Ethernet Routing Switch

8600/8800

Engineering

> PVST+ Technical Configuration Guide

Avaya Data Solutions

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Abstract

Revision Control

No	Date	Version	Revised By	Remarks
1	3 Oct 2009	1.0	JVE	Initial draft document release
2	24 Nov 2010	1.1	K. Marshall	Rebranded Avaya

Table of Contents

Figures

Tables

Conventions

This section describes the text, image, and command conventions used in this document.

Symbols

Tip – Highlights a configuration or technical tip.

Note – Highlights important information to the reader.

Warning – Highlights important information about an action that may result in equipment damage, configuration or data loss.

Text

Bold text indicates emphasis.

Italic text in a Courier New font indicates text the user must enter or select in a menu item, button or command:

```
ERS5520-48T# show running-config
```

Output examples from Avaya devices are displayed in a Lucida Console font:

```
ERS5520-48T# show sys-info

Operation Mode:          Switch
MAC Address:             00-12-83-93-B0-00
PoE Module FW:           6370.4
Reset Count:             83
Last Reset Type:         Management Factory Reset
Power Status:            Primary Power
Autotopology:            Enabled
Pluggable Port 45:       None
Pluggable Port 46:       None
Pluggable Port 47:       None
Pluggable Port 48:       None
Base Unit Selection:     Non-base unit using rear-panel switch
sysDescr:                Ethernet Routing Switch 5520-48T-PWR
                         HW:02       FW:6.0.0.10  SW:v6.2.0.009
                         Mfg Date:12042004    HW Dev:H/W rev.02
```

1. Per-VLAN Spanning Tree Plus (PVST+) Overview

Cisco and Avaya Ethernet Routing Switch 8600 both support standards based 802.1d Spanning Tree in addition to supporting proprietary mechanisms for multiple instances of Spanning Tree. Unfortunately, using 802.1d Spanning Tree only provides one instance of Spanning Tree that may lead to incomplete connectivity for certain VLANs depending on network topology. In a network where one or more VLANs span only some of the switches, as illustrated in the diagram below, 802.1d Spanning may block a path used by a VLAN that doesn't happen to span across all switches. To get around this issue, multiple Spanning Tree instances are used. In the Ethernet Routing Switch 8600 3.7 release, it now has capability of interoperating with Cisco's PVST+. PVST+ is Cisco's proprietary Spanning Tree mechanism using a Spanning Tree instance per VLAN.

