

MSTP Fundamentals

IMPORTANT! THIS GUIDE ASSUMES THAT THE AOS-CX OVA HAS BEEN INSTALLED AND WORKS IN GNS3 OR EVE-NG. PLEASE REFER TO GNS3/EVE-NG INITIAL SETUP LABS IF REQUIRED.

<https://www.eve-ng.net/index.php/documentation/howtos/howto-add-aruba-cx-switch/>

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Lab Objective

At the end of this lab you will be able to implement the basic configuration of Multiple Spanning Tree Protocol (MSTP) and show how MSTP creates a loop free VLAN topology with other Aruba CX switches.

The use case for MSTP is to provide a loop free redundant multipath Layer 2 network. MSTP is the default Spanning Tree Protocol for Aruba CX switches

For further details on MSTP please refer to the latest Aruba documentation located on <https://asp.arubanetworks.com/>

Lab Overview

This lab set up is as shown in Figure 1 and Figure 2. This will allow the reader to observe the behavior of MSTP

This lab covers configuration of the following:

- MSTP and VLAN mappings. (MSTP is the default STP for Aruba CX switches.)
- Root bridge placement and Identification
- STP timers and edge ports
- STP protection mechanisms

通过 MSTP 把一个交换网络划分成多个域，每个域叫做一个 MST 域（MST Region: Multiple Spanning Tree Region）。每个域内形成多棵生成树，生成树之间彼此独立，每棵生成树叫做一个 MSTI（Multiple Spanning Tree Instance）。每个实例是由一个或者多个 vlan 组成。

Lab Network Layout

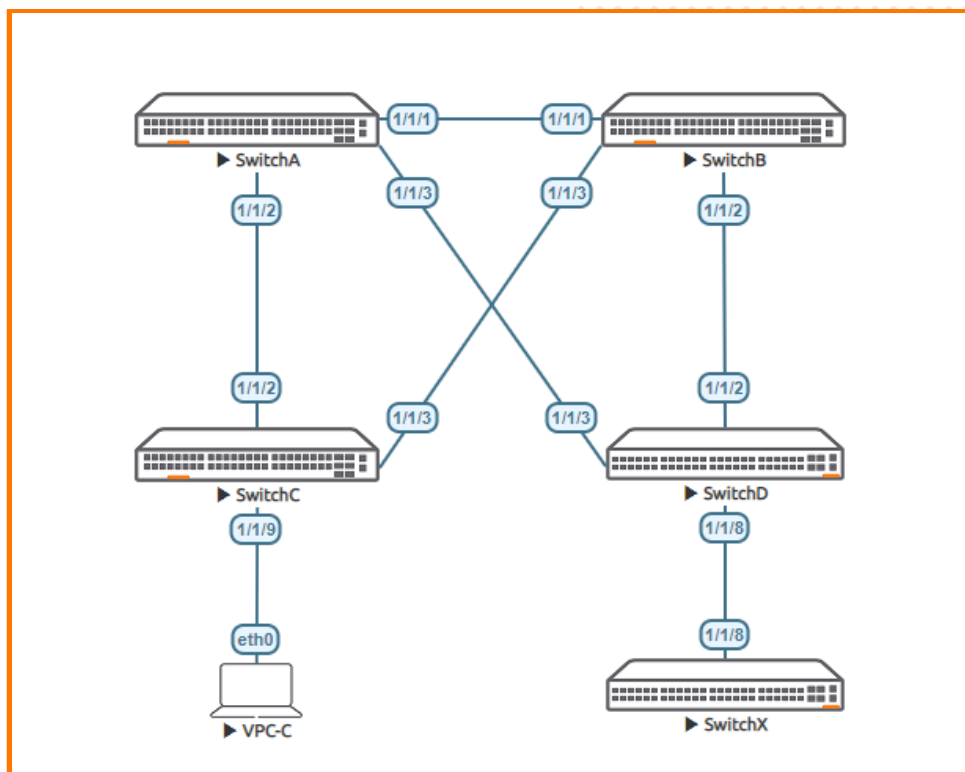


Figure 1. MSTP Lab topology

Lab Tasks

Task 1 - Lab setup

For this lab refer to Figure 1 for topology setup .Open each switch console and log in with user “admin” and no password.

