "v10") and virtual LAN 30 (labeled "v30").
- M2 is the designated router (DR) for virtual LAN 20 (labeled "v20") and virtual LAN 40 (labeled "v40").
- The switches labeled C-24 and C-60 can be any combination of Brocade VDX 6710, VDX 6720, VDX 6730, VDX 6740, or VDX 8770 models. These switches are pure L2 devices and need IGMP snooping enabled only.

The following steps show you how to configure PIM Sparse for the scenario depicted in the example figure for a deployment using a single VCS shown in Configuring PIM on page 593. These steps show you where to enable IGMP snooping, where to create IP addresses for Ve interfaces, and where to enable PIM Sparse:

1. Enable IGMP snooping on each access-level switch by performing the following steps on each of these switches:
   a) From the switch console, in privileged EXEC mode, enter global configuration mode.

```
switch# configure
```

   b) Enter VLAN interface configuration mode for the first VLAN.

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

   c) Enable IGMP snooping.

```
switch(config-Vlan-10)# ip igmp snooping enable
```

   d) Exit interface configuration mode.

```
switch(config-Vlan-10)# exit
```

   e) Enter VLAN interface configuration mode for the second VLAN.

```
switch (config)# int vlan 20
```

   f) Enable IGMP snooping.

```
switch(config-Vlan-20)# ip igmp snooping enable
```

   g) Exit interface configuration mode.

```
switch(config-Vlan-20)# exit
```

   h) Enter VLAN interface configuration mode for the third VLAN.

```
switch (config)# int vlan 30
```

   i) Enable IGMP snooping.

```
switch(config-Vlan-30)# ip igmp snooping enable
```

   j) Exit interface configuration mode.

```
switch(config-Vlan-30)# exit
```

   k) Enter VLAN interface configuration mode for the fourth VLAN.

```
switch (config)# int vlan 40
```

   l) Enable IGMP snooping.

```
switch(config-Vlan-40)# ip igmp snooping enable
```

   m) Exit interface configuration mode.

```
switch(config-Vlan-40)# exit
```

2. Do the following on switch M1 in the example figure for a deployment using a single VCS in Configuring PIM on page 593.
   a) From the switch console, in privileged EXEC mode, enter global configuration mode.

```
switch# configure
```

   b) Enter VLAN interface configuration mode for the first VLAN.

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

   c) Enable IGMP snooping.

```
switch(config-Vlan-10)# ip igmp snooping enable
```

   d) Exit interface configuration mode.

```
switch(config-Vlan-10)# exit
```

   e) Enter RBridge ID configuration mode for the RBridge associated with this switch (for this example, it is assumed that an RBridge ID of 17 has already been configured for this switch).

```
switch (config)# rbridge-id 17
```

   f) Issue the **router pim** command to enable PIM for this switch.

```
switch(config-rbridge-id-17)# router pim
```

   g) To add a static rendezvous point (RP) configuration, add the RP address for the router PIM.

```
switch(config-rbridge-id-17)# rp-address 10.22.22.22
```

   h) Enter interface subconfiguration mode for the Ve interface associated with VLAN 10.

```
switch(config-rbridge-id-17)# int ve 10
```

   i) Enter the **no shut** command to activate the Ve interface and bring the ports online.

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

   j) Assign a unique IP address for the interface:

```
switch (config-ve-10)# ip addr 10.1.1.11/24
```

   k) Enable PIM Sparse for this interface.

```
switch (config-ve-10)# ip pim-sparse
```

   l) Exit Ve configuration mode.

```
switch (config-ve-10)# end
```

   m) Repeat the configuration steps for each of the other VLANs in the example figure for a deployment using a single VCS in Configuring PIM on page 593.

3. Do the following on M2 in the example figure for a deployment using a single VCS in Configuring PIM on page 593:
   a) From the switch console, in privileged EXEC mode, enter global configuration mode.

      ```
      switch# configure
      ```

   b) Enter VLAN interface configuration mode for the first VLAN.

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

   c) Enable IGMP snooping.

      ```
      switch(config-Vlan-10)# ip igmp snooping enable
      ```

   d) Exit interface configuration mode:

      ```
      switch(config-Vlan-10)# exit
      ```

   e) Enter RBridge ID configuration mode for the RBridge associated with this switch (for this example, it is assumed that an RBridge ID of 2 has already been configured for this switch).

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

   f) Issue the **router pim** command to enable PIM for this switch.

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

   g) Enter interface subconfiguration mode for the Ve interface associated with VLAN 10.

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

   h) Enter the **no shut** command to activate the Ve interface and bring the ports online.

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

   i) Assign a unique IP address for the interface.

      ```
      switch (config-ve-10)# ip addr 10.1.1.12/24
      ```

   j) Enable PIM Sparse for this interface.

      ```
      switch (config-ve-10)# ip pim-sparse
      ```

   k) Exit Ve configuration mode.

      ```
      switch (config-ve-10)# end
      ```

   l) Repeat the configuration steps for each of the other VLANs shown in the example figure for a deployment using a single VCS in Configuring PIM on page 593.

      NOTE
      For more information about PIM, refer to the *Network OS Command Reference*. Global PIM CLIs are found in RBridge ID configuration mode, whereas the interface-level PIM CLIs are found under their respective interface subconfiguration modes.

Configuring OSPF

OSPF overview

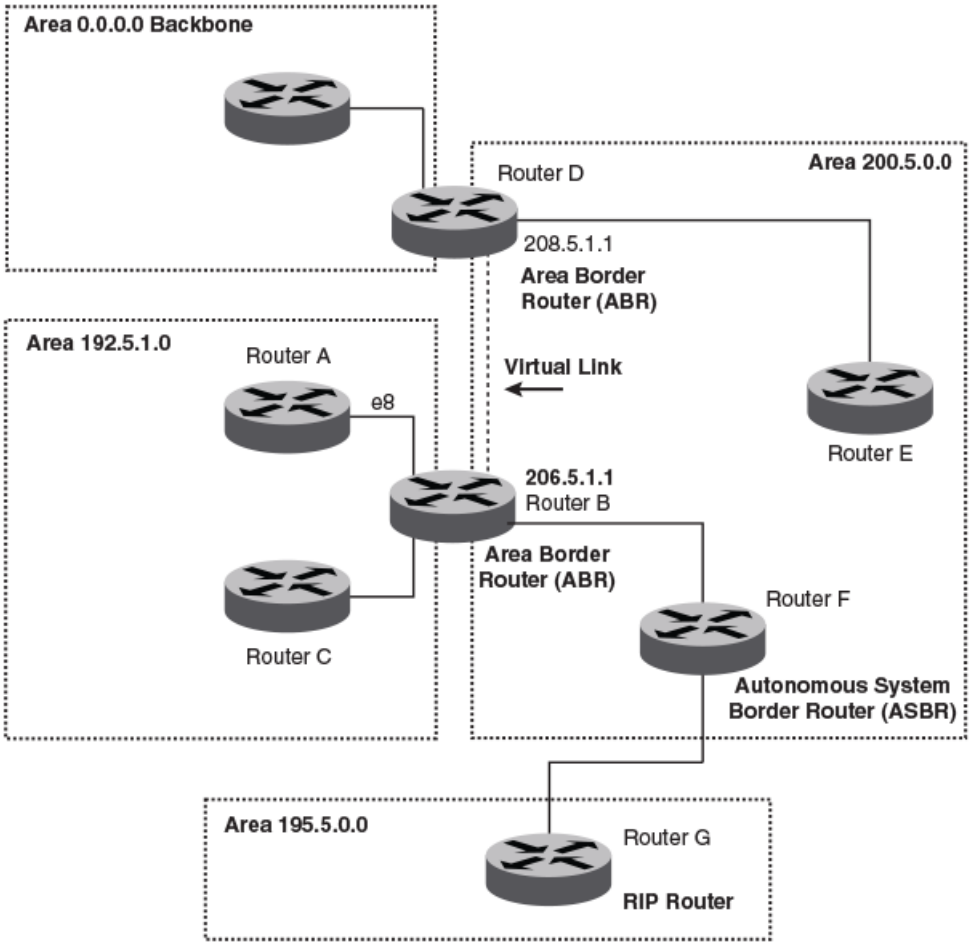
Open Shortest Path First (OSPF) is a link-state routing protocol that uses link-state advertisements (LSAs) to update neighboring routers about a router's interfaces. Each router maintains an identical area-topology database to determine the shortest path to any neighboring router.

OSPF is built upon a hierarchy of network components and *areas*. The highest level of the hierarchy is the *Autonomous System* (AS). An autonomous system is defined as a number of networks, all of which share the same routing and administration characteristics. A backbone area forms the core of the network, connecting all other areas. Details of these and other OSPF components are provided below.

Autonomous System

An AS can be divided into multiple areas as shown in the figure below. Each area represents a collection of contiguous networks and hosts (refer to OSPF areas on page 602). Areas limit the amount of advertisements sent (called flooding) within the network. An area is represented in OSPF by either an IP address or a number.

FIGURE 59 OSPF operating in a network



NOTE

For details of components and virtual links, refer to OSPF components and roles on page 600 and Virtual links on page 604, respectively.

Once OSPF is enabled on the system, the user assigns an IP address or number as the *area ID* for each area. The area ID is representative of all IP addresses (subnets) on a router port. Each port on a router can support one area.

OSPF components and roles

Routers can take a variety of roles in an OSPF topology, as discussed below.

Area Border Routers

An OSPF router can be a member of multiple areas. Routers with membership in multiple areas are known as *Area Border Routers (ABRs)* Each ABR maintains a separate topological database for each area the router is in. Each topological database contains all LSA databases for each router within a given area. The routers within the same area have identical topological databases. An ABR is responsible for forwarding routing information or changes among its border areas.

Autonomous System Boundary Routers

An *Autonomous System Boundary Router (ASBR)* is a router that is running multiple protocols and serves as a gateway to routers outside the OSPF domain and those operating with different protocols. The ASBR is able to import and translate different protocol routes into OSPF through a process known as *redistribution*. (For more information about redistribution, refer to the **redistribute** command in *Network OS Command Reference*.)

Designated routers

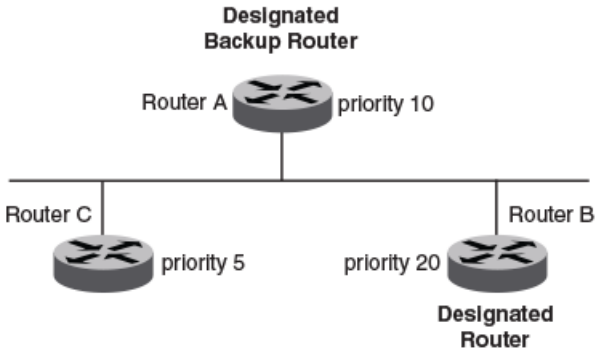
In an OSPF broadcast network, OSPF elects one router to serve as the designated router (DR) and another router on the segment to act as the backup designated router (BDR). This minimizes the amount of repetitive information that is forwarded on the network. OSPF forwards all messages to the designated router.

On broadcast networks such as LAN links, all routers on the LAN other than the DR and BDR form full adjacencies with the DR and BDR and pass LSAs only to them. The DR forwards updates received from one neighbor on the LAN to all other neighbors on that same LAN. One of the main functions of a DR is to ensure that all the routers on the same LAN have identical LSDBs. Therefore, on broadcast networks, an LSDB is synchronized between a DROther (a router that is not a DR or a BDR) and its DR and BDR.

> NOTE
> In an OSPF point-to-point network, where a direct Layer 3 connection exists between a single pair of OSPF routers, there is no need for designated or backup designated routers.

In a network with no designated router and no backup designated router, the neighboring router with the highest priority is elected as the DR, and the router with the next highest priority is elected as the BDR, as shown in the figure below. Priority is a configurable option at the interface level; refer to the **ip ospf priority** command in *Network OS Command Reference*.

FIGURE 60 Designated and backup router election



If the DR goes off line, the BDR automatically becomes the DR. The router with the next highest priority becomes the new BDR.

If two neighbors share the same priority, the router with the highest router ID is designated as the DR. The router with the next highest router ID is designated as the BDR. The DR and BDRs are recalculated after the OSPF protocol is disabled and re-enabled by means of the **[no] router ospf** command.

> NOTE
> By default, the Brocade device's router ID is the IP address configured on the lowest numbered loopback interface. If the device does not have a loopback interface, the default router ID is the lowest numbered IP address configured on the device.

When multiple routers on the same network are declaring themselves DRs, then both the priority and router ID are used to select the designated router and backup designated routers.

The DR and BDR election process is performed when one of the following events occurs:

- An interface is in a waiting state and the wait time expires.
- An interface is in a waiting state and receives a hello packet that addresses the BDR.
- A change in the neighbor state occurs, such as the following:
  - A neighbor state transitions from ATTEMPT state to a higher state.
  - Communication to a neighbor is lost.
  - A neighbor declares itself to be the DR or BDR for the first time.

OSPF areas

Consider the topics discussed below when configuring OSPF areas.

Backbone area

The backbone area (also known as area 0 or area 0.0.0.0) forms the core of an OSPF network. All other areas are connected to it, and inter-area routing happens via routers connected to the backbone area and to their own associated areas. The backbone area is the logical and physical structure for the OSPF domain and is attached to all nonzero areas in the OSPF domain.

The backbone area is responsible for distributing routing information between nonbackbone areas. The backbone must be contiguous, but it does not need to be physically contiguous; backbone connectivity can be established and maintained through the configuration of virtual links.

Area types

An area can be *normal*, a *stub*, a *not-so-stubby area* (NSSA), or a *totally stubby area* (TSA).

- *Normal* — OSPF routers within a normal area can send and receive external link state advertisements (LSAs).
- *Stub* — OSPF routers within a stub area cannot send or receive external LSAs. In addition, OSPF routers in a stub area must use a default route to the area's Area Border Router (ABR) or Autonomous System Boundary Router (ASBR) to send traffic out of the area.
- *NSSA* — The ASBR of an NSSA can import external route information into the area.
  - ASBRs redistribute (import) external routes into the NSSA as type 7 LSAs. Type 7 External LSAs are a special type of LSA generated only by ASBRs within an NSSA, and are flooded to all the routers within only that NSSA.
  - ABRs translate Type 7 LSAs into type-5 External LSAs, which can then be flooded throughout the AS. You can configure summary-addresses on the ABR of an NSSA so that the ABR converts multiple Type 7 external LSAs received from the NSSA into a single Type 5 external LSA.

  When an NSSA contains more than one ABR, OSPF elects one of the ABRs to perform the LSA translation for NSSA. OSPF elects the ABR with the highest router ID. If the elected ABR becomes unavailable, OSPF automatically elects the ABR with the next highest router ID to take over translation of LSAs for the NSSA. The election process for NSSA ABRs is automatic.

  NOTE
  For details refer to Not-so-stubby area (NSSA) on page 603.

- *TSA* — Similar to a stub area, a TSA does not allow summary routes in addition to not having external routes.

  NOTE
  For details refer to Totally stubby area on page 603.

Area range

You can further consolidate routes at an area boundary by defining an *area range*. The area range allows you to assign an aggregate value to a range of IP addresses. This aggregate value becomes the address that is advertised instead all of the individual addresses it represents being advertised. You can assign up to 32 ranges in an OSPF area.

Totally stubby area

By default, the device sends summary LSAs (LSA Type 3) into stub areas. You can further reduce the number of link state advertisements (LSA) sent into a stub area by configuring the device to stop sending summary LSAs (Type 3 LSAs) into the area. This is called *assigning a totally stubby area (TSA).* You can disable the summary LSAs when you are configuring the stub area or later after you have configured the area.

This feature disables origination of summary LSAs, but the device still accepts summary LSAs from OSPF neighbors and floods them to other neighbors.

When you enter a command to disable the summary LSAs, the change takes effect immediately. If you apply the option to a previously configured area, the device flushes all the summary LSAs it has generated (as an ABR) from the area.

> NOTE
> This feature applies only when the device is configured as an Area Border Router (ABR) for the area. To completely prevent summary LSAs from being sent to the area, disable the summary LSAs on each OSPF router that is an ABR for the area.

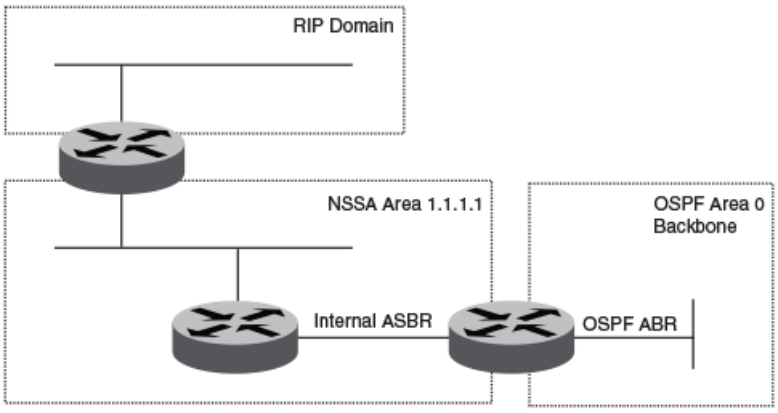
Not-so-stubby area (NSSA)

The OSPF not-so-stubby area (NSSA) feature enables you to configure OSPF areas that provide the benefits of stub areas, but that also are capable of importing external route information. OSPF does not flood external routes from other areas into an NSSA, but does translate and flood route information from the NSSA into other areas such as the backbone.

NSSAs are especially useful when you want to summarize Type 5 External LSAs (external routes) before forwarding them into an OSPF area. The OSPF specification prohibits summarization of Type 5 LSAs and requires OSPF to flood Type 5 LSAs throughout a routing domain. When you configure an NSSA, you can specify a summary-address for aggregating the external routes that the NSSA's ABR exports into other areas.

The figure below shows an example of an OSPF network containing an NSSA.

FIGURE 61 OSPF network containing an NSSA



This example shows two routing domains, a RIP domain and an OSPF domain. The ASBR inside the NSSA imports external routes from RIP into the NSSA as Type 7 LSAs, which the ASBR floods throughout the NSSA.

The ABR translates the Type 7 LSAs into Type 5 LSAs. If a summary-address is configured for the NSSA, the ABR also summarizes the LSAs into an aggregate LSA before flooding the Type 5 LSAs into the backbone.

Because the NSSA is partially stubby the ABR does not flood external LSAs from the backbone into the NSSA. To provide access to the rest of the Autonomous System (AS), the ABR generates a default Type 7 LSA into the NSSA.

Link state advertisements

Communication among areas is provided by means of link state advertisements (LSAs). The LSAs supported for each area type are as follows:

- Backbone (area 0) supports LSAs 1, 2, 3, 4, 5, and 7.
- Nonbackbone, not stub area supports LSAs 1, 2, 3, 4, and 5.
- Stub area supports LSAs 1, 2, and 3.
- Totally stubby area (TSA) supports LSAs 1 and 2, and also supports a single LSA 3 per ABR, advertising a default route.
- No so stubby area (NSSA) supports LSAs 1, 2, 3, and 7.

Virtual links

All ABRs must have either a direct or indirect link to the OSPF backbone area (0.0.0.0 or 0). If an ABR does not have a physical link to the area backbone, the ABR can configure a *virtual link* to another router within the same area, which has a physical connection to the area backbone.

The path for a virtual link is through an area shared by the neighbor ABR (router with a physical backbone connection), and the ABR requires a logical connection to the backbone.

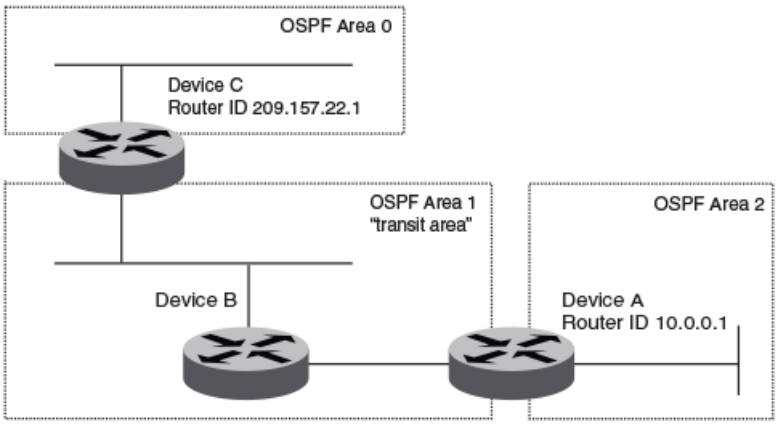
Two parameters fields must be defined for all virtual links — transit area ID and neighbor router:

- The *transit area ID* represents the shared area of the two ABRs and serves as the connection point between the two routers. This number should match the area ID value.
- The *neighbor router* field is the router ID (IP address) of the router that is physically connected to the backbone, when assigned from the router interface requiring a logical connection. When assigning the parameters from the router with the physical connection, be aware that the router ID is the IP address of the router requiring a logical connection to the backbone.

  NOTE
  By default, a device's router ID is the IP address configured on the lowest numbered loopback interface. If the device does not have a loopback interface, the default router ID is the lowest numbered IP address configured on the device. When you establish an area virtual link, you must configure it on both of the routers (both ends of the virtual link).

The figure below shows an OSPF area border router, Device A, that is cut off from the backbone area (area 0). To provide backbone access to Device A, you can add a virtual link between Device A and Device C using area 1 as a transit area. To configure the virtual link, you define the link on the router that is at each end of the link. No configuration for the virtual link is required on the routers in the transit area.

FIGURE 62 Defining OSPF virtual links within a network



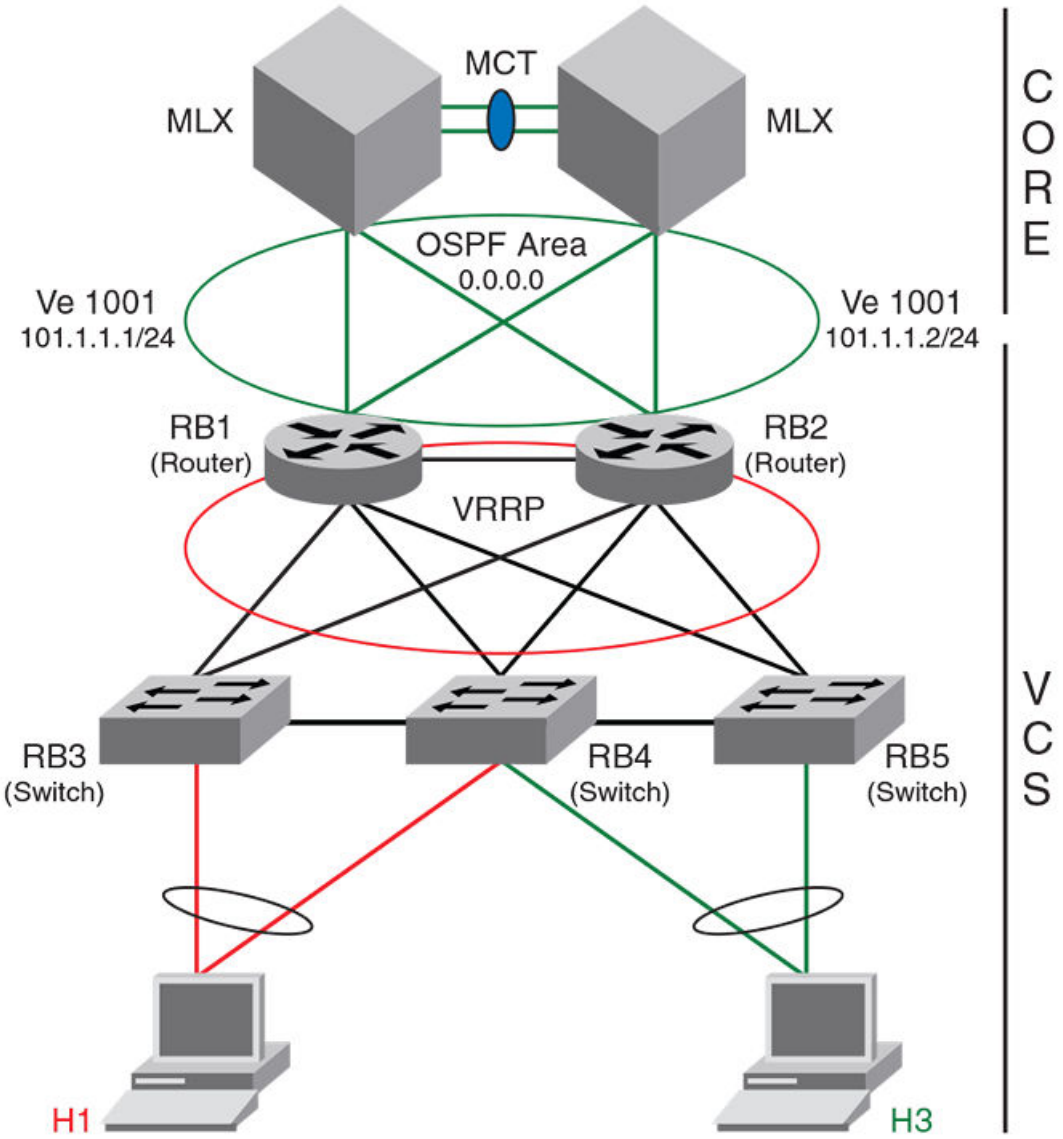
OSPF over VRF

With Network OS 4.0 and later, OSPF can run over multiple Virtual Routing and Forwarding (VRF) instances. OSPF maintains multiple instances of the routing protocol to exchange route information among various VRF instances. A multi-VRF-capable router maps an input interface to a unique VRF, based on user configuration. These input interfaces can be physical or a switched virtual interface (SVI). By default, all input interfaces are attached to the default VRF instance. All OSPF commands supported in Network OS 4.0 and later are available over default and nondefault OSPF instances.

OSPF in a VCS environment

The figure below shows one way in which OSPF can be used in a VCS fabric cluster environment. Routers RB1 and RB2, as well as the MLX switches, are configured with OSPF. Switches RB3, RB4, and RB5 are Layer 2 switches.

FIGURE 63 OSPF example in a VCS environment



OSPF considerations and limitations

- OSPF must be configured in a Virtual Cluster Switching (VCS) environment.
- The following platforms support OSPF:
  - Brocade VDX 6710-54
  - Brocade VDX 6720
  - Brocade VDX 6730
  - Brocade VDX 6740
  - Brocade VDX 6740T
  - Brocade VDX 6740T-1G
  - Brocade VDX 8770-4

  - Brocade VDX 8770-8
- OSPF can be configured on either a point-to-point or broadcast network.
- OSPF can be enabled on the following interfaces: gigabitethernet, tengigabitethernet, fortygigabitethernet, loopback, and ve.
- On enabling OSPF over a loopback interface, the network is advertised as a stub network in the router LSA for the attached area. OSPF control packets, such as *hellos* , are not transmitted on loopback interfaces and adjacencies will not form.

Configuring OSPF

Consider the topics discussed below when configuring OSPF.

Performing basic OSPF configuration

This section addresses the basics of OSPF configuration.

Enabling OSPF

To begin using OSPF on the router, perform these steps:

1. Follow the rules below.
   - If a router is to operate as an ASBR, you must enable the ASBR capability at the system level.
   - Redistribution must be enabled on routers configured to operate as ASBRs.
   - All router ports must be assigned to one of the defined areas on an OSPF router. When a port is assigned to an area, all corresponding subnets on that port are automatically included in the assignment.
2. Enter the **router ospf** command in RBridge ID configuration mode to enable OSPF on the router. This is shown in OSPF over VRF on page 605.
3. Assign the areas to which the router will be attached. Refer to Area types on page 602.
4. Assign individual interfaces to the OSPF areas. Refer to Assigning interfaces to an area on page 609.
5. Assign a virtual link to any ABR that does not have a direct link to the OSPF backbone area. Refer to Virtual links on page 604.
6. Refer to Changing default settings on page 612.

Setting up the backbone area

To set up the backbone area shown in Autonomous System on page 599, do the following:

1. In privileged EXEC mode on Router A, issue the **configure** command to enter global configuration mode.
2. Enter the **interface vlan** command followed by the VLAN number to create a VLAN.
3. Enter the **rbridge-id** command followed by the RBridge ID to enter RBridge configuration mode.
4. Enter the **interface ve** command followed by the VLAN number to enter interface configuration mode.
5. Enter the **ip address** operand followed by the IP address/subnet for the interface.
6. Issue the **ip ospf area** operand followed by the area ID to assign the interface to this area.

```
Router A# configure
Router A(config) # interface vlan 1001
Router A(config-Vlan-1001) # rbridge 10
Router A(config-rbridge-id-10) # interface Ve 1001
Router A(config-Ve-1001 )# ip address 101.1.1.1/24
Router A(config-Ve-1001) # ip ospf area 0.0.0.0
```

Configuring an NSSA

To configure OSPF area 1.1.1.1 as an NSSA, do the following:

1. In privileged EXEC mode, enter the **configure** command to enter global configuration mode.
2. Enter the **rbridge-id** command followed by the RBridge ID to enter RBridge configuration mode.
3. Enter the **router ospf** command to enable OSPF on the router.
4. Enter **area** followed by the *area ID*, then **nssa** followed by the *NSSA ID*.

```
switch# configure
switch(config)# rbridge-id 101
switch(config-rbridge-id-101)# router ospf
Switch(config-router-ospf-vrf-default-vrf)# area 1.1.1.1 nssa 1
```

Configuring a summary-address for the NSSA

If you want the ABR that connects the NSSA to other areas to summarize the routes in the NSSA before translating them into Type 5 LSAs and flooding them into the other areas, configure a summary-address. The ABR creates an aggregate value based on the summary-address. The aggregate value becomes the address that the ABR advertises instead of advertising the individual addresses represented by the aggregate. You can configure up to 32 ranges in an OSPF area.

To configure a summary-address in NSSA 1.1.1.1 (this example assumes that you have already configured NSSA 1.1.1.1.), do the following:

1. In privileged EXEC mode, issue the **configure** command to enter global configuration mode.
2. Enter **rbridge-id** followed by the RBridge ID to enter RBridge configuration mode.
3. Enter **router ospf** to enable OSPF on the router and to enter router OSPF configuration mode.
4. Enter **area** followed by the *area ID*, then **nssa** followed by the *NSSA ID*.
5. Enter **summary-address** followed by the IP address and mask for the summary route.

```
switch# configure
switch(config)# rbridge-id 101
switch(config-rbridge-id-101)# router ospf
switch(config-router-ospf-vrf-default-vrf)# area 1.1.1.1 nssa 10
switch(config-router-ospf-vrf-default-vrf)# summary-address 209.157.1.0    255.255.255.0
```

Disabling summary LSAs for a stub area

To disable summary LSAs for a stub area, enter a command such as the following:

```
switch(config-router-ospf-vrf-default-vrf)area 40 stub 99 no-summary
```

Assigning an area range (optional)

You can assign a *range* for an area, but it is not required. Ranges allow a specific IP address and mask to represent a range of IP addresses within an area, so that only that reference range address is advertised to the network, instead of all the addresses within that range. Each area can have up to 32 range addresses. For example, to define an area range for subnets on 0.0.0.10 and 0.0.0.20, do the following:

1. In privileged EXEC mode, issue the **configure** command to enter global configuration mode.
2. Issue the **rbridge-id** command followed by the RBridge ID to enter RBridge configuration mode.
3. Issue the **router ospf** command to enable OSPF on the router.

4. Issue the **area** operand followed by the area ID, then enter the range, and repeat as necessary.

```
switch# configure
switch(config)# rbridge-id 101
switch(config-rbridge-id-101)# router ospf
switch(config-router-ospf-vrf-default-vrf)# area 0.0.0.10 range 192.45.0.0 255.255.0.0
switch(config-router-ospf-vrf-default-vrf)# area 0.0.0.20 range 192.45.0.0 255.255.0.0
```

Assigning interfaces to an area

Once you define OSPF areas, you can assign interfaces to the areas. All router ports must be assigned to one of the defined areas on an OSPF router. When a port is assigned to an area, all corresponding subnets on that port are automatically included in the assignment.

For example, to assign a tengigabitethernet interface 101/0/1 to a router area whose IP address is 192.5.0.0, do the following:

1. In privileged EXEC mode, issue the **configure** command to enter global configuration mode.
2. Issue the **rbridge-id** command followed by the RBridge ID to enter RBridge sub-configuration mode.
3. Issue the **interface** command followed by the interface ID to enter interface configuration mode.
4. Issue the **ip ospf area** command followed by the IP address of the area.

```
switch# configure
switch(config)# rbridge-id 101
switch(config-rbridge-id-101)# int te 101/0/1
switch(conf-if-te-101/0/1)# ip ospf area 192.5.0.0
```

If you want to set an interface to passive mode, use the **ip ospf passive** command. If you want to block flooding of outbound LSAs on specific OSPF interfaces, use the **ip ospf database-filter all out** command.(Refer to the *Network OS Command Reference* for details.)

Configuring virtual links

Refer to Virtual links on page 604.

Do the following to configure virtual links. To define the virtual link on Device A:

1. In privileged EXEC mode, issue the **configure** command to enter global configuration mode.
2. Enter the **rbridge-id** command followed by the RBridge ID to enter RBridge configuration mode.
3. Enter the **router ospf** command to enable OSPF on the router.
4. Enter the **area** operand followed by the area ID, and repeat as necessary.
5. Enter the **area** operand followed by the area address in decimal or dotted-decimal format, then enter the **virtual-link** operand followed by ID of the OSPF router at the remote end of the virtual link.

```
Device A# configure
Device A(config)# rbridge-id 101
Device A(config-rbridge-id-101)# router ospf
Device A(config-router-ospf-vrf-default-vrf)# area 2
Device A(config-router-ospf-vrf-default-vrf)# area 1
Device A(config-router-ospf-vrf-default-vrf)# area 1 virtual-link 209.157.22.1
```

To configure the virtual link on Device C:

6. In privileged EXEC mode, issue the **configure** command to enter global configuration mode.
7. Enter the **rbridge-id** command followed by the RBridge ID to enter RBridge configuration mode.
8. Enter the **router ospf** command to enable OSPF on the router.
9. Enter the **area** operand followed by the area ID, and repeat as necessary.

10. Enter the **area** operand followed by the area address in decimal or dotted-decimal format, then enter the **virtual-link** operand followed by ID of the OSPF router at the remote end of the virtual link

```
Device C# configure
Device C(config)# rbridge-id 101
Device C(config-rbridge-id-101)# router ospf
Device C(config-router-ospf-vrf-default-vrf)# area 0
Device C(config-router-ospf-vrf-default-vrf)# area 1
Device C(config-router-ospf-vrf-default-vrf)# area 1 virtual-link 10.0.0.1
```

Enabling OSPF over VRF

Do the following to enable OSPF over VRF.

- To enable OSPF on a default VRF and to enter OSPF VRF router configuration mode, run the **router ospf** command in RBridge ID configuration mode, as shown in the following example:

```
switch# configure
switch(config)# rbridge-id 5
switch(config-rbridge-id-5)# router ospf
switch(config-router-ospf-vrf-default-vrf)#
```

- To enable OSPF on a non-default VRF and to enter OSPF VRF router configuration mode, run the **router ospf vrf** *name* command in RBridge ID configuration mode, as shown in the following example:

```
switch# configure
switch(config)# rbridge-id 5
switch(config-rbridge-id-5)# router ospf vrf vrfname
switch(config-router-ospf-vrf-vrfname)#
```

- OSPF **show** commands include the optional **vrf name** keyword to display data from non-default OSPF instances.
- Router-ID calculation for an OSPF instance includes IP addresses that are attached to the same VRF. The same subnets can coexist on multiple VRFs.

Enabling OSPF in a VCS environment

Do the following to enable OSPF in a VCS environment.

NOTE

If no RBridge ID is configured on the switch, deleting an VE interface will cause a spike in CPU usage. To prevent this, configure an RBridge ID before deleting a VE interface.

1. On Router RB1, do the following:
   a) Enter the **conf t** command to enter terminal configuration mode.
   b) Enter the **interface vlan** command followed by the VLAN number to create a VLAN for the router.
   c) Enter the **exit** command to exit interface configuration mode.
   d) Enter the **rbridge-id** command followed by the RBridge ID to enter RBridge configuration mode.
   e) Enter the **router ospf** command to enable the OSPF routing protocol and to enter OSPF VRF router configuration mode.
   f) Enter the **area** operand followed by the area ID to create this OSPF area on this router.
   g) Enter the **exit** command to exit OSPF VRF router configuration mode.
   h) Enter the **interface ve** command followed by the VLAN number to enter interface configuration mode.
   i) Enter the **ip address** operand followed by the IP address/subnet of the interface.
   j) Enter the **ip ospf area** operand followed by the area ID to assign the interface to this area.
   k) Enter the **no shutdown** command:

```
RB1# conf t
RB1(config)# interface vlan 1001
RB1(config-Vlan-1001)# exit
RB1(config)# rbridge-id 1

RB1(config-rbridge-id-1)# router ospf
RB1(config-router-ospf-vrf-default-vrf)# area 0.0.0.0
RB1(config-router-ospf-vrf-default-vrf)# exit
RB1(config-rbridge-id-1)# interface ve 1001
RB1(config-Ve-1001)# ip address 101.1.1.1/24
RB1(config-Ve-1001)# ip ospf area 0.0.0.0
RB1(config-Ve-1001)# no shutdown
```

2. On Router RB2, do the following:
   a) Enter the **conf t** command to enter terminal configuration mode.
   b) Enter the **interface vlan** command followed by the VLAN number to create a VLAN for the router.
   c) Enter the **exit** command to exit interface configuration mode.
   d) Enter the **rbridge-id** command followed by the RBridge ID to enter RBridge configuration mode.
   e) Enter the **router ospf** command to enable the OSPF routing protocol and to enter OSPF VRF router configuration mode.
   f) Enter the **area** operand followed by the area ID to create this OSPF area on this router.
   g) Enter the **exit** command to exit OSPF VRF router configuration mode.
   h) Enter the **interface ve** command followed by the VLAN number to enter interface configuration mode.
   i) Enter the **ip address** operand followed by the IP address/subnet of the interface.
   j) Enter the **ip ospf area** operand followed by the area ID to assign the interface to this area.
   k) Enter the **no shutdown** command:

```
RB2# conf t
RB2(config)# interface vlan 1001
RB2(config-Vlan-1001)# exit
RB2(config)# rbridge-id 2

RB2(config-rbridge-id-2)# router ospf
RB2(config-router-ospf-vrf-default-vrf)# area 0.0.0.0
RB2(config-router-ospf-vrf-default-vrf)# exit
RB2(config-rbridge-id-2)# interface ve 1001
RB2(config-Ve-1001)# ip address 101.1.1.2/24
RB2(config-Ve-1001)# ip ospf area 0.0.0.0
RB2(config-Ve-1001)# no shutdown
```

   l) Assign VLAN 1001 to a vLAG.

Changing default settings

Refer to the *Network OS Command Reference* for other commands you can use to change default OSPF settings. Some commonly configured items include the following:

- Changing reference bandwidth to change interface costs by using the **auto-cost reference-bandwidth** command.
- Defining redistribution filters for the Autonomous System Boundary Router (ASBR) by using the **redistribute** command.

Disabling OSPF on the router

Consider the topics discussed below when disabling OSPF.

Understanding the effects of disabling OSPF

Consider the following before disabling OSPF on a router:

- If you disable OSPF, the device removes all the configuration information for the disabled protocol from the running configuration. Moreover, when you save the configuration to the startup configuration file after disabling one of these protocols, all the configuration information for the disabled protocol is removed from the startup configuration file.
- If you are testing an OSPF configuration and are likely to disable and re-enable the protocol, you might want to make a backup copy of the startup configuration file containing the protocol's configuration information. This way, if you remove the configuration information by saving the configuration after disabling the protocol, you can restore the configuration by copying the backup copy of the startup configuration file into the flash memory.

- If the management default route information is available in the Chassis ID (CID) card, the OSPF default route is overwritten by the management default route when the switch reboots. In order to prevent this, remove the management default route after the switch reboots. The OSPF default route is automatically re-instated. Refer to Using the Chassis ID (CID) Recovery Tool on page 679.

