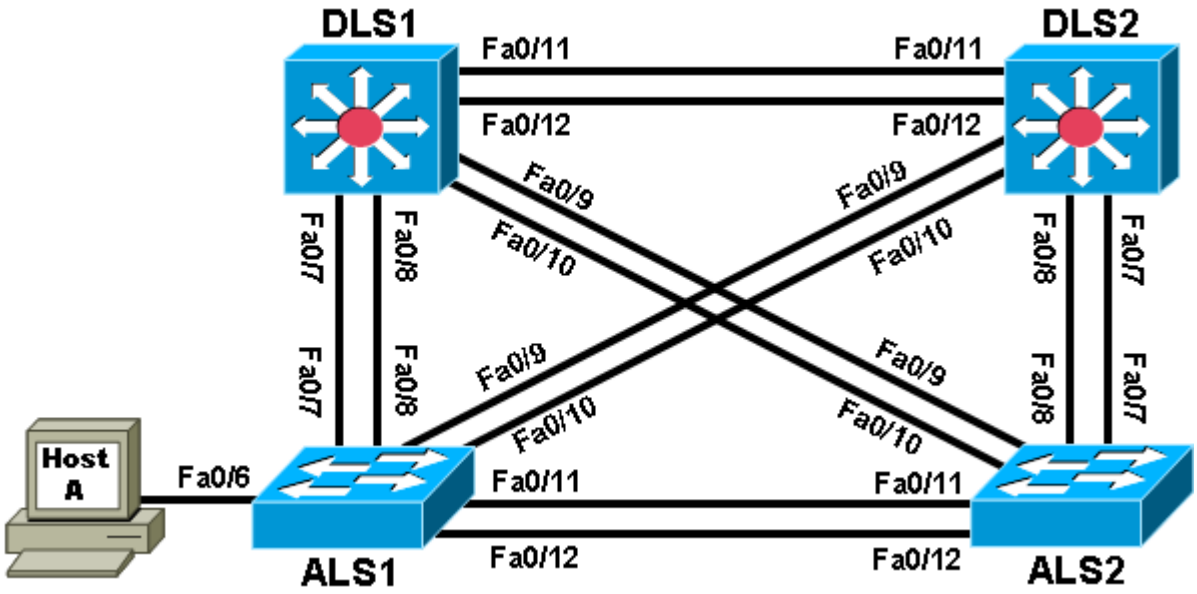
Chapter 3 Lab 3-2, Modifying Default Spanning Tree Behavior

Topology



Objective

- Observe what happens when the default spanning tree behavior is modified.

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 the default spanning tree behavior is modified.

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 switches 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)
- 1 PC (optional) attached to switch ALS1.
- Ethernet and console cables

Note: Configuring PortFast in Step 5 requires a PC attached to one of the access switches.

Step 1: Prepare the switches for the lab.

a. Delete vlan.dat, erase the startup configuration, and reload all switches. You can find detailed instructions in Lab 1-1 or 1-2.

b. Give each switch a hostname according to the topology diagram.

c. 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: Display default spanning tree information for all switches.

a. Use the **show spanning-tree** command to check how the non-configured switches created a spanning tree. Verify which switch became the root bridge. In the topology used in this lab, DLS2 is the root bridge.

```
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
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


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


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
```

b. If you receive the following message “No spanning tree instance exists”, issue the **no shutdown** command on all interfaces.

```
Switch# show spanning-tree

No spanning tree instance exists.

Switch# conf t
Switch(config)# interface range fastEthernet 0/1-24
Switch(config-if-range)# no shutdown
Switch(config-if-range)# end
Switch# show spanning-tree
```

Now that the switch is communicating with the other switches in the topology, you should receive spanning tree output.

c. Issue the **show interfaces trunk** command on DLS1 to verify the trunking mode, encapsulation and status for the trunk links.

```
DSL1# show interfaces trunk

Port        Mode             Encapsulation  Status        Native vlan
Fa0/7       on               802.1q         trunking      1
Fa0/8       on               802.1q         trunking      1
Fa0/9       on               802.1q         trunking      1
Fa0/10      on               802.1q         trunking      1
Fa0/11      on               802.1q         trunking      1
Fa0/12      on               802.1q         trunking      1

Port        Vlans allowed on trunk
Fa0/7       1-4094
Fa0/8       1-4094
Fa0/9       1-4094
Fa0/10      1-4094
Fa0/11      1-4094
Fa0/12      1-4094

<output omitted>
```

Are BPDUs propagated without trunk links?

