4

Multiple Instance Spanning-Tree Operation

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Overview

MSTP Features

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Viewing the MSTP Status and Configuration	n/a	—	page 4-33	—
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Configuring Basic Port Connectivity Parameters	edge-port: No mcheck: Yes hello-time: 2 path-cost: auto point-to-point MAC: Force-True priority: 128 (multiplier: 8)	—	page 4-22 and following	—
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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:

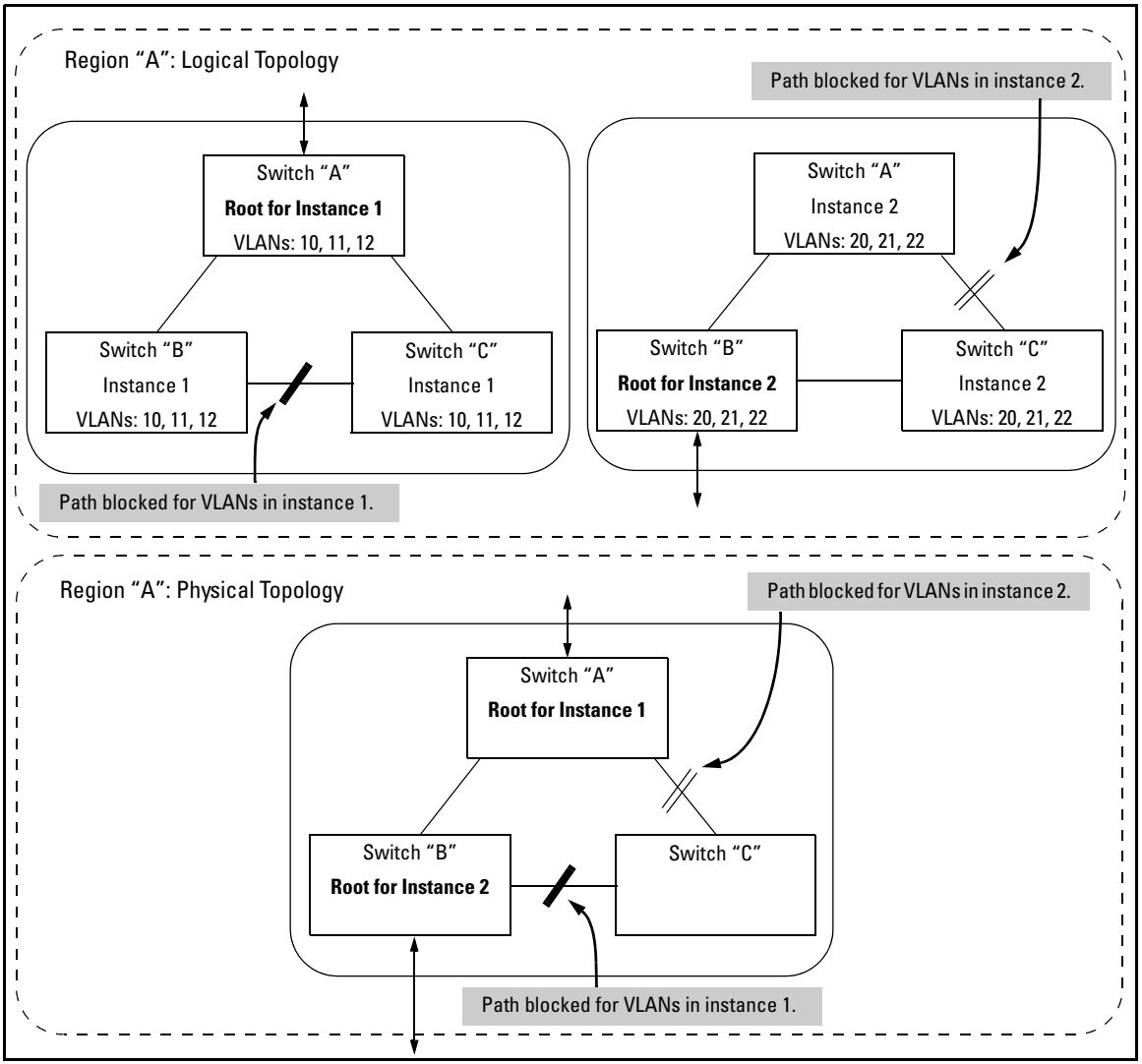

Figure 4-1. Example of a Multiple Spanning-Tree Application

Note on Path Cost

RSTP and MSTP implements a greater range of path costs and new default path cost values to account for higher network speeds. These values are different than the values defined by 802.1D STP as 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.