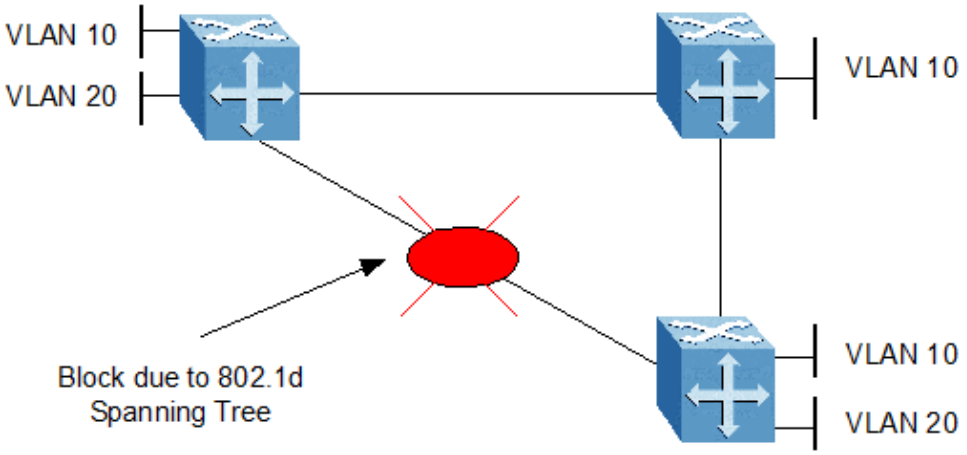

Figure 1.1 – 802.1d Spanning Tree Protocol

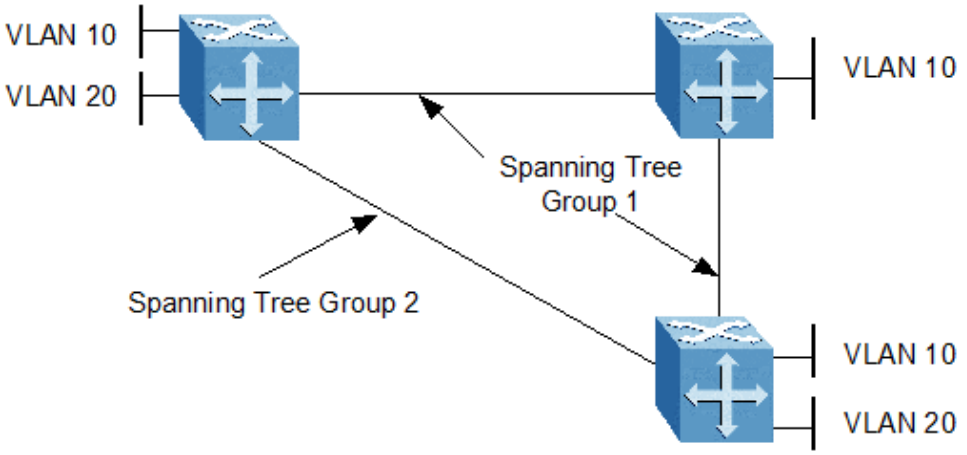

Figure 1.2 – Multiple Instances of Spanning Tree

2. PVST+ (Per VLAN Spanning Tree Plus) Overview

PVST+ is an extension of Cisco's PVST with support for the IEEE 802.1Q standard. It is the default Spanning Tree protocol used on Cisco switches. It uses a separate Spanning Tree instance for each VLAN configured.

When PVST+ is configured, it uses by default, normal STP BPDU's on VLAN 1 and PVST BPDUs for other VLANs. This allows a PVST+ switch to connect to a switch using IEEE 802.1Q spanning tree as a tunnels for PVST. PVST+ BPDU's are tunneled across the 802.1Q VLAN region as multicast data. The single STP is addressed to the well-known STP MAC address 01-80-C2-00-00-00. The PVST BPDUs for other VLANs are addressed to multicast address 01-00-0C-CC-CC-CD.

PVST+ can be used to load balance the VLANs by changing the VLAN bridge priority.

3. PVST+ Configuration on ERS8600

A PVST+ instance is configured under the Ethernet Routing Switch 8600 spanning tree group (STG) level for each VLAN that connects to a Cisco switching running PVST+. This is accomplished by using the following command:

```
ERS8600:6# config stg <1-64> create <ports> vlan <1-4094> ntstg disable
```

By default, ntstg is enable providing the default group stp operation. By setting the ntstg parameter to disable, this enables PVST+ for this particular VLAN.

To view spanning forward state, enter the following command:

```
ERS8600:6# show ports info stg main <port number>
```

To view the spanning tree configuration, enter the following command:

```
ERS8600:6# show stg info config
```

To view the spanning tree status, enter the following command:

```
ERS8600:6# show stg info status
```

3.1 Configuration Example – Basic Setup

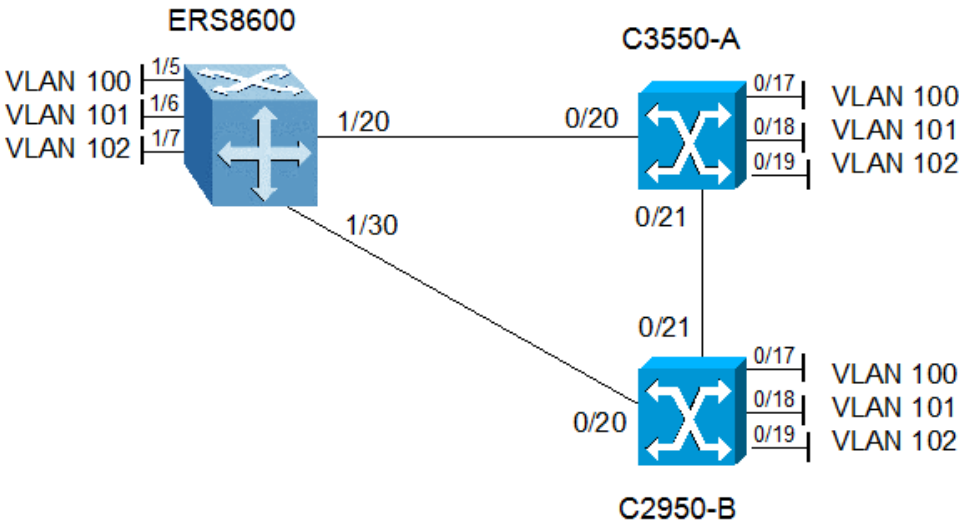

Figure 3.1 – PVST+

In this configuration example, we will configure the following

- Create VLANs 100, 101, and 102 on all switches
- Create trunk ports, i.e. 802.1Q tagging, on ports 1/20 and 1/30 on the Ethernet Routing Switch 8600 and ports 0/20 on both Cisco switches.

