4

Multiple Instance Spanning-Tree Operation

Contents

Overview

The switches covered in this guide, use the IEEE 802.1s Multiple Spanning Tree Protocol (MSTP) standard.

MSTP Features

802.1s Spanning Tree Protocol	Default Setting	Page Reference
Viewing the MSTP Status and Configuration	n/a	page 4-55
Configuring MSTP Operation Mode and Global Parameters	Disabled	page 4-21 and following
Configuring Basic Port Connectivity Parameters	admin-edge-port: No-disabled auto-edge-port: Yes-enabled bpdu-filter: No-disabled bpdu-protection: No-disabled hello-time: 2 path-cost: auto point-to-point MAC: Force-True priority: 128 (multiplier: 8) root-guard: No-disabled tcn-guard: No-disabled loop protection: Send disable	page 4-27 and following
Configuring MSTP Instance Parameters	instance (MSTPI): none priority: 32768 (multiplier: 8)	page 4-41
Configuring MSTP Instance Per-Port Parameters	path-cost: auto priority: 128 (multiplier: 8)	page 4-43
Enabling/Disabling MSTP Spanning Tree Operation	Disabled	page 4-46
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Without spanning tree, having more than one active path between a pair of nodes causes loops in the network, which can result in duplication of messages, leading to a “broadcast storm” that can bring down the network.

Multiple-Instance spanning tree operation (802.1s) ensures that only one active path exists between any two nodes in a spanning-tree *instance*. A spanning-tree instance comprises a unique set of VLANs, and belongs to a specific spanning-tree *region*. A region can comprise multiple spanning-tree

instances (each with a different set of VLANs), and allows one active path among regions in a network. Applying VLAN tagging to the ports in a multiple-instance spanning-tree network enables blocking of redundant links in one instance while allowing forwarding over the same links for non-redundant use by another instance.

For example, suppose you have three switches in a region configured with VLANs grouped into two instances, as follows:

VLANs	Instance 1	Instance 2
10, 11, 12	Yes	No
20, 21, 22	No	Yes

The logical and physical topologies resulting from these VLAN/Instance groupings result in blocking on different links for different VLANs:

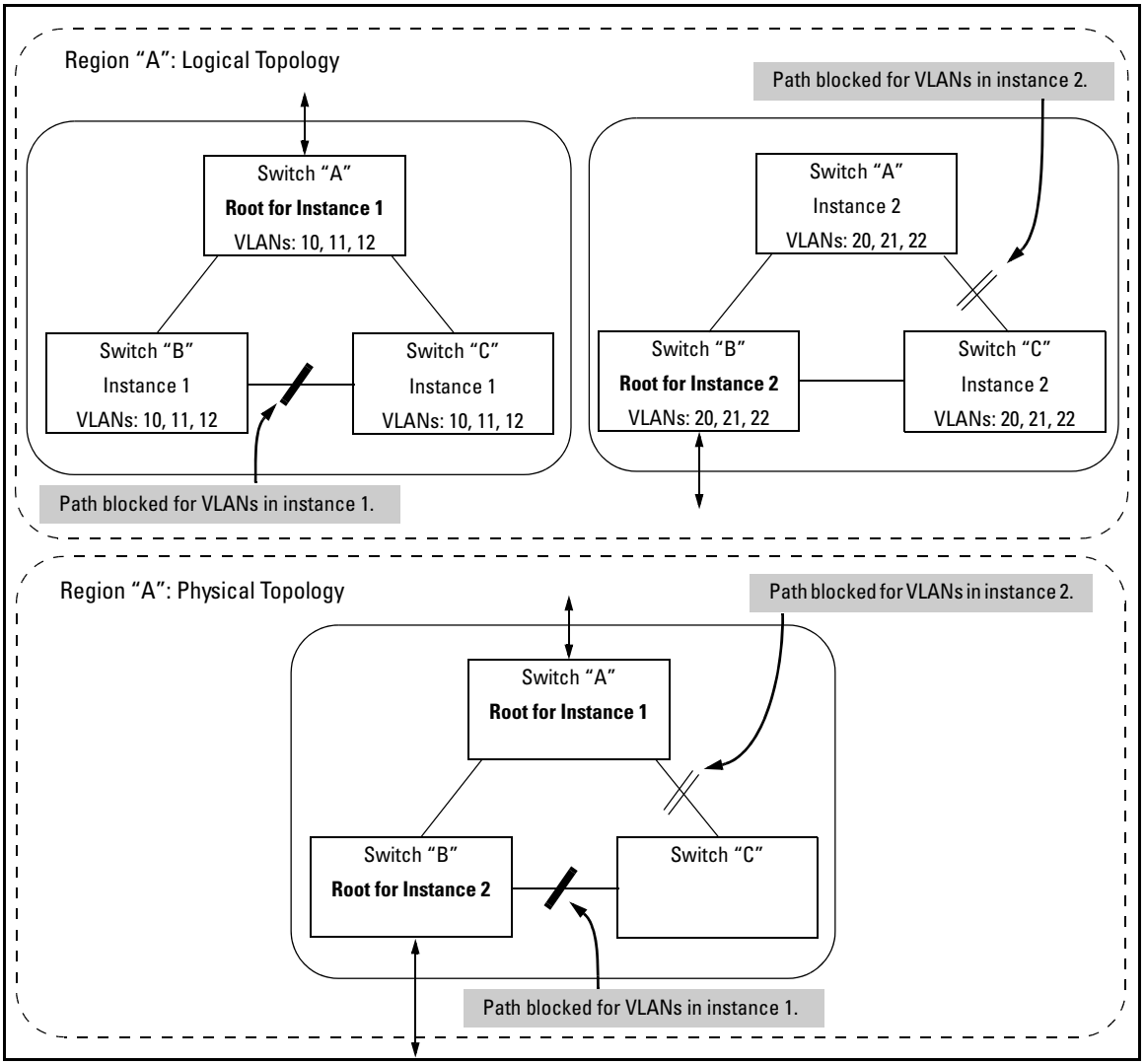

Figure 4-1. Example of a Multiple Spanning-Tree Application

802.1s Multiple Spanning Tree Protocol (MSTP)

The 802.1D and 802.1w spanning tree protocols operate without regard to a network's VLAN configuration, and maintain one common spanning tree throughout a bridged network. Thus, these protocols map one loop-free, logical topology on a given physical topology. The 802.1s Multiple Spanning Tree protocol (MSTP) uses VLANs to create multiple spanning trees in a network, which significantly improves network resource utilization while maintaining a loop-free environment.

While the per-VLAN spanning tree approach adopted by some vendors overcomes the network utilization problems inherent in using STP or RSTP, using a per-VLAN technology with multiple VLANs can overload the switch's CPU. MSTP on the switches covered in this guide complies with the IEEE 802.1s standard, and extends STP and RSTP functionality to map multiple independent spanning tree instances onto a physical topology. With MSTP, each spanning tree instance can include one or more VLANs and applies a separate, per-instance forwarding topology. Thus, where a port belongs to multiple VLANs, it may be dynamically blocked in one spanning tree instance, but forwarding in another instance. This achieves load-balancing across the network while keeping the switch's CPU load at a moderate level (by aggregating multiple VLANs in a single spanning tree instance). MSTP provides fault tolerance through rapid, automatic reconfiguration if there is a failure in a network's physical topology.

With MSTP-capable switches, you can create a number of MST regions containing multiple spanning tree instances. This requires the configuration of a number of MSTP-capable switches. However, it is NOT necessary to do this. You can just enable MSTP on an MSTP-capable switch and a spanning tree instance is created automatically. This instance always exists by default when spanning tree is enabled, and is the spanning tree instance that communicates with STP and RSTP environments. The MSTP configuration commands operate exactly like RSTP commands and MSTP is backward-compatible with the RSTP-enabled and STP-enabled switches in your network.

Caution

Spanning tree interprets a switch mesh as a single link. Because the switch automatically gives faster links a higher priority, the default MSTP parameter settings are usually adequate for spanning tree operation. Also, because incorrect MSTP settings can adversely affect network performance, you should not change the MSTP settings from their default values unless you have a strong understanding of how spanning tree operates.

In a mesh environment, the default MSTP timer settings (**Hello Time** and **Forward Delay**) are usually adequate for MSTP operation. Because a packet crossing a mesh may traverse several links within the mesh, using smaller-than-default settings for the MSTP **Hello Time** and **Forward Delay** timers can cause unnecessary topology changes and end-node connectivity problems.

For MSTP information beyond what is provided in this manual, refer to the IEEE 802.1s standard.

MSTP Structure

MSTP maps active, separate paths through separate spanning tree instances and between MST regions. Each MST region comprises one or more MSTP switches. Note that MSTP recognizes an STP or RSTP LAN as a distinct spanning-tree region.

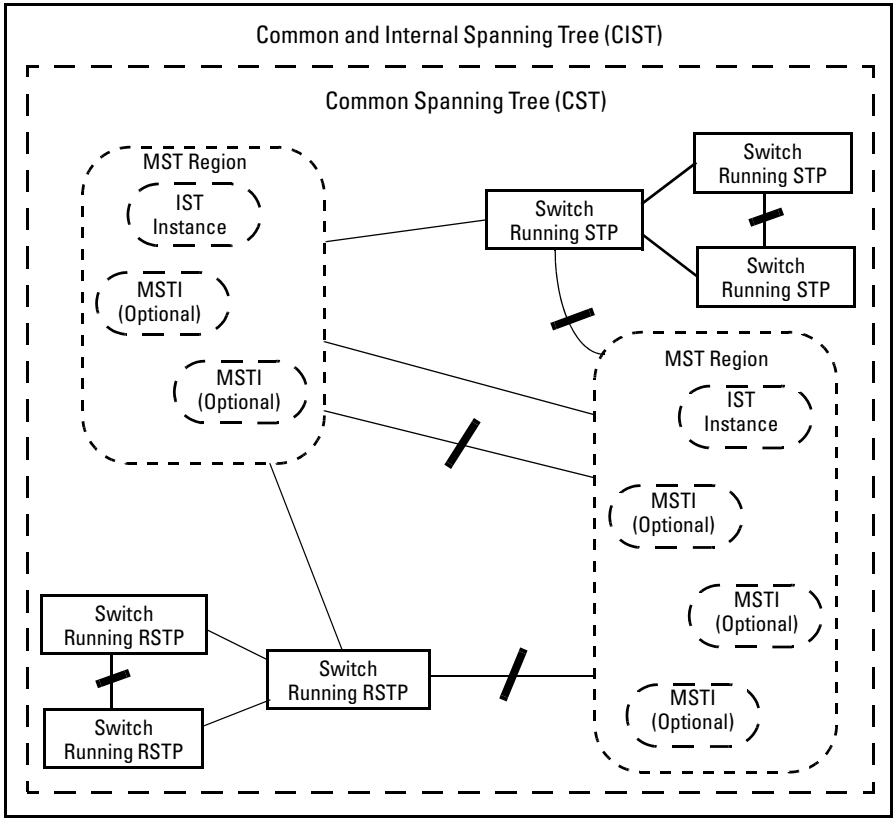

Figure 4-2. Example of MSTP Network with Legacy STP and RSTP Devices Connected

Common and Internal Spanning Tree (CIST): The CIST identifies the regions in a network and administers the CIST root bridge for the network, the root bridge for each region, and the root bridge for each spanning-tree instance in each region.

Common Spanning Tree (CST): The CST administers the connectivity among the MST regions, STP LANs, and RSTP LANs in a bridged network.

MST Region: An MST region comprises the VLANs configured on physically connected MSTP switches. All switches in a given region must be configured with the same VLANs, the same Multiple Spanning Tree Instances (MSTIs), and the same MST configuration identifiers.

Internal Spanning Tree (IST): The IST administers the topology within a given MST region. When you configure a switch for MSTP operation, the switch automatically includes all of the static VLANs configured on the switch in a single, active spanning tree topology (instance) within the IST. This is termed the “IST instance”. Any VLANs you subsequently configure on the switch are added to this IST instance. To create separate forwarding paths within a region, group specific VLANs into different Multiple Spanning Tree Instances (MSTIs). (Refer to “Multiple Spanning Tree Instance (MSTI)”, below.)

Types of Multiple Spanning Tree Instances: A multiple spanning tree network comprises separate spanning-tree instances existing in an MST region. (There can be multiple regions in a network.) Each instance defines a single forwarding topology for an exclusive set of VLANs. By contrast, an STP or RSTP network has only one spanning tree instance for the entire network, and includes all VLANs in the network. (An STP or RSTP network operates as a single-instance network.) A region can include two types of STP instances:

- **Internal Spanning-Tree Instance (IST Instance):** This is the default spanning tree instance in any MST region. It provides the root switch for the region and comprises all VLANs configured on the switches in the region that are not specifically assigned to Multiple Spanning Tree Instances (MSTIs, described below).

  Within a region, the IST instance provides a loop-free forwarding path for all VLANs associated with it. VLANs that are not associated with an MSTI are, by default, associated with the IST instance. Note that the switch automatically places dynamic VLANs (resulting from GVRP operation) in the IST instance. Dynamic VLANs cannot exist in an MSTI (described below).

- **Multiple Spanning Tree Instance (MSTI):** This type of configurable spanning tree instance comprises all static VLANs you specifically assign to it, and must include at least one VLAN. The VLAN(s) you assign to an

MSTI must initially exist in the IST instance of the same MST region. When you assign a static VLAN to an MSTI, the switch removes the VLAN from the IST instance. (Thus, you can assign a VLAN to only one MSTI in a given region.) All VLANs in an MSTI operate as part of the same single spanning tree topology. (The switch does not allow dynamic VLANs in an MSTI.)

Caution

When you enable MSTP on the switch, the default MSTP spanning tree configuration settings comply with the values recommended in the IEEE 802.1s Multiple Spanning Tree Protocol (MSTP) standard. Note that inappropriate changes to these settings can result in severely degraded network performance. For this reason, *ProCurve strongly recommends that changing these default settings be reserved only for experienced network administrators who have a strong understanding of the IEEE 802.1D/w/s standards and operation.*

How MSTP Operates

In the factory default configuration, spanning tree operation is off. Also, the switch retains its currently configured spanning tree parameter settings when disabled. Thus, if you disable spanning tree, then later re-enable it, the parameter settings will be the same as before spanning tree was disabled. The switch also includes a "Pending" feature that enables you to exchange MSTP configurations with a single command. (Refer to "Enabling an Entire MST Region at Once or Exchanging One Region Configuration for Another" on page 4-46.)

Note

The switch automatically senses port identity and type, and automatically defines spanning-tree parameters for each type, as well as parameters that apply across the switch. Although these parameters can be adjusted, *ProCurve strongly recommends leaving these settings in their default configurations unless the proposed changes have been supplied by an experienced network administrator who has a strong understanding of the IEEE 802.1D/w/s standards and operation.*

MST Regions

All MSTP switches in a given region must be configured with the same VLANs. Also, each MSTP switch within the same region must have the same VLAN-to-instance assignments. (A VLAN can belong to only one instance within any region.) Within a region:

- All of the VLANs belonging to a given instance compose a single, active spanning-tree topology for that instance.
- Each instance operates independently of other regions.

Between regions there is a single, active spanning-tree topology.

How Separate Instances Affect MSTP Operation. Assigning different groups of VLANs to different instances ensures that those VLAN groups use independent forwarding paths. For example, in figure 4-3 each instance has a different forwarding path.

