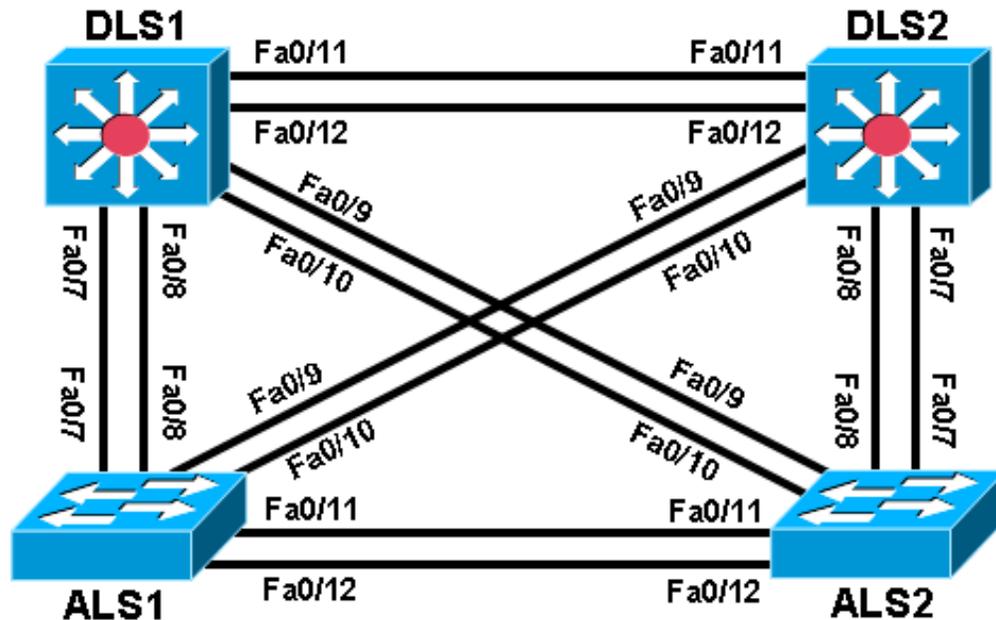


Chapter 3 Lab 3-3, Per-VLAN Spanning Tree Behavior

Topology



Objectives

- Observe the behavior of a separate spanning tree instance per VLAN.
- Change spanning tree mode to rapid spanning tree.

Background

Four switches have just been installed. The distribution layer switches are Catalyst 3560s, and the access layer switches are Catalyst 2960s. There are redundant uplinks between the access layer and distribution layer. Because of the possibility of bridging loops, spanning tree logically removes any redundant links. In this lab, you will see what happens when spanning tree is configured differently for different VLANs.

Note: This lab uses Cisco WS-C2960-24TT-L switches with the Cisco IOS image c2960-lanbasek9-mz.122-46.SE.bin and Catalyst 3560-24PS with the Cisco IOS image c3560-advipservicesk9-mz.122-46.SE.bin. Other switches (such as a 2950 or 3550), and Cisco IOS Software versions can be used if they have comparable capabilities and features. Depending on the switch model and Cisco IOS Software version, the commands available and output produced might vary from what is shown in this lab.

Required Resources

- 2 switches (Cisco 2960 with the Cisco IOS Release 12.2(46)SE C2960-LANBASEK9-M image or comparable)
- 2 switches (Cisco 3560 with the Cisco IOS Release 12.2(46)SE C3560-ADVIPSERVICESK9-M image or comparable)

- Ethernet and console cables

Step 1: Prepare the switches for the lab.

- Delete the vlan.dat file, erase the startup configuration, and reload the switches.
- Give each switch a hostname according to the topology diagram.
- Configure ports Fa0/7 through Fa0/12 on all switches to be trunks. On the 3560s, first set the trunk encapsulation to dot1q. On the 2960s, only dot1q is supported, therefore the **switchport trunk encapsulation** command is unavailable, but the mode still needs to be changed to trunk. If you do not set the mode of the ports to trunk, they will negotiate the operational mode according to their default DTP settings.

Note: The default mode on a 3560 or 2960 is dynamic auto; the default mode on a 3550 or 2950 is dynamic desirable.

DLS1 example:

```
DLS1(config)# interface range fastEthernet 0/7 - 12
DLS1(config-if-range)# switchport trunk encapsulation dot1q
DLS1(config-if-range)# switchport mode trunk
```

Step 2: Configure VTP.

