Sun Ethernet Fabric Operating System PVRST+ Administration Guide

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Contents

Using This Documentation

- **Overview** – Describes the configuration of PVRST+ on a switch running Oracle SEFOS
- **Audience** – Users implementing PVRST+ protocol with other protocols in the router stack
- **Required Knowledge** – Basic knowledge of the PVRST+ protocol

Product Notes

Documentation and resources for this product and related products are available at:

- http://www.oracle.com/goto/es2-72_es2-64/docs
- http://www.oracle.com/goto/ES1-24/docs
- http://www.oracle.com/goto/sn-10gbE-72p/docs
- http://www.oracle.com/goto/sb6k-24p-10gbe/docs

Acronyms and Abbreviations

Acronym or Abbreviation	Explanation
BPDU	Bridge protocol data unit
GVRP	Generic Attribute Registration Protocol VLAN Registration Protocol
ISL	Inter-switch links
LAN	Local area network
MI	Multiple instances
MSTP	Multiple Spanning-Tree Protocol
MST	Multiple spanning tree
PEB	Provider edge-bridge
PVID	Port VLAN ID
PVRST+	Per-VLAN Rapid Spanning Tree Protocol
RSTP	Rapid Spanning-Tree Protocol
SEFOS	Sun Ethernet Fabric Operating System

Acronym or Abbreviation	Explanation
STP	Spanning-Tree Protocol
TC	Topology change
VLAN	Virtual LAN

CLI Command Modes

The following table lists the configuration modes used in this document with their access and exit methods.

Command Mode	Access Method	Prompt	Exit Method
User EXEC	Access SEFOS from Oracle ILOM with read-only rights (privilege level 1).	`SEFOS>`	Use the `logout` or `exit` command to return to the Oracle ILOM prompt.
Privileged EXEC	Access SEFOS from Oracle ILOM with full administrative rights (privilege level 15).	`SEFOS#`	Use the `logout` or `exit` command to return to the Oracle ILOM prompt.
Global Configuration	From User EXEC mode, use the `enable` command.	`SEFOS(config)#`	Use the `end` command to return to Privileged EXEC mode.
Interface Configuration	From Global Configuration mode, use the `interface interface-type interface-id` command.	`SEFOS(config-if)#`	Use the `exit` command to return to Global Configuration mode, or use the `end` command to return to Privileged EXEC mode.

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PVRST+ Overview

This section provides an overview of PVRST+ and describes the PIM protocol.

Protocol Description

PVRST+ is an enhancement of RSTP, which works in conjunction with VLANs to provide better control over traffic in the network. A separate spanning tree is maintained for each active VLAN in the network, providing load balancing through multiple instances of the spanning tree, the fault tolerance (because failure of one spanning tree instance does not affect other spanning trees), and rapid reconfiguration support through the RSTP.

Rapid spanning tree is a link management protocol that provides path redundancy, while preventing undesirable loops in the network, such as multiple active paths between stations. To establish path redundancy, STP creates a tree that spans all of the switches in an extended network, forcing redundant paths into a standby or blocked state.

For an Ethernet network to function properly, only one active path must exist between two stations. Multiple active paths between stations in a bridged network can cause loops in which Ethernet frames can endlessly circulate. STP can logically break such loops and prevent looping traffic from clogging the network. The dynamic control of the topology provides continued network operation in the presence of redundant or unintended looping paths.

Topology Example

This topology is referenced in the descriptions and instructions in this guide.
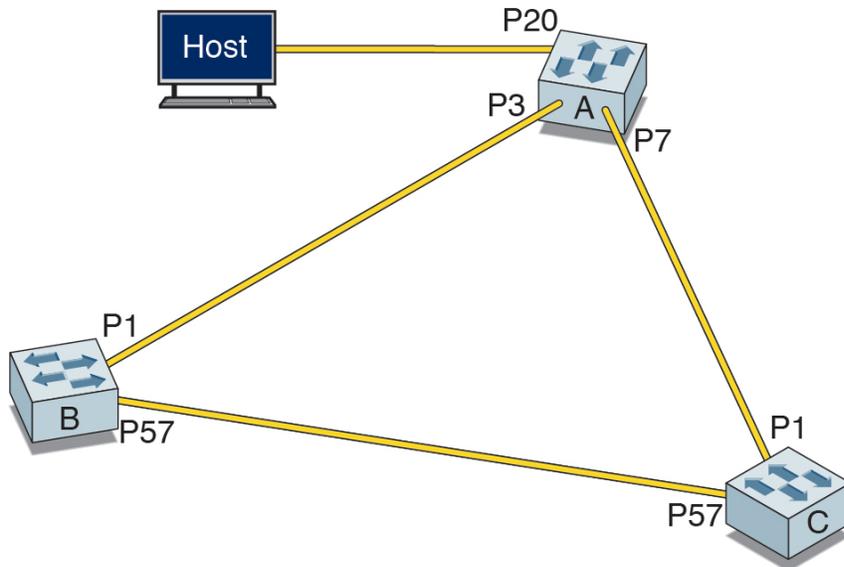
In this configuration, each switch A, B, and C, has two interfaces connected to the other two switches. Switch A has a third interface port 20 (P20) connected to a host. In addition to the default VLAN 1, VLAN 10 and VLAN 20 are used as command examples. The topology includes these details:

Switch	MAC Address	VLAN 10 Address and Mask
A (hostname - NEM-1)	00:14:4f:6c:56:6f	192.168.10.199/255.255.255.0
B (hostname - TOR-1)	00:14:4f:6c:69:ed	192.168.10.144/255.255.255.0
C (hostname - SEFOS-2)	00:14:4f:6c:6e:0d	192.168.10.149/255.255.255.0

Default Settings

When the switch comes up, MSTP is enabled. PVRST+ is started and enabled after GVRP is disabled. This table contains the default settings for the RSTP+ software:

Feature	Default Setting
Spanning-tree mode	MSTP
Spanning-tree status	Enabled
Spanning-tree timers	Hello time: 2 secondsForward-delay time: 15 seconds. Maximum-aging time: 20 seconds.

Feature	Default Setting
Switch priority	32768
STP priority (configurable on a per-interface basis)	128
STP cost (configurable on a per-interface basis)	2000
PVRST module	Disabled
Port type	Hybrid
GVRP	Enabled
VLAN module	Enabled

Rapid STP

The bridge allows interconnection of end stations attached to separate LANs and allows the stations to communicate as if they are attached to a single LAN. The bridge operates below the MAC service boundary and is transparent to the protocols operating above this boundary.

In complex networks, a loop can occur when there are two or more paths between two end points. This situation leads to the duplication of frames, which in turn leads to heavy traffic in the network. To avoid this situation, STP is used. STP forms a logical, loop-free topology from the physical topology and forwards the frames without duplication. To avoid prolonged stabilization time following a reconfiguration event in the spanning tree algorithm, PVRST + provides support for RSTP. The operation of RSTP enables rapid recovery of connectivity following the failure of a bridge, bridge port, or a LAN.

To isolate link fluctuations to a particular VLAN segment and to provide load balancing, PVRST+ creates a separate spanning tree for each VLAN. The spanning-tree-to-VLAN mapping is configured on a per-VLAN basis.

The PVRST+ protocol is an enhancement of RSTP, which works in conjunction with VLAN to provide better control over traffic in the network.

A switch takes the role of either a root or designated switch. STP assigns port roles to the port to calculate the best loop-free path. This list contains the possible roles:

- **Root** - Port that offers the lowest cost path towards the root bridge.
- **Designated** - Forwarding port elected for every switched LAN segment.
- **Alternate** - Blocked port providing an alternate path to the root bridge of the spanning tree.
- **Backup** - Blocked port that acts as a backup for the path provided by a designated port.

These elements determine the stable and active spanning-tree topology of a switched network.

- Bridge ID (instance ID, switch priority, and MAC address)
- Path cost to the root switch maintained for each instance
- Port identifier (port priority and the port number)

- Designated bridge ID (the bridge through which the root bridge is connected)

When switches in a network come up, each switch assumes itself to be the root bridge and starts sending configuration messages through all of its ports. BPDUs are used to communicate and compute the spanning tree topology. The BPDUs contain the following information:

- VLAN ID to which the BPDU belongs
- Unique bridge ID of the switch that has been identified as the root
- Spanning-tree path cost to the root
- Bridge ID of the sending switch
- Message age
- Identifier of the sending interface (port priority and port number)
- Values for the hello, forward-delay, and max-age protocol timers

When a switch receives a superior configuration BPDU on a port, it stores the received information for that port. If the port is a root port, the switch forwards the updated message to all of the attached LANs for which the switch is the designated bridge. If the switch receives an inferior configuration BPDU to the BPDU that is currently stored for that port, the switch discards the BPDU. If the switch is a designated switch for the LAN from which the inferior information was received, then the switch sends up-to-date information stored for that port, discards the inferior information, and propagates the superior information in the network.