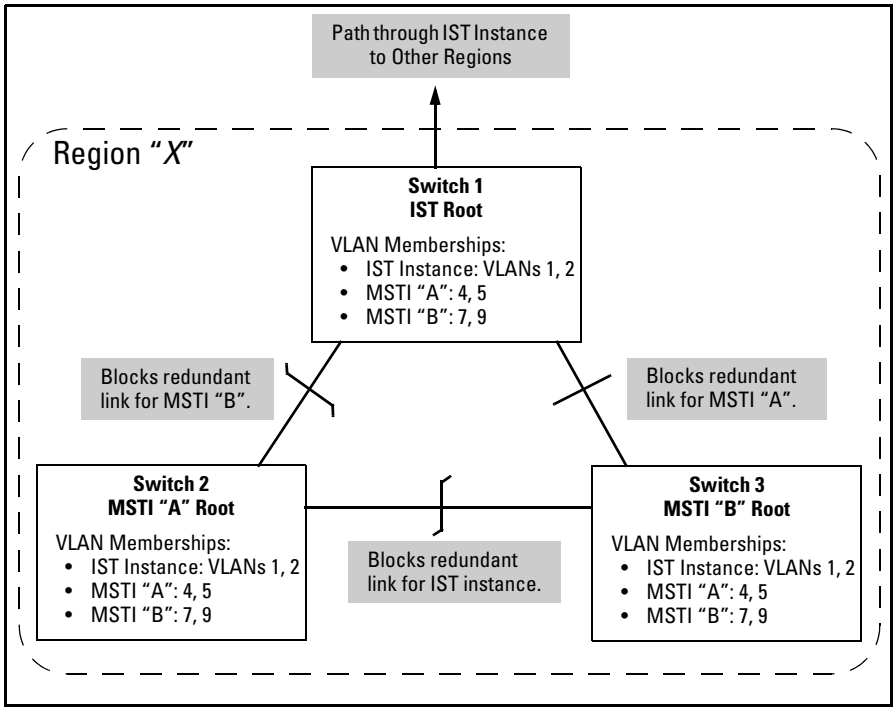

Figure 4-3. Active Topologies Built by Three Independent MST Instances

While allowing only one active path through a given instance, MSTP retains any redundant physical paths in the instance to serve as backups (blocked) paths in case the existing active path fails. Thus, if an active path in an instance fails, MSTP automatically activates (unblocks) an available backup to serve as the new active path through the instance for as long as the original active path is down. Note also that a given port may simultaneously operate in different states (forwarding or blocking) for different spanning-tree instances within the same region. This depends on the VLAN memberships to which the port is assigned. For example, if a port belongs to VLAN 1 in the IST instance of a region and also belongs to VLAN 4 in MSTI "*x*" in the same region, the port may apply different states to traffic for these two different instances.

Within a region, traffic routed between VLANs in separate instances can take only one physical path. To ensure that traffic in all VLANs within a region can travel between regions, all of the boundary ports for each region should belong to all VLANs configured in the region. Otherwise, traffic from some areas within a region could be blocked from moving to other regions.

All MSTP switches (as well as STP and RSTP switches) in a network use BPDUs (Bridge Protocol Data Units) to exchange information from which to build multiple, active topologies in the individual instances within a region and between regions. From this information:

- The MSTP switches in each LAN segment determine a designated bridge and designated port or trunk for the segment.
- The MSTP switches belonging to a particular instance determine the root bridge and root port or trunk for the instance.
- For the IST instance within a region, the MSTP switches linking that region to other regions (or to STP or RSTP switches) determine the IST root bridge and IST root port or trunk for the region. (For any Multiple Spanning-Tree instance—MSTI—in a region, the regional root may be a different switch that is not necessarily connected to another region.)
- The MSTP switches block redundant links within each LAN segment, across all instances, and between regions, to prevent any traffic loops.

As a result, each individual instance (spanning tree) within a region determines its regional root bridge, designated bridges, and designated ports or trunks.

Regions, Legacy STP and RSTP Switches, and the Common Spanning Tree (CST)

The IST instance and any MST instances in a region exist only within that region. Where a link crosses a boundary between regions (or between a region and a legacy STP or RSTP switch), traffic is forwarded or blocked as determined by the Common Spanning Tree (CST). The CST ensures that there is only one active path between any two regions, or between a region and a switch running STP and RSTP. (Refer to figure 4-2 on page 4-7.)

MSTP Operation with 802.1Q VLANs

As indicated in the preceding sections, within a given MST instance, a single spanning tree is configured for all VLANs included in that instance. This means that if redundant physical links exist in separate VLANs within the same instance, MSTP blocks all but one of those links. However, you can prevent the bandwidth loss caused by blocked redundant links for different VLANs in an instance by using a port trunk. The following example shows how you can use a port trunk with 802.1Q (tagged) VLANs and MSTP without unnecessarily blocking any links or losing any bandwidth.

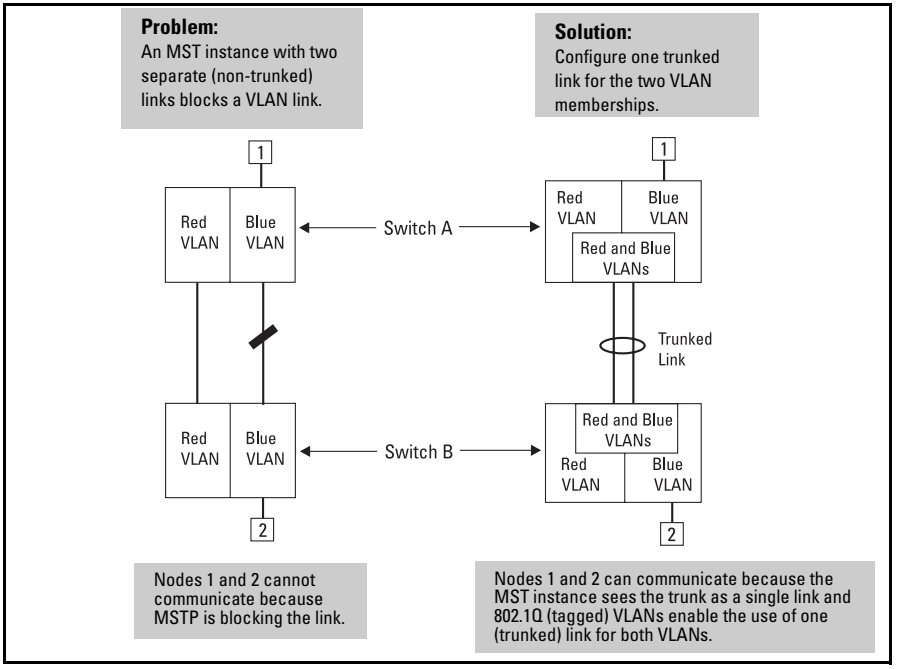

Figure 4-4. Example of Using a Trunked Link To Support Multiple VLAN Connectivity within the Same MST Instance

Note

All switches in a region should be configured with the VLANs used in that region, and all ports linking MSTP switches together should be members of all VLANs in the region. Otherwise, the path to the root for a given VLAN will be broken if MSTP selects a spanning tree through a link that does not include that VLAN.

Terminology

BPDU — Acronym for bridge protocol data unit. BPDUs are data messages that are exchanged between the switches within an extended LAN that use a spanning tree protocol topology. BPDU packets contain information on ports, addresses, priorities and costs and ensure that the data ends up where it was intended to go. BPDU messages are exchanged across bridges to detect loops in a network topology. The loops are then removed by placing redundant switch ports in a backup, or blocked, state.

BPDU Filtering — Spanning-tree configuration mode that prevents the switch from receiving and transmitting BPDU frames on a specific port (see page 4-30 for details).

BPDU Protection — Spanning-tree configuration mode which disables a port where BPDU frames are received (see page 4-31 for details).

Bridge: See "MSTP Bridge".

Common and Internal Spanning Tree (CIST): Comprises all LANs, STP, and RSTP bridges and MSTP regions in a network. The CIST automatically determines the MST regions in a network and defines the root bridge (switch) and designated port for each region. The CIST includes the Common Spanning Tree (CST), the Internal Spanning Tree (IST) within each region, and any multiple spanning-tree instances (MSTIs) in a region.

Common Spanning Tree (CST): Refers to the single forwarding path the switch calculates for STP (802.1D) and RSTP (802.1w) topologies, and for inter-regional paths in MSTP (802.1s) topologies. Note that all three types of spanning tree can interoperate in the same network. Also, the MSTP switch interprets a device running 802.1D STP or 802.1w RSTP as a separate region. (Refer to figure 4-2 on page 4-7.)

Internal Spanning Tree (IST): Comprises all VLANs within a region that are not assigned to a multiple spanning-tree instance configured within the region. All MST switches in a region should belong to the IST. In a given region "X", the IST root switch is the regional root switch and provides information on region "X" to other regions.

MSTP (Multiple Spanning Tree Protocol): A network supporting MSTP allows multiple spanning tree instances within configured regions, and a single spanning tree among regions, STP bridges, and RSTP bridges.

MSTP BPDU (MSTP Bridge Protocol Data Unit): These BPDUs carry region-specific information, such as the region identifier (region name and revision number). If a switch receives an MSTP BPDU with a region identifier that differs from its own, then the port on which that BPDU was received is on the boundary of the region in which the switch resides.

MSTP Bridge: In this manual, an MSTP bridge is a switch (or another 802.1s-compatible device) configured for MSTP operation.

MST Region: An MST region forms a multiple spanning tree domain and is a component of a single spanning-tree domain within a network. For switches internal to the MST region:

- All switches have identical MST configuration identifiers (region name and revision number).
- All switches have identical VLAN assignments to the region's IST and (optional) MST instances.
- One switch functions as the designated bridge (IST root) for the region.
- No switch has a point-to-point connection to a bridging device that cannot process RSTP BPDUs.

RSTP — Rapid Spanning Tree Protocol, defined in IEEE 802.1w and ratified in IEEE 802.1D-2004.

Spanning-tree — Generic term to refer to the many spanning-tree flavors: now deprecated STP, RSTP and VLAN-aware MSTP.

STP — Spanning Tree Protocol, part of the original IEEE 802.1D specification. The 2004 edition completely deprecates STP. Both RSTP and MSTP have fallback modes to handle STP.

SNMP — Simple Network Management Protocol, used to remotely manage network devices.

Operating Rules

- All switches in a region must be configured with the same set of VLANs, as well as the same MST configuration name and MST configuration number.
- Within a region, a VLAN can be allocated to either a single MSTI or to the region's IST instance.
- All switches in a region must have the same VID-to-MST instance assignment.
- There is one root MST switch per configured MST instance.
- Because boundary ports provide the VLAN connectivity between regions, all boundary ports on a region's root switch should be configured as members of all static VLANs defined in the region.
- There is one root switch for the Common and Internal Spanning Tree (CIST). At any given time, all switches in the network will use the per-port **hello-time** parameter assignments configured on the CIST root switch.
- Where multiple MST regions exist in a network, there is only one active, physical communication path between any two regions, or between an MST region and an STP or RSTP switch. MSTP blocks any other physical paths as long as the currently active path remains in service.
- Within a network, an MST region appears as a virtual RSTP bridge to other spanning tree entities (other MST regions, and any switches running 802.1D or 802.1w spanning-tree protocols).
- Within an MSTI, there is one physical communication path between any two nodes, regardless of how many VLANs belong to the MSTI. Within an IST instance, there is also one spanning tree across all VLANs belonging to the IST instance.
- An MSTI comprises a unique set of VLANs and forms a single spanning-tree instance within the region to which it belongs.
- A dynamic VLAN learned by GVRP will always be placed in the IST instance and cannot be moved to any configured MST instance.

  Starting in software release 13.*x*.*x*, dynamically learned GVRP VLANs can be mapped to MSTIs and support MSTP load balancing.
- In software release 13.*x*.*x* and later, you can preconfigure static and dynamic VLAN ID-to-MSTI mappings before the VLAN is created on the switch. Later, when the static VLAN ID is configured or a dynamic GVRP VLAN is learned, the VLAN is automatically associated with the preconfigured MSTI. For more information, refer to the **spanning-tree instance vlan** command description on page 4-42.
- Communication between MST regions uses a single spanning tree.

- If a port on a switch configured for MSTP receives a legacy (STP/802.1D or RSTP/802.1w) BPDU, it automatically operates as a legacy port. In this case, the MSTP switch interoperates with the connected STP or RSTP switch as a separate MST region.
- Within an MST region, there is one logical forwarding topology per instance, and each instance comprises a unique set of VLANs. Where multiple paths exist between a pair of nodes using VLANs belonging to the same instance, all but one of those paths will be blocked for that instance. However, if there are different paths in different instances, all such paths are available for traffic. Separate forwarding paths exist through separate spanning tree instances.
- A port can have different states (forwarding or blocking) for different instances (which represent different forwarding paths).
- MSTP interprets a switch mesh as a single link.

MSTP Compatibility with RSTP or STP

IEEE 802.1s MSTP includes RSTP functionality and is designed to be compatible with both IEEE 802.1D and 802.1w spanning-tree protocols. Using the default configuration values, your switches will interoperate effectively with RSTP and STP devices. MSTP automatically detects when the switch ports are connected to non-MSTP devices in the spanning tree and communicates with those devices using 802.1D or 802.1w STP BPDU packets, as appropriate.

To enable effective interoperation with STP (802.1D) configured devices, however, you may need to adjust the default configuration values. Here are two such examples:

- The rapid state transitions employed by MSTP may result in an increase in the rates of frame duplication and misordering in the switched LAN. To allow the switch to support applications and protocols that may be sensitive to frame duplication and misordering, you can disable rapid transitions by setting the Force Protocol Version parameter to **STP-compatible**. The value of this parameter applies to all ports on the switch. See information on **force version** on page 4-22.
- One of the benefits of MSTP is the implementation of a larger range of port path costs, which accommodates higher network speeds. However, this can create some incompatibility between devices running the older 802.1D STP. You can adjust to this incompatibility by implementing the global **spanning-tree legacy-path cost** command (see page 4-23). See also the “Note on Path Cost” below.

Note on Path Cost

RSTP and MSTP implement a greater range of path costs than 802.1D STP, and use different default path cost values to account for higher network speeds. These values are shown below.

Port Type	802.1D STP Path Cost	RSTP and MSTP Path Cost
10 Mbps	100	2 000 000
100 Mbps	10	200 000
1 Gbps	5	20 000

Because the maximum value for the path cost allowed by 802.1D STP is 65535, devices running that version of spanning tree cannot be configured to match the values defined by MSTP, at least for 10 Mbps and 100 Mbps ports. In LANs where there is a mix of devices running 802.1D STP, RSTP, and/or MSTP, you should reconfigure the devices so the path costs match for ports with the same network speeds.

Configuring MSTP

This section outlines the main pre-requisites for configuring MSTP in your network, and describes MSTP settings at the global level, per individual port, and per MST instance.

Planning an MSTP Application

Before configuring MSTP, keep in mind the following tips and considerations:

- Ensure that the VLAN configuration in your network supports all of the forwarding paths necessary for the desired connectivity. All ports connecting one switch to another within a region and one switch to another between regions should be configured as members of all VLANs configured in the region.
- Configure all ports or trunks connecting one switch to another within a region as members of all VLANs in the region. Otherwise, some VLANs could be blocked from access to the spanning-tree root for an instance or for the region.

