LAB GUIDE

RPVST 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/

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Lab Objective

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

The use case for RPVST is to provide a loop free redundant multipath Layer 2 network. RPVST is **not** the default Spanning Tree Protocol for Aruba CX switches.

For further details on RPVST 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 RPVST

This lab covers configuration of the following:

- RPVST and associated VLANs
- Root bridge placement and identification
- STP timers and edge ports
- STP protection mechanisms

Lab Network Layout

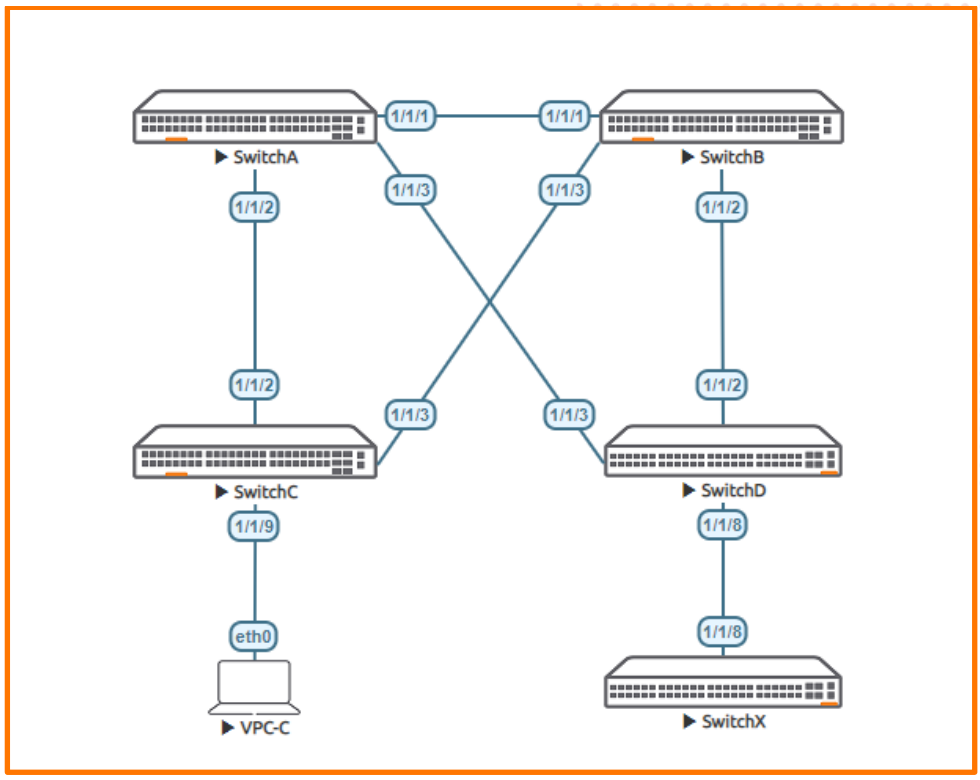

Figure 1. RPVST Lab topology

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 SwitchA 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      SwithcB

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 RPVST and VLANs

Each VLAN has its own independent topology and in the Lab guide we set up RPVST, Root bridges and VLANs as per Figure 2 below

- VLAN 10 Root bridge Switch A, Secondary Root bridge Switch B
- VLAN 11 Root bridge Switch A, Secondary Root bridge Switch B
- VLAN 20 Root bridge Switch B, Secondary Root bridge Switch A
- VLAN 21 Root bridge Switch B, Secondary Root bridge 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.