- Configure all switches with VTP mode transparent and VTP domain CISCO. Add VLAN 10 and 20 to all of them. Use the **show vlan brief** command to view the VLAN configurations.

DLS1 example:

```
DLS1(config)# vtp mode transparent
Setting device to VTP TRANSPARENT mode.
```

```
DLS1(config)# vtp domain CISCO
Changing VTP domain name from NULL to CISCO
```

```
DLS1(config)# vlan 10,20
DLS1(config-vlan)# end
```

DLS1# **show vlan brief**

VLAN	Name	Status	Ports
1	default	active	Fa0/1, Fa0/2, Fa0/3, Fa0/4 Fa0/5, Fa0/6, Fa0/9, Fa0/10 Fa0/13, Fa0/14, Fa0/15, Fa0/16 Fa0/17, Fa0/18, Fa0/19, Fa0/20 Fa0/21, Fa0/22, Fa0/23, Fa0/24 Gi0/1, Gi0/2
10	VLAN0010	active	
20	VLAN0020	active	
1002	fddi-default	act/unsup	
1003	token-ring-default	act/unsup	
1004	fddinet-default	act/unsup	
1005	trnet-default	act/unsup	

- b. Issue the **show spanning-tree** command on any of the four switches. Notice that instead of just one VLAN there are three non-reserved VLANs. VLANs 1002-1005 are reserved for internal switch usage. All other VLANs shown are non-reserved.

Note: By default Cisco switches use PVST+, a Cisco-proprietary IEEE 802.1Q-compatible per-VLAN spanning tree protocol.

DLS1# **show spanning-tree**

VLAN0001

Spanning tree enabled protocol ieee

```

Root ID      Priority      32769
             Address      000a.b8a9.d680
             Cost        19
             Port        13 (FastEthernet0/11)
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
    
```

```

Bridge ID    Priority      32769 (priority 32768 sys-id-ext 1)
             Address      000a.b8a9.d780
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time  15
    
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Desg	FWD	19	128.9	P2p
Fa0/8	Desg	FWD	19	128.10	P2p
Fa0/9	Desg	FWD	19	128.11	P2p
Fa0/10	Desg	FWD	19	128.12	P2p
Fa0/11	Root	FWD	19	128.13	P2p
Fa0/12	Altn	BLK	19	128.14	P2p

VLAN0010

Spanning tree enabled protocol ieee

```

Root ID      Priority      32778
             Address      000a.b8a9.d680
             Cost        19
             Port        13 (FastEthernet0/11)
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
    
```

```

Bridge ID    Priority      32778 (priority 32768 sys-id-ext 10)
             Address      000a.b8a9.d780
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time  15
    
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Desg	FWD	19	128.9	P2p
Fa0/8	Desg	FWD	19	128.10	P2p
Fa0/9	Desg	FWD	19	128.11	P2p
Fa0/10	Desg	FWD	19	128.12	P2p
Fa0/11	Root	FWD	19	128.13	P2p
Fa0/12	Altn	BLK	19	128.14	P2p

VLAN0020

```
Spanning tree enabled protocol ieee
Root ID    Priority    32788
          Address    000a.b8a9.d680
          Cost      19
          Port      13 (FastEthernet0/11)
          Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec

Bridge ID  Priority    32788 (priority 32768 sys-id-ext 20)
          Address    000a.b8a9.d780
          Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec
          Aging Time 15
```

Interface	Role	Sts	Cost	Prio.	Nbr	Type
Fa0/7	Desg	FWD	19	128.9		P2p
Fa0/8	Desg	FWD	19	128.10		P2p
Fa0/9	Desg	FWD	19	128.11		P2p
Fa0/10	Desg	FWD	19	128.12		P2p
Fa0/11	Root	FWD	19	128.13		P2p
Fa0/12	Altn	BLK	19	128.14		P2p

Step 3: Assign a root switch for each VLAN.

Notice that all the ports have identical spanning tree behavior for each VLAN. This is because all VLANs are running spanning tree with the default behavior. However, you can modify the default spanning tree behavior on a per-VLAN basis. The default priority is 32768. Configuring a switch with a lower priority value for a given VLAN makes it the root bridge for that VLAN. For this lab, we assign DLS1 as the root bridge for VLAN 10, and DLS2 for VLAN 20.

