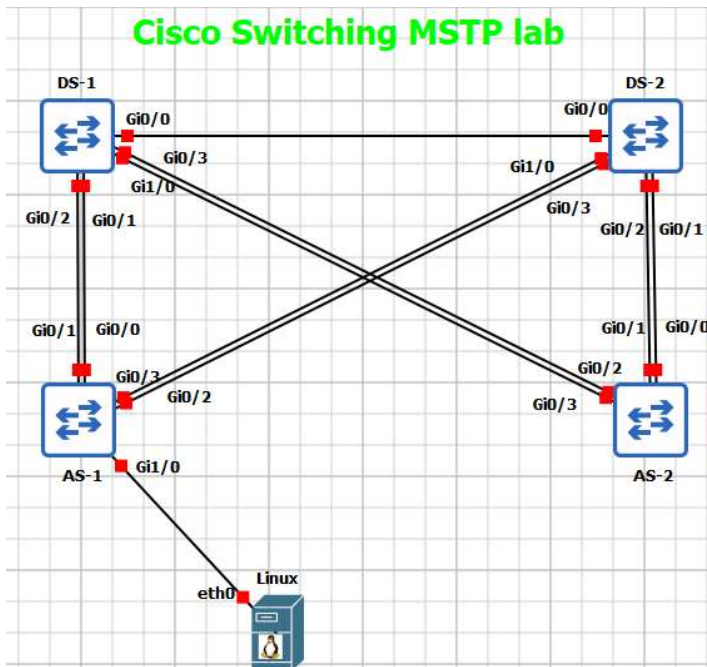


CCNP Switching MSTP Lab

Topology



Objectives

1. Configure Basic Device Settings
2. Implement MST
3. Configure, Tune and Verify Basic MST Operation
4. Controlling Root Bridge election
5. Port cost and priority values

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In this lab, you will set up two instances of MST, one for VLANs 20 and 30 and the other for VLANs 40 and 50. All other VLANs will be mapped to the default MST instance (also referred to as IST or Internal Spanning Tree).

Task 1: Configure Basic

Switch DS-1

```
hostname DS-1
spanning-tree mode rapid-pvst
line con 0
exec-timeout 0 0
logging synchronous
exit
interface range g0/0-3, g1/0-3
shutdown
exit
interface range g0/0-3, g1/0
switchport trunk encapsulation dot1q
switchport mode trunk
no shutdown
exit
vlan 20
name Studentgroup20
exit
vlan 30
name Studentgroup30
exit
vlan 40
name Studentgroup40
exit
vlan 50
name Studentgroup50
exit
```

Switch

DS-2

```
hostname DS-2
spanning-tree mode rapid-pvst
line con 0
exec-timeout 0 0
logging synchronous
exit
interface range g0/0-3, g1/0-3
shutdown
exit
interface range g0/0-3, g1/0
switchport trunk encapsulation dot1q
switchport mode trunk
no shutdown
exit
vlan 20
```

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```
    name Studentgroup20
    exit
vlan 30
    name Studentgroup30
    exit
vlan 40
    name Studentgroup40
    exit
vlan 50
    name Studentgroup50
    exit
```

Switch AS-1

```
hostname AS-1
spanning-tree mode rapid-pvst
line con 0
    exec-timeout 0 0
    logging synchronous
    exit
interface range g0/0-3, g1/0-3
    shutdown
    exit
interface range g0/0-3
    switchport trunk encapsulation dot1q
    switchport mode trunk
    no shutdown
    exit
vlan 20
    name Studentgroup20
    exit
vlan 30
    name Studentgroup30
    exit
vlan 40
    name Studentgroup40
    exit
vlan 50
    name Studentgroup50
    exit
```

Switch AS-2

```
hostname AS-2
spanning-tree mode rapid-pvst
line con 0
    exec-timeout 0 0
    logging synchronous
    exit
interface range g0/0-3, g1/0-3
    shutdown
```

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```

exit
interface range g0/0-3
    switchport trunk encapsulation dot1q
    switchport mode trunk
    no shutdown
exit
vlan 20
    name Studentgroup20
    exit
vlan 30
    name Studentgroup30
    exit
vlan 40
    name Studentgroup40
    exit
vlan 50
    name Studentgroup50
    exit

```

Task 2: Configure MST

Step 1. Configure MST on DS-1 and DS-2

On D1 and D2, issue the command **spanning-tree mode mst**.

```
DS-1(config)# spanning-tree
DS-2(config)# spanning-tree mode mst
mode mst
```

Step 2. Verify MST

At this point, with no MST-specific configuration, MST Instance 0 is operational for all VLANs. Issue the command **show spanning-tree** and you will see in the output that the spanning tree information is about MST 0.

