Configuring Multiple Spanning Tree

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Information About MST

MST Overview

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.

MST maps multiple VLANs into a spanning tree instance with each instance having a spanning tree topology independent of other spanning tree instances. This architecture provides multiple forwarding paths for data traffic, enables load balancing, and reduces the number of STP instances required to support a large number of VLANs.

MST provides rapid convergence through explicit handshaking as each MST instance uses the IEEE 802.1w standard, which eliminates the 802.1D forwarding delay and quickly transitions root bridge ports and designated ports to the forwarding state.

MAC address reduction is always enabled while you are using MST. You cannot disable this feature.

MST improves spanning tree operation and maintains backward compatibility with these STP versions:

- Original 802.1D spanning tree
- Rapid per-VLAN spanning tree (Rapid PVST+)

  IEEE 802.1w defined the Rapid Spanning Tree Protocol (RSTP) and was incorporated into IEEE 802.1D.
- IEEE 802.1s defined MST and was incorporated into IEEE 802.1Q.

Note You must enable MST; Rapid PVST+ is the default spanning tree mode.

MST Regions

To allow switches to participate in MST instances, you must consistently configure the switches with the same MST configuration information.

A collection of interconnected switches that have the same MST configuration is an MST region. An MST region is a linked group of MST bridges with the same MST configuration.

The MST configuration controls the MST region to which each switch belongs. The configuration includes the name of the region, the revision number, and the MST VLAN-to-instance assignment map.

A region can have one or multiple members with the same MST configuration. Each member must be capable of processing 802.1w bridge protocol data units (BPDUs). There is no limit to the number of MST regions in a network.

Each region can support up to 65 MST instances (MSTIs). Instances are identified by any number in the range from 1 to 4094. The system reserves Instance 0 for a special instance, which is the IST. You can assign a VLAN to only one MST instance at a time.

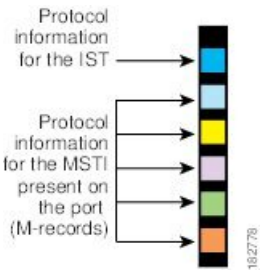
The MST region appears as a single bridge to adjacent MST regions and to other Rapid PVST+ regions and 802.1D spanning tree protocols.

Note We recommend that you do not partition the network into a large number of regions.

MST BPDUs

Each region has only one MST BPDU, and that BPDU carries an M-record for each MSTI within the region (see the following figure). Only the IST sends BPDUs for the MST region; all M-records are encapsulated in that one BPDU that the IST sends. Because the MST BPDU carries information for all instances, the number of BPDUs that need to be processed to support MSTIs is significantly reduced.

Figure 1: MST BPDU with M-Records for MSTIs



MST Configuration Information

The MST configuration that must be identical on all switches within a single MST region is configured by the user.

You can configure the following three parameters of the MST configuration:

- Name—32-character string, null padded and null terminated, identifying the MST region
- Revision number—Unsigned 16-bit number that identifies the revision of the current MST configuration

Note You must set the revision number when required as part of the MST configuration. The revision number is *not* incremented automatically each time that the MST configuration is committed.

- MST configuration table—4096-element table that associates each of the potential 4094 VLANs supported to a given instance with the first (0) and last element (4095) set to 0. The value of element number X represents the instance to which VLAN X is mapped.

Caution When you change the VLAN-to-MSTI mapping, the system restarts MST.

MST BPDUs contain these three configuration parameters. An MST bridge accepts an MST BPDU into its own region only if these three configuration parameters match exactly. If one configuration attribute differs, the MST bridge considers the BPDU to be from another MST region.

IST, CIST, and CST

IST, CIST, and CST Overview

Unlike Rapid PVST+, in which all the STP instances are independent, MST establishes and maintains IST, CIST, and CST spanning trees, as follows:

- An IST is the spanning tree that runs in an MST region.

MST establishes and maintains additional spanning trees within each MST region; these spanning trees are called multiple spanning tree instances (MSTIs).

Instance 0 is a special instance for a region, known as the IST. The IST always exists on all ports; you cannot delete the IST, or instance 0. By default, all VLANs are assigned to the IST. All other MST instances are numbered from 1 to 4094.

The IST is the only STP instance that sends and receives BPDUs. All of the other MSTI information is contained in MST records (M-records), which are encapsulated within MST BPDUs.

All MSTIs within the same region share the same protocol timers, but each MSTI has its own topology parameters, such as the root bridge ID, the root path cost, and so forth.

An MSTI is local to the region; for example, MSTI 9 in region A is independent of MSTI 9 in region B, even if regions A and B are interconnected.

- The CST interconnects the MST regions and any instance of 802.1D and 802.1w STP that may be running on the network. The CST is the one STP instance for the entire bridged network and encompasses all MST regions and 802.1w and 802.1D instances.
- A CIST is a collection of the ISTs in each MST region. The CIST is the same as an IST inside an MST region, and the same as a CST outside an MST region.