Each layer 2 interface in the switch running the per-VLAN rapid spanning tree protocol is in one of these states for each VLAN running on the switch:

- **Blocking** - The interface discards the frames and does not learn the MAC addresses.
- **Listening** - This is the first state in which a port transit resides after the port has been blocked. The interface enters this state when STP decides that the interface must participate in frame forwarding.
- **Learning** - An interface enters this state from the listening state. The interface gets ready to participate in frame forwarding and learns MAC addresses from the received packets.
- **Forwarding** - The interface receives frames on the port and forwards the frames switched from another port. The transition from blocking to forwarding takes 30 seconds.

These sections describe switch priorities and election, port states and roles, rapid convergence, proposal agreement and how to detect topology change.

Bridge ID and Switch Priority

Each switch has a unique bridge identifier (bridge ID), that determines the selection of the root switch. The bridge ID is an 8-byte field that is composed of two sub fields:

2-Byte Bridge Priority Field		6-Byte MAC Address
Priority	VLAN ID	MAC Address

The value for the priority ranges from 0 to 61440 in steps of 4096. The default value for the priority is 32768. The VLAN ID ranges from 1 to 4096.

Election of the Root Switch

All of the switches in the layer 2 network, participating in STP, gather information on other switches in the network through an exchange of BPDUs. The exchange of messages results in these actions:

- Election of a unique root switch for each spanning tree instance
- Election of a designated switch for every switched LAN segment
- Removal of loops in the switched network by blocking layer 2 interfaces connected to redundant links

The switch with the highest switch priority (the lowest numerical priority value) is elected as the root switch. If all of the switches are configured with the default priority (32768) for a VLAN with ID 1 (that is, a bridge priority of 32769), then the switch with the lowest MAC address becomes the root switch. The switch priority value occupies the most significant bits of the bridge ID. The root switch is the logical center of the STP topology in a switched network. Redundant paths to the root are put in STP blocking mode.

BPDUs contain information about the sending switch and its ports. The information includes switch and port MAC addresses, switch priority, port priority, and path cost. The STP uses this information to elect the root switch, the root port for the switched network, the root port, and the designated port for each switched segment.

Port States

This table contains the port states for RSTP:

STP (802.1w) Port State	RSTP Port State	Port Included in Active Topology?	Port Learning MAC Address
Disabled	Discarding	No	No
Blocking	Discarding	No	No
Listening	Discarding	No	No
Learning	Learning	No	Yes
Forwarding	Forwarding	Yes	Yes

Port Roles

The following table contains the port roles for RSTP:

Port Role	Description
Root	Provides the best path to the root. This is the port that receives the best BPDU on a bridge.
Designated	Can send the best BPDU on a segment to which it is connected. Bridges connected to a given segment listen to the BPDUs of other bridges and agree on the bridge sending the best BPDU as the designated bridge for that segment and the port as the designated port.
Alternate	Blocked because another port on the bridge received superior information from another bridge. This port corresponds to the blocking state of 802.1w.
Back-up	Blocked because another port received superior information from the same bridge. This port also corresponds to the blocking state of 802.1w.

A port with the root or a designated port role is included in the active topology. A port with the alternate or backup port is excluded from the active topology.

Rapid Convergence

Faster convergence compared to legacy spanning tree algorithm is the most important feature in RSTP. RSTP relies on two new variables to achieve this situation:

- **Edge port** - Ports that are directly connected to end stations do not create bridging loops. Thus, they rapidly transition to forwarding, skipping the learning and listening states. The topology change is not triggered when the link toggles on an edge port. Whenever a BPDU is received on an edge port, it loses its edge-port status and becomes a normal spanning tree port. PVRST+ uses the portfast keyword for edge-port configuration.
- **Link types** - PVRST+ achieves rapid transition on point-to-point links. The link type is automatically derived from the duplex mode of a port. A port operating in full-duplex

is assumed to be point-to-point, but a half-duplex port is considered as a shared port by default. This automatic link type setting can be overridden by explicit configuration.

Proposal Agreement Sequence

In the spanning tree algorithm, a port selected as a designated port waits two times the fwd-delay rate (that is, 2 x 15 seconds) before transitioning to the forwarding state. In the PVRST+ software, this port corresponds to a designated role and blocking state. This illustration shows the rapid transition of a port to forwarding state.
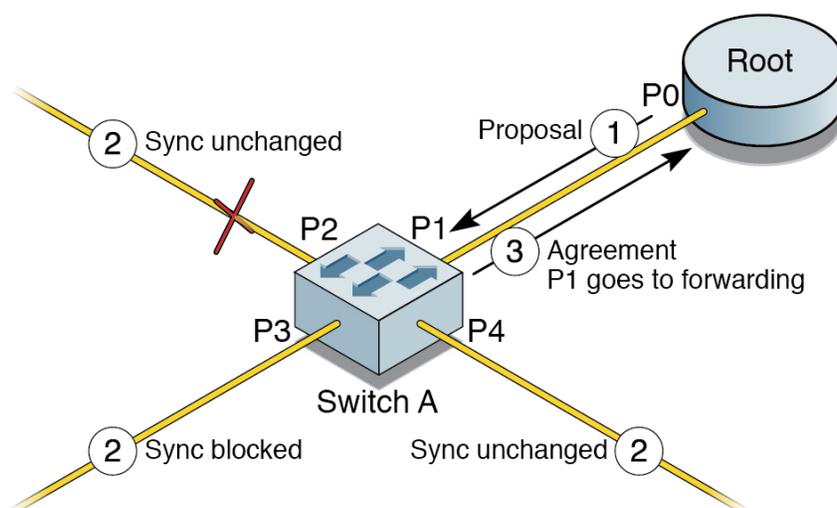
In the illustration, P0 is a designated port, P1 is the new root port, P2 is an alternate port, P3 is a designated port, and P4 is an edge port. If a new link is created between the root and switch A, then both ports on the link are put in the designated blocking state until the ports receive a BPDU from their counterparts. When a designated port is in discarding or learning state (and only in this state), it sets a proposal bit on the BPDUs it sends out. This situation occurs for port P0 of the root bridge, as shown in Step 1 of the illustration. Because switch A receives superior information, it immediately knows that P1 will be its new root port. Switch A then starts a sync operation to ensure that all of its ports are in-sync with this new information. A port is in-sync if it meets either of these criteria:

- Port is in blocking state
- Port is an edge port

If an alternate port (P2), a designated forwarding port (P3), and an edge port (P4) already exist on switch A, then P2 and P4 already meet one of the listed criteria. To be in-sync, switch A blocks port P3 by assigning the discarding state to the port. If all of the ports are in-sync, switch

A unblocks its newly selected root port (P1) and replies to the root by sending an agreement message (Step 3). This message is a copy of the proposal BPDU with the agreement bit set instead of the proposal bit. Thus, when port P0 receives the agreement, the port knows exactly to which proposal the agreement corresponds.

When P0 receives the agreement, it immediately transits to the forwarding state. In Step 3, port P3, which was left in a designated discarding state after the sync, is in the exact same state as port P0 was in Step 1. Port P3 then starts proposing to its neighbor to quickly transit to forwarding. The handshake mechanism propagates quickly towards the edge of the network, quickly restoring connectivity after a change in the topology.

Topology Change and Topology Change Detection

When an 802.1D bridge detects a topology change, it first notifies the root bridge using a reliable mechanism. After the root bridge is aware of a change in the topology of the network, it sets the TC flag on the BPDUs it sends out. The BPDUs are then relayed to all of the bridges in the network. When a bridge receives a BPDU with the TC-flag bit set, it reduces its bridging-table aging time to forward delay seconds, ensuring a relatively quick flushing of any stale information.

In RSTP, only non edge ports moving to the forwarding state cause a topology change. Thus, a loss of connectivity is not considered as a topology change any more, contrary to 802.1D (that is, a port moving to the blocking state no longer generates a TC). When an RSTP bridge detects a topology change, the following happens:

- The bridge starts the TC-while timer with a value equal to twice the hello time for all of its non-edge designated ports and its root port, if necessary.
- It flushes the MAC addresses associated with all of the non-edge designated ports.
- As long as the TC-while timer is running on a port, the BPDUs sent out have the TC bit set. The BPDUs are also sent on the root port while the timer is active.

VLAN Module

To make the PVRST+ module completely operational, you must configure the VLAN module. A VLAN is a network of computers that behave as if they are connected to the same wire even though they are physically located on different segments of a LAN. VLANs are configured through software rather than hardware, which make them extremely flexible. One of the biggest advantages of VLANs is that when a computer is physically moved to another location, the computer can stay on the same VLAN without any hardware reconfiguration.

For VLAN information to be passed between switches, trunking must be configured between the switches. VLAN trunking allows a port to pass traffic from multiple VLANs between the two switches. Frames traveling over a trunk are tagged to identify to which VLAN the

frames belong. When implementing trunking between switches, the ports at either end of the connection is set up for trunk mode and the trunk encapsulation mode must match.