- a. To change the priority for a given VLAN, use the **spanning-tree vlan *number* priority *number*** command. Configure DLS1 with priority 4096 for VLAN 10. Configure DLS2 similarly for VLAN 20.

```
DLS1(config)# spanning-tree vlan 10 priority 4096
```

```
DLS2(config)# spanning-tree vlan 20 priority 4096
```

- b. If you look at the output of **show spanning-tree** on the four switches, you see that the port states and root switches vary on a per VLAN basis.

```
DLS1# show spanning-tree
```

```
VLAN0001
Spanning tree enabled protocol ieee
Root ID    Priority    32769
          Address    000a.b8a9.d680
          Cost      19
          Port      13 (FastEthernet0/11)
          Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec

Bridge ID  Priority    32769 (priority 32768 sys-id-ext 1)
          Address    000a.b8a9.d780
          Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec
          Aging Time 300
```

Interface	Role	Sts	Cost	Prio.	Nbr	Type
Fa0/7	Desg	FWD	19	128.9		P2p

CCNPv6 SWITCH

```
Fa0/8      Desg FWD 19      128.10  P2p
Fa0/9      Desg FWD 19      128.11  P2p
Fa0/10     Desg FWD 19      128.12  P2p
Fa0/11     Root FWD 19      128.13  P2p
Fa0/12     Altn BLK 19      128.14  P2p
```

VLAN0010

Spanning tree enabled protocol ieee

```
Root ID    Priority    4106
Address    000a.b8a9.d780
```

This bridge is the root

```
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
```

```
Bridge ID  Priority    4106 (priority 4096 sys-id-ext 10)
Address    000a.b8a9.d780
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Desg	FWD	19	128.9	P2p
Fa0/8	Desg	FWD	19	128.10	P2p
Fa0/9	Desg	FWD	19	128.11	P2p
Fa0/10	Desg	FWD	19	128.12	P2p
Fa0/11	Desg	FWD	19	128.13	P2p
Fa0/12	Desg	FWD	19	128.14	P2p

VLAN0020

Spanning tree enabled protocol ieee

```
Root ID    Priority    4116
Address    000a.b8a9.d680
Cost       19
Port       13 (FastEthernet0/11)
```

```
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
```

```
Bridge ID  Priority    32788 (priority 32768 sys-id-ext 20)
Address    000a.b8a9.d780
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Desg	FWD	19	128.9	P2p
Fa0/8	Desg	FWD	19	128.10	P2p
Fa0/9	Desg	FWD	19	128.11	P2p
Fa0/10	Desg	FWD	19	128.12	P2p
Fa0/11	Root	FWD	19	128.13	P2p
Fa0/12	Altn	BLK	19	128.14	P2p

DLS2# **show spanning-tree**

VLAN0001

Spanning tree enabled protocol ieee

```
Root ID    Priority    32769
Address    000a.b8a9.d680
```

This bridge is the root

Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
 Address 000a.b8a9.d680
 Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
 Aging Time 300

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Desg	FWD	19	128.9	P2p
Fa0/8	Desg	FWD	19	128.10	P2p
Fa0/9	Desg	FWD	19	128.11	P2p
Fa0/10	Desg	FWD	19	128.12	P2p
Fa0/11	Desg	FWD	19	128.13	P2p
Fa0/12	Desg	FWD	19	128.14	P2p

VLAN0010

Spanning tree enabled protocol ieee

Root ID Priority 4106
 Address 000a.b8a9.d780
 Cost 19
 Port 13 (FastEthernet0/11)
 Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32778 (priority 32768 sys-id-ext 10)
 Address 000a.b8a9.d680
 Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
 Aging Time 300

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Desg	FWD	19	128.9	P2p
Fa0/8	Desg	FWD	19	128.10	P2p
Fa0/9	Desg	FWD	19	128.11	P2p
Fa0/10	Desg	FWD	19	128.12	P2p
Fa0/11	Root	FWD	19	128.13	P2p
Fa0/12	Altn	BLK	19	128.14	P2p

VLAN0020

Spanning tree enabled protocol ieee

Root ID Priority 4116
 Address 000a.b8a9.d680
 This bridge is the root
 Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 4116 (priority 4096 sys-id-ext 20)
 Address 000a.b8a9.d680
 Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
 Aging Time 300