Disabling OSPF

To disable OSPF on the router, use the **no router ospf** command:

1. In privileged EXEC mode, issue the **configure** command to enter global configuration mode.
2. Enter the **rbridge-id** command followed by the RBridge ID to enter RBridge configuration mode.
3. Issue the **no router ospf** command to disable OSPF on the router.

```
switch# configure
switch(config)# rbridge-id 101
switch(config-rbridge-id-101)# no router ospf
```

Configuring VRRP

VRRP overview

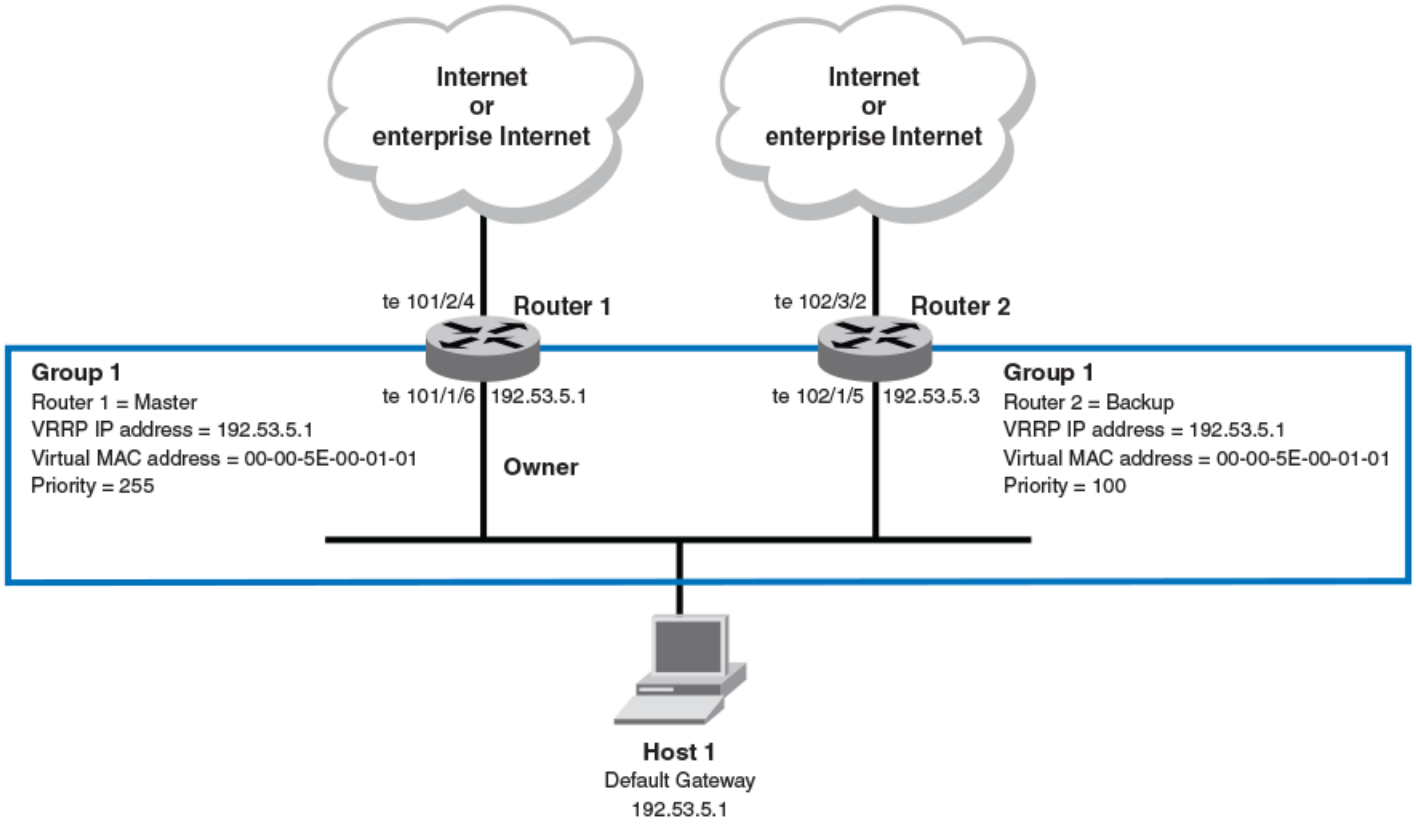
A virtual router is a collection of physical routers that can use the Virtual Router Redundancy Protocol (VRRP) to provide redundancy to routers within a LAN. Two or more VRRP-configured routers can create a virtual router.

VRRP eliminates a single point of failure in a static, default-route environment by dynamically assigning virtual IP routers to participating hosts. The interfaces of all routers in a virtual router must belong to the same IP subnet. There is no restriction against reusing a virtual router ID (VRID) with a different address mapping on different LANs.

Basic VRRP topology

The figure below shows a basic VRRP topology to illustrate some basic VRRP concepts. Router 1 and Router 2 are two physical routers that can be configured to compose one virtual router. This virtual router provides redundant network access for Host1. If Router 1 were to fail, Router 2 would provide the default gateway out of the subnet.

FIGURE 64 Basic VRRP topology



The virtual router shown in the figure above is identified as Group 1. A physical router forwards packets for the virtual router. This physical router is called the *master* router.

The following are some common VRRP-related terms and concepts:

- *Virtual router* — A collection of physical routers that can use either the VRRP or VRRP Extended (VRRP-E) protocol to provide redundancy to routers within a LAN.

  NOTE
  Most of the information presented here applies to both VRRP and VRRP-E, and, therefore, the term "VRRP" is often used to mean either VRRP or VRRP-E. Where there are differences between the two protocols, these differences are explicitly described.

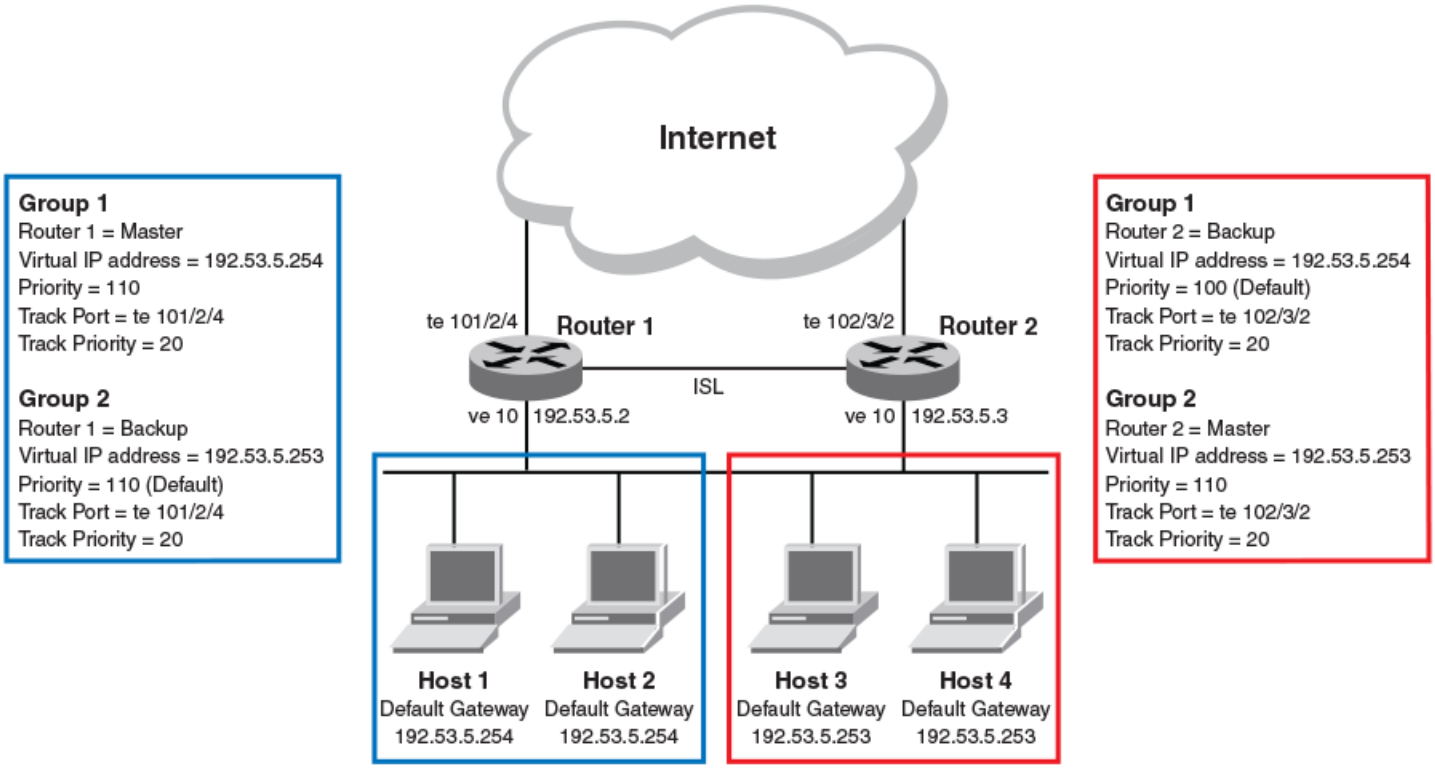
- *Virtual router group* — A group of physical routers that are assigned to the same virtual router.
- *Virtual router address* — The address you are backing up:
  - For VRRP: The virtual router IP address must belong to the same subnet as a real IP address configured on the VRRP interface, and can be the same as a real IP addresses configured on the VRRP interface. The virtual router whose virtual IP address is the same as a real IP address is the IP address *owner* and the default *master*.
  - For VRRP-E: The virtual router IP address must belong to the same subnet as a real IP address configured on the VRRP-E interface, but cannot be the same as a real IP address configured on the VRRP-E interface.
- *Owner* — This term applies only to the VRRP protocol, not to VRRP-E. The owner is the physical router whose real interface IP address is the IP address that you assign to the virtual router. The owner responds to packets addressed to any of the IP addresses in the corresponding virtual router. The owner, by default, is the master and has the highest priority (255).
- *Master* — The physical router that responds to packets addressed to any of the IP addresses in the corresponding virtual router. For VRRP, if the physical router whose real interface IP address is the IP address of the virtual router, then this physical router is always the master. For VRRP-E, the router with the highest priority becomes the master. The **priority** command is used to set priority for a physical router.
- *Backup* — Routers that belong to a virtual router but are not the master. Then, if the master becomes unavailable, the backup router with the highest priority (a configurable value) becomes the new master. By default, routers are given a priority of 100.

  NOTE
  VRRP operation is independent of the Open Shortest Path First (OSPF) protocol or the Border Gateway Protocol (BGP).and is unaffected when enabled on interfaces running those protocols.

VRRP multigroup clusters

The figure below depicts a commonly employed virtual router topology. This topology introduces redundancy by configuring two virtual router groups — the first group has Router 1 as the master and Router 2 as the backup, and the second group has Router 2 as the master and Router 1 as the backup. This type of configuration is sometimes called *Multigroup VRRP*.

FIGURE 65 Two routers configured for dual redundant network access for the host



In this example, Router 1 and Router 2 use VRRP-E to load share as well as provide redundancy to the hosts. The load sharing is accomplished by creating two VRRP-E groups, each with its own virtual IP addresses. Half of the clients point to Group 1's virtual IP address as their default gateway, and the other half point to Group 2's virtual IP address as their default gateway. This enables some of the outbound Internet traffic to go through Router 1 and the rest to go through Router 2.

Router 1 is the master for Group 1 (master priority = 110) and Router 2 is the backup for Group 1 (backup priority = 100). Router 1 and Router 2 both track the uplinks to the Internet. If an uplink failure occurs on Router 1, its backup priority is decremented by 20 (track-port priority = 20) to 90, so that all traffic destined to the Internet is sent through Router 2 instead.

Similarly, Router 2 is the master for Group 2 (master priority = 110) and Router 1 is the backup for Group 2 (backup priority = 100). Router 1 and Router 2 are both tracking the uplinks to the Internet. If an uplink failure occurs on Router 2, its backup priority is decremented by 20 (track-port priority = 20) to 90, so that all traffic destined to the Internet is sent through Router 1 instead.

VRRP/VRRP-E packet behavior

There are some differences in how VRRP and VRRP-E handle ARP and VRRP control packets, as summarized below.

Gratuitous ARP

VRRP: Sent only once when the VRRP router becomes the master.

VRRP-E: Sent every two seconds by the virtual router master because VRRP-E control packets do not use the virtual MAC address.

The source MAC address of the gratuitous ARP sent by the master is the virtual MAC address.

When a router (either master or backup) sends an ARP request or a reply packet, the MAC address of the sender is the MAC address of the router interface. One exception is if the owner sends an ARP request or a reply packet, in which case the MAC address of the sender is the virtual MAC address.

Only the master answers an ARP request for the virtual router IP address. Any backup router that receives this request forwards the request to the master.

VRRP control packets

VRRP: VRRP control packets are IP protocol type 112 (reserved for VRRP), and are sent to VRRP multicast address 224.0.0.18.

VRRP-E: control packets are UDP packets destined to port 8888, and are sent to the all-router multicast address 224.0.0.2.

Source MAC in VRRP control packets

VRRP: The virtual MAC address is the source.

VRRP-E: The physical MAC address is the source.

Track ports and track priority with VRRP and VRRP-E

A track port allows you to monitor the state of the interfaces on the other end of a the route path. A track port also allows the virtual router to lower its priority if the exit path interface goes down, allowing another virtual router in the same VRRP (or VRRP-E) group to take over. Consider the following conditions and limitations for track ports:

- Track priorities must be lower than VRRP/VRRP-E priorities.
- The dynamic change of router priority can trigger mastership switchover if preemption is enabled. However, if the router is an owner (applicable only for VRRP), the mastership switchover will not occur.
- Maximum number of interfaces that can be tracked for a virtual router is 16.
- Port tracking is allowed for physical interfaces and port-channels.

Short-path forwarding (VRRP-E only)

VRRP-E is enhanced with the VRRP-E extension for Server Virtualization feature so that Brocade devices attempt to bypass the VRRP-E master router and directly forward packets to their destination through interfaces on the backup router. This is called *short-path forwarding*. A backup router participates in a VRRP-E session only when short-path-forwarding is enabled.

VRRP-E active-active load-balancing is achieved with the ingress RBridge, by hashing either the L2-7 header information (Brocade VDX 8770) or the destination MAC address (Brocade VDX 67xx) to determine the path. All nodes in the VCS are aware of all VRRP-E sessions and the participating RBridges in each session.

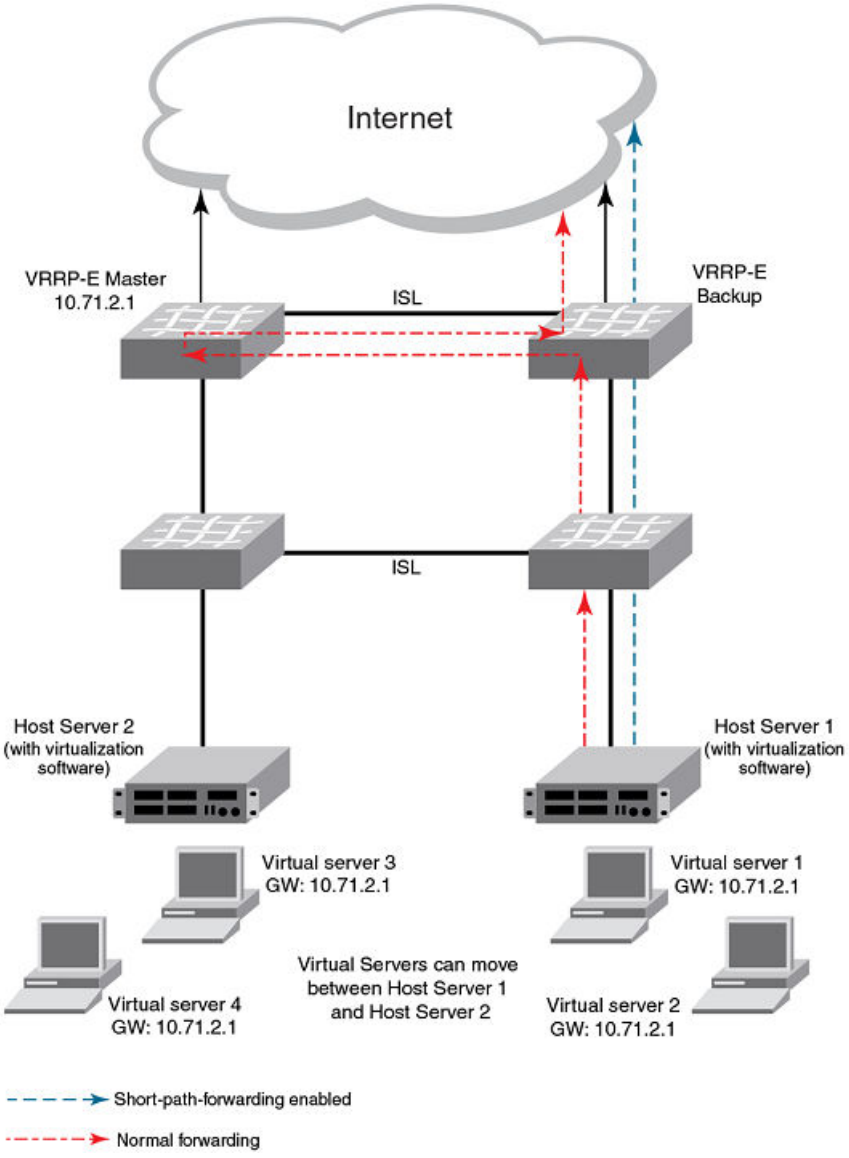
If short-path forwarding is enabled, traffic travels through the short-path forwarding path (dashed line in the figure in Packet routing with short-path forwarding (VRRP-E only) on page 618) to reach the client.

Packet routing with short-path forwarding (VRRP-E only)

If you enable short-path forwarding for VRRP-E, all packets sent by the local subnet of the virtual IP address are routed to the WAN instead of being switched to the master router.

In the figure below, the virtual servers are dynamically moved between Host Server 1 and Host Server 2.

FIGURE 66 Short path forwarding



VRRP considerations and limitations

Virtual routers must be configured in a Virtual Cluster Switching (VCS) environment.

- The following platforms support VRRP and VRRP-E:
  - Brocade VDX 6710-54
  - Brocade VDX 6720
  - Brocade VDX 6730
  - Brocade VDX 6740
  - Brocade VDX 6740T
  - Brocade VDX 6740T-1G
  - Brocade VDX 8770-4

  - Brocade VDX 8770-8
- Brocade supports two VRRP protocols:
  - *Standard VRRP* — The standard router redundancy protocol, VRRP v2 supports the IPv4 environment. Also, the Brocade version of standard VRRP is compliant with RFC 3768.
  - *VRRP-E (Extended)* — A Brocade proprietary protocol similar to standard VRRP that is not standard compliant and cannot interoperate with VRRP.
- Supported ports:
  - For VRRP — fortygigabitethernet, tengigabitethernet, gigabitethernet, and ve.
  - For VRRP-E — *ve* ports only.
- Only IPv4 support is provided. IPv6 and VRRPv3 are not supported.
- Maximum number of supported configured VRRP and VRRP-E instances (an instance is a session configured on a router):
  - Brocade VDX 8770: 1,024
  - Brocade VDX 6740, 6740T, and 6740T-1GT: 255
  - Brocade VDX 6710, VDX 6720, and VDX 6730: 64.
- The maximum number of virtual IP addresses per virtual router session is 16 for VRRP and one for VRRP-E.

Configuring VRRP

Configuring basic VRRP

You can implement the IPv4 VRRP configuration shown in Basic VRRP topology on page 615 by entering just a few commands. This section contains information for configuring each router shown in Basic VRRP topology on page 615. This is for a VCS fabric cluster mode environment.

Configuring Router 1 as master for VRRP

1. From the Router 1 switch (host name *sw1* for this example) console, in privileged EXEC mode, enter configuration mode by issuing the **configure** command.

```
sw1# configure
```

2. Enter the **rbridge-id** command, using the RBridge ID (which has an asterisk next to it when you run a **do show vcs** command).

```
sw1(config)# rbridge-id 101
```

3. Globally enable both the VRRP and VRRP-E protocols.

```
sw1(config-rbridge-id-101)# protocol vrrp
```

4. Configure the tengigabitethernet interface link for Router 1.

```
sw1(config-rbridge-id-101)# int te 101/1/6
```

5. Configure the IP address of the interface.

```
sw1(conf-if-te-101/1/6)# ip address 192.53.5.1/24
```

6. Assign Router 1 to a group called Group 1.

```
sw1(conf-if-te-101/1/6)# vrrp-group 1
```

NOTE
You can assign a group number in the range of 1 through 255.

7. Assign a virtual router IP address.

```
sw1(config-vrrp-group-1)# virtual-ip 192.53.5.1
```

NOTE
For VRRP, the physical router whose IP address is the same as the virtual router group IP address becomes the owner and master. However, for VRRP-E, you use the **priority** command to assign the highest priority to the router you want as master.

Configuring Router 2 as backup for VRRP

1. From the Router 2 switch (host name *sw2* for this example) console, in privileged EXEC mode, enter configuration mode by issuing the **configure** command.

```
sw2# configure
```

2. Enter the **rbridge-id** command, using the RBridge ID (which has an asterisk next to it when you run a **do show vcs** command).

```
sw2(config)# rbridge-id 102
```

3. Globally enable both the VRRP and VRRP-E protocols.

```
sw2(config-rbridge-id-102)# protocol vrrp
```

4. Configure the tengigabitethernet interface for Router 2.

```
sw1(config-rbridge-id-102)# int te 102/1/5
```

5. Configure the IP address of interface:

```
sw2(conf-if-te-102/1/5)# ip address 192.53.5.3/24
```

NOTE
This router will become the backup router to Router 1.

6. Assign Router 2 to the same VRRP group as Router 1.

```
sw2(conf-if-te-102/1/5)# vrrp-group 1
```

7. To assign Group 1 a virtual IP address, use the same virtual IP addresses you used for Router 1.

```
sw2(config-vrrp-group-1)# virtual-ip 192.53.5.1
```

Understanding VRRP-E differences for basic configuration

If you were to configure the two routers shown in Basic VRRP topology on page 615, you would need to consider the following items specific to VRRP-E:

- On the Brocade VDX 8770, 6710, 6720, and 6730 platforms, the **protocol vrrp** command enables both VRRP and VRRP-E.

- On the Brocade VDX 6740 series platforms, the **protocol vrrp** command enables only VRRP; the **protocol vrrp-extended** command enables only VRRP-E. VRRP and VRRP-E cannot be simultaneously enabled on the VDX 6740 series platforms.
- The **group** command for VRRP-E is **vrrp-extended-group** *group-id*
- VRRP-E virtual routers can be configured on Ve interfaces only.

Enabling VRRP preemption

You can allow a backup router that is acting as the master to be preempted by another backup router with a higher priority value.

Default : Preemption is enabled for VRRP, disabled for VRRP-E.

> NOTE
> If preemption is disabled for VRRP, the owner router is not affected because the owner router always preempts the active master.

To enable preemption for a virtual router, run the **preempt-mode** command in virtual-router-group configuration mode, as shown in the following example:

```
switch(config-vrrp-group-5)# preempt-mode
```

Track priority example

Using the figure in VRRP multigroup clusters on page 616 as an example, you can configure interface ve 10 on Router 1 to track interface 101/2/4, Then, if 101/2/4 goes down, interface ve 10 can respond by lowering the Router 1 VRRP priority by the track-port priority value. The backup routers detect this change and negotiate to become the new master, thus providing a master with an uninterrupted path out of the network.

The following example sets the track port and priority as described above.

1. Enter interface configuration mode and run the following command:

   ```
   switch(config)# int ve 10
   ```

2. Run the following command to enter group configuration mode.

   ```
   switch(conf-Ve-10)# vrrp-group 1
   ```

3. Run the following command to set the track port and priority:

   ```
   switch(config-vrrp-group-1)# track te 101/2/4 priority 60
   ```

   Refer also to Track ports and track priority with VRRP and VRRP-E on page 618.

Configuring short-path forwarding

Refer to Short-path forwarding (VRRP-E only) on page 618.

Under the VRRP-E group-configuration level, there is an option to enable short-path-forwarding.

For example, follow these steps:

1. Enter global configuration mode.

   ```
   switch# config
   ```

2. In global configuration mode, entering the **int vlan** command.

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

3. Exit the interface configuration mode by entering the **end** command.

```
switch(config-Vlan-10)# end
```

4. Enter global configuration mode.

```
switch# config
```

5. Enter RBridge ID configuration mode.

```
switch (config)# rbridge-id 101
```

6. In RBridge ID configuration mode, enter the **int ve** command.

```
switch(config-rbridge-id-101)# int ve 10
```

7. In interface configuration mode, enter the **vrrp-extended-group** command.

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

8. In group configuration mode, enter the **short-path-forwarding** command.

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

Configuring multigroup VRRP routing

Refer also to VRRP multigroup clusters on page 616.

Configuring a multi-group virtual router cluster

To implement the configuration shown in the figure in VRRP multigroup clusters on page 616, configure one VRRP-E router to act as a master in the first virtual router group and a backup in the second virtual group. Then configure the second VRRP-E router to act as a backup in the first virtual group and master in the second virtual group.

NOTE
This example is for VRRP-E. There are minor syntax differences for VRRP, which you can determine by consulting *Network OS Command Reference* for Network OS 3.0 or later. This example is for a VCS fabric cluster mode environment.

Configuring Router 1 as master for first virtual router group

Make sure that VCS is enabled and then perform these steps:

1. Enter the **rbridge-id** command, using the RBridge ID (which has an asterisk next to it when you run a **do show vcs** command).

```
sw101(config)# rbridge-id 101
```

2. Configure the VRRP-E protocol globally.

```
sw101(config-rbridge-id-101)# protocol vrrp
```

3. Configure the Ve interface link for Router 1.

```
sw101(config-rbridge-id-101)# int ve 10
```

NOTE
You first would need to create **int vlan 10** in global configuration mode.

4. Configure the IP address of the Ve link for Router 1.

```
sw101(conf-Ve-10)# ip address 192.53.5.2/24
```

5. To assign Router 1 to a VRRP-E group called Group 1, enter the command:

```
sw101(conf-Ve-10)# vrrp-extended-group 1
```

6. Configure the tengigabitethernet port 101/2/4 as the tracking port for the interface ve 15, with a track priority of 20.

```
sw101(config-vrrp-extended-group-1)# track te 101/2/4 priority 20
```

7. Configure an IP address for the virtual router.

```
sw101(config-vrrp-extended-group-1)# virtual-ip 192.53.5.254
```

NOTE
(For VRRP-E only) The address you enter with the **virtual-ip** command cannot be the same as a real IP address configured on the interface.

8. To configure Router 1 as the master, set the priority to a value higher than the default (which is 100).

```
sw101(config-vrrp-group-1)# priority 110
```

Configuring Router 1 as backup for second virtual router group

1. Enter the **rbridge-id** command, using the RBridge ID (which has an asterisk next to it when you run a **do show vcs** command).

```
sw101(config)# rbridge-id 101
```

2. Configure the Ve interface link for Router 1.

```
sw101(config-rbridge-id-101)# int ve 15
```

3. Configure the IP address of the Ve link for router 1.

```
sw101(config-Ve-15)# ip address 192.54.6.2/24
```

4. Assign Router 1 to a group called Group 2.

```
sw101(config-Ve-15)# vrrp-extended-group 2
```

5. Configure the tengigabitethernet port 101/2/4 as the tracking port for the interface ve 10, with a track priority of 20.

```
sw101(config-vrrp-extended-group-2)# track te 101/2/4 priority 20
```

6. Configure an IP address for the virtual router.

```
sw101(config-vrrp-extended-group-2)# virtual-ip 192.53.6.253
```

NOTE
(For VRRP-E only) The address you enter with the **virtual-ip** command cannot be the same as a real IP address configured on the interface.

Configuring Router 2 as backup for first virtual router group

Make sure that VCS is enabled and then perform these steps:

1. Enter the **rbridge-id** command, using the RBridge ID (which has an asterisk next to it when you run a **do show vcs** command).

```
sw102(config)# rbridge-id 102
```

2. Configure the VRRP protocol globally.

```
sw102(config-rbridge-id-102)# protocol vrrp
```

3. Configure the Ve interface link for Router 2.

```
sw102(config-rbridge-id-102)# int ve 10
```

4. Configure the IP address of the Ve link for Router 2.

```
sw102(conf-Ve-10)# ip address 192.53.5.3/24
```

5. Assign Router 2 to the group called Group 1.

```
sw102(conf-Ve-10)# vrrp-extended-group 1
```

6. Configure the tengigabitethernet port 102/3/2 as the tracking port for interface ve 10, with a track priority of 20.

```
sw102(config-vrrp-extended-group-1)# track te 102/3/2 priority 20
```

7. Configure an IP address for the virtual router.

```
sw102(config-vrrp-extended-group-1)# virtual-ip 192.53.5.254
```

NOTE
(For VRRP-E only) The address you enter with the **virtual-ip** command cannot be the same as a real IP address configured on the interface.

Configuring Router 2 as master for second virtual router group

1. Enter the **rbridge-id** command, using the RBridge ID (which has an asterisk next to it when you run a **do show vcs** command).

```
sw102(config)# rbridge-id 102
```

2. Configure the Ve interface link for Router 2.

```
sw102(config-rbridge-id-102)# int ve 15
```

3. Configure the IP address of the Ve link for Router 2.

sw102(conf-Ve-15)# **ip address 192.54.6.3/24**

4. Assign Router 2 to the group called Group 2.

```
sw102(conf-Ve-15)# vrrp-extended-group 2
```

5. Configure the tengigabitethernet port 102/2/4 as the tracking port for interface ve 15, with a track priority of 20.

```
sw102(config-vrrp-extended-group-2)# track te 102/2/4 priority 20
```

6. To configure Router 2 as the master, set the priority to a value higher than the default (which is 100):.

```
sw102(config-vrrp-extended-group-2)# priority 110
```

7. Configure an IP address for the virtual router.

```
sw101(config-vrrp-extended-group-2)# virtual-ip 192.53.6.253
```

NOTE

(For VRRP-E only) The address you enter with the **virtual-ip** command cannot be the same as a real IP address configured on the interface.

Virtual Routing and Forwarding configuration

VRF overview

VRF (Virtual Routing and Forwarding) is a technology that controls information flow within a network by isolating the traffic by partitioning the network into different logical VRF domains. This allows a single router or switch to have multiple containers of routing tables or Forwarding Information Bases (FIB) inside it, with one routing table for each VRF instance. This permits a VRF-capable router to function as a group of multiple virtual routers on the same physical router. VRF, in conjunction with virtual private network (VPN) solutions, guarantees privacy of information and isolation of traffic within a logical VRF domain.

A typical implementation of a Virtual Routing and Forwarding instance (referred to as a VRF) are designed to support Border Gateway Protocol (BGP) or Multiprotocol Label Switching (MPLS) VPNs, whereas implementations of VRF-Lite (also referred to as Multi-VRF) typically are much simpler with reduced scalability. The two VRF flavors have a lot in common but differ in the interconnect schemes, routing protocols used over the interconnect, and also in VRF classification mechanisms.

VRF is supported on the Brocade VDX 8770 and VDX 6740 series platforms. The VDX 8770 supports 128 VRF instances and the VDX 6740 supports 32 VRF instances per physical switch.

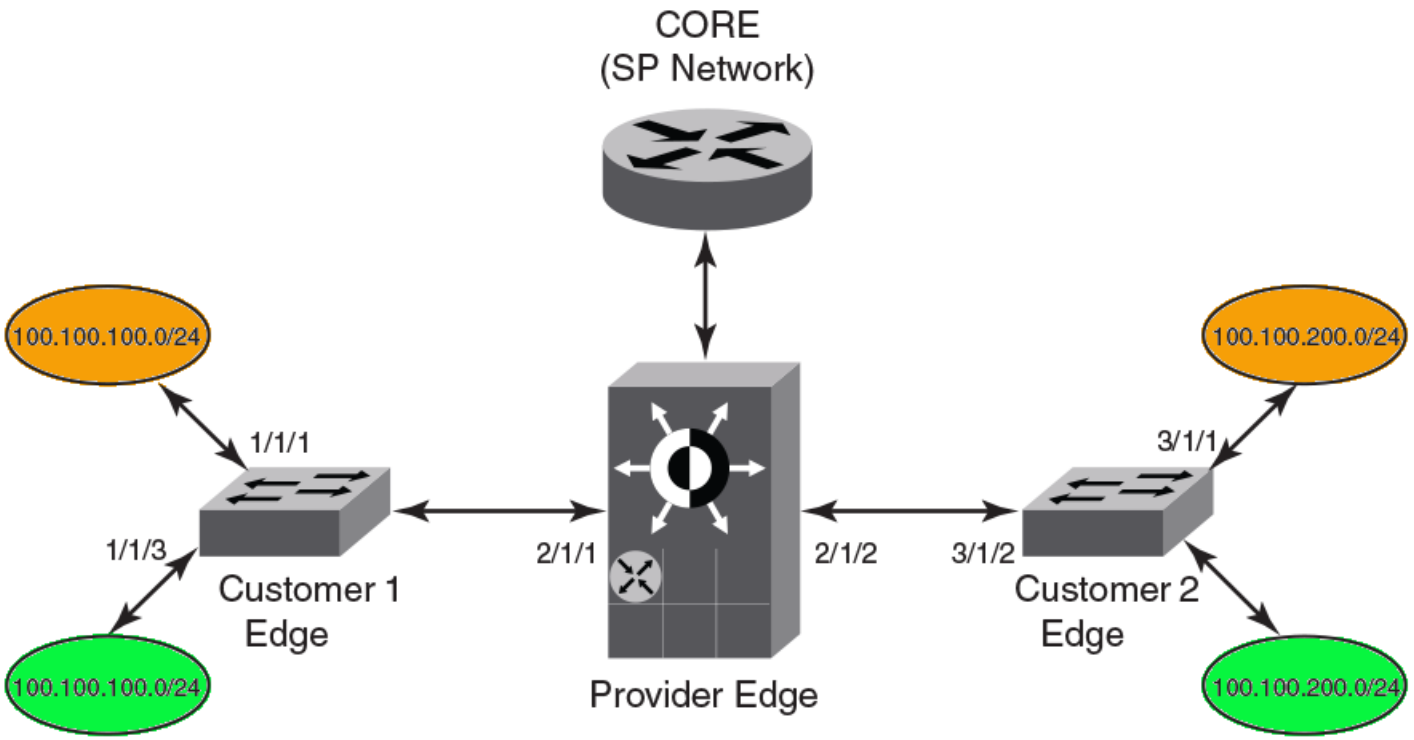
Brocade Network OS 4.0.0 and later supports the VRF-Lite implementation. Unless otherwise noted, all references to VRF in this document also apply to VRF-Lite.

VRF topology

This diagram illustrates a typical VRF topology with a single VCS comprising Customer 1 Edge, Provider Edge, and Customer 2 Edge routers.

The orange and green ovals indicate two VPNs supporting two different customer sites. Both of them have overlapping IP subnets; 100.100.100.0/24 and 100.100.200.0/24.

FIGURE 67 VRF topology



OSPF VRF-Lite for customer-edge routers

A customer edge (CE) router acts as the provider edge (PE) router in VRF-Lite. When a type 3, 5, or 7 link-state advertisement (LSA) is sent from a PE router running multiprotocol BGP to a CE router, the DN (down) bit in the LSA options field must be set. This prevents any type 3, 5, or 7 LSA messages sent from the CE router to the PE router from being distributed any farther. The PE router ignores messages with the DN bit set and does not add these routes to the VRF (Virtual Routing and Forwarding) routing table.

Configuring VRF

NOTE
The following configuration gives an example of a typical VRF-Lite use case and is not meant to give an ideal configuration.

The examples in this section are based on the VRF topology on page 627 and use the OSPF routing protocol.

Refer to the *Network OS Command Reference* for detailed information on VRF commands.

The following example enables routing and configures VRF on the "orange" edge router. If you want to match the VRF topology diagram, you can repeat the steps here to configure the "green" edge router.

1. Enter RBridge ID configuration mode.

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

2. Set up the VRF instance.
   a) Enter VRF configuration mode and specify "orange" as the VRF name.

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

   b) Specify the router differentiator.

```
switch(config-vrf-orange)# rd 1:1
```

   c) Enable IPv4 address-family support for VRF routing, and specify the maximum number of routes to be used.

```
switch(config-vrf-orange)# address-family ipv4 max-route 3600
```

3. Enable the OSPF routing protocol for the instance in VRF configuration mode, and assign it to area 10.

   NOTE
   All OSPF commands that are present under OSPF router configuration mode are applicable to the new OSPF VRF router configuration mode for a non-default VRF instance, the same as for the default VRF instance.

```
switch(vrf-ipv4)# router ospf vrf orange
switch(config-router-ospf-vrf-orange)# area 10
switch(vrf-ipv4)# exit
switch(config-vrf-orange)# exit
```

4. Bind the interface to the VRF instance.

   NOTE
   After a VRF instance is enabled on an interface, all Layer 3 configurations on the interface are removed, and you will need to configure them again.

```
switch(config)# rbridge-id 1
switch(config-rbrfidge-id-1)# interface ve 128
switch(config-Ve-128)# vrf forwarding orange
switch(config-vrf-orange)# address-family ipv4 max-route 3600
```

5. Configure the static routes.

```
switch(vrf-ipv4)# ip route 10.31.1.0/30 10.30.2.1
```

6. Configure static ARP for the interface.

```
switch(vrf-ipv4)# arp 10.2.2.3 0000.0011.0022 int ve 128
```

7. Confirm the VRF configuration with the **show vrf** command (using **do** in this configuration mode).

```
switch(vrf-ipv4)# do show vrf

Total number of VRFs configured: 1
Status Codes - A: active, D: pending deletion, I: inactive
Name        Default RD IFL ID vrf|v4|v6  Interfaces
orange      1:1        131072  A | A| I  Ve 128
```

Enabling VRRP for VRF

To enable the Virtual Router Redundancy Protocol (VRRP) or VRRP-Extended (VRRP-E) for a Virtual Routing and Forwarding (VRF) region, an interface should be assigned to a VRF before enabling the VRRP or VRRP-E protocol. The VRRP protocol is enabled or disabled globally on the switch under RBridge ID configuration mode; it cannot be enabled or disabled on a specific VRF instance.

For more information on the VRRP protocol on Brocade switches, refer to VRRP overview on page 615.

1. Enter RBridge ID configuration mode.

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

2. Set the protocol to VRRP.

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

3. Select the interface.

```
switch(config-rbridge-id-1)# interface ve 128
```

4. Configure an IP address for the interface.

```
switch(config-rbridge-id-1)# ip address 172.128.20.10/24
```

5. Enable the VRRP or VRRP-E protocol for the interface. (In this example, VRRP-E.)

```
switch(config-rbridge-id-1)# vrrp-extended 10
```

6. Set the virtual IP address.

```
switch(config-rbridge-id-1)# virtual-ip 172.128.20.1
```

Configuring OSPF VRF-Lite for customer-edge routers

When you enable VRF-Lite on a customer-edge (CE) router, the down (DN) bit setting is ignored, allowing the CE router to add these routes to the Virtual Routing and Forwarding (VRF) routing table.

To enable VRF-Lite, perform the following steps:

1. Enable OSPF routing on a VRF instance.

```
switch(config)# router ospf vrf 1
```

2. Enable VRF-Lite for the VRF instance.

```
switch(config-ospf-router-vrf-1)# vrf-lite-capability
```

NOTE
To disable VRF-Lite, use the **no vrf-lite-capability** command. This disables the VRF instance only. It does not disable the default VRF.

Inter-VRF route leaking

Virtual Routing and Forwarding (VRF) is a technology that provides you with the ability to have multiple virtual routers on a single physical router or switch. VRFs operate without knowledge of one another unless they are imported or exported into one another using Inter-VRF Route Leaking. Inter-VRF route leaking allows leaking of specific route prefixes from one VRF instance to another VRF instance on the same physical router, which eliminates the need for external routing. This is useful in cases where multiple VRFs share the same path to reach an external domain, while maintaining their internal routing information limited to their own VRF. This feature enables a data center to consolidate multiple VRF services onto a single server.

The restrictions on Inter-VRF route leaking are:

- Each routed interface (whether virtual or physical) can only belong to one VRF.
- Dynamic routes from BGP or OSPF cannot be leaked.
- HA is not supported.

For more information on VRF functionality, refer to VRF overview on page 627.

Inter-VRF route conflicts

VRF Route Leaking is a feature which should only be deployed by an advanced user, as route leak configuration in source VRFs may collide with route/interface definitions in target VRFs. This may lead to unpredictable behavior in packet forwarding.

Some of the ways that leaked route conflicts can occur are:

- Static route conflict
- Dynamic route conflict
- Connected route conflict

A static route conflict may happen when the same prefix is reachable by two different nexthops in the target VRF. The forwarding behavior would be different based on which command occurred later. This following example presents a static route conflict for 10.1.2.0/24.

```
switch(config)# vrf red
switch(config)# ip route 10.1.2.0/24 next-hop-vrf green 10.1.1.1
switch(config)# vrf green
switch(config)# ip route 10.1.2.0/24 18.1.1.1
```

A dynamic route conflict can occur when dynamic routing protocols advertise different routes to the same prefix in the target VRF.