Note - The current release of PVRST+ does not support GVRP.

To configure the VLAN module when the spanning tree mode is set to PVRST+, you must:

1. Disable the GVRP module.
2. Create all VLANs on each switch in the network, as dynamic VLAN learning (GVRP) is not supported.
3. Configure the ports as a trunk or access port.
4. Restart PVRST+ in the case of multiple instances of VLANs after you have mapped the ports to any context in MST mode.

These configuration guidelines must be met:

- A port that is an untagged member of a VLAN cannot be configured as a trunk port.
- An access port must become a member of the VLAN that is configured as PVID.
- Port membership is not allowed in the PVRST+ software. The port becomes a member of a VLAN only after you configure the port as a trunk or access port.
- Because explicit VLAN member port configurations are not encouraged in PVRST+ mode, you should explicitly configured ports as access or trunk to ensure that they are assigned to different VLANs.
- The port configured as trunk automatically becomes a member port for all VLANs created on the switch.

Configuring RSTP in PVRST+

The RSTP used in the PVRST+ module is based on the IEEE 802.1w rapid reconfiguration. The existing STP takes significant time to reconfigure and to restore the service on link failure or restoration. RSTP avoids reconvergence delay by calculating an alternate root port and immediately switching over to the alternate port if the root port becomes unavailable.

This section contains procedures for configuring RSTP in the PVRST+ software. Throughout this chapter the instructions use, "Topology Example" on page 9.

- "Enable IPv6 Support and Assign IPv6 Addresses" on page 19
- "Configure the Spanning-Tree Path Cost" on page 24
- "Configure the Spanning Tree Link Type" on page 26
- "Configure the Spanning-Tree `portfast` Setting" on page 27
- "Configure Spanning Tree Timers" on page 29
- "Display the Spanning Tree Status" on page 31
- "Configure the Transmit Hold Count" on page 38
- "Configure Encapsulation" on page 39
- "Configure the BPDU Guard" on page 40
- "Configure the Root Guard" on page 41

▼ Enable IPv6 Support and Assign IPv6 Addresses

Before you execute the following instructions, ensure that all of the switches are in their default configuration. Also, disable GVRP, and start and enable PVRST+ on all switches. In the default configuration, vlan 1 is the default VLAN. If you plan to use another VLAN ID as the default VLAN, you must configure and enable the VLAN ID.

In the following examples, ports are configured as trunk, and vlan 10 is enabled on all three switches. vlan 10 is also used to show spanning tree status on switch C. See "VLAN Module" on page 16 for information about configuring the VLAN module.

After the topology stabilizes, switch A is elected as the root because it has the lowest MAC address. All ports on all switches, except port 57 on switch C, should be in forwarding state. Port 57 on switch C should be detected as an alternate port in the discarding state.

Complete the following task on all three switches before setting the priority on switch C for the STP. Note that the following examples are run on switch C and similar commands must be run on switches A and B as well.

1. **Enter the configuration mode.**

    ```
    SEFOS-2 SEFOS# configure terminal
    SEFOS-2 SEFOS(config)#
    ```

2. **Disable the GVRP module.**

    ```
    SEFOS-2 SEFOS(config)# set gvrp disable
    SEFOS-2 SEFOS(config)#
    ```

3. **Enable VLAN 10.**

    ```
    SEFOS-2 SEFOS(config)# vlan 10
    SEFOS-2 SEFOS(config-vlan)# vlan active
    SEFOS-2 SEFOS(config-vlan)# exit
    SEFOS-2 SEFOS(config)#
    ```

4. **Configure and bring up port 1 and port 57 as trunk.**

    ```
    SEFOS-2 SEFOS(config)# interface extreme-ethernet 0/1
    SEFOS-2 SEFOS(config-if)# switchport mode trunk
    SEFOS-2 SEFOS(config-if)# no shutdown
    SEFOS-2 SEFOS(config-if)# exit
    SEFOS-2 SEFOS(config)#
    SEFOS-2 SEFOS(config)# interface extreme-ethernet 0/57
    SEFOS-2 SEFOS(config-if)# switchport mode trunk
    SEFOS-2 SEFOS(config-if)# no shutdown
    SEFOS-2 SEFOS(config-if)# exit
    SEFOS-2 SEFOS(config)#
    ```

5. **Configure IP address and mask for VLAN 10.**

    ```
    SEFOS-2 SEFOS(config)# interface vlan 10
    SEFOS-2 SEFOS(config-if)# shutdown
    SEFOS-2 SEFOS(config-if)# ip address 192.168.10.149 255.255.255.0
    SEFOS-2 SEFOS(config-if)# no shutdown
    SEFOS-2 SEFOS(config-if)# end
    SEFOS-2 SEFOS#
    ```

6. **Repeat Steps 1 - 5 on switches A and B with their own port numbers, IP addresses, and masks.**

7. **After all three switches are properly configured and the spanning tree topology is stabilized, display the spanning tree information for VLAN 10 on switch C.**

    Port 57 should be in discarding state.

    ```
    SEFOS-2 SEFOS# show spanning-tree vlan 10

    ----------------------------------------------------------------

    Spanning-tree for VLAN 10
    Root Id       Priority   32778
                  Address    00:14:4f:6c:56:6f
                  Cost       2000
                  Port       Ex0/1
                  Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

    Spanning Tree Enabled Protocol PVRST
    Bridge Id       Priority 32778
                    Address 00:14:4f:6c:6e:0d
                    Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
    Name     Role         State       Cost    Prio   Type
    ----     ----         -----       ----    ----   ------
    Ex0/1    Root         Forwarding  2000    128    P2P
    Ex0/57   Alternate    Discarding  2000    128    P2P

    SEFOS-2 SEFOS#
    ```

8. **Ping the `VLAN 10` IP address of switch A or B from C.**

    ```
    SEFOS-2 SEFOS# ping 192.168.10.199
    Reply Received From :192.168.10.199, TimeTaken : 160 msecs
    Reply Received From :192.168.10.199, TimeTaken : 110 msecs
    Reply Received From :192.168.10.199, TimeTaken : 90 msecs

    --- 192.168.10.199 Ping Statistics ---
    3 Packets Transmitted, 3 Packets Received, 0% Packets Loss
    SEFOS-2 SEFOS#

    SEFOS-2 SEFOS# ping 192.168.10.144
    Reply Received From :192.168.10.144, TimeTaken : 100 msecs
    Reply Received From :192.168.10.144, TimeTaken : 100 msecs
    Reply Received From :192.168.10.144, TimeTaken : 110 msecs

    --- 192.168.10.144 Ping Statistics ---
    3 Packets Transmitted, 3 Packets Received, 0% Packets Loss
    SEFOS-2 SEFOS#
    ```

9. **To display the effect of the bridge priority on the port spanning tree state, in switch C, set the priority for the STP.**

    ```
    SEFOS-2 SEFOS# configure terminal
    ```

```
SEFOS-2 SEFOS(config)# spanning-tree vlan 10 brg-priority 4096
SEFOS-2 SEFOS(config)# end
SEFOS-2 SEFOS#
```

In the PVRST+ software, the spanning-tree parameters apply only to the specified VLAN.

For `brg-priority`, you can provide a value from 0 to 61440 in increments of 4096. The priority you provide is combined with the VLAN ID to obtain the actual priority for the instance created for the VLAN. If you do not specify a value, the VLAN ID is combined with a default value of 32768. If the combined number is lower than the other switches, the more likely it is that the switch will be chosen as the root switch.

Valid priority values are: 0, 4096, 8192, 12288, 16384, 20480, 24576, 28672, 32768, 36864, 40960, 45056, 49152, 53248, 57344, and 61440.

Note - After you configure the bridge priority, you should confirm that switch C has been detected as the root and that port 1 of switch B is the alternate port.