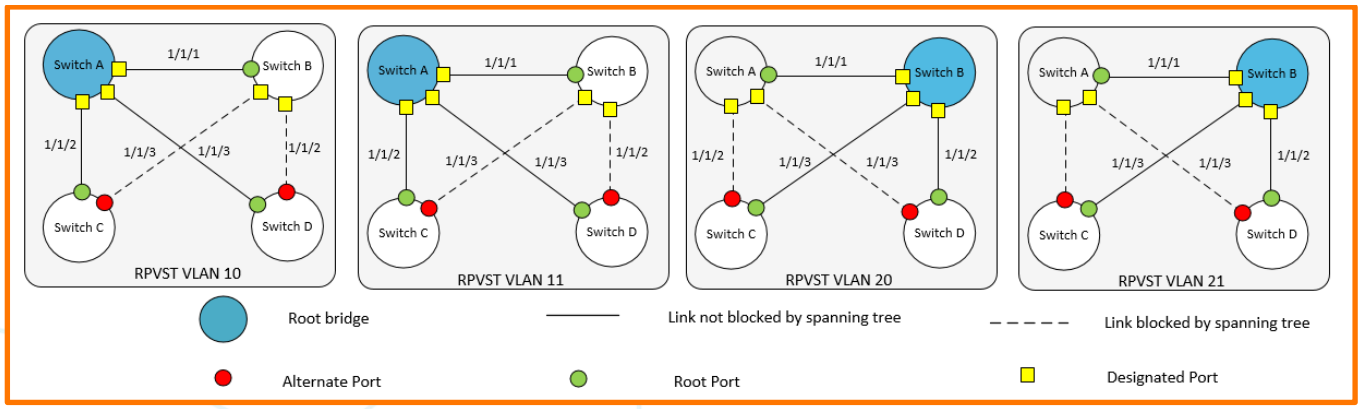

Figure 2 RPVST Topology

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

```
SwitchA#
configure
vlan 10-11,20-21
exit
spanning-tree mode rpvst                < ----- Enable RPVST
spanning-tree
spanning-tree vlan 10-11,20-21          < ----- Define VLANS for RPVST
spanning-tree vlan 10-11 priority 1     < ----- Make Switch A Root Bridge for VLANs
spanning-tree vlan 20-21 priority 2     < ----- Make Switch A Secondary Root Bridge for VLANS
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 RPVST making Switch B Root for VLAN 20-11 and Secondary Root for 10-11, then trunk all VLANs for interface 1/1/1 to 1/1/3.

```
SwitchB#
configure
vlan 10-11,20-21
exit
spanning-tree mode rpvst
spanning-tree
spanning-tree vlan 10-11,20-21
spanning-tree vlan 10-11 priority 2
spanning-tree vlan 20-21 priority 1
int 1/1/1-1/1/3
vlan trunk allowed all
vlan trunk native 1
```

- On Switch C and D define the VLANS for RPVST and trunk all vlans (same config on both with exception of hostname)

```
configure
vlan 10-11,20-21
exit
spanning-tree mode rpvst
spanning-tree
spanning-tree vlan 10-11,20-21
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 RPVST
- Check System ID matches Root for the VLAN

```
SwitchA#show spanning-tree summary root
STP status            : Enabled
Protocol              : RPVST
System ID             : 08:00:09:8a:14:fa

Root bridge for VLANs : 10,11

                                        Root Hello Max Fwd
VLAN     Priority Root ID               cost  Time Age Dly    Root Port
-------- -------- ------------------ --------- ----- --- --- ------------
VLAN10       4096 08:00:09:8a:14:fa          0     2  20  15            0
VLAN11       4096 08:00:09:8a:14:fa          0     2  20  15            0
VLAN20       4096 08:00:09:12:8e:9e      20000     2  20  15        1/1/1
VLAN21       4096 08:00:09:12:8e:9e      20000     2  20  15        1/1/1
```

As shown above Switch A is Root for VLAN 10 and 11, identified by the System ID, and VLAN 20 and 21 Root is another device which is expected to be Switch B based on previous configurations.

- Examine Switch B and check Root switches for VLANs 20 and 21 are as expected

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

Root bridge for VLANs : 20,21

                                        Root Hello Max Fwd
VLAN     Priority Root ID               cost  Time Age Dly    Root Port
-------- -------- ------------------ --------- ----- --- --- ------------
VLAN10       4096 08:00:09:8a:14:fa      20000     2  20  15        1/1/1
VLAN11       4096 08:00:09:8a:14:fa      20000     2  20  15        1/1/1
VLAN20       4096 08:00:09:12:8e:9e          0     2  20  15            0
VLAN21       4096 08:00:09:12:8e:9e          0     2  20  15            0
```

As shown above Switch B is Root for VLAN 20 and 21 identified by the System ID, and VLAN 10 and 11 Root is Switch A identified by the 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. Here we observe VLAN 10 only and see ports are as set out in Figure 2. The reader can look at other VLANS at their leisure.

- Examine Switch A output for VLAN 10

```
SwitchA# show spanning-tree vlan 10

VLAN10
Spanning tree status : Enabled Protocol: RPVST
  Root ID     Priority   : 4096
              MAC-Address: 08:00:09:8a:14:fa
              This bridge is the root
              Hello time(in seconds):2  Max Age(in seconds):20
              Forward Delay(in seconds):15

  Bridge ID   Priority   : 4096
              MAC-Address: 08:00:09:8a:14:fa
              Hello time(in seconds):2  Max Age(in seconds):20
              Forward Delay(in seconds):15