Note: Switch X will be configured later in the lab. The Virtual PC (VPC-C) is not required to be configured and just shown to represent an access port.

- Change all hostnames as shown in the topology:

```
configure
hostname <device host name>
```

- On **Switch A and B** bring up required ports:

```
int 1/1/1-1/1/3
no routing
no shutdown
```

use “exit” to go back a level

- On **Switch C and D** bring up required ports:

```
int 1/1/2-1/1/3
no routing
no shutdown
```

use “exit” to go back a level

- Validate LLDP neighbors appear as expected on each switch. Here we show Switch A output only.

If all switches have been configured as shown in *Figure 1* you should see Switch B, C and D via Switch A as shown below using LLDP. It is left to the reader to check other switches respectively.

```
SwitchA#show lldp neighbor-info
```

```
LLDP Neighbor Information
=====
```

```
Total Neighbor Entries      : 3
Total Neighbor Entries Deleted : 0
Total Neighbor Entries Dropped : 0
Total Neighbor Entries Aged-Out : 0
```

LOCAL-PORT	CHASSIS-ID	PORT-ID	PORT-DESC	TTL	SYS-NAME
1/1/1	08:00:09:12:8e:9e	1/1/1	1/1/1	120	SwitchB
1/1/2	08:00:09:16:7b:7e	1/1/2	1/1/2	120	SwitchC
1/1/3	08:00:09:ee:11:82	1/1/3	1/1/3	120	SwitchD

Task 2 - Configure MSTP and VLAN mappings

Now set up MSTP, Root bridges and map VLANs as per Figure 2

- VLAN 10-11 assigned to MSTP instance 1, Root bridge Switch A, Secondary Root bridge Switch B
- VLAN 20-21 assigned to MSTP instance 2 Root bridge Switch B, Secondary Root bridge Switch A
- All other VLANs assigned to the default MSTP 0 as shown below Switch A

Note: Having deterministic Root and Secondary Root bridges is a *typically* accepted design, these are placed at the Core of the Layer 2 domain, as shown in Figure 2, where Switch A and Switch B are the core/center of the Layer 2 domain as well as providing Root redundancy for one another.

