Configuring STP Extensions

This chapter describes how to configure Spanning Tree Protocol (STP) extensions on Cisco NX-OS devices using Cisco Data Center Network Manager (DCNM) for LAN.

For more information about the Cisco DCNM features, see the .

This chapter includes the following sections:

Information About STP Extensions

Note See the *Interfaces Configuration Guide, Cisco DCNM for LAN, Release 5.x*, for information on creating Layer 2 interfaces.

Cisco has added extensions to STP that enhances loop prevention, protects against some possible user misconfigurations, and provides better control over the protocol parameters. Although, in some cases, similar functionality may be incorporated into the IEEE 802.1w Rapid Spanning Tree Protocol (RSTP) standard, we recommend using these extensions. All of these extensions, except PVST Simulation, can be used with both Rapid PVST+ and MST. You use PVST Simulation only with MST.

The available extensions are spanning tree edge ports (which supply the functionality previously known as PortFast), Bridge Assurance, BPDU Guard, BPDU Filtering, Loop Guard, Root Guard, and PVT Simulation. Many of these features can be applied either globally or on specified interfaces.

Note Spanning tree is used to refer to IEEE 802.1w and IEEE 802.1s. If the text is discussing the IEEE 802.1D Spanning Tree Protocol, 802.1D is stated specifically.

The Cisco NX-OS release that is running on a managed device many not support all the features or settings described in this chapter. For the latest feature information and caveats, see the documentation and release notes for your platform and software release.

STP Port Types

You can configure a spanning tree port as an edge port, a network port, or a normal port. A port can be in only one of these states at a given time. The default spanning tree port type is normal.

Edge ports, which are connected to Layer 2 hosts, can be either an access port or a trunk port.

Note If you configure a port connected to a Layer 2 switch or bridge as an edge port, you might create a bridging loop.

Network ports are connected only to Layer 2 switches or bridges.

Note If you mistakenly configure ports that are connected to Layer 2 hosts, or edge devices, as spanning tree network ports, those ports will automatically move into the blocking state.

STP Edge Ports

You connect STP edge ports only to Layer 2 hosts. The edge port interface immediately transitions to the forwarding state, without moving through the blocking or learning states. (This immediate transition was previously configured as the Cisco-proprietary feature PortFast.)

Interfaces that are connected to Layer 2 hosts should not receive STP bridge protocol data units (BPDUs).

Bridge Assurance

You can use Bridge Assurance to protect against certain problems that can cause bridging loops in the network. Specifically, you use Bridge Assurance to protect against a unidirectional link failure or other software failure and a device that continues to forward data traffic when it is no longer running the spanning tree algorithm.

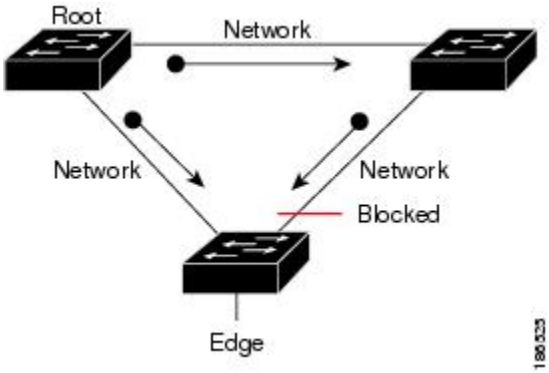
Note Bridge Assurance is supported only by Rapid PVST+ and MST.

Bridge Assurance is enabled by default and can only be disabled globally. Also, Bridge Assurance can be enabled only on spanning tree network ports that are point-to-point links. Finally, both ends of the link must have Bridge Assurance enabled. If the device on one side of the link has Bridge Assurance enabled and the device on the other side either does not support Bridge Assurance or does not have this feature enabled, the connecting port is blocked.

With Bridge Assurance enabled, BPDUs are sent out on all operational network ports, including alternate and backup ports, for each hello time period. If the port does not receive a BPDU for a specified period, the port moves into the blocking state and is not used in the root port calculation. Once that port receives a BPDU, it resumes the normal spanning tree transitions.