The spanning tree computed in an MST region appears as a subtree in the CST that encompasses the entire switched domain. The CIST is formed by the spanning tree algorithm running among switches that support the 802.1w, 802.1s, and 802.1D standards. The CIST inside an MST region is the same as the CST outside a region.

Spanning Tree Operation Within an MST Region

The IST connects all the MST switches in a region. When the IST converges, the root of the IST becomes the CIST regional root. The CIST regional root is also the CIST root if there is only one region in the network. If the CIST root is outside the region, the protocol selects one of the MST switches at the boundary of the region as the CIST regional root.

When an MST switch initializes, it sends BPDUs that identify itself as the root of the CIST and the CIST regional root, with both the path costs to the CIST root and to the CIST regional root set to zero. The switch also initializes all of its MSTIs and claims to be the root for all of them. If the switch receives superior MST root information (lower switch ID, lower path cost, and so forth) than the information that is currently stored for the port, it relinquishes its claim as the CIST regional root.

During initialization, an MST region might have many subregions, each with its own CIST regional root. As switches receive superior IST information from a neighbor in the same region, they leave their old subregions and join the new subregion that contains the true CIST regional root. This action causes all subregions to shrink except for the subregion that contains the true CIST regional root.

All switches in the MST region must agree on the same CIST regional root. Any two switches in the region will only synchronize their port roles for an MSTI if they converge to a common CIST regional root.

Spanning Tree Operations Between MST Regions

If you have multiple regions or 802.1 w or 802.1D STP instances within a network, MST establishes and maintains the CST, which includes all MST regions and all 802.1w and 802.1D STP switches in the network. The MSTIs combine with the IST at the boundary of the region to become the CST.

The IST connects all the MST switches in the region and appears as a subtree in the CIST that encompasses the entire switched domain. The root of the subtree is the CIST regional root. The MST region appears as a virtual switch to adjacent STP switches and MST regions.

The following figure shows a network with three MST regions and an 802.1D switch (D). The CIST regional root for region 1 (A) is also the CIST root. The CIST regional root for region 2 (B) and the CIST regional root for region 3 (C) are the roots for their respective subtrees within the CIST.

Figure 2: MST Regions, CIST Regional Roots, and CST Root

Only the CST instance sends and receives BPDUs. MSTIs add their spanning tree information into the BPDUs (as M-records) to interact with neighboring switches and compute the final spanning tree topology. Because of this process, the spanning tree parameters related to the BPDU transmission (for example, hello time, forward time, max-age, and max-hops) are configured only on the CST instance but affect all MSTIs. You can configure the parameters related to the spanning tree topology (for example, the switch priority, the port VLAN cost, and the port VLAN priority) on both the CST instance and the MSTI.

MST switches use Version 3 BPDUs or 802.1D STP BPDUs to communicate with 802.1D-only switches. MST switches use MST BPDUs to communicate with MST switches.

MST Terminology

MST naming conventions include identification of some internal or regional parameters. These parameters are used only within an MST region, compared to external parameters that are used throughout the whole network. Because the CIST is the only spanning tree instance that spans the whole network, only the CIST

parameters require the external qualifiers and not the internal or regional qualifiers. The MST terminology is as follows:

- The CIST root is the root bridge for the CIST, which is the unique instance that spans the whole network.
- The CIST external root path cost is the cost to the CIST root. This cost is left unchanged within an MST region. An MST region looks like a single switch to the CIST. The CIST external root path cost is the root path cost calculated between these virtual switches and switches that do not belong to any region.
- If the CIST root is in the region, the CIST regional root is the CIST root. Otherwise, the CIST regional root is the closest switch to the CIST root in the region. The CIST regional root acts as a root bridge for the IST.
- The CIST internal root path cost is the cost to the CIST regional root in a region. This cost is only relevant to the IST, instance 0.

Hop Count

MST does not use the message-age and maximum-age information in the configuration BPDU to compute the STP topology inside the MST region. Instead, the protocol uses the path cost to the root and a hop-count mechanism similar to the IP time-to-live (TTL) mechanism.

By using the **spanning-tree mst max-hops** global configuration command, you can configure the maximum hops inside the region and apply it to the IST and all MST instances in that region.

The hop count achieves the same result as the message-age information (triggers a reconfiguration). The root bridge of the instance always sends a BPDU (or M-record) with a cost of 0 and the hop count set to the maximum value. When a switch receives this BPDU, it decrements the received remaining hop count by one and propagates this value as the remaining hop count in the BPDUs that it generates. When the count reaches zero, the switch discards the BPDU and ages the information held for the port.