ERS8600 Configuration

1. Configure ports 1/20 and 1/30 with VLAN tagging

```
ERS8600:6# config ethernet 1/20,1/30 perform-tagging enable
```

2. Configure a PVST+ STG instance for each VLAN

```
ERS8600:6# config stg 20 create 1/5,1/20,1/30 vlan 100 ntstg disable
ERS8600:6# config stg 21 create 1/6,1/20,1/30 vlan 101 ntstg disable
ERS8600:6# config stg 22 create 1/7,1/20,1/30 vlan 102 ntstg disable
```

3. Create VLAN 100

```
ERS8600:6# config vlan 100 create byport 20
ERS8600:6# config vlan 100 ports add 1/5,1/20,1/30
```

4. Create VLAN 101

```
ERS8600:6# config vlan 101 create byport 21
ERS8600:6# config vlan 101 ports add 1/6,1/20,1/30
```

5. Create VLAN 102

```
ERS8600:6# config vlan 102 create byport 22
ERS8600:6# config vlan 102 ports add 1/7,1/20,1/30
```

Cisco C2950 Configuration

By default, PVST+ is enabled so the only configuration step is to add the VLAN's (via vlan database) then add the ports to each VLAN.

```
!
version 12.1
!
interface FastEthernet0/17
 switchport access vlan 100
 switchport mode access
 no ip address
!
interface FastEthernet0/18
 switchport access vlan 101
 switchport mode access
 no ip address
!
interface FastEthernet0/19
 switchport access vlan 102
 switchport mode access
 no ip address
!
interface FastEthernet0/20
 switchport trunk allowed vlan 100-102
 switchport mode trunk
 no ip address
!
interface FastEthernet0/21
 switchport trunk allowed vlan 100-102
 switchport mode trunk
 no ip address
!
```

Cisco C3550 Configuration

By default, PVST+ is enabled so the only configuration step is to add the VLAN's (via vlan database) then add the ports to each VLAN.

```
C3550# vlan data
C3550(vlan)# vlan 100 state active
C3550(vlan)# vlan 101 state active
C3550(vlan)# vlan 102 state active
```

```
C3550(vlan)# exit


!
version 12.1
!
spanning-tree mode pvst
spanning-tree extend system-id
!
!
interface FastEthernet0/17
 switchport access vlan 100
 switchport mode access
 no ip address
!
interface FastEthernet0/18
 switchport access vlan 101
 switchport mode access
 no ip address
!
interface FastEthernet0/19
 switchport access vlan 102
 switchport mode access
 no ip address
!
interface FastEthernet0/20
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 100-102
 switchport mode trunk
 no ip address
!
interface FastEthernet0/21
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 100-102
 switchport mode trunk
 no ip address
!
```

3.1.1 Verifying Spanning Tree State

To view the forwarding state for each spanning tree instance for each core port, enter the following command:

```
ERS8600:6# show port info stg main 3/20,3/30
```

```
================================================================================
                                    Port Stg
================================================================================
                             ENABLE                      FORWARD    CHANGE
SID PORT_NUM PRIO STATE       STP   FASTSTART PATHCOST TRANSITION DETECTION
--------------------------------------------------------------------------------
1   1/20     128  forwarding true   false     10       3          true
20  1/20     128  forwarding true   false     10       3          true
21  1/20     128  forwarding true   false     10       3          true
22  1/20     128  forwarding true   false     10       3          true
1   1/30     128  forwarding true   false     10       2          true
20  1/30     128  forwarding true   false     10       1          true
21  1/30     128  forwarding true   false     10       1          true
22  1/30     128  forwarding true   false     10       1          true
```

```
ERS8600:6# show stg info status
```

```
================================================================================
                                    Stg Status
================================================================================
STG  BRIDGE            NUM   PROTOCOL      TOP
ID   ADDRESS           PORTS SPECIFICATION CHANGES
--------------------------------------------------------------------------------
1    00:e0:7b:82:9c:01 105   ieee8021d     25
20   00:e0:7b:82:9c:14 3     ieee8021d     3
21   00:e0:7b:82:9c:15 3     ieee8021d     3
22   00:e0:7b:82:9c:16 3     ieee8021d     3

STG  DESIGNATED              ROOT  ROOT  MAX  HELLO  HOLD  FORWARD
ID   ROOT                    COST  PORT  AGE  TIME   TIME  DELAY
--------------------------------------------------------------------------------
1    80:00:00:08:a4:43:ce:00 10    1/30  2000 200    100   1500
20   80:00:00:08:a4:43:ce:02 10    1/30  2000 200    100   1500
21   80:00:00:08:a4:43:ce:03 10    1/30  2000 200    100   1500
22   80:00:00:08:a4:43:ce:04 10    1/30  2000 200    100   1500
```

