CHAPTER 16

Understanding and Configuring Multiple Spanning Trees

This chapter describes how to configure the Cisco implementation of the IEEE 802.1s Multiple STP (MSTP) on the Catalyst 4500 series switch. The Multiple Spanning-tree (MST) implementation is a pre-standard implementation based on the draft version of the IEEE standard.

This chapter includes the following major sections:

Note For complete syntax and usage information for the switch commands used in this chapter, refer to the *Catalyst 4500 Series Switch Cisco IOS Command Reference* and related publications at http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/index.htm.

Overview of MST

The following sections describe how MST works on a Catalyst 4500 series switch:

IEEE 802.1s MST

Note MST in this release is based on the draft version of the IEEE standard.

MST extends the IEEE 802.1w rapid spanning tree (RST) algorithm to multiple spanning trees. This extension provides both rapid convergence and load balancing in a VLAN environment. MST converges faster than Per VLAN Spanning Tree Plus (PVST+) and is backward compatible with 802.1D STP, 802.1w (Rapid Spanning Tree Protocol [RSTP]), and the Cisco PVST+ architecture.

MST allows you to build multiple spanning trees over trunks. You can group and associate VLANs to spanning tree instances. Each instance can have a topology independent of other spanning tree instances. This architecture provides multiple forwarding paths for data traffic and enables load balancing. Network fault tolerance is improved because a failure in one instance (forwarding path) does not affect other instances.

In large networks, you can more easily administer the network and use redundant paths by locating different VLAN and spanning tree instance assignments in different parts of the network. A spanning tree instance can exist only on bridges that have compatible VLAN instance assignments. You must configure a set of bridges with the same MST configuration information, which allows them to participate in a specific set of spanning tree instances. Interconnected bridges that have the same MST configuration are referred to as an MST region.

MST uses the modified RSTP, MSTP. MST has the following characteristics:

- MST runs a variant of spanning tree called Internal Spanning Tree (IST). IST augments Common Spanning Tree (CST) information with internal information about the MST region. The MST region appears as a single bridge to adjacent single spanning tree (SST) and MST regions.
- A bridge running MST provides interoperability with SST bridges as follows:
  - MST bridges run IST, which augments CST information with internal information about the MST region.
  - IST connects all the MST bridges in the region and appears as a subtree in the CST that includes the whole bridged domain. The MST region appears as a virtual bridge to adjacent SST bridges and MST regions.
  - The Common and Internal Spanning Tree (CIST) is the collection of the following: ISTs in each MST region, the CST that interconnects the MST regions, and the SST bridges. CIST is identical to an IST inside an MST region and identical to a CST outside an MST region. The STP, RSTP, and MSTP together elect a single bridge as the root of the CIST.
- MST establishes and maintains additional spanning trees within each MST region. These spanning trees are termed MST instances (MSTIs). The IST is numbered 0, and the MSTIs are numbered 1, 2, 3, and so on. Any MSTI is local to the MST region and is independent of MSTIs in another region, even if the MST regions are interconnected.

  MST instances combine with the IST at the boundary of MST regions to become the CST as follows:
  - Spanning tree information for an MSTI is contained in an MSTP record (M-record).

    M-records are always encapsulated within MST bridge protocol data units (BPDUs). The original spanning trees computed by MSTP are called M-trees, which are active only within the MST region. M-trees merge with the IST at the boundary of the MST region and form the CST.
- MST provides interoperability with PVST+ by generating PVST+ BPDUs for the non-CST VLANs.
- MST supports some of the PVST+ extensions in MSTP as follows:
  - UplinkFast and BackboneFast are not available in MST mode; they are part of RSTP.
  - PortFast is supported.

- BPDU filter and BPDU guard are supported in MST mode.
- Loop guard and root guard are supported in MST. MST preserves the VLAN 1 disabled functionality except that BPDUs are still transmitted in VLAN 1.
- MST switches operate as if MAC reduction is enabled.
- For private VLANs (PVLANs), you must map a secondary VLAN to the same instance as the primary.