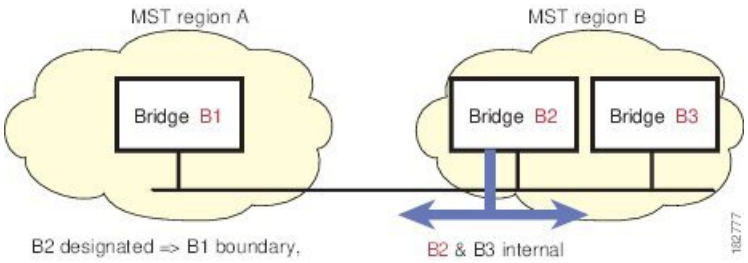
The message-age and maximum-age information in the 802.1w portion of the BPDU remain the same throughout the region (only on the IST), and the same values are propagated by the region-designated ports at the boundary.

You configure a maximum aging time as the number of seconds that a switch waits without receiving spanning tree configuration messages before attempting a reconfiguration.

Boundary Ports

A boundary port is a port that connects one region to another. A designated port knows that it is on the boundary if it detects an STP bridge or receives an agreement proposal from an MST bridge with a different configuration or a Rapid PVST+ bridge. This definition allows two ports that are internal to a region to share a segment with a port that belongs to a different region, creating the possibility of receiving both internal and external messages on a port (see the following figure).

Figure 3: MST Boundary Ports



At the boundary, the roles of MST ports do not matter; the system forces their state to be the same as the IST port state. If the boundary flag is set for the port, the MST port-role selection process assigns a port role to the boundary and assigns the same state as the state of the IST port. The IST port at the boundary can take up any port role except a backup port role.

Spanning-Tree Dispute Mechanism

Currently, this feature is not present in the IEEE MST standard, but it is included in the standard-compliant implementation. The software checks the consistency of the port role and state in the received BPDUs to detect unidirectional link failures that could cause bridging loops.

When a designated port detects a conflict, it keeps its role but reverts to a discarding state because disrupting connectivity in case of inconsistency is preferable to opening a bridging loop.

The following figure shows a unidirectional link failure that typically creates a bridging loop. Switch A is the root bridge, and its BPDUs are lost on the link leading to Switch B. Rapid PVST+ (802.1w) and MST BPDUs include the role and state of the sending port. With this information, Switch A can detect that Switch B does not react to the superior BPDUs that it sends and that Switch B is the designated, not root port. As a result, Switch A blocks (or keeps blocking) its port, which prevents the bridging loop. The block is shown as an STP dispute.

Figure 4: Detecting a Unidirectional Link Failure

Port Cost and Port Priority

Spanning tree uses port costs to break a tie for the designated port. Lower values indicate lower port costs, and spanning tree chooses the least costly path. Default port costs are taken from the bandwidth of the interface, as follows:

- 10 Mbps—2,000,000
- 100 Mbps—200,000
- 1 Gigabit Ethernet—20,000
- 10 Gigabit Ethernet—2,000

You can configure the port costs in order to influence which port is chosen.

Note MST always uses the long path-cost calculation method, so the range of valid values is between 1 and 200,000,000.

The system uses port priorities to break ties among ports with the same cost. A lower number indicates a higher priority. The default port priority is 128. You can configure the priority to values between 0 and 224, in increments of 32.

Interoperability with IEEE 802.1D

A switch that runs MST supports a built-in protocol migration feature that enables it to interoperate with 802.1D STP switches. If this switch receives an 802.1D configuration BPDU (a BPDU with the protocol version set to 0), it sends only 802.1D BPDUs on that port. In addition, an MST switch can detect that a port is at the boundary of a region when it receives an 802.1D BPDU, an MST BPDU (Version 3) associated with a different region, or an 802.1w BPDU (Version 2).

However, the switch does not automatically revert to the MST mode if it no longer receives 802.1D BPDUs because it cannot detect whether the 802.1D switch has been removed from the link unless the 802.1D switch is the designated switch. A switch might also continue to assign a boundary role to a port when the switch to which this switch is connected has joined the region.

To restart the protocol migration process (force the renegotiation with neighboring switches), enter the **clear spanning-tree detected-protocols** command.

All Rapid PVST+ switches (and all 8021.D STP switches) on the link can process MST BPDUs as if they are 802.1w BPDUs. MST switches can send either Version 0 configuration and topology change notification (TCN) BPDUs or Version 3 MST BPDUs on a boundary port. A boundary port connects to a LAN, the designated switch of which is either a single spanning tree switch or a switch with a different MST configuration.

Note MST interoperates with the Cisco prestandard Multiple Spanning Tree Protocol (MSTP) whenever it receives prestandard MSTP on an MST port; no explicit configuration is necessary.

Interoperability with Rapid PVST+: Understanding PVST Simulation

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

Note PVST simulation is enabled by default. That is, by default, all interfaces on the switch 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 Rapid PVST+-enabled port. Because Rapid PVST+ is the default STP mode, you may encounter many Rapid PVST+-enabled connections.

Disabling Rapid PVST+ simulation, which can be done per port or globally for the entire switch, 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.