- Plan individual regions based on VLAN groupings. That is, plan on all MSTP switches in a given region supporting the same set of VLANs. Within each region, determine the VLAN membership for each spanning-tree instance. (Each instance represents a single forwarding path for all VLANs in that instance.)
- Verify that there is one logical spanning-tree path through the following:
  - Any inter-regional links
  - Any IST or MST instance within a region
  - Any legacy (802.1D or 802.1w) switch or group of switches. (Where multiple paths exist between an MST region and a legacy switch, expect the CST to block all but one such path.)
- Determine the root bridge and root port for each instance.
- Determine the designated bridge and designated port for each LAN segment.
- Determine which VLANs to assign to each instance, and use port trunks with 802.1Q VLAN tagging where separate links for separate VLANs would result in a blocked link preventing communication between nodes on the same VLAN. (Refer to "MSTP Operation with 802.1Q VLANs" on page 4-12.)
- Identify the edge ports connected to end nodes and enable the admin-edge-port setting for these ports. Leave the admin-edge-port setting disabled for ports connected to another switch, a bridge, or a hub.

Note on MSTP Rapid State Transitions

Under some circumstances the rapid state transitions employed by MSTP can increase the rates of frame duplication and misordering in the switched LAN. To allow MSTP switches to support applications and protocols that may be sensitive to frame duplication and misordering, setting the Force Protocol Version (**force-version**) parameter to **stp-compatible** allows MSTP to operate with rapid transitions disabled. The value of this parameter applies to all ports on the switch. See the information on **force-version** on page 4-22.

MSTP Configuration Overview

This section describes the general steps for configuring MSTP via the CLI, assuming that you have already determined the VLANs you want MSTP to use (see "Planning an MSTP Application" on page 4-17). A description of each MSTP command syntax is provided in the following sections.

1. **Configure MSTP global parameters**.

   This step involves configuring the following:

   - Required parameters for MST region identity:

     Region Name: **spanning-tree config-name**

     Region Revision Number: **spanning-tree config-revision**

   - Optional MSTP parameter changes for region settings:

     ProCurve recommends that you leave these parameters at their default settings for most networks. See the "Caution" on page 4-9.

     – The maximum number of hops before the MSTP BPDU is discarded: **spanning-tree max-hops** (default: 20)

     – Force-Version operation: **spanning-tree force-version**

     – Forward Delay: **spanning-tree forward-delay**

     – Hello Time (if it is the root device): **spanning-tree hello-time**

     – Maximum age to allow for STP packets before discarding: **spanning-tree maximum-age**

     – Device spanning-tree priority. Specifies the priority value used along with the switch MAC address to determine which device is root. The lower a priority value, the higher the priority. **spanning-tree priority**

2. **Configure per port parameters.**

   ProCurve recommends that you use the default settings for these parameters and apply changes on a per-port basis only where a non-default setting is clearly indicated by the circumstances of individual links. Other features you might consider include BPDU Filtering or BPDU Protection—these provide additional per-port control over spanning-tree operations and security on the switch.

3. **Configure MST instances.**
   - Configure one instance for each VLAN group that you want to operate as an active topology within the region to which the switch belongs. When you create the instance, you must include a minimum of one VID. You can add more VIDs later if desired.

     spanning-tree instance < *n* > **vlan** < *vid* >

     To move a VLAN from one instance to another, first use **no spanning-tree instance** < *n* > **vlan** < *vid* > to unmap the VLAN from the current instance, then add the VLAN to the other instance. (While the VLAN is unmapped from an MSTI, it is associated with the region's IST instance.)

4. **Configure the priority for each instance.**
   spanning-tree instance < *n* > priority < *n* >

5. **Configure MST instance port parameters.**

   ProCurve recommends that you apply changes on a per-port basis only where a non-default setting is clearly indicated by the circumstances of individual links. For example, you might want to set the path cost value for the port(s) used by a specific MST instance.
   spanning-tree instance < *1..16* >< *port-list* > **path-cost** < *auto* | *1..200000000* >

   Alternatively, leaving this setting at the default (auto) allows the switch to calculate the path-cost from the link speed.

6. **Enable spanning-tree operation on the switch**.
   spanning-tree

For an example of a complete MSTP network configuration:

- Go to the ProCurve Web site at **www.procurve.com**.
- Click on **Technical Support**.
- Under **Additional support**, click on **Configuration examples**.
- Click on **ProCurve Switch 8212zl**.
- Under **STP Example**, click on **ProCurve & Cisco Spanning Tree Interoperability**.

Configuring MSTP Operation Mode and Global Settings

The commands in this section apply at the switch (global) level. For details of how to configure spanning tree settings on individual ports, see "Configuring MSTP Per-Port Parameters" on page 4-26.

MSTP Global Command	Page
spanning-tree	*
config-name < *ascii-string* >	4-21
config-revision < *revision-number* >	4-22
force-version < stp-compatible | rstp-operation | mstp-operation>	4-22
forward-delay	4-23
hello-time < 1..10 >	4-23
legacy-mode	4-23
legacy-path-cost	4-23
max-hops < *hop-count* >	4-23
maximum-age	4-23
pending	4-24
priority	4-25
trap errant-bpdu	4-25

** Enabling MSTP operation using the **spanning-tree** global command is the final step in the configuration process. See "Enabling or Disabling Spanning Tree Operation" on page 4-46.*

Syntax: [no] spanning-tree config-name < *ascii-string* >

This command resets the configuration name of the MST region in which the switch resides. This name can include up to 32 nonblank characters and is case-sensitive. On all switches within a given MST region, the configuration names must be identical. Thus, if you want more than one MSTP switch in the same MST region, you must configure the identical region name on all such switches. If you retain the default configuration name on a switch, it cannot exist in the same MST region with another switch.
(Default Name: A text string using the hexadecimal representation of the switch's MAC address)

The **no** *form of the command overwrites the currently configured name with the default name.*

Note: *This option is available only when the switch is configured for MSTP operation. Also, there is no defined limit on the number of regions you can configure.*

Syntax: spanning-tree config-revision < *revision-number* >

This command configures the revision number you designate for the MST region in which you want the switch to reside. This setting must be the same for all switches residing in the same region. Use this setting to differentiate between region configurations in situations such as the following:

- *Changing configuration settings within a region where you want to track the configuration versions you use*
- *Creating a new region from a subset of switches in a current region and want to maintain the same region name.*
- *Using the* **pending** *option to maintain two different configuration options for the same physical region.*

Note that this setting must be the same for all MSTP switches in the same MST region. (Range: **0 - 65535***; Default:* **0***)*

Note: *This option is available only when the switch is configured for MSTP operation.*

Syntax: spanning-tree force-version < stp-compatible | rstp-operation | mstp-operation >

Sets the spanning-tree compatibility mode. This command forces the switch to emulate behavior of earlier versions of spanning tree protocol, or return to MSTP behavior. The command is useful in test or debug applications, and removes the need to reconfigure the switch for temporary changes in spanning-tree operation.

stp-compatible: *The switch applies 802.1D STP operation on all ports.*

rstp-operation: *The switch applies 802.1w operation on all ports except those ports where it detects a system using 802.1D Spanning Tree.*

mstp-operation: *The switch applies 802.1s MSTP operation on all ports where compatibility with 802.1D or 802.1w spanning tree protocols is not required.*

Note that even when mstp-operation is selected, if the switch detects an 802.1D BPDU or an 802.1w BPDU on a port, it communicates with the device linked to that port using STP or RSTP BPDU packets. Also, if errors are encountered as described in the "Note on MSTP Rapid State Transitions" on page 4-18, setting **force-version** *to* **stp-compatible** *forces the MSTP switch to communicate out all ports using operations that are compatible with IEEE 802.1D STP.*

Syntax: spanning-tree forward-delay

Sets time the switch waits between transitioning from listening to learning and from learning to forwarding states.

(*Range: 4 - 30; Default:* **15**.)

Syntax: spanning-tree legacy-mode

Sets spanning-tree protocol to operate in 802.1D legacy mode (STP-compatible).

(*Default:* **MSTP-operation**.)

The **no** *form of the command returns the switch to the default 802.1s native mode (MSTP-operation).*

Syntax: spanning-tree legacy-path-cost

Sets spanning-tree to operate with 802.1d (legacy) path cost values.

(*Default:* **802.1t**.)

The **no** *form of the command returns the switch to the default 802.1t (not legacy) path cost values.*

Syntax: spanning-tree hello-time < 1..10 >

If MSTP is running and the switch is operating as the CIST root for your network, this command specifies the time in seconds between transmissions of BPDUs for all ports on the switch configured with the **Global** *option. (the default). This parameter applies in MSTP, RSTP and STP modes. During MSTP operation, you can override this global setting on a per-port basis with this command:* **spanning-tree < *port-list* > hello-time < 1..10 >** (see page 4-28). (*Default:* **2**.)

Syntax: spanning-tree max-hops < *hop-count* >

This command resets the number of hops allowed for BPDUs in an MST region. When an MSTP switch receives a BPDU, it decrements the hop-count setting the BPDU carries. If the hop-count reaches zero, the receiving switch drops the BPDU. Note that the switch does not change the message-age and maximum-age data carried in the BPDU as it moves through the MST region and is propagated to other regions. (Range: 1 - 40; Default: 20)

Syntax: spanning-tree maximum age

Sets the maximum age of received STP information before it is discarded.

(*Default:* **20**.)

Syntax: spanning-tree pending < apply | config-name | config-revision | instance | reset >

Manipulates the pending MSTP configuration. The command is useful in test or debug applications, and enables rapid reconfiguration of the switch for changes in spanning-tree operation.

apply: *Apply pending MSTP configuration (swaps active and pending configurations).*

config-name: *Sets the pending MST region configuration name (default is switch's MAC address).*

config-revision: *Sets the pending MST region configuration revision number (default is 0).*

instance: *Change pending MST instance configuration.*

reset: *Copy active configuration to pending.*

Syntax: spanning-tree priority < priority-multiplier >

Every switch running an instance of MSTP has a Bridge Identifier, which is a unique identifier that helps distinguish this switch from all others. The switch with the lowest Bridge Identifier is elected as the root for the tree.

The Bridge Identifier is composed of a configurable Priority component (2 bytes) and the bridge's MAC address (6 bytes). The ability to change the Priority component provides flexibility in determining which switch will be the root for the tree, regardless of its MAC address.

This command sets the switch (bridge) priority for the designated region in which the switch resides. The switch compares this priority with the priorities of other switches in the same region to determine the root switch for the region. The lower the priority value, the higher the priority. (If there is only one switch in the region, then that switch is the root switch for the region.) The root bridge in a region provides the path to connected regions for the traffic in VLANs assigned to the region's IST instance. (Traffic in VLANs assigned to a numbered STP instance in a given region moves to other regions through the root switch for that instance.)

The priority range for an MSTP switch is 0-61440. However, this command specifies the priority as a multiplier (0 - 15) of 4096. That is, when you specify a priority multiplier value of 0 - 15, the actual priority assigned to the switch is:

(*priority-multiplier*) x 4096

*For example, if you configure "***2***" as the priority-multiplier on a given MSTP switch, then the* **Switch Priority** *setting is 8,192.*

Note: *If multiple switches in the same MST region have the same priority setting, then the switch with the lowest MAC address becomes the root switch for that region.*

Syntax: spanning-tree trap errant-bpdu

Enables SNMP traps for errant-BPDUs. Note that this command is designed to be used in conjunction with the spanning-tree bpdu-filter command (see page 4-30) and bpdu-protection command (see page 4-31).

The **no** *form of the command disables traps on the switch.* (*Default:* **Disabled**.)

Configuring MSTP Per-Port Parameters

In an MSTP topology, you configure per-port parameters in the global configuration context.

In most cases, ProCurve recommends that you use the default settings for these parameters and apply changes on a per-port basis only where a non-default setting is clearly indicated by the circumstances of individual links. Some port parameters (such as **admin-edge-port**) affect all MSTI instances that consist of VLANs configured on the port; other port parameters (such as **path-cost**) affect only the specified MST.

Per Port Command	Page
spanning-tree < *port-list* >	
admin-edge-port	below
auto-edge-port	4-27
bpdu-filter	4-30
bpdu-protection	4-32
mcheck	4-27
hello-time < global | 1..10 >	4-28
path-cost < auto | 200000000 >	4-42
point-to-point-mac < force-true | force-false | auto>	4-25
priority <priority-multiplier>	4-25
root-guard	4-29
tcn-guard	4-30
pvst-protection	4-34
pvst-filter	4-36
loop protection	4-38

Configuring Per Port Parameters

Syntax: [no] spanning-tree <port-list> admin-edge-port

Enable **admin-edge-port** *on ports connected to end nodes. During spanning tree establishment, ports with* **admin-edge-port** *enabled transition immediately to the forwarding state. If a bridge or switch is detected on the segment, the port automatically operates as non-edge, not enabled. (Default:* **No** *- disabled)*

If **admin-edge-port** *is disabled on a port and* **auto-edge-port** *has not been disabled, the* **auto-edge-port** *setting controls the behavior of the port.*

The **no spanning-tree < *port-list* > admin-edge-port** *command disables edge-port operation on the specified ports.*

Syntax: [no] spanning-tree < *port-list* > auto-edge-port

Supports the automatic identification of edge ports. The port will look for BPDUs for 3 seconds; if there are none it begins forwarding packets. If **admin-edge-port** *is enabled for a port, the setting for* **auto-edge-port** *is ignored whether set to yes or no. If* **admin-edge-port** *is set to* **No**, *and* **auto-edge-port** *has not been disabled (set to* **No***), then the* **auto-edge-port** *setting controls the behavior of the port. (Default:* **Yes - enabled***)*

The **no spanning-tree < *port-list* > auto-edge-port** *command disables* **auto-edge-port** *operation on the specified ports.*

Syntax: spanning-tree < *port-list* > mcheck

Forces a port to send RST/MST BPDUs for 3 seconds. This tests whether all STP bridges on the attached LAN have been removed and the port can migrate to native MSTP mode and use RST/MST BPDUs for transmission.

Syntax: spanning-tree < *port-list* > hello-time < global | 1 - 10 >

When the switch is the CIST root, this parameter specifies the interval (in seconds) between periodic BPDU transmissions by the designated ports. This interval also applies to all ports in all switches downstream from each port in the < *port-list*>. *A setting of* **global** *indicates that the ports in* < *port-list*> *on the CIST root are using the value set by the global spanning-tree* **hello-time** *value (page 4-23). When a given switch "X" is not the CIST root, the per-port* **hello-time** *for all active ports on switch "X" is propagated from the CIST root, and is the same as the* **hello-time** *in use on the CIST root port in the currently active path from switch "X" to the CIST root. (That is, when switch "X" is not the CIST root, then the upstream CIST root's port* **hello-time** *setting overrides the* **hello-time** *setting configured on switch "X").*

(Default Per-Port setting: **Use Global**.
Default Global Hello-Time: **2**.*)*

Syntax: spanning-tree < *port-list* > path-cost < auto | 1..200000000 >

Assigns an individual port cost that the switch uses to determine which ports are forwarding ports in a given spanning tree. In the default configuration (auto) the switch determines a port's path cost by the port's type:

- *10 Mbps:* **2000000**
- *100 Mbps:* **200000**
- *1 Gbps:* **20000**

Refer to "Note on Path Cost" on page 4-17 for information on compatibility with devices running 802.1D STP for the path cost values

(Default: Auto).