IEEE 802.1w RSTP

RSTP, specified in 802.1w, supersedes STP specified in 802.1D, but remains compatible with STP. You configure RSTP when you configure the MST feature. For more information, see the "Configuring MST" section on page 16-9.

RSTP provides the structure on which the MST operates, significantly reducing the time to reconfigure the active topology of a network when its physical topology or configuration parameters change. RSTP selects one switch as the root of a spanning-tree-connected active topology and assigns port roles to individual ports of the switch, depending on whether that port is part of the active topology.

RSTP provides rapid connectivity following the failure of a switch, switch port, or a LAN. A new root port and the designated port on the other side of the bridge transition to the forwarding state through an explicit handshake between them. RSTP allows switch port configuration so the ports can transition to forwarding directly when the switch reinitializes.

RSTP provides backward compatibility with 802.1D bridges as follows:

- RSTP selectively sends 802.1D-configured BPDUs and Topology Change Notification (TCN) BPDUs on a per-port basis.
- When a port initializes, the migration delay timer starts and RSTP BPDUs are transmitted. While the migration delay timer is active, the bridge processes all BPDUs received on that port.
- If the bridge receives an 802.1D BPDU after a port's migration delay timer expires, the bridge assumes it is connected to an 802.1D bridge and starts using only 802.1D BPDUs.
- When RSTP uses 802.1D BPDUs on a port and receives an RSTP BPDU after the migration delay expires, RSTP restarts the migration delay timer and begins using RSTP BPDUs on that port.

RSTP Port Roles

In RSTP, the port roles are defined as follows:

- Root—A forwarding port elected for the spanning tree topology.
- Designated—A forwarding port elected for every switched LAN segment.
- Alternate—An alternate path to the root bridge to that provided by the current root port.
- Backup—A backup for the path provided by a designated port toward the leaves of the spanning tree. Backup ports can exist only where two ports are connected together in a loopback mode or bridge with two or more connections to a shared LAN segment.
- Disabled—A port that has no role within the operation of spanning tree.

The system assigns port roles as follows:

- A root port or designated port role includes the port in the active topology.
- An alternate port or backup port role excludes the port from the active topology.

RSTP Port States

The port state controls the forwarding and learning processes and provides the values of discarding, learning, and forwarding. Table 16-1 shows the STP port states and RSTP port states.

Table 16-1 Comparison Between STP and RSTP Port States

Operational Status	STP Port State	RSTP Port State	Port Included in Active Topology
Enabled	Blocking[1]	Discarding[2]	No
Enabled	Listening	Discarding	No
Enabled	Learning	Learning	Yes
Enabled	Forwarding	Forwarding	Yes
Disabled	Disabled	Discarding	No

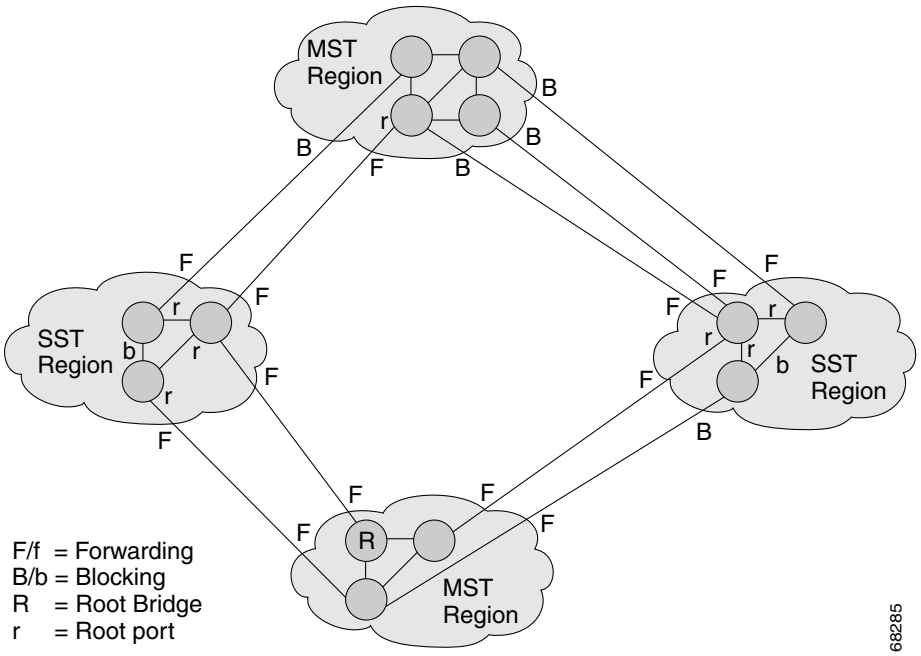
1. IEEE 802.1D port state designation.
2. IEEE 802.1w port state designation. Discarding is the same as blocking in MST.

