## LAB GUIDE

# **MSTP Fundamentals**



a Hewlett Packard Enterprise company

. . . . . . .

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/

# TABLE OF CONTENTS

Lab Objective																1
Lab Overview	• •	•••		• •	• •	• •	• •	• •	• •	• •	• •	• •	• •	• •	• • •	1
Lab Network Lavout	•	2	• •	• •	• •	• •	• •		•••			• •		• •	• • •	2
Lab Tasks													• •			2
Task 1 - Lab setup		•	• •	• •	• •	• •	• •	• •	• •	• •	• •	• •	• •	• •	• • •	2
Task 2 - Configure MSTP and VLAN map	poinas															3
Task 3 - Check configurations and output	t			•	• •	• •	• •	• •	• •	• •	• •	• •	• •	• •		4
Task 4 - Path Cost					••	• •	• •	• •	• •	• •	• •	• •	• •	• •	• • •	6
Task 5 - MST timers and tuning							• •					• •				7
Task 5 - Spanning tree protection							•	• •	• •	• •	• •	• •	• •	• •	• • •	8
Appendix – Complete Configurations																11
ripportaix complete comiguratione																

# 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



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#shc	w lldp neighbor-inf	0			• •		• • •	• •		• •	• •	• •										
					• •	• • •		• •		• •	• •	• •										
LLDP Neighb	or Information			• • •	• •	• • •	• • •	• •	• • •	• •	• •	• •	• .									
					• •			• •		• •	• •	• •	• •									
			0 0 0 0		• •		• • •	• •	• • •	• •	• •			•								
Total Neigh	bor Entries	: 3																				
Total Neigh	bor Entries Deleted	: 0																				
Total Neigh	bor Entries Dropped	: 0																				
Total Neigh	bor Entries Aged-Ou	t : 0																	÷ .			
											11											
LOCAL-PORT	CHASSIS-ID	PORT-ID	PORT-DESC			TTL		SYS	-NAM	E	11											
1/1/1	08:00:09:12:80:90	1/1/1	1/1/1			120		Swi	theB												 	
1/1/1	00.00.00.12.00.90	1/1/1	1/1/1			120		0.01													 	
1 / 1 / 0	00.00.00.16.75.75	1/1/0	1/1/0			1 20		• <b>•</b> ••••	h C	• •	• •	• •						• •	• •		 	
1/1/2	08.00.09.16.7b.7e	1/1/2	1/1/2			120		SWI	Lenc	• •	• •	• •	• •	• •			• •	• •	• •		 	
						•				• •	• •		• •					• •			 	
1/1/3	08:00:09:ee:11:82	1/1/3	1/1/3			120		Swi	tchD	• •	• •	• •	• •		•	• •	• •	• •	• •		 	
										• •	• •	• •	• •	• •	•	• •	• •	• •	• •		 	
							•			• •	• •	• •	• •	• •	•	• •	• •	• •	• •		 	
										• •	• •	• •	• •	• •	•	• •	• •	• •	• •	/ • •	 	
Task 2 -	Configure MST	P and VI AN i	mappings							• •	• •	• •	• •	• •	•	• •	• •	• •	• •		 	
T GOIL	configure mer		nappingo						• •	• •	• •	• •	• •	• •	•	• •	• •	• •	• •		 	
										• •	• •	• •	• •		•	• •	• •	• •	• •		 	
										•	• •	• •	• •	• •	•	• •	• •	• •	• •		 	
Now set up	MSTP Root bridge	es and map VLAN	s as per Figure 2								<u> </u>	• •			•		• •	• •	• •		 	

- 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 spl
spanning-tree config-revision 1
```

```
Lab Guide
                                                                                                           MSTP
spanning-tree instance 1 vlan 10-11 < ---- Map vlans to instance
spanning-tree instance 2 vlan 20-21
                                       < ---- MST 0 Root
spanning-tree priority 0
spanning-tree instance 1 priority 0 <-----MST 1 Root</pre>
spanning-tree instance 2 priority 1 <-----MST 2 Secondary Root</pre>
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
   ٠
       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 sp1
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
                       : 2
  Number of instances
                Member VLANs
Instance ID
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 spa STP status Protocol System ID	anning-tre	ee summary root : Enabled : MSTP : 08:00:09:8a	:14:fa				
Root bridge for	STP Insta	ance : 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