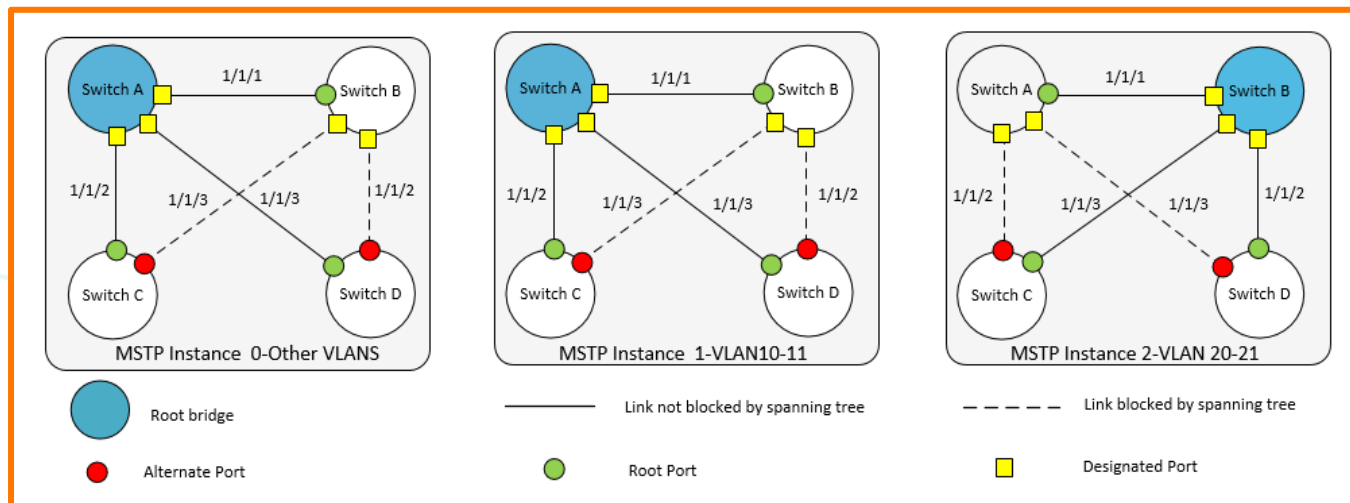


Figure 2 MSTP Topology

- On Switch A add VLAN 10-11 and 20-21. Configure STP making Switch A Root for VLAN 10-11 instance 1 and Secondary Root for 20-21 instance 2, then trunk all VLANs for interface 1/1/1 to 1/1/3. Here also make Switch A the Root for the CIST

```
SwitchA#
configure
vlan 10-11,20-21
exit
spanning-tree
spanning-tree config-name sp1
spanning-tree config-revision 1
```

```
spanning-tree instance 1 vlan 10-11 < ----- Map vlans to instance
spanning-tree instance 2 vlan 20-21
spanning-tree priority 0 < ----- MST 0 Root
spanning-tree instance 1 priority 0 < -----MST 1 Root
spanning-tree instance 2 priority 1 < -----MST 2 Secondary Root
int 1/1/1-1/1/3
vlan trunk allowed all
vlan trunk native 1
exit
```

- On Switch B add VLAN 10-11 and 20-21. Configure STP making Switch B Root for VLAN 20-11 instance 2 and Secondary Root for 10-11 instance 1, then trunk all VLANs for interface 1/1/1 to 1/1/3.

```
SwitchB#
configure
vlan 10-11,20-21
exit
spanning-tree
spanning-tree config-name spl
spanning-tree config-revision 1
spanning-tree instance 1 vlan 10-11
spanning-tree instance 2 vlan 20-21
spanning-tree instance 1 priority 1 < ----- MST 1 Secondary Root
spanning-tree instance 2 priority 0 < ----- MST 2 Root
int 1/1/1-1/1/3
vlan trunk allowed all
vlan trunk native 1
exit
```

- On Switch C and D define the VLANs and add MSTP mapping to VLANs

```
configure
vlan 10-11,20-21
exit
spanning-tree
spanning-tree config-name spl
spanning-tree config-revision 1
spanning-tree instance 1 vlan 10-11
spanning-tree instance 2 vlan 20-21
int 1/1/2-1/1/3
vlan trunk allowed all
vlan trunk native 1
exit
```

Task 3 - Check configurations and output

- Examine and check configuration and mappings from Switch A

```
SwitchA#show spanning-tree mst-config
MST configuration information
MST config ID : spl
MST config revision : 1
MST config digest : 098798F08296B22CADC0650E39604C10
Number of instances : 2
```

```
Instance ID      Member VLANs
-----
0                1-9,12-19,22-4094
1                10,11
2                20,21
```

Above we see the general MSTP configuration, check other switches in the domain, they should all be similar.

- Check configuration and mappings from Switch A. Check System ID matches Root for the MSTP Instance

```
SwitchA#show spanning-tree summary root
STP status : Enabled
Protocol : MSTP
System ID : 08:00:09:8a:14:fa
Root bridge for STP Instance : 0,1
```

Instance ID	Priority	Root ID	Root cost	Hello Time	Max Age	Fwd Dly	Root Port
0	0	08:00:09:8a:14:fa	0	2	20	15	0
1	0	08:00:09:8a:14:fa	0	2	20	15	0
2	0	08:00:09:12:8e:9e	20000	2	20	15	1/1/1

As shown above Switch A is Root for Instance 0 and 1 identified by the System ID, and Instance 2 Root is another device which is expected to be Switch B based on previous configurations.

- Examine switch B and check Root switches are as expected

```
SwitchB# show spanning-tree summary root
STP status      : Enabled
Protocol        : MSTP
System ID       : 08:00:09:12:8e:9e
```

Root bridge for STP Instance : 2

Instance ID	Priority	Root ID	Root cost	Hello Time	Max Age	Fwd Dly	Root Port
0	0	08:00:09:8a:14:fa	20000	2	20	15	1/1/1
1	0	08:00:09:8a:14:fa	20000	2	20	15	1/1/1
2	0	08:00:09:12:8e:9e	0	2	20	15	0

As shown above Switch B is Root for Instance 2 based on the identified System ID, and Instance 0 and 1 Root is SwitchA System ID