---

10. **In switch A, review the spanning-tree information.**

```
NEM-1 SEFOS# show spanning-tree vlan 10

------------------------------------------------------------------
Spanning-tree for VLAN 10
Root Id         Priority   4106
                Address    00:14:4f:6c:6e:0d
                Cost       2000
                Port       Ex0/7
                Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32778
                Address 00:14:4f:6c:56:6f
                Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name      Role         State       Cost    Prio   Type
----      ----         -----       ----    ----   ------
Ex0/3     Designated   Forwarding  2000    128    P2P
Ex0/7     Root         Forwarding  2000    128    P2P
Ex0/20    Designated   Forwarding  2000    128    P2P
NEM-1 SEFOS#
```

11. **In switch B, review the spanning-tree information.**

```
TOR-1 SEFOS# show spanning-tree vlan 10

------------------------------------------------------------------
Spanning-tree for VLAN 10
Root Id         Priority   4106
                Address    00:14:4f:6c:6e:0d
                Cost       2000
```

```
                    Port        Ex0/57
                    Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

    Spanning Tree Enabled Protocol PVRST
    Bridge Id       Priority 32778
                    Address 00:14:4f:6c:69:ed
                    Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
    Name      Role         State       Cost    Prio   Type
    ----      ----         -----       ----    ----   ------
    Ex0/1     Alternate    Discarding  2000    128    P2P
    Ex0/57    Root         Forwarding  2000    128    P2P

    TOR-1 SEFOS#
```

12.   In switch C, review the spanning-tree information.

```
    SEFOS-2 SEFOS# show spanning-tree vlan 10

    -------------------------------------------------------------------
    Spanning-tree for VLAN 10

    We are the root of the Spanning Tree
    Root Id         Priority   4106
                    Address    00:14:4f:6c:6e:0d
                    Cost       0
                    Port       0
                    Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec
    Spanning Tree Enabled Protocol PVRST
    Bridge Id       Priority 4106
                    Address 00:14:4f:6c:6e:0d
                    Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
    Name      Role         State       Cost    Prio   Type
    ----      ----         -----       ----    ----   ------
    Ex0/1     Designated   Forwarding  2000    128    P2P
    Ex0/57    Designated   Forwarding  2000    128    P2P

    SEFOS-2 SEFOS#
```

13.   In switch C, reset the priority to the default value. Switch A should be reelected as root again.

```
    SEFOS-2 SEFOS# configure terminal
    SEFOS-2 SEFOS(config)# no spanning-tree vlan 10 brg-priority
    SEFOS-2 SEFOS(config)# end
    SEFOS-2 SEFOS#
```

14.   In switch A, review the spanning-tree information (it shows switch A is a root again).

```
    NEM-1 SEFOS# show spanning-tree vlan 10
```

```
-----------------------------------------------------------------
Spanning-tree for VLAN 10
We are the root of the Spanning Tree

Root Id         Priority    32778
                Address     00:14:4f:6c:56:6f
                Cost        0
                Port        0
                Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec


Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32778
                Address 00:14:4f:6c:56:6f
                Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name      Role          State        Cost     Prio   Type
----      ----          -----        ----     ----   ------
Ex0/3     Designated    Forwarding   2000     128    P2P
Ex0/7     Designated    Forwarding   2000     128    P2P
Ex0/20    Designated    Forwarding   2000     128    P2P

NEM-1 SEFOS#
```

▼ Configure the Spanning-Tree Path Cost

When a loop occurs in the network topology, STP uses path cost to determine the spanning-tree states of the ports. Path cost is obtained from the speed of the interface. You can configure a lower path cost for an interface if the port needs to be selected first, or you can configure a higher path cost if the port needs to be selected last to configure it to the forwarding state. The path cost is used to determine the topology only if the loop in the network cannot be resolved using only the bridge IDs. If all of the ports have the same path cost values, then the spanning tree puts the lowest numbered port into forwarding state.

See for details on the topology that is referenced in the following procedure. After the topology stabilizes and switch A is elected as the root, the ports on all of the switches, except port 57 of switch C, should be in the forwarding state. Port 57 of switch C should be an alternate port and in the discarding state.

1. **In switch C, specify the interface on which the path cost is to be configured.**

```
SEFOS-2 SEFOS# configure terminal
SEFOS-2 SEFOS(config)# interface extreme-ethernet 0/1
SEFOS-2 SEFOS(config-if)#
```

Valid interfaces include physical interfaces and port-channel logical interfaces (`port-channel` *port_channel_number*).

2. **Configure the cost for the interface (2000 in this example).**

```
SEFOS-2 SEFOS(config-if)# spanning-tree vlan 10 cost 2000

Pvrst Vlan Cost is set

SEFOS-2 SEFOS(config-if)# end
SEFOS-2 SEFOS#
```

For `cost`, the range is 0 to 200000. The default value is derived from the media speed of the interface.

Note - After you configure the path cost for port 1 in switch C, you should observe that port 57 of switch B is the alternate port, and that port 57 of switch C is a designated port.

---

3. **In switch B, review the spanning tree information.**

```
TOR-1 SEFOS# show spanning-tree vlan 10

----------------------------------------------------------------------
Spanning-tree for VLAN 10
Root Id         Priority   32778
                Address    00:14:4f:6c:56:6f
                Cost       2000
                Port       Ex0/1
                Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32778
                Address 00:14:4f:6c:69:ed
                Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name    Role         State       Cost    Prio   Type
----    ----         -----       ----    ----   ------
Ex0/1   Root         Forwarding  2000    128    P2P
Ex0/57  Alternate    Discarding  2000    128    P2P
TOR-1 SEFOS#
```

4. **In switch C, review the spanning tree information.**

```
SEFOS-2 SEFOS# show spanning-tree vlan 10

----------------------------------------------------------------------
Spanning-tree for VLAN 10
Root Id         Priority   32778
                Address    00:14:4f:6c:56:6f
                Cost       200
                Port       Ex0/1
                Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32778
```

```
                    Address 00:14:4f:6c:6e:0d
                    Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
         Name      Role         State       Cost     Prio   Type
         ----      ----         -----       ----     ----   ------
         Ex0/1     Root         Forwarding  200      128    P2P
         Ex0/57    Designated   Forwarding  2000     128    P2P

         SEFOS-2 SEFOS#
```

5.   In switch C, reset the default value of the spanning-tree path cost.

```
         SEFOS-2 SEFOS# configure terminal
         SEFOS-2 SEFOS(config)# interface extreme-ethernet 0/1
         SEFOS-2 SEFOS(config-if)# no spanning-tree vlan 10 cost
         Pvrst Vlan Cost is set
         SEFOS-2 SEFOS(config-if)# end
         SEFOS-2 SEFOS#
```

6.   In switch C, view the spanning tree information on `VLAN 10`.
Port 57 should be in discarding state again.

```
         SEFOS-2 SEFOS# show spanning-tree vlan 10

         -------------------------------------------------------------------
         Spanning-tree for VLAN 10
         Root Id         Priority   32778
                         Address    00:14:4f:6c:56:6f
                         Cost       2000
                         Port       Ex0/1
                         Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec


         Spanning Tree Enabled Protocol PVRST
         Bridge Id       Priority 32778
                         Address 00:14:4f:6c:6e:0d
                         Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
         Name      Role         State       Cost     Prio   Type
         ----      ----         -----       ----     ----   ------
         Ex0/1     Root         Forwarding  2000     128    P2P
         Ex0/57    Alternate    Discarding  2000     128    P2P

         SEFOS-2 SEFOS#
```

▼ Configure the Spanning Tree Link Type

If a port is configured as a point-to-point link and its port role is designated, then PVRST+ negotiates a rapid transition to the forwarding state with the other port by using a proposal-handshake agreement mechanism to ensure that the topology is loop free. By default, if the interface is full-duplex, then it is considered to have a point-to-point connection. The default setting of link type can be overridden to enable rapid transition to the forwarding state.

1. **In switch C, specify the interface for which the link type is to be configured.**

```
SEFOS-2 SEFOS# configure terminal
SEFOS-2 SEFOS(config)# interface extreme-ethernet 0/1
```

Valid interfaces include physical interfaces and port-channel logical interfaces (`port-channel` *port_channel_number*).

2. **Configure the link type of the interface as point-to-point.**

```
SEFOS-2 SEFOS(config-if)# spanning-tree link-type point-to-point
SEFOS-2 SEFOS(config-if)# end
```

3. **Review the spanning tree properties.**

```
SEFOS-2 SEFOS# show spanning-tree vlan 10

--------------------------------------------------------------------
Spanning-tree for VLAN 10
Root Id        Priority   32778
               Address    00:14:4f:6c:56:6f
               Cost       2000
               Port       Ex0/1
               Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec
Spanning Tree Enabled Protocol PVRST
Bridge Id      Priority 32778
               Address 00:14:4f:6c:6e:0d
               Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name     Role        State       Cost    Prio   Type
----     ----        -----       ----    ----   ------
Ex0/1    Root        Forwarding  2000    128    P2P
Ex0/57   Alternate   Discarding  2000    128    P2P

SEFOS-2 SEFOS#
```

4. **Reset the default link type for the interface.**

```
SEFOS-2 SEFOS# configure terminal
SEFOS-2 SEFOS(config)# interface extreme-ethernet 0/1
SEFOS-2 SEFOS(config-if)# no spanning-tree link-type
SEFOS-2 SEFOS(config-if)# end
SEFOS-2 SEFOS#
```

▼ Configure the Spanning-Tree `portfast` Setting

Any port that is directly connected to an end station cannot create bridging loops. Therefore, the port can rapidly transition to the forwarding state by skipping the learning and listening states.

To enable immediate transition into the forwarding state, you can enable the STP `portfast` feature. The `portfast` feature immediately transitions the port into STP forwarding mode upon link-up. The port still participates in STP, so if the port is to be a part of the loop, the port eventually transitions into STP blocking mode.

In switch A, run the following commands as port 20 is connected to a host.