TP status	spanning-tree s	unuary 1000								
rotocol	2	: Enabled : MSTP								
ystem ID		: <mark>08:00:09:</mark>	L2:8e:9e	\ e		· · · · · · ·				
loot bridge fo	or STP Instance	: 2				0 0 0 0 0 0 0 0 0 0 0 0	• • • •		0 0 0 0 L 0 0 0 0 0 0	
instance ID	Priority Root	ID	R C	oot Hello ost Time	Max Fwd Age Dly	Root Port			•       •	
)	0 08:0 0 08:0	0:09:8a:14: 0:09:8a:14:	Ea 20 Ea 20	000 2 000 2	20 15 20 15	1/1/1 1/1/1	• • • • •	· · · · · · · · ·		
	0 08:0	0:09:12:8e:9	9 <mark>e</mark>	0 2	20 15	0	• • • • •	• • • • • • • •	• • • • • • • •	• • • • • •
s shown abov System ID	ve Switch B is R	oot for Insta	nce 2 ba	sed on the	identified S	ystem ID,	and Ins	ance 0 and	d 1 Root is S	SwitchA
Continue to ch	eck switch C an	d D in a sim	ilar fashi	on (not sh	own in this la	ıb guide)			0       0       0       0       0       0         0       0       0       0       0       0       0         0       0       0       0       0       0       0         0       0       0       0       0       0       0         0       0       0       0       0       0       0	
• Now e 2 for e	examine the beh each switch can	avior of port be observed	s and the d showing	eir state, b g_a loop fr	y examining ee Layer 2 te	spanning t opology.	ree stat	e. The logi	cal topology	in Figure
witchA# show	spanning-tree m	st							<b>1</b> 0 0 0	
### MSTO 'lans mapped: Bridge Root	1-9,12-19,22-4 Address:08:00:	094 09:8a:14:fa	prior	ity:0						~ • • •
egional Root perational Configured Coot	Hello time(in Hello time(in Address:08:00: Port:0	<pre>seconds): 2 seconds): 2 09:8a:14:fa</pre>	Forward Forward Priorit Path co	delay(in delay(in y:0 st:0	seconds):15 seconds):15	Max-age( Max-age(	in seco in seco	nds):20 ta nds):20 Ma	HoldCount(i ax-Hops:20	n pps): 6
egional Root	Address:08:00: Internal cost:	09:8a:14:fa 0	Priorit Rem Hop	y:0 s:20						
ort x	Role	State	Cost	Priori	ty Type		BPDU-Tx	BPDU-R2	C TCN-Tx	TCN-
/1/1	Designated	Forwarding	20000	128	 D2D		22000	28093	10	 6
./1/2 ./1/3	Designated Designated	Forwarding Forwarding	20000 20000	128 128	P2P P2P		32902 32898	8 5	8 2	4 3
/1/2 /1/3	Designated Designated	Forwarding Forwarding : True	20000 20000	128 128	P2P P2P P2P		32900 32902 32898	8 5	8	4 3
///2 ///3 'opology chang fumber of topo ast topology	Designated Designated de flag blogy changes change occurred	Forwarding Forwarding : True : 9 : 55669 sec	20000 20000 conds ago	128 128	P2P P2P		32900 32902 32898	8 5	8	4
///2 ///3 Copology chang Tumber of topo .ast topology ### MST1	Designated Designated e flag logy changes change occurred	Forwarding Forwarding : True : 9 : 55669 sea	20000 20000 conds ago	128 128	P2P P2P P2P		32900 32902 32898	8	8 2	4 3
