



Configuring Optional Spanning-Tree Features

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Information About Optional Spanning-Tree Features

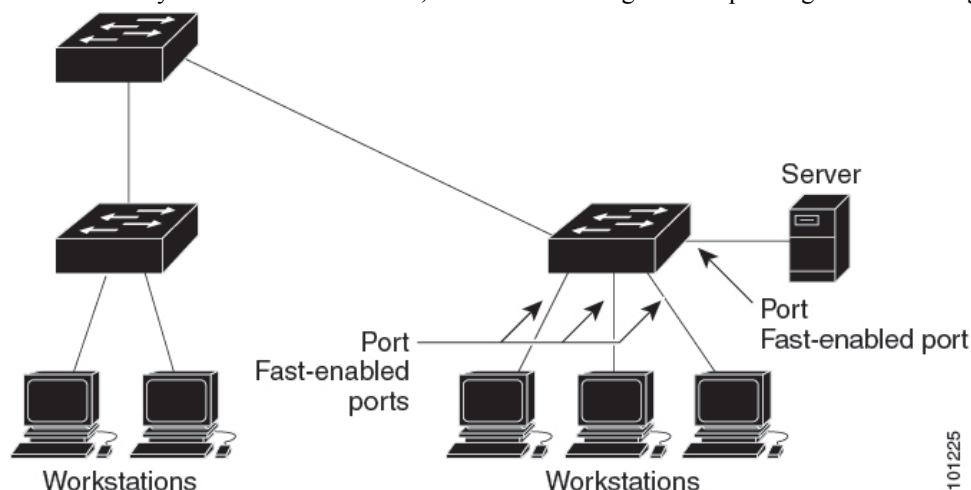
The following sections provide information about Optional Spanning-Tree features:

PortFast

PortFast immediately brings an interface that is configured as an access or trunk port to the forwarding state from a blocking state, bypassing the listening and learning states.

Figure 1: PortFast-Enabled Interfaces

You can use PortFast on interfaces that are connected to a single workstation or server to allow those devices to immediately connect to the network, rather than waiting for the spanning tree to converge.



Interfaces connected to a single workstation or server should not receive bridge protocol data units (BPDUs). An interface with PortFast enabled goes through the normal cycle of spanning-tree status changes when the switch is restarted.

You can enable this feature by enabling it on either the interface or on all nontrunking ports.

Bridge Protocol Data Unit Guard

The Bridge Protocol Data Unit (BPDU) guard feature can be globally enabled on the switch or can be enabled per port, but the feature operates with some differences.

When you enable BPDU guard at the global level on PortFast enabled ports, spanning tree shuts down ports that are in a PortFast operational state if any BPDU is received on them. In a valid configuration, PortFast enabled ports do not receive BPDUs. Receiving a BPDU on a PortFast enabled port means an invalid configuration, such as the connection of an unauthorized device, and the BPDU guard feature puts the port in the error-disabled state. When this happens, the switch shuts down the entire port on which the violation occurred.

When you enable BPDU guard at the interface level on any port without also enabling the PortFast feature, and the port receives a BPDU, it is put in the error-disabled state.

The BPDU guard feature provides a secure response to invalid configurations because you must manually put the interface back in service. Use the BPDU guard feature in a service-provider network to prevent an access port from participating in the spanning tree.

Bridge Protocol Data Unit Filtering

The BPDU filtering feature can be globally enabled on the switch or can be enabled per interface, but the feature operates with some differences.

Enabling BPDU filtering on PortFast enabled interfaces at the global level keeps those interfaces that are in a PortFast operational state from sending or receiving BPDUs. The interfaces still send a few BPDUs at link-up before the switch begins to filter outbound BPDUs. You should globally enable BPDU filtering on a switch so that hosts that are connected to these interfaces do not receive BPDUs. If a BPDU is received on a PortFast enabled interface, the interface loses its PortFast operational status, and BPDU filtering is disabled.

Enabling BPDU filtering on an interface without also enabling the PortFast feature keeps the interface from sending or receiving BPDUs.