Configuring MST

MST Configuration Guidelines

When configuring MST, follow these guidelines:

- When you work with private VLANs, enter the **private-vlan synchronize** command to map the secondary VLANs to the same MST instance as the primary VLAN.
- When you are in the MST configuration mode, the following guidelines apply:
  - Each command reference line creates its pending regional configuration.
  - The pending region configuration starts with the current region configuration.
  - To leave the MST configuration mode without committing any changes, enter the **abort** command.
  - To leave the MST configuration mode and commit all the changes that you made before you left the mode, enter the **exit** command.

Enabling MST

You must enable MST; Rapid PVST+ is the default.

Caution Changing the spanning tree mode disrupts traffic because all spanning tree instances are stopped for the previous mode and started for the new mode.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch# **configure terminal**
3. switch(config)# **spanning-tree mode mst**
4. (Optional) switch(config)# **no spanning-tree mode mst**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch# **configure terminal**	Enters configuration mode.
Step 3	switch(config)# **spanning-tree mode mst**	Enables MST on the switch.

	Command or Action	Purpose
Step 4	(Optional) switch(config)# **no spanning-tree mode mst**	Disables MST on the switch and returns you to Rapid PVST+.

Example

This example shows how to enable MST on the switch:

```
switch# configure terminal
switch(config)# spanning-tree mode mst
```

Note Because STP is enabled by default, entering a **show running-config** command to view the resulting configuration does not display the command that you entered to enable STP.

Entering MST Configuration Mode

You enter MST configuration mode to configure the MST name, VLAN-to-instance mapping, and MST revision number on the switch.

For two or more switches to be in the same MST region, they must have the identical MST name, VLAN-to-instance mapping, and MST revision number.

Note Each command reference line creates its pending regional configuration in MST configuration mode. In addition, the pending region configuration starts with the current region configuration.

When you are working in MST configuration mode, note the difference between the **exit** and **abort** commands.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **spanning-tree mst configuration**
3. switch(config-mst)# **exit** or switch(config-mst)# **abort**
4. (Optional) switch(config)# **no spanning-tree mst configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config)# **spanning-tree mst configuration**	Enters MST configuration mode on the system. You must be in the MST configuration mode to assign the MST configuration parameters, as follows: • MST name

	Command or Action	Purpose
		• Instance-to-VLAN mapping • MST revision number • Synchronize primary and secondary VLANs in private VLANs
Step 3	switch(config-mst)# **exit** or switch(config-mst)# **abort**	Exits or aborts. • The **exit** command commits all the changes and exits MST configuration mode. • The **abort** command exits the MST configuration mode without committing any of the changes.
Step 4	(Optional) switch(config)# **no spanning-tree mst configuration**	Returns the MST region configuration to the following default values: • The region name is an empty string. • No VLANs are mapped to any MST instance (all VLANs are mapped to the CIST instance). • The revision number is 0.

Specifying the MST Name

You configure a region name on the bridge. For two or more bridges to be in the same MST region, they must have the identical MST name, VLAN-to-instance mapping, and MST revision number.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **spanning-tree mst configuration**
3. switch(config-mst)# **name** *name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config)# **spanning-tree mst configuration**	Enters MST configuration submode.
Step 3	switch(config-mst)# **name** *name*	Specifies the name for MST region. The *name* string has a maximum length of 32 case-sensitive characters. The default is an empty string.

Example

This example shows how to set the name of the MST region:

```
switch# configure terminal
switch(config)# spanning-tree mst configuration
switch(config-mst)# name accounting
```

Specifying the MST Configuration Revision Number

You configure the revision number on the bridge. For two or more bridges to be in the same MST region, they must have the identical MST name, VLAN-to-instance mapping, and MST revision number.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **spanning-tree mst configuration**
3. switch(config-mst)# **revision** *version*

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config)# **spanning-tree mst configuration**	Enters MST configuration submode.
Step 3	switch(config-mst)# **revision** *version*	Specifies the revision number for the MST region. The range is from 0 to 65535, and the default value is 0.

Example

This example shows how to configure the revision number of the MSTI region for 5:

```
switch# configure terminal
switch(config)# spanning-tree mst configuration
switch(config-mst)# revision 5
```

Specifying the Configuration on an MST Region

For two or more switches to be in the same MST region, they must have the same VLAN-to-instance mapping, the same configuration revision number, and the same MST name.