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.

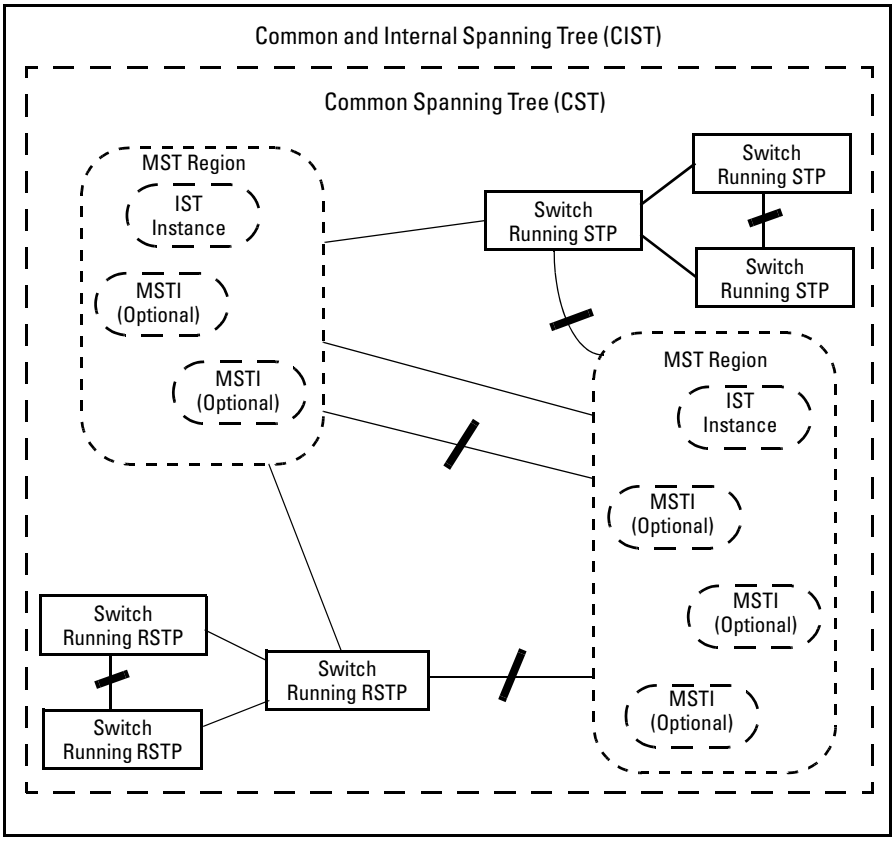

Figure 4-2. Example of MSTP Network with Legacy STP and RSTP Devices Connected

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 and Multiple Spanning Tree Instances (MSTIs).

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”, 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). All VLANs in the IST instance of a region are part of the same, single spanning tree topology, which allows only one forwarding path between any two nodes belonging to any of the VLANs included in the IST instance. All switches in the region must belong to the set of VLANs that comprise 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).
- **MSTI (Multiple Spanning Tree Instance):** 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 4-31.)

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.