3.1.2 Changing Spanning Tree Instance Priority

Each Spanning Tree Instance priority can be modified to select the root bridge. For example, the following command increases the priority for STG 20. The default priority is 32768.

```
ERS8600:6# config stg 20 priority 8000
```

If you now look at the Spanning Instance, notice that now the ERS8600 is the root bridge.

```
ERS8600:6# show stg info status

================================================================================
                                    Stg Status
================================================================================
STG  BRIDGE            NUM   PROTOCOL      TOP
ID   ADDRESS           PORTS SPECIFICATION CHANGES
--------------------------------------------------------------------------------
1    00:e0:7b:82:9c:01 105   ieee8021d     26
20   00:e0:7b:82:9c:14 3     ieee8021d     4
21   00:e0:7b:82:9c:15 3     ieee8021d     3
22   00:e0:7b:82:9c:16 3     ieee8021d     3

STG  DESIGNATED              ROOT  ROOT  MAX  HELLO  HOLD  FORWARD
ID   ROOT                    COST  PORT  AGE  TIME   TIME  DELAY
--------------------------------------------------------------------------------
1    80:00:00:09:97:e3:40:00 10    7/7   2000 200    100   1500
20   1f:40:00:e0:7b:82:9c:14 0     cpp   2000 200    100   1500
21   80:00:00:08:a4:43:ce:03 10    3/30  2000 200    100   1500
22   80:00:00:08:a4:43:ce:04 10    3/30  2000 200    100   1500
```

3.2 Configuration Example – Load Balance with ERS8600 as Distribution Switch and Cisco as Access Switch

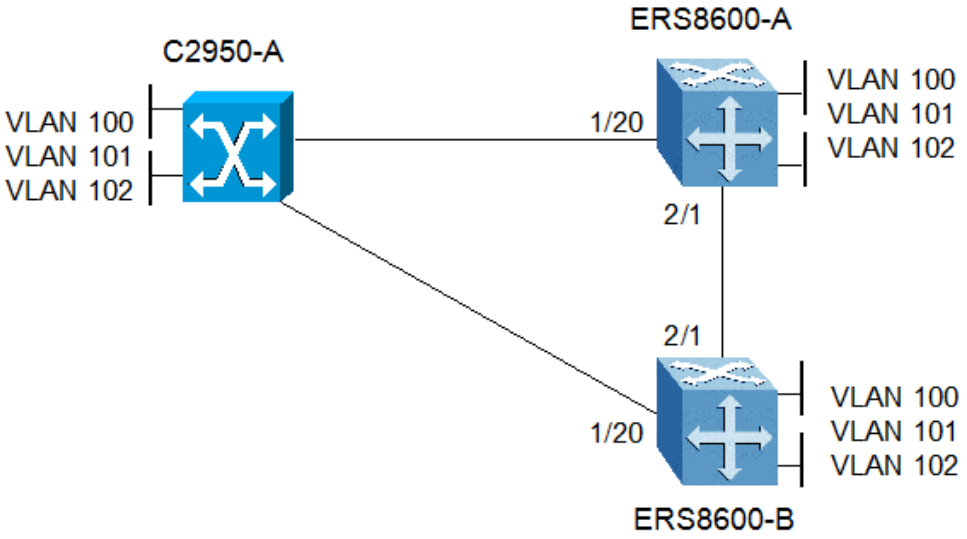

Figure 3.2 – PVST+ VLAN Load Balance

For this configuration example, we wish to configure the following:

- Use the Cisco switch as an access switch
- Use ERS8600-A and ERS8600-B as distribution switches
- Forward all even number VLANs from C2950-A to ERS8600-A. This is accomplished by configuring the STG bridge priority. By default, all STG groups have a bridge priority of 32768. To increase the STG priority, we will lower the STG priority to a lower value for all even number VLANs, in this example 4096.
- Forward all odd number VLANs from C2950-A to ERS8600-B. To increase the STG priority, we will lower the STG priority to a lower value for all odd number VLANs, in this example 4096.Please see Appendix A for ERS8600 configuration files.