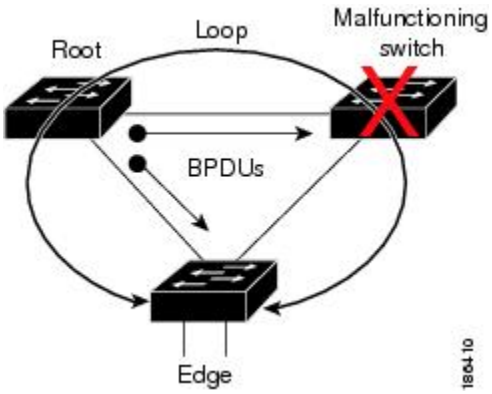
This figure shows a normal STP topology.

Figure 1: Network with Normal STP Topology



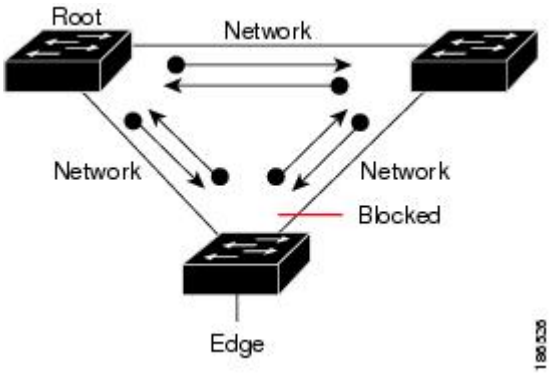
This figure demonstrates a potential network problem when the device fails and you are not running Bridge Assurance.

Figure 2: Network Problem without Running Bridge Assurance



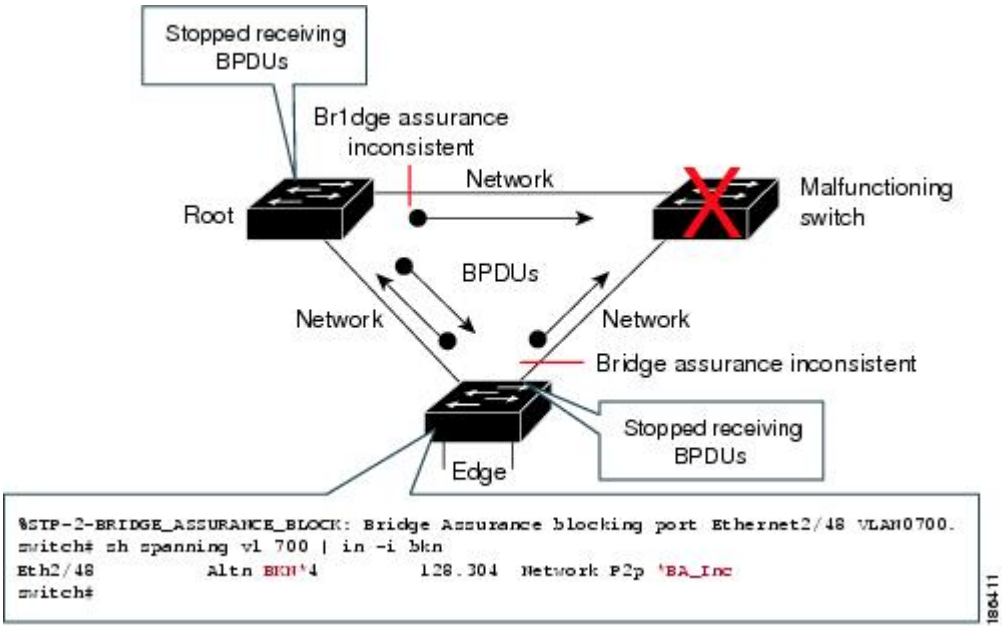
This figure shows the network with Bridge Assurance enabled, and the STP topology progressing normally with bidirectional BPDUs issuing from every STP network port.

Figure 3: Network STP Topology Running Bridge Assurance



This figure shows how the potential network problem does not happen when you have Bridge Assurance enabled on your network.

Figure 4: Network Problem Averted with Bridge Assurance Enabled



BPDU Guard

Enabling BPDU Guard shuts down that interface if a BPDU is received.