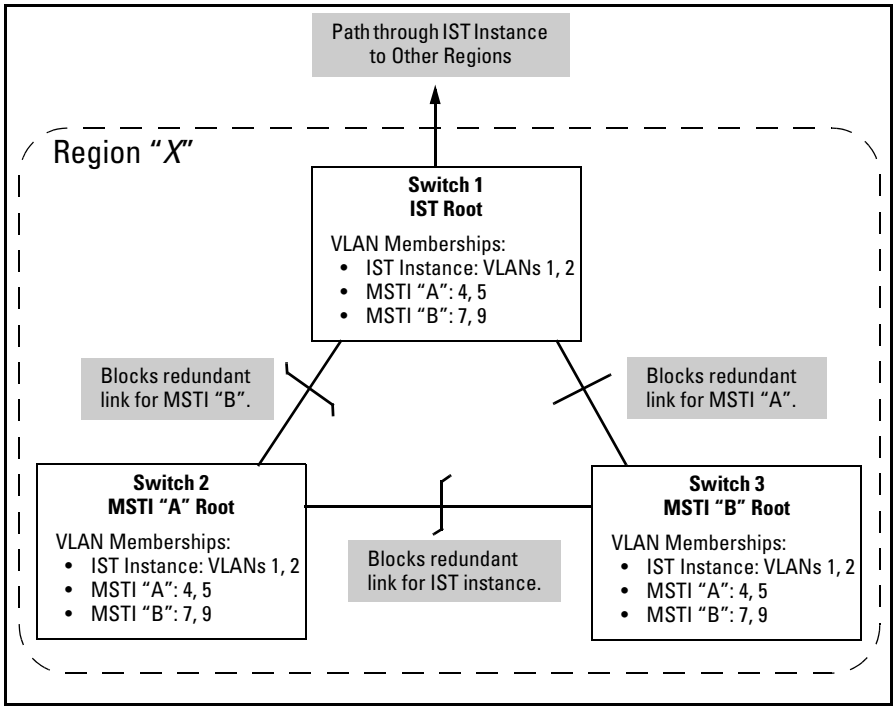

Figure 4-3. Active Topologies Built by Three Independent MST Instances

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.

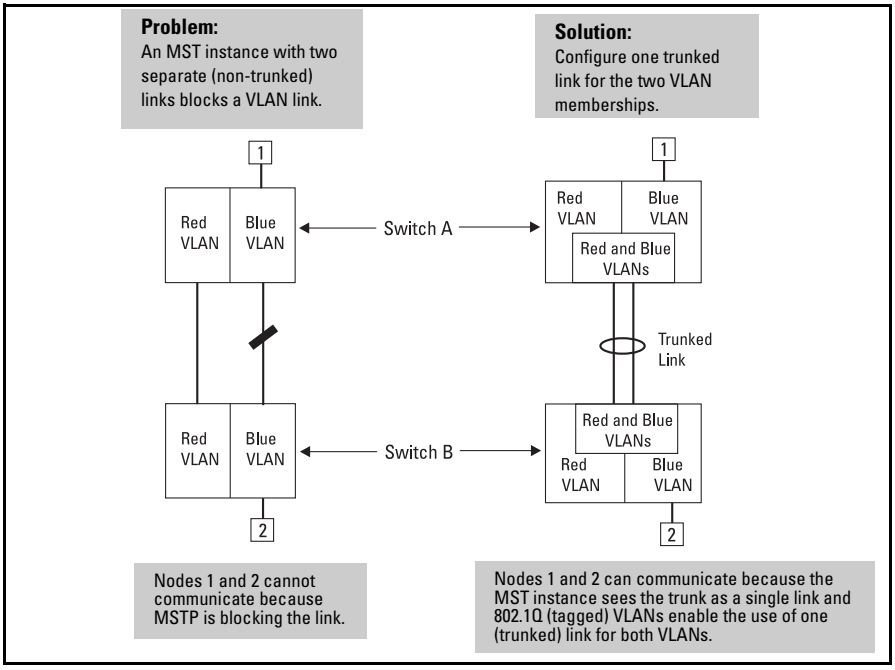

Figure 4-4. Example of Using a Trunked Link To Support Multiple VLAN Connectivity within the Same MST Instance

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

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.

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 and VID-to-IST instance assignments.
- There is one root MST switch per configured MST instance.
- Within any region, the root switch for the IST instance is also the root switch for the region. 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). Note that the per-port **hello-time** parameter assignments on the CIST root switch propagate to the ports on downstream switches in the network and override the **hello-time** configured on the downstream switch ports.
- 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 spanning tree (one physical, communication path) between any two nodes. That is, within an MSTI, there is one instance of spanning tree, 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.
- 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.
- A dynamic VLAN learned by GVRP will always be placed in the IST instance and cannot be moved to any configured MST instance.