Continue to check switch C and D in a similar fashion (not shown in this lab guide)

- Now examine the behavior of ports and their state, by examining spanning tree state. The logical topology in Figure 2 for each switch can be observed showing a loop free Layer 2 topology.

```
SwitchA# show spanning-tree mst
#### MST0
Vlans mapped: 1-9,12-19,22-4094
Bridge Address:08:00:09:8a:14:fa priority:0
Root
Regional Root
Operational Hello time(in seconds): 2 Forward delay(in seconds):15 Max-age(in seconds):20 txHoldCount(in pps): 6
Configured Hello time(in seconds): 2 Forward delay(in seconds):15 Max-age(in seconds):20 Max-Hops:20
Root Address:08:00:09:8a:14:fa Priority:0
Port:0 Path cost:0
Regional Root Address:08:00:09:8a:14:fa Priority:0
Internal cost:0 Rem Hops:20
```

Port Rx	Role	State	Cost	Priority	Type	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/1	Designated	Forwarding	20000	128	P2P	32900	28093	10	6
1/1/2	Designated	Forwarding	20000	128	P2P	32902	8	8	4
1/1/3	Designated	Forwarding	20000	128	P2P	32898	5	2	3

```
Topology change flag : True
Number of topology changes : 9
Last topology change occurred : 55669 seconds ago
```

```
#### MST1
Vlans mapped: 10,11
Bridge Address:08:00:09:8a:14:fa Priority:0
Root Address:08:00:09:8a:14:fa Priority:0
Port:0, Cost:0, Rem Hops:20
```

Port	Role	State	Cost	Priority	Type	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/1	Designated	Forwarding	20000	128	P2P	32900	28093	10	6
1/1/2	Designated	Forwarding	20000	128	P2P	32902	8	8	4
1/1/3	Designated	Forwarding	20000	128	P2P	32898	5	2	3

```
Topology change flag : True
Number of topology changes : 9
Last topology change occurred : 55669 seconds ago
```

```
#### MST2
Vlans mapped: 20,21
Bridge Address:08:00:09:8a:14:fa Priority:4096
Root Address:08:00:09:12:8e:9e Priority:0
Port:1/1/1, Cost:20000, Rem Hops:19
```

Port	Role	State	Cost	Priority	Type	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/1	Root	Forwarding	20000	128	P2P	32900	28093	10	6
1/1/2	Designated	Forwarding	20000	128	P2P	32902	8	8	4
1/1/3	Designated	Forwarding	20000	128	P2P	32898	5	2	3

```
Topology change flag : True
```

Number of topology changes : 7
Last topology change occurred : 55673 seconds ago

As shown above Switch A for instance 0 and 1 all ports are Designated and Forwarding, instance 2 has a Root port 1/1/1 towards Switch B the Root switch for VLANs 20-21, and other ports are Designated Forwarding leading to Switch C and D respectively.

The reader can continue to check switch B, C and D in a similar fashion (not shown in this lab guide) and build a logical picture of the MSTP instances as shown in Figure 2

Task 4 - Path Cost

Now examine path cost and the MSTP port state from Switch D perspective in MSTP instance 1.

- In Figure 3 below the Root port path cost to the Root Switch A from Switch D perspective is 20,000 via port 1/1/3
- The next alternate path is via 1/1/2 with the next lowest path being through Switch B port 1/1/1. This next alternate best path cost is 40,000 (20,000 (Switch D interface 1/1/2) + 20,000 (Switch B interface 1/1/1)) and is the summation of associated link cost.

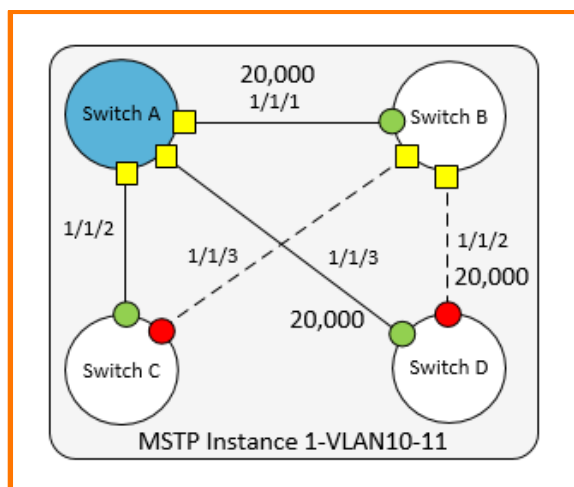


Figure 3 MSTP 1 path cost from Switch D

- Check the port roles and cost from Switch D perspective

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

```
#### MST1
Vlans mapped: 10,11
Bridge
Address:08:00:09:ee:11:82 Priority:32768
Root
Address:08:00:09:8a:14:fa Priority:0
Port:1/1/3, Cost:20000, Rem Hops:19
```