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Step 3: Configure specific switches to be primary and secondary root.

In this step you configure other switches to be the primary root and secondary root. Because DLS2 is the root switch in this topology, this lab changes DLS1 to be the primary root and ALS1 to be the secondary. Do the same in your topology, regardless of which switch is the initial root. On one of the switches that you are not changing, you can use the **debug spanning-tree events** command to monitor topology changes. To change the spanning tree root status, use the global configuration commands **spanning-tree vlan** *vlan_number* **root primary** and **spanning-tree vlan** *vlan_number* **root secondary**. On a switch that you are not going to be modifying, issue the **debug** command and then watch the output.

a. Issue the **debug** command on DLS2.

```
DLS2# debug spanning-tree events
Spanning Tree event debugging is on
```

b. Change DLS1 to be the primary root switch.

```
DLS1(config)# spanning-tree vlan 1 root primary
```

c. Change ALS1 to the secondary root.

```
ALS1(config)# spanning-tree vlan 1 root secondary
```

You can see the topology changes on the switch that you enabled debugging on (your output may vary depending on your initial topology):

```
DLS2#
00:10:43: STP: VLAN0001 heard root 24577-000a.b8a9.d780 on Fa0/11
00:10:43:     supersedes 32769-000a.b8a9.d680
00:10:43: STP: VLAN0001 new root is 24577, 000a.b8a9.d780 on port Fa0/11, cost
19
00:10:43: STP: VLAN0001 sent Topology Change Notice on Fa0/11
00:10:43: STP: VLAN0001 Fa0/12 -> blocking
00:10:53: STP: VLAN0001 sent Topology Change Notice on Fa0/11
00:10:53: STP: VLAN0001 Fa0/9 -> blocking
00:10:53: STP: VLAN0001 Fa0/10 -> blocking
```

Notice the timestamps on the debugs to see the difference between changes caused by the commands done in both steps.

d. Display the running config on the new root switches, DLS1 and ALS1.

```
DLS1# show run | include span
spanning-tree mode pvst
spanning-tree extend system-id
spanning-tree vlan 1 priority 24576
```

```
ALS1# show run | include span
spanning-tree mode pvst
spanning-tree extend system-id
spanning-tree vlan 1 priority 28672
```

Notice the spanning tree commands in the running configuration. You see a different command than the one you entered. This is because **spanning-tree vlan** *vlan_number* **root** is a command that sets the priority

number on that VLAN automatically rather than typing in a specific priority number. The priority number of a VLAN can be between 0 and 61440 in increments of 4096. To manually set the specific priority number, use the **spanning-tree vlan** *vlan_number* **priority** *priority_number* command.

The command **spanning-tree vlan** *vlan_number* **root primary** sets the priority to 24576 instead of the default (32768). The command **spanning-tree vlan** *vlan_number* **root secondary** sets the priority to 28672. Given this information, would a lower or higher priority number result in a switch becoming the root bridge?

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e. You can also view the priority modification with the **show spanning-tree** command:

```
DLS1# show spanning-tree

VLAN0001
  Spanning tree enabled protocol ieee
  Root ID     Priority    24577
              Address     000a.b8a9.d780
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    24577  (priority 24576 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           Desg FWD 19        128.13   P2p
Fa0/12           Desg FWD 19        128.14   P2p
```

Step 4: Change the root port using the spanning-tree port-priority command.