Transitioning from STP or RSTP to MSTP

IEEE 802.1s MSTP includes RSTP functionality and is designed to be compatible with both IEEE 802.1D and 802.1w spanning-tree protocols. Even if all the other devices in your network are using STP, you can enable MSTP on the switches covered in this guide. Also, using the default configuration values, your switches will interoperate effectively with STP and RSTP 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.

Because MSTP is so efficient at establishing the network path, ProCurve highly recommends that you update all of the switches covered in this guide to support 802.1s/MSTP. (For switches that do not support 802.1s/MSTP, ProCurve recommends that you update to RSTP to benefit from the convergence times of less than one second under optimal circumstances.) To make the best use of MSTP and achieve the fastest possible convergence times, there are some changes that you should make to the MSTP default configuration.

Note

Under some circumstances, it is possible for the rapid state transitions employed by MSTP and RSTP to result in an increase in the rates of frame duplication and misordering in the switched LAN. In order to allow MSTP and RSTP switches to support applications and protocols that may be sensitive to frame duplication and misordering, setting the Force Protocol Version param-

eter to **STP-compatible** allows MSTP and RSTP to operate with the rapid transitions disabled. The value of this parameter applies to all ports on the switch. See information on **force version** on page 4-21.

As indicated above, one of the benefits of MSTP and RSTP is the implementation of a larger range of port path costs, which accommodates higher network speeds. New default values have also been implemented for the path costs associated with the different network speeds. This can create some incompatibility between devices running the older 802.1D STP and your switch running MSTP or RSTP. Please see the "Note on Path Cost" on page 4-4 for more information on adjusting to this incompatibility.

Tips for Planning an MSTP Application

- 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.
- All ports or trunks connecting one switch to another within a region should be configured 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.)
- 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 4-11.)
- Identify the edge ports connected to end nodes and enable the edge-port setting for these ports. Leave the 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 4-21.

Steps for Configuring MSTP

This section outlines the general steps for configuring MSTP operation in your network, and assumes you have already planned and configured the VLANs you want MSTP to use. The actual MSTP parameter descriptions are in the following sections.

Note

The switch supports MSTP configuration through the CLI.

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. Refer to the "Caution" on page 4-9.
     – The maximum number of hops before the MSTP BPDU is discarded (default: 20)
       spanning-tree max-hops

– Force-Version operation
spanning-tree force-version

– Forward Delay
spanning-tree forward-delay

– Hello Time (used if the switch operates as 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 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

     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.)
   - Configure the priority for each instance.
     spanning-tree instance
3. Configure MST instance port parameters. Enable **edge-port** for ports connected to end nodes (page 4-22), but leave it disabled (the default) for connections to another switch, a bridge, or a hub. Set the path cost value for the port(s) used by a specific MST instance. Leaving this setting at the default auto allows the switch to calculate the path-cost from the link speed.
   spanning-tree instance
4. Enable spanning-tree operation on the switch.
   spanning-tree

Configuring MSTP Operation Mode and Global Parameters

Command	Page
spanning-tree config-name < *ascii-string* >	4-19
spanning-tree config-revision < *revision-number* >	4-20
spanning-tree max-hops < *hop-count* >	4-20
spanning-tree force-version < stp-compatible | rstp-operation | mstp-operation>	4-21
spanning-tree hello-time < 1..10 >	4-21
spanning-tree legacy-mode	4-21
spanning-tree legacy-path-cost	4-21

The commands in this section apply on the switch level, and do not affect individual port configurations.

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 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 force-version < stp-compatible | rstp-operation | mstp-operation >

Sets the spanning-tree compatibility mode. When the switch is configured with MSTP 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.*

This command is available when the protocol version is set to **mstp** *(see 'protocol-version' above).*

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 4-17, 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 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 >** (page 4-22). (*Default:* **2**.)

Syntax spanning-tree legacy-mode

Set spanning tree protocol to operate either in 802.1d legacy mode or in 802.1s native mode.

Syntax spanning-tree legacy-path-cost

Set 802.1d (legacy) or 802.1t (not legacy) default pathcost values.