You can configure BPDU Guard at the interface level. When configured at the interface level, BPDU Guard shuts the port down as soon as the port receives a BPDU, regardless of the port type configuration.

When you configure BPDU Guard globally, it is effective only on operational spanning tree edge ports. In a valid configuration, Layer 2 LAN edge interfaces do not receive BPDUs. A BPDU that is received by an edge

Layer 2 LAN interface signals an invalid configuration, such as the connection of an unauthorized device. BPDU Guard, when enabled globally, shuts down all spanning tree edge ports when they receive a BPDU.

BPDU Guard provides a secure response to invalid configurations, because you must manually put the Layer 2 LAN interface back in service after an invalid configuration.

Note When enabled globally, BPDU Guard applies to all operational spanning tree edge interfaces.

BPDU Filtering

You can use BPDU Filtering to prevent the device from sending or even receiving BPDUs on specified ports.

When configured globally, BPDU Filtering applies to all operational spanning tree edge ports. You should connect edge ports only to hosts, which typically drop BPDUs. If an operational spanning tree edge port receives a BPDU, it immediately returns to a normal spanning tree port type and moves through the regular transitions. In that case, BPDU Filtering is disabled on this port, and spanning tree resumes sending BPDUs on this port.

In addition, you can configure BPDU Filtering by the individual interface. When you explicitly configure BPDU Filtering on a port, that port does not send any BPDUs and drops all BPDUs that it receives. You can effectively override the global BPDU Filtering setting on individual ports by configuring the specific interface. This BPDU Filtering command on the interface applies to the entire interface, whether the interface is trunking or not.

Caution Use care when configuring BPDU Filtering per interface. If you explicitly configure BPDU Filtering on a port that is not connected to a host, it can result in bridging loops because the port will ignore any BPDU that it receives and go to forwarding.

This table lists all the BPDU Filtering combinations.

Table 1: BPDU Filtering Configurations

BPDU Filtering Per Port Configuration	BPDU Filtering Global Configuration	STP Edge Port Configuration	BPDU Filtering State
Default [1]	Enable	Enable	Enable [2]
Default	Enable	Disable	Disable
Default	Disable	Not applicable	Disable
Disable	Not applicable	Not applicable	Disable
Enable	Not applicable	Not applicable	Enable

2 The port transmits at least 10 BPDUs. If this port receives any BPDUs, the port returns to the spanning tree normal port state and BPDU filtering is disabled.

1 No explicit port configuration.

Loop Guard

Loop Guard helps prevent bridging loops that could occur because of a unidirectional link failure on a point-to-point link.

An STP loop occurs when a blocking port in a redundant topology erroneously transitions to the forwarding state. Transitions are usually caused by a port in a physically redundant topology (not necessarily the blocking port) that stops receiving BPDUs.

When you enable Loop Guard globally, it is useful only in switched networks where devices are connected by point-to-point links. On a point-to-point link, a designated bridge cannot disappear unless it sends an inferior BPDU or brings the link down. However, you can enable Loop Guard on shared links per interface,

You can use Loop Guard to determine if a root port or an alternate/backup root port receives BPDUs. If the port that was previously receiving BPDUs is no longer receiving BPDUs, Loop Guard puts the port into an inconsistent state (blocking) until the port starts to receive BPDUs again. If such a port receives BPDUs again, the port—and link—is deemed viable again. The protocol removes the loop-inconsistent condition from the port, and the STP determines the port state because the recovery is automatic.

Loop Guard isolates the failure and allows STP to converge to a stable topology without the failed link or bridge. Disabling Loop Guard moves all loop-inconsistent ports to the listening state.

You can enable Loop Guard on a per-port basis. When you enable Loop Guard on a port, it is automatically applied to all of the active instances or VLANs to which that port belongs. When you disable Loop Guard, it is disabled for the specified ports.

Root Guard

When you enable Root Guard on a port, Root Guard does not allow that port to become a root port. If a received BPDU triggers an STP convergence that makes that designated port become a root port, that port is put into a root-inconsistent (blocked) state. After the port stops sending superior BPDUs, the port is unblocked again. Through STP, the port moves to the forwarding state. Recovery is automatic.