A region can have one member or multiple members with the same MST configuration; each member must be capable of processing IEEE 802.1w RSTP BPDUs. There is no limit to the number of MST regions in a network, but each region can support only up to 65 MST instances. You can assign a VLAN to only one MST instance at a time.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **spanning-tree mst configuration**
3. switch(config-mst)# **instance** *instance-id* **vlan** *vlan-range*
4. switch(config-mst)# **name** *name*
5. switch(config-mst)# **revision** *version*

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config)# **spanning-tree mst configuration**	Enters MST configuration submode.
Step 3	switch(config-mst)# **instance** *instance-id* **vlan** *vlan-range*	Maps VLANs to an MST instance as follows: • For *instance-id* , the range is from 1 to 4094. • For **vlan** *vlan-range* , the range is from 1 to 4094. When you map VLANs to an MST instance, the mapping is incremental, and the VLANs specified in the command are added to or removed from the VLANs that were previously mapped. To specify a VLAN range, enter a hyphen; for example, enter the **instance 1 vlan 1-63** command to map VLANs 1 through 63 to MST instance 1. To specify a VLAN series, enter a comma; for example, enter the **instance 1 vlan 10, 20, 30** command to map VLANs 10, 20, and 30 to MST instance 1.
Step 4	switch(config-mst)# **name** *name*	Specifies the instance name. The *name* string has a maximum length of 32 case-sensitive characters.
Step 5	switch(config-mst)# **revision** *version*	Specifies the configuration revision number. The range is from 0 to 65535.

Example

To return to defaults, do the following:

- To return to the default MST region configuration settings, enter the **no spanning-tree mst configuration** configuration command.
- To return to the default VLAN-to-instance map, enter the **no instance** *instance-id* **vlan** *vlan-range* MST configuration command.
- To return to the default name, enter the **no name** MST configuration command.
- To return to the default revision number, enter the **no revision** MST configuration command.

- To reenable Rapid PVST+, enter the **no spanning-tree mode** or the **spanning-tree mode rapid-pvst** global configuration command.

This example shows how to enter MST configuration mode, map VLANs 10 to 20 to MST instance 1, name the region region1, set the configuration revision to 1, display the pending configuration, apply the changes, and return to global configuration mode:

```
switch(config)# spanning-tree mst configuration
switch(config-mst)# instance 1 vlan 10-20
switch(config-mst)# name region1
switch(config-mst)# revision 1
switch(config-mst)# show pending
Pending MST configuration
Name      [region1]
Revision  1
Instances configured 2
Instance  Vlans Mapped
--------  ---------------------
0         1-9,21-4094
1         10-20
-------------------------------
```

Mapping and Unmapping VLANs to MST Instances

Caution When you change the VLAN-to-MSTI mapping, the system restarts MST.

Note You cannot disable an MSTI.

For two or more bridges to be in the same MST region, they must have the identical MST name, VLAN-to-instance mapping, and MST revision number.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **spanning-tree mst configuration**
3. switch(config-mst)# **instance** *instance-id* **vlan** *vlan-range*
4. switch(config-mst)# **no instance** *instance-id* **vlan** *vlan-range*

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config)# **spanning-tree mst configuration**	Enters MST configuration submode.
Step 3	switch(config-mst)# **instance** *instance-id* **vlan** *vlan-range*	Maps VLANs to an MST instance, as follows: • For *instance-id* the range is from 1 to 4094. Instance 0 is reserved for the IST for each MST region. • For *vlan-range* the range is from 1 to 4094. When you map VLANs to an MSTI, the mapping is incremental, and the VLANs specified in the command are added to or removed from the VLANs that were previously mapped.
Step 4	switch(config-mst)# **no instance** *instance-id* **vlan** *vlan-range*	Deletes the specified instance and returns the VLANs to the default MSTI, which is the CIST.

Example

This example shows how to map VLAN 200 to MSTI 3:

```
switch# configure terminal
switch(config)# spanning-tree mst configuration
switch(config-mst)# instance 3 vlan 200
```

Mapping Secondary VLANs to Same MSTI as Primary VLANs for Private VLANs

When you are working with private VLANs on the system, all secondary VLANs must be in the same MSTI and their associated primary VLAN.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **spanning-tree mst configuration**
3. switch(config-mst)# **private-vlan synchronize**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config)# **spanning-tree mst configuration**	Enters MST configuration submode.

	Command or Action	Purpose
Step 3	switch(config-mst)# **private-vlan synchronize**	Automatically maps all secondary VLANs to the same MSTI as their associated primary VLAN in all private VLANs.

Example

This example shows how to automatically map all the secondary VLANs to the same MSTI as their associated primary VLANs in all private VLANs:

```
switch# configure terminal
switch(config)# spanning-tree mst configuration
switch(config-mst)# private-vlan synchronize
```

Configuring the Root Bridge

You can configure the switch to become the root bridge.

Note The root bridge for each MSTI should be a backbone or distribution switch. Do not configure an access switch as the spanning tree primary root bridge.

Enter the **diameter** keyword, which is available only for MSTI 0 (or the IST), to specify the network diameter (that is, the maximum number of hops between any two end stations in the network). When you specify the network diameter, the switch automatically sets an optimal hello time, forward-delay time, and maximum-age time for a network of that diameter, which can significantly reduce the convergence time. You can enter the **hello** keyword to override the automatically calculated hello time.