Port         Role           State      Cost           Priority   Type       BPDU-Tx    BPDU-Rx    TCN-Tx     TCN-Rx
------------ -------------- ---------- -------------- ---------- ---------- ---------- ---------- ---------- ---------
1/1/1        Designated     Forwarding 20000          128        P2P        2586       533        10         8
1/1/2        Designated     Forwarding 20000          128        P2P        2679       434        5          7
1/1/3        Designated     Forwarding 20000          128        P2P        3106       5          6          2

Number of topology changes    : 6
Last topology change occurred : 4828 seconds ago
```

Above all ports shown on Switch A the Root Bridge for VLAN 10, are Designated Forwarding as expected.

- Examine Switch B output for VLAN 10

```
SwitchB# show spanning-tree vlan 10

VLAN10
Spanning tree status : Enabled Protocol: RPVST
  Root ID     Priority   : 4096
              MAC-Address: 08:00:09:8a:14:fa
              Hello time(in seconds):2  Max Age(in seconds):20
              Forward Delay(in seconds):15

  Bridge ID   Priority   : 8192
              MAC-Address: 08:00:09:12:8e:9e
              Hello time(in seconds):2  Max Age(in seconds):20
              Forward Delay(in seconds):15

Port         Role           State      Cost           Priority   Type       BPDU-Tx    BPDU-Rx    TCN-Tx     TCN-Rx
------------ -------------- ---------- -------------- ---------- ---------- ---------- ---------- ---------- ---------
1/1/1        Root           Forwarding 20000          128        P2P        537        2770       8          9
1/1/2        Designated     Forwarding 20000          128        P2P        3298       7          6          2
1/1/3        Designated     Forwarding 20000          128        P2P        3298       9          9          3

Number of topology changes    : 3
Last topology change occurred : 5247 seconds ago
```

Above on Switch B the Root Bridge for VLAN 10 is identified by its MAC address "`08:00:09:8a:14:fa`" , which is Switch A. The port connecting to Switch A 1/1/1 is the Root port and Forwarding and other two ports are Designated Forwarding leading to Switch C and D respectively. All ports follow the VLAN 10 topology as expected, as per Figure 2.

- Finally examine Switch C output for VLAN 10. The reader can also observe Switch D, output not shown in this Lab Guide

```
SwitchC# show spanning-tree vlan 10

VLAN10
Spanning tree status : Enabled Protocol: RPVST
  Root ID     Priority   : 4096
              MAC-Address: 08:00:09:8a:14:fa
              Hello time(in seconds):2  Max Age(in seconds):20
              Forward Delay(in seconds):15

  Bridge ID   Priority   : 32768
              MAC-Address: 08:00:09:16:7b:7e
              Hello time(in seconds):2  Max Age(in seconds):20
              Forward Delay(in seconds):15

Port         Role           State      Cost           Priority   Type       BPDU-Tx    BPDU-Rx    TCN-Tx     TCN-Rx
------------ -------------- ---------- -------------- ---------- ---------- ---------- ---------- ---------- ---------
1/1/2        Root           Forwarding 20000          128        P2P        438        3553       7          4
1/1/3        Alternate      Blocking   20000          128        P2P        9          3986       3          8

Number of topology changes    : 5
```

```
Last topology change occurred : 6811 seconds ago
```

Above on Switch C the Root Bridge for VLAN 10 is identified by its MAC address "08:00:09:8a:14:fa" , which is Switch A. The port connecting to Switch A 1/1/2 is the Root port and Forwarding and other port 1/1/3 towards Switch B is Alternate Blocking preventing a looped topology for VLAN 10.

The reader can continue to check switch D, as well as check other VLANs for their own understanding in a similar fashion (not shown in this lab guide) and build a logical picture of the RPVST map as shown in Figure 2

Task 4 - Path Cost

Now examine path cost and the RPVST port state from Switch D perspective with VLAN 10.

- 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.

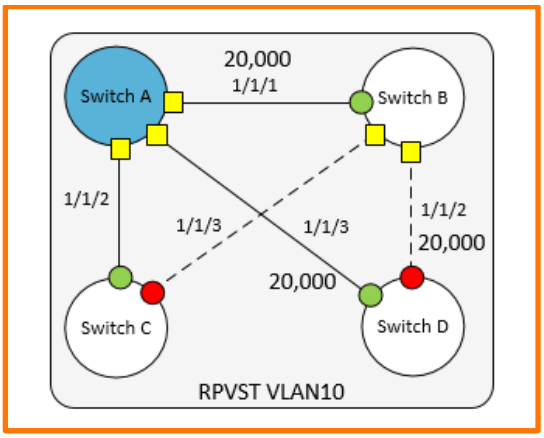

Figure 3 RPVST VLAN 10 path cost from Switch D

- Check the port roles and cost from Switch D perspective