A connected route conflict is illustrated by the following example:

```
switch(config)# vrf red
switch(config)# ip route 10.1.2.0/24 next-hop-vrf green 10.1.1.1
switch(config)# interface Te 1/2/1
switch(config)# vrf forwarding green
switch(config)# ip address 10.1.2.1/24
```

NOTE

You will need to be aware of such possible conflicts before deploying the route leak feature, as currently there is no error checking for these problems. A good rule is to make sure that definitions are globally unique and route collisions do not exist.

Displaying Inter-VRF route leaking

The show command for the IP routing table (**show ip route**) displays a '+' sign next to the route type for the leaked routes in a VRF.

The following example shows the static route using the next-hop VRF option for route leaking:

```
switch# show ip route
Total number of IP routes: 3
Type Codes - B:BGP D:Connected I:ISIS O:OSPF R:RIP S:Static; Cost - Dist/Metric
BGP  Codes - i:iBGP e:eBGP
ISIS Codes - L1:Level-1 L2:Level-2
OSPF Codes - i:Inter Area 1:External Type 1 2:External Type 2 s:Sham Link
    Destination      Gateway       Port      Cost     Type   Uptime
1   0.0.0.0/0        10.24.64.1    mgmt 1    1/1      S      8m24s
2   1.1.1.0/24       10.1.1.10     Ve 10     1/1      S+     3m11s
3   10.24.64.0/20    DIRECT        mgmt 1    0/0      D      8m28s
```

Notice the '+' sign next to the Type entry for route entry 2.

You can also determine the leaked route for a specific pair of VRFs by specifying the pair as part of the (**show ip route**) command, as illustrated in the following example:

```
switch# show ip route vrf vrf1
Total number of IP routes: 2
Type Codes - B:BGP D:Connected I:ISIS O:OSPF R:RIP S:Static; Cost - Dist/Metric
BGP  Codes - i:iBGP e:eBGP
ISIS Codes - L1:Level-1 L2:Level-2
OSPF Codes - i:Inter Area 1:External Type 1 2:External Type 2 s:Sham Link
        Destination      Gateway       Port      Cost    Type   Uptime
1       0.0.0.0/0        192.168.64.1  mgmt 1    1/1     S      8m24s
2       10.11.11.0/24    192.168.21.2  Ve 12     1/1     S+     3m11s
```

Notice the '+' sign next to the Type entry for route entry 2.

Configuring Inter-VRF route leaking

Inter-VRF route leaking is a feature which should only be deployed by an advanced user.

Use the following procedure to set up Inter-VRF route leaking. Refer to the Example of Inter-VRF leaking on page 632 for an illustration.

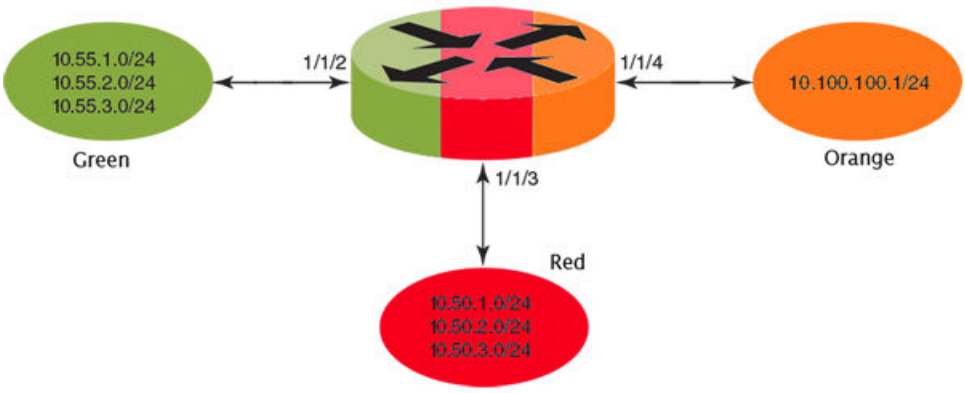
1. Set the switch to config mode.
2. Configure the VRF instances you want to be the leaker (source VRF) and where the route is being leaked to (destination VRF).
3. Specify the interface for the source VRF and map it to the source VRF.
4. Enter the IP address/mask to be used for this VRF instance.
5. Specify the interface you want to be the destination VRF and map it to the destination VRF.
6. Specify the IP address/mask to receive the leak.
7. Change the config mode to source VRF address family context.
8. Configure the route to be leaked, specifying the route prefix, the next-hop-VRF name as destination VRF and the next hop to the destination VRF.
9. Optional: For bidirectional IVRF leaking, repeat these steps, reversing the source and destination addresses.

Example of Inter-VRF leaking

In this example, one of the static routes in the "Red" VRF (10.50.2.0/24) is being allowed to communicate with one in the "Green" VRF (10.55.2.0/24).

The center icon represents a Brocade VDX router. The red, green and orange ovals represent virtual partitions (VRFs) in that same router. The Destination VRF is where the route is being leaked to ("Green"), and the Source VRF is where the route is being leaked from ("Red").

FIGURE 68 Inter-VRF leaking



1. Configure VRF "Green".

```
switch(config)# rbridge-id 1
switch(conf-rbridge-id-1)# vrf Green
switch(conf-vrf-Green)# rd 1:2
switch(conf-vrf-Green)# address-family ipv4
```

2. Configure VRF "Red".

```
switch(config)# rbridge-id 1
switch(conf-rbridge-id-1)# vrf Red
switch(conf-vrf-Red)# rd 2:1
switch(conf-vrf-Red)# address-family ipv4
```

3. Configure interface in the destination VRF "Green" (using the IP address and subnet mask).

```
switch(config)# interface ten 1/1/2
switch(conf-te-1/1/2)# vrf forwarding Green
switch(conf-te-1/1/2)# ip address 10.55.1.2/24
```

4. Configure interface in the source VRF "Red" (using the IP address and subnet mask).

```
switch(config)# interface ten 1/1/3
switch(conf-te-1/1/3)# vrf forwarding Red
switch(conf-te-1/1/3)# ip address 10.50.1.2/24
```

5. Navigate to the source VRF address family context for configuring static route leak.

```
switch(config)# rbridge-id 1
switch(conf-rbridge-id-1)# vrf Red
switch(conf-vrf-Red)# address-family ipv4 max-route
```

6. Configure the route leak for a network (using the IP address and subnet mask), by mentioning the destination next-hop VRF name and the next hop in the destination VRF.

```
switch(vrf-ipv4)# ip route 10.55.2.0/24 next-hop-vrf Green 10.55.1.1
```

7. For bidirectional route leak traffic, configure a route leak from VRF "Green" to VRF "Red".

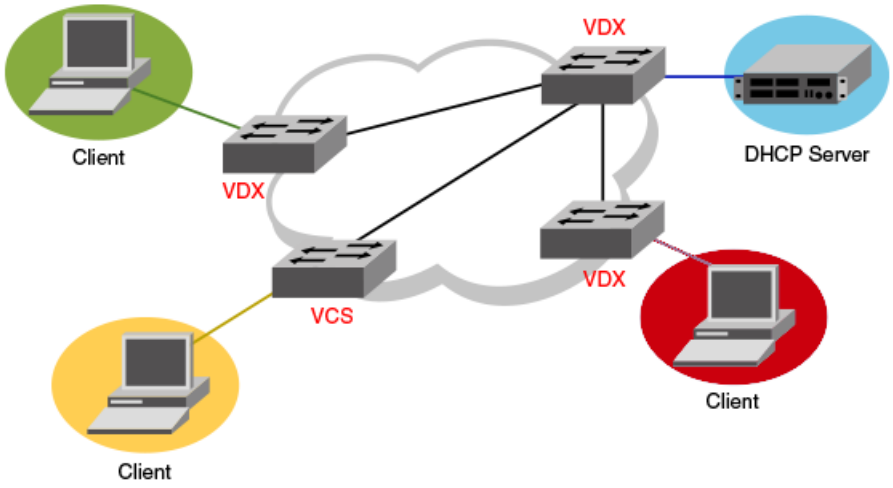
Inter-VRF route leaking and DHCP relay

In a DHCP relay setting, route leaking is controlled through a single DHCP server (which may be on a different VRF); this permits multiple VRFs to communicate with that server, something that would normally be not permitted. DHCP Relay deployments in a data center can

use Inter-VRF route leaking to achieve server consolidation; this permits clients in multiple VRFs to communicate with a single DHCP server in a different VRF (normally this is not permitted as VRFs provide route/traffic isolation).

The illustration below shows four VRFs, with three of them connecting to the fourth for DHCP services. For more information on working with DHCP IP Relay, refer to Configuring IP DHCP Relay on page 667.

FIGURE 69 Inter-VRF route leak example for connecting clients to a DHCP server in a different VRF.



The following example shows setting up Inter-VRF route leaking and DHCP between the red VRF and the blue VRF.

1. Set up the VRF forwarding.

```
switch(config)# interface ve 100
switch(conf-ve-100)# no shutdown
switch(conf-ve-100)# vrf forwarding red
     <- interface is in vrf "red" ->
switch(conf-ve-100)# ip address 10.1.1.1/24
switch(conf-ve-100)# ip dhcp relay address 20.1.1.2 use-vrf blue
     <- server is in vrf "blue" ->
```

2. Configure the leaked route on vrf red.

```
switch(config) rbridge-id 1
switch(conf-rbridge-id-1)# vrf red
switch(conf-vrf-red)# address-family ipv4 max-route
switch(vrf-ipv4)#ip route 20.1.1.2/32 next-hop-vrf blue 20.2.1.2
```

Configuring BGP

BGP overview

Border Gateway Protocol (BGP) is an exterior gateway protocol that performs inter-autonomous system (AS) or inter-domain routing. It peers to other BGP-speaking systems over TCP to exchange network reachability and routing information. BGP primarily performs two types of routing: inter-AS routing, and intra-AS routing. BGP peers belonging to different autonomous systems use the inter-AS routing, referred as Exterior BGP (EBGP). On the other hand, within an AS BGP can be used to maintain a consistent view of network topology, to provide optimal routing, or to scale the network.

BGP is a path vector protocol and implements this scheme on large scales by treating each AS as a single point on the path to any given destination. For each route (destination), BGP maintains the AS path and uses this to detect and prevent loops between autonomous systems.

The Open Shortest Path First (OSPF) protocol (supported in Network OS 3.0 and later) provides dynamic routing within the VCS and internal domain. However, even though OSPF suffices for most of the routing needs within the VCS, an exterior gateway protocol such as BGP is needed for inter-domain routing outside the VCS domain.

BGP support

Support for BGP on Network OS platforms is for BGP4 (compliant with RFC 1771 and 4271), and provides the following:

- Connectivity from the VCS to a core/external network or cloud
- A foundation to support virtual routing and forwarding (VRF) for multi-tenancy and remote-VCS access and route distribution across VRFs
- A foundation to support VRF scaling (OSPF does not scale well with lots of VRFs)
- A foundation to support OSPF Interior Gateway Protocol (IGP) scaling needs in future

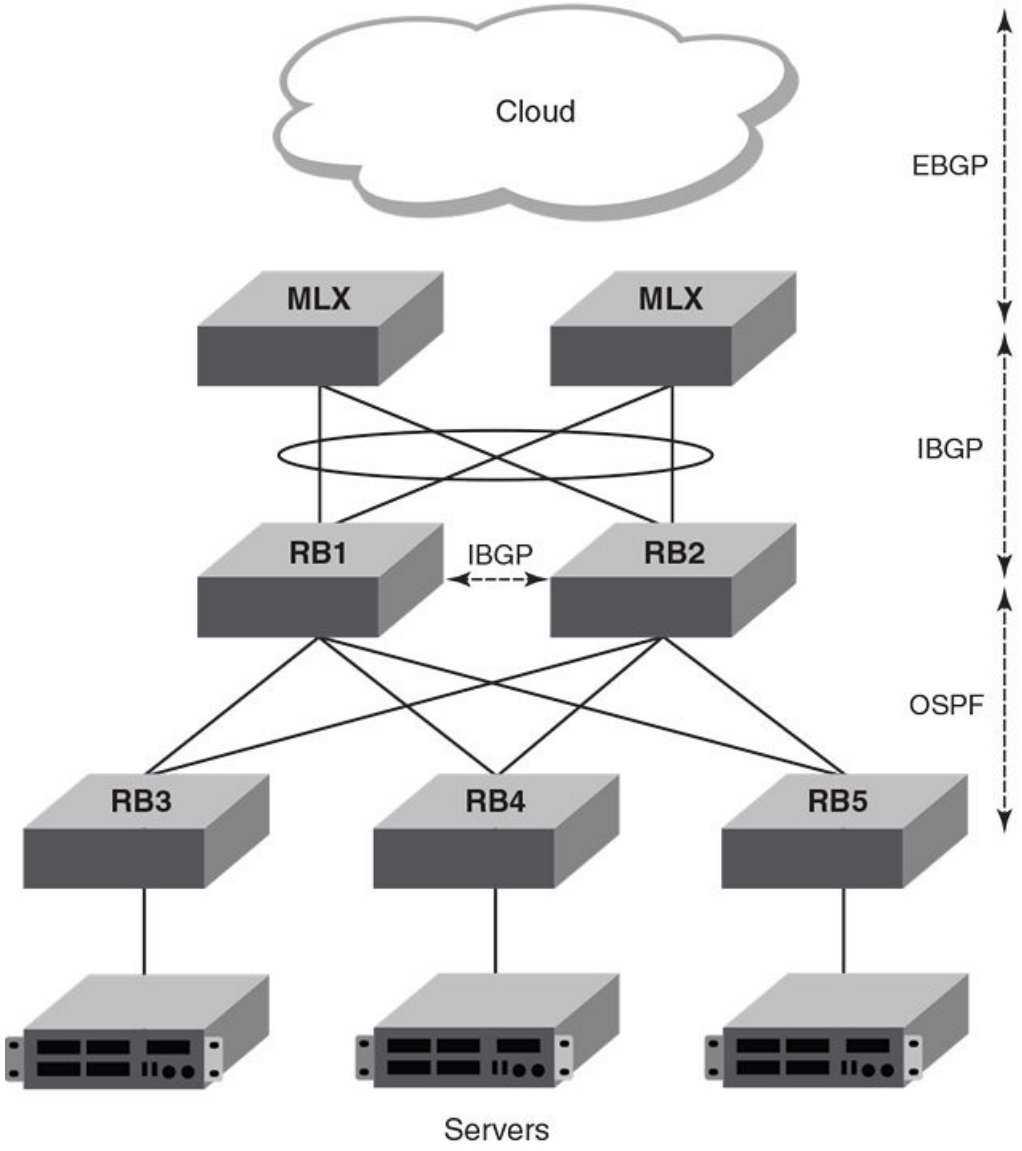
NOTE
An L3 License is required to enable BGP routing.

Deployment scenarios

BGP is typically used in a VCS Fabric at the aggregation layer and in connecting to the core. Routing bridges at the aggregation layer can either connect directly to the core, or connect through an MLX. The topologies below illustrate connectivity with and without an MLX. The details of these topologies are discussed in subsequent sections.

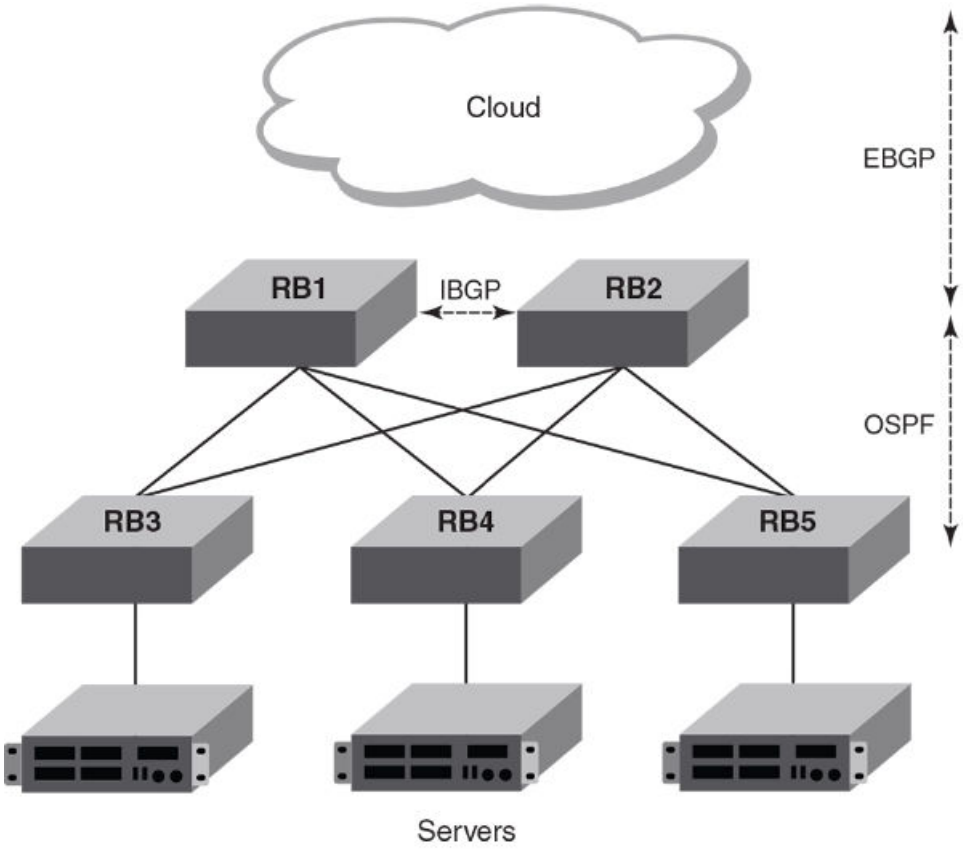
The figure below illustrates connectivity to the core through an MLX. The RBridges use OSPF and IBGP to communicate with each other, connecting to the MLX through IBGP. The MLX connects in turn to the core through EBGP.

FIGURE 70 Connectivity to the core through an MLX



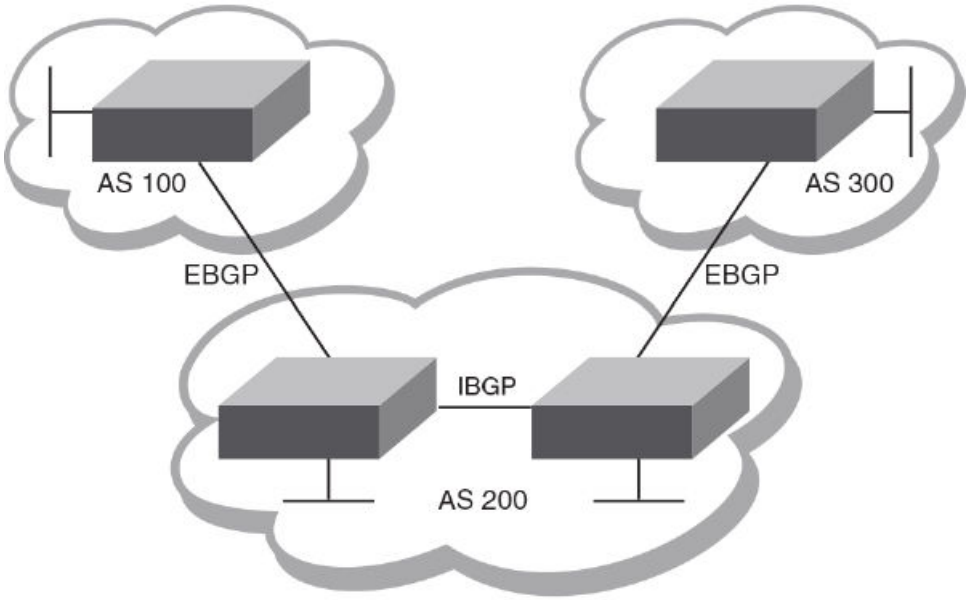
The figure below illustrates the previous topology but without an MLX.

FIGURE 71 Connectivity to the core without an MLX



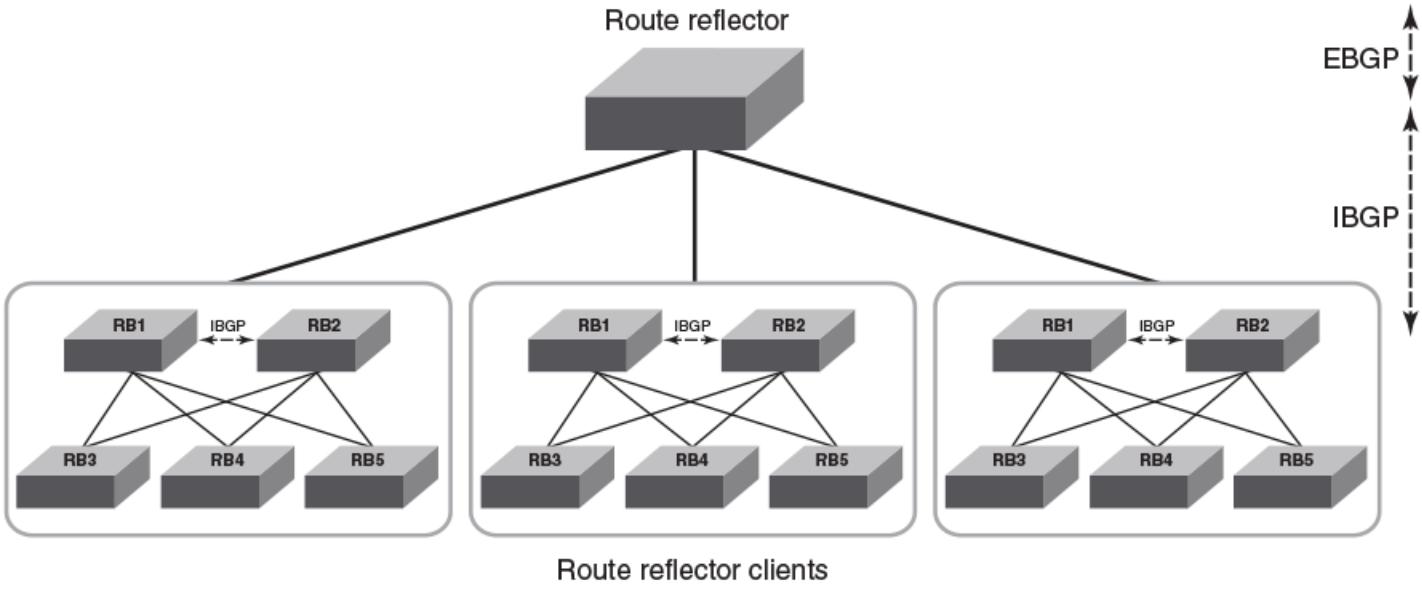
The figure below illustrates the role of BGP in communicating through multiple VCS clusters and autonomous systems.

FIGURE 72 BGP with multiple VCS clusters and autonomous systems



The figure below illustrates a BGP topology that incorporates a route-reflector server and route-reflector clients.

FIGURE 73 BGP route-reflector server and clients



BGP peering

Unlike OSPF or other IGP protocols, BGP does not have neighbor detection capability. BGP neighbors (or peers) must be configured manually. A router configured to run BGP is called a BGP "speaker." A BGP speaker connects to another speaker (either in the same or a different AS) by using a TCP connection to port 179 (the well-known BGP port), to exchange the routing information. The TCP connection is maintained throughout the peering session. While the connection between BGP peers is alive, two peers communicate by means of the following types of messages:

- OPEN
- UPDATE
- KEEPALIVE
- NOTIFICATION
- ROUTE REFRESH

BGP peering can be internal or external, depending on whether the two BGP peers belong to the same AS or different ASs. A BGP session between peers within a single AS is referred to as an Interior BGP (IBGP) session; a session between peers belonging to different ASs is referred to as an Exterior BGP (EBGP) session.

In order to establish a TCP connection between two IBGP peers, the IP reachability should be established either by means of the underlying IGP protocol (OSPF) or by means of static routes. When routes are advertised within IBGP peers, the following primary actions are taken in contrast to EBGP peering:

- Routes learned from an IBGP peer are not usually advertised to other IBGP peers, in order to prevent loops within an AS.
- Path attributes are not usually changed, in order to maintain the best path selection at other nodes within an AS.
- The AS path and next hop are not normally changed.

BGP message types

All BGP messages use a common packet header, with the following byte lengths:

Marker	Length	Type	Data
16	2	1	variable

NOTE
All values in the following tables are in bytes.

Type can be OPEN, UPDATE, NOTIFICATION, or KEEPALIVE, as described below.

OPEN message

After establishing TCP connection, BGP peers exchange OPEN message to identify each other.

Version	Autonomous System	Hold-Time	BGP Identifier	Optional Parameter Len	Optional Parameters
1	2 or 4	2	4	1	4

Version

Only BGP4 version 4 is supported.

Autonomous System

Both 2-byte and 4-byte AS numbers are supported.

KEEPALIVE and **HOLDTIME** messages

A BGP **timer** command specifies both **keep-alive** and **hold-time** operands that manage the intervals for BGP KEEPALIVE and HOLDTIME messages. The first operand sets the number of seconds the device waits for UPDATE/KEEPALIVE message before closing the TCP connection. The second operand sets the number of seconds that BGP maintains a session with a neighbor without receiving messages. When two neighbors have different hold-time values, the lowest value is used. A hold-time value of 0 means "always consider neighbor to be active."

BGP Identifier

Indicates the router (or device) ID of the sender. When router-id is not configured, device-id is taken from the loopback interface. Otherwise, the lowest IP address in the system is used.

Parameter List

Optional list of additional parameters used in peer negotiation.

UPDATE message

The UPDATE message is used to advertise new routes, withdraw previously advertised routes, or both.

WithdrawnRoutesLength	WithdrawnRoutes	Total PathAttributes Len	Path Attributes	NLRI
2	variable	2	variable	variable

Withdrawn Routes Length

Indicates the length of next (withdrawn routes) field. It can be 0.

Withdrawn Routes

Contains list of routes (or IP-prefix/Length) to indicate routes being withdrawn.

Total Path Attribute Len

Indicates length of next (path attributes) field. It can be 0.

Path Attributes

Indicates characteristics of the advertised path. Possible attributes: Origin, AS Path, Next Hop, MED (Multi-Exit Discriminator), Local Preference, Atomic Aggregate, Aggregator.

NLRI

Network Layer Reachability Information — the set of destinations whose addresses are represented by one prefix. This field contains a list of IP address prefixes for the advertised routes.

NOTIFICATION message

In case of an error that causes the TCP connection to close, the closing peer sends a notification message to indicate the type of error.

Error Code	ErrorSubcode	Error Data
1	1	variable

Error Code

Indicates the type of error, which can be one of following:

- Message header error
- Open message error
- Update message error
- Hold timer expired
- Finite state-machine error
- Cease (voluntarily)

Error Subcode

Provides specific information about the error reported.

Error Data

Contains data based on error code and subcode.

KEEPALIVE message

Because BGP does not regularly exchanges route updates to maintain a session, KEEPALIVE messages are sent to keep the session alive. A KEEPALIVE message contains just the BGP header without data field. Default KEEPALIVE time is 60 seconds and is configurable.

REFRESH message

A REFRESH message is sent to a neighbor requesting that the neighbor resend the route updates. This is useful when the inbound policy has been changed.

BGP attributes

BGP attributes are passed in UPDATE messages to describe the characteristics of a BGP path by the advertising router. At a high level, there are only two types of attributes: well-known and optional. All of the well-known attributes as described in RFC 4271 are supported in Network OS 4.0 and later.

Best-path algorithm

The BGP decision process is applied to the routes contained in the Routing Information Base, Incoming (RIB-In), which contains routes learned from inbound update messages. The output of the decision process is the set of routes that will be advertised to BGP speakers in local or remote autonomous systems and are stored in the Adjacency RIB, Outgoing (RIB-Out).

When multiple paths for the same route prefix are known to a BGP4 device, the device uses the following algorithm to weigh the paths and determine the optimal path for the route. (The optimal path depends on various parameters, which can be modified.)

1. Verify that the next hop can be resolved by means of Interior Gateway Protocol (IGP).
2. Use the path with the largest weight.
3. Prefer the path with the higher local preference.
4. Prefer the route that was self-originated locally.
5. Prefer the path with the shortest AS-path. An AS-SET counts as 1. A confederation path length, if present, is not counted as part of the path length. (An **as-path ignore** command disables the comparison of the AS path lengths of otherwise equal paths.)

6. Prefer the path with the lowest origin type. From low to high, route origin types are valued as follows:
   - IGP is lowest.
   - EGP is higher than IGP, but lower than INCOMPLETE.
   - INCOMPLETE is highest.
7. Prefer the path with the lowest MED.

   The device compares the MEDs of two otherwise equivalent paths if and only if the routes were learned from the same neighboring AS. This behavior is called deterministic MED. Deterministic MED is always enabled and cannot be disabled.

   To ensure that the MEDs are always compared, regardless of the AS information in the paths, the **always-compare-med** command can be used. This option is disabled by default.

   The **med-missing-as-worst** command can be used to make the device regard a BGP4 route with a missing MED attribute as the least-favorable path when the MEDs of the route paths are compared.

   MED comparison is not performed for internal routes that originate within the local AS or confederation, unless the **compare-med-empty-aspath** command is configured.
8. Prefer paths in the following order:
   - Routes received through EBGP from a BGP4 neighbor outside of the confederation
   - Routes received through EBGP from a BGP4 device within the confederation *or* routes received through IBGP.
9. If all the comparisons above are equal, prefer the route with the lowest IGP metric to the BGP4 next hop. This is the closest internal path inside the AS to reach the destination.
10. If the internal paths also are the same and BGP4 load sharing is enabled, load-share among the paths. Otherwise go to Step 11.

    NOTE
    For EBGP routes, load sharing applies only when the paths are from neighbors within the same remote AS. EBGP paths from neighbors in different ASs are not compared, unless multipath multi-as is enabled.

11. If **compare-routerid** is enabled, prefer the path that comes from the BGP4 device with the lowest device ID. If a path contains originator ID attributes, then the originator ID is substituted for the router ID in the decision.
12. Prefer the path with the minimum cluster-list length.
13. Prefer the route that comes from the lowest BGP4 neighbor address.

BGP limitations and considerations

The following limitations and considerations apply to BGP support on Network OS platforms:

- IPv6 is not supported.
- VRF functionality is not supported.
- There is no backward compatibility. In case of a downgrade, BGP configurations are lost.
- There is no support for graceful restart or nonstop routing. Following a failover or switchover, BGP routes and active neighbors are lost. However, the configuration is restored with a restart.
- RASLogs are generated when a BGP session begins.
- RASTRACE logs are available with module ID "261 BGP".

Understanding BGP configuration fundamentals

This section provides an overview of the configuration considerations and basic steps required to enable BGP functionality. Examples are provided in Configuring BGP on page 654.

Similar to other Layer 3 protocols in Network OS, BGP is supported only in the VCS mode of operation. Each RBridge in a VCS fabric running BGP acts as an individual BGP device. BGP can form IBGP peering with other RBridges in the same VCS fabric running BGP.

Configuring BGP

To enable BGP on an RBridge, enter Bridge ID configuration mode and issue the **router bgp** command:

```
switch(config-rbridge-id-12)# router bgp
```

There are two CLI modes for BGP:

- Global BGP
- BGP Address-Family IPv4 Unicast

After issuing the **router bgp** command, you first enter into BGP configuration mode, where an address-family-specific configuration can be applied. In order to apply an IPv4 address-family-specific configuration, issue the **address-family ipv4 unicast** command.

To create a route map, enter the **route-map** command while in RBridge ID configuration mode. Then declare a route-map name by using a **permit** or **deny** statement and an instance number.

To remove the entire BGP configuration, issue the **no router bgp** command.

Device ID

BGP automatically calculates the device identifier it uses to specify the origin in routes it advertises. If a router-id configuration is already present in the system, then device-id is used as the router-id. Otherwise, BGP first checks for a loopback interface, and the IP address configured on that interface is chosen as the device-id. However, if a loopback interface is not configured, the device-id is chosen from lowest-numbered IP interface address configured on the device. Once device-id is chosen, the device identifier is not calculated unless the IP address configured above is deleted.

Local AS number

The local AS number (ASN) identifies the AS in which the BGP device resides. It can be configured from BGP global mode:

```
switch(config-bgp-router)# local-as 6500
```

Use well-known private ASNs in the range from 64512 through 65535 if the AS number of the organization is not known.

IPv4 unicast address family

Currently only the IPv4 unicast address family is supported. This configuration is applied in the IPv4 address-family unicast submode of BGP:

```
switch(config-bgp-router)# address-family ipv4 unicast
switch(config-bgp-ipv4u)#
```

The following configurations are allowed under BGP IPv4 address-family unicast mode:

- Network (including static networks)

- Route aggregation
- Route redistribution
- Route reflection
- Dampening
- Default route origination
- Multipathing (including maximum paths)
- Address-family-specific neighbor configuration
- Explicit specification of networks to advertise

The following illustrates CLI options in address-family mode:

```
switch(config-bgp-router)# address-family ipv4 unicast

switch(config-bgp-ipv4u)# ?
Possible completions:
  aggregate-address               Configure BGP aggregate entries
  always-propagate                Allow readvertisement of best BGP routes not in IP Forwarding table
  bgp-redistribute-internal       Allow redistribution of iBGP routes into IGPs
  client-to-client-reflection     Configure client to client route reflection
  dampening                       Enable route-flap dampening
  default-information-originate   Originate Default Information
  default-metric                  Set metric of redistributed routes
  do                              Run an operational-mode command
  exit                            Exit from current mode
  help                            Provide help information
  maximum-paths                   Forward packets over multiple paths
  multipath                       Enable multipath for ibgp or ebgp neighbors only
  neighbor                        Specify a neighbor router
  network                         Specify a network to announce via BGP
  next-hop-enable-default         Enable default route for BGP next-hop lookup
  next-hop-recursion              Perform next-hop recursive lookup for BGP route
  no                              Negate a command or set its defaults
  pwd                             Display current mode path
  redistribute                    Redistribute information from another routing protocol
  rib-route-limit                 Limit BGP rib count in routing table
  static-network                  Special network that do not depends on IGP and always treat as best route
in BGP
  table-map                       Map external entry attributes into routing table
  top                             Exit to top level and optionally run command
  update-time                     Configure igp route update interval
```

BGP global mode

Configurations that are not specific to address-family configuration are available in the BGP global configuration mode:

```
switch(config-bgp-router)# ?
Possible completions:
  address-family                Enter Address Family command mode
  always-compare-med            Allow comparing MED from different neighbors
  as-path-ignore                Ignore AS_PATH length for best route selection
  capability                    Set capability
  cluster-id                    Configure Route-Reflector Cluster-ID
  compare-med-empty-aspath    Allow comparing MED from different neighbors even with empty as-path attribute
  compare-routerid              Compare router-id for identical BGP paths
  default-local-preference      Configure default local preference value
  distance                      Define an administrative distance
  enforce-first-as              Enforce the first AS for EBGP routes
  fast-external-fallover        Reset session if link to EBGP peer goes down
  install-igp-cost              Install igp cost to nexthop instead of MED value as BGP cost
  local-as                      Configure local AS number
  log-dampening-debug           Log dampening debug messages
  maxas-limit                   Impose limit on number of ASes in AS-PATH attribute
  med-missing-as-worst          Consider routes missing MED attribute as least desirable
```

```
  neighbor                      Specify a neighbor router
  timers                        Adjust routing timers
```

Neighbor configuration

For each neighbor a device is going to peer with, there must be a neighbor configuration that specifies an IP address (which must be the primary IP address of interface connection to get established) and an AS number of the neighbor. For each neighbor, you can specify a set of attributes. However, in case a set of neighbors share same set of attributes, then it is advisable to use a peer-group. The peer-group configuration is described in the next subsection.

The following illustrates the configuration of a neighbor's IP address and AS number:

```
switch(config-bgp-router)# neighbor 10.231.64.10 remote-as 6500
switch(config-bgp-router)#
```

Notice that the neighbor configuration appears in both the global and address-family modes of BGP. The neighbor parameters/attributes that are common to all of the address families appear in the BGP global mode; the parameters/attributes that are specific to an address family appear within the BGP address-family submode. Even though only the IPv4 unicast address family is supported currently, the options of the **neighbor** command are divided, to support future address families such as IPv6.

The following **running-config** excerpt illustrates the neighbor configurations that are allowed in BGP global mode and IPv4 address-family submode:

```
router bgp
  local-as 6500
  neighbor 10.231.64.10 advertisement-interval 60
  neighbor as-override
  neighbor 10.231.64.10 capability as4-enable
  neighbor 10.231.64.10 description "Example Neighbor Configuration"
  neighbor 10.231.64.10 ebgp-multihop 2
  neighbor 10.231.64.10 enforce-first-as
  neighbor 10.231.64.10 local-as 64900
  neighbor 10.231.64.10 maxas-limit in disable
  neighbor 10.231.64.10 next-hop-self always
  neighbor 10.231.64.10 password default
  neighbor 10.231.64.10 remote-as 1200
  neighbor 10.231.64.10 remove-private-as
  neighbor 10.231.64.10 shutdown generate-rib-out
  neighbor 10.231.64.10 soft-reconfiguration inbound
  neighbor 10.231.64.10 timers keep-alive 120 hold-time 240
  neighbor 10.231.64.10 update-source loopback lo0
  address-family ipv4 unicast
   neighbor 10.231.64.10 default-originate route-map test-map
   neighbor 10.231.64.10 filter-list [ 1 ] in
   neighbor 10.231.64.10 maximum-prefix 15000 teardown
   neighbor 10.231.64.10 prefix-list test-prefix in
   neighbor 10.231.64.10 route-map in test-map
   neighbor 10.231.64.10 send-community both
   neighbor 10.231.64.10 unsuppress-map test-map-2
   neighbor 10.231.64.10 weight 10
```

As mentioned above, a set of configurations can be specified for each neighbor, with support for the following:

- Advertisement interval
- Default route origination
- Enforcing of first AS in AS-path list as AS of originator
- AS path filter list
- Enforcing of local ASN of neighbor
- Enabling/disabling of 4-byte ASN capability at the BGP global level
- Maximum AS path length

- Ignoring of AS path lengths of otherwise equal paths
- Maximum routes learned from neighbor
- Enforcing of nexthop as self in routes advertised
- MD5 password authentication
- Prefix list for route filtering
- Remote AS
- Removing of private ASN while advertising routes
- Route map filtering
- Sending community attributes
- Shutting down of neighbor without removing the configuration
- Applying policy changes without resetting neighbor
- Keepalive and hold time
- Specifying of routes not to be suppressed in route aggregation
- Specifying of source IP to be used in TCP connection to neighbor
- Adding of weight to each route received from neighbor

Peer groups

Neighbors having the same attributes and parameters can be grouped together by means of the **peer-group** command. You must first create a peer-group, after which you can associate neighbor IP addresses with the peer-group. All of the attributes that are allowed on a neighbor are allowed on a peer-group as well.

Configurations for both creating a peer-group and associating neighbors to the peer-group are available in BGP global mode. As an example, you can create a peer-group named "external-group" as follows:

```
switch(config-bgp-router)# neighbor external-group peer-group
```

Subsequently, you can associate neighbors to "external-group," and configure attributes on the peer-group as illustrated below:

```
switch(config-bgp-router)# neighbor 172.29.233.2 peer-group external-group
switch(config-bgp-router)# neighbor 10.120.121.2 peer-group external-group
switch(config-bgp-router)# neighbor external-group remote-as 1720
```

An attribute value configured explicitly for a neighbor takes precedence over the attribute value configured on peer-group. In case neither the peer-group nor the individual neighbor has the attribute configured, the default value for the attribute is used.

Four-byte AS numbers

Four-byte autonomous system numbers (ASNs) can be optionally configured on a device, peer-group, or neighbor. If this is enabled, the device announces and negotiates "AS4" capability with its neighbors. You can configure AS4 capability to be enabled or disabled at the BGP global level:

```
switch(config-bgp-router)# capability as4-enable
```

You can do the same at the neighbor or peer-group level:

```
switch(config-bgp-router)# neighbor 172.29.233.2 capability as4-enable
```

You can configure AS4 capability to be enabled for a neighbor while still keeping AS4 numbers disabled at the global level, or vice-versa. The neighbor AS4 capability configuration takes precedence. If AS4 capability is not configured on the neighbor, then the peer-group

configuration takes effect. The global configuration is used if AS4 capability is configured neither at the neighbor nor at the peer-group level. If a device having a 4-byte ASN tries to connect to a device that does not have AS4 support, peering will not be established.

Route redistribution

The redistribution of static, connected, and OSPF routes into BGP is supported. Similarly, routes learned through BGP can also be redistributed into OSPF. An optional route-map can be specified, and this map will be consulted before routes are added to BGP. Management routes are not redistributed.

You configure redistribution under IPv4 address-family mode:

```
switch(config-bgp-router)# address-family ipv4 unicast

switch(config-bgp-ipv4u)# redistribute ?
Possible completions:
  connected               Connected
  ospf            Open Shortest Path First (OSPF)
  static          Static routes
```

While redistributing routes learned by OSPF, you can specify the type of routes to be redistributed. You can choose to redistribute internal, external type1, or external type2 routes.