Note With the switch configured as the root bridge, do not manually configure the hello time, forward-delay time, and maximum-age time using the **spanning-tree mst hello-time**, **spanning-tree mst forward-time**, and **spanning-tree mst max-age** global configuration commands.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **spanning-tree mst** *instance-id* **root** {**primary** | **secondary**} [**diameter** *dia* [**hello-time** *hello-time*]]
3. (Optional) switch(config)# **no spanning-tree mst** *instance-id* **root**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.

	Command or Action	Purpose
Step 2	switch(config)# **spanning-tree mst** *instance-id* **root** {**primary** | **secondary**} [**diameter** *dia* [**hello-time** *hello-time*]]	Configures a switch as the root bridge as follows: • For *instance-id*, you can specify a single instance, a range of instances separated by a hyphen, or a series of instances separated by a comma. The range is from 1 to 4094. • For diameter *net-diameter*, specify the maximum number of hops between any two end stations. The default is 7. This keyword is available only for MST instance 0. • For hello-time *seconds*, specify the interval in seconds between the generation of configuration messages by the root bridge. The range is from 1 to 10 seconds; the default is 2 seconds.
Step 3	(Optional) switch(config)# **no spanning-tree mst** *instance-id* **root**	Returns the switch priority, diameter, and hello time to default values.

Example

This example shows how to configure the switch as the root switch for MSTI 5:

```
switch# configure terminal
switch(config)# spanning-tree mst 5 root primary
```

Configuring a Secondary Root Bridge

You can execute this command on more than one switch to configure multiple backup root bridges. Enter the same network diameter and hello-time values that you used when you configured the primary root bridge with the **spanning-tree mst root primary** configuration command.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **spanning-tree mst** *instance-id* **root** {**primary** | **secondary**} [**diameter** *dia* [**hello-time** *hello-time*]]
3. (Optional) switch(config)# **no spanning-tree mst** *instance-id* **root**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.

	Command or Action	Purpose
Step 2	switch(config)# **spanning-tree mst** *instance-id* **root** {**primary** | **secondary**} [**diameter** *dia* [**hello-time** *hello-time*]]	Configures a switch as the secondary root bridge as follows: • For *instance-id*, you can specify a single instance, a range of instances separated by a hyphen, or a series of instances separated by a comma. The range is from 1 to 4094. • For diameter *net-diameter*, specify the maximum number of hops between any two end stations. The default is 7. This keyword is available only for MST instance 0. • For hello-time *seconds*, specify the interval in seconds between the generation of configuration messages by the root bridge. The range is from 1 to 10 seconds; the default is 2 seconds.
Step 3	(Optional) switch(config)# **no spanning-tree mst** *instance-id* **root**	Returns the switch priority, diameter, and hello-time to default values.

Example

This example shows how to configure the switch as the secondary root switch for MSTI 5:

```
switch# configure terminal
switch(config)# spanning-tree mst 5 root secondary
```

Configuring the Port Priority

If a loop occurs, MST uses the port priority when selecting an interface to put into the forwarding state. You can assign lower priority values to interfaces that you want selected first and higher priority values to the interface that you want selected last. If all interfaces have the same priority value, MST puts the interface with the lowest interface number in the forwarding state and blocks the other interfaces.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **interface** {{*type slot*/*port*} | {**port-channel** *number*}}
3. switch(config-if)# **spanning-tree mst** *instance-id* **port-priority** *priority*

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config)# **interface** {{*type slot*/*port*} | {**port-channel** *number*}}	Specifies an interface to configure, and enters interface configuration mode.

	Command or Action	Purpose
Step 3	switch(config-if)# **spanning-tree mst** *instance-id* **port-priority** *priority*	Configures the port priority as follows: • For *instance-id*, you can specify a single MSTI, a range of MSTIs separated by a hyphen, or a series of MSTIs separated by a comma. The range is from 1 to 4094. • For *priority*, the range is 0 to 224 in increments of 32. The default is 128. A lower number indicates a higher priority. The priority values are 0, 32, 64, 96, 128, 160, 192, and 224. The system rejects all other values.

Example

This example shows how to set the MST interface port priority for MSTI 3 on Ethernet port 3/1 to 64:

```
switch# configure terminal
switch(config)# interface ethernet 3/1
switch(config-if)# spanning-tree mst 3 port-priority 64
```

You can only apply this command to a physical Ethernet interface.

Configuring the Port Cost

The MST path-cost default value is derived from the media speed of an interface. If a loop occurs, MST uses the cost when selecting an interface to put in the forwarding state. You can assign lower cost values to interfaces that you want selected first and higher cost to interfaces values that you want selected last. If all interfaces have the same cost value, MST puts the interface with the lowest interface number in the forwarding state and blocks the other interfaces.

Note MST uses the long path-cost calculation method.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **interface** {{*type slot*/*port*} | {**port-channel** *number*}}
3. switch(config-if)# **spanning-tree mst** *instance-id* **cost** [*cost* | **auto**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.