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Desg	FWD	19	128.9	P2p
Fa0/8	Desg	FWD	19	128.10	P2p
Fa0/9	Desg	FWD	19	128.11	P2p

CCNPv6 SWITCH

```
Fa0/10      Desg FWD 19      128.12  P2p
Fa0/11      Desg FWD 19      128.13  P2p
Fa0/12      Desg FWD 19      128.14  P2p
```

ALS1# **show spanning-tree**

VLAN0001

Spanning tree enabled protocol ieee

```
Root ID      Priority    32769
Address      000a.b8a9.d680
Cost         19
Port         11 (FastEthernet0/9)
Hello Time   2 sec    Max Age 20 sec    Forward Delay 15 sec
```

```
Bridge ID    Priority    32769 (priority 32768 sys-id-ext 1)
Address      0019.0635.5780
Hello Time   2 sec    Max Age 20 sec    Forward Delay 15 sec
Aging Time   300
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Altn	BLK	19	128.9	P2p
Fa0/8	Altn	BLK	19	128.10	P2p
Fa0/9	Root	FWD	19	128.11	P2p
Fa0/10	Altn	BLK	19	128.12	P2p
Fa0/11	Desg	FWD	19	128.13	P2p
Fa0/12	Desg	FWD	19	128.14	P2p

VLAN0010

Spanning tree enabled protocol ieee

```
Root ID      Priority    4106
Address      000a.b8a9.d780
Cost         19
Port         9 (FastEthernet0/7)
Hello Time   2 sec    Max Age 20 sec    Forward Delay 15 sec
```

```
Bridge ID    Priority    32778 (priority 32768 sys-id-ext 10)
Address      0019.0635.5780
Hello Time   2 sec    Max Age 20 sec    Forward Delay 15 sec
Aging Time   15
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Root	FWD	19	128.9	P2p
Fa0/8	Altn	BLK	19	128.10	P2p
Fa0/9	Altn	BLK	19	128.11	P2p
Fa0/10	Altn	BLK	19	128.12	P2p
Fa0/11	Desg	FWD	19	128.13	P2p
Fa0/12	Desg	FWD	19	128.14	P2p

VLAN0020

Spanning tree enabled protocol ieee

```
Root ID      Priority    4116
Address      000a.b8a9.d680
Cost         19
```

CCNPv6 SWITCH

Port 11 (FastEthernet0/9)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32788 (priority 32768 sys-id-ext 20)
Address 0019.0635.5780
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 15

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Altn	BLK	19	128.9	P2p
Fa0/8	Altn	BLK	19	128.10	P2p
Fa0/9	Root	FWD	19	128.11	P2p
Fa0/10	Altn	BLK	19	128.12	P2p
Fa0/11	Desg	FWD	19	128.13	P2p
Fa0/12	Desg	FWD	19	128.14	P2p

ALS2# show spanning-tree

VLAN0001

Spanning tree enabled protocol ieee
Root ID Priority 32769
Address 000a.b8a9.d680
Cost 19
Port 9 (FastEthernet0/7)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
Address 0019.068d.6980
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Root	FWD	19	128.9	P2p
Fa0/8	Altn	BLK	19	128.10	P2p
Fa0/9	Altn	BLK	19	128.11	P2p
Fa0/10	Altn	BLK	19	128.12	P2p
Fa0/11	Altn	BLK	19	128.13	P2p
Fa0/12	Altn	BLK	19	128.14	P2p

VLAN0010

Spanning tree enabled protocol ieee
Root ID Priority 4106
Address 000a.b8a9.d780
Cost 19
Port 11 (FastEthernet0/9)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32778 (priority 32768 sys-id-ext 10)
Address 0019.068d.6980
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 15

Interface	Role	Sts	Cost	Prio.Nbr	Type
-----------	------	-----	------	----------	------

CCNPv6 SWITCH

```
Fa0/7      Altn BLK 19      128.9    P2p
Fa0/8      Altn BLK 19      128.10   P2p
Fa0/9      Root FWD 19      128.11   P2p
Fa0/10     Altn BLK 19      128.12   P2p
Fa0/11     Altn BLK 19      128.13   P2p
Fa0/12     Altn BLK 19      128.14   P2p
```