The **redistribute ospf** command redistributes internal OSPF routes in a way that is equivalent to the effect of the **redistribute ospf match internal** command, as illustrated in this running-config excerpt:

```
router bgp
  local-as 6500
  address-family ipv4 unicast
   redistribute ospf match internal
   redistribute ospf match external1
   redistribute ospf match external2
```

Advertised networks

As described in the previous section, you can advertise routes into BGP by redistributing static, connected, or OSPF routes. However, you can explicitly specify routes to be advertised by BGP by using the **network** command in IPv4 address-family submode:

```
switch(config-bgp-ipv4u)# network 10.40.25.0/24
```

Before BGP can advertise this route, the routing table must have this route already installed.

Another use of the **network** command is to specify a route to be local. In case the same route is received by means of EBGP, the local IGP route will be preferred. The **backdoor** parameter changes the administrative distance of the route to this network from the EBGP administrative distance (20 by default) to the local BGP4 weight (200 by default), tagging the route as a backdoor route. Use this parameter when you want the device to prefer IGP routes such as RIP or OSPF routes over the EBGP route for the network.

```
switch(config-bgp-ipv4u)# network 10.40.25.0/24 backdoor
```

The **neighbor weight** command specifies a weight that the device adds to routes that are received from the specified BGP neighbor. (BGP4 prefers larger weights over smaller weights.)

Static networks

Before advertising any route, BGP checks for its existence in the routing table. If you want BGP to advertise a stable route that does not depend on its existence in the routing table, then use the **static-network** command to advertise that network:

```
switch(config-bgp-ipv4u)# static-network 10.40.25.0/24
```

When the configured route is lost, BGP installs the "null0" route in the routing table. Later, when the route is resolved, the null0 route is removed. You can override the administrative local distance of 200 by specifying the distance value in the command:

```
switch(config-bgp-ipv4u)# static-network 10.40.25.0/24 distance 300
```

Route reflection

A BGP device can act as a route-reflector client or as a route reflector. You can configure a BGP peer as a route-reflector client from the device that is going to reflect the routes and act as the route reflector:

```
switch(config-bgp-ipv4u)# neighbor 10.61.233.2 route-reflector-client
```

When there is more than one route-reflector, they should all belong to the same cluster. By default, the value for **cluster-id** is used as the device ID. However, the device ID can be changed:

```
switch(config-bgp-router)# cluster-id ipv4-address 10.30.13.4
switch(config-bgp-router)# cluster-id 2300
```

The route-reflector server reflects the routes as follows:

- Routes from the client are reflected to client as well as to nonclient peers.
- Routes from nonclient peers are reflected only to client peers.

In case route-reflector clients are connected in a full IBGP mesh, you may wish to disable client-to-client reflection on the route reflector:

```
switch(config-bgp-ipv4u)# no client-to-client-reflection
```

A BGP device advertises only those routes that are preferred ones and are installed into the Routing Table Manager (RTM). When a route could not be installed into the RTM because the routing table was full, the route reflector may not reflect that route. In case the route reflector is not placed directly in the forwarding path, you can configure the route reflector to reflect routes even though those routes are not in the RTM:

```
switch(config-bgp-ipv4u)# always-propagate
```

Route flap dampening

Unstable routes can trigger a lot of route state changes. You can configure dampening in IPv4 address-family mode to avoid this churn by penalizing the unstable routes:

```
switch(config-bgp-ipv4u)# dampening
```

This command uses default values for the dampening parameters described below:

half-life

Number of minutes after which penalty for a route becomes half of its value. The route penalty allows routes that have remained stable for a period despite earlier instability to become eligible for reuse after the interval configured by this parameter. The decay rate of the penalty is proportional to the value of the penalty. After the half-life expires, the penalty decays to half its value. A dampened route that is no longer unstable can eventually again become eligible for use. You can configure the half-life to be from 1 through 45 minutes. The default is 15 minutes.

reuse

Minimum penalty below which routes becomes reusable again. You can set the reuse threshold to a value from 1 through 20000. The default is 750 (0.75, or three-fourths, of the penalty assessed for one flap).

suppress

Maximum penalty above which route is suppressed by the device. You can set the suppression threshold to a value from 1 through 20000. The default is 2000 (more than two flaps).

max-suppress-time

Maximum number of minutes a route can be suppressed by the device, regardless of how unstable the route is. You can set maximum suppress time to a value from 1 through 255 minutes. The default is 40 minutes.

> NOTE
> A dampening value for half-life can also be adjusted through a route map, by means of the **set dampening** option for the **route-map** command.

Default route origination

While redistributing routes from OSPF, BGP does not advertise default route 0.0.0.0/0 even if it exists. You can enable default route origination by using the **default-information-originate** command under IPv4 address-family mode:

```
switch(config-bgp-ipv4u)# default-information-originate
```

In order to advertise a default route without OSPF redistribution, use the **network** command.

Multipath load sharing

Unlike IGP, BGP does not perform multipath load sharing by default. Therefore, the maximum number of paths across which BGP can balance the traffic is set to 1 by default. You can change this value by using the **maximum-paths** command in IPv4 address-family mode:

```
switch(config-bgp-ipv4u)# maximum-paths 4
```

You can specify the maximum path value explicitly for IBGP or EBGP:

```
switch(config-bgp-ipv4u)# maximum-paths ebgp 2
```

In case the maximum-path value must be picked up from the **ip load-sharing** configuration on the router, use the following:

```
sw0(config-bgp-ipv4u)# maximum-paths use-load-sharing
```

You can enable multipathing for both IBGP or EBGP. By default, the AS numbers of the two paths should match for them to be considered for multipathing. However, you can remove this restriction by specifying a **multi-as** option, as illustrated in the following **running-config** excerpt:

```
router bgp
  local-as 6500
  address-family ipv4 unicast
   multipath ebgp
   multipath ibgp
   multipath multi-as
```

Configuring the default route as a valid next-hop

BGP does not use the default route installed in the device to resolve the BGP next-hop. You can change this in IPv4 address-family mode to enable BGP to use default route for next-hop resolution:

```
sw0(config-bgp-ipv4u)# next-hop-enable-default
```

Next-hop recursion

Next-hop recursion is disabled by default in BGP, but you can enable it. When next-hop recursion is disabled, only one route lookup is performed to obtain the next-hop IP address. If the lookup result does not succeed or the result points to another BGP path, then route destination is considered unreachable. Enable it as follows:

```
sw0(config-bgp-ipv4u)# next-hop-recursion
```

When next-hop recursion is enabled, if the first lookup for the destination IP address results in an IBGP path that originated in the same AS, the device performs lookup for the IP address of the next-hop gateway. This goes on until the final lookup results in an IGP route. Otherwise, the route is declared unreachable.

Route filtering

The following route filters are supported:

- AS-path filter
- Community filter
- Prefix list
- Route map
- Table map

NOTE
Support for access lists in route filtering is not available, and has been replaced by prefix-list filtering. BGP does not use community and extended-community filters directly. Rather, it uses them indirectly through route-map filtering by means of the **route-map** command.

Timers

You can change keepalive and hold-time values from their default values of 60 and 180 seconds, respectively:

```
sw0(config-bgp-router)# timers keep-alive 10 hold-time 60
```

A hold-time value of 0 means that the device will wait indefinitely for messages from a neighbor without tearing down the session.

Once the IGP routes are changed, BGP routing tables are affected after 5 seconds by default. You can change this value by using the **update-time** command:

```
sw0(config-bgp-ipv4u)# update-time 0
```

An **update-time** value of 0 will trigger BGP route calculation immediately after the IGP routes are changed.

Using route maps

A route map is a named set of match conditions and parameter settings that the device can use to modify route attributes and to control redistribution of the routes into other protocols. A route map consists of a sequence of instances, the equivalent of rows in a table. The device evaluates a route according to route map instances in ascending numerical order. The route is first compared against instance 1, then against instance 2, and so on. When a match is found, the device stops evaluating the route.

Route maps can contain **match** clauses and **set** statements. Each route map contains a **permit** or **deny** statement for routes that match the **match** clauses:

- If the route map contains a **permit** statement, a route that matches a match statement is permitted; otherwise, the route is denied.
- If the route map contains a **deny** statement, a route that matches a match statement is denied.
- If a route does not match any **match** statements in the route map, then the route is denied. This is the default action. To change the default action, configure the last **match** statement in the last instance of the route map to **permit any any** .
- If there is no **match** statement, the software considers the route to be a match.
- For route maps that contain address filters, AS-path filters, or community filters, if the action specified by a filter conflicts with the action specified by the route map, the route map action takes precedence over the filter action.

If the route map contains **set** statements, routes that are permitted by the route map **match** statements are modified according to the **set** statements.

Match statements compare the route against one or more of the following:

- The route BGP4 MED (metric)
- The IP address of the next hop device
- The route tag
- For OSPF routes only, the route type (internal, external type 1, or external type 2)
- An AS-path access control list (ACL)
- A community ACL
- An IP prefix list

For routes that match all of the **match** statements, the route map **set** statements can perform one or more of the following modifications to the route attributes:

- Prepend AS numbers to the front of the route AS-path. By adding AS numbers to the AS-path, you can cause the route to be less preferred when compared to other routes based on the length of the AS-path.
- Add a user-defined tag or an automatically calculated tag to the route.
- Set the community attributes.
- Set the local preference.
- Set the MED (metric).
- Set the IP address of the next-hop device.
- Set the origin to IGP or INCOMPLETE.
- Set the weight.

When you configure parameters for redistributing routes into BGP4, one of the optional parameters is a route map. If you specify a route map as one of the redistribution parameters, the device matches the route against the match statements in the route map. If a match is found and if the route map contains **set** statements, the device sets the attributes in the route according to the set statements.

To create a route map, you define instances of the map by a sequence number.

The **route-map***name* is a string of characters that defines the map instance. Map names can be up to 80 characters long. The following is the complete syntax of the **route-map** command:

[**no**] **route-map** *name* [**permit** | **deny**] *instance_number*] | [**continue** *sequence_number* | **match** [**as-path** *ACL_name* | **community** *ACL_name* | **interface** [**fortygigabitethernet** *rbridge-id/slot/port* **gigabitethernet** *rbridge-id/slot/port* | **loopback** *port* **tengigabitethernet** *rbridge-id/slot/port* **ve** *port*] | **ip** [**address prefix-list** *name*] | **next-hop prefix-list** *name* | **route-source prefix-list** *name*] | **metric** *number* | **protocol bgp** [**external** | **internal** | **static-network**] | **route-type** [**internal** | **type-1** | **type-2**] | **tag** *number* | **set** [**as-path** [**prepend** | **tag**] |

automatic-tag | **comm-list** | **community** *community_number* | **additive** | **local-as** | **no-advertise** | **no-export** | **none**] | **dampening** *number* | **distance** *number*] **ip next-hop** [*A.B.C.D* | **peer-address**] | **local-preference** *number*] | **metric** [**add** *number* | **assign** | **none** | **sub**] | **metric-type** [**external** | **internal** | **type-1** | **type-2**] | **origin** [**igp** | **incomplete**] | **route-type** [**internal** | **type-1** | **type-2**] | **tag** *number* | **weight** *number*]

Operands for this command are defined below.

The **permit** | **deny** options specify the action the device will take if a route matches a match statement:

- If you specify **deny**, the device does not advertise or learn the route.
- If you specify **permit**, the device applies the match and set clauses associated with this route map instance.

The *instance-number* parameter specifies the instance of the route map you are defining. The following illustrates a creation of a route-map instance 10, which is done in RBridge ID mode. Notice the change in the command prompt.

```
switch(config)# rbridge-id 5
switch(config-rbridge-id-5)# routemap myroutemap1 permit 10
switch(config-route-map-myroutemap1/permit/10)#
```

To delete a route map, enter a command such as the following in RBridge ID configuration mode. When you delete a route map, all the permit and deny entries in the route map are deleted.

```
switch(config-rbridge-id-5)# no route-map myroutemap1
```

This command deletes a route map named myroutemap1. All entries in the route map are deleted.

To delete a specific instance of a route map without deleting the rest of the route map, enter a command such as the following.

```
switch(config-rbridge-id-5)# no route-map myroutemap1 permit 10
```

This command deletes the specified instance from the route map but leaves the other instances of the route map intact.

Specifying the match conditions

Use the **match** command to define the match conditions for instance 10 of the route map myroutemap1.

```
switch(config-route-map-myroutemap1/permit/10)# match ?
```

Operands for the route-map **match** statement are as follows:

community *num* — Specifies a community ACL. (The ACL must already be configured.)

ip address | **next-hop** *acl-num* | **prefix-list** *string* — Specifies an ACL or IP prefix list. Use this parameter to match based on the destination network or next-hop gateway. To configure an IP ACL for use with this command, use the**ip access-list** command. To configure an IP prefix list, use the **ip prefix-list** command.

ip route-source *acl* | **prefix** *name* — Matches on the source of a route (the IP address of the neighbor from which the device learned the route).

metric *num* — Compares the route MED (metric) to the specified value.

next-hop *address-filter-list* — Compares the IP address of the route next-hop to the specified IP address filters. The filters must already be configured.

route-type [**internal** | **type-1** | **type-2**] — Applies only to OSPF routes.

- **internal** — Sets an internal route type.
- **type-1** — Sets an OSPF external route type 1.
- **type-2** — Sets an OSPF external route type 2.

tag *tag-value* — Compares the route tag to the specified tag value.

protocol bgp static-network — Matches on BGP4 static-network routes.

protocol bgp external — Matches on EBGP (external) routes.

protocol bgp internal — Matches on IBGP (internal) routes.

Setting parameters in the routes

Use the following command to define a **set** statement that prepends an AS number to the AS path on each route that matches the corresponding match statement.

```
switch(config-routemap-myroutemap1/permit10)# set as-path prepend 7701000
```

Operands for the route-map **set** statement are as follows:

as-path prepend *num,num,...* — Adds the specified AS numbers to the front of the AS-path list for the route. Values range from 1 through 65535 for two-byte ASNs, and from 1 through 4294967295 if AS4s have been enabled.

automatic-tag — Calculates and sets an automatic tag value for the route. (This parameter applies only to routes redistributed into OSPF.)

comm-list — Deletes a community from the community attributes field for a BGP4 route.

community — Sets the community attribute for the route to the number or well-known type specified.

dampening [*half-life*] — Sets route dampening parameters for the route; *half-life* specifies the number of minutes after which the route penalty becomes half its value.

ip next hop *ip-addr* — Sets the next-hop IP address for a route that matches a **match** statement in the route map.

ip next hop *peer-address* — Sets the BGP4 next hop for a route to the neighbor address.

local-preference *num* — Sets the local preference for the route. Values range from 0 through 4294967295.

metric [**+** |**-**] *num* | **none** — Sets the Multi-Exit Discriminator (MED) value for the route. Values range from 0 through 4294967295. The default is 0.

- **set metric** *num* — Sets the metric for the route to the specified number.
- **set metric+** *num* — Increases the route metric by the specified number.
- **set metric-** *num* — Decreases route metric by the specified number.
- **set metric none** — Removes the metric from the route (removes the MED attribute from the BGP4 route).

metric-type type-1 | **type-2** — Changes the metric type of a route redistributed into OSPF.

metric-type internal — Sets the route MED to the same value as the IGP metric of the BGP4 next-hop route, for advertising a BGP4 route to an EBGP neighbor.

next hop *ip-addr* — Sets the IP address of the next-hop device.

origin igp incomplete — Sets the route's origin to IGP or INCOMPLETE.

tag — Keyword that sets the tag to be an AS-path attribute. (This parameter applies only to routes redistributed into OSPF.)

weight *num* — Sets the weight for the route. Values range from 0 through 65535.

Using a route-map continue statement for BGP4 routes

A **continue** statement in a route-map directs program flow to skip over route-map instances to another, user-specified instance. If a matched instance contains a **continue** statement, the system looks for the instance that is identified in the statement.

The **continue** statement in a matching instance initiates another traversal at the instance specified. The system records all of the matched instances and, if no **deny** statements are encountered, proceeds to execute the **set** clauses of the matched instances.

If the system scans all route-map instances but finds no matches, or if a **deny** condition is encountered, then it does not update the routes. Whenever a matched instance contains a **deny** statement, the current traversal terminates, and none of the updates specified in the **set** statements of the matched instances in both current and previous traversals are applied to the routes.

This supports a more programmable route-map configuration and route filtering scheme for BGP4 peering. It can also execute additional instances in a route map after an instance is executed by means of successful **match** statements. You can configure and organize more-modular policy definitions to reduce the number of instances that are repeated within the same route map.

This feature currently applies to BGP4 routes only. For protocols other than BGP4, **continue** statements are ignored.

Configuring BGP

This section expands upon the preceding overview and provides the following additional BGP management examples.

Adjusting defaults to improve routing performance

The following examples illustrate a variety of options for enabling and fine-tuning route flap dampening.

To enable default dampening as an address-family function:

```
switch(config)# rbridge-id 10
switch(config-rbridge-id-10)# router bgp
switch(config-bgp-router)# address-family ipv4 unicast
switch(config-bgp-ipv4u)# dampening
```

To change the all dampening values as an address-family function:

```
switch(config)# rbridge-id 10
switch(config-rbridge-id-10)# router bgp
switch(config-bgp-router)# address-family ipv4 unicast
switch(config-bgp-ipv4u)# dampening 20 200 2500 40
```

NOTE

To change any of the parameters, you must specify all the parameters in the command in the following order: **half-life**, **reuse**, **suppress**, **max-suppress-time**. To leave any parameters unchanged, enter their default values.

For more details about the use of route maps, including more flap-dampening options, refer to Using route maps with match and set statements on page 654.

Using route maps with match and set statements

This section presents the following match and set examples.

Matching on an AS-path ACL

To configure a route map that matches on AS-path ACL 1:

```
switch(config)# rbridge-id 5
switch(config-rbridge-id-5)# route-map myaclroutemap1 permit 10
switch(config-route-map-myaclroutemap1/permit/10)# match as-path 1
```

Matching on a community ACL

To configure a route map that matches on community ACL 1:

```
switch(config)# rbridge-id 5
switch(config-rbridge-id-5)# ip community-list standard 1 permit 123:2
switch(config-rbridge-id-5)# route-map mycommroutemap1 permit 10
switch(config-route-map-mycommroutemap1/permit/10)# match community 1
```

Matching on a destination network

NOTE

You can use the results of an IP ACL or an IP prefix list as the match condition.

To configure a route map that matches on a destination network:

```
switch(config)# rbridge-id 5
switch(config-rbridge-id-5)# route-map mynetroutemap1 permit 10
switch(config-route-map-mynetroutemap1/permit/10)# match ip address prefix-list 1
```

Matching on a next-hop device

To configure a route map that matches on a next-hop device:

```
switch(config)# rbridge-id-5
switch(config-rbridge-id-5)# route-map myhoproutemap1 permit 10
switch(config-route-map-myhoproutemap1/permit/10)# match ip next-hop    prefix-list 1
```

Matching on a route source

To configure a route map that matches on a route source:

```
switch(config)# rbridge-id 5
switch(config)# access-list 10 permit 192.168.6.0 0.0.0.255
switch(config-rbridge-id-5)# route-map mysourceroutemap1 permit 1
switch(config-route-map-mysourceroutemap1/permit/10)# match ip route-source prefix-list 10
```

Matching on routes containing a specific set of communities

To configure a route map that matches on a set of communities:

```
switch(config)# rbridge-id 5
switch(config-rbridge-id-5)# ip community-list standard std_1 permit 12:34 no-export
switch(config-rbridge-id-5)# route-map mycommroutemap2 permit 1
switch(config-routemap-mycommroutemap2/permit/1)# match community std_1 exact-match
```

NOTE

The first command configures a community ACL that contains community number 12:34 and community name "no-export." The remaining commands configure a route map that matches the community attributes field in BGP4 routes against the set of communities in the ACL. A route matches the route map only if the route contains all the communities in the ACL and no other communities.

To configure an additional community-based route map for comparison with the first:

```
switch(config)# rbridge-id 5
switch(config-rbridge-id-5)# ip community-list standard std_2 permit 23:45 56:78
switch(config-rbridge-id-5)# route-map mycommroutemap3 permit 1
switch(config-routemap-mycommroutemap3/permit/1)# match community std_1 std_2 exact-match
```

NOTE

These commands configure an additional community ACL, std_2, that contains community numbers 23:45 and 57:68. Route map mycommroutemap3 compares each BGP4 route against the sets of communities in ACLs std_1 and std_2. A BGP4 route that contains either but not both sets of communities matches the route map. For example, a route containing communities 23:45 and 57:68 matches. However, a route containing communities 23:45, 57:68 and 12:34, or communities 23:45, 57:68, 12:34, and "no-export" does not match. To match, the route communities must be the same as those in exactly one of the community ACLs used by the **match community** statement.

Matching on a BGP4 static network

To configure a route map that matches on a static network:

```
switch(config)# rbridge-id 5
switch(config-rbridge-id-5)# route-map mystaticroutemap3 permit 1
switch(config-routemap-mystaticroutemap3/permit/1)# match protocol bgp static-network
switch(config-routemap-mystaticroutemap3/permit/1)# set local-preference 150
switch(config-routemap-mystaticroutemap3/permit/1)# set community no-export
switch(config-routemap-mystaticroutemap3/permit/1)# exit
switch(config)# router bgp
switch(config-bgp)# neighbor 192.168.6.0 route-map out mystaticroutemap3
```

Matching on an interface

To configure a route map that matches on an interface:

```
switch(config)# rbridge-id 5
switch(config-rbridge-id-5)# route-map myintroutemap1 permit 99
switch(config-rbridge-id-5)# match interface ten 5/1/1 ten 5/3/2
```

Setting a BGP4 route MED to equal the next-hop route IGP metric

To set a route's Multi-Exit Discriminator (MED) to the same value as the IGP metric of the BGP4 next-hop route, when advertising the route to a neighbor:

```
switch(config)# rbridge-id 5
switch(config-rbridge-id-5)# route-map mymedroutemap1 permit 1
switch(config-routemap-mymedroutemap/permit/1)# match ip address 1
switch(config-routemap-mymedroutemap/permit/1)# set metric-type internal
```

Setting the next-hop of a BGP4 route

To set the next-hop address of a BGP4 route to a neighbor address:

```
switch(config)# rbridge-id 5
switch(config-rbridge-id-5)# route-map mhoproutemap1 permit 1
switch(config-routemap-myhoproutemap/permit/1)# match ip address 1
switch(config-routemap-myhoproutemap/permit/1)# set ip next-hop peer-address
```

Deleting a community from a BGP4 route

To delete a community from a BGP4 route's community attributes field:

```
switch(config)# rbridge-id 5
switch(config-rbridge-id-5)# ip community-list standard std_3 permit 12:99 12:86
switch(config-rbridge-id-5)# route-map mcommroutemap1 permit 1
switch(config-routemap-mycommroutemap/permit/1)# match ip address 1
switch(config-routemap-mycommroutemap/permit/1)# set comm-list std_3 delete
```

NOTE
The first command configures a community ACL containing community numbers 12:99 and 12:86. The remaining commands configure a route map that matches on routes whose destination network is specified in ACL 1, and deletes communities 12:99 and 12:86 from those routes. The route does not need to contain all the specified communities in order for them to be deleted. For example, if a route contains communities 12:86, 33:44, and 66:77, community 12:86 is deleted.

Using route-map continue statements

To configure **continue** statements in a route map:

```
switch(config)# rbridge-id 5
switch(config-rbridge-id-5)# route-map mcontroutemap1 permit 1
switch(config-routemap-mycontroutemap/permit/1)# match metric 10
switch(config-routemap-mycontroutemap/permit/1)# set weight 10
switch(config-routemap-mycontroutemap/permit/1)# match metric 10
switch(config-routemap-mycontroutemap/permit/1)# continue 2
switch(config-routemap-mycontroutemap/permit/1)# route-map mcontroutemap1 permit 2
switch(config-routemap-mycontroutemap/permit/2)# match tag 10
switch(config-routemap-mycontroutemap/permit/2)# set weight 20
```

NOTE
This configures the route map to continue to evaluate and execute **match** statements after a successful match occurs. The **continue** statement proceeds to the route map with the specified sequence number. If no sequence number is specified, the statement proceeds to the route map with the next sequence number (an "implied" continue).

Using a route map to configure dampening

To apply the dampening half-life established in a route map:

```
switch(config)# rbridge-id 10
switch(config-rbridge-id-10)# route-map myroutemap permit 1
switch(config-route-map-myroutemap/permit/1)# set dampening 20
```

NOTE
To change any of the parameters, you must specify all the parameters with the command. To leave any parameters unchanged, enter their default values.

Clearing configurations

To refresh all BGP4 neighbor routes:

```
switch# clear ip bgp neighbor all
```

To refresh a route to a specific neighbor:

```
switch# clear ip bgp neighbor 10.11.12.13
```

To clear BGP4 routes:

```
switch# clear ip bgp routes 10.0.0.0/16
```

To clear the BGP4 message counters:

```
switch# clear ip bgp traffic
```

To unsuppress all suppressed BGP4 routes:

```
switch# clear ip bgp dampening
```

To clear the dampening statistics for a BGP4 route:

```
switch# clear ip bgp flap-statistics 10.0.0.0/16
```

Configuring IGMP

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 664.

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.

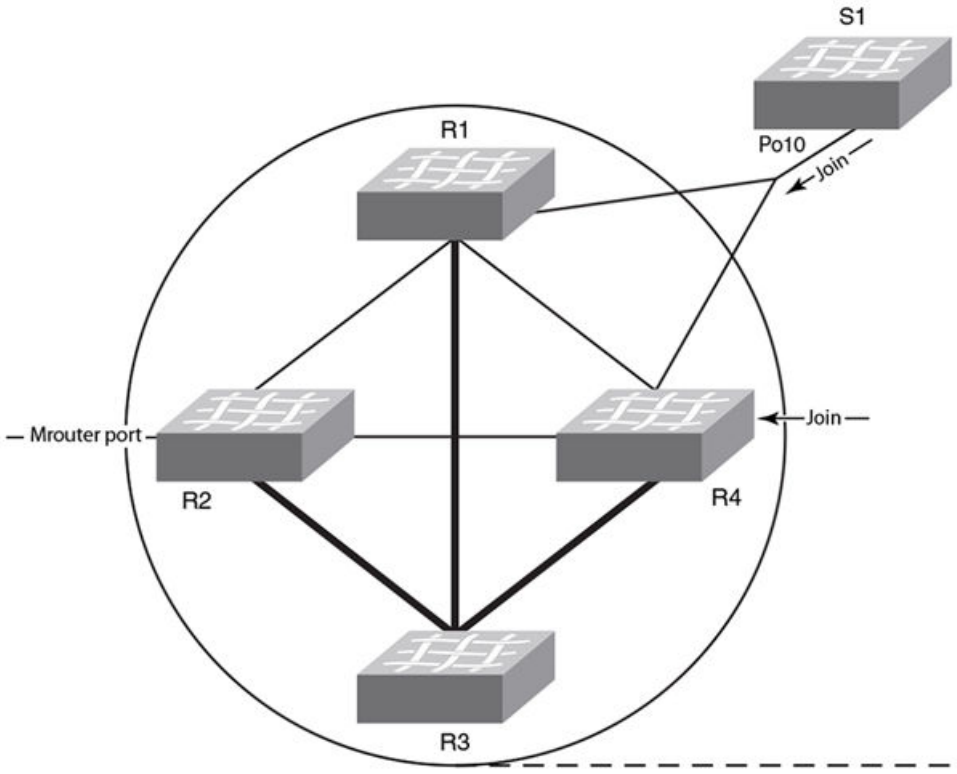
In response to the request, the switch creates an entry in its Layer 2 forwarding table for that VLAN. When other hosts send join requests for the same multicast, the switch adds them to the existing table entry. Only one entry is created per VLAN in the Layer 2 forwarding table for each multicast group.

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 74 IGMP snooping in Brocade VCS Fabric mode



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.

IGMP Metric	Description
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 standalone mode

In standalone mode, the VDX switch functions as an isolated device, possibly connected as a top-of-rack (TOR) switch. The table below provides details about the metric levels.

TABLE 93 IGMP snooping: standalone mode 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	

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 94 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 95 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 96 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.

TABLE 96 IGMP snooping: Brocade VDX 8770-4 and VDX 8770-8 cluster metrics (continued)

Metric	Limit	Comments
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 97 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
   ```

4. 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
   ```

5. When you have reviewed the IGMP statistics for the switch, refer to Configuring IGMP snooping on page 662 or Configuring IGMP snooping querier on page 663 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
ip igmp immediate-leave	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.
ip igmp static-group	Configures the static group membership entries for a specific interface.

Configuring IP DHCP Relay

DHCP protocol

Dynamic Host Configuration Protocol (DHCP) is an IP network protocol that provides network configuration data, such as IP addresses, default routes, DNS server addresses, access control, QoS policies, and security policies stored in DHCP server databases to DHCP clients upon request.

You can enable DHCP service on VDX switches so that they can automatically obtain an Ethernet IP address, prefix length, and default gateway address from the DHCP server. Refer to Configuring an IPv4 address with DHCP on page 70 for more information.

IP DHCP Relay function

DHCP relays are an important feature for large networks as they allow communication between DHCP servers and clients located on different subnets.

In small networks with only one IP subnet, DHCP clients can communicate directly with DHCP servers. Clients located on a different subnet than the DHCP server cannot communicate with that server without obtaining an IP address with appropriate routing information.

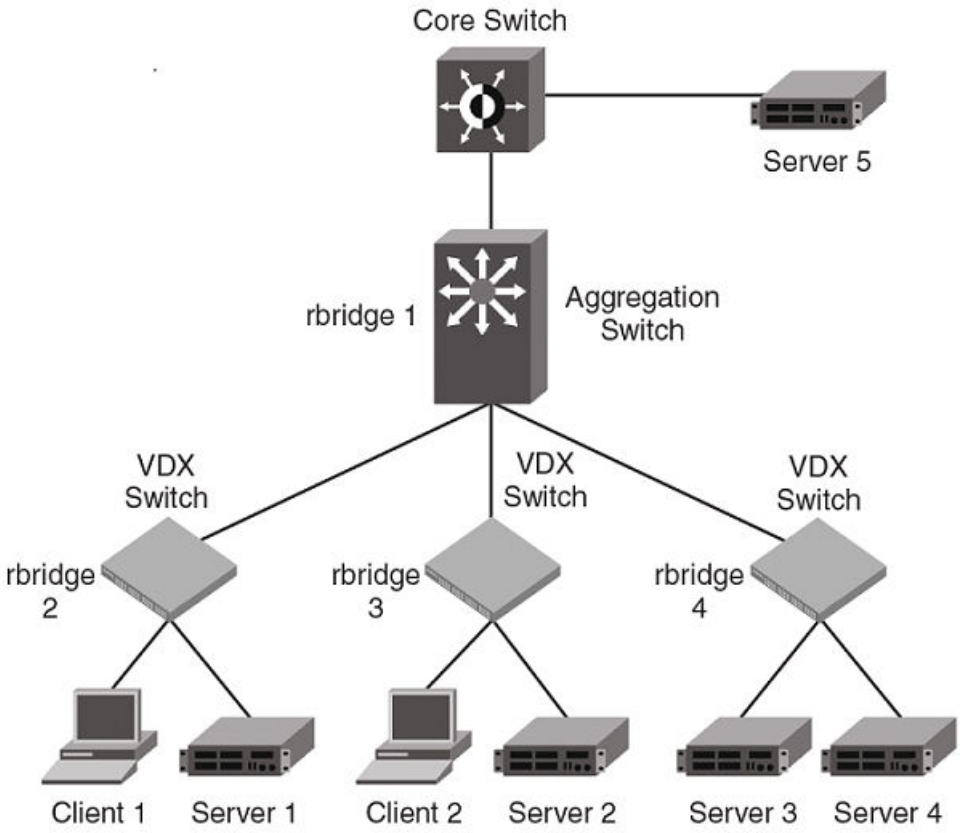
By installing a DHCP relay agent on different subnets in a large network, broadcast DHCP packets can be forwarded from a DHCP client to locate a DHCP server on a remote subnet. The relay agent's IP address is stored in the gateway IP address (GIADDR) field of the DHCP packet, The DHCP server uses the GIADDR field to find the subnet where the relay agent received the broadcast, and then assigns IP addresses to that subnet. The DHCP server replies to the client with a unicast message to the GIADDR address and the relay agent will forward the response to the local network.

Brocade IP DHCP Relay overview

The Brocade IP DHCP Relay feature on allows forwarding of requests and replies between DHCP servers and clients connected to the switch when these servers and clients are not on the same subnet.

You can configure the Brocade IP DHCP Relay feature on any L3 interface to forward requests and replies between DHCP servers and clients connected to the switch when these servers and clients are not on the same subnet. An L3 interface could be the switch front-end Ethernet interface (VE port) or physical interface. The following figure shows an example of a VCS cluster configuration with DHCP servers and clients located on different subnets.

FIGURE 75 VCS cluster with clients and servers



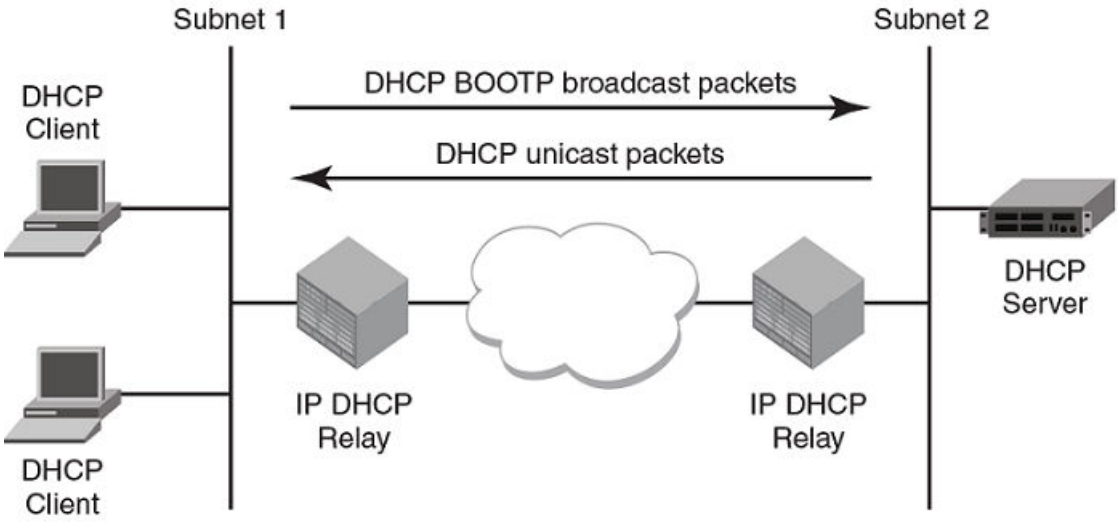
The previous figure illustrates a VCS cluster with clients and servers passing data between different subnets. Note the following examples of configurations supported and not supported by the IP DHCP Relay feature.

Supported configuration examples:

- Local DHCP server. DHCP Client 1 and Server 1 are on the same rbridge, but on different subnets. This configuration supports the IP DHCP Relay feature.
- Remote DHCP server. Client 1 and Server 2 are on different rbridges, but on different subnets. This configuration supports the IP DHCP Relay feature.
- DHCP server across a WAN. Client 1 and Server 5 are on different subnets across the WAN.
- DHCP server is in a different Virtual Routing and Forwarding instance (VRF). Client 1 and Server 2 are in different VRFs.

The only unsupported configuration is a Network DHCP server. Client 1 is on a different subnet than Server 3 and Server 4, which are on the same subnet.

The Brocade DHCP Relay agent forwards DHCP BOOTP broadcast packets from the DHCP clients to the appropriate server and processes broadcast or unicast packets from the server to forward to the DHCP client. BOOTP is a network protocol used to obtain an IP address from a DHCP server. Refer to the following figure.



Supported platforms

The IP DHCP Relay feature is supported on specific Brocade VDX platforms.

The IP DHCP Relay feature is supported on the following Brocade platforms:

- VDX 6710, VDX 6720, and VDX 6730
- VDX 6740, VDX 6740T, and VDX 6740T-1G
- VDX 8770-4 and VDX 8770-8

Configuring IP DHCP Relay

Configure the IP DHCP Relay agent on any Layer 3 (L3) interface using the IP address of the DHCP server where client requests are to be forwarded. L3 interfaces can be a virtual Ethernet (Ve) or a physical 1, 10, or 40 Gigabit Ethernet interface.

Configure the IP DHCP Relay agent using the **ip dhcp relay address** command followed by the IP address of the DHCP server. Use the **use-vrf** *vrf-name* parameter if the DHCP Server and client interface are on different Virtual Forwarding and Routing (VRF) instances.

The following are considerations and limitations when configuring the IP DHCP Relay agent:

- You can configure the feature in standalone mode (applicable switches only) or VCS mode.
- You can configure up to four DHCP server IP addresses per interface. When multiple addresses are configured, the relay agent relays the packets to all server addresses.
- The DHCP server and clients it communicates with can be attached to different Virtual Forwarding and Routing (VRF) instances. When clients and the DHCP server are on different VRFs, use the **use-vrf** *vrf-name* option with the **ip dhcp relay address** command, where *vrf-name* is the VRF where the DHCP server is located. For more information on VRF support for the IP DHCP Relay, refer to VRF support on page 673.

Perform the following steps to configure an IP DHCP Relay:

1. In privileged EXEC mode, issue the **configure terminal** command to enter the global configuration mode.

2. Enter the **interface** command followed by the interface ID to enter the interface configuration mode for the Ve or physical interface where you want to configure the IP DHCP Relay.
3. Enter the **ip dhcp relay address** *ip-addr* **use-vrf** *vrf-name* command where *ip-addr* is the IP address of the DHCP server. Use the **use-vrf** *vrf-name* option if the DHCP server is on a different VRF instance than the interface where the client is connected.
4. To remove the IP DHCP Relay address enter the **no ip dhcp relay address** *ip-addr* **use-vrf** *vrf-name* command.

Example: Standalone mode

The following is an example of configuring an IP DHCP Relay address on a 10 GbE interface.

```
switch# configure terminal
Entering configuration mode terminal

switch(config)# int Te 3/1
switch(config-if-te-3/1)# ip dhcp relay address 100.1.1.2
```

The following is an example of configuring an IP DHCP Relay address on virtual Ethernet interface 100.

```
switch# configure terminal
Entering configuration mode terminal

switch(config)# int Ve 100
switch(config-Ve-100)# ip dhcp relay address 100.1.1.2
```

To remove the IP DHCP Relay address use the **no** option in the **ip dhcp relay address** *ip-addr* command as in the following example:

```
switch(config-if)# no ip dhcp relay address 100.1.1.2
```

Example: VCS mode

The following is an example of configuring two IP DHCP Relay addresses on a physical 1 GbE interface in slot 2, port 4 on RBridge ID 2.

NOTE
In this example, the local DHCP server IP address is 3.1.1.2.

```
switch# config
Entering configuration mode terminal

switch(config)# rbridge-id 1
switch(config-rbridge-id-1)# int Ve 101
switch(config-Ve-101)# ip dhcp relay address 100.1.1.2
switch(config-Ve-101)# ip dhcp relay address 12.3.4.6
switch(config-Ve-101)# ip dhcp relay address 3.1.1.2
```

The following is an example of configuring two IP DHCP Relay addresses on virtual Ethernet interface 102.

NOTE
In this example, the IP address 3.1.1.255 is the local subnet broadcast address. The relay agent relays the DHCP packets to the directed broadcast address and all addresses for DHCP servers configured on the interface.

```
switch# config
Entering configuration mode terminal

switch(config)# rbridge-id 2
switch(config-rbridge-id-2)# int Ve 102
switch(config-Ve-102))# ip dhcp relay address 200.1.1.2
switch(config-Ve-102)# ip dhcp relay address 3.1.1.255
```

To remove an IP DHCP Relay address use the **no** option in the **ip dhcp relay address** *ip-addr* command as in the following example:

```
switch(config-if)# no ip dhcp relay address 200.1.1.2
```

Example: DHCP server and client interface on different VRFs

If the DHCP server is on a different Virtual Routing and Forwarding instance (VRF) than the interface where the client is connected, use the **use-vrf** *vrf-name* option in the **ip dhcp relay address** *ip-addr* command.