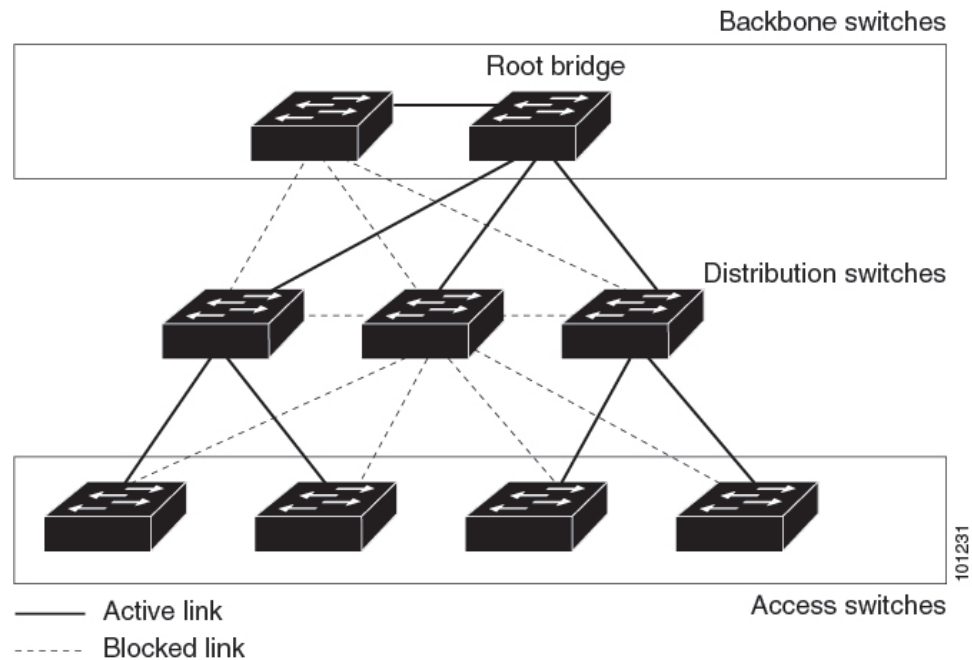
Caution Enabling BPDU filtering on an interface is the same as disabling spanning tree on it and can result in spanning-tree loops.

You can enable the BPDU filtering feature for the entire switch or for an interface.

UplinkFast

Figure 2: Switches in a Hierarchical Network

Switches in hierarchical networks can be grouped into backbone switches, distribution switches, and access switches. This complex network has distribution switches and access switches that each have at least one redundant link that spanning tree blocks to prevent loops.



If a switch loses connectivity, it begins using the alternate paths when the spanning tree selects a new root port. You can accelerate the choice of a new root port when a link or switch fails or when the spanning tree reconfigures itself by enabling UplinkFast. The root port transitions to the forwarding state immediately without going through the listening and learning states, as it would with the normal spanning-tree procedures.

When the spanning tree reconfigures the new root port, other interfaces flood the network with multicast packets, one for each address that was learned on the interface. You can limit these bursts of multicast traffic by reducing the max-update-rate parameter (the default for this parameter is 150 packets per second). However, if you enter zero, station-learning frames are not generated, so the spanning-tree topology converges more slowly after a loss of connectivity.



Note UplinkFast is most useful in wiring-closet switches at the access or edge of the network. It is not appropriate for backbone devices. This feature might not be useful for other types of applications.

UplinkFast provides fast convergence after a direct link failure and achieves load-balancing between redundant Layer 2 links using uplink groups. An uplink group is a set of Layer 2 interfaces (per VLAN), only one of which is forwarding at any given time. Specifically, an uplink group consists of the root port (which is forwarding) and a set of blocked ports, except for self-looping ports. The uplink group provides an alternate path in case the currently forwarding link fails.

Figure 3: UplinkFast Example Before Direct Link Failure

This topology has no link failures. Switch A, the root switch, is connected directly to Switch B over link L1 and to Switch C over link L2. The Layer 2 interface on Switch C that is connected directly to Switch B is in a blocking state.