VLAN0020

```
Spanning tree enabled protocol ieee
```

```
Root ID    Priority    4116
Address    000a.b8a9.d680
Cost       19
Port       9 (FastEthernet0/7)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
```

```
Bridge ID  Priority    32788 (priority 32768 sys-id-ext 20)
Address    0019.068d.6980
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 15
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Root	FWD	19	128.9	P2p
Fa0/8	Altn	BLK	19	128.10	P2p
Fa0/9	Altn	BLK	19	128.11	P2p
Fa0/10	Altn	BLK	19	128.12	P2p
Fa0/11	Altn	BLK	19	128.13	P2p
Fa0/12	Altn	BLK	19	128.14	P2p

Step 4: Configure RSTP.

Other spanning tree modes besides PVST+ are available. One of these is RSTP (rapid spanning tree protocol), which greatly reduces the time for a port to transition to forwarding state while still preventing bridging loops. Cisco-proprietary per-VLAN rapid spanning tree (PVRST+) combines the functionality of RSTP and PVST.

Note: You can use the **clear spanning-tree detected-protocols** command after configuring different spanning tree modes. This can avoid a mutual deadlock between two switches when they consider themselves as 802.1D legacy bridges when in fact they were configured for RSTP.

- To change the spanning tree mode to PVRST+, use the global configuration command **spanning-tree mode rapid-pvst**. Configure this on all four switches. During the transition period, rapid spanning tree falls back to 802.1D spanning tree on the links that have 802.1D spanning tree configured on one side.

```
DLS1(config)# spanning-tree mode rapid-pvst
```

- After configuring all four switches with this command, use the **show spanning-tree** command to verify the configuration:

```
DLS1# show spanning-tree
```

VLAN0001

```
Spanning tree enabled protocol rstp
Root ID    Priority    32769
Address    000a.b8a9.d680
Cost       19
```

CCNPv6 SWITCH

Port 13 (FastEthernet0/11)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
Address 000a.b8a9.d780
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Desg	FWD	19	128.9	P2p
Fa0/8	Desg	FWD	19	128.10	P2p
Fa0/9	Desg	FWD	19	128.11	P2p
Fa0/10	Desg	FWD	19	128.12	P2p
Fa0/11	Root	FWD	19	128.13	P2p
Fa0/12	Altn	BLK	19	128.14	P2p

VLAN0010

Spanning tree enabled protocol rstp

Root ID Priority 4106
Address 000a.b8a9.d780
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 4106 (priority 4096 sys-id-ext 10)
Address 000a.b8a9.d780
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Desg	FWD	19	128.9	P2p
Fa0/8	Desg	FWD	19	128.10	P2p
Fa0/9	Desg	FWD	19	128.11	P2p
Fa0/10	Desg	FWD	19	128.12	P2p
Fa0/11	Desg	FWD	19	128.13	P2p
Fa0/12	Desg	FWD	19	128.14	P2p

VLAN0020

Spanning tree enabled protocol rstp

Root ID Priority 4116
Address 000a.b8a9.d680
Cost 19
Port 13 (FastEthernet0/11)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32788 (priority 32768 sys-id-ext 20)
Address 000a.b8a9.d780
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/7	Desg	FWD	19	128.9	P2p
Fa0/8	Desg	FWD	19	128.10	P2p
Fa0/9	Desg	FWD	19	128.11	P2p

CCNPv6 SWITCH

Fa0/10	Desg FWD 19	128.12	P2p
Fa0/11	Root FWD 19	128.13	P2p
Fa0/12	Altn BLK 19	128.14	P2p

Challenge

- a. On each switch, add VLANs 50, 60, 70, 80, 90, and 100. Configure ALS1 to be the root bridge for VLANs 50, 60, and 70, and ALS2 to be the root bridge for VLANs 80, 90, and 100. Configure the root bridges with a single line on each switch.

HINT: Use the question mark when you type the global configuration command **spanning-tree vlan ?**. Notice that you can modify spanning tree attributes in ranges.

- b. Change the spanning tree cost of VLAN 20 on Fa0/11 and Fa0/12 between DLS1 and DLS2 to 15.

HINT: Use the question mark on the interface level command **spanning-tree vlan *number* ?**.