Syntax: spanning-tree < *port-list* > point-to-point-mac < force-true | force-false | auto >

This parameter informs the switch of the type of device to which a specific port connects.

Force-True ***(default)****: Indicates a point-to-point link to a device such as a switch, bridge, or end-node.*

Force-False*: Indicates a connection to a hub (which is a shared LAN segment).*

Auto: *Causes the switch to set Force-False on the port if it is not running at full duplex. (Connections to hubs are half-duplex.)*

Syntax: spanning-tree < *port-list* > priority < priority-multiplier >

MSTP uses this parameter to determine the port(s) to use for forwarding. The port with the lowest priority number has the highest priority for use. The range is 0 to 240, and is configured by specifying a multiplier from 0 - 15. When you specify a priority multiplier of 0 - 15, the actual priority assigned to the switch is:

(*priority-multiplier*) *x* 16

*For example, if you configure "***2***" as the priority multiplier on a given port, then the actual* **Priority** *setting is 32. Thus, after you specify the port priority multiplier, the switch displays the actual port priority (and not the multiplier) in the* **show spanning-tree** *or* **show spanning-tree < *port-list* >** *displays.*

You can view the actual multiplier setting for ports by executing **show running** *and looking for an entry in this format:*

spanning-tree < *port-list* > priority < *priority-multiplier* >

For example, configuring port A2 with a priority multiplier of "3" results in this line in the **show running** *output:*

```
spanning-tree A2 priority 3
```

Syntax: spanning-tree < *port-list* > root-guard

MSTP only. When a port is enabled as **root-guard**, *it cannot be selected as the root port even if it receives superior STP BPDUs. The port is assigned an "alternate" port role and enters a blocking state if it receives superior STP BPDUs. (A superior BPDU contains "better" information on the root bridge and/or path cost to the root bridge, which would normally replace the current root bridge selection.)*

The superior BPDUs received on a port enabled as **root-guard** *are ignored. All other BPDUs are accepted and the external devices may belong to the spanning tree as long as they do not claim to be the Root device.*

Use this command on MSTP switch ports that are connected to devices located in other administrative network domains to:

- *Ensure the stability of the core MSTP network topology so that undesired or damaging influences external to the network do not enter.*
- *Protect the configuration of the CIST root bridge that serves as the common root for the entire network.*

Default: The root-guard setting is disabled.

Syntax: spanning-tree < *port-list* > tcn-guard

When **tcn-guard** *is enabled for a port, it causes the port to stop propagating received topology change notifications and topology changes to other ports.*
(Default: **No** *- disabled)*

Configuring BPDU Filtering

The STP BPDU filter feature allows control of spanning-tree participation on a per-port basis. It can be used to exclude specific ports from becoming part of spanning tree operations. A port with the BPDU filter enabled will ignore incoming BPDU packets and stay locked in the spanning-tree forwarding state. All other ports will maintain their role.

Here are some sample scenarios in which this feature may be used:

- To have STP operations running on selected ports of the switch rather than every port of the switch at a time.
- To prevent the spread of errant BPDU frames.
- To eliminate the need for a topology change when a port's link status changes. For example, ports that connect to servers and workstations can be configured to remain outside of spanning-tree operations.
- To protect the network from denial of service attacks that use spoofing BPDUs by dropping incoming BPDU frames. For this scenario, BPDU protection offers a more secure alternative, implementing port shut down and a detection alert when errant BPDU frames are received (see page 4-32 for details).

Caution

Ports configured with the BPDU filter mode remain active (learning and forward frames); however, spanning-tree cannot receive or transmit BPDUs on the port. The port remains in a forwarding state, permitting all broadcast traffic. This can create a network storm if there are any loops (that is, trunks or redundant links) using these ports. If you suddenly have a high load, disconnect the link and disable the bpdu-filter (using the **no** command).

Command Syntax and Example. The following command is used to configure BPDU filters.

Syntax: [no] spanning-tree <port-list | all> bpdu-filter

Enables/disables the BPDU filter feature on the specified port(s). The bpdu-filter option forces a port to ***always*** *stay in the forwarding state and be excluded from standard STP operation.*

For example, to configure BPDU filtering on port a9, enter:

```
ProCurve(config)# spanning-tree a9 bpdu-filter
```

Viewing BPDU Filtering. The **spanning-tree show** < port> **configuration** command displays the BPDU's filter state.

```
ProCurve(config)# show spanning-tree a9 config

  ...
                  | Path      Prio  Admin Auto  Admin Hello  Root   TCN     BPDU
  Port  Type      | Cost      rity  Edge  Edge  PtP   Time   Guard  Guard   Flt
  ----- --------- + --------- ----- ----- ----- ----- ------ ------ ------ ----
  A9    100/1000T | Auto      128   No    Yes   True  Global No     No     Yes
```

Column showing BPDU filter status

Figure 4-5. Example of BPDU Filter in Show Spanning Tree Configuration Command

BPDU filters per port are displayed as separate entries of the spanning tree category within the configuration file.

```
ProCurve(config)# show configuration
  . . .
  spanning-tree
  spanning-tree A9 bpdu-filter
  spanning-tree C7 bpdu-filter
  spanning-tree Trk2 priority 4
  . . .
```

Rows showing ports with BPDU filters enabled

Figure 4-6. Example of BPDU Filters in the Show Configuration Command

Configuring BPDU Protection

BPDU protection is a security feature designed to protect the active STP topology by preventing spoofed BPDU packets from entering the STP domain. In a typical implementation, BPDU protection would be applied to edge ports connected to end user devices that do not run STP. If STP BPDU packets are received on a protected port, the feature will disable that port and alert the network manager via an SNMP trap as shown in Figure 4-7.

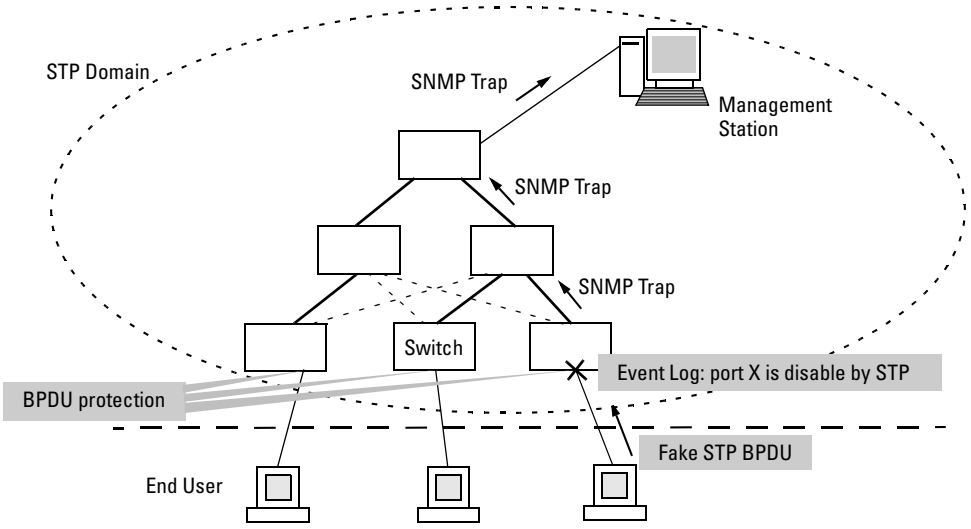

Figure 4-7. Example of BPDU Protection Enabled at the Network Edge

The following commands allow you to configure BPDU protection.

Syntax: [no] spanning-tree <*port-list*> bpdu-protection

Enables/disables the BPDU protection feature on a port

Syntax: [no] spanning-tree <*port-list*> bpdu-protection-timeout <*timeout*>

Configures the duration of time when protected ports receiving unauthorized BPDUs will remain disabled. The default value of 0 (zero) sets an infinite timeout (that is, ports that are disabled by **bpdu-protection** *are not, by default, re-enabled automatically). (Range: 0-65535 seconds; Default: 0)*

Syntax: [no] spanning-tree trap errant-bpdu

Enables/disables the sending of errant BPDU traps.

Caution

This command should only be used to guard edge ports that are not expected to participate in STP operations. Once BPDU protection is enabled, it will disable the port as soon as any BPDU packet is received on that interface.

Example. To configure BPDU protection on ports 1 to 10 with SNMP traps enabled, enter:

```
ProCurve(config)# spanning-tree 1-10 bpdu protection
ProCurve(config)# spanning-tree trap errant-bpdu
```

The following steps will then be set in process:

1. When an STP BPDU packet is received on ports 1-10, STP treats it as an unauthorized transmission attempt and shuts down the port that the BPDU came in on.
2. An event message is logged and an SNMP notification trap is generated.
3. The port remains disabled until re-enabled manually by a network administrator using the **interface** <*port-list*> **enable** command.

Note

To re-enable the bpdu-protected ports automatically, configure a timeout period using the **spanning-tree bpdu-protection-timeout** command.

Viewing BPDU Protection Status. The **show spanning-tree bpdu-protection** command displays a summary listing of ports with BPDU protection enabled. To display detailed per port status information, enter the specific port number(s) as shown in Figure 4-8 below.

```
ProCurve(config)# show spanning-tree bpdu-protection a1

 Status and Counters - STP BPDU Protection Information

  BPDU Protection Timeout (sec) : 0
  Protected Ports : A1

  Port Type         Protection    State          Errant BPDUs
  ---- ------------ ------------- -------------- ---------------
  A1   100/1000T    Yes           Bpdu Error     1
```

Specifying the port displays additional status information for the designated ports.

Figure 4-8. Example of Show Spanning Tree BPDU Protection Command

BPDU protected ports are displayed as separate entries of the spanning tree category within the configuration file.

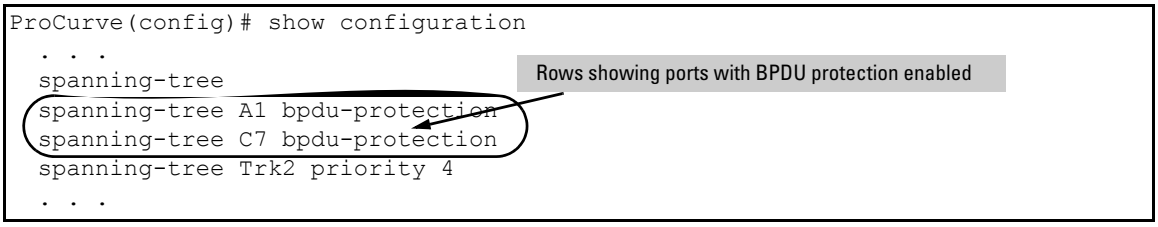

Figure 4-9. Example of BPDU Filters in the Show Configuration Command

PVST Protection and Filtering

Note These options are available for switches that support the MSTP protocol only. They are not supported for switches running RSTP.

PVST Protection

If a ProCurve switch in the core of a network receives Per Vlan Spanning Tree (PVST) BPDUs and forwards the unrecognized PVST BPDUs on to MSTP-only switches, those switches then disconnect themselves from the network. This can create instability in the network infrastructure.

When the PVST protection feature is enabled on a port and a PVST BPDU is received on that port, the interface on which the PVST BPDU arrived is shut down, which isolates the sending switch from the rest of the network. An event message is logged and an SNMP notification trap is generated. The errant BPDU counter hpSwitchStpPortErrantBpduCounter is incremented. The PVST protection feature is enabled per-port.

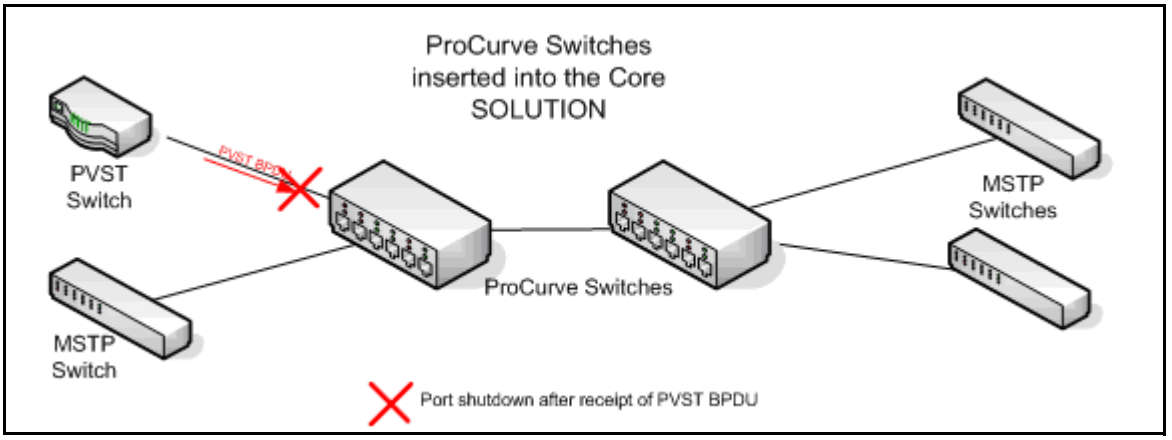

Figure 4-10. PVST Switch Being Isolated after Sending a PVST BPDU

Note

This is similar to the BPDU Guard feature where BPDU protection is applied to edge ports connected to end user devices that do not run STP. If STP BPDU packets are received on a protected port, the feature will disable that port and alert the network manager via an SNMP trap.

Syntax: [no] spanning-tree <port-list> pvst-protection

Enables or disables the PVST protection feature on the port or range of ports specified. The command indicates which ports are not expected to receive any PVST BPDUs.

Default: *Disabled on all ports*

For example, to enable the PVST protection feature on ports 4 through 8, enter this command:

```
ProCurve(config)# spanning-tree 4-8 pvst-protection
```

To disable the PVST protection feature on a port, for example, port 4, use this command:

```
ProCurve(config)# no spanning-tree 4 pvst-protection
```

PVST FilteringI

If you configure a port for PVST filtering instead of PVST protection, the port remains in operation but traps are still generated and the BPDU counter hpSwitchStpPortErrantBpduCounter is incremented.