In a stable topology, RSTP ensures that every root port and designated port transitions to the forwarding state while all alternate ports and backup ports are always in the discarding state.

MST-to-SST Interoperability

A virtual bridged LAN may contain interconnected regions of SST and MST bridges. Figure 16-1 shows this relationship.

Figure 16-1 Network with Interconnected SST and MST Regions



To STP running in the SST region, an MST region appears as a single SST or pseudobridge, which operates as follows:

- Although the values for root identifiers and root path costs match for all BPDUs in all pseudobridges, a pseudobridge differs from a single SST bridge as follows:
  - The pseudobridge BPDUs have different bridge identifiers. This difference does not affect STP operation in the neighboring SST regions because the root identifier and root cost are the same.
  - BPDUs sent from the pseudobridge ports may have significantly different message ages. Because the message age increases by one second for each hop, the difference in the message age is measured in seconds.
- Data traffic from one port of a pseudobridge (a port at the edge of a region) to another port follows a path entirely contained within the pseudobridge or MST region. Data traffic belonging to different VLANs might follow different paths within the MST regions established by MST.
- The system prevents looping by doing either of the following:
  - Blocking the appropriate pseudobridge ports by allowing one forwarding port on the boundary and blocking all other ports.
  - Setting the CST partitions to block the ports of the SST regions.

Common Spanning Tree

CST (802.1Q) is a single spanning tree for all the VLANs. In a Catalyst 4000 family switch running PVST+, the VLAN 1 spanning tree corresponds to CST. In a Catalyst 4000 family switch running MST, IST (instance 0) corresponds to CST.

MST Instances

This release supports up to 16 instances; each spanning tree instance is identified by an instance ID that ranges from 0 to 15. Instance 0 is mandatory and is always present. Instances 1 through 15 are optional.

MST Configuration Parameters

MST configuration has three parts, as follows:

- Name—A 32-character string (null padded) that identifies the MST region.
- Revision number—An 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 you commit the MST configuration.

- MST configuration table—An array of 4096 bytes. Each byte, interpreted as an unsigned integer, corresponds to a VLAN. The value is the instance number to which the VLAN is mapped. The first byte that corresponds to VLAN 0 and the 4096th byte that corresponds to VLAN 4095 are unused and always set to zero.

You must configure each byte manually. You can use SNMP or the CLI to perform the configuration.

MST BPDUs contain the MST configuration ID and the checksum. An MST bridge accepts an MST BPDU only if the MST BPDU configuration ID and the checksum match its own MST region configuration ID and checksum. If either value is different, the MST BPDU is considered to be an SST BPDU.

MST Regions

These sections describe MST regions:

MST Region Overview

Interconnected bridges that have the same MST configuration are referred to as an MST region. There is no limit on the number of MST regions in the network.

To form an MST region, bridges can be either of the following:

- An MST bridge that is the only member of the MST region.
- An MST bridge interconnected by a LAN. A LAN's designated bridge has the same MST configuration as an MST bridge. All the bridges on the LAN can process MST BPDUs.

If you connect two MST regions with different MST configurations, the MST regions do the following:

- Load balance across redundant paths in the network. If two MST regions are redundantly connected, all traffic flows on a single connection with the MST regions in a network.
- Provide an RSTP handshake to enable rapid connectivity between regions. However, the handshaking is not as fast as between two bridges. To prevent loops, all the bridges inside the region must agree upon the connections to other regions. This situation introduces a delay. We do not recommend partitioning the network into a large number of regions.