1. **Enter the configuration mode for the interface.**

```
NEM-1 SEFOS# configure terminal
NEM-1 SEFOS(config)# interface extreme-ethernet 0/20
NEM-1 SEFOS(config-if)#
```

Valid interfaces include physical interfaces and port-channel logical interfaces (`port-channel` *port_channel_number*).

2. **Shut down the interface.**

```
NEM-1 SEFOS(config-if)# shutdown
NEM-1 SEFOS(config-if)#
```

3. **Change the `portfast` setting.**

```
NEM-1 SEFOS(config-if)# spanning-tree portfast

Warning: portfast should only be enabled on ports connected to a single host. Connecting hubs,
 concentrators, switches, bridges, etc... to this interface when portfast is enabled, can
 cause temporary bridging loops.
Use with CAUTION

NEM-1 SEFOS(config-if)# no shutdown
NEM-1 SEFOS(config-if)# end
NEM-1 SEFOS#
```

4. **Review the `portfast` status.**

```
NEM-1 SEFOS# show spanning-tree interface extreme-ethernet 0/20 portfast

spanning-tree portfast is Enabled
NEM-1 SEFOS#
```

5. **Reset the default spanning tree `portfast` value for the interface.**

```
NEM-1 SEFOS# configure terminal
NEM-1 SEFOS(config)# interface extreme-ethernet 0/20
NEM-1 SEFOS(config-if)# no spanning-tree portfast
```

```
Warning:Portfast has been configured on this port but will have effect only when the interface
 is shutdown

NEM-1 SEFOS(config-if)# end
NEM-1 SEFOS#
```

6. **Review the `portfast` status.**

```
NEM-1 SEFOS# show spanning-tree interface extreme-ethernet 0/20 portfast

spanning-tree portfast is Disabled

NEM-1 SEFOS#
```

▼ Configure Spanning Tree Timers

Configure these variables:

Variable	Description
forward-time	Controls how fast a port changes its spanning tree state from blocking to forwarding.
hello-time	Determines how often the switch broadcasts its hello message to other switches. If a bridge is the root bridge for a topology, then all of the bridges in that topology use the value of the hello time from the root bridge to broadcast their hello message.
max-age	Controls the maximum time for the STP information to be retained before it is discarded.

1. **Configure the spanning tree timer (11 in this example).**

```
NEM-1 SEFOS# configure terminal
NEM-1 SEFOS(config)# spanning-tree vlan 10 forward-time 11

Forward Time for the given instance is set

NEM-1 SEFOS(config)# end
NEM-1 SEFOS#
```

The forward-time range is 4 to 30 seconds. The default value is 15 seconds.

2. **Review the spanning tree properties.**

```
NEM-1 SEFOS# show spanning-tree vlan 10

-------------------------------------------------------------------
Spanning-tree for VLAN 10
```

```
We are the root of the Spanning Tree
Root Id          Priority   32778
                 Address    00:14:4f:6c:56:6f
                 Cost       0
                 Port       0
                 Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 11 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id        Priority 32778
                 Address 00:14:4f:6c:56:6f
                 Hello Time 2 sec, Max Age 20 sec, Forward Delay 11 sec
Name     Role           State       Cost     Prio   Type
----     ----           -----       ----     ----   ------
Ex0/3    Designated     Forwarding  2000     128    P2P
Ex0/7    Designated     Forwarding  2000     128    P2P
Ex0/20   Designated     Forwarding  2000     128    P2P

NEM-1 SEFOS#
```

3.   Reset the spanning tree timer to its default value.

```
NEM-1 SEFOS# configure terminal
NEM-1 SEFOS(config)# no spanning-tree vlan 10 forward-time

Forward Time for the given instance is set

NEM-1 SEFOS(config)# end
NEM-1 SEFOS#
```

4.   Reviewing the spanning tree properties after resetting the forward timer to the default.

```
NEM-1 SEFOS# show spanning-tree vlan 10

--------------------------------------------------------------------
Spanning-tree for VLAN 10

We are the root of the Spanning Tree
Root Id          Priority   32778
                 Address    00:14:4f:6c:56:6f
                 Cost       0
                 Port       0
                 Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec
Spanning Tree Enabled Protocol PVRST
Bridge Id        Priority 32778
                 Address 00:14:4f:6c:56:6f
                 Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name     Role           State       Cost     Prio   Type
----     ----           -----       ----     ----   ------
Ex0/3    Designated     Forwarding  2000     128    P2P
Ex0/7    Designated     Forwarding  2000     128    P2P
```

```
Ex0/20   Designated   Forwarding   2000    128    P2P

NEM-1 SEFOS#
```

▼ Display the Spanning Tree Status

Variable	Description
`show spanning-tree active`	Displays the detail of the bridge and active ports for all of the active instances. Active ports are those ports that are participating in the spanning tree.
`show spanning-tree detail`	Displays detailed information about the port and bridge for all of the active instances. This information includes designated bridge details, designated port details, timer values, and root bridge details.
`show spanning-tree vlan 10 active`	Displays the detail of the bridge and the active port for the instance corresponding to requested VLAN.
`show spanning-tree vlan 10 detail`	Displays detailed information about the port and bridge. This information includes designated bridge details, designated port details, timer values, and root bridge details.
`show spanning-tree vlan 10 interface interface-id`	Displays spanning tree information for the specified interface.
`show spanning-tree vlan 10 summary`	Displays a summary of port states, or displays the total lines of the STP state section.

The preceding table shows the commands that display the spanning tree status and `VLAN 10` is used as command examples. Replace `VLAN 10` with a different VLAN ID to review the status for a particular VLAN.

The following examples show how to display general and detailed spanning tree status information. Before running the `show` commands, ensure that you have run the configuration commands in the previous sections (for example, disabling GVRP, enabling PVRST+, configuring ports as trunk, and enabling `VLAN 1`, `10`, `20`, `30`, and `40`).

1. Type the following `show` command in the switch to display general information.

```
TOR-1 SEFOS# show spanning-tree vlan 10
-----------------------------------------------------------------
Spanning-tree for VLAN 10
Root Id        Priority   32778
               Address    00:14:4f:6c:56:6f
               Cost       2000
               Port       Ex0/1
               Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec
Spanning Tree Enabled Protocol PVRST
Bridge Id      Priority 32778
               Address 00:14:4f:6c:69:ed
```

```
                    Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
          Name      Role         State       Cost     Prio   Type
          ----      ----         -----       ----     ----   ------
          Ex0/1     Root         Forwarding  2000     128    P2P
          Ex0/57    Alternate    Discarding  2000     128    P2P


          TOR-1 SEFOS# show spanning-tree active

          -------------------------------------------------------------------
          Spanning-tree for VLAN 1
          Root Id         Priority   32769
                          Address    00:14:4f:6c:56:6f
                          Cost       2000
                          Port       Ex0/1
                          Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

          Spanning Tree Enabled Protocol PVRST
          Bridge Id       Priority 32769
                          Address 00:14:4f:6c:69:ed
                          Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
          Name      Role         State       Cost     Prio   Type
          ----      ----         -----       ----     ----   ------
          Ex0/1     Root         Forwarding  2000     128    P2P
          Ex0/45    Designated   Forwarding  2000     128    P2P
          Ex0/57    Designated   Forwarding  2000     128    P2P


          -------------------------------------------------------------------
          Spanning-tree for VLAN 10
          Root Id         Priority   32778
                          Address    00:14:4f:6c:56:6f
                          Cost       2000
                          Port       Ex0/1
                          Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

          Spanning Tree Enabled Protocol PVRST
          Bridge Id       Priority 32778
                          Address 00:14:4f:6c:69:ed
                          Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
          Name      Role         State       Cost     Prio   Type
          ----      ----         -----       ----     ----   ------
          Ex0/1     Root         Forwarding  2000     128    P2P
          Ex0/57    Designated   Forwarding  2000     128    P2P


          -------------------------------------------------------------------
          Spanning-tree for VLAN 20
          Root Id         Priority   32788
                          Address    00:14:4f:6c:56:6f
                          Cost       2000
                          Port       Ex0/1
                          Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

          Spanning Tree Enabled Protocol PVRST
          Bridge Id       Priority 32788
```

```
                    Address 00:14:4f:6c:69:ed
                    Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
        Name     Role         State       Cost    Prio   Type
        ----     ----         -----       ----    ----   ------
        Ex0/1    Root         Forwarding  2000    128    P2P
        Ex0/57   Designated   Forwarding  2000    128    P2P


        --------------------------------------------------------------------
        Spanning-tree for VLAN 30
        Root Id        Priority   32798
                       Address    00:14:4f:6c:56:6f
                       Cost       2000
                       Port       Ex0/1
                       Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

        Spanning Tree Enabled Protocol PVRST
        Bridge Id      Priority 32798
                       Address 00:14:4f:6c:69:ed
                       Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
        Name     Role         State       Cost    Prio   Type
        ----     ----         -----       ----    ----   ------
        Ex0/1    Root         Forwarding  2000    128    P2P
        Ex0/57   Designated   Forwarding  2000    128    P2P


        --------------------------------------------------------------------
        Spanning-tree for VLAN 40
        Root Id        Priority   32808
                       Address    00:14:4f:6c:56:6f
                       Cost       2000
                       Port       Ex0/1
                       Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

        Spanning Tree Enabled Protocol PVRST
        Bridge Id      Priority 32808
                       Address 00:14:4f:6c:69:ed
                       Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
        Name     Role         State       Cost    Prio   Type
        ----     ----         -----       ----    ----   ------
        Ex0/1    Root         Forwarding  2000    128    P2P
        Ex0/57   Designated   Forwarding  2000    128    P2P

        TOR-1 SEFOS#
```