Issue the command **show spanning-tree mst** and you will see the MST-specific STP information that is specific to MST 0 only. Take note of the information displayed for interfaces g0/1-3 and g1/0 because they are connected to a switch that is not running MST. Their type is listed as P2p Bound (PVST).

```
DS-1#show spanning-tree
```

```

MST0
Spanning tree enabled protocol mstp
Root ID      Priority      32768
             Address      500a.0001.0000
             This bridge is the root
             Hello Time   2 sec    Max Age 20 sec    Forward Delay 15 sec

Bridge ID    Priority      32768 (priority 32768 sys-id-ext 0)
             Address      500a.0001.0000
             Hello Time   2 sec    Max Age 20 sec

```

```
Interface          Role Sts Cost           Prio.Nbr
-----
Gi0/0              Desg FWD 20000---- 128.1---  Twpward Delay 15 sec
```

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```

Gi0/1          Desg FWD 20000      128.2    P2p Bound(PVST)
Gi0/2          Desg FWD 20000      128.3    P2p Bound(PVST)
Gi0/3          Desg FWD 20000      128.4    P2p Bound(PVST)
Gi1/0          Desg FWD 20000      128.5    P2p Bound(PVST)

```

DS-1#

DS-1#**show spanning-tree mst**

```

##### MST0      vlans mapped: 1-4094
Bridge          address 500a.0001.0000 priority      32768 (32768 sysid 0)
Root            this switch for the CIST
Operational     hello time 2 , forward delay 15, max age 20, txholdcount 6
Configured      hello time 2 , forward delay 15, max age 20, max hops 20

```

Interface	Role	Sts	Cost	Prio.Nbr	Type

Gi0/0	Desg	FWD	20000	128.1	P2p
Gi0/1	Desg	FWD	20000	128.2	P2p Bound(PVST)
Gi0/2	Desg	FWD	20000	128.3	P2p Bound(PVST)
Gi0/3	Desg	FWD	20000	128.4	P2p Bound(PVST)
Gi1/0	Desg	FWD	20000	128.5	P2p Bound(PVST)

DS-1#

Issue the command **show spanning-tree root** on switch AS-1. Switch AS-1 is running five instances of spanning tree.

AS-1#**show spanning-tree root**

Vlan	Root ID	Root Cost	Hello Time	Max Age	Fwd Dly	Root Port
VLAN0001	32768 500a.0001.0000	4	2	20	15	Gi0/0
VLAN0020	32768 500a.0001.0000	4	2	20	15	Gi0/0
VLAN0030	32768 500a.0001.0000	4	2	20	15	Gi0/0
VLAN0040	32768 500a.0001.0000	4	2	20	15	Gi0/0
VLAN0050	32768 500a.0001.0000	4	2	20	15	Gi0/0

Issue the **show spanning-tree root** command on DS-2 and the output will be different. This is because with MST, only one instance of the spanning-tree algorithm runs, regardless of the number of VLANs mapped to it.

DS-2#**show spanning-tree root**

MST Instance	Root ID	Root Cost	Hello Time	Max Age	Fwd Dly	Root Port
MST0	32768 500a.0001.0000	0	2	20	15	Gi0/0

Step 3. Configure MST on AS-1 and AS-2.

Configure AS-1 and AS-2 to use MST.

```

AS-1(config)# spanning-tree
AS-2(config)# spanning-tree mode mst

```

Task 3: Configure, Tune and Verify Basic MST Operation

In the last part, you configured all four switches to run MST. In this part, you will further configure, tune, and verify MST to support the unique topological requirements.

Step 1. Create MST configuration.

MST allows network engineers to reduce the load of the spanning-tree protocol while still providing unique spanning-tree topologies for groups of VLANs. MST configuration must be completed by hand on each switch individually.

Complete the following tasks on switch DS-1:

Open configuration window

Enter MST configuration mode using the command **spanning-tree mst configuration**.

```
DS-1(config)# spanning-tree mst configuration
```

Configure an MST region name. Our example will be CCNPv8.