When you enable Root Guard on an interface, this functionality applies to all VLANs to which that interface belongs.

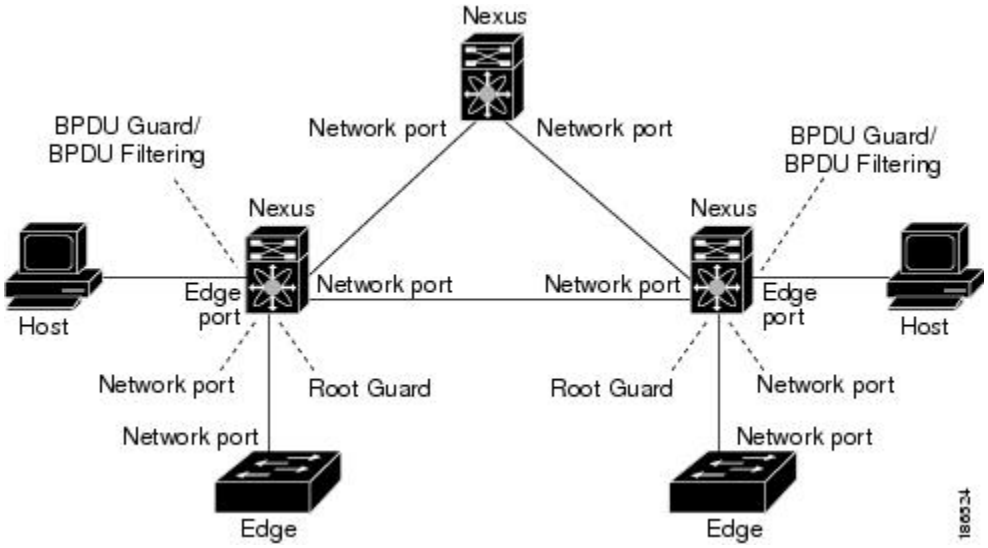
You can use Root Guard to enforce the root bridge placement in the network. Root Guard ensures that the port on which Root Guard is enabled is the designated port. Normally, root bridge ports are all designated ports, unless two or more of the ports of the root bridge are connected. If the bridge receives superior BPDUs on a Root Guard-enabled port, the bridge moves this port to a root-inconsistent STP state. In this way, Root Guard enforces the position of the root bridge.

You cannot configure Root Guard globally.

Applying STP Extension Features

We recommend that you configure the various STP extension features through your network as shown in this figure. Bridge Assurance is enabled on the entire network. You should enable either BPDU Guard or BPDU Filtering on the host interface.

Figure 5: Network with STP Extensions Correctly Deployed



PVST Simulation

MST interoperates with Rapid PVST+ with no need for user configuration. The PVST simulation feature enables this interoperability.

Note PVST simulation is enabled by default when you enable MST. By default, all interfaces on the device interoperate between MST and Rapid PVST+.

However, you may want to control the connection between MST and Rapid PVST+ to protect against accidentally connecting an MST-enabled port to a port enabled to run Rapid PVST+. Because Rapid PVST+ is the default STP mode, you may encounter many Rapid PVST+ connections.

Disabling Rapid PVST+ simulation, which can be done globally for the entire device, moves the MST-enabled port to the blocking state once it detects it is connected to a Rapid PVST+-enabled port. This port remains in the inconsistent state until the port stops receiving Rapid PVST+/SSTP BPDUs, and then the port resumes the normal STP transition process.

The root bridge for all STP instances must all be in either the MST region or the Rapid PVST+ side. If the root bridge for all STP instances are not on one side or the other, the software moves the port into a PVST simulation-inconsistent state.

Note We recommend that you put the root bridge for all STP instances in the MST region.

High Availability for STP

The software supports high availability for STP. However, the statistics and timers are not restored when STP restarts. The timers start again and the statistics begin from 0.

Note See the *Cisco Nexus 7000 Series NX-OS High Availability and Redundancy Guide, Release 5.x*, for complete information on high-availability features.

Virtualization Support for STP Extensions

The system provides support for virtual device contexts (VDCs), and each VDC runs a separate STP. You can run Rapid PVST+ in one VDC and MST in another VDC.