Boundary Ports

A boundary port is a port that connects to a LAN, the designated bridge of which is either an SST bridge or a bridge with a different MST configuration. A designated port knows that it is on the boundary if it detects an STP bridge or receives an agreement message from an RST or MST bridge with a different configuration.

At the boundary, the role of MST ports do not matter; their state is forced to be the same as the IST port state. If the boundary flag is set for the port, the MSTP Port Role selection mechanism assigns a port role to the boundary and the same state as that of the IST port. The IST port at the boundary can take up any port role except a backup port role.

IST Master

The IST master of an MST region is the bridge with the lowest bridge identifier and the least path cost to the CST root. If an MST bridge is the root bridge for CST, then it is the IST master of that MST region. If the CST root is outside the MST region, then one of the MST bridges at the boundary is selected as the IST master. Other bridges on the boundary that belong to the same region eventually block the boundary ports that lead to the root.

If two or more bridges at the boundary of a region have an identical path to the root, you can set a slightly lower bridge priority to make a specific bridge the IST master.

The root path cost and message age inside a region stay constant, but the IST path cost is incremented and the IST remaining hops are decremented at each hop. Enter the **show spanning-tree mst** command to display the information about the IST master, path cost, and remaining hops for the bridge.

Edge Ports

A port that is connected to a nonbridging device (for example, a host or a switch) is an edge port. A port that connects to a hub is also an edge port if the hub or any LAN that is connected to it does not have a bridge. An edge port can start forwarding as soon as the link is up.

MST requires that you configure each port connected to a host. To establish rapid connectivity after a failure, you need to block the non-edge designated ports of an intermediate bridge. If the port connects to another bridge that can send back an agreement, then the port starts forwarding immediately. Otherwise, the port needs twice the forward delay time to start forwarding again. You must explicitly configure the ports that are connected to the hosts and switches as edge ports while using MST.

To prevent a misconfiguration, the PortFast operation is turned off if the port receives a BPDU. You can display the configured and operational status of PortFast by using the **show spanning-tree mst** *interface* command.

Link Type

Rapid connectivity is established only on point-to-point links. You must configure ports explicitly to a host or switch. However, cabling in most networks meets this requirement, and you can avoid explicit configuration by treating all full-duplex links as point-to-point links by entering the **spanning-tree linktype** command.

Message Age and Hop Count

IST and MST instances do not use the message age and maximum age timer settings in the BPDU. IST and MST use a separate hop count mechanism that is very similar to the IP time-to live (TTL) mechanism. You can configure each MST bridge with a maximum hop count. The root bridge of the instance sends a BPDU (or M-record) with the remaining hop count that is equal to the maximum hop count. When a bridge receives a BPDU (or M-record), it decrements the received remaining hop count by one. The bridge discards the BPDU (M-record) and ages out the information held for the port if the count reaches zero after decrementing. The nonroot bridges propagate the decremented count as the remaining hop count in the BPDUs (M-records) they generate.

The message age and maximum age timer settings in the RST portion of the BPDU remain the same throughout the region, and the same values are propagated by the region's designated ports at the boundary.

MST-to-PVST+ Interoperability

Keep these guidelines in mind when you configure MST switches (in the same region) to interact with PVST+ switches:

- Configure the root for all VLANs inside the MST region as shown in this example:

```
Switch# show spanning-tree mst interface gigabitethernet 1/1

GigabitEthernet1/1 of MST00 is root forwarding
Edge port: no             (trunk)          port guard : none        (default)
Link type: point-to-point (auto)           bpdu filter: disable     (default)
Boundary : boundary       (PVST)           bpdu guard : disable     (default)
Bpdus sent 10, received 310

Instance Role Sts Cost      Prio.Nbr Vlans mapped
-------- ---- --- --------- -------- --------------------------------
0        Root FWD 20000     128.1    1-2,4-2999,4000-4094
3        Boun FWD 20000     128.1    3,3000-3999
```

  The ports that belong to the MST switch at the boundary simulate PVST+ and send PVST+ BPDUs for all the VLANs.