2.   **Type the following show command to display detailed information.**

```
TOR-1 SEFOS# show spanning-tree detail

Bridge is executing the rstp compatible PVRST Protocol
Bridge Identifier has priority 32769, Address 00:14:4f:6c:69:ed
Configured Hello time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Number of Topology Changes 9
Time since topology Change 0 seconds ago
Transmit Hold-Count 3
```

```
Max Age 20 Sec, Forward Delay 15 Sec, Hello Time 2 Sec

Port 1 [Ex0/1] of VLAN 1 is Root      , Forwarding
Port PathCost 2000     , Port Priority 128      , Port Identifier  128.1
Designated Root has priority 32769, address 00:14:4f:6c:56:6f
Designated Bridge has priority 32769, address 00:14:4f:6c:56:6f
Designated Port Id is 128.3, Designated PathCost 0
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :2
BPDUs : sent 33 , recieved 46616

Port 45 [Ex0/45] of VLAN 1 is Designated, Forwarding
Port PathCost 2000     , Port Priority 128      , Port Identifier  128.45
Designated Root has priority 32769, address 00:14:4f:6c:56:6f
Designated Bridge has priority 32769, address 00:14:4f:6c:69:ed
Designated Port Id is 128.45, Designated PathCost 2000
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :4
BPDUs : sent 12993 , recieved 0

Port 57 [Ex0/57] of VLAN 1 is Designated, Forwarding
Port PathCost 2000     , Port Priority 128      , Port Identifier  128.57
Designated Root has priority 32769, address 00:14:4f:6c:56:6f
Designated Bridge has priority 32769, address 00:14:4f:6c:69:ed
Designated Port Id is 128.57, Designated PathCost 2000
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :3
BPDUs : sent 44091 , recieved 2190

Bridge is executing the rstp compatible PVRST Protocol
Bridge Identifier has priority 32778, Address 00:14:4f:6c:69:ed
Configured Hello time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Number of Topology Changes 2
Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Max Age 20 Sec, Forward Delay 15 Sec, Hello Time 2 Sec

Port 1 [Ex0/1] of VLAN 10 is Root      , Forwarding
Port PathCost 2000     , Port Priority 128      , Port Identifier  128.1
Designated Root has priority 32778, address 00:14:4f:6c:56:6f
Designated Bridge has priority 32778, address 00:14:4f:6c:56:6f
Designated Port Id is 128.3, Designated PathCost 0
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :3
BPDUs : sent 16 , recieved 46611

Port 57 [Ex0/57] of VLAN 10 is Designated, Forwarding
Port PathCost 2000     , Port Priority 128      , Port Identifier  128.57
Designated Root has priority 32778, address 00:14:4f:6c:56:6f
Designated Bridge has priority 32778, address 00:14:4f:6c:69:ed
Designated Port Id is 128.57, Designated PathCost 2000
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :6
BPDUs : sent 4860 , recieved 41443
```

```
Bridge is executing the rstp compatible PVRST Protocol
Bridge Identifier has priority 32788, Address 00:14:4f:6c:69:ed
Configured Hello time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Number of Topology Changes 0
Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Max Age 20 Sec, Forward Delay 15 Sec, Hello Time 2 Sec

Port 1 [Ex0/1] of VLAN 20 is Root     , Forwarding
Port PathCost 2000     , Port Priority 128       , Port Identifier  128.1
Designated Root has priority 32788, address 00:14:4f:6c:56:6f
Designated Bridge has priority 32788, address 00:14:4f:6c:56:6f
Designated Port Id is 128.3, Designated PathCost 0
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :1
BPDUs : sent 4 , recieved 46607

Port 57 [Ex0/57] of VLAN 20 is Designated, Forwarding
Port PathCost 2000     , Port Priority 128       , Port Identifier  128.57
Designated Root has priority 32788, address 00:14:4f:6c:56:6f
Designated Bridge has priority 32788, address 00:14:4f:6c:69:ed
Designated Port Id is 128.57, Designated PathCost 2000
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :3
BPDUs : sent 46280 , recieved 2

Bridge is executing the rstp compatible PVRST Protocol
Bridge Identifier has priority 32798, Address 00:14:4f:6c:69:ed
Configured Hello time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Number of Topology Changes 0
Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Max Age 20 Sec, Forward Delay 15 Sec, Hello Time 2 Sec

Port 1 [Ex0/1] of VLAN 30 is Root     , Forwarding
Port PathCost 2000     , Port Priority 128       , Port Identifier  128.1
Designated Root has priority 32798, address 00:14:4f:6c:56:6f
Designated Bridge has priority 32798, address 00:14:4f:6c:56:6f
Designated Port Id is 128.3, Designated PathCost 0
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :1
BPDUs : sent 4 , recieved 46608

Port 57 [Ex0/57] of VLAN 30 is Designated, Forwarding
Port PathCost 2000     , Port Priority 128       , Port Identifier  128.57
Designated Root has priority 32798, address 00:14:4f:6c:56:6f
Designated Bridge has priority 32798, address 00:14:4f:6c:69:ed
Designated Port Id is 128.57, Designated PathCost 2000
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :3
BPDUs : sent 46281 , recieved 2
Bridge is executing the rstp compatible PVRST Protocol
Bridge Identifier has priority 32808, Address 00:14:4f:6c:69:ed
```

```
        Configured Hello time 2 sec, Max Age 20 sec, Forward Delay 15 sec
        Number of Topology Changes 3
        Time since topology Change 0 seconds ago
        Transmit Hold-Count 3
        Max Age 20 Sec, Forward Delay 15 Sec, Hello Time 2 Sec

        Port 1 [Ex0/1] of VLAN 40 is Root      , Forwarding
        Port PathCost 2000     , Port Priority 128      , Port Identifier  128.1
        Designated Root has priority 32808, address 00:14:4f:6c:56:6f
        Designated Bridge has priority 32808, address 00:14:4f:6c:56:6f
        Designated Port Id is 128.3, Designated PathCost 0
        Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
        No of Transitions to forwarding State :1
        BPDUs : sent 6 , recieved 46608

        Port 57 [Ex0/57] of VLAN 40 is Designated, Forwarding
        Port PathCost 2000     , Port Priority 128      , Port Identifier  128.57
        Designated Root has priority 32808, address 00:14:4f:6c:56:6f
        Designated Bridge has priority 32808, address 00:14:4f:6c:69:ed
        Designated Port Id is 128.57, Designated PathCost 2000
        Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
        No of Transitions to forwarding State :3
        BPDUs : sent 46281 , recieved 2

        TOR-1 SEFOS#
```

3. Type the following `show` command to display the general spanning-tree information for a VLAN (`VLAN 10` in this example).

```
TOR-1 SEFOS# show spanning-tree vlan 10 active

------------------------------------------------------------------
Spanning-tree for VLAN 10
Root Id        Priority   32778
               Address    00:14:4f:6c:56:6f
               Cost       2000
               Port       Ex0/1
               Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id      Priority 32778
               Address 00:14:4f:6c:69:ed
               Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name     Role         State       Cost    Prio   Type
----     ----         -----       ----    ----   ------
Ex0/1    Root         Forwarding  2000    128    P2P
Ex0/57   Designated   Forwarding  2000    128    P2P

TOR-1 SEFOS#
```

4. Type the following `show` command to display the detailed information for a VLAN (`VLAN 10` in this example).

```
TOR-1 SEFOS# show spanning-tree vlan 10 detail

Bridge is executing the rstp compatible PVRST Protocol
Bridge Identifier has priority 32778, Address 00:14:4f:6c:69:ed
Configured Hello time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Number of Topology Changes 2
Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Max Age 20 Sec, Forward Delay 15 Sec, Hello Time 2 Sec
Port 1 [Ex0/1] of VLAN 10 is Root      , Forwarding
Port PathCost 2000      , Port Priority 128      , Port Identifier  128.1
Designated Root has priority 32778, address 00:14:4f:6c:56:6f
Designated Bridge has priority 32778, address 00:14:4f:6c:56:6f
Designated Port Id is 128.3, Designated PathCost 0
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :3
BPDUs : sent 16 , recieved 46694
Port 57 [Ex0/57] of VLAN 10 is Designated, Forwarding
Port PathCost 2000      , Port Priority 128      , Port Identifier  128.57
Designated Root has priority 32778, address 00:14:4f:6c:56:6f
Designated Bridge has priority 32778, address 00:14:4f:6c:69:ed
Designated Port Id is 128.57, Designated PathCost 2000
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :6
BPDUs : sent 4942 , recieved 41443

TOR-1 SEFOS#
```