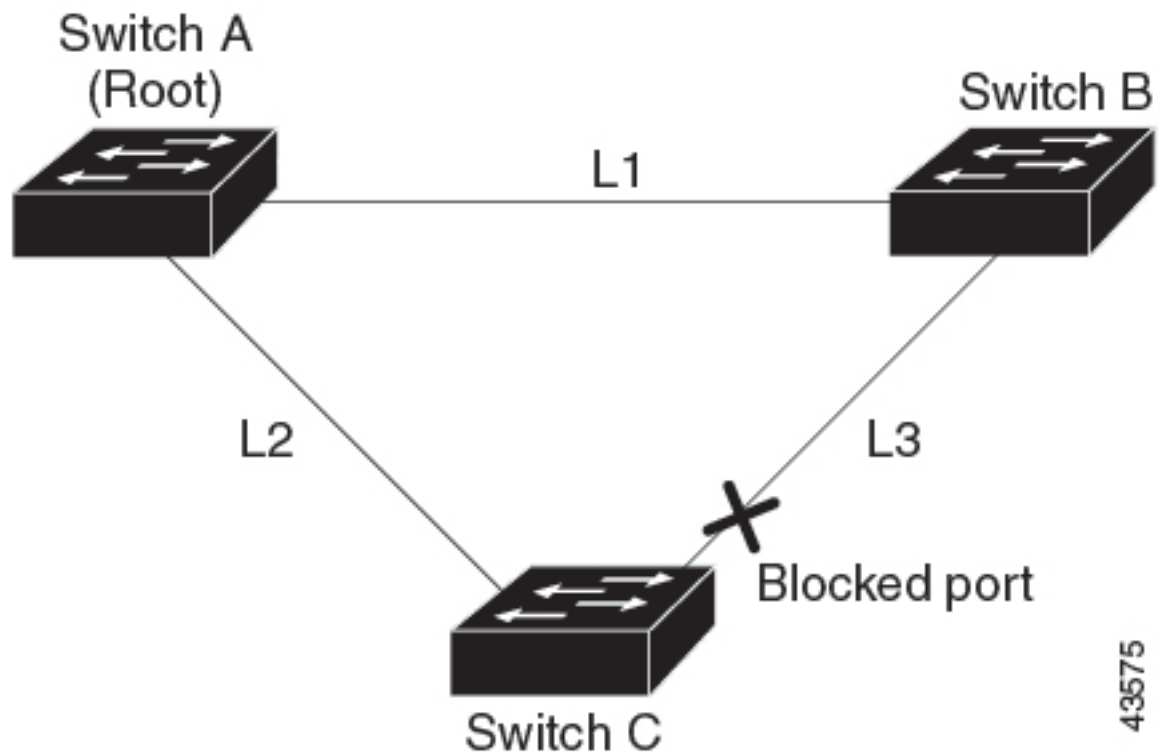
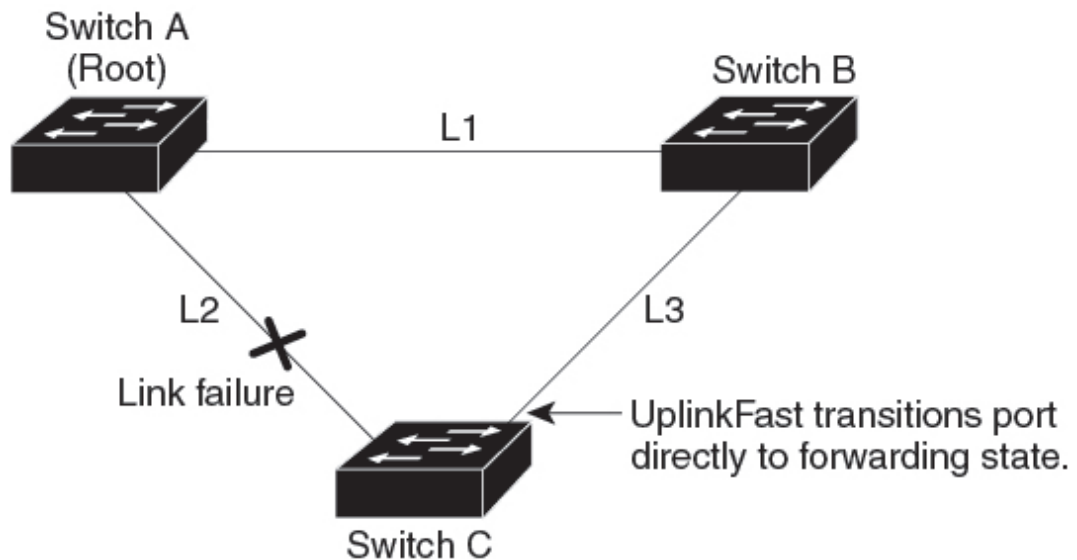


Figure 4: UplinkFast Example After Direct Link Failure

If Switch C detects a link failure on the currently active link L2 on the root port (a direct link failure), UplinkFast unblocks the blocked interface on Switch C and transitions it to the forwarding state without going through the listening and learning states. This change takes approximately 1 to 5 seconds.



BackboneFast

BackboneFast detects indirect failures in the core of the backbone. BackboneFast is a complementary technology to the UplinkFast feature, which responds to failures on links that are directly connected to access switches. BackboneFast optimizes the maximum-age timer, which controls the amount of time the switch stores protocol information that is received on an interface. When a switch receives an inferior BPDU from the designated port of another switch, the BPDU is a signal that the other switch might have lost its path to the root, and BackboneFast tries to find an alternate path to the root.

BackboneFast starts when a root port or blocked interface on a switch receives inferior BPDUs from its designated switch. An inferior BPDU identifies a switch that declares itself as both the root bridge and the designated switch. When a switch receives an inferior BPDU, it means that a link to which the switch is not directly connected (an indirect link) has failed (that is, the designated switch has lost its connection to the root switch). Under spanning-tree rules, the switch ignores inferior BPDUs for the maximum aging time (default is 20 seconds).