Caution

Enabling the PVST filter feature allows the port to continuously forward packets without spanning-tree intervention, which could result in loop formation. If this occurs, disable the port and then reconfigure it with these commands:

```
no spanning-tree <port-list> bpdu-filter
no spanning-tree <port-list> pvst-filter
```

Syntax: [no] spanning-tree <port-list> pvst-filter

Enables or disables the PVST filter feature on the port or range of ports specified. The command indicates which ports are not expected to receive any PVST BPDUs.
Default: *Disabled on all ports*

```
ProCurve(config)# spanning-tree 8 pvst-filter

Warning: The BPDU filter allows the port to go into a continuous
         forwarding mode and spanning-tree will not interfere, even if
         the port would cause a loop to form in the network topology.
         If you suddenly experience high traffic load, disable the port
         and reconfigure the BPDU filter with the CLI command(s):
           "no spanning-tree PORT_LIST bpdu-filter"
           "no spanning-tree PORT_LIST pvst-filter"
```

Figure 4-11. Example of Enabling PVST Filtering on a Port

Manually Re-enabling a Port

You can re-enable ports manually or use the automatic re-enable timer command as shown:

```
ProCurve(config)# spanning-tree
                    bpdu-protection-timeout 120
```

Syntax: [no] spanning-tree bpdu-protection-timeout <*timeout*>

Configures the duration of time protected ports remain disabled. The default value of 0 (zero) sets an infinite timeout (that is, ports that are disabled are not, by default, re-enabled automatically).
Note: *This is a GLOBAL command.*
(Range: 0-65535 seconds; Default: 0)

You can also set the timeout in the MIB with this MIB object:

hpSwitchStpBpduProtectionTimeout

Showing Ports Configured with PVST Protection and Filtering

To show which ports are configured for PVST protection, enter this command:

```
ProCurve(config)# show spanning-tree pvst-protection
```

```
ProCurve(config)# show spanning-tree pvst-protection

 Status and Counters - PVST Port(s) BPDU Protection Information

 BPDU Protection Timeout (sec) : 0
 PVST Protected Ports : 5-6
```

Figure 4-12. Example of Show Spanning-tree Command Displaying All Ports with PVST Protection Enabled

To show which ports are configured for PVST filtering, enter this command:

```
ProCurve(config)# show spanning-tree pvst-filter
```

```
ProCurve(config)# show spanning-tree pvst-filter

 Status and Counters - PVST Port(s) BPDU Filter Information

 PVST Filtered Ports : 8
```

Figure 4-13. Example of Show Spanning-tree Command Displaying All Ports with PVST Filtering Enabled

The **show spanning-tree <port-list> detail** command indicates which ports have PVST protection and/or PVST Filtering enabled.

```
.ProCurve(config)# show spanning-tree 7 detail
.
.
.

Port                        : 7
  Status                      : Down
  BPDU Protection             : Yes
  BPDU Filtering              : No
  PVST Protection             : Yes
  PVST Filtering              : No
  Errant BPDU Count           : 0
  Root Guard                  : No
  TCN Guard                   : No
  .
  .
  .
```

Figure 4-14. Example of Show Spanning-tree Command Displaying PVST Protection Enabled (Yes)

Configuring Loop Protection

You can use BPDU protection for systems that have spanning tree enabled (See "Configuring BPDU Protection" on page 4-31), however, the BPDU protection feature cannot detect the formation of loops when an unmanaged device on the network drops spanning tree packets. To protect against the formation of loops in these cases, you can enable the loop protection feature, which provides protection by transmitting loop protocol packets out ports on which loop protection has been enabled. When the switch sends out a loop protocol packet and then receives the same packet on a port that has **send-disable** configured, it shuts down the port from which the packet was sent.

You can configure the **disable-timer** parameter for the amount of time you want the port to remain disabled (0 to 604800 seconds). If you configure a value of zero, the port will not be re-enabled.

To enable loop protection, enter this command:

```
ProCurve(config)# loop-protect <port-list>
```

Syntax: [no] loop-protect <port-list> [receiver-action <send-disable | no-disable> |] [transmit-interval <1-10>] | [disable-timer <0-604800>] | [trap <loop-detected>]

Allows you to configure per-port loop protection on the switch.

[receiver-action <send-disable | no-disable>]

Sets the action to be taken when a loop is detected on the port. The port that received the loop protection packet determines what action is taken. If send-disable is configured, the port that transmitted the packet is disabled. If no-disable is configured, the port is not disabled.
Default: send-disable

[trap <loop-detected>]

Allows you to configure loop protection traps The "loop-detected" trap indicates that a loop was detected on a port.

[disable-timer <0-604800>]

How long (in seconds) a port is disabled when a loop has been detected. A value of zero disables the auto re-enable functionality.
Default: Timer is disabled

[transmit-interval <1-10>]

Allows you to configure the time in seconds between the transmission of loop protection packets.
Default: 5 seconds

To display information about ports with loop protection, enter this command.

Syntax: show loop-protect <*port-list*>

Displays the loop protection status. If no ports are specified, the information is displayed only for the ports that have loop protection enabled.

```
ProCurve(config)# show loop-protect 1-4

 Status and Counters - Loop Protection Information

 Transmit Interval (sec)  : 5
 Port Disable Timer (sec) : 5
 Loop Detected Trap       : Enabled


      Loop        Loop      Loop       Time              Rx           Port
 Port Protection  Detected  Count      Since Last Loop   Action       Status
 ---- ----------- --------- ---------- ----------------- ------------ --------
 1    Yes          No        0                           send-disable Up
 2    Yes          No        0                           send-disable Up
 3    Yes          No        0                           send-disable Up
 4    Yes          No        0                           send-disable Up
```

Figure 4-15. Example of Show Loop Protect Display

Configuring MST Instance Parameters

When you enable MSTP on the switch, a spanning tree instance is enabled automatically. The switch supports up to sixteen configurable MST instances for each VLAN group that you want to operate as an active topology within the region to which the switch belongs. When creating an instance, you must include a minimum of one VID. You can add more VIDs later if desired.

Command	Page
[no] spanning-tree instance < 1..16 > vlan < *vid*> [*vid..vid*] no spanning-tree instance < 1..16 >	4-27
spanning-tree instance < 1..16 > priority < 0..15 >	4-41

Syntax: [no] spanning-tree instance < 1..16 > vlan < *vid* [*vid..vid*] >
no spanning-tree instance < 1..16 >

Configuring MSTP on the switch automatically configures the IST instance and places all statically and dynamically configured VLANs on the switch into the IST instance. This command creates a new MST instance (MSTI) and moves the VLANs you specify from the IST to the MSTI.

You must map at least one VLAN to an MSTI when you create it. You cannot map a VLAN ID to more than one instance. You can create up to 16 MSTIs in a region.

The **no** *form of the command removes one or more VLANs from the specified MSTI. If no VLANs are specified, the* **no** *form of the command deletes the specified MSTI.*

When you remove a VLAN from an MSTI, the VLAN returns to the IST instance, where it can remain or be re-assigned to another MSTI configured in the region.

Note: *Starting in software release 13.x.x, you can enter the* ***spanning-tree instance vlan*** *command before a static or dynamic VLAN is configured on the switch to preconfigure VLAN ID-to-MSTI mappings. No error message is displayed. Later, each newly configured VLAN that has already been associated with an MSTI is automatically assigned to the MSTI.*

This new default behavior differs from automatically including configured (static and dynamic) VLANs in the IST instance and requiring you to manually assign individual static VLANs to an MSTI.

Syntax: [no] spanning-tree instance < 1..16 > vlan < *vid* [*vid..vid*] >
no spanning-tree instance < 1..16 >

— Continued —

Note: *The valid VLAN IDs that you can map to a specified MSTI are from 1 to 4094. The VLAN ID-to-MSTI mapping does not require a VLAN to be already configured on the switch. The MSTP VLAN enhancement allows you to preconfigure MSTP topologies before the VLAN IDs associated with each instance exist on a switch.*

When you use preconfigured VLAN ID-to-MSTI topologies, ensure that MSTP switches remain in the same region by mapping all VLAN IDs used in the region to the same MSTIs on each regional switch.

When you upgrade switch software to release 13.x.x and later, the existing MSTP topology configuration is automatically saved. All existing VLAN ID-to-MSTI assignments are maintained on a switch for uninterrupted MSTP network operation.

Syntax: spanning-tree instance < 1..16 > priority < priority-multiplier >

This command sets the switch (bridge) priority for the designated instance. This priority is compared with the priorities of other switches in the same instance to determine the root switch for the instance. The lower the priority value, the higher the priority. (If there is only one switch in the instance, then that switch is the root switch for the instance.) The IST regional root bridge provides the path to instances in other regions that share one or more of the same VLAN(s).

The priority range for an MSTP switch is 0-61440. However, this command specifies the priority as a multiplier (0 - 15) of 4096. That is, when you specify a priority multiplier value of 0 - 15, the actual priority assigned to the switch for the specified MST instance is:

(*priority-multiplier*) x 4096

*For example, if you configure "***5***" as the priority-multiplier for MST Instance 1 on a given MSTP switch, then the* **Switch Priority** *setting is 20,480 for that instance in that switch.*

Note: *If multiple switches in the same MST instance have the same priority setting, then the switch with the lowest MAC address becomes the root switch for that instance.*

Configuring MST Instance Per-Port Parameters

Command	Page
spanning-tree instance < 1..16 > < port-list > path-cost < auto | 1..200000000 >	4-43
spanning-tree instance < 1..16 > < *port-list* > priority < *priority-multiplier* >	4-44
spanning-tree < *port-list* > priority < *priority-multiplier* >	4-45

Syntax: spanning-tree instance < 1..16 > < *port-list* > path-cost < auto | 1..200000000 >

This command assigns an individual port cost for the specified MST instance. (For a given port, the path cost setting can be different for different MST instances to which the port may belong.) The switch uses the path cost to determine which ports are the forwarding ports in the instance; that is which links to use for the active topology of the instance and which ports to block. The settings are either **auto** *or in a range from 1 to 200,000,000. With the* **auto** *setting, the switch calculates the path cost from the link speed:*

10 Mbps — 2000000

100 Mbps — 200000

1 Gbps — 20000

(Default: **Auto***)*

Syntax: spanning-tree instance < 1..16 >< *port-list* > priority <*priority-multiplier*>

This command sets the priority for the specified port(s) in the specified MST instance. (For a given port, the priority setting can be different for different MST instances to which the port may belong.) The priority range for a port in a given MST instance is 0-255. However, this command specifies the priority as a multiplier (0 - 15) of 16. That is, when you specify a priority multiplier of 0 - 15, the actual priority assigned to the switch is:

(*priority-multiplier*) *x* 16

*For example, if you configure "***2***" as the priority multiplier on a given port in an MST instance, then the actual* **Priority** *setting is 32. Thus, after you specify the port priority multiplier in an instance, the switch displays the actual port priority (and not the multiplier) in the* **show spanning-tree instance < 1..16 >** *or* **show spanning-tree < *port-list* > instance < 1..16 >** *displays.*

You can view the actual multiplier setting for ports in the specified instance by executing **show running** *and looking for an entry in this format:*

spanning-tree instance < 1..15 > < *port-list* > priority < *priority-multiplier* >

For example, configuring port A2 with a priority multiplier of "3" in instance 1, results in this line in the **show running** *output:*

```
spanning-tree instance 1 A2 priority 3
```

Syntax: spanning-tree < *port-list* > priority < *priority-multiplier* >

This command sets the priority for the specified port(s) for the IST (that is, Instance 0) of the region in which the switch resides. The "priority" component of the port's "Port Identifier" is set. The Port Identifier is a unique identifier that helps distinguish this switch's ports from all others. It consists of the Priority value with the port number extension—PRIORITY:PORT_NUMBER. A port with a lower value of Port Identifier is more likely to be included in the active topology.

This priority is compared with the priorities of other ports in the IST to determine which port is the root port for the IST instance. The lower the priority value, the higher the priority. The IST root port (or trunk) in a region provides the path to connected regions for the traffic in VLANs assigned to the region's IST instance.

The priority range for a port in a given MST instance is 0-240. However, this command specifies the priority as a multiplier (0 - 15) of 16. That is, when you specify a priority multiplier of 0 - 15, the actual priority assigned to the switch is:

(*priority-multiplier*) x 16

*For example, configuring "***5***" as the priority multiplier on a given port in the IST instance for a region creates an actual* **Priority** *setting of* **80***. Thus, after you specify the port priority multiplier for the IST instance, the switch displays the actual port priority (and not the multiplier) in the* **show spanning-tree instance ist** *or* **show spanning-tree < *port-list* > instance ist** *displays. You can view the actual multiplier setting for ports in the IST instance by executing* **show running** *and looking for an entry in this format:*

spanning-tree < *port-list* > priority < *priority-multiplier* >

For example, configuring port A2 with a priority multiplier of "2" in the IST instance, results in this line in the **show running** *output:*

```
spanning-tree A2 priority 2
```

Enabling or Disabling Spanning Tree Operation

This command enables or disables spanning tree operation for any spanning tree protocol enabled on the switch. Before using this command to enable spanning tree, ensure that the version you want to use is active on the switch.

Syntax: [no] spanning-tree

Enabling spanning tree with MSTP configured implements MSTP for all physical ports on the switch, according to the VLAN groupings for the IST instance and any other configured instances. Disabling MSTP removes protection against redundant loops that can significantly slow or halt a network.

This command simply turns spanning tree on or off. It does not change the existing spanning tree configuration.

Note

The convergence time for implementing MSTP changes can be disruptive to your network. To minimize such disruption, consider using the **spanning-tree pending** command (refer to the following section on "Enabling an Entire MST Region at Once or Exchanging One Region Configuration for Another").

Enabling an Entire MST Region at Once or Exchanging One Region Configuration for Another

This operation exchanges the currently active MSTP configuration with the currently pending MSTP configuration. It enables you to implement a new MSTP configuration with minimal network disruption or to exchange MSTP configurations for testing or troubleshooting purposes.

When you configure or reconfigure MSTP, the switch re-calculates the corresponding network paths. This can have a ripple effect throughout your network as adjacent MSTP switches recalculate network paths to support the configuration changes invoked in a single switch. Although MSTP employs rapid spanning-tree operation, the convergence time for implementing MSTP changes can be disruptive to your network. However, by using the **spanning-tree pending** feature, you can set up an MSTP on the switch and then invoke all instances of the new configuration at the same time, instead of one at a time.

Syntax: [no] spanning-tree pending < apply | config-name | config-revision | instance | reset >

This command exchanges the currently active MSTP configuration with the current pending MSTP configuration. Options are as follows:

apply*: Exchanges the currently active MSTP configuration with the pending MSTP configuration.*

config-name*: Specifies the pending MST region name. Must be the same for all MSTP switches in the region. (Default: The switch's MAC address.)*

config-revision: *Specifies the pending MST region configuration revision number. Must be the same for all MSTP switches in the region. (Default: 0).*

instance < *1..16* > **vlan** < *vid | vid-range* >*: Creates the pending instance and assigns one or more VLANs to the instance.*

reset*: Copies the switch's currently active MSTP configuration to the pending configuration. This is useful when you want to experiment with the current MSTP configuration while maintaining an unchanged version.*

To Create a Pending MSTP Configuration. This procedure creates a pending MSTP configuration and exchanges it with the active MSTP configuration:

1. Configure the VLANs you want included in any instances in the new region. When you execute the **pending** command, all VLANs configured on the switch will be assigned to a single pending IST instance unless assigned to other, pending MST instances.(The **pending** command creates the region's IST instance automatically.)
2. Configure MSTP as the spanning-tree protocol, then execute **write mem** and reboot. (The pending option is available only with MSTP enabled.)
3. Configure the pending region **config-name** to assign to the switch.
4. Configure the pending **config-revision** number for the region name.
5. If you want an MST instance other than the IST instance, configure the instance number and assign the appropriate VLANs (VIDs) using the **pending instance** < *1..16* > **vlan** < *vid | vid-range* > command.
6. Repeat step 5 for each additional MST instance you want to configure.

7. To review your pending configuration, use the **show spanning-tree pending** command (see page 4-63).
8. To exchange the currently active MSTP configuration with the pending MSTP configuration, use the **spanning-tree pending apply** command.