Port	Role	State	Cost	Priority	Type	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/2	Alternate	Blocking	20000	128	P2P	25	41592	1	4
1/1/3	Root	Forwarding	20000	128	P2P	31	41590	3	2

Above we see the local path costs on Switch D, port 1/1/3 being the Forwarding Root port and 1/1/2 being the Blocked Alternate port

- Now manipulate the cost to change the MSTP instance 1 topology from Switch D perspective, by changing the cost on Root port. To influence a change in this topology we need to increase cost to greater than 40,000, based on our earlier calculation.

```
SwitchD#
configure
int 1/1/3
spanning-tree instance 1 cost 40001 < ----- change the path cost on the interface to 40001 or more
exit
```

```
SwitchD#show spanning-tree mst 1 < ----- check port roles
```

```
#### MST1
Vlans mapped: 10,11
```



```
Bridge      Address:08:00:09:ee:11:82   Priority:32768
Root        Address:08:00:09:8a:14:fa   Priority:0
            Port:1/1/2, Cost:40000, Rem Hops:18
```

Port	Role	State	Cost	Priority	Type	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/2	Root	Forwarding	20000	128	P2P	28	79916	1	4
1/1/3	Alternate	Blocking	40001	128	P2P	34	79914	3	2

As shown above by manipulating the path cost the behavior of the ports roles were changed.

Note Default cost is calculated based on port link speed for the Aruba CX OVA the ports simulate 1GbEs and are set to 20,000. Please refer to Layer 2 birding guide to get the path cost for various speed ports.

Task 5 - MSTP timers and tuning

Detailed information around STP timers is beyond the scope of this lab guide. However, it is possible to change some MSTP timers to tune and improve convergence time. However, use of such parameters depends on design and architecture of a network as it can impact switch resources under certain conditions.

- `spanning-tree forward-delay` is the time spent in the listening and learning state. This time is equal to 15 seconds by default, and can be tuned between 4 and 30 seconds
- `spanning-tree hello-time` is the time between each Bridge Protocol Data Unit (BPDU) that are sent on a port. The default is 2 seconds and can be tuned between 2 and 10 sec.
- `spanning-tree max-age` is the interval, specified in the BPDU, that BPDU data remains valid after its reception. The bridge re-computes the spanning tree topology if it does not receive a new BPDU before max-age expiry. Default is 20 Seconds and can be changed between 6 and 20 Seconds.

The above three parameters are mentioned for completeness. For this lab guide we will explore :

- `spanning-tree port-type admin-edge` which is primarily designed to optimize ports that are connected to end points to allow the ports to transition directly to forwarding, circumventing the learning and listening phase.

On Switch C configure the following

```
SwitchC#
configure
int 1/1/9
no shut
no routing
vlan access 10
```

Now examine the ports on Switch C

```
show spanning-tree mst 1
```

```
#### MST1
Vlans mapped: 10,11
Bridge      Address:08:00:09:16:7b:7e   Priority:32768
Root        Address:08:00:09:8a:14:fa   Priority:0
            Port:1/1/2, Cost:20000, Rem Hops:19
```

Port	Role	State	Cost	Priority	Type	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/2	Root	Forwarding	20000	128	P2P	0	2	0	0
1/1/3	Alternate	Blocking	20000	128	P2P	0	2	0	0
1/1/9	Designated	Forwarding	20000	128	P2P	2	0	0	0

```
Topology change flag      : True
Number of topology changes : 3
Last topology change occurred : 476 seconds ago
```

In the above we can see the newly configured switch port act like a regular P2P port and we know that it will go into a learning and listening phase which is undesirable for ports connected to endpoints.