ERS8600-A Configuration

1. Configure ports 1/20 and 2/1 with VLAN tagging

```
ERS8600-A:6# config ethernet 1/20,2/1 perform-tagging enable
```

2. Configure a PVST+ STG instance for each VLAN

```
ERS8600-A:6# config stg 20 create 1/5,1/20,2/1 vlan 100 ntstg disable
ERS8600-A:6# config stg 21 create 1/6,1/20,2/1 vlan 101 ntstg disable
ERS8600-A:6# config stg 22 create 1/7,1/20,2/1 vlan 102 ntstg disable
```

3. Configure bridge priority for each even number VLAN STG group

```
ERS8600-A:6# config stg 20 priority 4096
ERS8600-A:6# config stg 22 priority 4096
```

4. Create VLAN 100

```
ERS8600-A:6# config vlan 100 create byport 20
ERS8600-A:6# config vlan 100 ports add 1/5,1/20,2/1
```

5. Create VLAN 101

```
ERS8600-A:6# config vlan 101 create byport 21
ERS8600-A:6# config vlan 101 ports add 1/6,1/20,2/1
```

6. Create VLAN 102

```
ERS8600-A:6# config vlan 102 create byport 22
ERS8600-A:6# config vlan 102 ports add 1/7,1/20,2/1
```

ERS8600-B Configuration

1. Configure ports 1/20 and 2/1 with VLAN tagging

```
ERS8600-B:6# config ethernet 1/20,2/1 perform-tagging enable
```

2. Configure a PVST+ STG instance for each VLAN

```
ERS8600-B:6# config stg 20 create 1/5,1/20,2/1 vlan 100 ntstg disable
ERS8600-B:6# config stg 21 create 1/6,1/20,2/1 vlan 101 ntstg disable
ERS8600-B:6# config stg 22 create 1/7,1/20,2/1 vlan 102 ntstg disable
```

3. Configure bridge priority for each odd number VLAN STG group

```
ERS8600-B:6# config stg 21 priority 4096
```

4. Create VLAN 100

```
ERS8600-B:6# config vlan 100 create byport 20
ERS8600-B:6# config vlan 100 ports add 1/5,1/20,2/1
```

5. Create VLAN 101

```
ERS8600-B:6# config vlan 101 create byport 21
ERS8600-B:6# config vlan 101 ports add 1/6,1/20, 2/1
```

6. Create VLAN 102

```
ERS8600-B:6# config vlan 102 create byport 22
ERS8600-B:6# config vlan 102 ports add 1/7,1/20, 2/1
```

3.3 Configuration Example – Load Balance with Cisco as Distribution Switch and ERS8600 as Access Switch

Working from the basic PVST+ configuration example in step 3.2 above, we wish to configure the following:

- Use the ERS8600 as an access switch
- Use C2950-A and C2950-B as distribution switches
- Forward all even number VLANs from ERS8600 to C2950-A
- Forward all odd number VLANs from ERS8600 to C2950-B

In order to load balance traffic in this manner, the easiest way to accomplish this is by configuring C2950-A as the root for all even number VLAN and C2950-B as root for all odd number VLANs. To do this, enter the following commands:

1. Configure C2950-A as root from all even number VLANs:

```
Cat2950-A(config)# spanning-tree vlan 100 root primary
Cat2950-A(config)# spanning-tree vlan 102 root primary
```

2. Configure C2950-B as root for all odd number VLANs:

```
Cat2950-B(config)# spanning-tree vlan 101 root primary
```

The Cisco root command simply changes the bridge priority to 24576.