With spanning tree, you can also modify port priorities to determine which ports are forwarding and which are blocking. To choose which port becomes the root on a non-root switch when faced with equal-cost redundant root paths via the same neighbor, the switch looks at the port priorities first. If the sender port priorities are the same, the switch picks the port that receives BPDUs with the lowest sender port number. On the link between DLS1 and DLS2, the default forwarding port is Fa0/11 because it is lower, and the default blocking port is Fa0/12 because it is higher. The two ports have equal costs because they have the same speed.

a. You can verify this using the **show spanning-tree** command on the non-root switch, which is DLS2.

```
DLS2# show spanning-tree

VLAN0001
  Spanning tree enabled protocol ieee
  Root ID     Priority    24577
              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    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            Altn BLK 19        128.11   P2p
Fa0/10           Altn BLK 19        128.12   P2p
Fa0/11           Root FWD 19        128.13   P2p
Fa0/12           Altn BLK 19        128.14   P2p
```

b. For comparison, issue the **show spanning-tree** command on DLS1. Notice that all ports are forwarding because it is the root switch.

```
DLS1# show spanning-tree

VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    24577
             Address     000a.b8a9.d780
             This bridge is the root
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    24577  (priority 24576 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           Desg FWD 19        128.13   P2p
Fa0/12           Desg FWD 19        128.14   P2p
```

Port priorities range from 0 to 240, in increments of 16. The default priority is 128, and a lower priority is preferred. To change port priorities, change them on the switch closer to the root.

c. To make DLS2 Fa0/12 the root port, and Fa0/11 block, change the port priority on DLS1 with the interface-level command **spanning-tree port-priority** *priority*.

```
DLS1(config)# int fastEthernet 0/12
DLS1(config-if)# spanning-tree port-priority 112
```

d. Issue the **show spanning-tree** command to verify which port is blocking on DLS2.

```
DLS2# show spanning-tree

VLAN0001
  Spanning tree enabled protocol ieee
```

```
  Root ID     Priority    24577
              Address     000a.b8a9.d780
              Cost        19
              Port        14 (FastEthernet0/12)
              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 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            Altn BLK 19        128.11   P2p
Fa0/10           Altn BLK 19        128.12   P2p
Fa0/11           Altn BLK 19        128.13   P2p
Fa0/12           Root FWD 19        128.14   P2p
```

On DLS2, although the root port has changed, the port priorities have not. On DLS1, you can see the port priorities have changed, although all ports are still forwarding (because it is the root switch).

```
DLS1# show spanning-tree

VLAN0001
  Spanning tree enabled protocol ieee
  Root ID     Priority    24577
              Address     000a.b8a9.d780
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    24577  (priority 24576 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           Desg FWD 19        128.13   P2p
Fa0/12           Desg FWD 19        112.14   P2p
```

Using the above output, how does DLS2 know which port to change to the root port, without changing the port priorities on DLS2?

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Step 5: Configure PortFast on an access port.

a. (Optional) If you have a host attached to ASL1 Fa0/6 you can perform this step. If not, read through the following information to see how a port goes through the spanning tree states with and without PortFast enabled.

Another feature of spanning tree is PortFast. PortFast allows you to bypass the normal states of IEEE 802.1D spanning tree and move a port to the forwarding state as soon as it is turned on. This is useful when connecting hosts to a switch, because they can start communicating on the VLAN instantly rather than waiting for spanning tree. There is no danger of creating a spanning tree loop because you are not connecting another switch. A client that runs DHCP as soon as it starts up benefits, because the DHCP requests could be ignored if the port was not in the spanning tree forwarding state. PortFast must be used carefully to avoid inadvertently creating spanning tree loops.

b. Ensure that the port to which the host is attached (Fa0/6) on ALS1 is shut down initially.

```
ALS1(config)# interface fastEthernet 0/6
ALS1(config-if)# shutdown
```

c. Enable spanning tree debugging on ALS1.

```
ALS1# debug spanning-tree events
Spanning Tree event debugging is on
```