NOTE
If the **use-vrf** *vrf-name* option is not used, it is assumed that the DHCP server and client interface are on the same VRF.

```
switch# config
Entering configuration mode terminal

switch(config)# rbridge-id 2
switch(config-rbridge-id-2)# int Ve 103
switch(config-Ve-103)# ip dhcp relay address 3.1.2.255 use-vrf blue
```

To remove an IP DHCP Relay address use the **no** option in the **ip dhcp relay address** *ip-addr* **use-vrf** *vrf-name* command as in the following example:

```
switch(config-ve-103)# no ip dhcp relay address 3.1.2.255 use-vrf blue
```

Displaying IP DHCP Relay addresses for an interface

You can display IP DHCP Relay addresses configured on a specific interfaces of a local switch, specific RBridge, or all RBridge IDs in a logical chassis cluster.

To display the IP DHCP Relay addresses configured for a switch interface, use the **show ip dhcp relay address interface** command followed by the interface ID to display IP DHCP Relay addresses configured on a specific interface.

1. Access a switch where an IP DHCP Relay has been configured on an interface.
2. In privileged EXEC mode, issue the **show ip dhcp relay address interface** command followed by the interface ID.

Example: Displaying addresses for local switch interfaces

The following is an example for a 10GbE interface of a local switch.

```
sw0# show ip dhcp relay address interface te 1/0/24

              RBridge Id:    1
              ----------------
Interface     Relay Address       VRF Name
---------     -------------       --------
Te 1/0/24     10.3.4.5            Blue
Te 1/0/24     10.5.1.1            Blue
```

Example: Displaying addresses for a specific interface

The following is an example for a Virtual Ethernet interface on a specific switch (RBridge ID 1).

```
sw0# show ip dhcp rel add int ve 300 rbridge-id 1

              RBridge Id:    1
              ----------------
Interface     Relay Address       VRF Name
---------     -------------       --------
Ve 300        10.0.1.2            default-vrf
```

Example: Displaying addresses for specific interfaces on range of switches

The following is an example for displaying addresses on for a specific Virtual Ethernet interface on a range of switches (specified by RBridge IDs) in a logical chassis cluster.

> **NOTE**
> You can specify a list of RBridge IDs separated by commas, or a range separated by a dash (for example, 1-2). No spaces are allowed in the range string. The range does not need to be contiguous (for example, 1-2,5). You can also specify "all" for all RBridge IDs in the logical chassis cluster.

```
sw0# show ip dhcp rel add int ve
300 rbridge-id 1,3

             RBridge Id:    1
             ----------------

Interface    Relay Address       VRF Name
---------    -------------       --------
Ve 300       10.0.1.2            default-vrf
Ve 300       10.0.0.5            default-vrf

             RBridge Id: 3
             -------------
Interface    Relay Address       VRF Name
---------    -------------       --------
Ve 300       20.0.1.2            blue
Ve 300       30.1.1.5            green
Ve 300       40.2.1.1            default-vrf
```

Displaying IP DHCP Relay addresses on specific switches

Use the **show ip dhcp relay address rbridge_id** command to display all IP DHCP Relay addresses configured on specific switches (specified by RBridge IDs) in a logical chassis cluster. You can use the **all** parameter to display configured addresses on all RBridge IDs in a cluster.

1. Access a switch where an IP DHCP Relay has been configured.
2. In privileged EXEC mode, issue the **show ip dhcp relay address rbridge-id** *rbridge-id* command.

Example: Displaying addresses on local RBridge

The following is an example of displaying addresses configured on interfaces of a local switch. Notice that the RBridge ID is not needed in the command.

```
switch# show ip dhcp relay address

              RBridge Id:  2
              ----------------
Interface     Relay Address       VRF Name
---------     -----------         --------
Te 2/2/1      10.1.1.1            Blue
Te 2/4/2      20.1.1.1            Blue
Te 2/5/4      30.1.1.1            Default-vrf
Te 2/6/6      40.1.1.1            Green
```

NOTE

You can specify a list of RBridge IDs separated by commas, or a range separated by a dash (for example, 1-2). No spaces are allowed in the range string. The range does not need to be contiguous (for example, 1-2,5). You can also specify “all” for all RBridge IDs in the logical chassis cluster.

Example: Displaying addresses on specific RBridge

The following is an example of displaying addresses configured on interfaces on a specific RBridge.

```
switch# show ip dhcp relay address rbridge-id 2

              RBridge Id: 2
              ----------------
Interface     Relay Address     VRF Name
-------------  -------------    ---------
Te 1/0/24     2.3.4.5           default-vrf
Ve 300        10.0.1.2          default-vrf
```

Example: Displaying addresses on all RBridges in cluster

The following is an example of displaying addresses configured on interfaces on all RBridge IDs in a logical chassis cluster.

```
switch# show ip dhcp relay address rbridge-id all

               RBridge Id: 2
               -------------
Interface      Relay Address     VRF Name
----------     -------------     ---------
Te 1/0/24      2.3.4.5           default-vrf
Ve 300         10.0.1.2          default-vrf

               RBridge Id: 3
               -------------
Interface      Relay Address     VRF Name
----------     -------------     ---------
Ve 300         10.0.0.5          default-vrf
```

Displaying IP DHCP Relay statistics

Display information about the DHCP Relay function, such as the DHCP Server IP address configured on the switch and the number of various DHCP packets received by the interface configured for IP DHCP Relay.

Use the **show ip dhcp relay statistics** command to display the following information about the IP DHCP Relay function:

- DHCP Server IP Address configured in the switch.
- Number of DHCP DISCOVERY, OFFER, REQUEST, ACK, NAK, DECLINE, INFORM, and RELEASE packets received.
- Number of DHCP client packets received (on port 67) and relayed by the Relay Agent.
- Number of DHCP server packets received (on port 68) and relayed by the Relay Agent.

NOTE

You can specify a list of RBridge IDs separated by commas, or a range separated by a dash (for example, 1-2). No spaces are allowed in the range string. The range does not need to be contiguous (for example, 1-2,5). You can also specify “all” for all RBridge IDs in the logical chassis cluster.

1. Access a switch where an IP DHCP Relay has been configured on an interface.
2. In privileged EXEC mode, enter **show ip dhcp relay statistics**. Optionally, you can specify specific RBridge IDs if you only want to view the statistics for those RBridges.

Displaying statistics on a local switch

The following is an example of displaying statistics on a local switch.

```
sw0# show ip dhcp relay statistics

                DHCP Relay Statistics - RBridge Id: 3
                --------------------------------------
Address    Disc.   Offer  Req.   Ack   Nak   Decline   Release   Inform
-------    -----   -----  ----   ---   ---   -------   -------   ------
10.1.0.1     400     100  2972  2968     0         0         0        0
20.2.0.1     400     100  2979  2975     0         0         0        0
30.3.0.1     400     100  3003  2998     0         0         0        0
40.4.0.1     400     100  3026  3018     0         0         0        0

Client Packets: 12780
Server Packets: 12359
```

Displaying statistics for specific switches

The following is an example of displaying statistics for a cluster with RBridge 1 and RBridge 3.

```
sw0# show ip dhcp relay statistics rbridge-id 1,3

               DHCP Relay Statistics - RBridge Id: 1
               -------------------------------------
Address   Disc.   Offer  Req.   Ack   Nak   Decline   Release   Inform
-------   -----   -----  ----   ---   ---   -------   -------   ------
2.3.4.5     300     100  1211  1201     0         0         0        0
10.0.1.2    300     100  1211  1207     0         0         0        0

Client Packets: 2701
Server Packets: 2932

               DHCP Relay Statistics - RBridge Id: 3
               -------------------------------------
Address   Disc.   Offer  Req.   Ack   Nak   Decline   Release   Inform
-------   -----   -----  ----   ---   ---   -------   -------   ------
10.0.0.5      0       0     0     0     0         0         0        0
10.0.1.2      0       0     0     0     0         0         0        0

Client Packets: 0
Server Packets: 0
```

Clearing IP DHCP Relay statistics

Use the **clear ip dhcp relay statistics** command to clear all IP DHCP Relay statistics for specific relay IP addresses, for addresses on specific RBridge IDs, or all addresses for RBridge IDs in a logical chassis cluster.

For command parameters you can specify the IP DHCP Relay address and RBridge IDs. You can specify a list of RBridge IDs separated by commas, or a range separated by a dash (for example, 1-2). No spaces are allowed in the range string. The range does not need to be contiguous (for example, 1-2,5). You can also specify “all” for all RBridge IDs in the logical chassis cluster.

1. Access a switch where an IP DHCP Relay has been configured on an interface.
2. In privileged EXEC mode, issue the **clear ip dhcp relay statistics ip-address** *ip-address* **rbridge-id** *rbridge-id*.

The following command clears statistics for IP DHCP Relay address 10.1.0.1 configured on RBridges 1, 3, and 5.

```
clear ip dhcp relay statistics ip-address 10.1.0.1 rbridge-id 1,3,5
```

The following command clears statistics for all IP DHCP Relay addresses on RBridges 1, 3, and 5.

```
clear ip dhcp relay statistics rbridge-id 1,3,5
```

VRF support

VRF (Virtual Routing and Forwarding) is a technology that controls information flow within a network by partitioning the network into different logical VRF domains to isolate traffic. This allows a single router or switch to have multiple containers of routing tables or Forwarding Information Bases (FIBs), with one routing table for each VRF instance. This permits a VRF-capable router to function as a group of multiple virtual routers on the same physical router.

Inter-VRF route leaking allows leaking of specific route prefixes from one VRF instance to another on the same physical router, which eliminates the need for external routing. In a DHCP setting, route leaking is controlled through a single DHCP server (which may be on a different VRF). This permits multiple VRFs to communicate with that server.

The IP DHCP Relay is supported in configurations where the DHCP server is on the same or different VRFs than the interface through which the client is connected. When the DHCP server and client are on different VRFs, this is called inter-VRF deployment. For inter-VRF deployment, use the use-vrf *vrf-name* option with the **ip dhcp relay address** command, where *vrf-name* is the VRF where the DHCP server is located.

For more information on VRFs, refer to Virtual Routing and Forwarding configuration on page 627.

Supported VRF configuration examples

Following are examples of VRF configurations that are supported for IP DHCP Relay:

- Client interface and DHCP server are on same VRF. As an example:
  - Ve interface 100 in red VRF
  - IP address of interface - 3.1.1.1/24
  - IP DHCP Relay address (20.1.1.2) in red VRF
- Client interface and DHCP servers are on different VRFs. As an example:
  - Ve interface 100 in default VRF
  - IP address of interface - 3.1.1.1/24
  - IP DHCP Relay address (100.1.1.2) in blue VRF
  - IP DHCP Relay address (1.2.3.4.6) in red VRF

  A maximum of 128 of these inter-VRF IP DHCP Relay address configurations is allowed per node. A VRF route leak configuration is required for these configurations. In the preceding example, a VRF route leak configuration is required on the default VRF as follows:
  - ip route 100.1.1.2/32 next-hop-vrf blue 100.1.1.2
  - ip route 12.3.4.6/32 next-hop-vrf red 14.3.4.6

VRF configuration examples not recommended

The following examples of VRF configurations are not recommended for IP DHCP Relay.

- The same IP DHCP Relay address configured on different VRFs. As an example:
  - Ve interface 100 in default VRF
  - IP address of interface - 3.1.1.1/24
  - IP DHCP Relay address (30.1.1.2) in blue VRF
  - IP DHCP Relay address (30.1.1.2) in red VRF
- The same IP DHCP Relay address configured on two interfaces with the same address, and both interfaces are on different VRFs. As an example:
  - **Ve interface 100 in default VRF**
  - IP address of interface - 3.1.1.1/24
  - IP DHCP Relay address (20.1.1.2) in blue VRF
  - **Ve interface 200 in blue VRF**
  - IP address of interface - 3.1.1.1/24
  - IP DHCP Relay address (20.1.1.2) in blue VRF

High availability support

IP DHCP Relay address configurations are maintained when control is switched from the active to the standby management module (MM) in the VDX 8770-4 and VDX 8770-8 chassis.

Two management modules (MMs) provide redundancy on the Brocade VDX 8770-4 and VDX 8770-8 chassis. These modules host the distributed Network OS that provides overall management for the chassis. If the active module becomes unavailable, the standby module automatically takes over management of the system and becomes the active MM. For more information, refer to Configuring high availability on page 88.

IP DHCP Relay address configurations are maintained on the new active MM and the MM will continue to relay DHCP packets between DHCP clients and servers. IP DHCP Relay statistics will not be maintained, however.

Section V: Network OS Troubleshooting

Using the Chassis ID (CID) Recovery Tool

CID overview

Each Brocade VDX 8770-4 and VDX 8770-8 contains two chassis ID cards (CIDs) called *CD1* and *CD2*. Most data on each card is identical, and CID2 is used only as a backup if CID1 encounters an issue.

The data contained on the CID card is essential for correct operation of the switch and is accessed most frequently during system startup.

Each CID contains two serial electronically erasable programmable read-only memory (SEEPROM) devices:

- Critical SEEPROM. This SEEPROM is read-only.
- Noncritical SEEPROM. This SEEPROM can be written to by the software.

Critical SEEPROM data

The critical SEEPROM contains the following:

- A header with the CID part number, serial number, and other data about the CID card. If this data is corrupted or cannot be accessed, the card is identified as faulty in RASLogs:
  - [EM-1003], M1 | FFDC, CRITICAL, ..., CID 2 has unknown hardware identifier: FRU faulted.
  - [FW-1432], M1, WARNING, sw0, Switch status change contributing factor CID-Card: 1 bad.
- A chassis part number and serial number. Cluster configuration management uses the serial number to uniquely identify the chassis in the fabric.
- An eight-byte number that represents both the license ID and World Wide Name (WWN) base value for the chassis. The license ID is used to validate installed licenses. Licenses are invalid if the license ID is not available. The WWN is used to identify the switch in a fabric.

Noncritical SEEPROM data

The noncritical SEEPROM contains the following data sets.

- The FRU history table, which contains logs of insertions and removals of FRUs into and from the chassis. The content of this table is not audited or verified.
- The IP data table, which contains management module and chassis management IP addresses/masks, the IP default gateway, and the chassis name.
- A power-off list, which controls the order in which blades are automatically powered off if an impending power loss is detected.

- A set of Data Center Ethernet (DCE) data containing chassis MAC addresses, without which the switch will not function.

Automatic auditing and verification of CID card data

The contents of both CID cards are verified on a periodic basis and whenever an event indicates that an issue may exist.

Under normal circumstances, the CID card audit is run for about one hour after a system startup or restart, then is repeated every 24 hours. If no errors occur, no action is taken.

If CID card errors occur, if mismatches between data sets on the two CID cards are detected, or if a card is inserted, RASLogs are shown on the console:

- [EM-1020], ... M1, ERROR, ... A problem was found on one or both CID cards (x), please run the *cidrecov* tool to get more information and recovery options.
- [EM-1021], ... M1, INFO, ... A CID card has been inserted, a CID verification audit will be run to detect any mismatches or other problems.
- [EM-1022], ... M1, WARNING, ... A CID card access problem has been encountered, please run the cidrecov tool to get more information and recovery options.

Enabling the CID recovery tool

You should run the CID recovery tool when instructed by a RASLog, and you can also run the tool if you suspect an issue with one or both of the CID cards. To run the CID recovery tool, enter the **cidrecov** command in privileged EXEC mode on the command line:

```
sw0# cidrecov
```

Managing data corruption or mismatches

If **cidrecov** detects any CID 1 or CID 2 non-critical SEEPROM corruption or mismatches, the tool displays related data and the following data-recovery options as applicable for each data-set error:

- **Exit**. Select this option if you do not want to change any data values.
- **Recover with default values**. Select this option if you want to reset all data in the data set to the factory defaults. For IP data, dummy IP addresses and masks are written. DCE and chassis-configuration data are based on the chassis type.

A system restart repopulates IP addresses and chassis names that appear in the startup configuration file. If you want to manually change the IP data, you can use the **ip-address**, **chassis virtual-ip**, and **chassis-name** commands. For more information, refer to the *Network OS Command Reference*.

- **Recover BAD from GOOD**. This option is offered only if one CID card contains good data and the other card contains corrupt data. If you select this option, **cidrecov** copies the good data onto the affected card.
- **Recover CID 2 from CID 1** and **Recover CID 1 from CID 2**. These options are offered only if the data on both CID cards is good but there is a mismatch. You can select which card to use to overwrite data on the other card.

The following is an example of running the **cidrecov** tool, receiving errors that can be fixed, and selecting the **Recover BAD from GOOD** option (note that the example below contains only some of the actual output):

```
sw0# cidrecov
CID 1 Non-Critical Seeprom is Inaccessible or Corrupted.
  CID Non-Critical Seeprom Problem Details
CID 1 Non-Critical Seeprom IP address Control Data Checksum Bad !!!!
    CID Recovery Options
```

```
0. Exit
1. Recover with default values
2. Recover BAD from GOOD
Enter Selection > 2
Copy IP Data table...
  Copy 384 bytes from CID 2 to CID 1, num blks 1 resid 128
  Read block 1 from CID 2 succeeded
  Write block 1 to CID 1 succeeded
  Read last block from CID 2 succeeded
  Write last block to CID 1 succeeded
  copy successful
Copy succeeded for all data types attempted
IP Address CID Recovery completed.
```

Understanding CID card failure

If the critical SEEPROM of a CID card contains any errors, or if the noncritical SEEPROM cannot be read, then recovery is not possible and the following message is displayed:

```
Recovery is not possible. Please contact Brocade Technical Support for replacement of the inaccessible
CID(s).
```

Troubleshooting procedures

Troubleshooting overview

This chapter provides tips and procedures for troubleshooting issues that may occur while operating a Brocade switch running Network OS. It also introduces some of the common troubleshooting tools.

Gathering troubleshooting information

The first step in any successful troubleshooting is to gather the appropriate information (including *supportSave* data). For details refer to Using a troubleshooting methodology on page 684 and Capturing supportSave data on page 683.

Capturing supportSave data

Capturing *supportSave* data is key to successful troubleshooting. The **copy support** command not only runs diagnostic commands, but also gathers core dumps, trace files, and other relevant data. In the same action, the command also copies all this information to a remote host. Once on the remote host, your switch provider can proceed to analyze the problem. Meanwhile, your switch can be returned to production with minimal downtime.

To capture supportSave data, complete the following steps:

1. Log in to the switch.
2. In privileged EXEC mode, enter the **copy support** command to capture the supportSave data.

   The **copy support** command has options to copy the supportSave files to a remote server using FTP or SCP, or you can save to a local USB device. You can use the command in a single command line, or in interactive mode.

   The following example uses the single command line mode to copy the supportSave files to a remote host using FTP.

   ```
   switch# copy support ftp host 10.38.33.131 user admin directory 108
   Password: *****
   ```

   The following example uses the interactive form of the command and FTP:

   ```
   switch# copy support-interactive
   Server Name or IP Address: 10.38.33.131
   Protocol (ftp, scp): ftp
   User: admin
   Password: *****
   Directory:/home/admin/support
   VCS support [y/n]? (y): y
   ```

Using information resources

The following information is helpful for incident investigation and resolution when you contact your switch-support provider:

- A network diagram and topology information
- A record of the steps and events leading to the incident

- Lists of applications, management agents, and scripts running at the time of the incident
- supportSave files
- Output from the **show media** command if the issue is related to SFP transceivers
- Outputs from any commands run while attempting to troubleshoot the problem yourself
- Any network traces captured using Wireshark software or other network analyzer.
- Terminal Access Controller Access-Control System (TACACS) server version if the issue is related to TACACS.

Using a troubleshooting methodology

Once all relevant information is collected, success is improved significantly with a sound troubleshooting approach.

This section outlines a methodology for troubleshooting issues. It introduces steps that you might consider using, depending on the issue in question.

1. Check whether the switch has all the required licenses:
   - License requirements include the POD license, VCS Fabric license, and FCoE license.
   - License types include POD1, POD2, VCS Fabric (multi-node license for more than two nodes), and FCoE.
   - No VCS Fabric license is needed for a one-node or two-node VCS Fabric cluster.
   - The FCoE license needs VCS Fabric mode enabled to be installed.
   - After adding or modifying an FCoE or POD license, always reboot the switch to activate the license.
2. Verify the topology and switch configuration as conveyed by the switch
3. Enter the **copy support** command.
4. Run other relevant show commands (for example, **show logging raslog**) to look for clues or triggers of the reported failure.
5. Check the utilization of various resources.
   a) Enter the **show process cpu** command to determine CPU use.
   b) Enter the **show process me** command to determine memory use.
   c) Enter the **show mac-address-table count** command to determine the number of MAC addresses used.
   d) Enter the **show fabric route topology** command to determine the number of routes.
   e) Enter the **show fabric all** command to determine the number of VCS Fabric nodes.
   f) Enter the **show media** command to investigate any optics issues.

6. Conduct data-path fabric continuity tests:
   a) Issue pings from and to the end-stations or devices.
   b) Check the counters in the output of the **show interface** command to detect if packets are coming in or are being dropped as errors.
   c) Verify that optics used are Brocade-certified. Enter the **show media interface** command and verify that the Vendor name field shows "Brocade." Check also that the Tx and Rx Power fields are not zero.
   d) Verify that the MAC address table learns the MAC addresses.
   e) If the switch is part of a VCS Fabric cluster, verify that the MAC address tables are synchronized properly across all Brocade VDX switches in the cluster.
   f) Check whether LLDP reports neighbors.
   g) Check the Ethernet Name Server (ENS) functionality by ensuring that the MAC address table reports MAC addresses learned from other VCS Fabric switches.
   h) Use the **l2traceroute** command for validating the data-path fabric continuity. This command helps identify where the packets are being dropped within the fabric.

      The command prompts for some basic and allows you to choose to enter some extended parameters. Currently supported basic parameters include:

      - Source Address (SA) and Destination Address (DA) of dynamically learned MAC addresses
      - VLAN
      - Edge routing bridge (RBridge) ID

      Currently supported extended parameters include:

      - Protocol type (IP)
      - Source and destination IP addresses
      - IP protocol type (recommend TCP)
      - Source and destination port numbers

      The purpose of IP parameters is to provide a way to make the traceroute packet traverse a specific ECMP link.

      CAUTION
      The following step affects configuration and should be used with care.

7. To track certain flows within the fabric, use permit ACLs and monitor the hit increments.

Understanding troubleshooting hotspots

This section provides relevant background information and best practices guidance related to features of Network OS where problems have been reported. With this guidance, you should be able to avoid many potential problems.

Licensing

When a licensed feature does not work, one likely cause is that the license has not been installed correctly. Follow the guidelines and procedures in the *Network OS Software Licensing Guide* to ensure your features are licensed properly and those licenses installed correctly.

For license recovery procedures, refer to the *Network OS Software Licensing Guide*.

STP interoperability with Brocade MLX or other switches

- To use the Spanning Tree Protocol (STP) in a network with Brocade MLX switches, or switches from other vendors such as Juniper or Cisco, you may have to configure the interface to send BPDUs to the shared spanning tree MAC address 0100.0ccc.cccd. Without this setting, the RPVST/PVST root bridge is not recognized on VLANs other than VLAN 1.

  To interoperate with MLX switches or other vendors' switches, enter the following command in interface configuration mode:

  ```
  switch(conf-if-te-0/1)# spanning-tree bpdu-mac 0100.0ccc.cccd
  ```

- If a Brocade IP switch has a VLAN is configured with tagged ports and Rapid Spanning Protocol (RSTP) is enabled under the VLAN (PVST), then BPDUs from the tagged ports received by the Brocade VDX switch will be dropped if pvst-mode is not configured under the ports that are in the VLAN and connected to the Brocade VDX switches.

  The following example shows a configuration on a Brocade IP switch with tagged ports and RSTP enabled under the VLAN:

  ```
  vlan 2
  tagged ethe 1/24 ethe 2/1 to 2/2
  router-interface ve 2
  rstp priority 100
  ```

  If the conditions are met, then all the ports should have pvst-mode configured so that tagged BPDUs pass through the Brocade VDX switch. If pvst-mode is not enabled, enable it as follows:

  ```
  Brocade(config)# interface ethernet 2/1
  Brocade(config-if-2/1)# pvst-mode
  ```

Load balancing distribution

Understanding issues related to load balancing requires some basic knowledge of the criteria used by load balancing algorithms. The table below provides details for each feature that provides load balancing.

TABLE 98 Load balancing algorithms

Feature	Algorithm
ECMP IP	Paths are selected on the basis of a hash derived from the following parameters: • Source MAC address • Destination MAC address • VID • IP protocol • Source IP address • Destination IP address • Layer 4 source port • Layer 4 destination port You can configure the hashing fields using the **fabric-ecm load-balance** and **fabric-ecmp load-balance-hash-swap** commands. For related recovery procedures, refer to ECMP not load balancing as expected on page 698.
ECMP FCoE	Paths are selected on the basis of a hash derived from the following parameters: • Input Port ID • Source MAC address • Destination MAC address • VID • FID • SID

TABLE 98 Load balancing algorithms (continued)

Feature	Algorithm
	• DID • OXID
LACP	Provides adaptive load balancing based on up to seven criteria (7-tuple), depending upon what fields are available in the frame.
Brocade trunk	Provides equal packet load balancing (round-robin) among member links.

Static assignment of the routing bridge ID

Duplicate routing bridge (RBridge) IDs are a common source of error when a switch is added to an Ethernet fabric. Before adding a switch to an Ethernet fabric, you must assign it a unique RBridge ID. If the new switch is to be added to an existing VCS Fabric cluster, it must be assigned the same VCS ID as other switches in the cluster. Once the switch is added, the principal routing bridge performs the negotiation in the control plane to include the new switch and rebuild the fabric. The data plane remains unaffected.

Procedures for recovering from duplicate routing IDs are provided in RBridge ID is duplicated on page 725.

FSPF route change

When the Fabric Shortest Path First (FSPF) algorithms select a new route, a temporary disruption of traffic can occur. This behavior is normal as the old path is first deleted and then the new path is programmed. Such path changes can occur when FSPF calculates a new shortest route, or when the current path is down.

VCS Fabric mode and standalone mode

Some key differences exist between standalone mode and VCS Fabric mode that you should be aware of when troubleshooting your system:

- Interfaces are disabled by default in standalone mode but enabled by default in VCS Fabric mode. Thus, when you apply the default configuration, you should take this into account.
- The interface can be configured as a Layer 2 switch port in standalone and VCS Fabric modes.
- Switching between VCS Fabric mode and standalone mode and then reverting back to the original mode results in losing the configuration and booting up using the default configuration.
- A port-profile port is allowed only for Layer 2 ports.
- The out-of-band management through the management port allows default gateways to be configured.

vLAG overview

You should be aware of the following aspects of the vLAG feature before troubleshooting vLAG problems:

- Multicast (BUM) traffic in vLAG
- Edge-port feature requirements
- Failover

Multicast traffic in vLAG

Flooding traffic always goes through a primary link of the vLAG. You should consider this restriction when provisioning bandwidth for most traffic. This link is marked with an asterisk (*) in the output of the **show port-channel** command.

```
switch# show port-channel 38
LACP Aggregator: Po 38
Aggregator type: Standard
Admin Key: 0038 - Oper Key 0038
Partner System ID - 0x8000,01-e0-52-00-20-00
Partner Oper Key 0038
Member ports:
Link: Te 0/13 (0x180D0102) sync: 1
Link: Te 0/14 (0x180E0103) sync: 1 *
```

Edge-port feature requirements for vLAG

LACP can be configured on edge ports only with either Brocade or Standard types. If Brocade is chosen, so that Link Reset (LR) primitives are exchanged properly, make sure that the edge peering device is a Brocade Converged Network Adapter (CNA), a standalone Brocade VDX switch, or a Brocade VDX 8000 series switch.

Failover and vLAG

For the fast failover convergence requirements, Brocade recommends using the **vlag ignore-split** command, which enables sub-second failover times. This command is added automatically to all port-channel configurations when a Brocade VDX switch is upgraded to Network OS v2.1.x and later or when a new port-channel is added while running under Network OS v2.1.x or later.

When planning to deploy this feature in production, use care to prevent a "split-brain" scenario, in which vLAG members detach from each other. Brocade recommends having more than one interswitch link (ISL) between the vLAG member switches and physically routing them through separate conduits and cable trays. Secondly, Brocade strongly recommends using topologies that are certified by Brocade.

> NOTE
> Brocade does not recommend using vLAG failover in a network with Cisco or Juniper switches that are connected using copper. Brocade has observed greater than one-second failover times in networks with this hardware.

vLAG and split-brain

The following topics discuss the split-brain scenario and how to mitigate it.

Understanding "split-brain"

A split-brain can occur when the end-hosts or edge switches are connected to two separate cluster switches by way of a vLAG (using LACP). The end-devices perceive those two cluster switches as one switch because they have the same system ID advertised in LACP.

Under rare conditions, when all the ISLs between the two cluster switches are broken and both the cluster switches continue to advertise the same system ID to their LACP partner, a "segmented fabric" or "split-brain" condition exists, where the end-host or edge switch might not detect this segmentation and could continue to treat both the vLAG switches as one switch.

> ATTENTION
> This condition can cause packet duplication or unexpected packet loss.

Traffic protection during split-brain conditions

By default, Network OS has a capability to recover gracefully from the split-brain scenario. When all the ISLs between the VDX cluster switches go down, the switch with the lower RBridge ID uses LACP to inform the edge-switch partner that it has segmented out of the port-channel. It does this by changing its advertised system ID. When the edge switch learns a different system ID on one of its members, it removes this member from that port-channel, and continues to function with only one vLAG member — the switch with the higher RBridge ID. The other vLAG member switch still has the link up, but remains segmented out of the original port-channel (sync: 0). This capability prevents duplication of packets or potential packet drops resulting from a split-brain scenario.

When a member switch is reloaded

Reloading the switch with the lower RBridge ID has no impact.

When the switch with the higher RBridge ID is reloaded, the other vLAG member perceives all of its ISLs as down. Though this is *not* a real split-brain scenario, the switch with the lower RBridge ID may not be able to differentiate, and thus would inform the partner about a changed system ID. The partner edge switch would detect two events:

- The system ID on one link changes.
- The other interface goes down.

In such a case, LACP will renegotiate and reform the port-channel, which could flap the port-channel, impacting traffic momentarily. The same effect could occur when the switch boots up and joins the fabric again.

Thus, if the switch with the higher RBridge ID is reloaded, the potential impact could be a port-channel flap that can momentarily disrupt traffic. Notice that this effect does not occur when the switch with the lower RBridge ID is reloaded.

Avoiding traffic disruption during switch reload

Network OS switches offer flexibility to the user by providing a special vLAG **ignore-split** option that you can configure for the logical port-channel. This option should be configured on both vLAG member ports.

Configuring this option prevents the switch with the lower RBridge ID from changing its system ID, so both switches will continue to advertise the same system ID. This action prevents the partner edge switch from detecting a change when one of the member switches is reloaded and the traffic is handled gracefully.

Using the vLAG ignore-split option

To use the vLAG **ignore-split** option, redundancy should be built around ISLs to prevent a situation in which all ISLs are broken at the same time. Brocade recommends using multiple ISLs, and routing those ISLs through different physical paths or conduits to eliminate the possibility of accidental damage to all links at the same time.

Principal routing bridge availability

If a new principal routing bridge is introduced into a working VCS Fabric cluster, or if the principal routing bridge is lost and a new switch must be elected, the fabric is rebuilt from the control-plane viewpoint, whereas the data plane continues to forward traffic without disruption. The primary responsibilities of the principal routing bridge in a VCS Fabric are:

- RBridge ID allocation
- Ownership of virtual management IP address
- Keeping the configuration database synchronized

Brocade trunks

Brocade trunks is the only aggregation method that works using ISLs.

Brocade ISL trunks are formed automatically with other switches using Line Reset (LR) primitives signaling with the peer switch.

All ISL ports connected to the same neighbor Brocade switch attempt to form a trunk. For a successful trunk formation, all ports on the local switch must be part of the same port group and must be configured at the same speed. The number of ports allowed per trunk group is six. The trunk is turned on by default.

The table below shows the allocation of port numbers to port groups for Brocade VDX switches.

TABLE 99 Port groups

Brocade platform	Port groups	No. of port groups per platform
VDX 6710	te0/1-te0/6	4
	gi0/1-gi0/14	
	gi0/15-gi0/27	
	gi0/28-gi0/48	
VDX 6720-24 (10Gbe)	1-12, 13-24	2
VDX 6720-60 (10Gbe)	1-10, 11-20, 21-30, 31-40, 41-50, 51-60	6
VDX 6730-32 (10Gbe)	1-12, 13-24	2
VDX 6730-76 (10Gbe)	1-10, 11-20, 21-30, 31-40, 41-50, 51-60	6
VDX 6740 (10Gbe)	1-16, 17-32, 33-40, 41-48	4
VDX 8770 (with VDX LC48x1G line card)	1-8, 9-16, 17-24, 25-32, 33-40, 41-48	6 per 1G blade
VDX 8770 (with VDX LC48x10G line card)	1-8, 9-16, 17-24, 25-32, 33-40, 41-48	6 per 10G blade
VDX 8770 (with VDX LC12x40G line card)	1-2, 3-4, 5-6, 7-8, 9-10, 11-12	6 per 40G blade

NOTE
Brocade trunks are not supported over 1-Gbps links.

To utilize the advantages of Brocade trunking between VDX switches, Brocade recommends having at least a two-member trunk and multiple ECMP paths. Brocade also recommends routing the cables in a trunk through separate conduits to ensure connectivity in case a conduit is accidentally cut.

NIC teaming with vLAG

NIC teaming permits link aggregation between server and switch. It can be one of two types: active/passive model or active/active model. For the active/passive model, you may not need to configure a LAG on the switch side, as unique MAC addresses will be seen on only one link.

For the active/active model, the same MAC address may appear on both the links terminating on a switch (or pair of switches). In such a case, you must configure a LAG on the switch side.

Selecting the MTU

Always set the switch MTU to the maximum host MTU plus 100 bytes. This method is recommended because the definition of MTU sometimes varies among different vendors. If the switch MTU is set to the same as the connected host MTU, packets could be dropped.

Avoiding oversubscription

Under certain congestion conditions, you may observe incrementing packet drops representing "tail-drops" in the output of the **show qos rcv-queue interface tengigabitethernet** command, as shown underlined in the following example:

```
switch# show qos rcv-queue interface tengigabitethernet 5/0/1
Interface TenGigabitEthernet TenGigabitEthernet 5/0/1
 In-use 0 bytes, Total buffer 144144 bytes
 0 packets dropped
       In-use    Max
 CoS   Bytes     Bytes
 -------------------------
  0    0        18018
  1    0        18018
  2    0        18018
  3    0        18018
  4    0        18018
  5    0        18018
  6    0        18018
  7    0        18018
```

In such conditions, you must first identify the bottleneck, and then take action to mitigate the congestion.

Identifying the congestion bottleneck

To identify the bottleneck in the Brocade VDX network, enter the **show interface** command at various locations, and identify interfaces with incrementing TX and RX discards. Depending upon the TX or RX discards, the congestion could be anywhere downstream.

Mitigating the congestion

Try the following actions to mitigate congestion:

- Increase bottleneck bandwidth.
  - Add more links to the LAG and ECMP paths.
  - Use higher-speed interfaces.
- Implement flow control on the bottleneck and on neighboring devices.
- Implement QoS congestion management schemes.
  - Classify, mark, and prioritize critical traffic.
  - Modify scheduling schemes. Consider and compare the effects of using strict priority or deficit weighted round-robin (DWRR) scheduling schemes.

For the flow control solution, enable flow control either on the ports receiving the traffic from end-devices (servers or personal computers) and the connected end-device itself, or enable flow control on the port-channel as shown in the following example.

```
switch(conf-if-te-1/0/24)# interface port-channel 100
switch(config-Port-channel-100)# qos flowcontrol tx on rx on
```

Once flow control is enabled, enter the **show qos rcv-queue interface tengigabitethernet** command again and check the output. It should no longer be reporting packet drops. If the packet drops continue or the ingress rate is considerably lower than expected, contact your switch support provider for further investigation.

We recommend enabling asymmetric flow control with Brocade VDX switches. For any two adjacent devices, one device should have Rx ON and Tx OFF, while the other device should have Rx OFF and Tx ON.

Refer to Congestion control and queuing on page 347 for further details about congestion control.

ACL limits issues

If you keep within the supported limits of ACL usage as shown in the table below, you are unlikely to run into system limits issues. ACLs should instantiate quickly and correctly.

TABLE 100 ACL limits per switch in VCS mode

Feature	Limit
Number of standard or extended ACLs created but not applied	512
Number of Layer 3 standard or extended ACLs created but not applied	512
Number of rules per standard or extended ACL	2048
Maximum number of Layer 2 or Layer 3 standard or extended ACL rules	100k
Number of physical interfaces on which an ACL is applied concurrently	48(60 in standalone mode)
Number of VLAN interfaces on which ACL is applied concurrently	100
Number of ACL counters	252
Number of TCAM table entries	1000
Number of ACL rules	6000
Number of applied, co-existing standard and extended ACLs	50

In addition, up 30,720 MAC addresses are supported.

As you approach or exceed combinations of these limits, it is possible you might encounter slow instantiation of ACL rules, process exceptions, or ACL failure due to MAC learning issues.

Delays of several minutes can occur in the instantiation of ACL rules and counters if the number of ACLs or VLANs is excessive. The L2SYS process message queue can become full, or CPU context switching and process scheduling can increase to the point that ACL instantiation proceeds slowly. Periodic monitoring with the **show statistics access-list mac** command will show not more than 252 ACL rules with a nonzero and incrementing frame count for rules that are correctly instantiated and have hardware counters allocated.

Process exceptions can sometimes occur with the L2SYSD process when combinations of ACL limits are approached or exceeded.

Constant MAC learning and flushing can occur when ASIC table limitations are exceeded. Layer 2 frame switching can fail if the number of MAC address table entries is exceeded.

Troubleshooting standard issues

This section describes some potential problems you may encounter and suggestions on how to investigate or resolve each issue. If these steps do not lead to resolution of the problem, prepare a case for your switch provider, as described in Contacting Brocade Technical Support on page 25.

AMPP is not working

Configuring Brocade Automatic Migration of Port Profiles (AMPP) is complex. It works in standalone mode and VCS Fabric mode. For details on configuring AMPP, refer to Configuring AMPP on page 329.

Problems encountered while using AMPP are usually the result of configuration errors in the port-profile itself, errors in the associated virtual machine (VM) configuration, or compatibility problems between the host adapters and AMPP. Specifically, AMPP problems can be caused by the following conditions:

- A port-profile configuration does not exist on the target switch or does not contain a basic switchport and VLAN configuration. Refer to Verifying the port-profile configuration on page 694.
- The VM MAC address does not appear in the MAC address table. Refer to Verifying the VM MAC address on page 694.
- The port-profile is not activated or is not associated with the correct MAC address. Refer to Verifying the port-profile state on page 694.
- The VM kernel MAC addresses are not associated correctly with the port-profile on the respective switches. Refer to Verifying the VM kernel MAC addresses on page 695.
- The VM and its associated hosts do not share a common storage device. Refer to Verifying a shared storage device on page 695.
- The port-profile was learned on a nonprofiled VLAN. Refer to Verifying the status of a learned profiled MAC address on page 695.
- A conflicting port-profile is applied to the same interface. Refer to Verifying that port profiles do not conflict on page 696.
- The Ethernet Name Server is not functioning correctly. Refer to Verifying the Ethernet Name Server on page 696.
- An ESX host has an incompatible network adapter or driver installed. Refer to Verifying an ESX host on page 696.

Verifying the port-profile configuration

A valid port-profile must exist on the target switch. It must contain a basic switchport and VLAN configuration.

1. In the privileged EXEC mode, enter the **show running-config port-profile** command to verify that the port-profile configuration exists on the target switch, and that it contains a basic switchport and VLAN configuration.

```
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
 !
!
port-profile pp1
 vlan-profile
 !
!
port-profile pp2
 vlan-profile
 !
!
```

2. If the port-profile configuration does not exist or is missing the required switchport or VLAN configuration, create the port-profile as described in AMPP port-profiles on page 331.

Verifying the VM MAC address

For the correct functioning of AMPP, the MAC address for the VM and its associated hosts must appear in the MAC address table.

1. Enter the **show mac-address-table** command to verify that the VM MAC addresses appear in the switch MAC address table.

```
switch# show mac-address-table
VlanId  Mac-address     Type    State     Ports
1       0000.0010.0001  Static  Inactive  Te 4/0/3
1       0000.0010.0002  Static  Inactive  Te 4/0/3
Total MAC addresses  : 2
```

2. If a VM MAC address is not present, contact your switch support provider for further investigation and provide this data.

Verifying the port-profile state

For the correct functioning of AMPP, the port-profile must be active and must be associated with the correct MAC address.