MSTP VLAN Configuration Enhancement

Starting in software release 13.*x*.*x*, the MSTP VLAN configuration enhancement allows you to preconfigure an MSTP regional topology and ensure that the same VLAN ID-to-MSTI assignments exist on each MSTP switch in the region.

Caution

When this software version is installed, the prior VLAN ID-to-MSTI mappings do not change. However, this enhancement is not backward-compatible. If you install a software version prior to this version, and you have configured MSTI entries instances mapped to VLANs, they will be removed from the configuration file when booting to the prior version of software. You must do one of the following if you want to install or reload a prior version of the software:

1. Remove all MSTP mappings from the config file and then reconfigure the instance mapping after you are running the desired software version.
2. Save your current configuration file before updating your software to a new version. If you later reload this older version of the software, you can used this configuration file when you reload the older version. See "How to Save Your Current Configuration" on page 4-53.

The default behavior of the **spanning-tree instance vlan** command changes so that, before a static VLAN is configured or a dynamic VLAN is learned on the switch, you can preconfigure its VLAN ID-to-MSTI mapping. Later, when the VLAN is created, it is automatically assigned to the MSTI to which you had previously mapped it.

By supporting preconfigured VLAN ID-to-MSTI topologies, the VLAN Configuration enhancement provides the following benefits:

- Scalability: In a network design in which you plan to use a large number of VLANs, you can preconfigure identical VLAN ID-to-MSTI mappings on all switches in a single, campus-wide MST region, regardless of the specific VLANs that you later configure on each switch. After the initial VLAN ID-to-MSTI mapping, you can decide on the exact VLANs that you need on each switch.

All switches in a region must be configured with the same VLAN ID-to-MSTI mappings and the same MSTP configuration identifiers (region name and revision number).

- Flexibility: By preconfiguring identical VLAN ID-to-MSTI mappings on all switches in an MST region, you can combine switches that support different maximum numbers of VLANs.
- Network stability: You can reduce the interruptions in network connectivity caused by the regeneration of spanning trees in the entire network each time a configuration change in VLAN-to-MSTI mapping is detected on a switch. The negative impact on network performance is reduced if all newly created VLANs are pre-mapped to the correct MST instances. Later, VLAN creation and deletion are ignored by MSTP and no interruption in spanning-tree traffic occurs.
- Usability: Dynamically learned GVRP VLANs can be mapped to MSTIs and support MSTP load balancing.

PreConfiguring VLANs in an MST Instance

When you configure an MSTP regional topology, you create multiple spanning-tree instances. Each MST instance provides a fully connected active topology for a particular set of VLANs.

Each switch in an MSTP region is configured with the following set of common parameters:

- Region name (**spanning-tree config-name**)
- Region revision number (**spanning-tree config-revision**)
- Identical VLAN ID-to-MSTI mapping (**spanning-tree instance vlan**)

Each MST instance supports a different set of VLANs. A VLAN that is mapped to an MST instance cannot be a member of another MST instance.

The MSTP VLAN configuration enhancement allows you to ensure that the same VLAN ID-to-MSTI assignments exist on each MSTP switch in a region. Before a static VLAN is configured or a dynamic VLAN is learned on the switch, you can used the **spanning-tree instance vlan** command to map VLANs to each MST instance in the region. Later, when the VLAN is created, the switch automatically assigns it to the MST instance to which you had previously mapped it.

Syntax: [no] spanning-tree instance < 1..16 > vlan < *vid* [*vid..vid*] >
no spanning-tree instance < 1..16 >

Configuring MSTP on the switch automatically configures the IST instance and places all statically and dynamically configured VLANs on the switch into the IST instance. This command creates a new MST instance (MSTI) and moves the VLANs you specify from the IST to the MSTI.

You must map at least one VLAN to an MSTI when you create it. You cannot map a VLAN ID to more than one instance. You can create up to 16 MSTIs in a region.

The **no** *form of the command removes one or more VLANs from the specified MSTI. If no VLANs are specified, the* **no** *form of the command deletes the specified MSTI.*

When you remove a VLAN from an MSTI, the VLAN returns to the IST instance, where it can remain or be re-assigned to another MSTI configured in the region.

Note: *The valid VLAN IDs that you can map to a specified MSTI are from 1 to 4094. The VLAN ID-to-MSTI mapping does not require a VLAN to be already configured on the switch. The MSTP VLAN enhancement allows you to preconfigure MSTP topologies before the VLAN IDs associated with each instance exist on a switch.*

When you use preconfigured VLAN ID-to-MSTI topologies, ensure that MSTP switches remain in the same region by mapping all VLAN IDs used in the region to the same MSTIs on each regional switch.

Configuring MSTP Instances with the VLAN Range Option

For the ProCurve Series 3500/5400/6200 switches, if you use the **spanning-tree instance** command with the VLAN range option, even if the range includes VLANs that are not currently present on the switch, the entire range of VLANs is configured. For example, if VLANs 1, 5, and 7 are currently present and you enter this command:

```
ProCurve(config)# spanning-tree instance 1 vlan 1-10
```

then all the VLANs from 1 through 10 are included, even those VLANs that are not present.

On other ProCurve switches, only the VLANs that are present will be included, that is, only VLANs 1, 5, and 7 would be included. The switch will map these VLANs to MSTP Instance 1, which results in a Configuration Digest that is not the same as the Configuration Digest for the Series 3500/5400/6200 switches running this enhancement. (See Figure 4-16 and Figure 4-17)

Figure 4-16 shows an example of an MSTP instance configured with the VLAN range option. All the VLANs are included in the instance whether they exist or not. Figure 4-17 shows an example of an MSTP instance configured on a ProCurve switch other than the Series 3500/5400/6200. Only VLANs 1, 5, and 7 are included in the instance.

```
ProCurve(config)# show spanning-tree mst-config

MST Configuration Identifier Information
 MST Configuration Name: MSTP1
 MST Configuration Revision: 1
 MST Configuration Digest: 0x51B7EBA6BEED8702D2BA4497D4367517

 IST Mapped VLANs :

 Instance ID Mapped VLANs
 -------- ---------------
 1        1-10
```

Figure 4-16. An Example of Mapping VLANs with the Range Option where all VLANs are Included

The Configuration Digest value shown in Figure 4-17 is not the same as in Figure 4-16, indicating that these switches do not operate in the same instance.

The Common Spanning Tree (CST) will still have the correct root associations.

```
ProCurve(config)# show spanning-tree mst-config

MST Configuration Identifier Information
 MST Configuration Name: MSTP1
 MST Configuration Revision: 1
 MST Configuration Digest: 0x89D3ADV471668D6D832F6EC4AA9CF4AA

 IST Mapped VLANs :

 Instance ID Mapped VLANs
 -------- ---------------
 1        1, 5, 7
```

Figure 4-17. Example of Mapping VLANs on Switches other than ProCurve Series 3500/5400/6200

Operating Notes for the VLAN Configuration Enhancement

- Configuring MSTP on the switch automatically configures the Internal Spanning Tree (IST) instance and places all statically and dynamically configured VLANs on the switch into the IST instance. The spanning-tree instance vlan command creates a new MST instance and moves the VLANs you specify from the IST to the MSTI.

  You must map a least one VLAN ID to an MSTI when you create it. You cannot map a VLAN ID to more than one instance. You can create up to 16 MSTIs in a region.

- The **no** form of the spanning-tree instance vlan command removes one or more VLANs from the specified MSTI. If no VLANs are specified, the **no** form of the command deletes the specified MSTI.

  When you remove a VLAN from and MSTI, the VLAN returns to the IST instance, where it can remain or be re-assigned to another MSTI configured in the region.

- If you enter the spanning-tree instance vlan command before a static or dynamic VLAN is configured on the switch to preconfigure VLAN ID-to-MSTI mappings, no error message is displayed. Later, each newly configured VLAN that has already been associated with an MSTI is automatically assigned to the MSTI.

  This new default behavior differs from automatically including configured (static and dynamic) VLANs in the IST instance and requiring you to manually assign individual static VLANs to an MSTI.

- The valid VLAN IDs that you can map to a specified MSTI are from 1 to 4094. The VLAN ID-to-MSTI mapping does not require a VLAN to be already configured on the switch. The MSTP VLAN enhancement allows you to preconfigure MSTP topologies before the VLAN IDs associated with each instance exist on a switch.

- When you use preconfigured VLAN ID-to-MSTI topologies, ensure that MSTP switches remain in the same region by mapping all VLAN IDs used in the region to the same MSTIs on each regional switch.

- When you upgrade switch software to release K.13.XX and later, the existing MSTP topology configuration is automatically saved. All existing VLAN ID-to-MSTI assignments are maintained on a switch for uninterrupted MSTP network operation.

How to Save Your Current Configuration

You can save your current configuration before updating to a new version of software by following these steps:

1. Enter the **show config files** command to display your current configuration files, as shown in Figure 4-18.

```
ProCurve(config)# show config files

Configuration files:

 id | act pri sec | name
 ---+-------------+--------------------
  1 |  *   *   *  | config1
  2 |             | config2
  3 |             |
```

Figure 4-18. An Example of the show config files Command Output

2. To save a configuration file for software version K.12.43, enter this command:

   ```
   ProCurve(config)# copy config config1 config
   configK1243.cfg
   ```

   You can choose any name for the saved configuration file that you prefer.

3. Display the configuration files as shown in Figure 4-19. You will see your newly created configuration file listed.

```
ProCurve(config)# show config files

Configuration files:

 id | act pri sec | name
 ---+-------------+----------------------
  1 |  *   *   *  | config1
  2 |             | config2
  3 |             | configK1243.cfg
```

Figure 4-19. A Config File for the Current Software Version is Created

4. Now update your switch to the desired version, for example, K.12.51. Enter the **show flash** command to see the results. The switch is now running the software version K.12.51.

```
ProCurve(config)# show flash

Image            Size(Bytes)   Date   Version
-----            -----------  -------- -------
Primary Image    : 6771179   10/15/07 K.12.51
Secondary Image  : 7408949   08/24/07 K.12.43
Boot Rom Version: K.12.12
Default Boot     : Primary
```

Figure 4-20. Show Flash Command after Upgrading the Switch to a New Version of the Software (K.12.51)

5. If you want to run the prior software version, K.12.43 in this example, enter this command:

   ```
   ProCurve(config)# boot system flash secondary config
   configK1243.cfg
   ```

   After rebooting, the switch is running software version K.12.43 and is using the configuration file that you saved for this software version, configK1243.cfg.

You can also save the K.12.43 configuration file on a TFTP server. If you wanted to reload the K.12.43 version of the software again, reload the configuration file before you do the reload.

Displaying MSTP Statistics and Configuration

Command	Page
MSTP Statistics:	
show spanning-tree [< *port-list* >]	below
show spanning-tree [< *port-list* >] detail	4-58
show spanning-tree instance < ist | 1..16 >	4-59
MSTP Configuration	
show spanning-tree [*port-list*] config	4-60
show spanning-tree [port-list] config instance < ist | 1..16 >	4-61
show spanning-tree mst-config	4-62
show spanning-tree pending < < instance | ist > | mst-config >	4-63

SNMP MIB Support for MSTP. MSTP is a superset of the STP/802.1D and RSTP/802.1w protocols and uses the MIB objects defined for these two protocols.

Displaying Global MSTP Status

The following commands display the MSTP statistics for the connections between MST regions in a network.

Syntax: show spanning-tree

This command displays the switch's global and regional spanning-tree status, plus the per-port spanning-tree operation at the regional level. Note that values for the following parameters appear only for ports connected to active devices: **Designated Bridge**, **Hello Time**, **PtP**, *and* **Edge**.

Syntax: show spanning-tree < *port-list* >

This command displays the spanning-tree status for the designated port(s). You can list data for a series of ports and port trunks by specifying the first and last port or trunk of any consecutive series of ports and trunks. For example, to display data for port A20-A24 and trk1, you would use this command: **show spanning-tree a20-a42,trk1**

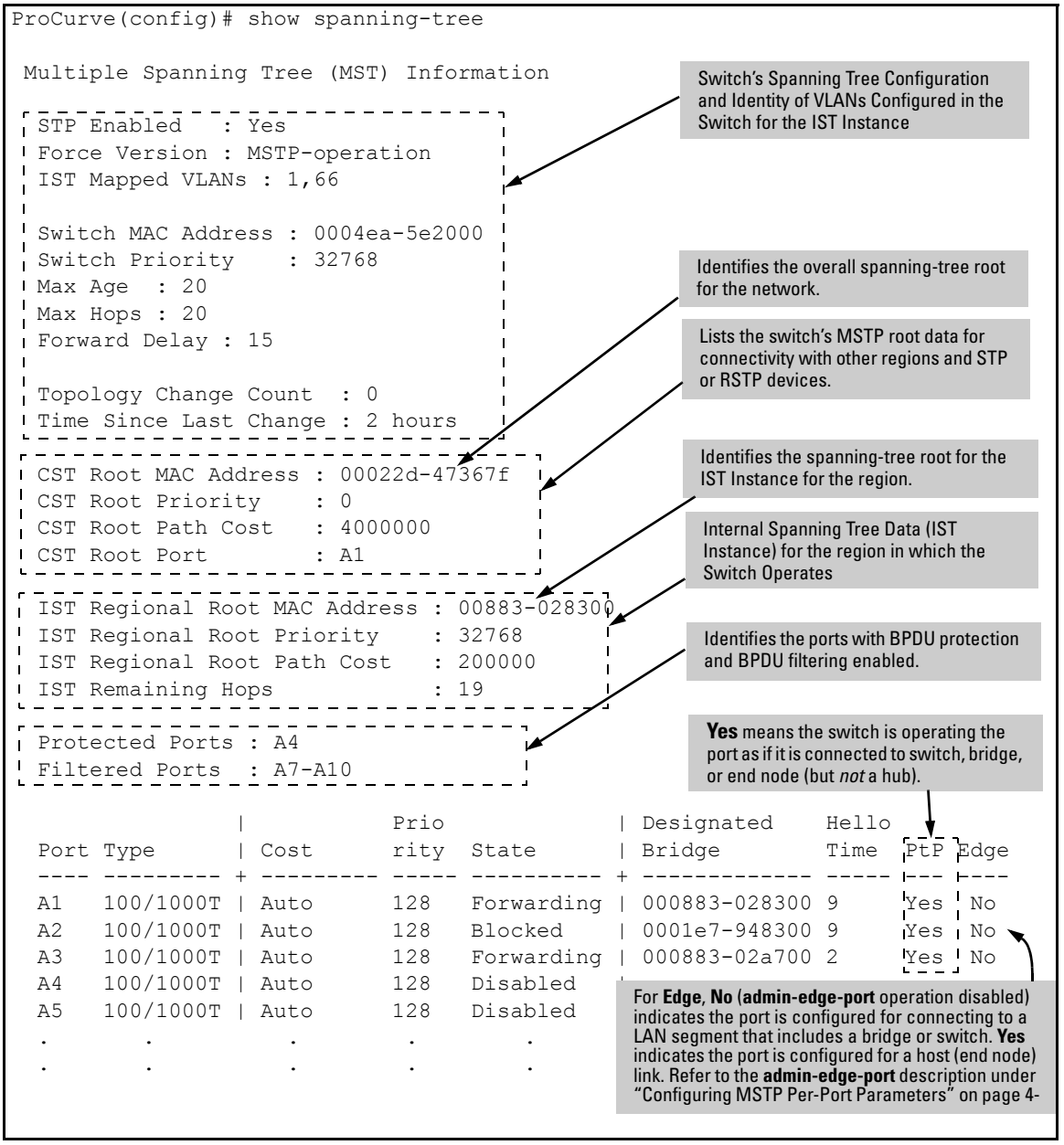

Figure 4-21. Example of Common Spanning Tree Status

Displaying Detailed Port Information

The following commands display the MSTP statistics for the connections between MST regions in a network.