  If you enable loop guard on the PVST+ switches, the ports might change to a loop-inconsistent state when the MST switches change their configuration. To correct the loop-inconsistent state, you must disable and renewable loop guard on that PVST+ switch.

- Do not locate the root for some or all of the VLANs inside the PVST+ side of the MST switch because when the MST switch at the boundary receives PVST+ BPDUs for all or some of the VLANs on its designated ports, root guard sets the port to the blocking state.

When you connect a PVST+ switch to two different MST regions, the topology change from the PVST+ switch does not pass beyond the first MST region. In such a case, the topology changes are propagated only in the instance to which the VLAN is mapped. The topology change stays local to the first MST region, and the Cisco Access Manager (CAM) entries in the other region are not flushed. To make the topology change visible throughout other MST regions, you can map that VLAN to IST or connect the PVST+ switch to the two regions through access links.

MST Configuration Restrictions and Guidelines

Follow these restrictions and guidelines to avoid configuration problems:

- Do not disable spanning tree on any VLAN in any of the PVST bridges.
- Do no use PVST bridges as the root of CST.
- Do not connect switches with access links, because access links may partition a VLAN.
- Ensure that all PVST root bridges have lower (numerically higher) priority than the CST root bridge.
- Ensure that trunks carry all of the VLANs mapped to an instance or do not carry any VLANs at all for this instance.
- Complete any MST configuration that incorporates a large number of either existing or new logical VLAN ports during a maintenance window because the complete MST database gets reinitialized for any incremental change (such as adding new VLANs to instances or moving VLANs across instances).

Configuring MST

The following sections describe how to configure MST:

Enabling MST

To enable and configure MST on a Catalyst 4006 switch with Supervisor Engine III, perform this task:

	Command	Purpose
Step 1	`Switch(config)# spanning-tree mode mst`	Enters MST mode.
Step 2	`Switch(config)# spanning-tree mst configuration`	Enters MST configuration submode. You can use the **no** keyword to clear the MST configuration.
Step 3	`Switch(config-mst)# show current`	Displays the current MST configuration.
Step 4	`Switch(config-mst)# name` *name*	Sets the MST region name.
Step 5	`Switch(config-mst)# revision` *revision_number*	Sets the MST configuration revision number.
Step 6	`Switch(config-mst)# instance` *instance_number* `vlan` *vlan_range*	Maps the VLANs to an MST instance. If you do not specify the **vlan** keyword, you can use the **no** keyword to unmap all the VLANs that were mapped to an MST instance. If you specify the **vlan** keyword, you can use the **no** keyword to unmap a specified VLAN from an MST instance.
Step 7	`Switch(config-mst)# show pending`	Displays the new MST configuration to be applied.
Step 8	`Switch(config-mst)# end`	Applies the configuration and exit MST configuration submode.
Step 9	`Switch# show spanning-tree mst configuration`	Displays the current MST configuration.

This example show how to enable MST:

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# spanning-tree mode mst

Switch(config)# spanning-tree mst configuration
```

```
Switch(config-mst)# show current
Current MST configuration
Name      []
Revision  0
Instance  Vlans mapped
--------  ---------------------------------------------------------------------
0         1-4094
-------------------------------------------------------------------------------
Switch(config-mst)# name cisco
Switch(config-mst)# revision 2
Switch(config-mst)# instance 1 vlan 1
Switch(config-mst)# instance 2 vlan 1-1000
Switch(config-mst)# show pending
Pending MST configuration
Name      [cisco]
Revision  2
Instance  Vlans mapped
--------  ---------------------------------------------------------------------
0         1001-4094
2         1-1000
-------------------------------------------------------------------------------
Switch(config-mst)# no instance 2
Switch(config-mst)# show pending
Pending MST configuration
Name      [cisco]
Revision  2
Instance  Vlans mapped
--------  ---------------------------------------------------------------------
0         1-4094
-------------------------------------------------------------------------------
Switch(config-mst)# instance 1 vlan 2000-3000
Switch(config-mst)# no instance 1 vlan 1500
Switch(config-mst)# show pending
Pending MST configuration
Name      [cisco]
Revision  2
Instance  Vlans mapped
--------  ---------------------------------------------------------------------
0         1-1999,2500,3001-4094
1         2000-2499,2501-3000
-------------------------------------------------------------------------------
Switch(config-mst)# end
Switch(config)# no spanning-tree mst configuration
Switch(config)# end
Switch# show spanning-tree mst configuration
Name      []
Revision  0
Instance  Vlans mapped
--------  ---------------------------------------------------------------------
0         1-4094
-------------------------------------------------------------------------------
```

Configuring MST Instance Parameters

To configure MST instance parameters, perform this task:

	Command	Purpose
Step 1	`Switch(config)# spanning-tree mst X priority Y`	Configures the priority for an MST instance.
Step 2	`Switch(config)# spanning-tree mst X root [primary | secondary]`	Configures the bridge as root for an MST instance.
Step 3	`Switch(config)# Ctrl-Z`	Exits configuration mode.
Step 4	`Switch# show spanning-tree mst`	Verifies the configuration.

This example shows how to configure MST instance parameters:

```
Switch(config)# spanning-tree mst 1 priority ?
 <0-61440>  bridge priority in increments of 4096

Switch(config)# spanning-tree mst 1 priority 1
% Bridge Priority must be in increments of 4096.
% Allowed values are:
  0     4096  8192  12288 16384 20480 24576 28672
  32768 36864 40960 45056 49152 53248 57344 61440

Switch(config)# spanning-tree mst 1 priority 49152
Switch(config)#

Switch(config)# spanning-tree mst 0 root primary
 mst 0 bridge priority set to 24576
 mst bridge max aging time unchanged at 20
 mst bridge hello time unchanged at 2
 mst bridge forward delay unchanged at 15
Switch(config)# ^Z
Switch#

Switch# show spanning-tree mst

###### MST00        vlans mapped:  11-4094
Bridge      address 00d0.00b8.1400  priority  24576 (24576 sysid 0)
Root        this switch for CST and IST
Configured  hello time 2, forward delay 15, max age 20, max hops 20

Interface        Role Sts Cost      Prio.Nbr Status
---------------- ---- --- --------- -------- --------------------------------
Fa4/4            Back BLK 1000      240.196  P2p
Fa4/5            Desg FWD 200000    128.197  P2p
Fa4/48           Desg FWD 200000    128.240  P2p Bound(STP)

###### MST01        vlans mapped:  1-10
Bridge      address 00d0.00b8.1400  priority  49153 (49152 sysid 1)
Root        this switch for MST01

Interface        Role Sts Cost      Prio.Nbr Status
---------------- ---- --- --------- -------- --------------------------------
Fa4/4            Back BLK 1000      160.196  P2p
Fa4/5            Desg FWD 200000    128.197  P2p
Fa4/48           Boun FWD 200000    128.240  P2p Bound(STP)

Switch#
```

Configuring MST Instance Port Parameters

To configure MST instance port parameters, perform this task:

	Command	Purpose
Step 1	`Switch(config-if)# spanning-tree mst x cost y`	Configures the MST instance port cost.
Step 2	`Switch(config-if)# spanning-tree mst x port-priority y`	Configures the MST instance port priority.
Step 3	`Switch(config-if)# Ctrl-Z`	Exits configuration mode.
Step 4	`Switch# show spanning-tree mst x interface y`	Verifies the configuration.

This example shows how to configure MST instance port parameters:

```
Switch(config)# interface fastethernet 4/4
Switch(config-if)# spanning-tree mst 1 ?
  cost           Change the interface spanning tree path cost for an instance
  port-priority  Change the spanning tree port priority for an instance

Switch(config-if)# spanning-tree mst 1 cost 1234567

Switch(config-if)# spanning-tree mst 1 port-priority 240
Switch(config-if)# ^Z

Switch# show spanning-tree mst 1 interface fastethernet 4/4

FastEthernet4/4 of MST01 is backup blocking
Edge port:no             (default)        port guard :none        (default)
Link type:point-to-point (auto)           bpdu filter:disable     (default)
Boundary :internal                        bpdu guard :disable     (default)
Bpdus (MRecords) sent 125, received 1782