Configuring Basic Port Connectivity Parameters

Command	Page
spanning-tree < *port-list* >	
edge-port	below
mcheck	below
hello-time < global | 1..10 >	4-23
spanning-tree path-cost < auto | 200000000 >	4-26
spanning-tree point-to-point-mac < force-true | force-false | auto>	4-27
spanning-tree priority <priority-multiplier>	4-27

The basic port connectivity parameters affect spanning-tree links at the global level. 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.

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

[edge-port]

Enable **edge-port** *on ports connected to end nodes. During spanning tree establishment, ports with* **edge-port** *enabled transition immediately to the forwarding state. Disable this feature on any switch port that is connected to another switch, bridge, or hub. (Default:* **No** *- disabled)*

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

[mcheck]

Forces a port to send RSTP BPDUs for 3 seconds. This allows for another switch connected to the port and running RSTP to establish its connection quickly and for identifying switches running 802.1D STP. If the whole-switch force-version parameter is set to stp-compatible, the switch ignores the mcheck setting and sends 802.1D STP BPDUs out all ports. Disable this feature on all ports that are known to be connected to devices that are running 802.1D STP. (Default: **Yes** *- enabled)*

The **no spanning-tree < *port-list* > mcheck** *command disables mcheck.*

Syntax: spanning-tree < *port-list* > < hello-time | path-cost | point-to-point-mac | priority >

[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 4-21). 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***.)*

[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 4-4 for information on compatibility with devices running 802.1D STP for the path cost values (Default: Auto.).