///2 //1/3 Copology chang Jumber of topo .ast topology #### MST1 'lans mapped: bridge .oot	Designated Designated Designated () Designat	Forwarding Forwarding : True : 9 : 55669 sec 09:8a:14:fa 09:8a:14:fa , Rem Hops:	20000 20000 conds ago Prior Prior 20	128 128	P2P P2P		32902	855	8	4 3
////2 //1/3 Copology chang Number of topo .ast topology ### MST1 Clans mapped: Bridge Loot	Designated Designated Te flag logy changes change occurred 10,11 Address:08:00: Port:0, Cost:0 Role	Forwarding Forwarding : True : 9 : 55669 sec 09:8a:14:fa 09:8a:14:fa , Rem Hops:: State	20000 20000 conds ago Prior Prior 20 Cost	128 128 ity:0 ity:0 Priority	Type	BPD	U-Tx	BPDU-Rx	TCN-Tx	4 3 TCN-Rx
////2 ////2 ////3 Propology chang number of topo .ast topology ************************************	Designated Designated Designated ilogy changes change occurred 10,11 Address:08:00: Port:0, Cost:0 Role Designated Designated Designated	Forwarding Forwarding : True : 9 : 55669 sed 09:8a:14:fa 09:8a:14:fa , Rem Hops:: State Forwarding Forwarding Forwarding	20000 20000 conds ago Prior Prior 20 Cost  20000 20000 20000	128 128 ity:0 ity:0 Priority 128 128 128	P2P P2P P2P P2P P2P P2P P2P P2P P2P	BPD  329 329 328	U-Tx  02 98	BPDU-Rx 	TCN-Tx 10 8 2	4 3 TCN-Rx 6 4 3
///2 //1/2 //1/3 Copology chang Jumber of topo .ast topology #### MST1 /lans mapped: %ridge Coot /ort ./1/1 /1/2 ./1/3 'opology chang fumber of topo .ast topology	Designated Designated Designated Designated Designated Designated 10,11 Address:08:00: Address:08:00: Port:0, Cost:0 Role Designated Designated Designated Designated Designated Designated Designated Designated Designated Designated Designated	Forwarding Forwarding : True : 9 : 55669 sed 09:8a:14:fa 09:8a:14:fa , Rem Hops:: State Forwarding Forwarding Forwarding i True : 9 : 55669 sed	20000 20000 conds ago Prior Prior 20 Cost  20000 20000 20000 conds ago	128 128 ity:0 ity:0 Priority 128 128	Р2р Р2Р Р2Р Р2Р Р2Р Р2Р Р2Р Р2Р	BPD  329 329 328	U-Tx  00 02 98	BPDU-Rx 28093 8 5	TCN-Tx 10 8 2	4 3 TCN-Rx 6 4 3
<pre>////2 //1/2 //1/3 Copology chang fumber of topo .ast topology #### MST1 flans mapped: Bridge Coot 'ort</pre>	Designated Designated Designated logy changes change occurred 10,11 Address:08:00: Address:08:00: Port:0, Cost:0 Role Designated Designated Designated Designated Designated Designated Designated Designated Designated	Forwarding Forwarding : True : 9 : 55669 sed 09:8a:14:fa 09:8a:14:fa , Rem Hops:: State Forwarding Forwarding Forwarding i True : 9 : 55669 sed	20000 20000 conds ago Prior Prior 20 Cost  20000 20000 20000 conds ago	128 128 ity:0 ity:0 Priority 128 128	Р2Р Р2Р Туре Р2Р Р2Р Р2Р Р2Р Р2Р	BPD 329 328 328	U-Tx  00 98	BPDU-Rx 	TCN-Tx 10 8 2	4 3 TCN-Rx 6 4 3