Note See the *Virtual Device Context Configuration Guide, Cisco DCNM for LAN, Release 5.x*, for complete information on VDCs and assigning resources.

Licensing Requirements for STP Extensions

The following table shows the licensing requirements for this feature:

Product	License Requirement
Cisco DCNM	STP extensions require no license. Any feature not included in a license package is bundled with the Cisco DCNM and is provided at no charge to you.
Cisco NX-OS	STP extensions require no license. Any feature not included in a license package is bundled with the Cisco NX-OS system images and is provided at no extra charge to you. For a complete explanation of the Cisco NX-OS licensing scheme, see *Cisco NX-OS Licensing Guide*.

However, using VDCs requires an Advanced Services license.

Prerequisites for STP Extensions

STP has the following prerequisites:

- You must be logged onto the device.

Guidelines and Limitations for Configuring STP Extensions

STP extensions have the following configuration guidelines and limitations:

- Connect STP network ports only to switches.
- You should configure host ports as STP edge ports and not as network ports.

- If you enable STP network port types globally, ensure that you manually configure all ports connected to hosts as STP edge ports.
- You should configure all access and trunk ports connected to Layer 2 hosts as edge ports.
- Bridge Assurance runs only on point-to-point spanning tree network ports. You must configure each side of the link for this feature.
- We recommend that you enable Bridge Assurance throughout your network.
- We recommend that you enable BPDU Guard on all edge ports.
- Enabling Loop Guard globally works only on point-to-point links.
- Enabling Loop Guard per interface works on both shared and point-to-point links.
- Root Guard forces a port to always be a designated port; it does not allow a port to become a root port. Loop Guard is effective only if the port is a root port or an alternate port. You cannot enable Loop Guard and Root Guard on a port at the same time.
- Loop Guard has no effect on a disabled spanning tree instance or a VLAN.
- Spanning tree always chooses the first operational port in the channel to send the BPDUs. If that link becomes unidirectional, Loop Guard blocks the channel, even if other links in the channel are functioning properly.
- If you group together a set of ports that are already blocked by Loop Guard to form a channel, spanning tree loses all the state information for those ports and the new channel port may obtain the forwarding state with a designated role.
- If a channel is blocked by Loop Guard and the channel members go back to an individual link status, spanning tree loses all the state information. The individual physical ports may obtain the forwarding state with the designated role, even if one or more of the links that formed the channel are unidirectional.

Note You can enable UniDirectional Link Detection (UDLD) aggressive mode to isolate the link failure. A loop may occur until UDLD detects the failure, but Loop Guard will not be able to detect it.

- You should enable Loop Guard globally on a switch network with physical loops.
- You should enable Root Guard on ports that connect to network devices that are not under direct administrative control.

Platform Support for STP Extensions

The following platforms support this feature but may implement it differently. For platform-specific information, including guidelines and limitations, system defaults, and configuration limits, see the corresponding documentation.

Platform	Documentation
Cisco Nexus 7000 Series switches	Cisco Nexus 7000 Series switch documentation
Cisco Nexus 4000 Series switches	Cisco Nexus 4000 Series switch documentation

Platform	Documentation
Cisco Nexus 5000 Series switches	Cisco Nexus 5000 Series switch documentation