[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.)*

[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. The range is 0 to 240, and is configured by specifying a multiplier in the range of 0 - 15. 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, 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
```

Configuring MST Instance Parameters

Command	Page
[no] spanning-tree instance < 1..16 > vlan < *vid*> [*vid..vid*] no spanning-tree instance < 1..16 >	4-22
spanning-tree instance < 1..16 > priority < 0..15 >	4-25
spanning-tree priority < 0..15 >	4-26

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 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. At least one VLAN must be mapped to a MSTI when you create it. (A VLAN cannot be mapped to more than one instance at a time.) You can create up to 16 MSTIs in a region. The **no** *form of the command deletes the specified VLAN or if no VLANs are specified, the* **no** *form of the command deletes the specified MSTI. (Removing a VLAN from an MSTI returns the VLAN to the IST instance, where it can either remain or be re-assigned to another MSTI configured in the region.)*

The **no** *form of the command deletes the specified VLAN, or if no VLANs are specified, the* **no** *form of the command deletes the specified MSTI.*

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 root bridge in a given instance provides the path to connected instances in other regions that share one or more of the same VLAN(s). (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 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.*

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.*

Configuring MST Instance Per-Port Parameters

Command	Page
spanning-tree instance < 1..16 > < port-list > path-cost < auto | 1..200000000 >	4-28
spanning-tree instance < 1..16 > < *port-list* > priority < *priority-multiplier* >	4-29
spanning-tree < *port-list* > priority < *priority-multiplier* >	4-30

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.

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

Command	Page
spanning-tree pending < apply | config-name | config-revision | instance | reset >	4-32

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 RSTP 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.

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 create the pending region, all VLANs configured on the switch will be assigned to the pending IST instance unless assigned to other, pending MST instances.
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 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). (The **pending** command creates the region's IST instance automatically.)
6. Repeat step 5 for each additional MST instance you want to configure.
7. Use the **show spanning-tree pending** command to review your pending configuration (page 4-39).
8. Use the **spanning-tree pending apply** command to exchange the currently active MSTP configuration with the pending MSTP configuration.

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

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.

9. To view the current pending MSTP configuration, use the **show spanning-tree pending** command (page 4-39).

Displaying MSTP Statistics and Configuration

Command	Page
MSTP Statistics:	
show spanning-tree [< *port-list* >]	below
show spanning-tree instance < ist | 1..16 >	4-35
MSTP Configuration	
show spanning-tree [*port-list*] config	4-36
show spanning-tree [port-list] config instance < ist | 1..16 >	4-37
show spanning-tree mst-config	4-38
show spanning-tree pending< < instance | ist > | mst-config >	4-39

Displaying MSTP Statistics

Displaying Switch Statistics for the Common Spanning Tree. This command displays 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**

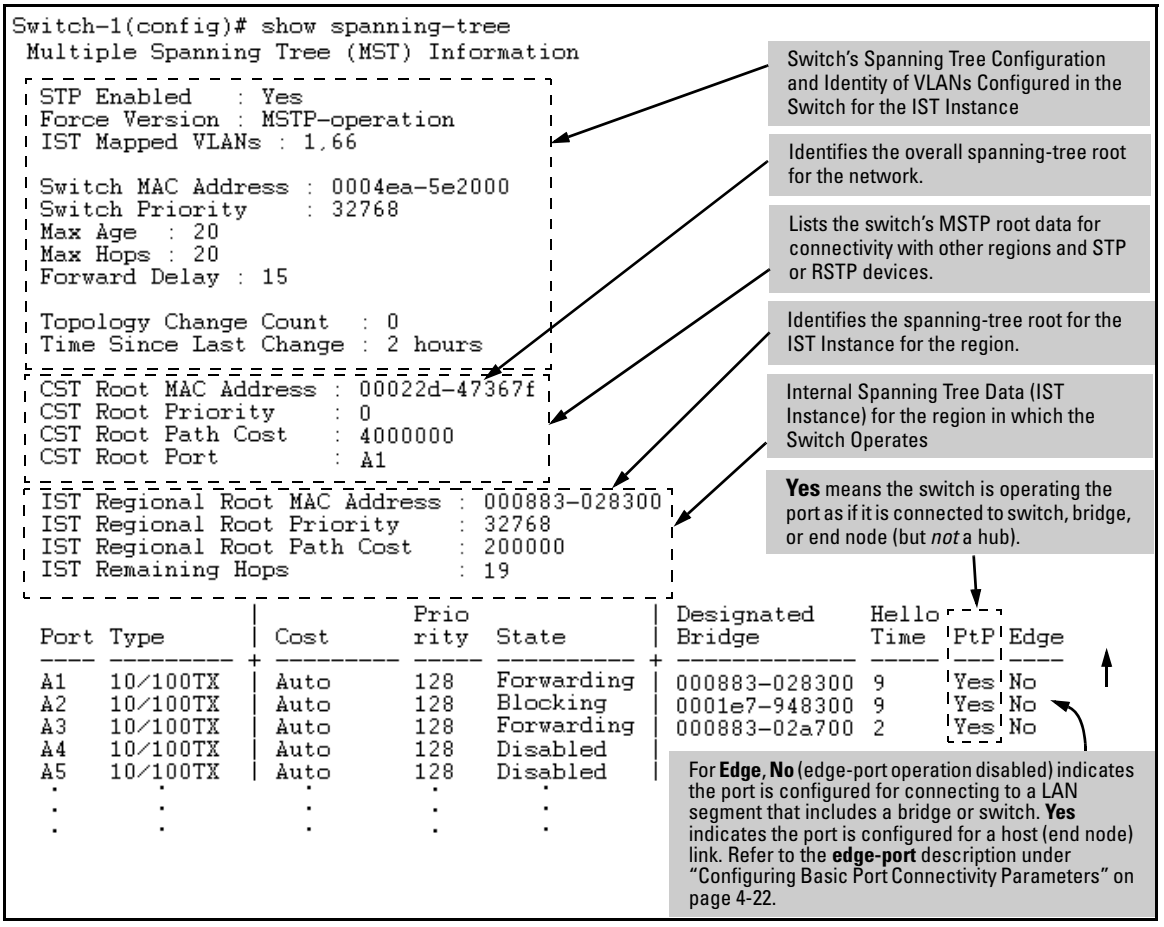

Figure 4-5. Example of Common Spanning Tree Status on an MSTP Switch

Displaying Switch Statistics for a Specific 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.