The switch tries to find if it has an alternate path to the root switch. If the inferior BPDU arrives on a blocked interface, the root port and other blocked interfaces on the switch become alternate paths to the root switch. (Self-looped ports are not considered alternate paths to the root switch.) If the inferior BPDU arrives on the root port, all blocked interfaces become alternate paths to the root switch. If the inferior BPDU arrives on the root port and there are no blocked interfaces, the switch assumes that it has lost connectivity to the root switch, causes the maximum aging time on the root port to expire, and becomes the root switch according to normal spanning-tree rules.

If the switch has alternate paths to the root switch, it uses these alternate paths to send a root link query (RLQ) request. The switch sends the RLQ request on all alternate paths to learn of an alternate root to the root switch and waits for an RLQ reply from other switches in the network. The switch sends the RLQ request on all alternate paths and waits for an RLQ reply from other switches in the network.

If the switch discovers that it still has an alternate path to the root, it expires the maximum aging time on the interface that received the inferior BPDU. If all the alternate paths to the root switch indicate that the switch has lost connectivity to the root switch, the switch expires the maximum aging time on the interface that received the RLQ reply. If one or more alternate paths can still connect to the root switch, the switch makes all interfaces on which it received an inferior BPDU its designated ports and moves them from the blocking state (if they were in the blocking state), through the listening and learning states, and into the forwarding state.

Figure 5: BackboneFast Example Before Indirect Link Failure

This is an example topology with no link failures. Switch A, the root switch, connects directly to Switch B over link L1 and to Switch C over link L2. The Layer 2 interface on Switch C that connects directly to Switch B is in the blocking state.

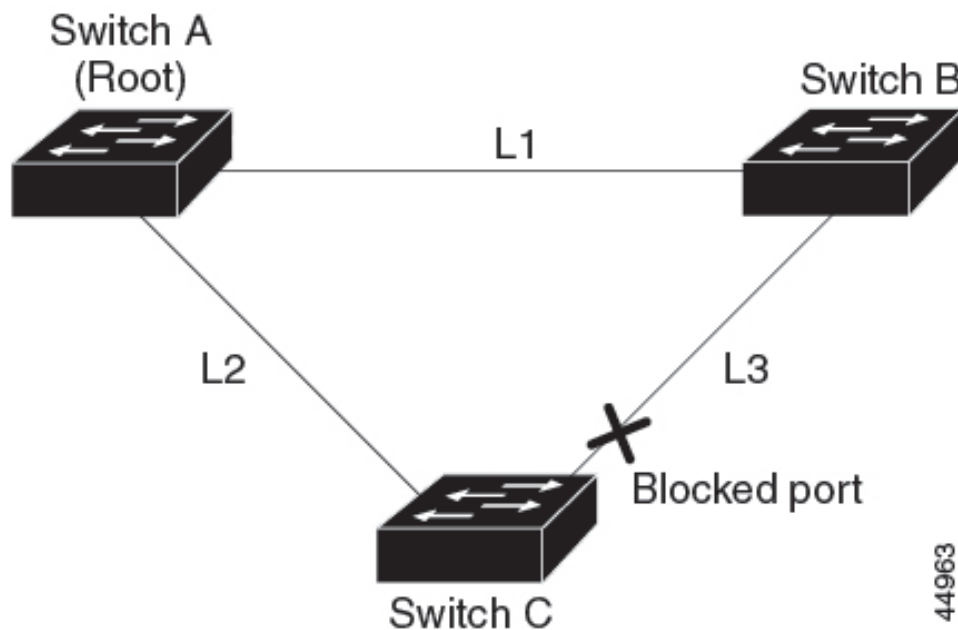


Figure 6: BackboneFast Example After Indirect Link Failure

If link L1 fails, Switch C cannot detect this failure because it is not connected directly to link L1. However, because Switch B is directly connected to the root switch over L1, it detects the failure, elects itself the root, and begins sending BPDUs to Switch C, identifying itself as the root. When Switch C receives the inferior BPDUs from Switch B, Switch C assumes that an indirect failure has occurred. At that point, BackboneFast allows the blocked interface on Switch C to move immediately to the listening state without waiting for the maximum aging time for the interface to expire. BackboneFast then transitions the Layer 2 interface on Switch C to the forwarding state, providing a path from Switch B to Switch A. The root-switch election takes approximately 30 seconds, twice the Forward Delay time if the default Forward Delay time of 15 seconds is set. BackboneFast reconfigures the topology to account for the failure of link L1.