Syntax: show spanning-tree detail

This command displays additional parameters concerning the common spanning tree (CST) ports.

Syntax: show spanning-tree < *port-list* > detail

This command displays detailed spanning-tree status for the designated port(s).

.

```
ProCurve# show spanning-tree a9 detail

 Status and Counters - CST Port(s) Detailed Information

  Port                        : A9
  Status                      : Up
  BPDU Filtering              : Yes
  Errant BPUDUs received      : 65
  MST Region Boundary         : Yes
  External Path Cost          : 200000
  External Root Path Cost     : 420021
  Administrative Hello Time   : Use Global
  Operational Hello Time      : 2
  AdminEdgePort               : No
  OperEdgePort                : No
  AdminPointToPointMAC        : Force-True
  OperPointToPointMAC         : Yes
  Aged BPDUs Count            : 0
  Loop-back BPDUs Count       : 0
  TC ACK Flag Transmitted     : 0
  TC ACK Flag Received        : 0

  MST         MST         CFG         CFG         TCN         TCN
  BPDUs Tx    BPDUs Rx    BPDUs Tx    BPDUs Rx    BPDUs Tx    BPDUs Rx
  ----------- ----------- ----------- ----------- ----------- -------
  8           28          0           0           0           0
```

Gives information concerning the Common Spanning Tree (CST) only. Use the show spanning-tree instance commands to view counters pertaining to particular IST instances.

Figure 4-22. Example of CST Port Information using Show Spanning Tree Detail Command

Note This command gives information about the CST only. To view details of specific MST Instances, use the **show spanning tree instance** commands.

Displaying Status for a Specific MST Instance

The following commands display the MSTP statistics for a specified MST instance.

Syntax: show spanning-tree instance < ist | 1..16 >

This command displays the MSTP statistics for either the IST instance or a numbered MST instance running on the switch.

Syntax: show spanning-tree instance < ist | 1..16 > detail

This command displays status on all active ports for a specific instance of MSTP.

Syntax: show spanning-tree < *port-list* > instance < ist | 1..16 > detail

This command displays detailed status for the designated port(s) for a specific instance of MSTP.

```
Switch-1(config)# show spanning-tree instance 1

 MST Instance Information

  Instance ID : 1
  Mapped VLANs : 11,22

  Switch Priority          : 32768

  Topology Change Count    : 4
  Time Since Last Change   : 6 secs

  Regional Root MAC Address : 0001e7-948300
  Regional Root Priority    : 32768
  Regional Root Path Cost   : 400000
  Regional Root Port        : A1
  Remaining Hops            : 18
                                                                  Designated
  Port Type       Cost       Priority Role       State      Bridge
  ---- ---------- ---------- -------- ---------- ---------- -------------
  A1   10/100TX   200000     128      Root       Forwarding 000883-028300
  A2   10/100TX   200000     128      Designated Forwarding 000883-02a700
  A3   10/100TX   200000     112      Designated Forwarding 000883-02a700
  A4   10/100TX   Auto       128      Disabled   Disabled
   .       .        .         .          .          .
   .       .        .         .          .          .
   .       .        .         .          .          .
```

Figure 4-23. Example of MSTP Statistics for a Specific Instance on an MSTP Switch

Displaying the MSTP Configuration

Displaying the Global MSTP Configuration. This command displays the switch's basic and MST region spanning-tree configuration, including basic port connectivity settings.

Syntax: show spanning-tree config

The upper part of this output shows the switch's global spanning-tree configuration that applies to the MST region. The port listing shows the spanning-tree port parameter settings for the spanning-tree region operation (configured by the **spanning-tree < *port-list* >** *command). For information on these parameters, refer to "Configuring MSTP Per-Port Parameters" on page 4-26.*

Syntax: show spanning-tree < *port-list* > config

This command shows the same data as the above command, but lists the spanning-tree port parameter settings for only the specified port(s) and/or trunk(s). You can list data for a series of ports and port trunks by specifying the first and last port or trunk of any consecutive series of ports and trunks. For example, to display data for port A20-A24 and trk1, use this command: **show spanning-tree a20-a24,trk1 config**

```
Switch-2(config)# show spanning-tree config

 Multiple Spanning Tree (MST) Configuration Information

  STP Enabled [No] : Yes
  Force Version [MSTP-operation] : MSTP-operation

  MST Configuration Name : REGION_1
  MST Configuration Revision : 1          Switch Priority : 32768
  Forward Delay [15] : 15                 Hello Time [2] : 2
  Max Age [20] : 20                       Max Hops [20] : 20

  Port  Type       | Cost      Priority Edge Point-to-Point MCheck Hello Time
  ----- ---------- + --------- -------- ---- -------------- ------ ----------
  A3    10/100TX   | Auto      128      Yes  Force-True     Yes    Use Global
  A4    10/100TX   | Auto      128      Yes  Force-True     Yes    Use Global
   :        :            :        :        :              :      :
   :        :            :        :        :              :      :
   .        .            .        .        .              .      .
  A20   10/100TX   | Auto      128      Yes  Force-True     Yes    Use Global
  A21   10/100TX   | Auto      128      Yes  Force-True     Yes    Use Global
  A22   10/100TX   | Auto      128      Yes  Force-True     Yes    Use Global
  A23   10/100TX   | Auto      128      Yes  Force-True     Yes    Use Global
  A24   10/100TX   | Auto      128      Yes  Force-True     Yes    Use Global
  Trk1             | Auto      128      Yes  Force-True     Yes    Use Global
```

Global Priority

Global Hello Time

Per-Port Hello Time (Overrides Global Hello-Time on individual ports.)

Per-Port Priority

Figure 4-24. Example of Displaying the Switch's Global Spanning-Tree Configuration

Displaying Per-Instance MSTP Configurations. These commands displays the per-instance port configuration and current state, along with instance identifiers and regional root data.

Syntax: show spanning-tree config instance < ist | 1..16 >

The upper part of this output shows the instance data for the specified instance. The lower part of the output lists the spanning-tree port settings for the specified instance.

Syntax: show spanning-tree < *port-list* > config instance < ist | 1..16 >

This command shows the same data as the above command, but lists the spanning-tree port parameter settings for only the specified port(s) and/or trunk(s). You can list data for a series of ports and port trunks by specifying the first and last port or trunk of any consecutive series of ports and trunks. For example, to display data for port A20-A24 and trk1, use this command:

show spanning-tree a20-a24,trk1 config instance 1

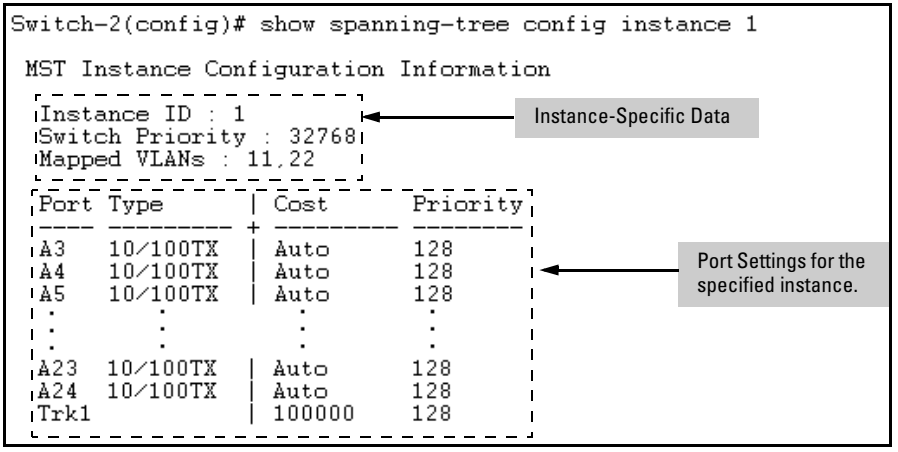

Figure 4-25. Example of the Configuration Listing for a Specific Instance

Displaying the Region-Level Configuration in Brief. This command output is useful for quickly verifying the allocation of VLANs in the switch's MSTP configuration and for viewing the configured region identifiers.

Syntax: show spanning-tree mst-config

This command displays the switch's regional configuration.

Note: *The switch computes the* ***MSTP Configuration Digest*** *from the VID to MSTI configuration mappings on the switch itself. As required by the 802.1s standard, all MSTP switches within the same region must have the same VID to MSTI assignments, and any given VID can be assigned to either the IST or one of the MSTIs within the region. Thus, the MSTP Configuration Digest must be identical for all MSTP switches intended to belong to the same region. When comparing two MSTP switches, if their Digest identifiers do not match, then they cannot be members of the same region.*

```
Switch-2(config)# show spanning-tree mst-config

 MST Configuration Identifier Information

  MST Configuration Name : REGION_1
  MST Configuration Revision : 1
  MST Configuration Digest : 0xDAD6A13EC5141980B7EBDA71D8991E7C

  IST Mapped VLANs : 1,66

  Instance ID Mapped VLANs
  ----------- ------------------------------------------------
  1           11,22
  2           33,44,55
```

Refer to the "Note", above.

Figure 4-26. Example of a Region-Level Configuration Display

Displaying the Pending MSTP Configuration. This command displays the MSTP configuration the switch will implement if you execute the spanning-tree pending apply command (Refer to "Enabling an Entire MST Region at Once or Exchanging One Region Configuration for Another" on page 4-46.)

Syntax: show spanning-tree pending < instance | mst-config >

instance < 1..16 | ist >

Lists region, instance I.D. and VLAN information for the specified, pending instance.

mst-config

Lists region, IST instance VLAN(s), numbered instances, and assigned VLAN information for the pending MSTP configuration.

```
ProCurve# show spanning-tree pending instance 1

 Pending MST Instance Configuration Information

  MST Configuration Name : New-Version_01
  MST Configuration Revision : 10
  Instance ID : 1
  Mapped VLANs : 1,22



Switch-1(config)# show spanning-tree pending mst-config

 Pending MST Configuration Identifier Information

  MST Configuration Name : New-Version_01
  MST Configuration Revision : 10

  IST Mapped VLANs : 11,33

  Instance ID Mapped VLANs
  ----------- ----------------------------------------------
  1           1,22
```

Figure 4-27. Example of Displaying a Pending Configuration

Troubleshooting an MSTP Configuration

This section describes the **show spanning-tree** commands that you can use to monitor, troubleshoot, and debug the operation of a multiple-instance spanning-tree configuration in your network.

Note that the **show spanning-tree** commands described in this section allow you to troubleshoot MSTP activity in your network by focusing on increasingly specific levels of operation. For example, you can display debug information for:

- All MST instances
- All ports used in one MST instance
- A specific port or several ports used in one MST instance

Also, you can display the change history for the root (bridge) switch used as the single forwarding path for:

- All MST regions, STP bridges, and RSTP bridges in an STP network
- All VLANs on MSTP switches in a region
- All VLANs on MSTP switches in an MST instance

Displaying the Change History of Root Bridges

The **show spanning-tree root-history** command allows you to display change history information (up to 10 history entries) for a specified root bridge in any of the following MSTP topologies:

- Common Spanning Tree (**cst**): Provides connectivity in a bridged network between MST regions, STP LANs, and RSTP LANs.
- Internal Spanning Tree (**ist**): Provides connectivity within an MST region for VLANs associated with the default Common and Internal Spanning Tree (CIST) instance in your network (VLANs that have not been mapped to an MST instance).

- MST Instance (**mst**): Connects all static and (starting from release 13.*x.x*) dynamic VLANs assigned to a multiple spanning-tree instance.

Syntax: show spanning-tree root-history <cst | ist | mst <*instance-id*>>

This command displays the change history for the root bridge in the specified MSTP topology.

The **cst** *parameter displays the change history for the root bridge of a spanning-tree network, including MST regions and STP and RSTP bridges.*

The **ist** *parameter displays the change history for the root bridge in the IST instance of an MST region.*

The **mst** *<instance-id> parameter displays the change history for the root bridge in an MST instance, where <instance-id> is an ID number from 1 to 16.*

Use the **show spanning-tree root-history** command to view the number and dates of changes in the assignment of a root bridge. Possible intrusion into your MST network may occur if an unauthorized external device gains access to a spanning tree by posing as the root device in a topology. To prevent an MST port connected to the device from being selected as the root port in a topology, use the **spanning-tree root-guard** command.

The following examples show sample output of the **show spanning-tree root-history** command for different MSTP topologies. Note that in each example, the root bridge ID is displayed in the format:
<*priority*:*mac-address*>

Where:

- <*priority*> is the MSTP switch priority calculated for one of the following:
  - The IST (regional) root switch using the **spanning-tree priority** command
  - An MSTI root switch using the **spanning-tree instance priority** command
- <*mac-address*> is the MAC address of the root (bridge) switch.

```
ProCurve(config)# show spanning-tree root-history cst

 Status and Counters - CST Root Changes History

  MST Instance ID        : 0
  Root Changes Counter   : 2
  Current Root Bridge ID : 32768:000883-024500

  Root Bridge ID      Date     Time
  ------------------- -------- --------
  32768:000883-024500 02/09/07 17:40:59
  36864:001279-886300 02/09/07 17:40:22
```

Identifies the root bridge of the common spanning tree in a bridged network that connects different MST regions and STP or RSTP devices.

Figure 4-28. Example of show spanning-tree root-history cst Command Output

```
ProCurve(config)# show spanning-tree root-history ist

 Status and Counters - IST Regional Root Changes History

  MST Instance ID        : 0
  Root Changes Counter   : 2
  Current Root Bridge ID : 32768:000883-024500

  Root Bridge ID      Date     Time
  ------------------- -------- --------
  32768:000883-024500 02/09/07 17:40:59
  36864:001279-886300 02/09/07 17:40:22
```

Identifies the root bridge of the internal spanning tree in an MST region.

Figure 4-29. Example of show spanning-tree root-history ist Command Output

```
ProCurve(config)# show spanning-tree root-history mst 2

 Status and Counters - MST Instance Regional Root Changes History

  MST Instance ID        : 2
  Root Changes Counter   : 2
  Current Root Bridge ID : 32770:000883-024500

  Root Bridge ID      Date     Time
  ------------------- -------- --------
  32770:000883-024500 02/09/07 17:40:59
  32770:001279-886300 02/09/07 17:40:22
```

Identifies the root bridge of an MST instance in an MST region.

Figure 4-30. Example of show spanning-tree root-history msti Command Output

Displaying Debug Counters for All MST Instances

The **show spanning-tree debug-counters** command allows you to display the aggregate values of all MSTP debug counters that are maintained on a switch. These aggregate values are a summary of the information collected from all ports and from all spanning-tree instances that forward traffic on switch ports.

Use the displayed diagnostic information to globally monitor MSTP operation on a per-switch basis.

Syntax: show spanning-tree debug-counters

This command displays debug counters for MSTP activity on all ports configured for VLANs used in spanning-tree instances.