```
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 4-6. 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 Basic Port Connectivity Parameters" on page 4-22.*

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**

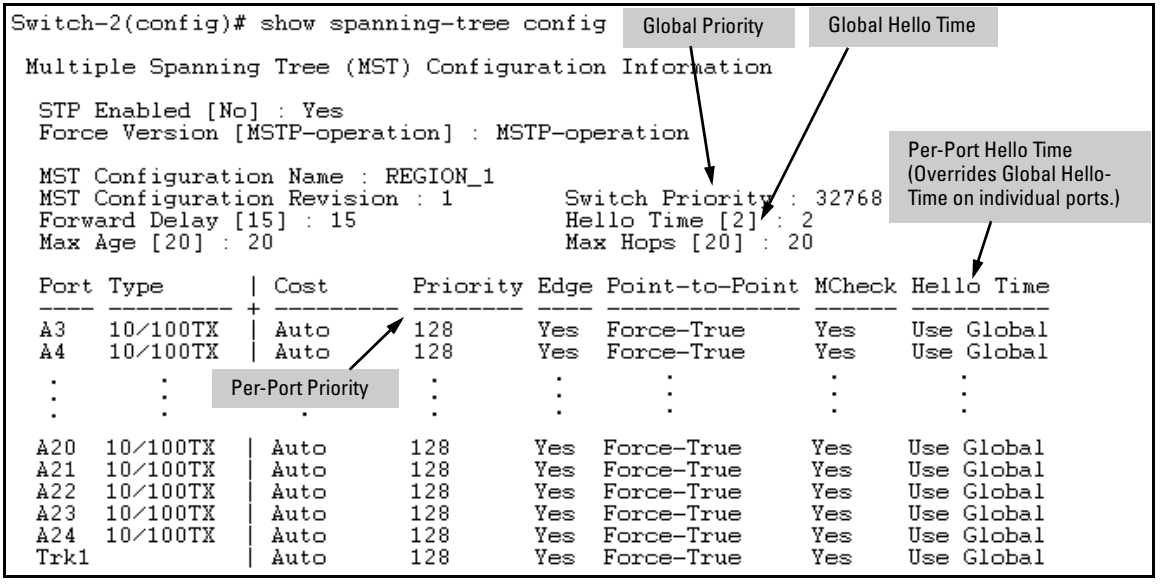

Figure 4-7. Example of Displaying the Switch's Global Spanning-Tree Configuration

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

```
Switch-2(config)# show spanning-tree config instance 1

 MST Instance Configuration Information

  Instance ID : 1                    <-- Instance-Specific Data
  Switch Priority : 32768
  Mapped VLANs : 11,22

  Port Type       | Cost       Priority
  ---- ---------- + ---------- --------
  A3   10/100TX   | Auto       128
  A4   10/100TX   | Auto       128      <-- Port Settings for the
  A5   10/100TX   | Auto       128          specified instance.
   .       .          .          .
   .       .          .          .
   .       .          .          .
  A23  10/100TX   | Auto       128
  A24  10/100TX   | Auto       128
  Trk1            | 100000     128
```

Figure 4-8. 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.*

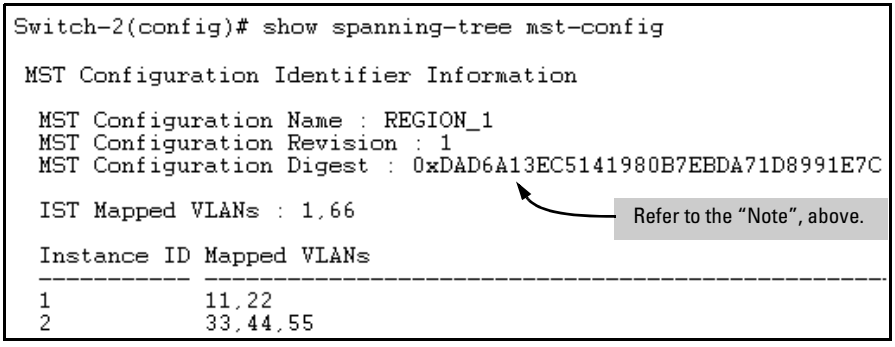

Figure 4-9. Example of a Region-Level Configuration Display

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 4-31.)

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 4-10. Example of Displaying a Pending Configuration

Operating Notes

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.

Troubleshooting

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 Within 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 and MSTP Configuration Revision number must be identical on all MSTP switches intended for the same region. Another possibility is that the set of VLANs configured on the switch may not match the set of VLANs configured on other switches in the intended region.