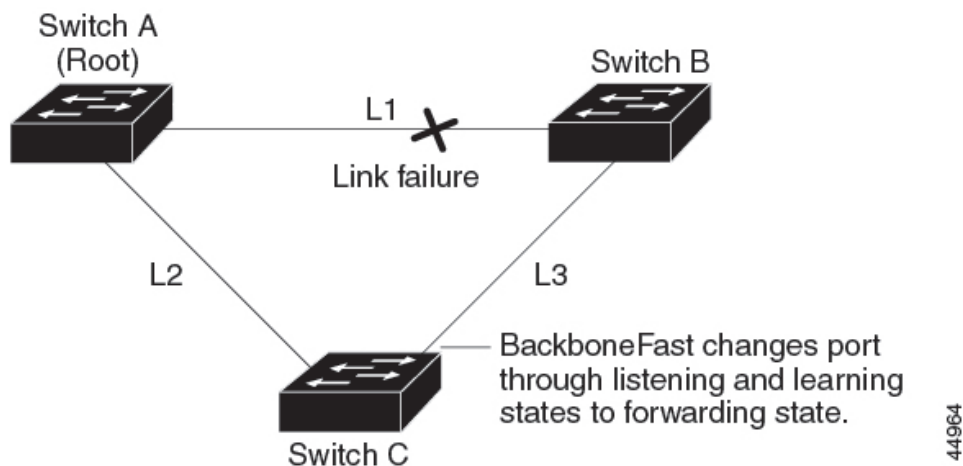
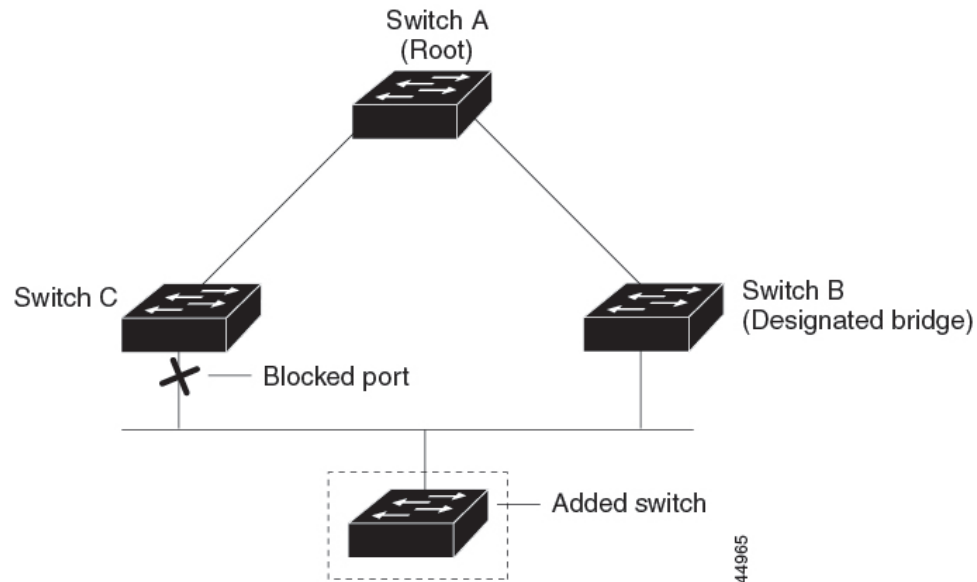


Figure 7: Adding a Switch in a Shared-Medium Topology

If a new switch is introduced into a shared-medium topology, BackboneFast is not activated because the inferior BPDUs did not come from the recognized designated switch (Switch B). The new switch begins

sending inferior BPDUs that indicate it is the root switch. However, the other switches ignore these inferior BPDUs, and the new switch learns that Switch B is the designated switch to Switch A, the root switch.



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EtherChannel Guard

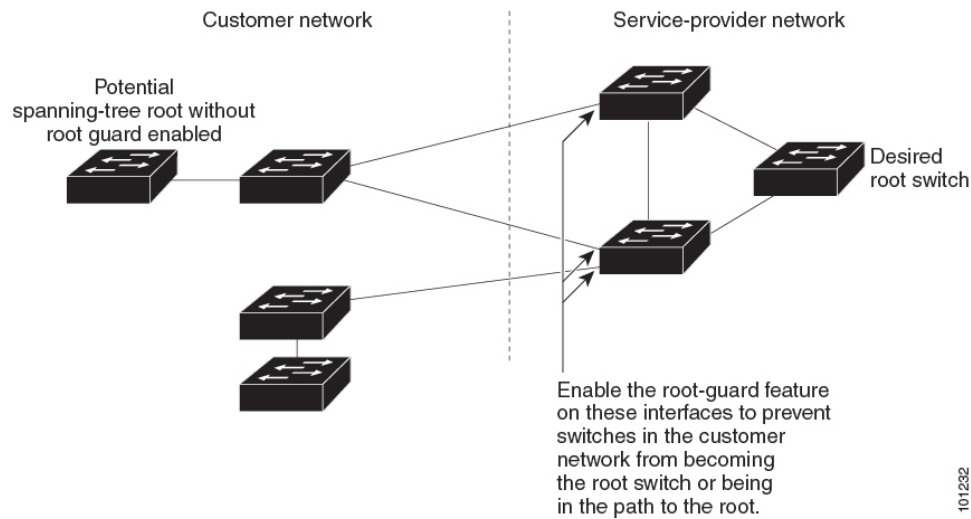
You can use EtherChannel guard to detect an EtherChannel misconfiguration between the switch and a connected device. A misconfiguration can occur if the switch interfaces are configured in an EtherChannel, but the interfaces on the other device are not. A misconfiguration can also occur if the channel parameters are not the same at both ends of the EtherChannel.