	Command or Action	Purpose
Step 2	switch(config)# **interface** {{*type slot*/*port*} | {**port-channel** *number*}}	Specifies an interface to configure, and enters interface configuration mode.
Step 3	switch(config-if)# **spanning-tree mst** *instance-id* **cost** [*cost* | **auto**]	Configures the cost. If a loop occurs, MST uses the path cost when selecting an interface to place into the forwarding state. A lower path cost represents higher-speed transmission as follows: • For *instance-id*, you can specify a single instance, a range of instances separated by a hyphen, or a series of instances separated by a comma. The range is from 1 to 4094. • For *cost*, the range is from 1 to 200000000. The default value is auto, which is derived from the media speed of the interface.

Example

This example shows how to set the MST interface port cost on Ethernet 3/1 for MSTI 4:

```
switch# configure terminal
switch(config)# interface ethernet 3/1
switch(config-if)# spanning-tree mst 4 cost 17031970
```

Configuring the Switch Priority

You can configure the switch priority for an MST instance so that it is more likely that the specified switch is chosen as the root bridge.

Note Exercise care when using this command. For most situations, we recommend that you enter the **spanning-tree mst root primary** and the **spanning-tree mst root secondary** global configuration commands to modify the switch priority.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **spanning-tree mst** *instance-id* **priority** *priority-value*

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.

	Command or Action	Purpose
Step 2	switch(config)# **spanning-tree mst** *instance-id* **priority** *priority-value*	Configures a switch priority as follows: • For *instance-id*, you can specify a single instance, a range of instances separated by a hyphen, or a series of instances separated by a comma. The range is from 1 to 4094. • For priority, the range is from 0 to 61440 in increments of 4096; the default is 32768. A lower number indicates that the switch will most likely be chosen as the root bridge. Priority values are 0, 4096, 8192, 12288, 16384, 20480, 24576, 28672, 32768, 36864, 40960, 45056, 49152, 53248, 57344, and 61440. The system rejects all other values.

Example

This example shows how to configure the priority of the bridge to 4096 for MSTI 5:

```
switch# configure terminal
switch(config)# spanning-tree mst 5 priority 4096
```

Configuring the Hello Time

You can configure the interval between the generation of configuration messages by the root bridge for all instances on the switch by changing the hello time.

Note Exercise care when using this command. For most situations, we recommend that you enter the **spanning-tree mst** *instance-id* **root primary** and the **spanning-tree mst** *instance-id* **root secondary** configuration commands to modify the hello time.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **spanning-tree mst hello-time** *seconds*

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config)# **spanning-tree mst hello-time** *seconds*	Configures the hello time for all MST instances. The hello time is the interval between the generation of configuration messages by the root bridge. These messages mean that the

	Command or Action	Purpose
		switch is alive. For *seconds*, the range is from 1 to 10, and the default is 2 seconds.

Example

This example shows how to configure the hello time of the switch to 1 second:

```
switch# configure terminal
switch(config)# spanning-tree mst hello-time 1
```

Configuring the Forwarding-Delay Time

You can set the forward delay timer for all MST instances on the switch with one command.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **spanning-tree mst forward-time** *seconds*

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config)# **spanning-tree mst forward-time** *seconds*	Configures the forward time for all MST instances. The forward delay is the number of seconds that a port waits before changing from its spanning tree blocking and learning states to the forwarding state. For *seconds*, the range is from 4 to 30, and the default is 15 seconds.

Example

This example shows how to configure the forward-delay time of the switch to 10 seconds:

```
switch# configure terminal
switch(config)# spanning-tree mst forward-time 10
```

Configuring the Maximum-Aging Time

The maximum-aging timer is the number of seconds that a switch waits without receiving spanning tree configuration messages before attempting a reconfiguration.

You set the maximum-aging timer for all MST instances on the switch with one command (the maximum age time only applies to the IST).

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **spanning-tree mst max-age** *seconds*

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config)# **spanning-tree mst max-age** *seconds*	Configures the maximum-aging time for all MST instances. The maximum-aging time is the number of seconds that a switch waits without receiving spanning tree configuration messages before attempting a reconfiguration. For *seconds*, the range is from 6 to 40, and the default is 20 seconds.

Example

This example shows how to configure the maximum-aging timer of the switch to 40 seconds:

```
switch# configure terminal
switch(config)# spanning-tree mst max-age 40
```

Configuring the Maximum-Hop Count

MST uses the path cost to the IST regional root and a hop-count mechanism similar to the IP time-to-live (TTL) mechanism. You configure the maximum hops inside the region and apply it to the IST and all MST instances in that region. The hop count achieves the same result as the message-age information (triggers a reconfiguration).

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **spanning-tree mst max-hops** *hop-count*

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config)# **spanning-tree mst max-hops** *hop-count*	Specifies the number of hops in a region before the BPDU is discarded, and the information held for a port is aged. For *hop-count*, the range is from 1 to 255, and the default value is 20 hops.