```
DS-1(config-mst)# name CCNPv8
```

Configure an MST configuration revision number. Our example will be 1.

```
DS-1(config-mst)# revision 1
```

Configure instance 1 to include VLAN 20.

```
DS-1(config-mst)# instance 1 vlan 20
```

Configure instance 2 to include VLAN 40.

```
DS-1(config-mst)# instance 2 vlan 40
```

Commit the configuration by typing exit and returning to global configuration mode.

```
DS-1(config-mst)# exit
```

```
DS-1(config)# end
```

Issue the command **show spanning-tree mst** to verify the configuration is in place.

Note: While in spanning-tree mst configuration mode, you can use the **show current** and **show pending** commands to view current and pending configuration settings.

```
DS-1#show spanning-tree mst
```

```
##### MST0      vlans mapped: 1-19,21-39,41-4094
Bridge          address 500a.0001.0000 priority      32768 (32768 sysid 0)
Root            this switch for the CIST
Operational     hello time 2 , forward delay 15, max age 20, txholdcount 6
Configured      hello time 2 , forward delay 15, max age 20, max hops 20

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

Gi0/0          Desg      20000      128.1      P2p
Gi0/1          Desg FWD 20000      128.2      P2p
Gi0/2          Desg FWD 20000      128.3      P2p
Gi0/3          Desg FWD 20000      128.4      P2p
Gi1/0          Desg FWD 20000      128.5      P2p
##### MST1      vlans mapped: 20
Bridge          address 500a.0001.0000 priority      32769 (32768 sysid 1)
Root            this switch for MST1      priority

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

Gi0/0          Desg FWD 20000      128.1      P2p
Gi0/1          Desg FWD 20000      128.2      P2p
Gi0/2          Desg FWD 20000      128.3      P2p
```

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```

Gi0/3          Desg FWD 20000      128.4    P2p
Gi1/0          Desg FWD 20000      128.5    P2p

#### MST2      vlans mapped:   40
Bridge         address 500a.0001.0000  priority          32770 (32768 sysid 2)
Root           this switch for MST2

```

Interface	Role	Sts	Cost	Prio.Nbr	Type

Gi0/0	Desg	FWD	20000	128.1	P2p
Gi0/1	Desg	FWD	20000	128.2	P2p
Gi0/2	Desg	FWD	20000	128.3	P2p
Gi0/3	Desg	FWD	20000	128.4	P2p
Gi1/0	Desg	FWD	20000	128.5	P2p

This configuration does not propagate to other switches. Each switch exchanges digest information summarizing the VLAN-to-Instance mappings it has configured. If a switch receives a BPDU with a different digest, it assumes that the sender is in a different MST region. The output below is what AS-1 shows in the topology used to create this lab. Notice that the ports connected to DS-1 are classified as P2p Bound (RSTP).

AS-1#show spanning-tree mst

```

#### MST0      vlans mapped:   1-4094
Bridge         address 500a.0003.0000  priority          32768 (32768 sysid 0)
Root           address 500a.0001.0000  priority          32768 (32768 sysid 0)
               port      Gi0/2          path cost        20000
Regional Root  address 500a.0002.0000  priority          32768 (32768 sysid 0)
               internal cost 20000      rem hops 19
Operational    hello time 2 , forward delay 15, max age 20, txholdcount 6
Configured     hello time 2 , forward delay 15, max age 20, max hops 20
Interface      Role Sts Cost      Prio.Nbr Type
-----
--
Gi0/0          Altn BLK 20000    128.2    P2p
Gi0/1          Altn      20000    128.3    P2p
Gi0/2          Root BLK 20000    128.4    P2p Bound(RSTP)
Gi0/3          Root BLK 20000    128.4    P2p Bound(RSTP)

```

AS-1#show spanning-tree mst configuration digest

```

Name          []
Revision 0     Instances configured 1
Digest        0xAC36177F50283CD4B83821D8AB26DE62
Pre-std Digest 0xBB3B6C15EF8D089BB55ED10D24DF44DE

```

And here is the digest from DS-1:

```

DS-1#show spanning-tree mst configuration digest
Name          [CCNPv8]
Revision 1     Instances configured 3
Digest        0xDD5B4DDB5BDF444012BFCC12F9D36D8C
Pre-std Digest 0x75ED995165115155BF464372066C225B

```

As you can see here, the digest values are different.