If the switch detects a misconfiguration on the other device, EtherChannel guard places the switch interfaces in the error-disabled state, and displays an error message.

Root Guard

Figure 8: Root Guard in a Service-Provider Network

The Layer 2 network of a service provider (SP) can include many connections to switches that are not owned by the SP. In such a topology, the spanning tree can reconfigure itself and select a customer switch as the root switch. You can avoid this situation by enabling root guard on SP switch interfaces that connect to switches in your customer's network. If spanning-tree calculations cause an interface in the customer network to be selected as the root port, root guard then places the interface in the root-inconsistent (blocked) state to prevent the customer's switch from becoming the root switch or being in the path to the root.



If a switch outside the SP network becomes the root switch, the interface is blocked (root-inconsistent state), and spanning tree selects a new root switch. The customer's switch does not become the root switch and is not in the path to the root.

If the switch is operating in MST mode, root guard forces the interface to be a designated port. If a boundary port is blocked in an internal spanning-tree (IST) instance because of root guard, the interface also is blocked in all MST instances. A boundary port is an interface that connects to a LAN, the designated switch of which is either an IEEE 802.1D switch or a switch with a different MST region configuration.

Root guard that is enabled on an interface applies to all the VLANs to which the interface belongs. VLANs can be grouped and mapped to an MST instance.



Caution Misuse of the root guard feature can cause a loss of connectivity.

Loop Guard

You can use loop guard to prevent alternate or root ports from becoming designated ports because of a failure that leads to a unidirectional link. This feature is most effective when it is enabled on the entire switched network. Loop guard prevents alternate and root ports from becoming designated ports, and spanning tree does not send BPDUs on root or alternate ports.

When the switch is operating in PVST+ or rapid-PVST+ mode, loop guard prevents alternate and root ports from becoming designated ports, and spanning tree does not send BPDUs on root or alternate ports.

When the switch is operating in MST mode, BPDUs are not sent on nonboundary ports only if the interface is blocked by loop guard in all MST instances. On a boundary port, loop guard blocks the interface in all MST instances.

How to Configure Optional Spanning-Tree Features

The following sections provide information about configuring Optional Spanning-Tree features:

(Optional) Enabling PortFast

An interface with the PortFast feature enabled is moved directly to the spanning-tree forwarding state without waiting for the standard forward-time delay.

If you enable the voice VLAN feature, the PortFast feature is automatically enabled. When you disable voice VLAN, the PortFast feature is not automatically disabled.

You can enable this feature if your switch is running PVST+, Rapid PVST+, or MSTP.



Caution Use PortFast only when connecting a single end station to an access or trunk port. Enabling this feature on an interface that is connected to a switch or hub could prevent spanning tree from detecting and disabling loops in your network, which could cause broadcast storms and address-learning problems.

To enable PortFast, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	interface <i>interface-id</i> Example: Device(config)# interface gigabitethernet 1/1	Specifies an interface to configure, and enters interface configuration mode.
Step 4	spanning-tree portfast [trunk] Example: Device(config-if)# spanning-tree portfast trunk	Enables PortFast on an access port that is connected to a single workstation or server. By specifying the trunk keyword, you can enable PortFast on a trunk port. Note To enable PortFast on trunk ports, you must use the spanning-tree portfast trunk interface configuration command. The spanning-tree portfast command will not work on trunk ports. Make sure that there are no loops in the network between the trunk port and the workstation or server before you enable PortFast on a trunk port.

	Command or Action	Purpose
		By default, PortFast is disabled on all interfaces.
Step 5	end Example: Device (config-if) # end	Returns to privileged EXEC mode.

What to do next

You can use the **spanning-tree portfast default** global configuration command to globally enable the PortFast feature on all nontrunking ports.