<pre>////2 ////2 ////2 ////2 ////2 ////3 //// ///2 ////2 ////2 ////3 ////2 ////2 ////3 ////2 ////2 ////3 ////2 ////2 ////2 ////2 ////2 ////3 ////2 ////2 ////3 ////2 ////3 ////2 ////3 ////2 ////3 ////2 ////2 ////3 ////2 ////3 ////2 ////2 ////3 ////2 ////3 ////2 ////3 ////2 ////2 ////2 ////3 ////2 ////2 ////2 ////3 ////2 ///// //////</pre>	Designated Designated Designated logy changes change occurred 10,11 Address:08:00: Port:0, Cost:0 Role Designated	Forwarding Forwarding : True : 9 : 55669 sed 09:8a:14:fa 09:8a:14:fa , Rem Hops: State Forwarding Forwarding Forwarding : True : 9 : 55669 sed 09:8a:14:fa 09:12:8e:9e st:20000, Ref	20000 20000 conds ago Prior Prior 20 Cost  20000 20000 20000 20000 conds ago Prior Prior Prior	128 128 128 ity:0 ity:0 Priority 128 128 128 128 128 128 128 128	Р2Р Р2Р Р2Р Р2Р Р2Р Р2Р Р2Р Р2Р	BPD  329 329 328	U-Tx  00 98	BPDU-Rx 	TCN-Tx 10 8 2	4 3 TCN-Rx 6 4 3
<pre>///1/2 //1/2 Copology chang Jumber of topc .ast topology #### MST1 Clans mapped: Bridge Coot //1/1 ./1/2 ./1/2 ./1/3 'opology chang Jumber of topo .ast topology #### MST2 Clans mapped: iridge .oot</pre>	Designated Designated Designated Designated ilogy changes change occurred Address:08:00: Address:08:00: Port:0, Cost:0 Role Designated Designated Designated Designated de flag blogy changes change occurred Address:08:00: Address:08:00: Port:1/1/1, Co	Forwarding Forwarding : True : 9 : 55669 sed 09:8a:14:fa 09:8a:14:fa , Rem Hops:: State Forwarding Forwarding Forwarding : True : 9 : 55669 sed 09:8a:14:fa 09:12:8e:9e st:2000, Re	20000 20000 conds ago Prior 20 Cost 20000 20000 20000 conds ago Prior Prior em Hops:1 Cost	128 128 128 ity:0 ity:0 Priority 128 128 128 128 128 128 128 128 128 128	P2P P2P P2P P2P P2P P2P P2P P2P	BPD 329 329 328 BPD	U-Tx  00 98	BPDU-Rx 	TCN-Tx TCN-Tx TCN-Tx	4 3 TCN-Rx 6 4 3
<pre>///1 //1/2 //1/3 Copology chang Jumber of topology #### MST1 /lans mapped: Boot //1/1 //1/2 /lang chang Lumber of topo ast topology chang Lumber of topo ast topology #### MST2 'lans mapped: Bridge Loot 'ort </pre>	Designated Designated Designated Designated ilogy changes change occurred 10,11 Address:08:00: Port:0, Cost:0 Port:0, Cost:0 Port:1/1/1, Co Role Posignated Designated Designated Designated	Forwarding Forwarding : True : 9 : 55669 sed 09:8a:14:fa 09:8a:14:fa , Rem Hops: State Forwarding Forwarding : True : 9 : 55669 sed 09:8a:14:fa 09:12:8e:9e ost:20000, Re State Forwarding Forwarding Forwarding Forwarding Forwarding Forwarding	20000 20000 conds ago Prior Prior 2000 20000 20000 conds ago Prior Prior Prior 2000 20000 20000 20000 20000	128 128 128 ity:0 ity:0 Priority 128 128 128 128 128 128 128 128 128 128	Р2Р Р2Р Р2Р Р2Р Р2Р Р2Р Р2Р Р2Р Р2Р Р2Р	BPD 329 329 328 328 328 328 329 329 329 329 329 329 329 328	U-Tx  00 02 98	BPDU-Rx 	TCN-Tx 10 8 2 TCN-Tx 10 8 2 TCN-Tx 10 8 2	4 3 7 7 6 4 3 7 7 7 7 7 8 4 3