d. Set port Fa0/6 switchport mode to access, enable the port and observe the debug output. Notice what happens when the port is brought up. Your output may vary.

```
ALS1(config)# interface fastEthernet 0/6
ALS1(config-if)# switchport mode access
ALS1(config-if)# no shut
ALS1(config-if)# end
ALS1#

22:32:23: set portid: VLAN0001 Fa0/6: new port id 800D
22:32:23: STP: VLAN0001 Fa0/6 -> listening
22:32:25: %LINK-3-UPDOWN: Interface FastEthernet0/6, changed state to up
22:32:26: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/6,
changed state to up
22:32:38: STP: VLAN0001 Fa0/6 -> learning
22:32:53: STP: VLAN0001 Fa0/6 -> forwarding
22:32:53: STP: VLAN0001 sent Topology Change Notice on Fa0/7
```

e. Shut down the port for the next part.

```
ALS1(config)# interface fastEthernet 0/6
ALS1(config-if)# shutdown
```

f. Activate PortFast on the port with the interface-level command **spanning-tree portfast**. The switch warns you about the possibility of creating switching loops.

```
ALS1(config)# interface fastEthernet 0/6
ALS1(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

%Portfast has been configured on FastEthernet0/6 but will only
 have effect when the interface is in a non-trunking mode.
```

g. Now, bring up the port by issuing the **no shutdown** command on the interface.

```
ALS1(config-if)# no shutdown

22:43:23: set portid: VLAN0001 Fa0/6: new port id 800D
22:43:23: STP: VLAN0001 Fa0/6 ->jump to forwarding from blocking
22:43:25: %LINK-3-UPDOWN: Interface FastEthernet0/6, changed state to up
22:43:26: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/6,
changed state to up
```

h. Be sure to turn off debugging before continuing:

```
ALS1(config-if)# end
ALS1#
22:55:23: %SYS-5-CONFIG_I: Configured from console by console
ALS1# undebug all
All possible debugging has been turned off
```

Why could enabling portfast on redundant switch access links be a bad idea?

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Note: The **spanning-tree portfast trunk** interface-level command can be useful if a trunk is being connected to a router or a server. If RSTP is used, both trunk and access links can be moved to a forwarding state rapidly. The **spanning-tree portfast trunk** command is to be used only on trunks connected to non-switching devices.

Step 6: Change root port using the spanning-tree cost command.

Another way of changing which port becomes the root is to modify the port costs using the interface command **spanning-tree cost** *cost*. The default cost is 4 for a gigabit Ethernet port, 19 for a Fast Ethernet port, and 100 for a 10baseT Ethernet port. Lower cost is preferred.

Note: Each port has a default cost value based on a guideline established as part of IEEE 802.1d. In the original specification, the cost of a port cost is calculated as 1,000 Mbps (1 gigabit per second) divided by the bandwidth at which the port is functioning. A 10 Mbps connection have a cost of (1,000/10) or 100. As the speed of networks has increased beyond gigabit, the standard cost has been modified somewhat. The new cost values are:

Bandwidth	STP Cost
4 Mbps	250
10 Mbps	100
16 Mbps	62
45 Mbps	39
100 Mbps	19

155 Mbps	14
622 Mbps	6
1 Gbps	4
10 Gbps	2

a. For this scenario, change the cost of port Fa0/10 on ALS2. First, look at the current port costs using the **show spanning-tree** command.

Note: The cost shown here is for the port. The root bridge path cost is the sum of link port costs between a switch and the root bridge. The cost of traversing this path is the sum of the costs of the segments on the path. This determines how far away the root bridge is.

```
ALS2# show spanning-tree

VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    24577
             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    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            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
```

Note that Fa0/9 is currently the root port.

b. Change the port cost for Fa0/10 on ALS2 to 10 and then issue the **show spanning-tree** command.

```
ALS2(config)# interface fastEthernet 0/10
ALS2(config-if-range)# spanning-tree cost 10



ALS2# show spanning-tree

VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    24577
             Address     000a.b8a9.d780
             Cost        10
```

```
              Port        12 (FastEthernet0/10)
              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            Altn BLK 19        128.9    P2p
Fa0/8            Altn BLK 19        128.10   P2p
Fa0/9            Altn FWD 19        128.11   P2p
Fa0/10           Root FWD 10        128.12   P2p
Fa0/11           Altn BLK 19        128.13   P2p
Fa0/12           Altn BLK 19        128.14   P2p
```