```
SwitchD# show spanning-tree vlan 10

VLAN10
Spanning tree status : Enabled Protocol: RPVST
  Root ID    Priority   : 4096
             MAC-Address: 08:00:09:8a:14:fa
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

  Bridge ID  Priority  : 32768
             MAC-Address: 08:00:09:ee:11:82
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

Port         Role           State      Cost           Priority   Type       BPDU-Tx    BPDU-Rx    TCN-Tx     TCN-Rx
------------ -------------- ---------- -------------- ---------- ---------- ---------- ---------- ---------- ---------
1/1/2        Alternate      Blocking   20000          128        P2P        7          4409       3          9
1/1/3        Root           Forwarding 20000          128        P2P        5          4406       2          9

Number of topology changes    : 3
Last topology change occurred : 7971 seconds ago
```

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 VLAN 10 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 vlan 10 cost 40001    < ----- change the path cost on  the interface to 40001 or more
```

```
SwitchD# show spanning-tree vlan 10

VLAN10
Spanning tree status : Enabled Protocol: RPVST
  Root ID    Priority   : 4096
             MAC-Address: 08:00:09:8a:14:fa
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

  Bridge ID  Priority  : 32768
             MAC-Address: 08:00:09:ee:11:82
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

Port         Role           State      Cost           Priority   Type       BPDU-Tx    BPDU-Rx    TCN-Tx     TCN-Rx
------------ -------------- ---------- -------------- ---------- ---------- ---------- ---------- ---------- ---------
1/1/2        Root           Forwarding 20000          128        P2P        10         4483       5          9
1/1/3        Alternate      Blocking   40001          128        P2P        8          4480       2          11

Number of topology changes    : 1
Last topology change occurred : 10 seconds ago
```

As shown above by manipulating the path cost the behavior of the ports roles 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 - RPVST timers and tuning

Detailed information around STP timers is beyond the scope of this lab guide. However, it is possible to change some RPVST 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. The timers are shown below:

- `spanning-tree <vlan-list> 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 <vlan-list> 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 <vlan-list> 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
exit
```

- Now examine the ports on Switch C

```
SwitchC# show spanning-tree vlan 10

VLAN10
Spanning tree status : Enabled Protocol: RPVST
  Root ID    Priority   : 4096
             MAC-Address: 08:00:09:8a:14:fa
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

  Bridge ID  Priority  : 32768
             MAC-Address: 08:00:09:16:7b:7e
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

Port         Role           State      Cost           Priority   Type       BPDU-Tx    BPDU-Rx    TCN-Tx     TCN-Rx
```

```
------------ -------------- ---------- ------------- ---------- ---------- ---------- ---------- ---------- ---------
1/1/2        Root           Forwarding 20000         128        P2P        444        4647       10         10
1/1/3        Alternate      Blocking   20000         128        P2P        15         5081       6          14
1/1/9        Designated     Forwarding 20000         128        P2P        7          0          0          0

Number of topology changes    : 2
Last topology change occurred : 1417 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
exit
```

Now examine the ports on Switch C

```
SwitchC# show spanning-tree vlan 10

VLAN10
Spanning tree status : Enabled Protocol: RPVST
  Root ID    Priority   : 4096
             MAC-Address: 08:00:09:8a:14:fa
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

  Bridge ID  Priority  : 32768
             MAC-Address: 08:00:09:16:7b:7e
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

Port         Role           State      Cost          Priority   Type       BPDU-Tx    BPDU-Rx    TCN-Tx     TCN-Rx
------------ -------------- ---------- ------------- ---------- ---------- ---------- ---------- ---------- ---------
1/1/2        Root           Forwarding 20000         128        P2P        444        4807       10         10
1/1/3        Alternate      Blocking   20000         128        P2P        15         5241       6          14
1/1/9        Designated     Forwarding 20000         128        P2P  Edge  167        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 topology by preventing spoofed BPDU packets from entering the network. Typically BPDU protection would be applied to edge ports connected to end user devices that do not run STP. If STP BPDU packets are received on a protected port, this feature disables the port and an alert 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
exit
```

- On Switch X configure the following

```
SwitchX#
Configure
hostname SwitchX
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 vlan 10