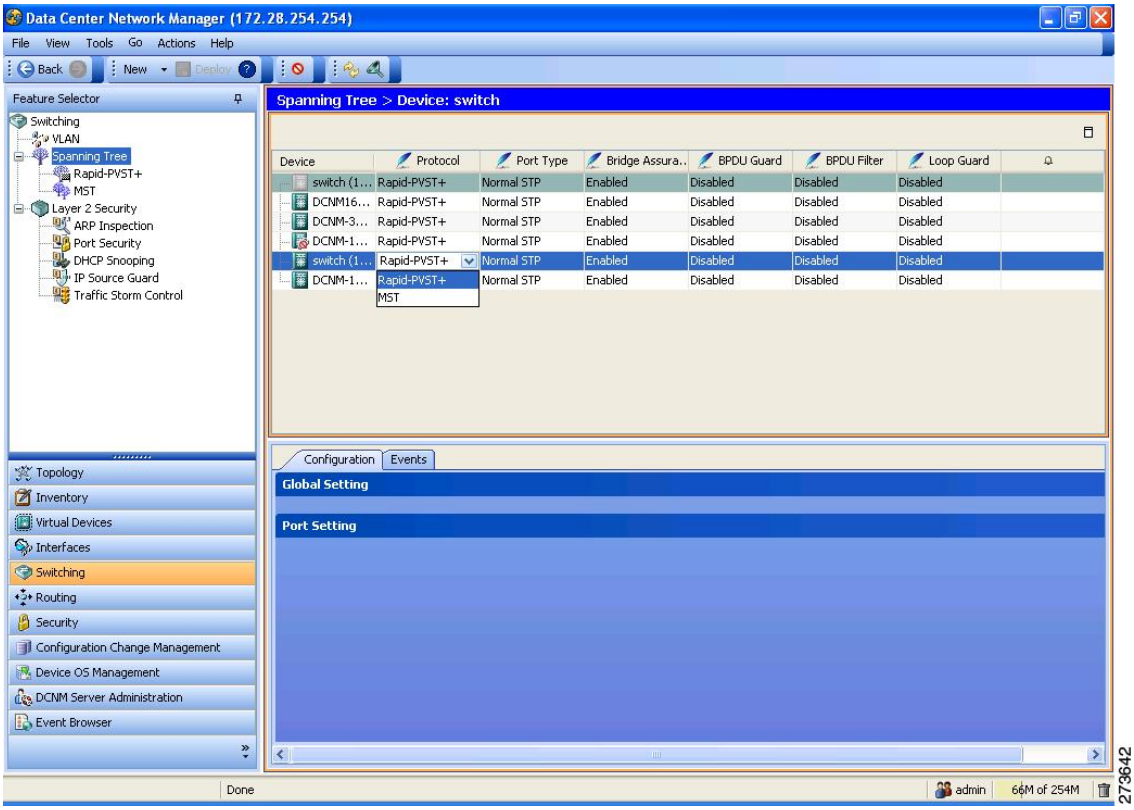
Configuring STP Extensions Steps

You can enable Loop Guard per interface on either shared or point-to-point links.

Setting Default Values for STP Extensions

You use the Spanning Tree pane shown in this figure to return to the default settings for these features.

Figure 6: Configuring STP Extensions



Procedure

Step 1 From the Feature Selector pane, choose **Switching ➤ Spanning Tree** to open the Spanning Tree pane.

Step 2 In the Summary pane, click the device to set the default settings globally for the entire device.

Step 3 On the menu bar, choose **Spanning-Tree ➤ Set to default**.

Step 4 In the Details pane, click the **Configuration** tab to set the default settings for the port.

Step 5 Click the **Port Setting** section.
The Port Setting section expands and displays the ports.

Step 6 In the Port Setting section, choose the interface that you want to configure.

Step 7 On the menu bar, choose **Spanning-Tree ➤ Set to default**.

Step 8 (Optional) From the menu bar, choose **File ➤ Deploy** to apply your changes to the device.

Related Topics

- Setting STP Extensions Globally, page 11
- Configuring PVST Simulation Globally, page 12
- Setting STP Extensions Per Interface, page 12

Setting STP Extensions Globally

You use the Spanning Tree pane to configure the STP extensions globally (see Figure 6: Configuring STP Extensions, page 10).

Procedure

Step 1 From the Feature Selector pane, choose **Switching ➤ Spanning Tree** to open the Spanning Tree pane.

Step 2 In the Summary pane, click the device.

Step 3 In the Details pane, click the **Configuration** tab.

Step 4 In the Details pane, click the **Global Setting** section.
The Global Setting section expands.

Step 5 From the Port Type drop-down list, choose the port type.
The default port type is Normal STP.

Step 6 From the Bridge Assurance drop-down list, choose **Enabled** or **Disabled**.
Bridge Assurance is enabled by default.

Step 7 From the BPDU Guard drop-down list, choose **Enabled** or **Disabled**.
BPDU Guard is disabled by default.