(Optional) Enabling Bridge Protocol Data Unit Guard

You can enable the BPDU guard feature if your switch is running PVST+, Rapid PVST+, or MSTP.



Caution Configure PortFast only on ports that connect to end stations; otherwise, an accidental topology loop could cause a data packet loop and disrupt switch and network operation.

To enable BPDU guard, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	spanning-tree portfast bpduguard default Example: Device (config) # spanning-tree portfast bpduguard default	Enables BPDU guard.
Step 4	interface interface-id Example: Device (config) # interface gigabitethernet 1/1	Specifies the interface that is connected to an end station, and enters interface configuration mode.
Step 5	spanning-tree portfast Example:	Enables the PortFast feature.

	Command or Action	Purpose
	Device(config-if)# spanning-tree portfast	
Step 6	end Example: Device(config-if)# end	Returns to privileged EXEC mode.

What to do next

To prevent the port from shutting down, you can use the **errdisable detect cause bpduguard shutdown vlan** global configuration command to shut down just the offending VLAN on the port where the violation occurred.

You also can use the **spanning-tree bpduguard enable** interface configuration command to enable BPDU guard on any port without also enabling the PortFast feature. When the port receives a BPDU, it is put in the error-disabled state.

(Optional) Enabling Bridge Protocol Data Unit Filtering

You can also use the **spanning-tree bpdupfilter enable** interface configuration command to enable BPDU filtering on any interface without also enabling the . This command prevents the interface from sending or receiving BPDUs.



Caution Enabling BPDU filtering on an interface is the same as disabling spanning tree on it and can result in spanning-tree loops.

You can enable the BPDU filtering feature if your switch is running PVST+, Rapid PVST+, or MSTP.



Caution Configure only on interfaces that connect to end stations; otherwise, an accidental topology loop could cause a data packet loop and disrupt switch and network operation.

To enable BPDU filter, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	spanning-tree portfast bpdupfilter default	Globally enables BPDU filtering.

(Optional) Enabling UplinkFast for Use with Redundant Links

	Command or Action	Purpose
	Example: Device(config)# spanning-tree portfast bpdupfilter default	By default, BPDU filtering is disabled.
Step 4	interface <i>interface-id</i> Example: Device(config)# interface gigabitethernet 1/1	Specifies the interface that is connected to an end station, and enters interface configuration mode.
Step 5	spanning-tree portfast Example: Device(config-if)# spanning-tree portfast	Enables the PortFast feature on the specified interface.
Step 6	end Example: Device(config-if)# end	Returns to privileged EXEC mode.

(Optional) Enabling UplinkFast for Use with Redundant Links

Note When you enable UplinkFast, it affects all VLANs on the switch. You cannot configure UplinkFast on an individual VLAN.

You can configure the UplinkFast feature for Rapid PVST+ or for the MSTP, but the feature remains disabled (inactive) until you change the spanning-tree mode to PVST+.

Follow these steps to enable UplinkFast and CSUF.

Before you begin

UplinkFast cannot be enabled on VLANs that have been configured with a switch priority. To enable UplinkFast on a VLAN with switch priority configured, first restore the switch priority on the VLAN to the default value using the **no spanning-tree vlan *vlan-id* priority** global configuration command.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	spanning-tree uplinkfast [max-update-rate <i>pkts-per-second</i>] Example: Device(config) # spanning-tree uplinkfast max-update-rate 200	Enables UplinkFast. (Optional) For <i>pkts-per-second</i> , the range is 0 to 32000 packets per second; the default is 150. If you set the rate to 0, station-learning frames are not generated, and the spanning-tree topology converges more slowly after a loss of connectivity. When you enter this command, CSUF also is enabled on all port interfaces.
Step 4	end Example: Device(config) # end	Returns to privileged EXEC mode.

When UplinkFast is enabled, the switch priority of all VLANs is set to 49152. If you change the path cost to a value less than 3000 and you enable UplinkFast or UplinkFast is already enabled, the path cost of all interfaces and VLAN trunks is increased by 3000 (if you change the path cost to 3000 or above, the path cost is not altered). The changes to the switch priority and the path cost reduce the chance that a switch will become the root switch.

When UplinkFast is disabled, the switch priorities of all VLANs and path costs of all interfaces are set to default values if you did not modify them from their defaults.

When you enable the UplinkFast feature using these instructions, CSUF is automatically globally enabled on all port interfaces.

(Optional) Disabling UplinkFast

Follow these steps to disable UplinkFast .

Before you begin

UplinkFast must be enabled.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	no spanning-tree uplinkfast Example: <pre>Device(config)# no spanning-tree uplinkfast</pre>	Disables UplinkFast and CSUF on the switch and all of its VLANs.
Step 4	end Example: <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.