1. Enter the **show port-profile status** command to verify that the port-profile is activated and is associated with the correct MAC address.

```
switch# show port-profile status
Port-Profile     PPID    Activated    Associated MAC    Interface
pp1              1       No           None              None
pp2              2       No           None              None
```

2. Correct any misconfigurations as follows:
   - If the port-profile is not activated, enter the **port-profile** *profile-name* **activate** command to activate it.
   - If the port-profile is not associated with a MAC address, enter the **port-profile** *port-profile-name* **static** command to perform the association.

     ```
     switch(config)# port-profile PP3 static 0050.5600.10030
     ```

   - If the port-profile is associated with the wrong MAC address, enter the **no port-profile** *port-profile-name* **static** command to break the association with the incorrect MAC address, and then reassociate the port with the correct MAC address.

     ```
     switch(config)# no port-profile PP3 static 0050.5600.10020
     switch(config)# port-profile PP3 static 0050.5600.10030
     ```

   Refer to Configuring a new port-profile on page 333 for details about activating a port-profile and associating a port-profile with a MAC address.

Verifying the VM kernel MAC addresses

Confirm that the virtual machine (VM) kernel MAC addresses are also associated with the port-profile on the respective switches. If not, perform the association as described in Verifying the port-profile configuration on page 694.

Verifying a shared storage device

Confirm that the VM and its associated hosts are sharing a storage device. If not, then reconfigure the VM and hosts to share a storage device.

Verifying the status of a learned profiled MAC address

For correct functioning of AMPP, the MAC address must be learned from a valid source— a profiled VLAN. This procedure determines whether a MAC address was learned from a valid source.

Enter the **show mac-address-table port-profile** command to check the status on learned profiled MAC addresses.

```
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
      (output truncated)
Total MAC addresses : 17
```

Check for and investigate MAC addresses identified in the output as "Not Profiled."

Verifying that port profiles do not conflict

1. Enter the **show port-profile name** *pp1_name* **name** *pp2_name* **validate** command to validate whether multiple port-profiles applied on an interface can co-exist without conflict.

```
switch# show port-profile name pp1 name pp2 validate
Port-Profile           Port-Profile           Conflicts
-------------------------------------------------------------------------
pp1                    pp2
vlan-profile           vlan-profile           No
qos-profile            qos-profile            No
security-profile       security-profile       No
```

2. If a conflict exists, reconfigure one of the port-profiles to avoid the conflict.

   Refer to Configuring AMPP on page 329 for information about the rules for co-existence.

Verifying the Ethernet Name Server

AMPP requires each VCS Fabric switch in the cluster have the same view of the MAC address table. Any differences in the view indicate a failure of the Ethernet Name Server (ENS). Refer to ENS not working correctly on page 698 for details.

Verifying an ESX host

Verify that each ESX host has the correct Converged Network Adapter (CNA) installed with appropriate drivers, and does not use the Cisco Nexus 1000V software switch, as that switch might send out specially crafted packets.

Panic reboots are continuous

If your switch is having continuous panic reboots, perform the following procedure.

1. Bring the switch to a stable state with the original binary or swap the other partition with a good image.
   a) In bootenv, execute **setenv OSLoadOptions 2**, **saveenv**, and **reset**.
   b) Immediately after reboot before panic, try to login and execute **do chkconfig fabos off**.

      This boots the switch in single-user mode, with just Linux OS and not loading the Network OS modules. Make the needed changes to the filesystem, such as changing the partition by using **bootenv** or replacing the image with original good binaries.

      In single-user mode the network is not accessible, so use the command **ifconfig eth0** for any network support. Furthermore, the command **init 3** boots the switch after reboot for case **a** above. Otherwise, reset the switch by using **chkconfig fabos on; reboot**.
2. If the switch comes to a halt after five repeated reboots, try cleaning up the DCMD database with the following command:

```
rm -rf /etc/fabos/Dcmd/*.cfg; rm -rf /etc/fabos/Dcmd/WaveDatabase; rm -rf /etc/fabos/Ccmd/*.cfg; rm -
rf /etc/fabos/Ccmd/WaveDatabase; reboot "/sbin/reboot -f"
```

3. Download a good build to return the switch to a stable state.

CID card is corrupted

In the case of a corrupted CID card, perform the following steps.

1. Link the **wwncardshow** command to survey the extent of the damage. (This does not have to be done for single boards.)

```
switch# ln -s /fabos/cliexec/em /fabos/bin/wwncardshow
```

2. Display the wwncardshow data.

```
switch# wwncardshow ipdata
packet count is 2
++ Wwn Card IP Data ++
Type Num Field  Address     Mask      Cfg/Zone
-----------------------------------------------------------
CP  0  Eth IP: 255.255.255.255 255.255.255.255
CP  1  Eth IP: 255.255.255.255 255.255.255.255
Chassis GW IP: 255.255.255.255
     LicID: 10:00:00:ff:ff:ff:ff:ff      enet cfg
     Name:  VDX 6710-54        Gen# : -1/0
Sw  0  Eth IP: 10.17.10.84   255.255.240.0
     FC IP: 0.0.0.0     0.0.0.0
     GW IP: 10.17.0.1
     WWN:  10:00:00: 05:33:14:b2:70
     Name:  swd77           Gen# : 0/0
Sw  1  Eth IP:
     FC IP:
     GW IP:
     WWN:  10:00:00:05:33:14:b2:71
     Name:              Gen# : 0/0
```

   Items that are FFs, 255s, or zeros are unacceptable. Only the first two groups count, and the items that must be correct are the following:

   - The CP Eth IP entries. They need valid data only if that CP/MM is present.
   - The chassis LicID entry.
   - The Sw 0 Eth IP entry.
   - The Sw 0 GW IP entry.
   - The Sw 0 WWN entry.

3. To correct the CP Eth IP entries, run **ipaddrset -cp** *x*, where *x* is 0 for MM1 and 1 for MM2, and put in correct data at the prompts. Then run **ipaddrset -chassis** and enter the correct data as needed.

   Sometimes, if the entries have enough 255/0xfFFs in them, running **ipaddrset** does not update the values properly, in which case you have to run **test_sysmod** to clear a couple of entries.

4. To correct Sw 0 WWN, enter **wwn -d626 xx:xx:xx:xx:xx:xx:xx:xx** with the correct wwn value. The system must be rebooted for the change to take effect (at the prompt or manually).

5. To correct chassis LicID, you need the test_sysmod tool. Mount a filesystem (if necessary get eth0 up manually with ifconfig, or set the gateway first).

```
switch# run test_sysmod
test_sysmod
```

6. At the first menu, enter `11` for WWN testing, then `2` for copy WWN to LID, and then enter `1` to confirm. Perform a **Ctrl+C** to exit.

7. The system must be rebooted for the change to take effect. Exit test_sysmod with **Ctrl+C**.

   If you have lost both the WWN and license ID, then you must perform step 4 first. If you do not know the value, it is available in the MAC address in the boot environment variables (for pizza boxes only).

   This value can be entered in the **wwn** command by inserting 10:00: before the MAC value).

8. Finally, if you can't correct the IP addresses, there is one more option in test_sysmod that can help. At the main menu, enter `11` for WWN testing and then `1` for clear WWN IP data entry, then `0`, `1`, `2`, or `3` for entries that had a lot of FFs. If you clear all of the entries that are corrupted with FFs, you should be able to run **ipaddrset** to restore the real addresses.
9. Reboot the switch in order for the change to take effect and make the **ipaddrset** command available.

Verifying SEEPROM data

1. To verify the SEEPROM, copy the *test_symod* file to */fabos/bin* as *test_sysmod* , and select option **10** for i2c and option **27** to Verify FRU Seeprom. The test begins automatically.
2. Use the offset of 0x6a4c, as that is where the IP table starts (size 256), but any offset (and size less than or equal to 256) will access that device.

CPU use is unexpectedly high

Unexpectedly high CPU use is usually the result of a process consuming a large percentage of available CPU cycles. It can prevent access to the switch by Telnet or make an ISL nonfunctional.

If you suspect high CPU use, complete the following steps.

1. In privileged EXEC mode, enter the **show process cpu** command to determine which process is causing the high CPU reading.
2. Shut down the corresponding interface or delete the configuration suspected of causing the high CPU use.

ECMP not load balancing as expected

Equal cost multipath (ECMP) routing increases throughput by balancing traffic across multiple routes that tie for best cost. If you suspect that traffic is not being balanced as expected, complete the following steps.

1. In privileged EXEC mode, enter the **show fabric route topology** command to display whether ECMP routes are expected.

```
switch# show fabric route topology
Total Path Count: 1
Src  Dst  Out  Out             Nbr  Nbr
RB-ID RB-ID Index Interface    Hops Cost Index Interface   BW   Trunk
------------------------------------------------------------------------
66    1     124   Fi 66/0/4    1    500  129   Fi 1/-1/-1  32G  Yes
```

   If the output shows multiple equal-cost paths between the source and destination switches, then ECMP load balancing is expected.
2. Check the interface utilization to verify whether it matches with the expected number of flows.
3. Enter the **l2traceroute** command to investigate whether Layer 2, Layer 3, and Layer 4 flows hash to separate ECMP links.

   To avoid disruption of operation inherent in ECMP, the correctly functioning Brocade routing strategy routes a specific flow along one deterministic route. Additional flows take available equal-cost routes. This step verifies whether this flow hashing strategy is functioning correctly.

   For details about using the **l2traceroute** command, refer to Using Layer 2 traceroute on page 734.

ENS not working correctly

The Ethernet Name Server (ENS) is working correctly when the content of MAC address tables is the same among switches in the same VCS Fabric cluster. Perform the following checks to ensure that ENS is working correctly:

- Check the that fabric membership information is what you expect. Refer to Verifying the fabric on page 699.

- Ensure that MAC addresses are not moving among ports. Refer to Checking for MAC address movement among ports on page 699.
- Ensure that no edge port has an external loopback. Refer to Verifying edge ports have no external loopback on page 699.

Verifying the fabric

Enter the **show fabric all** command and ensure that information about all switches in the VCS Fabric cluster is displayed.

```
switch# show fabric all
VCS Id: 1
Config Mode: Local-Only
Rbridge-id WWN                       IP Address       Name
------------------------------------------------------------------------
  1        50:00:51:E4:44:40:0E:04   0.0.0.0          "fcr_fd_1"
  2        50:00:51:E4:44:50:0F:09   0.0.0.0          "fcr_xd_2_128"
 60        10:00:00:05:33:5F:EA:A4   10.24.81.65      "switch"
 66        10:00:00:05:33:67:26:78   10.24.81.66     >"switch"
The Fabric has 4 Rbridge(s)
```

Checking for MAC address movement among ports

MAC address movement from port to port occurs when the same source address is detected on multiple ports. This condition is sometimes known as "MAC address flapping."

To check for MAC address flapping, enter the **show mac-address-table** command multiple times and check the output.

Verifying edge ports have no external loopback

Physically check for extended loopback.

FCoE devices unable to log in

The inability to log in from a device connected through FCoE is usually because either the port or LLDP has been incorrectly configured. Potential reasons include:

- The default profile map has not been applied correctly. Refer to Verifying the default profile map on page 700.
- Required TLVs have not been advertised under LLDP. Refer to Verifying TLVs on page 700.

Verifying CNA login

If CNAs are not logging into the switch, perform the following procedure.

1. Check that the physical port is provisioned for FCOE.

```
switch# show fcoe interface ethernet | include "1/0/5"
TenGigaBitEthernet 1/0/5      default
```

2. If the physical port is not provisioned, provision the interface for FCOE.

3. If the CNA is still not logging in, check that the logical FCOE interface is online by using the **show running-config interface fcoe** command, as in the following example:

```
switch# show running-config interface fcoe
interface Fcoe 1/11/1
no shutdown
!
interface Fcoe 1/11/2
no shutdown
!
interface Fcoe 1/11/3
no shutdown
!
interface Fcoe 1/11/4
no shutdown
!
interface Fcoe 1/11/5
no shutdown
!
interface Fcoe 1/11/6
no shutdown
!
interface Fcoe 1/11/7
no shutdown
```

4. Remove the FCOE provisioning and reprovision the physical interface.
5. If that does not work, execute the **shut** command, and then the **no shut** command on the FCOE logical interface.
6. If it still fails, collect the *supportSave* information and contact support. Refer also to Gathering troubleshooting information on page 683, which provides information about Network OS supportSave files.

Verifying the default profile map

1. In privileged EXEC mode, enter **show running-config interface tengigabitethernet** followed by the interface ID to determine whether the default profile map has been applied to the interface.

```
switch# show running-config interface tengigabitethernet 5/0/1
interface TenGigabitEthernet 5/0/1
 fcoeport default
 shutdown
```

2. If the default profile map has not been applied to the interface, or the initiator and target do not share the same VLAN ID, in interface configuration mode, enter **fcoeport default** to apply it.

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

   This command not only applies the default profile map, but also associates the initiator and target with the same VLAN ID.

Verifying TLVs

The following TLVs —**dcbx-fcoe-app-tlv**, **dcbx-fcoe-logical-link-tlv**, and **dcbx-tlv**— must be advertised under LLDP or FCoE devices will not be able to log in.

1. In the privileged EXEC mode, enter the **show running-config protocol lldp** command to verify that the required TLVs are advertised.

```
switch# show running-config protocol lldp
protocol lldp
advertise dcbx-fcoe-app-tlv
advertise dcbx-fcoe-logical-link-tlv
advertise dcbx-tlv
```

2. If any of the required TLVs is missing, in protocol configuration mode, enter the corresponding **advertise** command.

```
switch# configure terminal
switch(config)# protocol lldp
switch(conf-lldp)# advertise dcbx-fcoe-app-tlv
switch(conf-lldp)# advertise dcbx-fcoe-logical-link-tlv
switch(conf-lldp)# advertise dcbx-tlv
```

Traffic is not being forwarded

If the traffic is not being forwarded, perform the following steps:

1. Check for db packet capture. Below are the commands to enable and view a capture.

```
db 8/0/1 rte enable capture all
db 8/0/1 rte start capture
db 8/0/1 rte show capture
```

   After the **start capture** command, the system sends a stream and performs **show capture**. This displays most of the capture information:

   a) It shows all the fields resolved — whether it is trap, drop, or fwd.

   b) It shows the packet itself.

   c) It shows the Routing Engine (RTE) Layer 2 history, as in the result of the Layer 2 table hit or miss.

   d) It shows the RTE Layer 3 history, as in the result of the Layer 3 table hit or miss. If Layer 2 table has a success and Layer 3 table failed, then check for routing issues.

      For example, in the entry for trap (Ping to box), the Routed fields should display `Ipv4Rtd` and the entries hit. For a TRAP hit, it should display `trapen:1` (Bit set to 1 to indicate packet is trapped).

   e) Packet Capture displays the last four packets, Make sure those are the fwd packets (for example, check for SA DA MAC, pkttyp:0806).

```
db 8/0/1 rte enable capture all
db 8/0/1 rte start capture
db 8/0/1 rte show capture
```

   f) If the FWD and packets are not being forwarded, then it is an ASIC problem. If it is a DROP, proceed to the next step.

2. If result is DROP:

   a) Execute the **show ip route** command. If the route is not present, then it is an RTM issue.

   b) Execute the **show arp command**. If ARP is not resolved for the corresponding next hop, then it is an ARP issue. If it is VLAN along with ARP, MAC should be resolved. If MAC is not resolved then it is an L2SYS issue.

   c) If step **2b** passes, enter the **debug show ip lpm** command to display the routes in hardware, and verify that the corresponding destination ARP address is present. If it is not present, then it is an L3FWD issue. Collect the information from **debug show ip lpm** , attach the file `/tmp/fib_wlv_ioctl,` along with supportSave data and contact support. Specify that it failed in this step.

      Refer also to Gathering troubleshooting information on page 683, which provides information about Network OS supportSave files.

   d) If step **2c** passes and traffic is still dropping, then it is an ASIC issue.

      NOTE
      For additional information about packet capture, refer to Using the packet capture utility on page 743.

ISL does not come up on some ports

The failure of an Inter-SwitchLink (ISL) between two switches in a VCS Fabric cluster can occur for various reasons:

- The ISL configuration is disabled. Refer to Verifying the status of ISLs on page 702.
- The ISL is segmented. Refer to Verifying the status of ISLs on page 702.
- VCS Fabric mode is not enabled on one of the switches. Refer to Verifying VCS Fabric configuration and RBridge ID on page 703.
- Different VCS IDs on each of the switches. Refer to Verifying VCS Fabric configuration and RBridge ID on page 703.
- LLDP is not reporting its neighbors. Refer to Verifying LLDP on page 705.
- An overloaded CPU fails to generate keepalive packets. Refer to Checking for CPU overload on page 705.

Verifying the status of ISLs

If any port looks suspicious, begin by checking the status of ISLs.

1. On the switches at each end of the broken link, in privileged EXEC mode, enter the **show fabric isl** command to view the status of ISL connections.

```
switch1# show fabric isl
Rbridge-id: 2   #ISLs: 2
Src      Src     Nbr     Nbr
Index Interface Index Interface  Nbr-WWN                 BW    Trunk  Nbr-Name
------------------------------------------------------------------------------
1     Te 2/0/1   1     Te 3/0/1   10:00:00:05:1E:CD:7A:7A 10G   Yes    "switch1"
2     Te 2/0/2   ?     Te ?/?/?   ??:??:??:??:??:??:??:?? (segmented - incompatible)
26    Te 2/0/26  56    Te 25/0/56 10:00:00:05:33:40:2F:C9 60G   Yes    "Edget12r31_25"
34    Te 2/0/34  58    Te 26/0/58 10:00:00:05:33:41:1E:B7 40G   Yes    "Edget12r32_26"
```

   Ports on which the ISL link is broken appear with the text "(segmented - incompatible)." Ports for which the ISL configuration is disabled do not appear in the output.

2. Enter the **show fabric islports** command to gather more information about the status of suspect ports.

```
switch# show fabric islports
Name:          switch
Type:          107.4
State:         Online
Role:          Fabric Subordinate
VCS Id:        10
Config Mode:   Local-Only
Rbridge-id:    11
WWN:           10:00:00:05:33:6d:7f:77
FCF MAC:       00:05:33:6d:7f:77
Index Interface  State Operational State
==============================================================
  1   Te 11/0/1  Up    ISL 10:00:00:05:33:00:77:80 "switch" (upstream)(Trunk Primary)
  2   Te 11/0/2  Down
  3   Te 11/0/3  Down
  4   Te 11/0/4  Up    ISL (Trunk port, Primary is Te 11/0/1)
  5   Te 11/0/5  Down
  6   Te 11/0/6  Down
  7   Te 11/0/7  Down
  8   Te 11/0/8  Down
  9   Te 11/0/9  Down
 10   Te 11/0/10 Down
 11   Te 11/0/11 Up    ISL 10:00:00:05:1e:00:50:00 "switch" (Trunk Primary)
121   Fi 11/0/1  Up    LS ISL 50:00:53:37:b6:93:5e:02 "fcr_fd_160"(downstream)(Trunk Primary)
122   Fi 11/0/2  Up    LS ISL (Trunk port, Primary is Fi 11/0/1)
123   Fi 11/0/3  Down
124   Fi 11/0/4  Down
125   Fi 11/0/5  Down
126   Fi 11/0/6  Down
127   Fi 11/0/7  Down
```

3. If the port state is "Down," enable the port with the **no shutdown** command.

```
switch# configure terminal
Entering configuration mode terminal

switch(config)# interface tengigabitethernet 178/0/9
switch(conf-if-te-178/0/9)# no shutdown
```

4. If the port state is "Up", but the ISL is segmented, examine the Operational State string for further clues to the reason for the segmentation.

   Refer to the *Network OS Command Reference* for details about the **show fabric islports** command and help in interpreting the Operational State string for a segmented ISL.

Verifying VCS Fabric configuration and RBridge ID

For the ISL to function correctly, the following criteria must be true:

- Both switches must have VCS Fabric mode enabled.
- Both switches must have the same VCS ID.
- Each switch must have a unique RBridge ID.

To check the criteria, complete the following steps.

1. Enter the **show vcs** command on each switch.

2. Depending on the output, proceed as follows:
   - If the VCS Fabric mode is not enabled on either switch, enter the **vcs enable** command to enable it.

```
switch1# show vcs
Config Mode    : Distributed
VCS Mode       : Logical Chassis
VCS ID         : 44
VCS GUID       : bcab366e-6431-42fe-9af1-c69eb67eaa28
Total Number of Nodes           : 3
Rbridge-Id       WWN                           Management IP   VCS Status       Fabric
Status        HostName
-----------------------------------------------------------------------------------------------
-------------
144              10:00:00:27:F8:1E:3C:8C       10.18.245.143   Offline
Unknown              sw0
152             >10:00:00:05:33:E5:D1:93*      10.18.245.152   Online
Online               cz41-h06-m-r2
158              10:00:00:27:F8:F9:63:41       10.18.245.158   Offline
Unknown              sw0
switch2# show vcs
state   : Disabled
switch2# vcs vcsid 1 enable
```

   - If the **show vcs** command indicates that the VCS ID is not the same on each switch, enter the **vcs vcsid** command to correct the VCS ID on the switch that is in error.

```
switch1# show vcs
Config Mode  : Local-Only
VCS ID     : 1
Total Number of Nodes      : 1
Rbridge-Id       WWN                   Management IP    VCS Status       Fabric Status
HostName
-----------------------------------------------------------------------------------------------
-------------
66          >10:00:00:05:33:67:26:78*  10.24.81.66      Online           Online
cz41-h06-m-r2
switch2# show vcs
Config Mode  : Local-Only
VCS ID     : 2
Total Number of Nodes      : 1
Rbridge-Id    WWN                      Management IP   VCS Status       Fabric Status
HostName
-----------------------------------------------------------------------------------------------
-------------
66          >10:00:00:05:33:67:26:78*  10.24.81.77     Online           Online
cz41-h06-m-r2
switch2# vcs vcsid 1
```

   - If both switches have the same RBridge ID, enter the **vcs rbridge-id** command to change the RBridge ID to a unique value.

```
switch1# show vcs
Config Mode  : Local-Only
VCS ID     : 1
Total Number of Nodes      : 1
Rbridge-Id       WWN                   Management IP    VCS Status       Fabric Status
HostName
-----------------------------------------------------------------------------------------------
-------------
66          >10:00:00:05:33:67:26:78*  10.24.81.66      Online           Online
cz41-h06-m-r2
switch2# show vcs
Config Mode  : Local-Only
VCS ID     : 1
Total Number of Nodes      : 1
Rbridge-Id       WWN                   Management IP    VCS Status       Fabric Status
HostName
-----------------------------------------------------------------------------------------------
-------------
66          >10:00:00:05:33:67:26:78*  10.24.81.66      Online           Online
```

```
cz41-h06-m-r2
switch2# vcs rbridge-id 77
```

Verifying LLDP

When ISLs are functioning correctly, the **show lldp neighbors** command reports on each neighbor switch in the VCS Fabric cluster.

1. Enter the **show lldp neighbors** command to verify that LLDP reports on all of its neighbors.

```
switch1# show lldp neighbors
Local Intf    Dead Interval  Remaining Life   Remote Intf      Chassis ID         Tx          Rx
Te 66/0/55    120            106              port1            0005.1e78.f004     20300       19914
Te 66/0/60    120            108              port0            0005.1e55.16c8     20300       19911
```

2. If neighbors are missing, you will need to perform further debugging or contact your switch support provider.

Checking for CPU overload

An abnormally high CPU load can cause an ISL to malfunction. Use the **show process cpu** command as described in CPU use is unexpectedly high on page 698 to troubleshoot an overloaded CPU.

License is not properly installed

If a licensed feature is not functioning, a probable reason is that the license for that feature has not been installed correctly. Either the license was not installed, or it was installed and a required system reboot was not performed.

If on a Brocade VDX 6720-24 or VDX 6730-32 switch only eight Ethernet ports are working, it is probable that no Dynamic Ports on Demand (DPOD) license is installed. Similarly, if on a Brocade VDX 6720-60 or Brocade VDX 6730-76, only 40 Ethernet ports are working, it is probable that no DPOD license is installed.

If on a Brocade VDX 6720-60 or Brocade VDX 6730-76 50 Ethernet ports are working but the remaining 10 are not, it is likely that you have the DPOD1 license installed, but not the DPOD2 license.

If you are unable to add a third switch to a VCS Fabric cluster, it is likely that the VCS Fabric license is not installed.

If you are unable to connect an FCoE device or unable to use Fibre Channel ports on a Brocade VDX 6730 switch, it is likely that the FCoE license is not installed.

If you suspect a license is not properly installed, complete the following steps.

1. In privileged EXEC mode, enter the **show license** command to display the currently installed licenses.

```
switch# show license
rbridge-id: 66
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
    FCoE Base license
    Feature name:FCOE_BASE
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
    VCS Fabric license
    Feature name:VCS_FABRIC
```

2. If the FCoE or DPOD license appears in the **show license** command output, but the feature does not work for the expected ports, the probable cause is that the affected ports were not re-enabled after installing the license.

   NOTE
   After adding an FCoE or DPOD license, you must disable and re-enable all affected ports. The VCS Fabric license does not require re-enabling.

   You can disable and then enable each affected port, or you can enter the **chassis disable** command followed by the **chassis enable** command to re-enable the entire chassis.

   ```
   switch# chassis disable
   switch# chassis enable
   ```

3. If the license does not appear in the **show license** command output, then it was not installed. In privileged EXEC mode, enter the **license add lictstr** command to install the license. For FCoE and DPOD licenses, you must also disable and enable the switch or port.

   ```
   switch# license add licstr "*B
   slSETgzTgeVGUDeQR4WIfRx7mmXODdSwENoRGEnAmX3Ca3uHeZgXK0b,jzxyzfzKLrMsPN8ClSxvDQRRT8VyuULyyKTO0ryU6qm4s
   1jjiSAeV,COoedzCx1v6ycQgnYMeSVp#"
   License Added [*B
   slSETgzTgeVGUDeQR4WIfRx7mmXODdSwENoRGEnAmX3Ca3uHeZgXK0b,jzxyzfzKLrMsPN8ClSxvDQRRT8VyuULyyKTO0ryU6qm4s
   1jjiSAeV,COoedzCx1v6ycQgnYMeSVp# ]
   For license change to take effect, please disable/enable port or switch...
   switch# chassis disable
   switch# chassis enable
   ```

Packets are dropped in hardware

This section discusses how to troubleshoot problems in which loss of packets occurs in all traffic, on specific traffic flows, in specific types of traffic, consistently, or intermittently. Dropped packets could occur for many reasons, including the following:

- High latency in an end device. Refer to Verifying packets dropped because of high-latency end device on page 706.
- Broken data path. Refer to Verifying the data path on page 709.
- Noise on an optical line caused by too many CRC errors, packet errors, or NIC interoperability errors. Refer to Checking for noise on an optical line on page 711.

Verifying packets dropped because of high-latency end device

Packets can sometimes be dropped because of buffer overrun within the fabric caused by end devices taking longer to respond than expected. For example, an overloaded disk array can cause such latency, as can a host that does not process data as quickly as expected. Devices that stop receiving data for an extended period of time can cause excessive latency.

The ultimate solution to these problems is to fix the end device itself. However, some adjustments to the switch and fabric configuration can help to reduce the problem.

To detect and relieve congestion and dropped packets resulting from latency in end devices, complete the following steps:

1. Enter the **show lldp neighbors detail** command to check under "DCBX TLVs" that the end device is DCB-ready and confirm that the end device is also advertising its DCB capabilities.

```
switch# show lldp neighbors detail
Neighbors for Interface Te 66/0/55
MANDATORY TLVs
==============
Local Interface: Te 66/0/55 (Local Interface MAC: 0005.3367.26d3)
Remote Interface: port1 (Remote Interface MAC: 0005.1e78.f004)
Dead Interval: 120 secs
Remaining Life : 104 secs
Chassis ID: 0005.1e78.f004
LLDP PDU Transmitted: 2412 Received: 2372
OPTIONAL TLVs
==============
DCBX TLVs
===========
Version : CEE
DCBX Ctrl OperVersion: 0 MaxVersion: 0 SeqNo: 1 AckNo: 4
DCBX ETS OperVersion: 0 MaxVersion: 0 Enabled: 1 Willing: 1 Error: 0
Enhanced Transmission Selection (ETS)
 Priority-Group ID Map:
  Priority : 0 1 2 3 4 5 6 7
  Group ID : 2 2 2 1 2 2 2 15
 Group ID Bandwidth Map:
  Group ID  :  0  1  2  3  4  5  6  7
  Percentage:  0 40 60  0  0  0  0  0
  Number of Traffic Classes supported: 8
DCBX PFC OperVersion: 0 MaxVersion: 0 Enabled: 1 Willing: 1 Error: 0
Priority-based Flow Control (PFC)
   Enabled Priorities: 3
   Number of Traffic Class PFC supported: 8
FCoE App OperVersion: 0 MaxVersion: 0 Enabled: 1 Willing: 1 Error: 0
FCoE Application Protocol
   User Priorities: 3
```

2. Enter the **show qos flowcontrol interface** command to check for pause frames.

```
switch# show qos flowcontrol interface tengigabitethernet 66/0/55
Interface TenGigabitEthernet 66/0/55
 Mode PFC
 DCBX enabled for PFC negotiation
 TX 4926331124 frames
     TX     TX     RX     RX     Output Paused
 CoS Admin  Oper   Admin  Oper   512    BitTimes
 ----------------------------------------------
  0  Off    Off    Off    Off        0
  1  Off    Off    Off    Off        0
  2  Off    Off    Off    Off        0
  3  On     On     On     On         0
  4  Off    Off    Off    Off        0
  5  Off    Off    Off    Off        0
  6  Off    Off    Off    Off        0
  7  Off    Off    Off    Off        0
```

3. Enter the **show qos queue interface** command to check the CoS statistics.

```
switch# show qos queue interface tengigabitethernet 66/0/60
Interface TenGigabitEthernet 66/0/60
           RX       RX             TX         TX
 CoS     Packets   Bytes   TC    Packets     Bytes
 ------------------------------------------------
  0     1600    354184     0       0           0
  1        0         0     1    7962      636960
  2        0         0     2       0           0
  3     8508    544832     3      18        6048
  4        0         0     4       0           0
  5        0         0     5       0           0
  6        0         0     6       0           0
  7        0         0     7    2123      282360
 untag  2082   216528
```

4. Enter the **show qos rcv-queue interface** command to check for indicators of congestion, including dropped packets, buffer consumption, and real-time queue statistics.

```
switch# show qos rcv-queue interface tengigabitethernet 66/0/55
Interface TenGigabitEthernet TenGigabitEthernet 66/0/55
 In-use 27216 bytes, Total buffer 144144 bytes
 0 packets dropped
          In-use    Max
 TC       Bytes   Bytes
 ------------------------
  0        0        252
  1        0        252
  2        0        252
  3    27216      75284
  4        0        252
  5        0        252
  6        0      57456
  7        0       9576
```

5. Enter the **show qos interface** command to check the QoS configuration.

```
switch# show qos interface tengigabitethernet 66/0/55
Interface TenGigabitEthernet 66/0/55
 Provisioning mode cee
 Priority Tag disable
 CEE Map default
 FCoE Provisioned
 Default CoS 0
 Interface trust cos
                In-CoS: 0   1   2   3   4   5   6   7
   ------------------------------------------------------
   Out-CoS/TrafficClass: 0/6 1/6 2/6 3/3 4/6 5/6 6/6 0/7
 Per-Traffic Class Tail Drop Threshold (bytes)
          TC:  0    1    2    3       4    5    6       7
   ------------------------------------------------------
   Threshold:  252  252  252 75284  252  252 57456  9576
 Flow control mode PFC
   CoS3 TX on, RX on
 Multicast Packet Expansion Rate Limit 3000000 pkt/s, max burst 4096 pkts
 Multicast Packet Expansion Tail Drop Threshold (packets)
   TrafficClass:  0   1   2   3   4   5   6   7
   ------------------------------------------------------
      Threshold:  64  64  64  64  64  64  64  64
 Traffic Class Scheduler configured for 1 Strict Priority queues
   TrafficClass:  0   1   2   3   4   5   6   7
   ------------------------------------------------------
    DWRRWeight:   0   0   0   40  0   0   60  --
 Multicast Packet Expansion Traffic Class Scheduler
   TrafficClass:  0   1   2   3   4   5   6   7
   ------------------------------------------------------
    DWRRWeight:   12  13  12  13  12  13  12  13
```

6. Reconfigure QoS. Refer to Configuring QoS on page 477 for detailed information.

Verifying the data path

This procedure checks whether fabric continuity might be the reason for dropped packets.

NOTE
The E1MG-SX-OM and E1MG-LX-OM modules are not supported by Network OS. Despite being Brocade products, these modules will return the error 'Optic is not Brocade qualified, optical monitoring is not supported' and must be replaced with a supported module.

1. Enter the **ping** command to test for a complete path to the end device

```
switch# ping dest-address 10.24.81.2
PING 10.24.81.2 (10.24.81.2): 56 octets data
64 octets from 10.24.81.2: icmp_seq=0 ttl=128 time=9.4 ms
64 octets from 10.24.81.2: icmp_seq=1 ttl=128 time=0.3 ms
64 octets from 10.24.81.2: icmp_seq=2 ttl=128 time=0.3 ms
64 octets from 10.24.81.2: icmp_seq=3 ttl=128 time=0.3 ms
64 octets from 10.24.81.2: icmp_seq=4 ttl=128 time=0.3 ms
--- 10.24.81.2 ping statistics ---
5 packets transmitted, 5 packets received, 0% packet loss
round-trip min/avg/max = 0.3/2.1/9.4 ms
```

2. Enter the **show interface** command to display whether packets are coming in or are dropped as errors. Specifically, examine the output fields shown underlined in the following example.

```
switch# show interface tengigabitethernet 66/0/60
TenGigabitEthernet 66/0/60 is up, line protocol is up (connected)
Hardware is Ethernet, address is 0005.3367.26d8
  Current address is 0005.3367.26d8
Pluggable media present
Interface index (ifindex) is 283874428169
MTU 2500 bytes
LineSpeed Actual   : 10000 Mbit
LineSpeed Configured : Auto, Duplex: Full
Flowcontrol rx: off, tx: off
Last clearing of show interface counters: 22:07:59
Queueing strategy: fifo
Receive Statistics:
  15254 packets, 1395269 bytes
  Unicasts: 10641, Multicasts: 2637, Broadcasts: 1976
  64-byte pkts: 10874, Over 64-byte pkts: 3294, Over 127-byte pkts: 117
  Over 255-byte pkts: 969, Over 511-byte pkts: 0, Over 1023-byte pkts: 0
  Over 1518-byte pkts(Jumbo): 0
  Runts: 0, Jabbers: 0, CRC: 0, Overruns: 0
  Errors: 0, Discards: 0
Transmit Statistics:
  12633 packets, 1155963 bytes
  Unicasts: 18, Multicasts: 12615, Broadcasts: 0
  Underruns: 0
  Errors: 0, Discards: 0
Rate info (interval 299 seconds):
  Input 0.000128 Mbits/sec, 0 packets/sec, 0.00% of line-rate
  Output 0.000000 Mbits/sec, 0 packets/sec, 0.00% of line-rate
Time since last interface status change: 1d00h40m
```

3. Enter the **show media interface** command to check that the optics used are Brocade-certified. Verify the Vendor Name field, shown underlined in the following example, reads BROCADE. If the Vendor Name field shows anything other than BROCADE, replace the optics with Brocade-certified optics.

   Check also the TX Power and RX Power fields to ensure they are not zero.

```
switch# show media interface tengigabitethernet 66/0/60
 Interface   TenGigabitEthernet 66/0/60
 Identifier   3  SFP
 Connector   7  LC
 Transceiver      0000000000000010 10_GB/s
 Name      id
 Encoding    6
 Baud Rate   103 (units 100 megabaud)
 Length 9u   0  (units km)
 Length 9u   0  (units 100 meters)
 Length 50u   8  (units 10 meters)
 Length 62.5u  3  (units 10 meters)
 Length Cu   0  (units 1 meter)
 Vendor Name  BROCADE
 Vendor OUI   00:05:1e
 Vendor PN   57-0000075-01
 Vendor Rev   A
 Wavelength   850 (units nm)
 Options    001a
 BR Max     0
 BR Min     0
 Serial No   AAA209282044472
 Date Code   090709
 Temperature  35 Centigrade
 Voltage    3356.4 (mVolts)
 Current    5.564 (mAmps)
 TX Power    568.9 (uWatts)
 RX Power    549.9 (uWatts)
```

4. Enter the **show mac-address-table** command to verify that the MAC address table learns new values.

   The new MAC address should appear here.

```
switch# show mac-address-table
VlanId  Mac-address    Type   State   Ports
1002   0efc.0042.7300  FPMA   Active   Te 66/0/55
1002   0efc.0042.7302  FPMA   Active   Te 66/0/55
1002   0efc.0042.7800  FPMA   Active   Te 66/0/60
Total MAC addresses  : 3
```

5. Enter the **show lldp neighbors** command to verify that LLDP reports all neighbors.

```
switch# show lldp neighbors
Local Intf  Dead Interval Remaining Life  Remote Intf   Chassis ID      Tx     Rx
Te 66/0/55  120           101             port1         0005.1e78.f004  3000   2948
Te 66/0/60  120           117             port0         0005.1e55.16c8  2999   2945
```

   If the output does not show all neighbors, contact your switch support provider.

6. Enter the **show mac-address-table** command to verify the Ethernet Name Service functionality and to detect whether MAC addresses learned from other VCS Fabric switches are present.

   Enter this command on other switches in the fabric to ensure that those switches can detect this MAC address.

```
switch# show mac-address-table
VlanId  Mac-address    Type   State    Ports
1002   0efc.0042.7300  FPMA   Active   Te 66/0/55
1002   0efc.0042.7302  FPMA   Active   Te 66/0/55
1002   0efc.0042.7800  FPMA   Active   Te 66/0/60
Total MAC addresses  : 3
```

7. Enter the **l2traceroute** command to validate the data-path fabric continuity.
   - Enter dynamically learned source MAC address and destination MAC address for the data path.
   - Among the extended commands, use IP, SIP, DIP, TCP, Scr Port, and Dest Port commands.
   - Enter the IP command parameters to ensure that the traceroute packet traverses a specific ECMP link.

   For details on using the **l2traceroute** command, refer to Using Layer 2 traceroute on page 734.

Checking for noise on an optical line

Excessive noise on an optical line can result in dropped packets because of excessive CRC errors, NIC interoperability errors, or other conditions.

NOTE
The E1MG-SX-OM and E1MG-LX-OM modules are not supported by Network OS. Despite being Brocade products, these modules return the error 'Optic is not Brocade qualified, optical monitoring is not supported' and must be replaced with a supported module.

1. Enter the **show interface** command and check the output for CRC errors or TX discards; examine the fields shown underlined in the following example.

```
switch# show interface tengigabitethernet 66/0/55
TenGigabitEthernet 66/0/55 is up, line protocol is up (connected)
Hardware is Ethernet, address is 0005.3367.26d3
  Current address is 0005.3367.26d3
Pluggable media present
Interface index (ifindex) is 283874100484
MTU 2500 bytes
LineSpeed Actual   : 10000 Mbit
LineSpeed Configured : Auto, Duplex: Full
Flowcontrol rx: off, tx: off
Last clearing of show interface counters: 21:51:35
Queueing strategy: fifo
Receive Statistics:
  15433457505 packets, 32164575799774 bytes
  Unicasts: 15433454934, Multicasts: 2571, Broadcasts: 0
  64-byte pkts: 11357, Over 64-byte pkts: 242664576, Over 127-byte pkts: 0
  Over 255-byte pkts: 0, Over 511-byte pkts: 0, Over 1023-byte pkts: 0
  Over 1518-byte pkts(Jumbo): 15190781568
  Runts: 0, Jabbers: 0, CRC: 0, Overruns: 0
  Errors: 0, Discards: 0
Transmit Statistics:
  21456965161 packets, 32549136821934 bytes
  Unicasts: 15313174675, Multicasts: 6143790486, Broadcasts: 0
  Underruns: 0
  Errors: 0, Discards: 0
Rate info (interval 299 seconds):
  Input 3345.136864 Mbits/sec, 200572 packets/sec, 33.45% of line-rate
  Output 3386.493904 Mbits/sec, 281345 packets/sec, 33.86% of line-rate
Time since last interface status change: 1d00h24m
```

2. If errors are reported in the previous step, check the SFP transceiver and cable on the local switch and on the peer switch at the other end of the cable.
   a) Enter the **show media interface** command on each switch and check the Vendor Name field to check that the optics are Brocade-certified. If the Vendor Name field shows anything other than BROCADE, replace the optics with Brocade-certified optics.

      Replace any non-Brocade SFP transceiver.
   b) Try replacing the SFP transceiver.
   c) Try replacing the cable.

Recovering the root password by using the root account

Use this procedure if you have lost access to the admin account, but you do have access to the root account.