Step 8 From the BPDU Filter drop-down list, choose **Enabled** or **Disabled**.
BPDU Filter is disabled by default.

Step 9 From the Loop Guard drop-down list, choose **Enabled** or **Disabled**.
Loop Guard is disabled by default.

Step 10 (Optional) From the menu bar, choose **File ➤ Deploy** to apply your changes to the device.

Related Topics

- Setting Default Values for STP Extensions, page 10
- Configuring PVST Simulation Globally, page 12
- Setting STP Extensions Per Interface, page 12

Configuring PVST Simulation Globally

Note PVST simulation is enabled by default. By default, all interfaces on the device interoperate between MST and Rapid PVST+.

You configure PVST simulation only when you are running MST on the device (Rapid PVST+ is the default STP mode). MST interoperates with Rapid PVST+. However, to prevent an accidental connection to a device that does not run MST as the default STP mode, you may want to disable this automatic feature. If you disable PVST simulation, the MST-enabled port moves to the blocking state once it detects that it is connected to a Rapid PVST+-enabled port. This port remains in the inconsistent state until the port stops receiving BPDUs, and then the port resumes the normal STP transition process.

Procedure

Step 1 From the Feature Selector pane, choose **Switching ➤ Spanning Tree** to open the Spanning Tree pane.

Step 2 In the Summary pane, click the device on which you want to enable the PVST simulation setting.
The system highlights the device in the Summary pane, and tabs appear in the Details pane.

Step 3 In the Details pane, click the **Configuration** tab.

Step 4 Click the **Global Setting** section.

Step 5 In the MST Setting area, in the Simulate PVST field, click the drop-down list and click **Enabled**.
The default is Enabled.

Step 6 (Optional) From the menu bar, choose **File ➤ Deploy** to apply your changes to the device.

Related Topics

- Setting Default Values for STP Extensions, page 10
- Configuring PVST Simulation Globally, page 12
- Setting STP Extensions Per Interface, page 12

Setting STP Extensions Per Interface

You use the Spanning Tree panel to configure the STP extensions per interface (see Figure 6: Configuring STP Extensions, page 10).

Procedure

Step 1 From the Feature Selector pane, choose **Switching ➤ Spanning Tree** to open the Spanning Tree pane.

Step 2 In the Summary pane, click the device.

Step 3 In the Details pane, click the **Configuration** tab.

Step 4 In the Details pane, click the **Port Setting** section.
The Port Setting section expands.

Step 5 In the Port Setting section, click the interface that you want to configure.

Step 6 In the Port Type column, click the drop-down list and choose the port type.
By default, the port type for each interface is set to Default, which returns the port type to the globally set port type.

Step 7 In the BPDU Guard column, click the drop-down list and choose the **BPDU Guard** setting.
By default, the BPDU Guard setting for each interface is set to Default, which returns the interface to the globally set BPDU Guard value.

Step 8 In the BPDU Filter column, click the drop-down list and choose the **BDPU Filter** setting.
By default, the BPDU Filter setting for each interface is set to Default, which returns the interface to the globally set BPDU Filter value.

Step 9 In the Guard column, click the drop-down list and choose the **Loop Guard** or **Root Guard** setting.
By default, the Guard setting for each interface is set to Default, which returns the interface to the globally set Loop Guard value.

Step 10 (Optional) From the menu bar, choose **File ➤ Deploy** to apply your changes to the device.

Related Topics

- Setting Default Values for STP Extensions, page 10
- Configuring PVST Simulation Globally, page 12
- Setting STP Extensions Per Interface, page 12

Field Descriptions for Configuring STP Extensions

Device: Configuration: Global Setting Section

Table 2: Device: Configuration: Global Setting Section

Field	Description
STP Setting	
Device	*Display only.* The name or IP address of the device.
Protocol	STP protocol running in the device. The range is PVRST or MST. The default is PVRST.
Port Type	Global STP port type for the device. The range is Edge, Network, or Normal STP. The default port type is Normal STP.
Bridge Assurance	Bridge Assurance feature. The range is enabled or disabled, and the default is Enabled.
BPDU Guard	Bridge Guard feature. The range is enabled or disabled, and the default is Disabled.