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Configure MST on DS-1, change the revision number to 2 and add VLAN 30 to instance 1 and VLAN 50 to instance 2.

```
DS-1(config)#spanning-tree mst configuration
```

```
DS-1(config-mst)#show current
```

```
Current MST configuration
```

```
Name [CCNPv8]
```

```
Revision 1 Instances configured 3
```

```
Instance Vlans mapped
```

```
----
```

```
0 1-19,21-39,41-4094
```

```
1 20
```

```
2 40
```

```
----
```

```
DS-1(config-mst)#revision 2
```

```
DS-1(config-mst)#instance 1 vlan 30
```

```
DS-1(config-mst)#instance 2 vlan 50
```

```
DS-1(config-mst)#show pending
```

```
Pending MST configuration
```

```
Name [CCNPv8]
```

```
Revision 2 Instances configured 3
```

```
Instance Vlans mapped
```

```
----
```

```
0 1-19,21-29,31-39,41-49,51-4094
```

```
1 20,30
```

```
2 40,50
```

```
----
```

```
DS-1(config-mst)#end
```

Now configure DS-2, AS-1 and AS-2 with the same configuration settings (name CCNPv8, revision2, instance 1 vlans 20-30, instance 2 vlans 40-50). After completing the configuration on DS-2, AS-1 and AS-2, the output of **show spanning-tree mst** on AS-1 should be similar to the following output. DS-1 in this case is the root for all 3 instances.

```
AS-1#show spanning-tree mst
```

```
##### MST0 vlans mapped: 1-19,21-29,31-39,41-49,51-4094
Bridge address 500a.0003.0000 priority 32768 (32768 sysid 0)
Root address 500a.0001.0000 priority 32768 (32768 sysid 0)
port Gi0/0 path cost 0
Regional Root address 500a.0001.0000 priority 32768 (32768 sysid 0)
internal cost 20000 rem hops 19
Operational hello time 2, forward delay 15, max age 20, txholdcount 6
Configured hello time 2, forward delay 15, max age 20, max hops 20
```

```
--
```

```
Gi0/0 Root 20000 128.1 P2p
Gi0/1 Altn FWD 20000 128.2 P2p
Gi0/2 Altn BLK 20000 128.3 P2p
Gi0/3 Altn BLK 20000 128.4 P2p
```

```
##### MST1 vlans mapped: 20,30
```

```
Bridge address 500a.0003.0000 32769 (32768 sysid 1)
```

```
Root address 500a.0001.0000 priority 32769 (32768 sysid 1)
priority
```



```

port      Gi0/0      cost      20000      rem hops 19

Interface      Role Sts Cost      Prio.Nbr Type
-----
--
Gi0/0          Root FWD 20000      128.1      P2p
Gi0/1          Altn BLK 20000      128.2      P2p
Gi0/2          Altn BLK 20000      128.3      P2p
Gi0/3          Altn BLK 20000      128.4      P2p
##### MST2      vlans mapped: 40,50
Bridge         address 500a.0003.0000 priority      32770      (32768 sysid 2)
Root          address 500a.0003.0000 priority      32770      (32768 sysid 2)
              port Gi0/0      cost      20000      rem hops 19

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

Gi0/0          Root FWD 20000      128.1      P2p
Gi0/1          Altn BLK 20000      128.2      P2p
Gi0/2          Altn BLK 20000      128.3      P2p
Gi0/3          Altn BLK 20000      128.4      P2p
AS-1#

```

Task 4: Controlling the Root Bridge.

There are two basic ways to manipulate the configuration to control the location of the root bridge: The **spanning-tree mst instance-id priority value** command can be used to manually set a priority value

The **spanning-tree mst instance-id root { primary | secondary }** command can be used to automatically set a priority value.

The difference between the two is the **priority** command will set a specific number (multiple of 4096) as the priority, while the **root primary** command will set the local bridge's priority to 24,576 (if the local bridge MAC is lower than the current root bridge's MAC) or 4096 lower than the current root's priority (if the local bridge MAC is higher than the current root bridge's MAC).

The logic behind this operation is straight-forward. The **root primary** command tries to lower the priority only as much as is needed to win the root election, while leaving priorities between 24576 and the default 32768 for use by secondary bridges. The command always takes the entire Bridge ID into account when computing the resulting priority value.