When UplinkFast is disabled, the switch priorities of all VLANs and path costs of all interfaces are set to default values if you did not modify them from their defaults.

When you disable the UplinkFast feature using these instructions, CSUF is automatically globally disabled on port interfaces.

(Optional) Enabling BackboneFast

You can enable BackboneFast to detect indirect link failures and to start the spanning-tree reconfiguration sooner.

You can configure the BackboneFast feature for Rapid PVST+ or for the MSTP, but the feature remains disabled (inactive) until you change the spanning-tree mode to PVST+.

Follow these steps to enable BackboneFast on the switch.

Before you begin

If you use BackboneFast, you must enable it on all switches in the network. BackboneFast is not supported on Token Ring VLANs. This feature is supported for use with third-party switches.

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	spanning-tree backbonefast Example: <pre>Device(config)# spanning-tree backbonefast</pre>	Enables BackboneFast.

	Command or Action	Purpose
Step 4	end Example: Device(config) # end	Returns to privileged EXEC mode.

(Optional) Enabling EtherChannel Guard

You can enable EtherChannel guard to detect an EtherChannel misconfiguration if your device is running PVST+, Rapid PVST+, or MSTP.

Follow these steps to enable EtherChannel Guard on the device.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	spanning-tree etherchannel guard misconfig Example: Device(config) # spanning-tree etherchannel guard misconfig	Enables EtherChannel guard.
Step 4	end Example: Device(config) # end	Returns to privileged EXEC mode.

What to do next

You can use the **show interfaces status err-disabled** privileged EXEC command to show which device ports are disabled because of an EtherChannel misconfiguration. On the remote device, you can enter the **show etherchannel summary** command in privileged EXEC mode to verify the EtherChannel configuration.

After the configuration is corrected, enter the **shutdown** and **no shutdown** interface configuration commands on the port-channel interfaces that were misconfigured.

(Optional) Enabling Root Guard

Root guard that is enabled on an interface applies to all the VLANs to which the interface belongs. Do not enable the root guard on interfaces to be used by the UplinkFast feature. With UplinkFast, the backup interfaces (in the blocked state) replace the root port in the case of a failure. However, if root guard is also enabled, all

the backup interfaces used by the UplinkFast feature are placed in the root-inconsistent state (blocked) and are prevented from reaching the forwarding state.



Note You cannot enable both root guard and loop guard at the same time.

You can enable this feature if your switch is running PVST+, Rapid PVST+, or MSTP.

Follow these steps to enable root guard on the switch.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	interface <i>interface-id</i> Example: Device(config)# interface gigabitethernet 1/1	Specifies an interface to configure, and enters interface configuration mode.
Step 4	spanning-tree guard root Example: Device(config-if)# spanning-tree guard root	Enables root guard on the interface. By default, root guard is disabled on all interfaces.
Step 5	end Example: Device(config-if)# end	Returns to privileged EXEC mode.

(Optional) Enabling Loop Guard

You can use loop guard to prevent alternate or root ports from becoming designated ports because of a failure that leads to a unidirectional link. This feature is most effective when it is configured on the entire switched network. Loop guard operates only on interfaces that are considered point-to-point by the spanning tree.



Note You cannot enable both loop guard and root guard at the same time.

You can enable this feature if your device is running PVST+, Rapid PVST+, or MSTP.

Follow these steps to enable loop guard on the device.

Procedure

	Command or Action	Purpose
Step 1	Enter one of the following commands: <ul style="list-style-type: none"> • <code>show spanning-tree active</code> • <code>show spanning-tree mst</code> Example: Device# <code>show spanning-tree active</code> or Device# <code>show spanning-tree mst</code>	Verifies which interfaces are alternate or root ports.
Step 2	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 3	spanning-tree loopguard default Example: Device(config)# <code>spanning-tree loopguard default</code>	Enables loop guard. By default, loop guard is disabled.
Step 4	end Example: Device(config)# <code>end</code>	Returns to privileged EXEC mode.

Monitoring the Spanning-Tree Status

Table 1: Commands for Monitoring the Spanning-Tree Status

Command	Purpose
<code>show spanning-tree active</code>	Displays spanning-tree information on active interfaces only.
<code>show spanning-tree detail</code>	Displays a detailed summary of interface information.
<code>show spanning-tree interface interface-id</code>	Displays spanning-tree information for the specified interface.
<code>show spanning-tree mst interface interface-id</code>	Displays MST information for the specified interface.
<code>show spanning-tree summary [totals]</code>	Displays a summary of interface states or displays the total lines of the spanning-tree state section.

Command	Purpose
show spanning-tree mst interface <i>interface-id</i> portfast	Displays spanning-tree PortFast information for the specified interface.