- On Switch C configure the following

```
SwitchC#
configure
int 1/1/9
spanning-tree port-type admin-edge
```

Now examine the ports on Switch C

Show spanning-tree mst 1

MST1

```
Vlans mapped: 10,11
Bridge      Address:08:00:09:16:7b:7e  Priority:32768
Root        Address:08:00:09:8a:14:fa  Priority:0
Port:1/1/2, Cost:20000, Rem Hops:19
```

Port	Role	State	Cost	Priority	Type	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/2	Root	Forwarding	20000	128	P2P	0	2195	0	0
1/1/3	Alternate	Blocking	20000	128	P2P	0	2195	0	0
1/1/9	Designated	Forwarding	20000	128	P2P Edge	1028	0	0	0

In the above we can now see the newly configured switch port is in a different mode "P2P Edge". This port will now go into forwarding mode when an endpoint is connected.

Task 5 - Spanning tree protection

Various security mechanisms are in place to protect spanning tree configurations from interference and protect from rouge devices. We will explore both BPDU guard and Root guard.

BPDU protection secures the active MSTP topology by preventing spoofed BPDU packets from entering the MSTP domain. Typically BPDU protection would be applied to edge ports connected to end user devices that do not run MSTP. If MSTP BPDU packets are received on a protected port, this feature disables the port and an alerts can be sent out accordingly.

- On Switch D configure BPDU guard

```
SwitchD#
configure
interface 1/1/8
  no shutdown
  no routing
  vlan access 10
  spanning-tree bpdu-guard
```

- On Switch X configure the following

```
SwitchX#
configure
spanning-tree
interface 1/1/8
  no shutdown
  no routing
  vlan access 1
exit
```

Observe the output on Switch D. It can be observed that the port 1/1/8 is disabled as we received a BPDU on port 1/1/8 from Switch X. Timeouts can be configured to re-enable the port, not covered in this guide.

Below port 1/1/8 is disabled due to "Bpdu-Error"

SwitchD#show spanning-tree mst 1

```
#### MST1
Vlans mapped: 10,11
Bridge      Address:08:00:09:ee:11:82  Priority:32768
Root        Address:08:00:09:8a:14:fa  Priority:0
Port:1/1/2, Cost:40000, Rem Hops:18
```

Port	Role	State	Cost	Priority	Type	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/2	Root	Forwarding	20000	128	P2P	9	210294	0	8
1/1/3	Alternate	Blocking	40001	128	P2P	11	210295	4	4
1/1/8	Disabled	Bpdu-Error	20000	128	P2P	31	0	0	0

```
Topology change flag      : True
Number of topology changes : 7
Last topology change occurred : 350406 seconds ago
```

Below observe the state of the interface 1/1/8 is down as expected, due to Bpdu-Error.

SwitchD#show int 1/1/8

```
Interface 1/1/8 is down
Admin state is up
State information:
Link transitions: 0
```



```
Description:
Hardware: Ethernet, MAC Address: 08:00:09:ee:11:82
MTU 1500
Type --
Full-duplex
qos trust none
Speed 1000 Mb/s
Auto-negotiation is on
Flow-control: off
```

Note: On Switch X OVA Simulator toggle the port “shut” to “no shut” may be required to enable BPDUs initially.

Root Protection. Secures the active MSTP topology by preventing other switches declaring their ability to propagate superior BPDU, containing both better information on the root bridge and path cost to the root bridge, which would normally replace the current root bridge selection.

In this lab setup enable Root guard on Switch A 1/1/2 and Switch B 1/1/3 respectively and then try and make Switch C the Root for Instance 1 and observe the behavior.

```
SwitchA#
configure
interface 1/1/2
    spanning-tree root-guard
exit
```

```
SwitchB#
configure
interface 1/1/3
    spanning-tree root-guard
exit
```

```
SwitchC#
configure
spanning-tree instance 1 priority 0 <----- Make Switch C Root for instance 1
exit
```