5. **Type the following show command to display the detailed information for a VLAN interface (0/1 in this example).**

```
TOR-1 SEFOS# show spanning-tree vlan 10 interface extreme-ethernet 0/1

Role        State       Cost    Prio
----        -----       ----    ----
Root        Forwarding  2000    128
TOR-1 SEFOS#
```

6. **Type the following show command to display the spanning-tree summary for a VLAN (VLAN 10 in this example).**

```
TOR-1 SEFOS# show spanning-tree vlan 10 summary

Spanning tree enabled protocol is PVRST
Spanning-tree pathcost method is long

PVRST Port Roles and States
Port-Index  Port-Role   Port-State   Port-Status
----------  ---------   ----------   -----------
1           Root        Forwarding   Enabled
```

```
57          Designated   Forwarding   Enabled

TOR-1 SEFOS#
```

▼ Configure the Transmit Hold Count

The transmit hold count value is a counter used to limit the maximum transmission rate of the switch. The number or BPDUs transmitted during every hello-time period ranges from a minimum of one to a maximum that is not more than the TxHoldCount value.

1.   Configure the transmit hold count.

```
TOR-1 SEFOS# configure terminal
TOR-1 SEFOS(config)# spanning-tree vlan 10 hold-count 6

Hold Count for the given instance is set

TOR-1 SEFOS(config)# end
```

The transmit hold count value ranges from 1 to 10. The default value is 3.

2.   Review the spanning tree details.

```
TOR-1 SEFOS# show spanning-tree vlan 10 detail

Bridge is executing the rstp compatible PVRST Protocol
Bridge Identifier has priority 32778, Address 00:14:4f:6c:69:ed
Configured Hello time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Number of Topology Changes 2
Time since topology Change 0 seconds ago
Transmit Hold-Count 6
Max Age 20 Sec, Forward Delay 15 Sec, Hello Time 2 Sec

Port 1 [Ex0/1] of VLAN 10 is Root     , Forwarding
Port PathCost 2000     , Port Priority 128     , Port Identifier  128.1
Designated Root has priority 32778, address 00:14:4f:6c:56:6f
Designated Bridge has priority 32778, address 00:14:4f:6c:56:6f
Designated Port Id is 128.3, Designated PathCost 0
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :3
BPDUs : sent 16 , recieved 46817

Port 57 [Ex0/57] of VLAN 10 is Designated, Forwarding
Port PathCost 2000     , Port Priority 128     , Port Identifier  128.57
Designated Root has priority 32778, address 00:14:4f:6c:56:6f
Designated Bridge has priority 32778, address 00:14:4f:6c:69:ed
Designated Port Id is 128.57, Designated PathCost 2000
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :6
BPDUs : sent 5064 , recieved 41443
```

```
TOR-1 SEFOS#
```

3.   Reset the transmit hold count to the default value.

```
TOR-1 SEFOS# configure terminal
TOR-1 SEFOS(config)# no spanning-tree vlan 10 hold-count

Hold Count for the given instance is set

TOR-1 SEFOS(config)# end
TOR-1 SEFOS#
```

4.   Display the hold count after resetting it to the default.

```
TOR-1 SEFOS# show spanning-tree vlan 10 detail

Bridge is executing the rstp compatible PVRST Protocol
Bridge Identifier has priority 32778, Address 00:14:4f:6c:69:ed
Configured Hello time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Number of Topology Changes 2
Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Max Age 20 Sec, Forward Delay 15 Sec, Hello Time 2 Sec

Port 1 [Ex0/1] of VLAN 10 is Root     , Forwarding
Port PathCost 2000     , Port Priority 128     , Port Identifier  128.1
Designated Root has priority 32778, address 00:14:4f:6c:56:6f
Designated Bridge has priority 32778, address 00:14:4f:6c:56:6f
Designated Port Id is 128.3, Designated PathCost 0
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :3
BPDUs : sent 16 , recieved 46898

Port 57 [Ex0/57] of VLAN 10 is Designated, Forwarding
Port PathCost 2000     , Port Priority 128     , Port Identifier  128.57
Designated Root has priority 32778, address 00:14:4f:6c:56:6f
Designated Bridge has priority 32778, address 00:14:4f:6c:69:ed
Designated Port Id is 128.57, Designated PathCost 2000
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :6
BPDUs : sent 5146 , recieved 41443

TOR-1 SEFOS#
```

▼ Configure Encapsulation

Trunk encapsulation dictates the manner in which frames are identified (that is, tagged) on a trunk and defines the VLAN services available. To set the encapsulation type as ISL on the interface, you must first configure the port as trunk. By default, dot1q encapsulation is enabled.

1. **Configure the port as the trunk port.**

```
SEFOS# configure terminal
SEFOS(config)# interface extreme-ethernet 0/1
SEFOS(config-if)# switchport mode trunk
```

2. **Set the encapsulation type as ISL.**

```
SEFOS(config-if)# spanning-tree encap ISL
SEFOS(config-if)# end
```

3. **Review the port encapsulation type.**

```
SEFOS# show spanning-tree interface extreme-ethernet 0/1 encapsulationtype

Encapsulation Type is ISL
```

4. **Reset the encapsulation type to the default on the interface.**

```
SEFOS# configure terminal
SEFOS(config)# interface extreme-ethernet 0/1
SEFOS(config-if)# no spanning-tree encap
SEFOS(config-if)# end
```

▼ Configure the BPDU Guard

You can enable or disable the BPDU guard on per port basis. The BPDU guard disables the port upon the BPDU reception on the port. The disablement effectively denies devices behind such ports from participation in the STP. After you disable a port, it must be manually re-enabled. By default, the BPDU guard is disabled.

1. **Enter the interface configuration mode for the interface (0/1 in this example).**

```
TOR-1 SEFOS# configure terminal
TOR-1 SEFOS(config)# interface extreme-ethernet 0/1
TOR-1 SEFOS(config-if)#
```

2. **Enable the BPDU guard on the port.**

```
TOR-1 SEFOS(config-if)# spanning-tree bpduguard enable

PvrstBpduguard Enabled

TOR-1 SEFOS(config-if)# end
```

```
TOR-1 SEFOS#
```

3. Review the output for the BPDU guard on the port.

```
TOR-1 SEFOS# show spanning-tree interface extreme-ethernet 0/1 bpduguard

Bpdu Guard  is Enabled
TOR-1 SEFOS#
```

4. Disable the BPDU guard on the interface.

```
TOR-1 SEFOS# configure terminal
TOR-1 SEFOS(config)# interface extreme-ethernet 0/1
TOR-1 SEFOS(config-if)# no spanning-tree bpduguard

PvrstBpduguard Disabled

TOR-1 SEFOS(config-if)# end
TOR-1 SEFOS#
```

▼ Configure the Root Guard

You can enable the root guard on a per-port basis. If enabled on a port, the switch ignores superior BPDUs received on that port and blocks that port. The port reverts back to the forwarding state automatically after the port stops receiving superior BPDUs. You must configure the port as a trunk port before you enable the root guard on the interface. By default, the root guard is disabled.

1. Enter Configuration mode for the interface.

```
SEFOS# configure terminal
SEFOS(config)# interface extreme-ethernet 0/1
```

2. Configure the port as a trunk port.

```
SEFOS(config-if)# switchport mode trunk
```

3. Enable the root guard on the port.

```
SEFOS(config-if)# spanning-tree guard root
SEFOS(config-if)# end
```

4. Review the root guard output on the port.

```
SEFOS# show spanning-tree interface extreme-ethernet 0/1 rootguard

Root Guard  is Enabled
```

5.   Disable the root guard on the interface.

```
SEFOS# configure terminal
SEFOS(config)# interface extreme-ethernet 0/1
SEFOS(config-if)# no spanning-tree guard
SEFOS(config)# end
TOR-1 SEFOS#
```

Configuring the VLAN Module

To make the PVRST+ module completely operational, you must configure the VLAN module. Before you configure VLAN as described in these sections, see "VLAN Module" on page 16 to ensure that the configuration guidelines are satisfied.

The examples in this section use switch B (hostname TOR-1), port 0/1, and `VLAN 10` and `VLAN 20`.

- "Disable GVRP" on page 43
- "Configuring Trunk and Access Ports" on page 43
- "Configure VLANS and Display the PVRST+ Information for VLANs" on page 46

▼ Disable GVRP

You must disable GVRP before you configure the PVRST+ software.