4. Appendix A

4.1 Configuration Files for Section 3.2

ERS8600-A

```
#
# PORT CONFIGURATION - PHASE I
#

ethernet 1/20 perform-tagging enable
ethernet 2/1 perform-tagging enable

#
# STG CONFIGURATION
#

stg 20  create vlan 100 mac 01:00:0c:cc:cc:cd ntstg disable
stg 20  add ports 1/5,1/20,2/1
stg 20  priority 4096
stg 21  create vlan 101 mac 01:00:0c:cc:cc:cd ntstg disable
stg 21  add ports 1/6,1/20,2/1
stg 22  create vlan 102 mac 01:00:0c:cc:cc:cd ntstg disable
stg 22  add ports 1/7,1/20,2/1
stg 22  priority 4096

#
# VLAN CONFIGURATION
#

vlan 100 create byport 20
vlan 100 ports remove 1/1-1/4,1/6-1/19,1/21-1/48,2/2-2/8,3/1-3/8 member portmember
vlan 100 ports add 1/5,1/20,2/1 member portmember
vlan 101 create byport 21
vlan 101 ports remove 1/1-1/5,1/7-1/19,1/21-1/48,2/2-2/8,3/1-3/8 member portmember
vlan 101 ports add 1/6,1/20,2/1 member portmember
vlan 102 create byport 22
vlan 102 ports remove 1/1-1/6,1/8-1/19,1/21-1/48,2/2-2/8,3/1-3/8 member portmember
vlan 102 ports add 1/7,1/20,2/1 member portmember
```

ERS8600-B

```
#
# PORT CONFIGURATION - PHASE I
#

ethernet 1/20 perform-tagging enable
ethernet 2/1 perform-tagging enable

#
# STG CONFIGURATION
#

stg 20  create vlan 100 mac 01:00:0c:cc:cc:cd ntstg disable
stg 20  add ports 1/5,1/20,2/1
stg 21  create vlan 101 mac 01:00:0c:cc:cc:cd ntstg disable
stg 21  add ports 1/6,1/20,2/1
stg 21  priority 4096
stg 22  create vlan 102 mac 01:00:0c:cc:cc:cd ntstg disable
stg 22  add ports 1/7,1/20,2/1


#
# VLAN CONFIGURATION
#

vlan 100 create byport 20
vlan 100 ports remove 1/1-1/4,1/6-1/19,1/21-1/48,2/2-2/8,3/1-3/8 member portmember
vlan 100 ports add 1/5,1/20,2/1 member portmember
vlan 101 create byport 21
vlan 101 ports remove 1/1-1/5,1/7-1/19,1/21-1/48,2/2-2/8,3/1-3/8 member portmember
vlan 101 ports add 1/6,1/20,2/1 member portmember
vlan 102 create byport 22
vlan 102 ports remove 1/1-1/6,1/8-1/19,1/21-1/48,2/2-2/8,3/1-3/8 member portmember
vlan 102 ports add 1/7,1/20,2/1 member portmember
```

5. Appendix B – Cisco Default Spanning Tree Settings

The following are the default PVST+ settings on a Cisco switch.

Feature	Default Value
VLAN 1	All ports assigned to VLAN 1
Enable State	PVST+ enabled for all VLANs
Bridge Priority	32768
Port Priority	32
Port Cost	Gigabit Ethernet: 4 Fast Ethernet: 19 Ethernet: 100
Port VLAN Priority	Same as port priority but configurable on a per-VLAN basis in PVST+
Port VLAN cost	Same as port cost but configurable on a per-VLAN basis in PVST+
Bridge Priority	0, 4096, 8192, 12288, 16,384, 20480, 28672, 32768, 36864, 40960, 45056, 49152, 53248, 57344, or 61440

Table 5.0 – Cisco Default PVST+ Settings

5.1 Setting the PVST+ Bridge ID Priority

The bridge ID priority is the priority of a VLAN when the switch is in PVST+ mode.

1. When the switch is in PVST+ mode without MAC address reduction enabled, you can enter a bridge priority value between 0-65535. The bridge priority value you enter also becomes the VLAN bridge ID priority for that VLAN.
2. When the switch is in PVST+ mode with MAC address reduction enabled, you can enter one of 16 bridge priority values: 0, 4096, 8192, 12288, 16384, 20480, 24576, 28672, 32768, 36864, 40960, 45056, 49152, 53248, 57344, or 61440.
3. The bridge priority is combined with the system ID extension (that is, the ID of the VLAN) to create the bridge ID priority for the VLAN.

To set the spanning tree bridge priority for a VLAN, perform this task in privileged mode

6. Reference Documentation

Publication Number	Document Title
317177-A	Release Notes for the Ethernet Routing Switch 8600 Series Switch Release 3.7
314725-C	Configuring VLANs, Spanning Tree, and Link Aggregation (Release 3.7)