Below observe that for instance 1 both Switch A and B ports go into Root Inconsistent Alternate for instance 1. Thus protecting the rest of the network from the information that Switch C is sending “better” BPDUs, and maintaining Layer 2 stability.

```
SwitchA#show spanning-tree mst
#### MST0
Vlans mapped: 1-9,12-19,22-4094
Bridge Address:08:00:09:8a:14:fa priority:0
Root
Regional Root
Operational Hello time(in seconds): 2 Forward delay(in seconds):15 Max-age(in seconds):20 txHoldCount(in pps): 6
Configured Hello time(in seconds): 2 Forward delay(in seconds):15 Max-age(in seconds):20 Max-Hops:20
Root Address:08:00:09:8a:14:fa Priority:0
Port:0 Path cost:0
Regional Root Address:08:00:09:8a:14:fa Priority:0
Internal cost:0 Rem Hops:20
```

Port	Role	State	Cost	Priority	Type	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/1	Designated	Forwarding	20000	128	P2P	217571	217573	11	14
1/1/2	Designated	Forwarding	20000	128	P2P	217566	565	15	8
1/1/3	Designated	Forwarding	20000	128	P2P	217573	27	13	7

```
Topology change flag : True
Number of topology changes : 15
Last topology change occurred : 908 seconds ago

#### MST1
Vlans mapped: 10,11
Bridge Address:08:00:09:8a:14:fa Priority:0
Root Address:08:00:09:8a:14:fa Priority:0
Port:0, Cost:0, Rem Hops:20
```

Port	Role	State	Cost	Priority	Type	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/1	Designated	Forwarding	20000	128	P2P	217571	217573	11	14
1/1/2	Alternate	Root-Inc	20000	128	P2P	217566	565	15	8
1/1/3	Designated	Forwarding	20000	128	P2P	217573	27	13	7

```
Topology change flag : True
Number of topology changes : 18
Last topology change occurred : 908 seconds ago

#### MST2
Vlans mapped: 20,21
Bridge Address:08:00:09:8a:14:fa Priority:4096
```

Root Address:08:00:09:12:8e:9e Priority:0
Port:1/1/1, Cost:20000, Rem Hops:19

Port	Role	State	Cost	Priority	Type	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/1	Root	Forwarding	20000	128	P2P	217571	217573	11	14
1/1/2	Designated	Forwarding	20000	128	P2P	217566	565	15	8
1/1/3	Designated	Forwarding	20000	128	P2P	217573	27	13	7

Topology change flag : True
Number of topology changes : 13
Last topology change occurred : 911 seconds ago

SwitchB#show spanning-tree mst

MST0

Vlans mapped: 1-9,12-19,22-4094

Bridge Address:08:00:09:12:8e:9e Priority:32768

Operational Hello time(in seconds): 2 Forward delay(in seconds):15 Max-age(in seconds):20 txHoldCount(in pps): 6

Configured Hello time(in seconds): 2 Forward delay(in seconds):15 Max-age(in seconds):20 Max-Hops:20

Root Address:08:00:09:8a:14:fa Priority:0

Port:1/1/1 Path cost:0

Regional Root Address:08:00:09:8a:14:fa Priority:0

Internal cost:20000 Rem Hops:19

Port Rx	Role	State	Cost	Priority	Type	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-
1/1/1	Root	Forwarding	20000	128	P2P	217900	217897	14	11
1/1/2	Designated	Forwarding	20000	128	P2P	217902	25	13	1
1/1/3	Designated	Forwarding	20000	128	P2P	217900	895	12	2

Topology change flag : True
Number of topology changes : 16
Last topology change occurred : 1560 seconds ago

MST1

Vlans mapped: 10,11

Bridge Address:08:00:09:12:8e:9e Priority:4096

Root Address:08:00:09:8a:14:fa Priority:0

Port:1/1/1, Cost:20000, Rem Hops:19

Port	Role	State	Cost	Priority	Type	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/1	Root	Forwarding	20000	128	P2P	217900	217897	14	11
1/1/2	Designated	Forwarding	20000	128	P2P	217902	25	13	1
1/1/3	Alternate	Root-Inc	20000	128	P2P	217900	895	12	2

Topology change flag : True
Number of topology changes : 19
Last topology change occurred : 1560 seconds ago