Instance Role Sts Cost      Prio.Nbr Vlans mapped
-------- ---- --- --------- -------- --------------------------------
1        Back BLK 1234567   240.196  1-10

Switch#
```

Restarting Protocol Migration

RSTP and MST have built-in compatibility mechanisms that allow them to interact properly with other regions or other versions of IEEE spanning-tree. For example, an RSTP bridge connected to a legacy bridge can send 802.1D BPDUs on one of its ports. Similarly, when an MST bridge receives a legacy BPDU or an MST BPDU associated with a different region, it is also to detect that a port is at the boundary of a region.

Unfortunately, these mechanisms cannot always revert to the most efficient mode. For example, an RSTP bridge designated for a legacy 802.1D will stay in 802.1D mode even after the legacy bridge has been removed from the link. Similarly, an MST port still assumes that it is a boundary port when the bridge(s) to which it is connected have joined the same region. To force a Catalyst 4000 family switch to renegotiate with the neighbors (that is, to restart protocol migration), you must enter the **clear spanning-tree detected-protocols** command, as follows:

```
Switch# clear spanning-tree detected-protocols fastethernet 4/4
Switch#
```

Displaying MST Configurations

To display MST configurations, perform this task:

	Command	Purpose
Step 1	`Switch# show spanning-tree mst configuration`	Displays the active region configuration information.
Step 2	`Switch# show spanning-tree mst [detail]`	Displays detailed MST protocol information.
Step 3	`Switch# show spanning-tree mst instance-id [detail]`	Displays information about a specific MST instance.
Step 4	`Switch# show spanning-tree mst interface interface [detail]`	Displays information for a given port.
Step 5	`Switch# show spanning-tree mst instance-id interface interface [detail]`	Displays MST information for a given port and a given instance.
Step 6	`Switch# show spanning-tree vlan vlan_ID`	Displays VLAN information in MST mode.

The following examples show how to display spanning tree VLAN configurations in MST mode:

```
Switch(config)# spanning-tree mst configuration
Switch(config-mst)# instance 1 vlan 1-10
Switch(config-mst)# name cisco
Switch(config-mst)# revision 1
Switch(config-mst)# Ctrl-D

Switch# show spanning-tree mst configuration
Name      [cisco]
Revision  1
Instance  Vlans mapped
--------  ---------------------------------------------------------------------
0         11-4094
1         1-10
-------------------------------------------------------------------------------

Switch# show spanning-tree mst

###### MST00        vlans mapped:  11-4094
Bridge      address 00d0.00b8.1400  priority  32768 (32768 sysid 0)
Root        address 00d0.004a.3c1c  priority  32768 (32768 sysid 0)
            port    Fa4/48          path cost 203100
IST master  this switch
Operational hello time 2, forward delay 15, max age 20, max hops 20
Configured  hello time 2, forward delay 15, max age 20, max hops 20

Interface        Role Sts Cost      Prio.Nbr Status
---------------- ---- --- --------- -------- --------------------------------
Fa4/4            Back BLK 1000      240.196  P2p
Fa4/5            Desg FWD 200000    128.197  P2p
Fa4/48           Root FWD 200000    128.240  P2p Bound(STP)

###### MST01        vlans mapped:  1-10
Bridge      address 00d0.00b8.1400  priority  32769 (32768 sysid 1)
Root        this switch for MST01

Interface        Role Sts Cost      Prio.Nbr Status
---------------- ---- --- --------- -------- --------------------------------
Fa4/4            Back BLK 1000      240.196  P2p
Fa4/5            Desg FWD 200000    128.197  P2p
Fa4/48           Boun FWD 200000    128.240  P2p Bound(STP)
```

```
Switch# show spanning-tree mst 1

###### MST01        vlans mapped:  1-10
Bridge      address 00d0.00b8.1400  priority  32769 (32768 sysid 1)
Root        this switch for MST01