1. Enter the configuration mode.

```
TOR-1 SEFOS# configure terminal
TOR-1 SEFOS(config)#
```

2. Disable the GVRP module.

```
TOR-1 SEFOS(config)# set gvrp disable
TOR-1 SEFOS(config)# end
TOR-1 SEFOS#
```

Configuring Trunk and Access Ports

After you enable the PVRST+ software, you must explicitly use commands to configure ports as trunk or access, in order to make them a member of a VLAN. After you configure the port as a trunk port, it becomes a member port of all active VLANs in the system. After you configure a port as access, the port becomes a member port of the VLAN that is configured as PVID for that port.

- ■ "Configure a Trunk Port" on page 44
- ■ "Configure an Access Port" on page 45
- ■ "Set Up PVID on a Port" on page 45

▼ Configure a Trunk Port

1. Enter the configuration mode for the interface.

```
TOR-1 SEFOS# configure terminal
TOR-1 SEFOS(config)# interface extreme-ethernet 0/1
TOR-1 SEFOS(config-if)#
```

2. Set the switchport mode.

```
TOR-1 SEFOS(config-if)# switchport mode trunk
TOR-1 SEFOS(config-if)# end
TOR-1 SEFOS#
```

After you configure the port as a trunk port, it becomes a member port of all active VLANs in the system.

3. Display the VLAN-related parameters for port 0/1.

```
TOR-1 SEFOS# show vlan port config port ex 0/1

Vlan Port configuration table
-------------------------------
Port Ex0/1
 Port Vlan ID                      : 1
 Port Acceptable Frame Type        : Admit All
 Port Ingress Filtering            : Disabled
 Port Mode                         : Trunk
 Port Gvrp Status                  : Enabled
 Port Gmrp Status                  : Enabled
 Port Gvrp Failed Registrations    : 0
 Gvrp last pdu origin              : 00:00:00:00:00:00
 Port Restricted Vlan Registration : Disabled
 Port Restricted Group Registration : Disabled
 Mac Based Support                 : Disabled
 Subnet Based Support              : Disabled
 Port-and-Protocol Based Support   : Enabled
 Default Priority                  : 0
 Filtering Utility Criteria        : Default
 Port Protected Status             : Disabled
 -----------------------------------------------------
```

▼ Configure an Access Port

1.   Disable GVRP on the port.

Per-port GVRP must be disabled before configuring as access mode.

```
TOR-1 SEFOS# configure terminal
TOR-1 SEFOS(config)# set port gvrp extreme-ethernet 0/1 disable
TOR-1 SEFOS(config)#
```

2.   Enter the configuration mode for the interface.

```
TOR-1 SEFOS(config)# interface  extreme-ethernet 0/1
TOR-1 SEFOS(config-if)#
```

3.   Set the `switchport` mode.

```
SEFOS(config-if)# switchport acceptable-frame-type   untaggedAndPrioritytagged
SEFOS(config-if)# switchport mode access
SEFOS(config-if)# end
TOR-1 SEFOS#
```

After you configure the port as access, the port becomes a member port of the VLAN that is configured as PVID for that port.

▼ Set Up PVID on a Port

1.   Enter the configuration mode for the interface.

```
TOR-1 SEFOS# configure terminal
TOR-1 SEFOS(config)# interface  extreme-ethernet 0/1
TOR-1 SEFOS(config-if)#
```

2.   Set the PVID value.

```
TOR-1 SEFOS(config-if)# switchport pvid 10
TOR-1 SEFOS(config-if)# end
TOR-1 SEFOS#
```

3.   Display VLAN related parameters for port 0/1.

```
TOR-1 SEFOS# show vlan port config port extreme-ethernet 0/1

Vlan Port configuration table
```

```
                          -------------------------------
                          Port Ex0/1
                           Port Vlan ID                  : 10
                           Port Acceptable Frame Type    : Admit Only Untagged and Priority Tagged
                           Port Ingress Filtering        : Disabled
                           Port Mode                     : Access
                           Port Gvrp Status              : Disabled
                           Port Gmrp Status              : Enabled
                           Port Gvrp Failed Registrations  : 0
                           Gvrp last pdu origin            : 00:00:00:00:00:00
                           Port Restricted Vlan Registration   : Disabled
                           Port Restricted Group Registration  : Disabled
                           Mac Based Support             : Disabled
                           Subnet Based Support          : Disabled
                           Port-and-Protocol Based Support    : Enabled
                           Default Priority              : 0
                           Filtering Utility Criteria    : Default
                           Port Protected Status         : Disabled
                          -----------------------------------------------------

                          TOR-1 SEFOS#
```

▼ Configure VLANS and Display the PVRST+ Information for VLANs

You can use the show command to display the configuration details of a particular VLAN or for all of the configured VLANs. This section contains a sequence of commands to disable GVRP, configure STP mode, configure a port as a trunk port, enable VLANs, and display the STP information about the VLANs. These commands assume that no prior configuration commands have been used.

1. **Disable GVRP.**

```
TOR-1 SEFOS# configure terminal
TOR-1 SEFOS(config)# set gvrp disable
TOR-1 SEFOS(config)#
```

2. **Configure the STP mode.**

```
TOR-1 SEFOS(config)# spanning-tree mode pvrst

PVRST is started.
PVRST Module status is changed

TOR-1 SEFOS(config)#
```

3. **Enter the configuration mode for the interface.**

```
TOR-1 SEFOS(config)# interface extreme-ethernet 0/1
TOR-1 SEFOS(config-if)#
```

4. **Configure the port as a trunk port.**

```
TOR-1 SEFOS(config-if)# switchport mode trunk
TOR-1 SEFOS(config-if)#
```

5. **Bring up the interface.**

```
TOR-1 SEFOS(config-if)# no shutdown
TOR-1 SEFOS(config-if)# exit
TOR-1 SEFOS(config)#
```

6. **Enable VLAN 10.**

```
TOR-1 SEFOS(config)# vlan 10
TOR-1 SEFOS(config-vlan)# vlan active
TOR-1 SEFOS(config-vlan)# exit
TOR-1 SEFOS(config)#
```

7. **Enable VLAN 20.**

```
TOR-1 SEFOS(config)# vlan 20
TOR-1 SEFOS(config-vlan)# vlan active
TOR-1 SEFOS(config-vlan)# end
TOR-1 SEFOS#
```

8. **Display the VLAN related parameters specific for port 0/1.**

```
TOR-1 SEFOS# show vlan port config port extreme-ethernet 0/1

Vlan Port configuration table
------------------------------
Port Ex0/1
 Port Vlan ID                     : 1
 Port Acceptable Frame Type       : Admit All
 Port Ingress Filtering           : Disabled
 Port Mode                        : Trunk
 Port Gvrp Status                 : Disabled
 Port Gmrp Status                 : Enabled
 Port Gvrp Failed Registrations   : 0
 Gvrp last pdu origin             : 00:00:00:00:00:00
 Port Restricted Vlan Registration   : Disabled
 Port Restricted Group Registration  : Disabled
 Mac Based Support                : Disabled
```

```
 Subnet Based Support              : Disabled
 Port-and-Protocol Based Support   : Enabled
 Default Priority                  : 0
 Filtering Utility Criteria        : Default
 Port Protected Status             : Disabled
 -------------------------------------------------------
```

After you configure the port as trunk, the port acceptable frame type must be Admin All. If the frame type is not Admin All, use the `switchport acceptable-frame-type all` command in port interface mode to accept all types of packets.

9. **Review the STP information.**

```
TOR-1 SEFOS# show spanning-tree

-------------------------------------------------------------------
Spanning-tree for VLAN 1
Root Id        Priority   32769
               Address    00:14:4f:6c:56:6f
               Cost       2000
               Port       Ex0/1
               Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id      Priority 32769
               Address 00:14:4f:6c:69:ed
               Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name     Role        State       Cost    Prio   Type
----     ----        -----       ----    ----   ------
Ex0/1    Root        Forwarding  2000    128    P2P
Ex0/57   Designated  Forwarding  2000    128    P2P


-------------------------------------------------------------------
Spanning-tree for VLAN 10
Root Id        Priority   32778
               Address    00:14:4f:6c:56:6f
               Cost       2000
               Port       Ex0/1
               Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id      Priority 32778
               Address 00:14:4f:6c:69:ed
               Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name     Role        State       Cost    Prio   Type
----     ----        -----       ----    ----   ------
Ex0/1    Root        Forwarding  2000    128    P2P
Ex0/57   Designated  Forwarding  2000    128    P2P

-------------------------------------------------------------------
Spanning-tree for VLAN 20
Root Id        Priority   32788
```

```
                 Address     00:14:4f:6c:56:6f
                 Cost        2000
                 Port        Ex0/1
                 Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32788
                Address 00:14:4f:6c:69:ed
                Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name     Role         State       Cost     Prio   Type
----     ----         -----       ----     ----   ------
Ex0/1    Root         Forwarding  2000     128    P2P
Ex0/57   Designated   Forwarding  2000     128    P2P

TOR-1 SEFOS#
```

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