MST2

Vlans mapped: 20,21

Bridge Address:08:00:09:12:8e:9e Priority:0

Root Address:08:00:09:12:8e:9e Priority:0

Port:0, Cost:0, Rem Hops:20

Port	Role	State	Cost	Priority	Type	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/1	Designated	Forwarding	20000	128	P2P	217900	217897	14	11
1/1/2	Designated	Forwarding	20000	128	P2P	217902	25	13	1
1/1/3	Designated	Forwarding	20000	128	P2P	217900	895	12	2

Topology change flag : True
Number of topology changes : 13
Last topology change occurred : 1561 seconds ago

End of lab

Appendix – Complete Configurations

- If you face issues during your lab, you can verify your configs with the configs listed in this section
- If configs are the same, try powering off/powering on the switches to reboot them

Switch A

```
hostname SwitchA
!
!
ssh server vrf mgmt
vlan 1,10-11,20-21
spanning-tree
spanning-tree priority 0
spanning-tree config-name sp1
spanning-tree config-revision 1
spanning-tree instance 1 vlan 10,11
spanning-tree instance 1 priority 0
spanning-tree instance 2 vlan 20,21
spanning-tree instance 2 priority 1
interface mgmt
    no shutdown
    ip dhcp
interface 1/1/1
    no shutdown
    no routing
    vlan trunk native 1
    vlan trunk allowed all
interface 1/1/2
    no shutdown
    no routing
    vlan trunk native 1
    vlan trunk allowed all
    spanning-tree root-guard
interface 1/1/3
    no shutdown
    no routing
    vlan trunk native 1
    vlan trunk allowed all
!
!
https-server vrf mgmt
```

Switch B

```
hostname SwitcB
!
!
ssh server vrf mgmt
vlan 1,10-11,20-21
spanning-tree
spanning-tree config-name sp1
spanning-tree config-revision 1
spanning-tree instance 1 vlan 10,11
spanning-tree instance 1 priority 1
spanning-tree instance 2 vlan 20,21
spanning-tree instance 2 priority 0
interface mgmt
    no shutdown
    ip dhcp
interface 1/1/1
    no shutdown
    no routing
    vlan trunk native 1
    vlan trunk allowed all
interface 1/1/2
    no shutdown
    no routing
    vlan trunk native 1
    vlan trunk allowed all
interface 1/1/3
    no shutdown
```

```

no routing
vlan trunk native 1
vlan trunk allowed all
spanning-tree root-guard
!
!
https-server vrf mgmt

```

Switch C

```

hostname SwitchC
!
!
ssh server vrf mgmt
vlan 1,10-11,20-21
spanning-tree
spanning-tree config-name sp1
spanning-tree config-revision 1
spanning-tree instance 1 vlan 10,11
spanning-tree instance 1 priority 0
spanning-tree instance 2 vlan 20,21
interface mgmt
    no shutdown
    ip dhcp
interface 1/1/2
    no shutdown
    no routing
    vlan trunk native 1
    vlan trunk allowed all
interface 1/1/3
    no shutdown
    no routing
    vlan trunk native 1
    vlan trunk allowed all
interface 1/1/9
    no shutdown
    no routing
    vlan access 10
    spanning-tree port-type admin-edge
!
!
https-server vrf mgmt

```

Switch D

```

hostname SwitchD
!
!
ssh server vrf mgmt
vlan 1,10-11,20-21
spanning-tree
spanning-tree config-name sp1
spanning-tree config-revision 1
spanning-tree instance 1 vlan 10,11
spanning-tree instance 2 vlan 20,21
interface mgmt
    no shutdown
    ip dhcp
interface 1/1/2
    no shutdown
    no routing
    vlan trunk native 1
    vlan trunk allowed all
    spanning-tree instance 2 cost 40001
interface 1/1/3
    no shutdown
    no routing
    vlan trunk native 1
    vlan trunk allowed all
    spanning-tree instance 1 cost 40001
interface 1/1/8
    no shutdown
    no routing
    vlan access 10
    spanning-tree bpdu-guard
!

```

```
!  
https-server vrf mgmt
```

Switch X

```
hostname SwitchX  
!  
ssh server vrf mgmt  
vlan 1  
spanning-tree  
interface mgmt  
    no shutdown  
    ip dhcp  
interface 1/1/8  
    no shutdown  
    no routing  
    vlan access 1  
!  
!  
!  
!  
!  
https-server vrf mgmt
```



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