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: Bridge Root	10,11 Address:08:00:0 Address:08:00:0 Port:1/1/3, Cos	09:ee:11:82 09:8a:14:fa st:20000, Re	Prior Prior em Hops:1	rity:32768 rity:0 19					
Port	Role	State	Cost	Priority	Туре	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/2 1/1/3	Alternate Root	Blocking Forwarding	20000 20000	128 128	P2P P2P	25 31	41592 41590	1 3	4 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 exit	< change the path cost on the interface to 40001 or more
SwitchD#show spanning-tree mst 1	< check port roles
#### MST1 Vlans mapped: 10,11	

Bridge Root	Address:08:00: Address:08:00: Port:1/1/2, Co	09:ee:11:82 09:8a:14:fa st:40000, Re	Prior Prior em Hops:18	ity:3270 ity:0 3	58	<ul> <li>C</li> <li>C&lt;</li></ul>	0     0     0       0     0     0     0       0     0     0     0       0     0     0     0       0     0     0     0       0     0     0     0       0     0     0     0       0     0     0     0       0     0     0     0       0     0     0     0						0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		Lab Guide MSTP
Port	Role	State	Cost I	Priority		Type	•••	•••	•••	BPI	DU-T	'x	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/2 1/1/3	Root Alternate	Forwarding Blocking	20000 1 40001 1	128		P2P P2P			•••	28 34	• •	•••	79916 79914	1 3	4 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: Bridge Root	10,11 Address:08:00: Address:08:00: Port:1/1/2, Cos	09:16:7b:7e 09:8a:14:fa st:20000, Re	Prio Prio em Hops:1	rity:32768 rity:0 19					
Port	Role	State	Cost	Priority	Туре	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 Number of topo	e flag logy changes	: True : 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
```

					•••	•••	· • • • • •	•••		· • • · • •	•••	•••	•••	•				Lab Cuida
				• • • •	•••	•••		• •	• •	• • •	•••	•••	•••	•				MSTP
				• • • • • •	•••	•••		• •			•••	•••	•••	• •				
Now examine t	he ports on Swit	tch C			•••	•••		• •			•••	•••		•••				
Show spanning-	tree mst 1				• •	• • •		• •			•••	•••	•••					
#### MST1								• •	• •		• •	• •	• •		•			
Vlans mapped: Bridge	10,11 Address:08:00:	09:16:7b:7e	Prio:	rity:32	768	•••	) • • ) • •			) • • ) • •	•••	•••	•••					
Root	Address:08:00: Port:1/1/2, Co	09:8a:14:fa st:20000, Re	Prio: m Hops::	rity:0 19	•••	•••	• • •	• •	• •	• • •	•••	•••	•••	•••	• • •	• •		
Port	Role	State	Cost	Priorit	ty	Тур	e	•••			BPD	U-T	x	BPI	DU-Rx	•••	TCN-Tx	TCN-Rx
1/1/2	Root	Forwarding	20000	128		P2P	•••	• •	•••	• • •	0	•••	•••	219	95	•••	0	0
1/1/3 1/1/9	Alternate Designated	Blocking Forwarding	20000 20000	128 128		P2P <mark>P2P</mark>	Edg	<mark>je</mark>	• •	• • •	0 102	8	•••	219 0	95	• •	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 true 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 s	panning-tree ms	t 1							
#### MST1 Vlans mapped: Bridge Root	10,11 Address:08:00: Address:08:00: Port:1/1/2, Co	09:ee:11:82 09:8a:14:fa st:40000, Re	Prio Prio em Hops:	rity:32768 rity:0 18					
Port	Role	State	Cost	Priority	Туре	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-Rx
1/1/2 1/1/3 1/1/8	Root Alternate Disabled	Forwarding Blocking Bpdu-Error	20000 40001 20000	128 128 128	P2P P2P P2P	9 11 31	210294 210295 0	0 4 0	8 4 0
Topology chang Number of topo Last topology	e flag logy changes change occurred	: True : 7 : 350406 se	econds a	40					

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
```