Example

This example shows how to set the maximum hops to 40:

```
switch# configure terminal
switch(config)# spanning-tree mst max-hops 40
```

Configuring PVST Simulation Globally

You can block this automatic feature either globally or per port. You can enter the global command and change the PVST simulation setting for the entire switch while you are in interface command mode.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **no spanning-tree mst simulate pvst global**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config)# **no spanning-tree mst simulate pvst global**	Disables all interfaces on the switch from automatically interoperating with connected switch that is running in Rapid PVST+ mode. By default, all interfaces on the switch operate seamlessly between Rapid PVST+ and MST.

Example

This example shows how to prevent the switch from automatically interoperating with a connecting switch that is running Rapid PVST+:

```
switch# configure terminal
switch(config)# no spanning-tree mst simulate pvst global
```

Configuring PVST Simulation Per Port

MST interoperates seamlessly with Rapid PVST+. However, to prevent an accidental connection to a switch 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 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.

You can block this automatic feature either globally or per port.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **interface** {{*type slot*/*port*} | {**port-channel** *number*}}
3. switch(config-if)# **spanning-tree mst simulate pvst disable**
4. switch(config-if)# **spanning-tree mst simulate pvst**
5. switch(config-if)# **no spanning-tree mst simulate pvst**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config)# **interface** {{*type slot*/*port*} | {**port-channel** *number*}}	Specifies an interface to configure, and enters interface configuration mode.
Step 3	switch(config-if)# **spanning-tree mst simulate pvst disable**	Disables specified interfaces from automatically interoperating with a connected switch that is running in Rapid PVST+ mode. By default, all interfaces on the switch operate seamlessly between Rapid PVST+ and MST.
Step 4	switch(config-if)# **spanning-tree mst simulate pvst**	Reenables the seamless operation between MST and Rapid PVST+ on specified interfaces.
Step 5	switch(config-if)# **no spanning-tree mst simulate pvst**	Sets the interface to the switch-wide MST and Rapid PVST+ interoperation that you configured using the **spanning-tree mst simulate pvst global** command.

Example

This example shows how to prevent the specified interfaces from automatically interoperating with a connecting switch that is not running MST:

```
switch# configure terminal
switch(config)# interface ethernet 1/4
switch(config-if)# spanning-tree mst simulate pvst disable
```

Specifying the Link Type

Rapid connectivity (802.1w standard) is established only on point-to-point links. By default, the link type is controlled from the duplex mode of the interface. A full-duplex port is considered to have a point-to-point connection; a half-duplex port is considered to have a shared connection.

If you have a half-duplex link physically connected point-to-point to a single port on a remote switch, you can override the default setting on the link type and enable rapid transitions.

If you set the link to shared, STP reverts to 802.1D.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **interface** *type slot*/*port*
3. switch(config-if)# **spanning-tree link-type** {**auto** | **point-to-point** | **shared**}

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters configuration mode.
Step 2	switch(config)# **interface** *type slot*/*port*	Specifies the interface to configure, and enters interface configuration mode.
Step 3	switch(config-if)# **spanning-tree link-type** {**auto** | **point-to-point** | **shared**}	Configures the link type to be either point to point or shared. The system reads the default value from the switch connection. Half-duplex links are shared and full-duplex links are point to point. If the link type is shared, the STP reverts to 802.1D. The default is auto, which sets the link type based on the duplex setting of the interface.

Example

This example shows how to configure the link type as point to point:

```
switch# configure terminal
switch (config)# interface ethernet 1/4
switch(config-if)# spanning-tree link-type point-to-point
```

Restarting the Protocol

An MST bridge can detect that a port is at the boundary of a region when it receives a legacy BPDU or an MST BPDU that is associated with a different region. However, the STP protocol migration cannot determine whether the legacy switch, which is a switch that runs only IEEE 802.1D, has been removed from the link unless the legacy switch is the designated switch. Enter this command to restart the protocol negotiation (force the renegotiation with neighboring switches) on the entire switch or on specified interfaces.

SUMMARY STEPS

1. switch# **clear spanning-tree detected-protocol** [**interface** *interface* [*interface-num* | *port-channel*]]

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **clear spanning-tree detected-protocol** [**interface** *interface* [*interface-num* | *port-channel*]]	Restarts MST on the entire switch or specified interfaces.

Example

This example shows how to restart MST on the Ethernet interface on slot 2, port 8:

```
switch# clear spanning-tree detected-protocol interface ethernet 2/8
```

Verifying the MST Configuration

Use the following commands to display MST configuration information.

Command	Purpose
show running-config spanning-tree [**all**]	Displays the current spanning tree configuration.
show spanning-tree mst [*options*]	Displays detailed information for the current MST configuration.

This example shows how to display the current MST configuration:

```
switch# show spanning-tree mst configuration
% Switch is not in mst mode
Name      [mist-attempt]
Revision  1     Instances configured 2
Instance  Vlans mapped
--------  ---------------------------------------------------------------------
0         1-12,14-41,43-4094
1         13,42
```