VLAN10
Spanning tree status : Enabled Protocol: RPVST
  Root ID    Priority    : 4096
             MAC-Address: 08:00:09:8a:14:fa
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

  Bridge ID  Priority  : 32768
             MAC-Address: 08:00:09:ee:11:82
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

Port         Role           State      Cost           Priority   Type       BPDU-Tx    BPDU-Rx    TCN-Tx     TCN-Rx
------------ -------------- ---------- -------------- ---------- ---------- ---------- ---------- ---------- ----------
1/1/2        Root           Forwarding 20000          128        P2P        580        1237       400        395
1/1/3        Alternate      Blocking   40001          128        P2P        214        1057       212        303
1/1/8        Disabled       Bpdu-Error 20000          128        P2P        81         0          0          0

Number of topology changes    : 307
Last topology change occurred : 2 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 state: down
 Link transitions: 0
 Description:
 Hardware: Ethernet, MAC Address: 08:00:09:ee:11:c4
 MTU 1500
 Type --
 Full-duplex
 qos trust none
 Speed 1000 Mb/s
 Auto-negotiation is off
 Flow-control: off
 Error-control: off
 MDI mode: none
 VLAN Mode: access
 Access VLAN: 10
```

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 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 VLAN 10 ,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 vlan 10 priority 0    < ----- Make Switch C Root for instance 1
exit
```

Below observe that VLAN 10 on both Switch A and B ports go into Root Inconsistent Alternate. Thus protecting the rest of the network from the information that Switch C is sending “better” BPDUs, and maintaining Layer 2 stability.

Note: Prior to Root Inconsistent the protected ports will go into Designated Blocking, and may also be observed depending when show commands will be executed.

```
SwitchA# show spanning-tree vlan 10

VLAN10
Spanning tree status : Enabled Protocol: RPVST
  Root ID    Priority   : 4096
             MAC-Address: 08:00:09:8a:14:fa
             This bridge is the root
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

  Bridge ID  Priority  : 4096
             MAC-Address: 08:00:09:8a:14:fa
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

Port         Role           State      Cost           Priority   Type       BPDU-Tx    BPDU-Rx    TCN-Tx     TCN-Rx
------------ -------------- ---------- -------------- ---------- ---------- ---------- ---------- ---------- ---------
1/1/1        Designated     Forwarding 20000          128        P2P        1606       383        432        159
1/1/2        Alternate      Root-Inc   20000          128        P2P        1571       114        520        92
1/1/3        Designated     Forwarding 20000          128        P2P        1567       172        447        167

Number of topology changes    : 694
Last topology change occurred : 1 seconds ago


SwitchB# show spanning-tree vlan 10

VLAN10
Spanning tree status : Enabled Protocol: RPVST
  Root ID    Priority   : 4096
             MAC-Address: 08:00:09:8a:14:fa
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

  Bridge ID  Priority  : 8192
             MAC-Address: 08:00:09:12:8e:9e
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

Port         Role           State      Cost           Priority   Type       BPDU-Tx    BPDU-Rx    TCN-Tx     TCN-Rx
------------ -------------- ---------- -------------- ---------- ---------- ---------- ---------- ---------- ---------
1/1/1        Designated     Learning   20000          128        P2P        1127       551        608        125
1/1/2        Root           Forwarding 20000          128        P2P        1865       354        569        187
1/1/3        Alternate      Root-Inc   20000          128        P2P        1717       479        627        88

Number of topology changes    : 763
Last topology change occurred : 2 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 mode rpvst
spanning-tree
spanning-tree vlan 10,11,20,21
spanning-tree vlan 10 priority 1
spanning-tree vlan 11 priority 1
spanning-tree vlan 20 priority 2
spanning-tree vlan 21 priority 2
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 SwitchB
!
!
ssh server vrf mgmt
vlan 1,10-11,20-21
spanning-tree mode rpvst
spanning-tree
spanning-tree vlan 10,11,20,21
spanning-tree vlan 10 priority 2
spanning-tree vlan 11 priority 2
spanning-tree vlan 20 priority 1
spanning-tree vlan 21 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
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 mode rpvst
spanning-tree
spanning-tree vlan 10,11,20,21
spanning-tree vlan 10 priority 0
interface mgmt
    no shutdown
    ip dhcp
interface 1/1/2
    no shutdown
    no routing
    vlan trunk native 1
    vlan trunk allowed all
    spanning-tree vlan 10 cost 20000
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 mode rpvst
spanning-tree
spanning-tree vlan 10,11,20,21
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
    spanning-tree vlan 10 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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