Lab Guide MSTP Description: Hardware: Ethernet, MAC Address: 08:00:09:ee:11:82 MTU 1500 Type --Full-duplex gos 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 BPDU 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
```

#### SwithB#

```
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</pre>

Below observe that or 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.

#### SwithcA#show spanning-tree mst

Regional Root       Hello time(in seconds): 2       Forward delay(in seconds): 15       Max-age(in seconds): 20       txHoldCount(         Configured       Hello time(in seconds): 2       Forward delay(in seconds): 15       Max-age(in seconds): 20       txHoldCount(         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         Rx       Total cost:0       Total cost:0       Total cost:0       Total cost:0       Total cost:0	in pps): 6
Internal cost:0 Rem Hops:20 Port Role State Cost Priority Type BPDU-Tx BPDU-Rx TCN-Tx Rx	
Port Role State Cost Priority Type BPDU-Tx BPDU-Rx TCN-Tx Rx	
	TCN-
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
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	

					• • • • • • •				
						• • • • • • • • • • • • • •			
									Lab Guide
					• • • • • • •				MSTP
							0 L		Morr
Deal		00.10.00					• •		
Root	Address:08:00: Port:1/1/1. Co	09:12:8e:9e st:20000. R	Pric em Hops:	19			••		
	1010 1/1/1/ 00	20000, 10	can nopp						
Port	Role	State	Cost	Priority	Туре	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	PZP	21/5/3		13	1
Topology chang	e flag	: True		0 0				•	
Number of topo	logy changes	: 13		× •	••••			• • .	
Last topology	change occurred	: 911 seco	nds ago	•	• • • • • • • •			•••	
					••••••				6
SwithCB#show s	panning-tree ms	t						• • • • • • • •	
Vlans mapped:	1-9.12-19.22-4	094							
Bridge	Address:08:00:	09:12:8e:9e	pric	rity:32768					• • • • • • • • • • • •
Operational	Hello time(in	seconds): 2	Forwar	d delay(in	seconds):15	Max-age(in seco	nds):20 tx	HoldCount(i	n pps): 6
Configured	Hello time(in	seconds): 2	Forwar	d delay(in	seconds):15	Max-age(in seco	nds):20 Ma	x-Hops:20	
Root	Address:08:00:	09:8a:14:fa	Priori	ty:0	•				• • • • • • • • • • • •
Denienal Deet	Port:1/1/1	00.014.5-	Path c	ost:0				• • • • • • • •	
Regional Root	Internal cost:	20000	Rem Ho	Ly.U					
	incernar cobe.	20000	itelii iie	20.10					
Port	Role	State	Cost	Priorit	у Туре	BPDU-Tx	BPDU-Rx	TCN-Tx	TCN-
Rx									
1/1/1	Root	Forwarding	20000	128	P2P P2P	217900	217897	14	11
1/1/2	Designated	Forwarding	20000	128	P2P D2D	217902	895	12	•• • • • • • • • • • •
1/1/5	Debignatea	i oi waraing	20000	120	1 21	217900		• • • • • • • •	
Topology chang	e flag	: True						· · · · · · · ·	
Number of topo	logy changes	: 16							
Last topology	change occurred	: 1560 sec	onds ago	)				- <b>•</b>	• • • • • • • • • • • •
									0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
#### MST1									
Vlans mapped:	10,11								
Bridge	Address:08:00:	09:12:8e:9e	Pric	rity:4096					
Root	Address:08:00:	09:8a:14:fa	Pric	ority:0					
	Port:1/1/1, Co	st:20000, R	em Hops:	19					
Death	Dele	0+++-	Gaat	Deri erri terr	(The area of	DDDII	DDDII D	DOM De-	MON D
Port	ROIE	State	Cost	Priority	туре	BPDU-IX	BPDU-RX	TCN-IX	ICN-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 chang	e flag	: True							
Number of topo	logy changes	: 19							
Last topology	change occurred	• 1560 Sec	onds ago	)					
#### MST2									
Vlans mapped:	20,21								
Bridge	Address:08:00:	09:12:8e:9e	Pric	ority:0					
KOOT	Address:08:00:	UY:12:8e:9e	20 Pric	ority:0					
	POIL.0, COSL.0	, Kell 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	P35	217900	895	12	2
Topology chang	e flaα	: True							
Number of topo	logy changes	: 13							
Last topology	change occurred	: 1561 sec	onds 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 spl
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
1
!
https-server vrf mgmt
```

### Switch B

```
hostname SwithcB
!
!
ssh server vrf mgmt
vlan 1,10-11,20-21
spanning-tree
spanning-tree config-name spl
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
```

```
Lab Guide
                                                                                                       MSTP
    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
```

```
Switch D
```

!

interface 1/1/9 no shutdown no routing vlan access 10

https-server vrf mgmt

vlan trunk allowed all

spanning-tree port-type admin-edge

```
hostname SwitchD
!
!
ssh server vrf mgmt
vlan 1,10-11,20-21
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
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
!
```

	$, \ \circ \ $	
	) • • • • • • • • • • • • • • • • • • •	
	) • • • • • • • • • • • • • • • • • • •	Lab Guide
		MSTP
		MOTI
ļ.		
https_gorger urf mgmt		
neeps server vir myme		
	· · · · · · · · · · · · · · · · · · ·	
Switch X	<b>7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</b>	
hostname SwitchX		
!		
ssh server vrf mgmt		
vlan 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	6
spanning_tree		
spanning-cree		
interiace mgmt		
no shutdown		0 0 0 0 0 0 0 5
ip dhcp		
interface 1/1/8		
no shutdown		
no routing		
		• • • • • • • • • • • • • • • •
vian access i		•••••
!		
!		• • • • • • • • • • • • • • • • • • •
!		
•		
	· · · · · · · · · · · · · · · · · · ·	
https-server vri mgmt	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	
		•••••





www.arubanetworks.com