Field	Description
BPDU Filter	Bridge Filter feature. The range is enabled or disabled, and the default is Disabled.
Loop Guard	Loop Guard feature. The range is enabled or disabled, and the default is Disabled.
Path Cost	Path-cost feature. The range is short or long, and the default is short. **Note** This field applies to Rapid PVST+ only; the path-cost method is always long with MST.
MST Setting	
Name	Name for the MST region. You can enter up to 34 alphanumeric characters. The default is blank.
Hello Time	Hello time for the MST protocol. The range is from 1 to 10 seconds, and the default value is 2 seconds.
Revision Number	Revision of the current MST configuration. Valid values are from 0 to 65535, and the default value is 0.
Simulate PVST	PVST simulation. The range is enabled or disabled, and the default value is Enabled.
Digest	*Display only.* MD5 digest of VLAN-to-MST-instance mapping.
Pre-Standard Digest	*Display only.* MD5 digest of VLAN-to-MST-instance mapping using a prestandard key.
Forward Delay Time	Period that the learning state lasts before the interface begins forwarding. The range is from 4 to 30 seconds, and the default value is 15 seconds.
Max Age Time	Period that the protocol information received on a port is stored on the device. The range is from 6 to 40 seconds, and the default value is 20 seconds.
Max Hop Count	Number of hops permissible within the region before the BPDU is discarded. The range is from 1 to 255 hops, and the default value is 20 hops.

Device: Configuration: Port Setting Section

Table 3: Device: Configuration: Port Setting Section

Field	Description
Name	*Display only.* The name of the interface.
Priority	STP port priority for the interface. The range is 0 to 224 in increments of 32. The default value is 128.
Cost	STP port cost for the interface. The range is from 1 to 200,000,000, and the default is derived from the media speed of the interface.
Port Type	STP port type Valid values are as follows: • Network—Use only when a connection is to another switch or bridge. • Edge access—Use only when a connection is to a host port. • Edge trunk—Use only when a connection is to a host port and you want to carry traffic for more than one VLAN. • Disable—Sets the port to an STP Normal port. • Default—Returns the port to the global STP port type setting. The default value is Default.
BPDU Guard	BPDU Guard feature on the specified interface. Valid values are as follows: • Enable • Disable • Default—Returns the port to the global BPDU Guard setting. The default value is Default.
BPDU Filter	BPDU Filter feature on the specified interface. Valid values are as follows: • Enable • Disable

Field	Description
	• Default—Returns the port to the global BPDU Filter setting. The default value is Default.
Guard	Loop Guard or Root Guard. Valid values are as follows: • Loop • None • Root The default value is Default.
Simulate PVST	PVST simulation per interface. Valid values are as follows: • Enabled • Disabled • Default—Returns the interface to the global PVST simulation setting for the device. The default value is Default.
Link Type	Link type for this interface. Valid values are as follows: • Point-to-point • Shared • Auto—Sets the link type based on the duplex setting of the interface. The default value for this feature is Auto.

Additional References for STP Extensions - DCNM

	Document Title
Layer 2 interfaces	*Cisco DCNM Interfaces Configuration Guide*
DCNM fundamentals	*Cisco DCNM Fundamentals Configuration Guide*
VDCs	*Cisco DCNM Virtual Device Context Configuration Guide*

	Document Title
Release notes	*Cisco DCNM Release Notes, Release 4.0*

Standards for STP Extensions

Standards	Title
IEEE 802.1Q-2006 (formerly known as IEEE 802.1s), IEEE 802.1D-2004 (formerly known as IEEE 802.1w), IEEE 802.1D, IEEE 802.1t	—

MIBs for STP Extensions

MIBs	MIBs Link
• CISCO_STP_EXTENSION MIB • BRIDGE MIB	To locate and download MIBs, go to the following URL: http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

Feature History for Configuring STP Enhancements - DCNM

This table lists the release history for this feature.

Table 4: Feature History for Configuring STP Enhancements

Feature Name	Releases	Feature Information
No change.	4.2(1)	-
No change.	4.1(2)	-