The following example shows sample output of the **show spanning-tree debug-counters** command for all ports. For a description of each counter, refer to Table 4-1 on page 4-72.

```
ProCurve(config)# show spanning-tree debug-counters

 Status and Counters - MSTP Bridge Common Debug Counters Information

  Counter Name                      Aggregated Value Collected From
  --------------------------------- ---------------- --------------
  Invalid BPDUs                     0                CIST
  Errant BPDUs                      170927           CIST
  MST Config Error BPDUs            0                CIST
  Looped-back BPDUs                 0                CIST
  Starved BPDUs/MSTI MSGs           0                CIST/MSTIs
  Exceeded Max Age BPDUs            0                CIST
  Exceeded Max Hops BPDUs/MSTI MSGs 0                CIST/MSTIs
  Topology Changes Detected         2                CIST/MSTIs
  Topology Changes Tx               6                CIST/MSTIs
  Topology Changes Rx               4                CIST/MSTIs
  Topology Change ACKs Tx           0                CIST
  Topology Change ACKs Rx           0                CIST
  TCN BPDUs Tx                      0                CIST
  TCN BPDUs Rx                      0                CIST
  CFG BPDUs Tx                      0                CIST
  CFG BPDUs Rx                      0                CIST
  RST BPDUs Tx                      0                CIST
  RST BPDUs Rx                      0                CIST
  MST BPDUs/MSTI MSGs Tx            10               CIST/MSTIs
  MST BPDUs/MSTI MSGs Rx            341802           CIST/MSTIs
```

Figure 4-31. Example of show spanning-tree debug-counters Command Output

Displaying Debug Counters for One MST Instance

The **show spanning-tree debug-counters instance** command allows you to display the aggregate values of all MSTP debug counters maintained on a switch for a specified spanning-tree instance. These aggregate values are a summary of information collected from all ports that have VLANs assigned to the specified instance.

Use the **show spanning-tree debug-counters instance** command to troubleshoot the global MSTP diagnostic information displayed in **show spanning-tree debug-counters** command output when you suspect unauthorized MSTP activity in a specific MST instance.

Syntax: show spanning-tree debug-counters instance <*instance-id*>

This command displays debug counters for MSTP activity on all ports configured for VLANs in the specified MST instance. The valid values for **instance** <*instance-id*> *are from 0 to 16:*

- *0 specifies the default MST (CIST) instance.*
- *1 to 16 specify a multiple spanning-tree (MST) instance.*

The following example shows sample output of the **show spanning-tree debug-counters instance** command when applied to the Common and Internal Spanning Tree (CIST) instance (default MST instance 0) in the network. For a description of each counter, refer to Table 4-1 on page 4-72.

```
ProCurve(config)# show spanning-tree debug-counters instance 0

 Status and Counters - CIST Common Debug Counters Information

  MST Instance ID : 0

  Counter Name                     Aggregated Value Collected From
  -------------------------------- ---------------- --------------
  Invalid BPDUs                    0                Ports
  Errant BPDUs                     172603           Ports
  MST Config Error BPDUs           0                Ports
  Looped-back BPDUs                0                Ports
  Starved BPDUs                    0                Ports
  Exceeded Max Age BPDUs           0                Ports
  Exceeded Max Hops BPDUs          0                Ports
  Topology Changes Detected        1                Ports
  Topology Changes Tx              3                Ports
  Topology Changes Rx              2                Ports
  Topology Change ACKs Tx          0                Ports
  Topology Change ACKs Rx          0                Ports
  TCN BPDUs Tx                     0                Ports
  TCN BPDUs Rx                     0                Ports
  CFG BPDUs Tx                     0                Ports
  CFG BPDUs Rx                     0                Ports
  RST BPDUs Tx                     0                Ports
  RST BPDUs Rx                     0                Ports
  MST BPDUs Tx                     5                Ports
  MST BPDUs Rx                     172577           Ports
```

Figure 4-32. Example of show spanning-tree debug-counters instance Command Output for All Ports in the CIST Instance

Displaying Debug Counters for Ports in an MST Instance

The **show spanning-tree debug-counters instance ports** command allows you to display the aggregate values of all MSTP debug counters maintained on one or more ports used by a specified spanning-tree instance. These aggregate values are a summary of information collected from the specified ports that have VLANs assigned to the specified instance.

Use the **show spanning-tree debug-counters instance ports** command to troubleshoot at a finer level the more general MSTP diagnostic information displayed in **show spanning-tree debug-counters instance** command output when you suspect unauthorized MSTP activity on one or more MST ports in an MST instance.

Syntax: show spanning-tree debug-counters instance <*instance-id*> ports <*port-list*>

This command displays debug counters for MSTP activity on the specified ports configured for VLANs in the specified MST instance.

The valid values for **instance** <*instance-id*> *are from 0 to 16:*

- *0 specifies the default MST (CIST) instance.*
- *1 to 16 specify an MST instance.*

The **ports** <*port-list*> *parameter specifies one or more MST ports or trunk ports.*

In the port list, enter a series of ports by separating the first and last ports in the series with a dash (-); for example, **a2-a8** *or* **trk1-trk3**. *Separate individual ports and series of ports with a comma; for example,* **a2-a8**, **a20**, **trk1, trk4-trk5**.

The following examples shows sample output of the **show spanning-tree debug-counters instance ports** command for both the CIST (default MST instance 0) and an MST instance (instance 2) on port A15. For a description of each counter, refer to Table 4-1 on page 4-72.

```
ProCurve(config)# show spanning-tree debug-counters instance 0 ports a15

 Status and Counters - CIST Port(s) Debug Counters Information

  MST Instance ID : 0
  Port : A15

  Counter Name                 Value      Last Updated
  ---------------------------- ---------- -----------------
  Invalid BPDUs                0
  Errant BPDUs                 0
  MST Config Error BPDUs       0
  Looped-back BPDUs            0
  Starved BPDUs                0
  Exceeded Max Age BPDUs       0
  Exceeded Max Hops BPDUs      0
  Topology Changes Detected    1          02/09/07 17:40:59
  Topology Changes Tx          3          02/09/07 17:41:03
  Topology Changes Rx          2          02/09/07 17:41:01
  Topology Change ACKs Tx      0
  Topology Change ACKs Rx      0
  TCN BPDUs Tx                 0
  TCN BPDUs Rx                 0
  CFG BPDUs Tx                 0
  CFG BPDUs Rx                 0
  RST BPDUs Tx                 0
  RST BPDUs Rx                 0
  MST BPDUs Tx                 5          02/09/07 17:41:03
  MST BPDUs Rx                 173540     02/13/07 18:05:34
```

Figure 4-33. Example of show spanning-tree debug-counters instance ports Command Output for One Port in the CIST Instance

```
ProCurve(config)# show spanning-tree debug-counters instance 2 ports a15

 Status and Counters - MSTI Port(s) Debug Counters Information

  MST Instance ID : 2
  Port : A15

  Counter Name                 Value      Last Updated
  ---------------------------- ---------- -----------------
  Starved MSTI MSGs            0
  Exceeded Max Hops MSTI MSGs  0
  Topology Changes Detected    1          02/09/07 17:40:59
  Topology Changes Tx          3          02/09/07 17:41:03
  Topology Changes Rx          2          02/09/07 17:41:01
  MSTI MSGs Tx                 5          02/09/07 17:41:03
  MSTI MSGs Rx                 173489     02/13/07 18:03:52
```

Figure 4-34. Example of show spanning-tree debug-counters instance ports Command Output for One Port in an MST Instance

Field Descriptions in MSTP Debug Command Output

Table 4-1 contains descriptions of the debugging information displayed in the output of **show spanning-tree debug-counters** commands.

Table 4-1. MSTP Debug Command Output: Field Descriptions

Field	Description
Invalid BPDUs	Number of received BPDUs that failed standard MSTP (802.1Q-REV/D5.0 14.4) validation checks and were dropped. This counter is maintained by the CIST (default MST instance 0) on a per-port basis.
Errant BPDUs	Number of received BPDUs that were dropped on a port that is configured to not expect BPDU packets. This counter is maintained by the CIST (default MST instance 0 in the network) on a per-port basis and is incremented each time a BPDU packet is received on a port configured with the BPDU filter to ignore incoming BPDU packets (**spanning-tree bpdu-filter** command) or the BPDU protection feature to disable the port when BPDU packets are received (**spanning-tree bpdu-protection** command).

Field	Description
MST Config Error BPDUs	Number of BPDUs received from a neighbor bridge with inconsistent MST configuration information. For example, BPDUs from a transmitting bridge may contain the same MST configuration identifiers (region name and revision number) and format selector as the receiving bridge, but the value of the Configuration Digest field (VLAN ID assignments to regional IST and MST instances) is different. This difference indicates a probable configuration error in MST region settings on the communicating bridges. The received BPDU is still processed by MSTP. This counter is maintained by the CIST (default MST instance 0) on a per-port basis.
Looped-back BPDUs	Number of times a port has received self-sent BPDU packets as the result of an external loop condition in which the BPDUs were looped back to the originating transmission port. The received BPDU is still processed by MSTP and the port changes to a blocked state. This counter is maintained by the CIST (default MST instance 0) on a per-port basis.
Starved BPDUs	Number of times that no BPDUs are received within the scheduled interval (three times the Hello Time value configured with the **spanning-tree hello-time** command) from a downstream CIST-designated peer port on the CIST root, alternate, or backup port. As a result, the "starved" port triggers a spanning-tree topology regeneration. This counter is maintained by the CIST (default MST instance 0) on a per-port basis.
Starved MSTI MSGs	Number of times that no BPDUs are received within the scheduled interval (three times the Hello Time value configured with the **spanning-tree hello-time** command) from a downstream MSTI-designated peer port on the MSTI root, alternate, or backup port. As a result, the "starved" port triggers a spanning-tree topology regeneration. This counter is maintained by the CIST (default MST instance 0) on a per-port basis.
Exceeded Max Age BPDUs	Number of times that a BPDU packet is received from a bridge external to the MST region with a Message Age value greater than the configured value of the Max Age parameter (**spanning-tree maximum age** command). This may occur if the receiving bridge is located too far from the root bridge (beyond the configured size of the spanning-tree domain on the root bridge) or if a BPDU packet with invalid root information is continuously circulating between bridges in a spanning-tree domain and needs to be aged out. This counter is maintained by the CIST (default MST instance 0) on a per-port basis.
Exceeded Max Hops BPDUs	Number of times that a BPDU packet is received from a bridge internal to the MST region with a CIST Remaining Hops value less than or equal to 1. This may occur if the receiving bridge is located too far from the CIST regional root bridge (beyond the configured size of the MST region on the CIST regional root bridge) or if a PDU packet with invalid CIST regional root bridge information is continuously circulating between bridges in the MST Region and needs to be aged out. This counter is maintained by the CIST (default MST instance 0 in the region) on a per-port basis.

Field	Description
Exceeded Max Hops MSTI MSGs	Number of times that an MSTI MSG packet is received from a bridge internal to the MST region with an MSTI Remaining Hops value less than or equal to 1. This may occur if the receiving bridge is located too far from the MSTI regional root bridge (beyond the configured size of the MST region on the MSTI regional root bridge) or if a BPDU packet with invalid MSTI regional root bridge information is continuously circulating between bridges in an MST region and needs to be aged out. This counter is maintained on a per-MSTI per-port basis.
Topology Changes Detected	Number of times that a Topology Change event is detected by the CIST or MSTI port and the port triggers a topology change propagation throughout the network. A Topology Change event occurs when a non-edge port enters forwarding state. This counter is maintained on a per-CIST per-port and on a per-MSTI per-port basis.
Topology Changes Tx	Number of times that Topology Change information is propagated (sent out) through the port to the rest of the network. For a CIST port, the counter is the number of times that a CFG, RST or MST BPDU with the TC flag set is transmitted out of the port. For an MSTI port, the counter is the number of times that a MSTI configuration message with the TC flag set is transmitted out of the port. This counter is maintained on a per-CIST per-port and on a per-MSTI per-port bases.
Topology Changes Rx	Number of times that Topology Change information is received from the peer port. For a CIST port, the counter is the number of times that a CFG, RST or MST BPDU with the TC flag set is received. For an MSTI port, the counter is the number of times that an MSTI configuration message with the TC flag set is received. This counter is maintained on a per-CIST per-port and on a per-MSTI per-port basis.
Topology Change ACKs Tx	Number of times that the Topology Change acknowledgement is transmitted through the port (number of CFG, RST or MST BPDUs transmitted with the Topology Change Acknowledge flag set). This counter is maintained by the CIST (default MST instance 0) on a per-port basis.
Topology Change ACKs Rx	Number of times the Topology Change acknowledgement is received on the port (number of CFG, RST or MST BPDUs received with the Topology Change Acknowledge flag set). This counter is maintained by the CIST (default MST instance 0) on a per-port basis.
TCN BPDUs Tx	Number of Topology Change Notification BPDUs that are transmitted through the port. This counter is maintained by the CIST (default MST instance 0) on a per-port basis.
TCN BPDUs Rx	Number of Topology Change Notification BPDUs that are received on the port. This counter is maintained by the CIST (default MST instance 0) on a per-port basis.
CFG BPDUs Tx	Number of (802.1D) Configuration BPDUs that are transmitted through the port. This counter is maintained by the CIST (default MST instance 0) on a per-port basis.
CFG BPDUs Rx	Number of (802.1D) Configuration BPDUs that are received on the port. This counter maintained by the CIST (default MST instance 0) on a per-port basis.

Field	Description
RST BPDUs Tx	Number of (802.1w) RST BPDUs that are transmitted through the port. This counter is maintained by the CIST (default MST instance 0) on a per-port basis.
RST BPDUs Rx	Number of (802.1w) RST BPDUs that are received on the port. This counter is maintained by the CIST (default MST instance 0) on a per-port basis.
MST BPDUs Tx	Number of (802.1s) MST BPDUs that are transmitted through the port. This counter is maintained by the CIST (default MST instance 0) on a per-port basis.
MST BPDUs Rx	Number of (802.1s) MST BPDUs that are received on the port. This counter is maintained by the CIST (default MST instance 0) on a per-port basis.
MSTI MSGs Tx	Number of times that a configuration message for a specific MSTI was encoded in (802.1s) MST BPDUs that are transmitted through the port. This counter is maintained on a per-MSTI per-port basis.
MSTI MSGs Rx	Number of times that the MSTI detected a configuration message destined to the MSTI in (802.1s) MST BPDUs received on the port. This counter is maintained on a per-MSTI per-port basis.

Troubleshooting MSTP Operation

Table 4-2. Troubleshooting MSTP Operation

Problem	Possible Cause
Duplicate packets on a VLAN, or packets not arriving on a LAN at all.	The allocation of VLANs to MSTIs may not be identical among all switches in a region.
A switch intended to operate in a region does not receive traffic from other switches in the region.	An MSTP switch intended for a particular region may not have the same configuration name or region revision number as the other switches intended for the same region. The MSTP configuration name (**spanning-tree config-name** command) and MSTP configuration revision number (**spanning-tree config-revision** command) must be identical on all MSTP switches intended for the same region. Another possible cause is that the set of VLANs and VLAN ID-to-MSTI mappings (**spanning-tree instance vlan** command) configured on the switch may not match the set of VLANs and VLAN ID-to-MSTI mappings configured on other switches in the intended region.