To reset any account password from the root account, follow these steps:

> NOTE
> For a non-secured system, you can use the serial interface or Telnet. For a secure system, you can use the serial interface or secure Telnet.

1. Open a CLI session to the switch.
2. Log in as root.
3. At the prompt, enter the **noscli** command to start the Network OS command line.

```
switch:root> noscli
```

4. Enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
switch(config)#
```

5. Use the following syntax of the **username** command to reset passwords for the admin or user accounts, or for any other nondefault users.

```
username account-name password new-password
```

The following example resets the admin password to the default value of "password."

```
switch(config)# username admin password password
```

You can now use the admin account to manage the admin and user passwords by using normal password-management procedures.

> IMPORTANT
> Keep a hard copy of your switch passwords in a secure location.

Obtaining the Boot PROM recovery password

Use this procedure when you do not have the Boot PROM password.

This procedure obtains a Boot PROM recovery password. It does not reset the Network OS passwords on the switch. Once the Boot PROM password has been recovered, you must go through the Boot PROM command shell to reset the Network OS passwords on the switch.

This procedure explains how to gather the information you need to send to your switch support provider in order to get a Boot PROM recovery password. Once you have received the Boot PROM recovery password, and gained access to the Boot PROM, you must reset the passwords by using Recovering the root password for Brocade VDX 67xx platforms on page 716, or Recovering the root password for Brocade VDX 8770 platforms on page 720.

After completing this procedure, the Boot PROM password will be set. To avoid having to obtain a Boot PROM recovery password for future password-recovery operations, you can choose to reset the Boot PROM password as described in Clearing the Boot PROM password on page 714

To obtain the Boot PROM recovery password from your switch support provider, perform the following steps:

1. Connect to the serial console port of the switch.

2. Manually reboot the switch.
3. When prompted to stop test or stop AutoBoot, press **ESC.**

   NOTE
   If the **ESC** key is not effective during reboot, turn the power off and back on, and then try again. If the **ESC** key is still not effective, check the serial console cable. If the cable is connected correctly, then the unit must be returned for service or repair.

   The Boot PROM menu is displayed with the following options:

Start system.	Used to reboot the system.
Recover password.	Used to generate a character string for your support provider to recover the Boot PROM password. ATTENTION Use this feature only when directed by technical support personnel.
Enter command shell.	Used to enter the command shell to reset all passwords on the system.

```
Checking system RAM - press any key to stop test
Checking memory address: 00100000
System RAM test terminated by keyboard
set_bootstatus: BS_LOAD_OS, platform_idx = 6
Hit ESC to stop autoboot: 0

1) Start system.
2) Recover password.
3) Enter command shell.

Option?
```

4. Enter 2 at the prompt. A character string is displayed, highlighted in the following example.

```
1) Start system.
2) Recover password.
3) Enter command shell.

Option? 2
Send the following string to Customer Support for password recovery:
/uasLR1raCqT3FToqy0ZjA==
```

5. Send the character string to your switch support provider to obtain a Boot PROM recovery password.

   CAUTION
   Do not reboot the switch at this point. Doing so will cause the password recovery string to change.

6. As prompted, perform the appropriate steps to set the Boot PROM password if it was not set.

```
Recovery password is NOT set. Please set it now.
```

7. When prompted, enter the Recovery Password that is generated from your support provider, and reenter it when prompted.

```
Enter the supplied recovery password.
Recovery Password: YnfG9DDrlFMDVkNM0RkPtg== < Supplied by your support provider

Re-enter Recovery Password: YnfG9DDrlFMDVkNM0RkPtg==
```

8. When prompted with "New password:", enter a new Boot PROM password, and reenter it when prompted.

```
New password: xxx
Re-enter new password: xxx
```

The switch reboots.

ATTENTION
Record the new password for future reference.

You are now ready to record passwords as described in either Recovering the root password for Brocade VDX 67xx platforms on page 716, or Recovering the root password for Brocade VDX 8770 platforms on page 720.

Clearing the Boot PROM password

After you complete the procedure Obtaining the Boot PROM recovery password on page 712, the BootPROM password is set. To avoid needing the Boot PROM password during future password-recovery operations, you can reset the Boot PROM password.

To reset the Boot PROM password, perform the following steps:

1. Connect to the serial console port of the switch.
2. Manually reboot the switch.
3. When prompted to stop test or stop AutoBoot, press **ESC.**

NOTE
If the **ESC** key is not effective during reboot, turn the power off and back on, and then try again. If the **ESC** key is still not effective, check the serial console cable. If the cable is connected correctly, then the unit must be returned for service or repair.

The Boot PROM menu is displayed with the following options:

Start system.	Used to reboot the system.
Recover password.	Used to generate a character string for your support provider to recover the Boot PROM password. **ATTENTION** Use this feature only when directed by technical support personnel.
Enter command shell.	Used to enter the command shell to reset all passwords on the system.

```
Checking system RAM - press any key to stop test
Checking memory address: 00100000
System RAM test terminated by keyboard
set_bootstatus: BS_LOAD_OS, platform_idx = 6
Hit ESC to stop autoboot: 0

1) Start system.
2) Recover password.
3) Enter command shell.

Option?
```

4. Enter `3` at the prompt to open the command shell.
5. At the prompt, enter the Boot PROM password.

```
password: *******
=>
```

6. To reset the password, enter the **resetpw** command.

```
=> resetpw
.
.
Done
```

7. To allow the switch to continue booting up, enter the **reset** command.

```
=> reset
do_reset: PERFORM HARD RESETí
The system is coming up, please wait...
```

When the boot-up process is finished, the Boot PROM password is gone.

Need to recover password for Brocade VDX 8770 or VDX 67xx

Use these procedures to recover access to your switch when normal access to the admin account has been lost.

CAUTION

Because of the complexity of these procedures, we highly recommend that you contact support for guidance, especially for recovering the root password. The recovery steps must be followed exactly as presented below. Any variation in the procedure might cause unpredictable results.

There are several methods for recovering passwords on a Brocade Network OS switch. The correct approach depends on the accounts to which you have access. The table below lists the procedures and conditions under which under which you would use each procedure to recover passwords. These procedures apply to all versions of Network OS firmware across all Network OS platforms, except where noted.

Account access availability	Use these procedures
• Access to admin account	Use normal password management procedures.
• No access to admin account • Access to root account	Recovering the root password by using the root account on page 712.
• No access to admin account • No access to root account • Access to boot PROM interface	Refer to either of the following: • Recovering the root password for Brocade VDX 67xx platforms on page 716 • Recovering the root password for Brocade VDX 8770 platforms on page 720
• No access to admin account • No access to root account • No access to boot PROM interface	Refer to Obtaining the Boot PROM recovery password on page 712 and either of the following: • Recovering the root password for Brocade VDX 67xx platforms on page 716 • Recovering the root password for Brocade VDX 8770 platforms on page 720

If you still have access to the admin account, you can change the admin account password or change passwords on user accounts by using normal password-management procedures. Refer to Managing User Accounts on page 261.

Even if you have lost access to the admin account but you do have access to the root account, you can use the root account to reset passwords for the root, admin, and user accounts. Refer to Recovering the root password by using the root account on page 712. Once you have reset the admin account password, you can use that account to set user login passwords.

If you do not have access to the root account, you can use the Boot PROM method. Refer to either Recovering the root password for Brocade VDX 67xx platforms on page 716 or Recovering the root password for Brocade VDX 8770 platforms on page 720 in this

section. If the password is set on the boot PROM and is unknown, contact your switch service provider for a boot PROM recovery string to regain access to the switch. Refer to Obtaining the Boot PROM recovery password on page 712 in this section.

Try the factory default passwords before proceeding in case any are still in effect. The following table lists the default passwords for Network OS switches.

Account	Default password
root	fibranne
admin	password
user	password

NOTE
When connected through a serial cable to the console, always save the output by using the capture functionality under Windows, or the script functionality for UNIX or Linux.

Recovering the root password for Brocade VDX 67xx platforms

This procedure must be performed from the serial interface console. It applies to Brocade VDX 6710, VDX 6720, and VDX 6730 platforms.

This procedure must be performed from the serial interface console. It applies to Brocade VDX 6710, VDX 6720, and VDX 6730 platforms.

CAUTION
Enter commands at the Boot PROM interface exactly as shown. Commands entered incorrectly at the Boot PROM interface can render your switch unstable or unusable. To recover, you would need to seek help from your switch service provider or return your switch to the factory for repair.

You can use this procedure if you need to recover passwords on a device for which the root account is not accessible. If the root account is accessible, use Recovering the root password by using the root account on page 712 instead.

To use this procedure, you must have access to the Boot PROM interface; that is, its password must be available or not set. If you do not have access to the Boot PROM interface, use Obtaining the Boot PROM recovery password on page 712 before using this procedure.

This section provides detailed procedures for performing password recovery, in addition to a quick reference for advanced users who need only a reminder of the basic steps:

- Recovering the root password for Brocade VDX 67xx platforms: Quick reference on page 716
- Recovering the root password for Brocade VDX 67xx platforms: Detailed procedure on page 717

Recovering the root password for Brocade VDX 67xx platforms: Quick reference

Advanced users who need only a reminder of the basic steps can use this quick reference to recover passwords.

1. Press **ESC** during reboot.

   NOTE
   If the **ESC** key is not effective during reboot, turn the power off and back on, and then try again. If the **ESC** key is still not effective, check the serial console cable. If the cable is not connected correctly, then the unit must be returned for service or repair.

2. Choose option **3**.

3. Enter the following commands in sequence:
   a) **setenv OSLoadOptions "single"**
   b) **savenv**
   c) **boot**
   d) **mount -o remount,rw,noatime /**
   e) **mount /dev/hda1 /mnt**
      For Step 3e, choose the root partition that was not returned in Step 3d.
   f) **/sbin/passwddefault**
   g) **bootenv OSLoadOptions "quiet/quiet"**
   h) **reboot -f**
4. Log in as root and enter the following commands in sequence:
   a) **noscli**
   b) **configure**
   c) **username** *name*
   d) **password** *new-password*

Recovering the root password for Brocade VDX 67xx platforms: Detailed procedure

Use this procedure if you do not have access to the root account.

To reset the root password to its factory default value on a Brocade VDX 6710, VDX 6720, or VDX 6730 switch, and then set a password for the admin account, follow these steps:

1. Connect to the serial console port of the switch.
2. Manually reboot the switch.

3. When prompted to stop test or stop AutoBoot, press **ESC**.

   NOTE
   If the **ESC** key is not effective during reboot, turn the power off and back on, and then try again. If the **ESC** key is still not effective, check the serial console cable. If the cable is connected correctly, then the unit must be returned for service or repair.

   The Boot PROM menu is displayed with the following options:

Start system	Used to reboot the system.
Recover password	Used to generate a character string for your support provider to recover the Boot PROM password. ATTENTION Use this feature only when directed by technical support personnel.
Enter command shell	Used to enter the command shell to reset all passwords on the system.

```
Checking system RAM - press any key to stop test
Checking memory address: 00100000
System RAM test terminated by keyboard
set_bootstatus: BS_LOAD_OS, platform_idx = 6
Hit ESC to stop autoboot: 0

1) Start system.
2) Recover password.
3) Enter command shell.

Option?
```

4. Enter `3` at the prompt to open the command shell.
5. If prompted, enter the Boot PROM password and press **Enter**.

   NOTE
   The Boot PROM has a password only if one has been defined.

6. Change the "OSLoadOptions=quiet;quiet" setting so that the switch boots into single-user mode, by entering the following at the prompt:
   setenv OSLoadOptions "single"
7. Enter the **printenv** command to verify the change.

```
=> printenv
AutoLoad=yes
BootromVerbose=no
InitTest=MEM()
LoadIdentifiers=Fabric Operating System;Fabric Operating System
OSLoadOptions=single
     (output truncated)
```

8. Enter the **savenv** command to save the changes.

```
=> saveenv
Saving Environment to Flash.....Done
```

9. Enter the **boot** command with no parameters to bring up the device in single-user mode

```
=> boot
Map file at LBA sector 0x17da68
## Booting image at 00400000 ...
     (output truncated)
```

10. Enter the **mount** command with the following parameters to remount the root partition as read/write capable.

```
sh-2.04# mount -o remount,rw /
EXT3 FS on hda1, internal journal
```

11. Mount the secondary partition.

    If the previous command returns hda2, then use **hda1** in this command. If the previous command returns hda1, then use **hda2**.

```
sh-2.04# mount /dev/hda2 /mnt
kjournald starting. Commit interval 5 seconds
EXT3 FS on hda2, internal journal
EXT3-fs: mounted filesystem with ordered data mode.
```

12. Enter the **passwddefault** command to reset the root password to the factory default value.

```
sh-2.04# /sbin/passwddefault
```

    NOTE
    For Network OS, the **passwddefault** command restores the passwords of factory default accounts to their default values and removes nondefault user accounts that are present. The nondefault user accounts will be restored later in this procedure.

    Any additional user accounts remain intact.

13. Reset the OSLoadOptions parameters to "quiet;quiet."

```
sh-2.04# bootenv OSLoadOptions "quiet;quiet"
```

14. Reboot the switch by using the **reboot -f** command.

```
sh-2.04# reboot -f
```

    Traffic flow resumes when the switch completes rebooting. If you do not use the **-f** option, you must reboot the switch manually.

15. Log in as root to the switch by using the serial interface or Telnet. Use the default root password (fibranne).
16. Start the Network OS command line.

```
switch:root> noscli

WARNING: The default password of 'admin' and 'user' accounts have not been changed.

Welcome to the Brocade Network Operating System Software
admin connected from 127.0.0.1 using console on switch
```

17. Enter global configuration mode.

```
switch# config
Entering configuration mode terminal
switch(config)#
```

18. Use the following syntax of the **username** command to reset passwords for the admin or user accounts, or for any other nondefault users.

    ```
    username account-name password new-password
    ```

    The following example resets the admin password to the default value of "password."

    ```
    switch(config)# username admin password password
    ```

19. To restore the nondefault user accounts, perform the following steps:
    a) Copy the running-config to a file.

    ```
    switch: copy running-config flash://running-config.cfg
    2012/07/09-11:51:21, [DCM-1108], 4930, INFO, VDX6740, Running
    configuration file has been uploaded successfully to the remote location.
    ```

    b) Copy the default-config to the startup-config, to reset the startup-config.

    ```
    switch# copy default-config startup-config
    ```

    c) Reboot the switch.

    ```
    switch# 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 !!
    ```

    d) Copy the file saved in Step 19a to the running-config.

    ```
    switch# copy flash://running-config.cfg running-config
    Loading.
    2012/07/09-12:08:13, [DCM-1105], 5456, M2, INFO, VDX6740, Copy of the
    downloaded config file to the current running-config has completed
    successfully on this node.
    ```

    e) Copy the running-config to the startup-config.

    ```
    switch# copy running-config startup-config
    ```

The password recovery procedure is now complete. You can now use normal password-management procedures from the admin account.

Dual Management Modules (MM)s operating alone need a slight change in this task for both the root-enabled or root-disabled scenarios.

To perform the recovery procedure for dual Management Modules, stop both MMs in the command shell prompt. Then follow the listed recovery steps in the document for the Brocade VDX 87xx series in the ACTIVE MM.

After the 10th step in the ACTIVE MM, enter the **reset** command in the STAND-BY shell prompt. When this recovery succeeds, then all passwords are set to the factory default.

Recovering the root password for Brocade VDX 8770 platforms

This procedure must be performed from the serial interface console. It applies only to Brocade VDX 8770-4 and 8770-8 platforms, running Brocade Network OS 3.0.0 and later releases.

CAUTION
Enter commands at the Boot PROM interface exactly as shown. Commands entered incorrectly at the Boot PROM interface can render your switch unstable or unusable. To recover, you would need to seek help from your switch service provider or return your switch to the factory for repair.

You can use this procedure if you need to recover passwords on a device for which the root account is not accessible. If the root account is accessible, use Recovering the root password by using the root account on page 712 instead.

To use this procedure, you must have access to the Boot PROM interface; that is, its password must be available or not set. If you do not have access to the Boot PROM interface, use Obtaining the Boot PROM recovery password on page 712 before using this procedure.

This section provides detailed procedures for performing password recovery in addition to a quick reference for advanced users who need only a reminder of the basic steps:

- Recovering the root password for Brocade VDX 8770 platforms: Quick reference on page 721
- Recovering the root password for Brocade VDX 8770 platforms: Detailed procedure on page 722

Recovering the root password for Brocade VDX 8770 platforms: Quick reference

Advanced users who need only a reminder of the basic steps can use this quick reference to recover passwords.

1. Press **ESC** during reboot.

   NOTE
   If the **ESC** key is not effective during reboot, turn the power off and back on, and then try again. If the **ESC** key is still not effective, check the serial console cable. If the cable is not connected correctly, then the unit must be returned for service or repair.

2. Choose option **3**.
3. Enter the following commands in sequence:
   a) **setenv bootargs "root=/dev/sda1 rootfstype=ext4 quiet S"**
   b) **savenv**
   c) **boot**
   d) **mount -vo remount,rw,noatime /**
   e) mount /dev/sda1 /mnt
   For Step 3e, choose the root partition that was not set as root in Step 3a.
   f) **/sbin/passwddefault**
   g) **bootenv bootargs "root=/dev/sda1 rootfstype=ext4 quiet"**
   h) **partman -r**
4. Log in as root and enter the following commands in sequence:
   a) **noscli**
   b) **configure**
   c) **username** *name*
   d) **password** *new-password*
5. Restore nondefault user accounts.

Recovering the root password for Brocade VDX 8770 platforms: Detailed procedure

Use this procedure if you do not have access to the root account.

To reset the root password to its factory default value on a Brocade VDX 8770-4 or 8770-8 switch, set a password for the admin account, and then restore nondefault user accounts, follow these steps:

1. Connect to the serial console port of the switch.
2. Manually reboot the switch.
3. When prompted to stop test or stop AutoBoot, press **ESC.**

   NOTE
   If the **ESC** key is not effective during reboot, turn the power off and back on, and then try again. If the **ESC** key is still not effective, check the serial console cable. If the cable is connected correctly, then the unit must be returned for service or repair.

   The Boot PROM menu is displayed with the following options:

Start system	Used to reboot the system.
Recover password	Used to generate a character string for your support provider to recover the Boot PROM password. ATTENTION Use this feature only when directed by technical support personnel.
Enter command shell	Used to enter the command shell to reset all passwords on the system.

```
Checking system RAM - press any key to stop test
Checking memory address: 00100000
System RAM test terminated by keyboard
set_bootstatus: BS_LOAD_OS, platform_idx = 6
Hit ESC to stop autoboot: 0

1) Start system.
2) Recover password.
3) Enter command shell.

Option?
```

4. Enter `3` at the prompt to open the command shell.
5. If prompted, enter the Boot PROM password and press **Enter**.

   NOTE
   The Boot PROM has a password only if one has been defined. If you are prompted to enter a new Boot PROM password, make sure that it is at least 8 characters long. Do not select this option unless specifically instructed to do so by support personnel.

6. Append "S" to the boot arguments so that the switch boots into single-user mode, by entering the following at the prompt:
   => setenv bootargs "root=/dev/sda1 rootfstype=ext4 quiet S"

7. Enter the **printenv** command to verify the change.

```
=> printenv
AutoLoad=yes
LoadIdentifiers=Fabric Operating System;Fabric Operating System
OSLoadOptions=quiet
OSRootPartition=sda2;sda1
SkipWatchdog=yes
autoset_mac=true
baudrate=9600
bootargs=root=/dev/sda1 rootfstype=ext4 quiet S
bootcmd=execute_internal_bootcmd
      (output truncated)
```

8. Enter the **savenv** command to save the changes.

```
=> saveenv
Saving Environment to Flash.....Done
```

9. Enter the **reset** command to bring up the device in single-user mode

```
=> reset
BootROM version: 1.0.48
Copyright (C) 2011 Brocade Communication.

CPU0: P4080E, Version: 2.0, (0x82080020)
     (output truncated)
```

10. Enter the **mount** command with the following parameters to remount the root partition as read/write capable.

```
sh-2.04# mount -vo remount,rw,noatime /

/dev/root on / type ext4 (rw,noatime)
```

11. Mount the secondary partition.

    Examine the output of the **printenv** command in Step 7, to check which partition the root points to in the boot arguments (bootargs = root setting). If the root partition is sda2, then use **sda1** in this command. If the root partition is sda1, then use **sda2**.

```
sh-2.04# mount /dev/sda2 /mnt
```

12. Enter the **passwddefault** command to reset the root password to the factory default value.

```
sh-2.04# /sbin/passwddefault
```

    NOTE
    For Network OS, the **passwddefault** command restores the passwords of factory default accounts to their default values and removes nondefault user accounts that are present. Error messages seen during the execution of that command (applicable to Network OS 3.0.0) should be ignored.

    In a dual management-module (MM) chassis, enter the **passwddefault** command on the standby MM for password recovery.

13. Reset the boot arguments by removing the "S".

```
sh-2.04# bootenv bootargs "root=/dev/sda1 rootfstype=ext4 quiet"
```

14. Reboot the switch by using the **partman -r** command.

```
sh-2.04# partman -r
```

15. Log in to the switch by using the serial interface or Telnet. Use the factory default accounts (root/admin/user).

16. Start the Network OS command line.

```
switch:root> noscli

WARNING: The default password of 'admin' and 'user' accounts have not been changed.

Welcome to the Brocade Network Operating System Software
admin connected from 127.0.0.1 using console on switch
```

17. Enter global configuration mode.

```
switch# configure terminal
Entering configuration mode terminal
switch(config)#
```

18. Use the following syntax of the **username** command to reset passwords for the admin or user accounts, or for any other nondefault users.

```
username account-name password new-password
```

The following example resets the admin password to the default value of "password."

```
switch(config)# username admin password password
```

19. To restore the nondefault user accounts, perform the following steps:
    a) Copy the running-config to a file.

```
switch: copy running-config flash://running-config.cfg
2012/07/09-11:51:21, [DCM-1108], 4930, M2, INFO, VDX8770-4, Running
configuration file has been uploaded successfully to the remote location.
```

    b) Copy the default-config to the startup-config, to reset the startup-config.

```
switch# copy default-config startup-config
```

    c) Reboot the switch.

```
switch# 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 !!
```

    d) Copy the file saved in Step 19a to the running-config.

```
switch# copy flash://running-config.cfg running-config
Loading.
2012/07/09-12:08:13, [DCM-1105], 5456, M2, INFO, VDX8770-4, Copy of the
downloaded config file to the current running-config has completed
successfully on this node.
```

    e) Copy the running-config to the startup-config.

```
switch# copy running-config startup-config
```

The password recovery procedure is now complete. You can now use normal password-management procedures from the admin account.

Ping fails

If pings do not successfully traverse the switch, try the following operations.

1. Trace the packet flow and check whether ARP or ICMP packets are getting dropped.
2. Trace which direction is failing by using interface statistics.
3. Locate the device that is dropping the packets.
4. Look for any error counters incrementing on that device.
5. Check the MAC address table to determine whether the MAC addresses are learned on the correct port or port-channel.

QoS configuration causes tail drops

Tail-drop queueing is the most basic form of congestion control. Normal operation is first-in, first-out (FIFO) until all buffers are exhausted. After that, new frames are dropped. You can reduce the impact of such drops by configuring thresholds for each COS priority through the **qos rcv-queue multicast threshold** command. Refer to Configuring QoS on page 477.

QoS is not marking or treating packets correctly

Use the Switched Port Analyzer (SPAN) feature to mirror the ingress and egress ports to check that QoS is marking and treating packets correctly. Refer to Configuring Switched Port Analyzer on page 545 for details.

RBridge ID is duplicated

Switches with the same RBridge ID cannot coexist in the same VCS Fabric cluster. Any attempt to add a switch with the same RBridge ID as an existing cluster switch will fail. The ISL between the two switches will not be formed; it will be segmented.

1. On the new switch, enter the **show vcs** command to determine the RBridge ID.

```
switch2# show vcs
Config Mode  : Local-Only
VCS ID       : 1
Total Number of Nodes      : 1
Rbridge-Id  WWN                       Management IP Status  HostName
-----------------------------------------------------------------------
22        >10:00:00:05:33:13:B3:5A*  10.24.84.41   Online
```

2. On any switch in the functioning VCS Fabric cluster, enter the **show vcs** command to display the RBridge IDs for all the switches in the cluster.

```
switch1# show vcs
Config Mode  : Local-Only
VCS ID       : 1
Total Number of Nodes      : 2
Rbridge-Id  WWN                       Management IP Status  HostName
-----------------------------------------------------------------------
60          10:00:00:05:33:5F:EA:A4  10.24.81.65   Online  switch1
66         >10:00:00:05:33:67:26:78* 10.24.81.66   Online  switch 2
```

3. If the new switch has the same RBridge ID as any switch in the existing cluster, on the new switch, in privileged EXEC mode, enter the **vcs rbridge-id** command to change the RBridge ID to a unique value.

```
switch2# vcs rbridge-id 77
```

SNMP MIBs report incorrect values

If SNMP MIBs report incorrect values, complete the following steps.

1. Ensure you are using a supported MIB browser.
2. Ensure that the issue is seen consistently.
3. Ensure that the SNMP configuration is correct.
4. If the MIB browser is supported, the SNMP configuration is correct, and you still see the issue consistently, contact your switch support provider.

SNMP traps are missing

If SNMP traps are missing, complete the following procedure.

1. Ensure that the correct SNMP configuration is enabled. Refer to SNMP configuration on page 139 for details.
2. Ensure that the SNMP host is reachable.
3. If the problem still persists, contact your switch support provider.

   As a workaround, set a trap configuration for syslog messages.

Telnet operation into the switch fails

Assuming a correct IP address and correct login credentials, failure to access the switch using Telnet could be for one of the following reasons:

- The management port is down. Refer to Verifying the status of the management port on page 726 for details.
- Access to the management interface is denied by an ACL. Refer to Checking for a deny ACL on page 727 for details.
- The switch CPU is overloaded. Refer to Checking for overloaded CPU on page 727 for details.

Verifying the status of the management port

1. On the system console, enter the **show system** command to check the status of the management port, shown underlined in the following example.

```
switch# show system
Stack MAC                   : 00:05:33:67:26:78
 -- UNIT 0 --
Unit Name                   : switch
Switch Status               : Online
Hardware Rev                : 107.4
TengigabitEthernet Port(s)  : 60
Up Time                     : up 1 day, 2:52
Current Time                : 23:40:50 GMT
NOS Version                 :
Jumbo Capable               : yes
Burned In MAC               : 00:05:33:67:26:78
Management IP               : 10.24.81.66
Management Port Status      : UP
 -- Power Supplies --
PS1 is faulty
PS2 is OK
 -- Fan Status --
Fan 1 is Ok
Fan 2 is Ok
Fan 3 is Ok
```

2. If the status of the management port is DOWN, enter the **interface management** command to configure the management port correctly. Refer to Configuring Ethernet management interfaces on page 69.
3. If the problem persists, contact your switch support provider.

Checking for a deny ACL

On the system console, enter the **show running-config ip access-list** command and check the output to determine whether an ACL is denying access to the management port.

Checking for overloaded CPU

An overloaded switch CPU can prevent Telnet access. Refer to CPU use is unexpectedly high on page 698.

Trunk member not used

If you suspect that one or more members of a trunk are not being used, complete the following steps.

NOTE
The E1MG-SX-OM and E1MG-LX-OM modules are not supported by Network OS. Despite being Brocade products, these modules will return the error 'Optic is not Brocade qualified, optical monitoring is not supported' and must be replaced with a supported module.

1. Enter the **show running-config interface** command to determine which interfaces have trunking enabled.

```
switch# show running-config interface
interface Management 66/0
 no ip address dhcp
 ip address 10.24.81.66/20
 ip route 0.0.0.0/0 10.24.80.1
 ipv6 address ""
 no ipv6 address autoconfig
!
interface TenGigabitEthernet 66/0/1
 fabric isl enable
 fabric trunk enable
 no shutdown
!
interface TenGigabitEthernet 66/0/2
 fabric isl enable
 fabric trunk enable
 no shutdown
!
interface TenGigabitEthernet 66/0/3
 fabric isl enable
 fabric trunk enable
 no shutdown
!
      (output truncated)
```

2. Verify the status of the ISL port and link.
   a) Enter the **show fabric isl** command to verify whether the ISL is up.
   b) Enter the **show fabric islports** command to examine the status of each port.

   Refer to Verifying the status of ISLs on page 702 for details and corrective action.

3. Enter the **show interface** command for each trunk link and examine the rate information to check for an equal distribution of traffic on the interfaces in the trunk. The rate information is shown underlined in the following example.

```
switch# show interface tengigabitethernet 66/0/12
TenGigabitEthernet 66/0/12 is up, line protocol is down (link protocol down)
Hardware is Ethernet, address is 0005.3367.26a8
  Current address is 0005.3367.26a8
Pluggable media not present
Interface index (ifindex) is 283871281409
MTU 2500 bytes
LineSpeed Actual   : Nil
LineSpeed Configured : Auto, Duplex: Full
Flowcontrol rx: off, tx: off
Last clearing of show interface counters: 1d00h42m
Queueing strategy: fifo
Receive Statistics:
  0 packets, 0 bytes
  Unicasts: 0, Multicasts: 0, Broadcasts: 0
  64-byte pkts: 0, Over 64-byte pkts: 0, Over 127-byte pkts: 0
  Over 255-byte pkts: 0, Over 511-byte pkts: 0, Over 1023-byte pkts: 0
  Over 1518-byte pkts(Jumbo): 0
  Runts: 0, Jabbers: 0, CRC: 0, Overruns: 0
  Errors: 0, Discards: 0
Transmit Statistics:
  0 packets, 0 bytes
  Unicasts: 0, Multicasts: 0, Broadcasts: 0
  Underruns: 0
  Errors: 0, Discards: 0
Rate info (interval 299 seconds):
  Input 0.000000 Mbits/sec, 0 packets/sec, 0.00% of line-rate
  Output 0.000000 Mbits/sec, 0 packets/sec, 0.00% of line-rate
Time since last interface status change: 1d03h16m
```

4. Having found a trunk member that carries no traffic while the other trunk members are busy, from the same **show interface** command output, check the interface status, configuration, and error statistics.
   - If the interface is disabled, enable it with the **no shutdown** command.
   - If misconfiguration is apparent, refer to Trunk member not used for information on how to configure fabric trunks.
   - If you notice significant errors in the error statistics counters, depending on the error, check the SFP transceiver and cable on the local switch and on the peer switch at the other end of the cable.
     1. Enter the **show media interface** command on each switch and check the Vendor Name field to check that the optics are Brocade-certified. If the Vendor Name field shows anything other than BROCADE, replace the optics with Brocade-certified optics.
     2. Replace any non-Brocade SFP transceiver.
     3. Try replacing the SFP transceiver.
     4. Try replacing the cable.

Upgrade fails

If a failure occurs during firmware upgrade, complete the following steps.

1. Revert to the previous firmware version.
2. Contact your switch support provider to evaluate whether retrying the upgrade is appropriate.

VCS Fabric cannot be formed

A VCS Fabric can fail to form for several reasons:

- The required licenses are not active. Refer to Verifying VCS Fabric licenses on page 729.
- The VCS Fabric configuration is incorrect. The following configuration issues will prevent the VCS Fabric from forming:
  - VCS Fabric mode has not been enabled.
  - The VCS ID on the constituent switches is not the same.
  - Multiple switches have the same RBridge ID.
  - ISL ports that connect the switches are not up.

Refer to Verifying the VCS Fabric configuration on page 729.

Verifying VCS Fabric licenses

If the VCS Fabric cluster has just one or two switches, no VCS Fabric license is required. For more than two switches to exist in a VCS Fabric cluster, you must have the VCS Fabric license installed.

1. Enter the **show license** command to check whether the required VCS Fabric license is installed.

```
switch# show license
rbridge-id: 66
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
    FCoE Base license
    Feature name:FCOE_BASE
```

2. If the VCS Fabric license is not listed in the output of the **show license** command, enter the **license add licstr** command to enable the license.

```
switch# license add licstr "*B r84pNRtHKdRZujmwAUT63GORXIpBhBZK0ckRq6Bvvl3Strvw1:fUjANF
av5W:gWx3hH2:9RsMv3BHfeCRFM2gj9NlkrdIiBPBOa4xfSD2jf,Xx1RwksliX8fH6gpx7,73t#"
Adding license [*B r84pNRtHKdRZujmwAUT63GORXIpBhBZK0ckRq6Bvvl3Strvw1:fUjANF
av5W:gWx3hH2:9RsMv3BHfeCRFM2gSLj9NlkrdIiBPBOa4xfSD2jf,Xx1RwksliX8fH6gpx7,73t#]
```

3. Enter the **show license** command again to verify that the license has been added.

   NOTE
   It is not necessary to reboot the switch to enable the VCS Fabric license.

```
switch# show license
Rbridge-Id: 66
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
    FCoE Base license
    Feature name:FCOE_BASE
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
     VCS Fabric license
     Feature name:VCS
```

   Refer to the *Network OS Software Licensing Guide* for more information about license management.

Verifying the VCS Fabric configuration

To verify the VCS Fabric configuration, complete the following steps.

1. Enter the **show vcs** command on each switch to verify that the VCS Fabric mode is enabled, the VCS ID on each switch is the same, and the RBridge ID on each switch is different.
2. Enter the **show fabric isl** command to verify whether the ISL is up.

3. Enter the **show fabric islports** command to examine the status of each port.

   Refer to ISL does not come up on some ports on page 702 for details and corrective action.

vLAG cannot be formed

A vLAG trunk can fail to form for several reasons:

- The link between the VCS Fabric switches does not exist. Refer to Verifying the link between the VCS Fabric switches on page 730.
- A bad connection causes abnormal reception or transmission of LACPDUs. Refer to Verifying LACPDUs on page 730.
- Port-channel numbers are not the same on the VCS Fabric switches. Refer to Verifying the vLAG configuration on page 731.
- The peer switches are not configured in the same LACP mode (static or dynamic). Refer to Verifying the LACP mode of each switch on page 731.
- A 1-Gbps port-channel has been upgraded to Network OS 2.1.x or later. Refer to Explicitly setting the speed for a 1-Gbps port-channel on page 731.

Verifying the link between the VCS Fabric switches

The link between switches could be broken for various reasons:

- A port is not activated.
- The ISL is segmented.
- The VCS Fabric is not properly formed.
- The CPU is overload.

Refer to ISL does not come up on some ports on page 702 for details on detecting and correcting the problem.

Verifying LACPDUs

LACPDUs should be transmitted and received on both ends of the vLAG. This procedure verifies whether that is happening, and also checks for PDU errors.

1. On both switches, enter the **show lacp counter** command to verify that LACPDUs are transmitted and received, and there are no error PDUs.

```
switch# show lacp counter 10
% Traffic statistics
Port       LACPDUs        Marker     Pckt err
         Sent   Recv    Sent   Recv   Sent  Recv
         % Aggregator  Po 10 1000000
Te 0/1   65     0       0      0       0     0
Te 0/2   64     0       0      0       0     0
Te 0/3   64     0       0      0       0     0
Te 0/4   0      0       0      0       0     0
```

   In this case, LACPDUs are being transmitted by the switch, but none are being received.

2. If the output shows that LACPDUs are not being transmitted and received correctly, or packet errors are showing, contact your switch support provider.

Verifying the vLAG configuration

The port-channel number must be the same across all vLAG member switches, or the vLAG will not form.

1. On each vLAG member switch, in privileged EXEC mode, enter the **show port-channel summary** command.

```
switch# show port-channel summary
 Static Aggregator: Po 15
 Aggregator type: Standard
 Member ports:
  Te 0/6
  Te 0/7
  Te 0/14
  Te 0/15
...
switch2# show port-channel summary
switch2#
```

2. If the port-channel does not appear on both switches, on the switch where it does not appear, in global configuration mode, enter the **interface port-channel** command to create the port-channel.

```
switch2(config)# interface port-channel 15
```

   Refer to Configuring Link Aggregation on page 443 for details.

Verifying the LACP mode of each switch

A vLAG must be configured either statically on both ends of the vLAG, or dynamically on both ends of the vLAG. Refer to Configuring Link Aggregation on page 443 for details.

Explicitly setting the speed for a 1-Gbps port-channel

To set the port speed to 1 Gbps, complete the following steps.

1. In interface configuration mode, shut down the port-channel.

```
switch(config-Port-channel-2)# shutdown
```

2. Set the port-channel speed to 1 Gbps.

```
switch(config-Port-channel-2)# speed 1000
```

3. Re-enable all port members in the port-channel.