The **spanning-tree mst instance-id secondary** command will statically set the local bridge's priority to 28,672. In an otherwise unconfigured network where all switch priorities default to 32,768, the **root primary** command will set the priority on the switch to 24,576 (two increments lower than the default priority) while the **root secondary** command will set the priority on the secondary root to the 28,672 (one increment lower than the default priority).

Step 1. Modify MST priorities

Modify DS-1 and DS-2 so that DS-1 is elected the primary root bridge for MST Instance 1 and DS-2 is elected the primary root bridge for MST Instance 2. DS-1 should be elected as the secondary root bridge for MST Instance 2, and DS-2 should be elected as the secondary root bridge for MST Instance 1. You will need to make configuration changes on both D1 and D2.

```

DS-1(config)# spanning-tree 1 primary
DS-1(config)# spanning-tree mst 2 root secondary
DS-2(config)# spanning-tree mst 2 root primary
DS-2(config)# spanning-tree mst 1 root secondary

```

After you have configured both DS-1 and DS-2, go to AS-1 and issue the command **show spanning-tree root**. In this output, you will see the root bridges differentiated.

```
AS-1#show spanning-tree root
```

MST Instance	Root ID	Root Cost	Hello Time	Max Age	Fwd Dly	Root Port
MST0	32768 500a.0001.0000	0	2	20	15	Gi0/0
MST1	24577 500a.0001.0000	20000	2	20	15	Gi0/0
MST2	24578 500a.0002.0000	20000	2	20	15	Gi0/2

From the above output, you can see that the root port for VLAN 20 is G0/0 and the root port for VLAN 40 is G0/2. DS-1 is the root bridge for MST Instance 0 in this example.

Task 5: Adjust port cost and priority values to impact root and designated port selection.

As the network is implemented right now, there are two direct paths between switch AS-1 and the root bridge for each MST. Path and port costs are evaluated to determine the shortest path to the root bridge. In the case where there are multiple equal cost paths to the root bridge, additional attributes must be evaluated. In our case, the lower interface number (for example, G0/0) is chosen as the Root Port, and the higher interface number (for example, G0/1) is put into a spanning tree Blocking state.

You can see which ports are blocked with the **show spanning-tree vlan-id** command or the **show spanning-tree blockedports** command. For now, examine VLAN 20 on DS-1.

Step 1. Observe blocked ports

On A1, issue the commands **show spanning-tree mst 1** and **show spanning-tree blockedports**.

```
AS-1#show spanning-tree mst 1
```

```
##### MST1      vlans mapped: 20,30
Bridge          address 500a.0003.0000  priority      32769 (32768 sysid 1)
Root            address 500a.0001.0000  priority      24577 (24576 sysid 1)
                port      Gi0/0          cost          20000      rem hops 19
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
---	---	---	---	---	---
Gi0/0	Root	FWD	20000	128.1	P2p
Gi0/1	Altn	BLK	20000	128.2	P2p
Gi0/2	Altn	BLK	20000	128.3	P2p
Gi0/3	Altn	BLK	20000	128.4	P2p

```
AS-1#show spanning-tree blockedports
```

Name	Blocked Interfaces List
MST0	Gi0/1, Gi0/2, Gi0/3
MST1	Gi0/1, Gi0/2, Gi0/3
MST2	Gi0/0, Gi0/1, Gi0/3

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Number of blocked ports (segments) in the system : 9

As you can see, MST 1 has its Root Port on G0/0 and G0/1, G0/2, and G0/3 are Alternate Blocking Ports.

To manipulate which port becomes the Root Port on non-root bridges, change the port cost (a value between 1 and 200,000,000) or port priority value (a value between 0 and 240 in increments of 16). Remember that this change could have an impact on downstream switches as well.

Note: The changes you are about to implement are considered topology changes and could have a significant impact on the overall structure of the spanning tree in your switch network. Do not make these changes in a production network without careful planning and prior coordination.

Step 2. Change MST port cost

On A1, shutdown interfaces F0/1 and F0/2, assign a new port cost of 1000 to F0/2 using the **spanning-tree mst 1 cost** value command, and then issue the **no shutdown** command on the ports.