Interface        Role Sts Cost      Prio.Nbr Status
---------------- ---- --- --------- -------- --------------------------------
Fa4/4            Back BLK 1000      240.196  P2p
Fa4/5            Desg FWD 200000    128.197  P2p
Fa4/48           Boun FWD 200000    128.240  P2p Bound(STP)

Switch# show spanning-tree mst interface fastethernet 4/4

FastEthernet4/4 of MST00 is backup blocking
Edge port:no             (default)        port guard :none        (default)
Link type:point-to-point (auto)           bpdu filter:disable     (default)
Boundary :internal                        bpdu guard :disable     (default)
Bpdus sent 2, received 368

Instance Role Sts Cost      Prio.Nbr Vlans mapped
-------- ---- --- --------- -------- --------------------------------
0        Back BLK 1000      240.196  11-4094
1        Back BLK 1000      240.196  1-10


Switch# show spanning-tree mst 1 interface fastethernet 4/4

FastEthernet4/4 of MST01 is backup blocking
Edge port:no             (default)        port guard :none        (default)
Link type:point-to-point (auto)           bpdu filter:disable     (default)
Boundary :internal                        bpdu guard :disable     (default)
Bpdus (MRecords) sent 2, received 364

Instance Role Sts Cost      Prio.Nbr Vlans mapped
-------- ---- --- --------- -------- --------------------------------
1        Back BLK 1000      240.196  1-10

Switch# show spanning-tree mst 1 detail

###### MST01        vlans mapped:  1-10
Bridge      address 00d0.00b8.1400  priority  32769 (32768 sysid 1)
Root        this switch for MST01

FastEthernet4/4 of MST01 is backup blocking
Port info             port id        240.196  priority    240  cost        1000
Designated root       address 00d0.00b8.1400  priority  32769  cost           0
Designated bridge     address 00d0.00b8.1400  priority  32769  port id  128.197
Timers:message expires in 5 sec, forward delay 0, forward transitions 0
Bpdus (MRecords) sent 123, received 1188

FastEthernet4/5 of MST01 is designated forwarding
Port info             port id        128.197  priority    128  cost      200000
Designated root       address 00d0.00b8.1400  priority  32769  cost           0
Designated bridge     address 00d0.00b8.1400  priority  32769  port id  128.197
Timers:message expires in 0 sec, forward delay 0, forward transitions 1
Bpdus (MRecords) sent 1188, received 123
```

```
FastEthernet4/48 of MST01 is boundary forwarding
Port info             port id        128.240  priority    128  cost      200000
Designated root       address 00d0.00b8.1400  priority  32769  cost           0
Designated bridge     address 00d0.00b8.1400  priority  32769  port id  128.240
Timers:message expires in 0 sec, forward delay 0, forward transitions 1
Bpdus (MRecords) sent 78, received 0

Switch# show spanning-tree vlan 10

MST01
  Spanning tree enabled protocol mstp
  Root ID    Priority    32769
             Address     00d0.00b8.1400
             This bridge is the root
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32769  (priority 32768 sys-id-ext 1)
             Address     00d0.00b8.1400
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

Interface        Role Sts Cost      Prio.Nbr Status
---------------- ---- --- --------- -------- --------------------------------
Fa4/4            Back BLK 1000      240.196  P2p
Fa4/5            Desg FWD 200000    128.197  P2p

Switch# show spanning-tree summary
Root bridge for:MST01
EtherChannel misconfiguration guard is enabled
Extended system ID   is enabled
Portfast             is disabled by default
PortFast BPDU Guard  is disabled by default
Portfast BPDU Filter is disabled by default
Loopguard            is disabled by default
UplinkFast           is disabled
BackboneFast         is disabled
Pathcost method used is long

Name                   Blocking Listening Learning Forwarding STP Active
---------------------- -------- --------- -------- ---------- ----------
MST00                     1        0         0        2          3
MST01                     1        0         0        2          3
---------------------- -------- --------- -------- ---------- ----------
2 msts                    2        0         0        4          6
Switch#
```