```
switch(config-Port-channel-2)# no shutdown
```

Zoning conflict needs resolution

When merging two fabrics, multiple zoning CLI sessions can be launched on the same switch, or on different switches. This section describes these situations and how they are automatically resolved.

Dual-CLI sessions from the same switch: If you start a zone transaction from CLI-Session1 and then try to perform a zone modification from CLI-Session2, the CLI-Session2 zone transaction is not allowed, as CLI-Session2 is not the owner of the open transaction. If CLI-Session1 logs out, this ends the open transaction and aborts any current zone modifications. CLI-Session2 is then able to perform zone modifications. Therefore, the zone transaction locking mechanism works on a single switch from the CLI perspective and there is no dangling transaction.

Dual-CLI sessions from different switches: If you start a CLI zone transaction on Switch1 and started another CLI zone transaction on Switch2, when the zone transaction from Switch1 is committed, the open zone transaction from Switch2 is aborted by Switch1. The following message is posted on Switch2 at the time of zone commit from Switch1:

```
2014/01/09-21:45:26, [ZONE-1027], 3285, FID 128, INFO, switch, Zoning transaction aborted Zone Config
update Received
```

Zone does not form correctly

Some problems you might encounter when configuring zones include potential Fibre Channel router issues. For a more detailed discussion of possible Fibre Channel issues, refer to the *Fabric OS Troubleshooting and Diagnostics Guide*.

Some of the following problems may contribute to the zone not forming correctly:

- A Brocade VDX switch gets isolated when an RBridge ID matches the front domain ID or translate domain ID in a mixed network. Refer to Recovering an isolated switch in a mixed FCoE fabric on page 732.
- A "FID over-subscribed" message occurs during attempts to connect a backbone fabric to an edge fabric. Refer to Recovering from FID oversubscription on page 733.
- A "FID conflict" message occurs during attempts to connect a backbone fabric to an edge fabric. Refer to Recovering from Fabric ID conflict on page 733.
- Interfabric link (IFL) traffic does not flow over the intended link. Refer to Rebalancing traffic over multiple IFLs on page 733.
- Zone merge was expected to be blocked following reboot, but was not blocked. Refer to Blocking zone merge after reboot on page 733.
- Stale translate domains exist in an edge fabric. Refer to Removing stale translate domains on page 734.

Recovering an isolated switch in a mixed FCoE fabric

In an FCoE fabric that spans Network OS switches and Fabric OS switches, a Network OS switch with an RBridge ID that matches a front phantom domain ID or translate phantom domain ID of a connecting Fibre Channel router can become isolated.

FCoE connectivity across the Fibre Channel link between VCS Fabric clusters and Fibre Channel routers uses domain IDs to identify switches. Within a VCS Fabric cluster, a domain ID is the same as an RBridge ID. When you connect to a Fibre Channel router, the Fibre Channel router service in the Fibre Channel fabric emulates virtual phantom Fibre Channel domains in the FCoE fabric. Each Fibre Channel router-enabled switch emulates a single front phantom domain and each FC fabric is represented by a translate phantom domain.

To recover an isolated Network OS switch, complete the following steps.

1. Disable all FC routers that connect to the VCS Fabric cluster.
2. Reboot the isolated Network OS switch.
3. Re-enable all disabled FC routers.
4. To prevent switch isolation, follow these steps on each FC router that attaches to a VCS Fabric cluster.
   a) Enter the **portCfgExPort -d** Fabric OS command to set a unique front phantom domain ID.
   b) Enter the **fcrXlateConfig** *importedFID exportedFID preferredDomainID* command to set a unique translate phantom domain ID.

      Refer to the *Fabric OS Command Reference* for details about the **portCfgExPort** and **fcrXlateConfig** commands.

Recovering from FID oversubscription

A "FID over-subscribed" message occurs when different Fibre Channel backbones attempt to connect to the same edge fabric using different Fabric IDs (FIDs). When you assign a FID to the edge fabric (**portCfgExPort -f** command), you must use the same FID as any other Fibre Channel backbone that connects to the edge fabric.

To resolve this problem, complete the following steps.

1. On the Fibre Channel router on the backbone with the errant FID configured, disable the EX_Port.
2. Enter the **portCfgExPort -f** command to configure the EX_Port with the same FID as the EX_Port on the other Fibre Channel router that connects to the same edge fabric.
3. Re-enable the EX_Port.

   Refer to "Configuring an IFL for both edge and backbone connections" in the *Fabric OS Administrator's Guide* for details.

Recovering from Fabric ID conflict

The "FID conflict" message occurs when a backbone fabric connects to two or more edge fabrics that have the same Fabric ID (FID). Every edge fabric that a Fibre Channel router connects to must have a Fabric ID configured for the EX_Port that is unique on that Fibre Channel backbone. This error is most likely to occur when an edge fabric temporarily splits, causing it to appear as two edge fabrics with the same Fabric ID. This symptom might occur during VCS Fabric or Fibre Channel fabric upgrade, or as a result of a Brocade VDX or Fibre Channel switch reboot or crash.

Problem resolution depends on the cause of the problem. If the error is due to a temporary split, the problem will go away when the fabrics merge again.

If the problem is not due to a temporary fabric split, the most likely cause is misconfiguration. In this case, enter the **portCfgExPort -f** command to reconfigure one of the EX_Ports with a unique fabric ID.

Rebalancing traffic over multiple IFLs

If traffic across multiple interfabric links (IFLs) between a Fibre Channel router and an edge fabric is not balanced as you intended, it may be because the Fibre Channel router cannot determine an FSFP path from the Fibre Channel backbone to the target in the edge fabric. It uses all paths.

To direct the traffic the way you intend, on the FC router, use the **fcrRouterPortCost** command to configure a cost for each IFL. Traffic will flow across the lowest-cost IFL.

1. Connect to the FC router and log in using an account with admin permissions.
2. Disable the EX_Port.
3. Enter the **fcrRouterPortCost** command to configure the link cost.

   Set the cost to 1000 if you want to the link to carry traffic during normal operation. If you want the link to not carry traffic under normal operation, set the cost to 10000 (ten thousand) and set the cost of at least one other link to 1000. The default value is 1000, which you get when you enter a value of 0.
4. Re-enable the port.

   For details about the **fcrRouterPortCost** command, refer to the *Fabric OS Command Reference*.

Blocking zone merge after reboot

To be sure of blocking zone merge following a switch reboot, enter the **no fabric isl enable** command to disable the ISL between neighboring Brocade VDX switches.

CAUTION
Brocade recommends that you do *not* use the shutdown command. If you use the shutdown command, then following switch reboot, the zone merge could happen before the shutdown command is replayed by the running configuration.

To block zone merge following reboot, follow these steps on each ISL port.

1. In global configuration mode, enter the **interface tengigabitethernet** (or **interface gigabitethernet**) command to enter interface configuration mode.
2. Enter the **no fabric isl enable** command.

Removing stale translate domains

A translate domain becomes stale when the edge fabric it represents becomes unreachable. By default, the stale translate domain is not deleted until the local edge fabric is rebuilt.

To delete a stale translate domain and avoid the disruption caused by rebuilding the local edge fabric, complete the following steps.

1. Connect to the Fibre Channel router and log in using an account with admin permissions.
2. On the FC router, enter the **fcrXlateConfig --show stalexd** command to list any stale translate domains.
3. Enter the **fcrXlateConfig --delete stalexd** command to delete the stale translate domain.

   Refer to the *Fabric OS Command Reference* for details about the **fcrXlateConfig** command.

Using troubleshooting and diagnostic tools

This section describes the various troubleshooting and diagnostic tools available with Network OS and provides some guidelines for their use

Refer also to Gathering troubleshooting information on page 683, which provides information about Network OS supportSave files.

Using Layer 2 traceroute

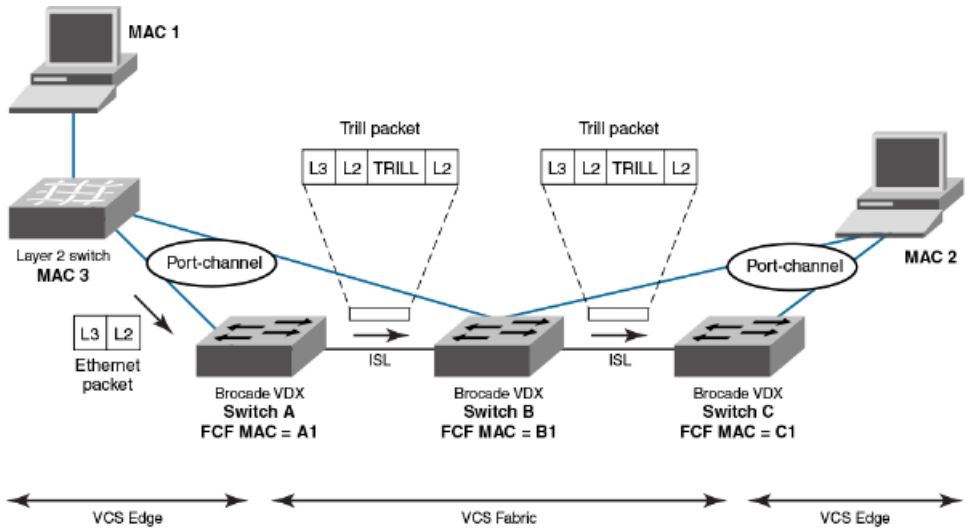
TRILL OAM provides the **l2traceroute** command to verify the fabric path continuity. When the **l2traceroute** command is used with extended options, it provides granular control over the Layer 2 path that a Layer 2 traceroute packet takes.

Layer 2 traceroute packets

To use the Layer 2 traceroute tool, you need to understand the structure of the Layer 2 traceroute packet when observed on the wire, when it is a request frame, and when it is a response frame.

The figure below shows what a normal Layer 2 packet looks like when traversing through an Ethernet fabric, without Layer 2 traceroute applied.

FIGURE 76 Normal Layer 2 packet traversing a VCS fabric



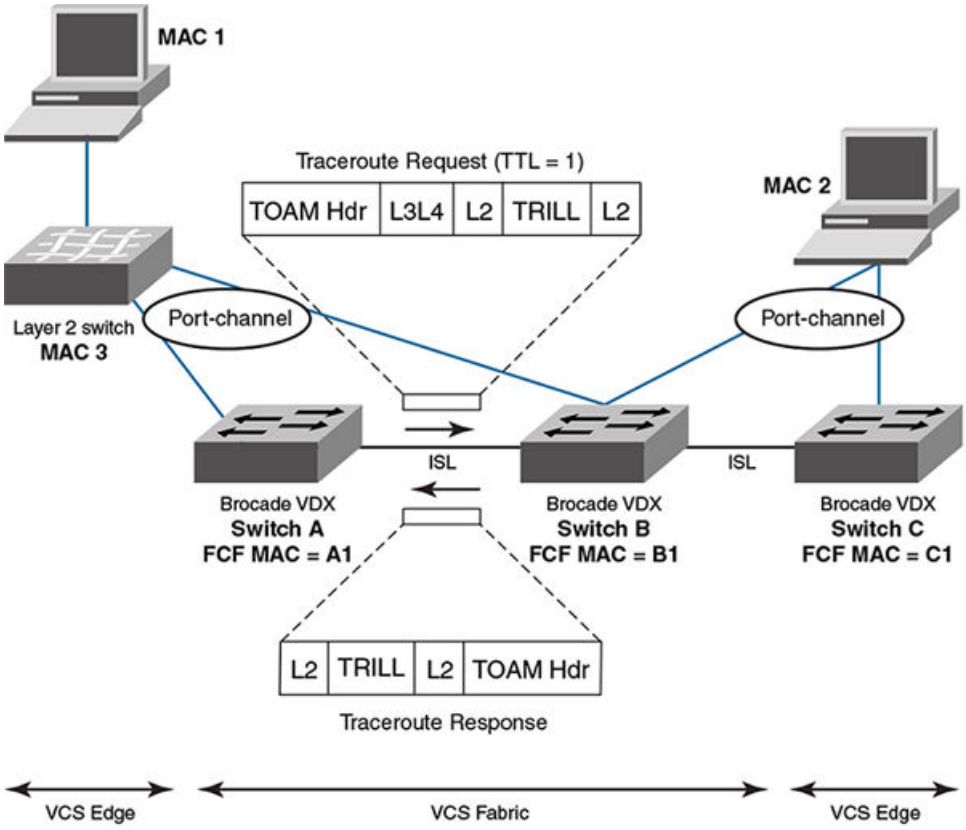
In the figure above, an Ethernet packet arrives from MAC 1 at the VCS fabric edge. TRILL header information is added while the packet passes through the VCS fabric. The TRILL information is removed on leaving the VCS fabric, and a regular Ethernet packet arrives at MAC 2. The table below shows the Layer 2 packet header details.

TABLE 101 Packet header details — Layer 2 packer traverses VCS fabric

Ethernet packet	TRILL packet — first hop	TRILL packet — second hop
L2 DA = MAC 2L2 SA = MAC 1	Outer L2 DA = B1Outer L2 SA = A1Outer 802.1q tagOuter etype = TRILLTRILL destination RBridge ID = CTRILL source RBridge ID = ATRILL flagsInner L2 DA = MAC 2Inner L2 SA = MAC 1 Inner 802.1q tagInner etype = 0x800	Outer L2 DA = C1Outer L2 SA = B1Outer 802.1q tagOuter etype = TRILLTRILL destination RBridge ID = CTRILL source RBridge ID = ATRILL flagsInner L2 DA = MAC 2Inner L2 SA = MAC 1 Inner 802.1q tagInner etype = 0x800

When viewing packets while using the **l2traceroute** command, notice the TRILL OAM header information added to the packets as they traverse the VCS Fabric. Starting the trace on Switch A, TRILL OAM first verifies path continuity with its immediate neighbor, in this case Switch B. It does this as shown in the figure below, by sending a Layer 2 traceroute request packet with the time-to-live (TTL) TRILL attribute set to 1. Switch B replies with reachability information regarding the next hop.

FIGURE 77 Verifying path continuity with immediate neighbor



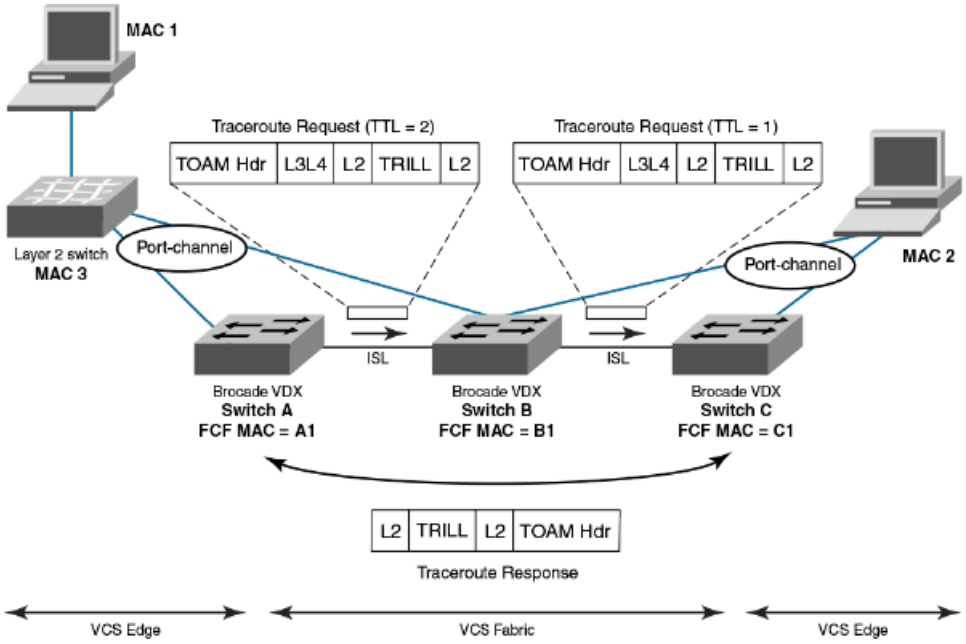
The table below shows the packet header information for the request and response. The added TRILL OAM information is shown in **bold**.

TABLE 102 Packet header details with Layer 2 traceroute — first hop

Traceroute request packet header	Traceroute reply packet header
Outer L2 DA = B1Outer L2 SA = A1Outer 802.1q tagOuter etype = TRILLTRILL destination RBridge ID = CTRILL source RBridge ID = ATRILL flags: **TTL = 1** Inner L2 DA = MAC 2Inner L2 SA = MAC 1	Outer L2 DA = B1Outer L2 SA = A1Outer 802.1q tagOuter etype = TRILLTRILL destination RBridge ID = ATRILL source RBridge ID = BTRILL flags: **TTL = MAX (63)** Inner L2 DA = A1Inner L2 SA = B1
Inner 802.1q tagInner etype = 0x800	Inner 802.1q tag**Inner etype = TRILL OAM**
TOAM Opcode = 5 (request)	**TOAM Opcode = 4 (reply)**
	C reachable

Having successfully exchanged packets with the immediate neighbor (Switch B) and established the reachability of Switch C, the Layer 2 traceroute feature issues another request with TTL set to 2. Switch B decrements the TTL count and forwards the packet to Switch C, which returns a response to Switch A. Refer to the figure below.

FIGURE 78 Verifying path continuity— second hop TTL count



The table below shows the packet header information for the request and response packets. Information specific to the Layer 2 traceroute feature is show in **bold**.

TABLE 103 Packet header details with Layer 2 traceroute — second hop

Traceroute request — first hop (TTL = 2)	Traceroute request — second hop (TTL = 1)	Traceroute reply
Outer L2 DA = B1Outer L2 SA = A1Outer 802.1q tagOuter etype = TRILLTRILL destination RBridge ID = CTRILL source RBridge ID = ATRILL flags: **TTL = 2** Inner L2 DA = MAC 2Inner L2 SA = MAC 1	Outer L2 DA = C1Outer L2 SA = B1Outer 802.1q tagOuter etype = TRILLTRILL destination RBridge ID = CTRILL source RBridge ID = ATRILL flags: **TTL = 1** Inner L2 DA = MAC 2Inner L2 SA = MAC 1	Outer L2 DA = B1->A1Outer L2 SA = C1->B1Outer 802.1q tagOuter etype = TRILLTRILL destination RBridge ID = ATRILL source RBridge ID = CTRILL flags: **TTL = MAX (63)** Inner L2 DA = A1Inner L2 SA = B1
Inner 802.1q tagInner etype = 0x800	Inner 802.1q tagInner etype = 0x800	Inner 802.1q tag**Inner etype = TRILL OAM**
TOAM Opcode = 5 (request)	**TOAM Opcode = 5 (request)**	**TOAM Opcode = 4 (reply)**

Tracing a route with the l2traceroute command

In the following example, the **l2traceroute** command verifies the path between port 3/0/1 (source MAC address 0050.5685.0003) and port 2/0/9 (destination MAC address 0024.3878.3720).

1. enter the **show mac-address-table** command to display all known MAC addresses in the network.

```
switch# show mac-address-table

VlanId  Mac-address    Type   State   Ports
100   0024.3878.e720  Dynamic Active   Po 11
100   0050.5685.0001  Dynamic Active   Po 1
101   0000.0000.0003  Dynamic Active   Po 1
101   0024.3878.e720  Dynamic Active   Po 11
101   0050.5685.0003  Dynamic Active   Po 1
Total MAC addresses  : 5
```

   From the output, choose the source and destination MAC address:

   - Source MAC address: 0050.5685.0003
   - Destination MAC address: 0024.3878.e720

2. Enter the **l2traceroute** command.

```
switch2# l2traceroute
Source mac address            : 0050.5685.0003
Destination mac address       : 0024.3878.e720
Vlan [1-3962]                 : 101
Edge rbridge-id [1-239]       : 3
Extended commands [Y/N]?      : y
Protocol Type [IP]            : IP
Source IP address             : 101.101.101.10
Destination IP address        : 101.101.101.101
IP Protocol Type [TCP/UDP]    : TCP
Source port number [0-65535]  : 3000
Dest port number [0-65535]    : 22
Rbridge  Ingress                 Egress                    Rtt(usec)
-------------------------------------------------------------------------
3        Te 3/0/1(std-lag, Po 1)  Te 3/0/20(isl)            0
2        Te 2/0/20(isl)           Te 2/0/9(std-lag, Po 11)  34041
```

   Be advised of the following points:

   - The MAC addresses used should be present in the MAC address-table (dynamic or static).
   - The **l2traceroute** command can be used in VCS Fabric mode only.
   - Make use of IP parameters to influence path selection.

Using show commands

The table below lists some **show** commands that are often used for troubleshooting. Refer to the *Network OS Command Reference* for details of all **show** commands.

TABLE 104 show commands used for troubleshooting

Command group	Commands	Specific fields or purpose
System commands	show system show license show running-config show startup-config show logging raslog	

TABLE 104 show commands used for troubleshooting (continued)

Command group	Commands	Specific fields or purpose
	show version show chassis show environment show vlan brief show mac-address-table show process cpu show process memory show firmwaredownloadstatus	
Interface commands	show interface show media show ip int brief show qos flowcontrol interface show qos queue interface show qos rcv-queue interface show qos int	Check pause-frames Check the CoS statistics Check packet drops, buffer consumption, real-time queue statistics Check the QoS configuration on an interface
Diagnostic commands	show diags status show diags post results detailed show diag burninerrshow show diag burninstatus	
Feature commands	show port-channel detail show lacp counter show port-profile status show fcoe login show fcoe interface brief show fcoe internal fcf-mac-address show lldp neighbors detail show lldp statistics show qos interface all show udld statistics	
VCS Fabric commands	show vcs show fabric trunk all show fabric all show fabric isl show fabric islports show fabric route linkinfo show fabric route multicast show fabric route neighbor-state	

TABLE 104 show commands used for troubleshooting (continued)

Command group	Commands	Specific fields or purpose
	show fabric route pathinfo show fabric route topology show name-server detail all	

Using debug commands

You can perform the following operations related to debugging features:

- To enable debugging on a feature, use the **debug** command.

  ```
  debug feature required-keywords
  ```

- To check whether debugging is enabled on a feature, use the **show debug** command.

  ```
  show debug feature
  ```

- To disable debugging, use the **no debug** command.

  ```
  no debug feature required-keywords
  ```

Use caution when debugging in real time on a production switch, because real-time debugging is CPU-intensive. Brocade recommends checking the debug output on a lab switch first, and then if the output looks acceptable, enable it on the production switch to get more data. In addition, to reduce CPU load, Brocade recommends using keywords such as **events** and **summary** that limit the extent of debugging rather than more comprehensive options such as **detail** and **all**.

Debugging operations are used mainly for debugging control plane protocols such as LACP and LLDP. For example, to view received LLDP packets on the console, use the following command.

```
switch# debug lldp packets all rx
```

If the switch is accessed through Telnet, enable logging using a terminal monitor.

The following are the most often used debug commands:

- **debug lldp packets interface** [**rx** | **tx** | **both**]
- **debug lacp pdu** [**rx** | **tx**]
- **debug spanning-tree bpdu** [**rx** | **tx**] (Standalone mode only)
- **debug dot1x packet** (Standalone mode only)

Using SPAN port and traffic mirroring

In certain instances, you may need to examine packets in transit across links to understand the traffic pattern on a specific port. In such situations, Switched Port Analyzer (SPAN) can be configured to copy the traffic (with the desired direction) on the specific Ethernet port to a mirror port where a sniffing device is connected. You can then analyze the packets captured by the sniffing device.

```
switch(config)# monitor session 1
switch(conf-mon-sess-1)# source tengigabitethernet 1/0/10 destination tengigabitethernet 1/0/15 direction
both

switch# show monitor 1
Session :1
Description :Test SPAN Session
State :Enabled
```

```
Source interface : 1/0/10 (Up)
Destination interface : 1/0/15 (Up)
Direction :Both
```

The source and destination ports must belong to the same ASIC. The Brocade VDX 6720-24 and Brocade VDX 6730-32 switches have just one ASIC, so source and destination can be any 10-GbE port. Other Brocade VDX switches have multiple ASICs; The table below shows the mapping of ports to these ASICs.

TABLE 105 ASICs and ports

Network OS switch	ASIC	Port numbers
Brocade VDX 6720-60 and Brocade VDX 6730-76	0	te0/1 through te0/10
	1	te0/11 through te0/20
	2	te0/21 through te0/30
	3	te0/31 through te0/40
	4	te0/41 through te0/50
	5	te0/51 through te0/60
Brocade VDX 6710	0	te0/1 through te0/6 and gi0/1 through gi0/14
	1	gi0/15 through gi0/27
	2	gi0/28 through gi0/48

The destination port cannot be an ISL, Layer 2, Layer 3, QoS, ACL, 802.1x, LAG member, LLDP, or port-profile port. The source port cannot be an ISL port. In VCS Fabric mode, only edge ports are eligible for mirroring.

Using hardware diagnostics

The following diagnostic types currently exist:

- Power-on self-test (POST)
- Offline diagnostics

Online diagnostics are not currently supported on Brocade VDX switches.

Using POST diagnostics

POST is run on bootup and the results are stored. Use the **show diag post results** command to view the stored results.

To enable POST, enter the **diag post rbridge-id** *rbridge-id* **enable** command.

Using offline diagnostics

Before proceeding, note the following Caution:

CAUTION

Offline diagnostics — otherwise known as system verification tests — are disruptive tests that check the individual hardware components thoroughly and report the findings. You must disable the chassis before running these tests. Do not run production traffic during this time.

Enter the **diag systemverification** command to run the entire set of offline diagnostics. This command can take up to two hours to finish, so Brocade recommends the less disruptive **diag systemverification short** command, which typically takes 10 to 15 minutes.

Alternatively, you can run subsets of the offline commands that check various parts of the hardware. The table below shows the complete list of supported offline commands.

TABLE 106 Offline diagnostic commands

Offline diagnostic command	Purpose
diag burninerrclear	Clears the errors that are stored in the nonvolatile storage during the burn-in process.
diag clearerror	Clears the diagnostics failure status.
diag portledtest	Runs various action modes on the port LEDs and validates the functionality.
diag portloopbacktest	Sends frames between various ASICs on the switch and validates the ASIC functionality.
diag setcycle	Configures all the parameters required for the system verification test.
diag systemverification	Runs a combination of various hardware diagnostic tests.
diag turboramtest	Performs a turbo static RAM (SRAM) test of the ASIC chips.

The table below lists the show commands that provide output from offline diagnostics.

TABLE 107 Offline diagnostic show commands

Show offline diagnostic command	Purpose
show diag burninerrshow	Displays the errors that are stored in the nonvolatile storage during burn-in.
show diag burninstatus	Displays the diagnostics burn-in status.
show diag setcycle	Displays the current values used in system verification.
show diag status	Displays the currently running diagnostics tests.

For details of the commands listed in these tables, refer to the *Network OS Command Reference*.

Viewing routing information

The **show fabric route pathinfo** command displays routing and statistical information from a source port index on the local switch to a destination port index on another switch in the same VCS Fabric cluster, a different VCS Fabric cluster, a connected Fabric OS backbone fabric, or Fabric OS edge fabric. This routing information describes the full path that a data stream travels between these ports, including all intermediate switches.

The routing and statistics information are provided by every switch along the path, based on the current routing table information and statistics calculated continuously in real time. Each switch represents one hop.

Use the **show fabric route pathinfo** command to display routing information from a source port on the local switch to a destination port on another switch. The command output describes the exact data path between these ports, including all intermediate switches.

To use the **show fabric route pathinfo** command across remote fabrics, you must specify both the VCS ID (or Fabric ID) and the RBridge ID (or domain ID) of the remote switch. When obtaining path information across remote fabrics, the destination switch must be identified by its RBridge ID or domain ID. Identifying the switch by name or WWN is not accepted.

For details about the **show fabric route pathinfo** command, refer to the *Network OS Command Reference*.

Using the packet capture utility

When a packet is received at a switch's source port, it is routed through the switch to the destination port. If a problem occurs, SPAN or sFlow are commonly used. However, SPAN requires a network analyzer, and sFlow requires a collector. The packet capture utility, executed by means of the **capture packet interface** command, makes it possible to capture packets destined toward the CPU, as well as transit packets if a trap is enabled by means of ACL logging. This command can provide significant help in debugging, especially for Layer 2 TRILL and Layer 3 packets.

There are two ways to view the results of packet capture:

- By using the **show capture packet interface** command on the target switch.
- By viewing the results in an automatically generated file.

For command details, refer to the *Network OS Command Reference*.

Captured packets are stored in a circular buffer, and they are also written to an automatically generated `pktcapture.pcap` file, which can store up to 1500 KB of data in flash memory (the equivalent of approximately 10KB packets, each having an average size of 100 bytes). Once this file is full, it is saved as `*_old.pcap` and data are written to a new `pktcapture.pcap` file. These files can be exported and viewed through a packet analyzer such as Wireshark.

> NOTE
> Up to 100 packets per interface can be captured. Once the buffer is filled, the oldest packets are replaced with the most recent.

Note the following limitations:

- Support is provided only on physical interfaces (1-, 10-, and 40-gigabit Ethernet), not on logical interfaces. To capture packets on logical interfaces, first enable the capture on the corresponding physical interfaces.
- Support for capturing transit traffic requires ACL logging.
- Packets that are dropped in the ASIC cannot be captured.

> CAUTION
> **Capturing packets over multiple sessions and over long durations can affect system performance.**

TACACS+ Accounting Exceptions

TACACS+ command-accounting limitations

TACACS+ command accounting is subject to the following limitations:

- The TACACS+ command-accounting logs only the Network OS CLI base command name. For example, if the command executed is **secpolicy defined-policy SCC_POLICY+**, only the **secpolicy** command is logged in the TACACS+ server.
- the **no radius-sever** command is logged as the **radius-server** command.
- A number of Network OS CLI commands are not supported by TACACS+ accounting; refer to Unsupported Network OS command line interface commands on page 745 for a listing of unsupported operational and configuration commands.

Unsupported Network OS command line interface commands

The following table lists the Network OS CLI commands that are not supported in privileged EXEC mode.

TABLE 108 Unsupported Network OS CLI commands in privileged EXEC mode

Command name	Command Description
cipherset	Configures FIPS-compliant secure ciphers for LDAP and SSH.
clear	Clears the specified parameter.
clear arp	Clears Address Resolution Protocol (ARP) configuration data.
clear counters	Clears statistics from the switch.
clear dot1x	Clears IEEE 802.1X Port-Based Access Control configuration data.
clear fcoe	Clears FCoE configuration data.
clear ip	Clears Internet Protocol (IP) configuration data.
clear lacp	Clears Link Aggregation Control Protocol (LACP) configuration data.
clear lldp	Clears Link Layer Discovery Protocol (LLDP) configuration data.
clear mac-address-table	Clears the MAC address table.
clear mcagt	Clears the MCAGT agent.
clear policy-map-counters	Clears the policy map counters.
clear sflow	Clears sFlow configuration data.
clear spanning-tree	Clears Spanning Tree Protocol (STP) configuration data.
clear vrrp	Clears Virtual Router Redundancy Protocol (VRRP) configuration data.
configure	Configures access mode.
copy	Copies data.
debug	Sets debugging options.
delete	Delete a specified file.
dir	Displays a directory listing.

TABLE 108 Unsupported Network OS CLI commands in privileged EXEC mode (continued)

Command name	Command Description
dot1x	Executes IEEE 802.1X Port-Based Access Control options.
exit	Exits to the top level and optionally runs a command.
fips	Executes FIPS-related operations.
help	Provides help information.
history	Configures the size of the history log.
logout	Terminates the current login session.
mac-rebalance	Rebalances MAC on a port channel
ping	Executes the **ping** command.
quit	Terminates the current session.
rename	Renames a file.
reload	Reboots the system.
resequence	Re-orders a list.
send	Sends a message to terminal of one or all users.
terminal	Configures terminal properties.
show arp	Displays the Address Resolution Protocol (ARP) configuration.
show bpdu-drop	Displays the Bridge Protocol Data Unit (BPDU) drop configuration.
show cee maps	Displays CEE maps.
show cipherset	Displays ciphers for LDAP and SSH.
show cli	Displays CLI session parameters.
show clock	Displays the date and time settings.
show diag	Displays diagnostic information.
show dot1x	Displays IEEE 802.1X Port-Based Access Control configuration data.
show edge-loop-detection globals	Displays system-wide Edge-Loop-Detection status information.
show fcoe login	Displays the FCoE CNA Login information.
show file	Displays the contents of a file.
show history	Displays command history.
show interface	Displays interface status and configuration.
show ip	Displays Internet Protocol (IP) information.
show lacp counter	Displays Link Aggregation Control Protocol (LACP) counters.
show lldp	Displays Link Layer Discovery Protocol (LLDP) configuration data
show monitor	Displays interface status and configuration.
show netconf-state	Displays NETCONF statistics.
show ntp	Displays the active NTP server.
show parser dump	Displays a parser dump.
show policy-map	Displays the configured rate-limiting policy maps.
show port	Displays port parameters.
show port-channel	Displays the port-channel configuration.
show port-profile	Displays the port profile configuration
show qos	Display the Quality of Service (QoS) configuration.
show running-config	Displays the running configuration.
show sflow	Displays the sFlow configuration.

TABLE 108 Unsupported Network OS CLI commands in privileged EXEC mode (continued)

Command name	Command Description
show spanning-tree	Displays the Spanning Tree Protocol configuration.
show ssm	Displays the switch services subsystem.
show startup-db	Displays the startup configuration.
show storm-control	Displays storm control configuration.
show statistics	Displays accounting information.
show system	Displays runtime system information.
show rmon	Displays the Remote Monitoring Protocol (RMON) configuration.
show vcs	Displays VCS information.
show vlan	Displays the VLAN configuration
show mac-address-table	Displays the MAC address table.
show startup-config	Displays the contents of the startup-configuration file.
show zoning	Displays zoning information.
traceroute	Executes the **traceroute** command.

The following table lists the Network OS CLI commands that are not supported in global configuration mode.

TABLE 109 Unsupported Network OS CLI commands in global configuration mode

Command name	Command Description
abort	Aborts the current configuration session.
diag	Manages diagnostic commands.
do	Executes an operational command while in global configuration mode.
end	Terminates the current configuration session.
exit	Exits from the current mode.
help	Provides help information.
pwd	Displays the current mode path.
service	Performs password encryption services.
top	Exits to the top level and optionally runs a command.
no vlan	Disables VLAN configuration.

Supported NTP Regions and Time Zones

Africa

The table below lists region and city time zones supported in the Africa region.

TABLE 110 Region/city time zones in Africa region

Africa/Luanda	Africa/Banjul	Africa/Mogadishu
Africa/Ouagadougou	Africa/Conakry	Africa/Sao_Tome
Africa/Bujumbura	Africa/Malabo	Africa/Mbabane
Africa/Porto-Novo	Africa/Bissau	Africa/Ndjamena
Africa/Gaborone	Africa/Nairobi	Africa/Lome
Africa/Kinshasa	Africa/Monrovia	Africa/Tunis
Africa/Lubumbashi	Africa/Maseru	Africa/Dar_es_Salaam
Africa/Bangui	Africa/Tripoli	Africa/Kampala
Africa/Brazzaville	Africa/Casablanca	Africa/Johannesburg
Africa/Abidjan	Africa/Bamako	Africa/Lusaka
Africa/Douala	Africa/Nouakchott	Africa/Harare
Africa/Djibouti	Africa/Blantyre	
Africa/Algiers	Africa/Maputo	
Africa/Cairo	Africa/Windhoek	
Africa/El_Aaiun	Africa/Niamey	
Africa/Asmara	Africa/Lagos	
Africa/Ceuta	Africa/Kigali	
Africa/Addis_Ababa	Africa/Khartoum	
Africa/Libreville	Africa/Freetown	
Africa/Accra	Africa/Dakar	

America

The table below lists region and city time zones supported in the America region.

TABLE 111 Region/city time zones in America region

America/Antigua	America/Guatemala	America/Edmonton
America/Anguilla	America/Guyana	America/Cambridge_Bay
America/Curacao	America/Tegucigalpa	America/Yellowknife
America/Argentina/Buenos_Aires	America/Port-au-Prince	America/Inuvik
America/Argentina/Cordoba	America/Guadeloupe	America/Dawson_Creek
America/Argentina/San_Luis	America/Jamaica	America/Vancouver
America/Argentina/Jujuy	America/St_Kitts	America/Whitehorse
America/Argentina/Tucuman	America/Cayman	America/Thunder_Bay
America/Argentina/Catamarca	America/St_Lucia	America/Iqaluit
America/Argentina/La_Rioja	America/Marigot	America/Pangnirtung
America/Argentina/San_Juan	America/Adak	America/Resolute
America/Argentina/Mendoza	America/Martinique	America/Rankin_Inlet
America/Argentina/Rio_Gallegos	America/Montserrat	America/Winnipeg
America/Argentina/Ushuaia	America/Mexico_City	America/Rainy_River
America/Aruba	America/Cancun	America/Regina
America/Barbados	America/Merida	America/Montevideo
America/St_Barthelemy	America/Monterrey	America/St_Vincent
America/La_Paz	America/Mazatlan	America/Caracas
America/Noronha	America/Chihuahua	America/Tortola
America/Belem	America/Hermosillo	America/St_Thomas
America/Fortaleza	America/Tijuana	America/New_York
America/Recife	America/Managua	America/Detroit
America/Araguaina	America/Panama	America/Kentucky/Monticello
America/Maceio	America/Lima	America/Indiana/Indianapolis
America/Bahia	America/Miquelon	America/Indiana/Vincennes
America/Sao_Paulo	America/Puerto_Rico	America/Indiana/Knox
America/Campo_Grande	America/Asuncion	America/Indiana/Winamac
America/Cuiaba	America/Paramaribo	America/Indiana/Marengo
America/Santarem	America/El_Salvador	America/Indiana/Vevay
America/Porto_Velho	America/Grand_Turk	America/Chicago
America/Boa_Vista	America/Swift_Current	America/Indiana/Tell_City
America/Manaus	America/Dawson	America/Indiana/Petersburg
America/Eirunepe	America/Santiago	America/Menominee
America/Rio_Branco	America/Bogota	America/North_Dakota/Center
America/Nassau	America/Costa_Rica	America/North_Dakota/New_Salem

TABLE 111 Region/city time zones in America region (continued)

America/Belize	America/Havana	America/Denver
America/St_Johns	America/Dominica	America/Boise
America/Halifax	America/Santo_Domingo	America/Shiprock
America/Glace_Bay	America/Guayaquil	America/Phoenix
America/Moncton	America/Grenada	America/Los_Angeles
America/Goose_Bay	America/Cayenne	America/Anchorage
America/Blanc-Sablon	America/Godthab	America/Juneau
America/Montreal	America/Danmarkshavn	America/Yakutat
America/Toronto	America/Scoresbysund	America/Nome
America/Nipigon	America/Thule	America/Port_of_Spain

Antarctica

The table below lists region and city time zones supported in the Antarctica region.

TABLE 112 Region/city time zones in Antarctica region

Antarctica/McMurdo	Antarctica/Mawson	Antarctica/Vostok
Antarctica/South_Pole	Antarctica/Davis	Antarctica/DumontDUrville
Antarctica/Rothera	Antarctica/Casey	Antarctica/Syowa

Arctic

The table below lists region and city time zones supported in the Arctic region.

TABLE 113 Region/city time zone in Arctic region

Arctic/Longyearbyen		

Asia

The table below lists region and city time zones supported in the Asia region.

TABLE 114 Region/city time zones in Asia region

Asia/Dubai	Asia/Tokyo	Asia/Gaza
Asia/Kabul	Asia/Bishkek	Asia/Qatar
Asia/Yerevan	Asia/Phnom_Penh	Asia/Yekaterinburg
Asia/Baku	Asia/Pyongyang	Asia/Omsk
Asia/Dhaka	Asia/Seoul	Asia/Novosibirsk
Asia/Bahrain	Asia/Kuwait	Asia/Krasnoyarsk
Asia/Brunei	Asia/Almaty	Asia/Irkutsk
Asia/Thimphu	Asia/Qyzylorda	Asia/Yakutsk

TABLE 114 Region/city time zones in Asia region (continued)

Asia/Shanghai	Asia/Aqtobe	Asia/Vladivostok
Asia/Harbin	Asia/Aqtau	Asia/Sakhalin
Asia/Chongqing	Asia/Oral	Asia/Magadan
Asia/Urumqi	Asia/Vientiane	Asia/Kamchatka
Asia/Kashgar	Asia/Beirut	Asia/Anadyr
Asia/Nicosia	Asia/Colombo	Asia/Riyadh
Asia/Tbilisi	Asia/Rangoon	Asia/Singapore
Asia/Hong_Kong	Asia/Ulaanbaatar	Asia/Damascus
Asia/Jakarta	Asia/Hovd	Asia/Bangkok
Asia/Pontianak	Asia/Choibalsan	Asia/Dushanbe
Asia/Makassar	Asia/Macau	Asia/Dili
Asia/Jayapura	Asia/Kuala_Lumpur	Asia/Ashgabat
Asia/Jerusalem	Asia/Kuching	Asia/Taipei
Asia/Kolkata	Asia/Katmandu	Asia/Samarkand
Asia/Baghdad	Asia/Muscat	Asia/Tashkent
Asia/Tehran	Asia/Manila	Asia/Ho_Chi_Minh
Asia/Amman	Asia/Karachi	Asia/Aden

Atlantic

The table below lists region and city time zones supported in the Atlantic region.

TABLE 115 Region/city time zones in Atlantic region

Atlantic/Bermuda	Atlantic/Faroe	Atlantic/Azores
Atlantic/Cape_Verde	Atlantic/South_Georgia	Atlantic/St_Helena
Atlantic/Canary	Atlantic/Reykjavik	
Atlantic/Stanley	Atlantic/Madeira	

Australia

The table below lists region and city time zones supported in the Australia region.

TABLE 116 Region/city time zones in Australia region

Australia/Lord_Howe	Australia/Sydney	Australia/Darwin
Australia/Hobart	Australia/Brisbane	Australia/Perth
Australia/Currie	Australia/Lindeman	Australia/Eucla
Australia/Melbourne	Australia/Adelaide	

Europe

The table below lists region and city time zones supported in the Europe region.

TABLE 117 Region/city time zones in Europe region

Europe/Andorra	Europe/Gibraltar	Europe/Warsaw
Europe/Tirane	Europe/Athens	Europe/Lisbon
Europe/Vienna	Europe/Zagreb	Europe/Bucharest
Europe/Mariehamn	Europe/Budapest	Europe/Belgrade
Europe/Sarajevo	Europe/Dublin	Europe/Kaliningrad
Europe/Brussels	Europe/Isle_of_Man	Europe/Moscow
Europe/Sofia	Europe/Rome	Europe/Volgograd
Europe/Minsk	Europe/Jersey	Europe/Samara
Europe/Zurich	Europe/Vaduz	Europe/Stockholm
Europe/Prague	Europe/Vilnius	Europe/Ljubljana
Europe/Berlin	Europe/Luxembourg	Europe/Bratislava
Europe/Copenhagen	Europe/Riga	Europe/San_Marino
Europe/Tallinn	Europe/Monaco	Europe/Istanbul
Europe/Madrid	Europe/Chisinau	Europe/Kiev
Europe/Helsinki	Europe/Podgorica	Europe/Uzhgorod
Europe/Paris	Europe/Skopje	Europe/Zaporozhye
Europe/London	Europe/Malta	Europe/Simferopol
Europe/Guernsey	Europe/Amsterdam	Europe/Vatican
Europe/Oslo		

Indian

The table below lists region and city time zones supported in the Indian region.

TABLE 118 Region/city time zones in Indian region

Indian/Cocos	Indian/Antananarivo	Indian/Mahe
Indian/Christmas	Indian/Mauritius	Indian/Kerguelen
Indian/Chagos	Indian/Maldives	Indian/Mayotte
Indian/Comoro	Indian/Reunion	

Pacific

The table below lists region and city time zones supported in the Pacific region.

TABLE 119 Region/city time zones in Pacific region

Pacific/Pago_Pago	Pacific/Kwajalein	Pacific/Palau

TABLE 119 Region/city time zones in Pacific region (continued)

Pacific/Rarotonga	Pacific/Saipan	Pacific/Guadalcanal
Pacific/Easter	Pacific/Noumea	Pacific/Fakaofo
Pacific/Galapagos	Pacific/Norfolk	Pacific/Tongatapu
Pacific/Fiji	Pacific/Nauru	Pacific/Funafuti
Pacific/Truk	Pacific/Niue	Pacific/Johnston
Pacific/Ponape	Pacific/Auckland	Pacific/Midway
Pacific/Kosrae	Pacific/Chatham	Pacific/Wake
Pacific/Guam	Pacific/Tahiti	Pacific/Honolulu
Pacific/Tarawa	Pacific/Marquesas	Pacific/Efate
Pacific/Enderbury	Pacific/Gambier	Pacific/Wallis
Pacific/Kiritimati	Pacific/Port_Moresby	Pacific/Apia
Pacific/Majuro	Pacific/Pitcairn	