```
AS-1# conf t
Enter configuration commands, one per line. End with CNTL/Z.
AS-1(config)# interface range g0/0-1
AS-1(config-if-range)# shutdown
AS-1(config-if-range)# exit
AS-1(config)# interface g0/1
AS-1(config-if)# spanning-tree mst 1 cost 1000
AS-1(config-if)# exit
AS-1(config)# interface range g0/0-1
AS-1(config-if-range)# no shutdown
AS-1(config-if-range)# exit
```

Now verify that this impacts root port selection on A1 using the **show spanning-tree vlan 1** and **show spanning-tree blockedports** commands.

```
AS-1#show spanning-tree mst 1
```

```
#### MST1      vlans mapped: 20,30
Bridge         address 500a.0003.0000 priority 32769 (32768 sysid 1)
Root           address 500a.0001.0000 priority 24577 (24576 sysid 1)
               port    Gi0/1          cost    1000      rem hops 19
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
Gi0/0	Altn	BLK	20000	128.1	P2p
Gi0/1	Root	FWD	1000	128.2	P2p
Gi0/2	Desg	FWD	20000	128.3	P2p
Gi0/3	Desg	FWD	20000	128.4	P2p

```
AS-1#show spanning-tree blockedports
```

Name	Blocked Interfaces List
MST0	Gi0/1, Gi0/2, Gi0/3
MST1	Gi0/0
MST2	Gi0/0, Gi0/1, Gi0/3

Number of blocked ports (segments) in the system : 7

From the output, you can see that the root port selected by As-1 for VLAN 20 is now interface G0/1, and the port (and root) cost is now 1000.

Step 3. Adjust port priority values to impact root port selection.

The next method to impact root port selection is configured on the root bridge itself. In our current network topology, AS-1 has two connections to the root bridge for MST Instance 2, switch DS-2. The root port has been selected, in this case based on the lowest port ID. Port ID is made up of two values, labeled as Prio (Priority) and Nbr (Number).

Note: The port number is not necessarily equal to the interface ID. A switch may use any port number for STP purposes as long as they are unique for each port on the switch.

The port priority can be any value between 0 and 240, in increments of 16 (older switches may allow setting the priority in different increments).

On A1, issue the command **show spanning-tree mst 2** and take note of the port ID values listed.

```
AS-1#show spanning-tree mst 2
```

```
##### MST2      vlans mapped:   40,50
Bridge          address 500a.0003.0000  priority      32770 (32768 sysid 2)
Root            address 500a.0002.0000  priority      24578 (24576 sysid 2)
                port    Gi0/2          cost          20000      rem hops 19
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
Gi0/0	Altn	BLK	20000	128.1	P2p
Gi0/1	Altn	BLK	20000	128.2	P2p
Gi0/2	Root	FWD	20000	128.3	P2p
Gi0/3	Altn	BLK	20000	128.4	P2p

As expected with two equal-cost paths to the root bridge, the lower port ID was selected as the root port.

Modify the port priority of D2 interface G1/0/6 so that it becomes the preferred port by issuing the **spanning-tree mst 2 port-priority value** interface configuration command. Use a value of 64.

```
DS-2# config t
```

```
Enter configuration commands, one per line.  End with CNTL/Z.
```

```
DS-2(config)# interface range g1/0, g0/3
```

```
DS-2(config-if-range)# shutdown
```

```
DS-2(config-if-range)# exit
```

```
DS-2(config)# interface g1/0
```

```
DS-2(config-if)# spanning-tree mst 2 port-priority 64
```

```
DS-2(config-if)# exit
```

```
DS-2(config)# interface range g1/0, g0/3
```

```
DS-2(config-if-range)# no shutdown
```

```
DS-2(config-if-range)# exit
```

On AS-1, issue the **show spanning-tree mst 2** command and you will see that Fa0/4 is now the selected root port. This selection is based on the lower priority value of D2 interface G1/0/6.

Notice that the lower priority value does not appear in any A1 output.

```
AS-1#show spanning-tree mst 2
```

```
##### MST2      vlans mapped:   40,50
Bridge          address 500a.0003.0000  priority      32770 (32768 sysid 2)
Root            address 500a.0002.0000  priority      24578 (24576 sysid 2)
                port    Gi0/3          cost          20000      rem hops 19
```

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Interface	Role	Sts	Cost	Prio.	Nbr	Type

--						
Gi0/0	Altn	BLK	20000	128.1		P2p
Gi0/1	Altn	BLK	20000	128.2		P2p
Gi0/2	Altn	BLK	20000	128.3		P2p
Gi0/3	Root	FWK	20000	128.4		P2p