Lab 2.3 –Configuring Load Balancing Using PVST+

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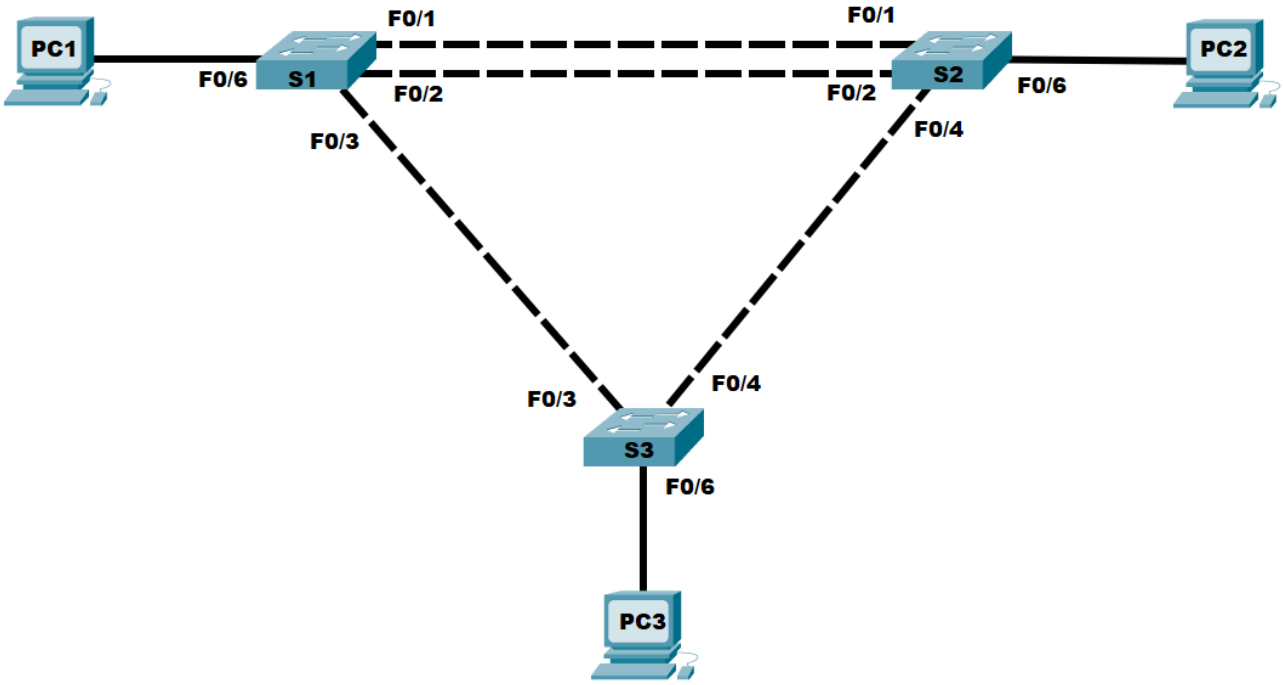

Addressing Table

Device	Interface	IP Address	Subnet Mask
S1	VLAN 1	192.168.1.1	255.255.255.0
S2	VLAN 1	192.168.1.2	255.255.255.0
S3	VLAN 1	192.168.1.3	255.255.255.0
PC1	NIC	192.168.2.1	255.255.255.0
PC2	NIC	192.168.2.2	255.255.255.0
PC3	NIC	192.168.2.3	255.255.255.0

Objectives

Part 1: Build the Network and Configure Basic Device Settings

Part 2: Configure VLANs and Trunking

Part 3: Determine the Root Bridge and Port States

Part 4: Implement Load Balancing using PVST+ Configuration

Background / Scenario

The Per-VLAN Spanning Tree (PVST) protocol is a Cisco proprietary enhancement of STP that maintains a separate sp anning tree instance per VLAN in the network. This allows each spanning tree to be independently fine-tuned to implement load balancing in the network.

In this activity, you will configure VLANs and trunks, then optimize the switched topology using PVST+ to implement VLAN load balancing.

Part 1: Build the Network and Configure Basic Device Settings

In Part 1, you will set up the network topology and configure basic settings on the switches.

Step 1: Cable the network as shown in the topology.

Attach the devices as shown in the topology diagram, and cable as necessary.

Step 2: Initialize and reload the switches as necessary.

Step 3: Configure basic settings for each switch.

a. Configure the device name as shown in the topology.

b. Configure the IP address listed in the Addressing Table for VLAN 1 on all switches.

Part 2: Configure VLANs and Trunking

In Part 2, you will create a new VLAN in the switch network and observe the spanning tree instances of all VLANs.

Step 1: Create a new VLAN in the network.

Configure ports connecting **ALL** switches as trunks. A sample configuration is shown below.

```
S1(config)# interface range f0/1-4
S1(config-if-range)# switchport mode trunk
S1(config-if-range)# end
```

Step 2: Create a new VLAN in the network.

a. Create VLAN 2 on **ALL** switches. A sample configuration is shown below

```
S1(config)# vlan 2
```

b. Assign fa0/6 on **ALL** switches to VLAN 2. A sample configuration for S1 is shown below.

```
S1(config)# interface f0/6
S1(config)# switchport access vlan 2
```

Step 3: Test connectivity

a. Test connectivity between hosts.

Can PC1 ping PC2?	yes

Can PC1 ping PC3?	yes
Can PC2 ping PC3?	yes
Can S1 ping S2?	yes
Can S1 ping S3?	yes
Can S2 ping S3?	yes

If any of these do not work, recheck your configurations and troubleshoot VLAN and trunk configurations as necessary.

Part 3: Determine the Root Bridge and Port States

In PVST+, the BPDU bridge priority field contains both the priority value and the VLAN ID of the spanning tree; hence the bridge priorities are displayed as the sum of the actual priority value + the VLAN ID of the spanning tree.

Issue the **show spanning-tree** command on the switches. Observe that there are two sets of spanning tree details listed in the output – each corresponding to a VLAN currently active in the network.

```
S1# show spanning-tree

VLAN0001
  Spanning tree enabled protocol ieee
  Root ID     Priority    32769
              Address     0cd9.96d2.4000
              Cost        19
              Port        1 (FastEthernet0/1)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32769  (priority 32768 sys-id-ext 1)
              Address     0cd9.96e8.8a00
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time  15  sec

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------------
Fa0/1               Root FWD 19        128.1    P2p
Fa0/2               Altn BLK 19        128.2    P2p
Fa0/3               Altn BLK 19        128.3    P2p

VLAN0002
  Spanning tree enabled protocol ieee
  Root ID     Priority    32770
              Address     0cd9.96d2.4000
              Cost        19
              Port        1 (FastEthernet0/1)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
```

```
Bridge ID  Priority    32770  (priority 32768 sys-id-ext 2)
           Address     0cd9.96e8.8a00
           Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
           Aging Time  15  sec

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------------
Fa0/1               Root FWD 19        128.1    P2p
Fa0/2               Altn BLK 19        128.2    P2p
Fa0/3               Altn BLK 19        128.3    P2p
```

Currently, all switches are set equally at the default bridge priority value. Note that your own output may differ in terms of root bridge and port roles.

Record the spanning tree information of each switch in the table below:

	VLAN 1			VLAN 2		
Switch	**Bridge Priority**	**Port**	**Port Status**	**Bridge Priority**	**Port**	**Port Status**
S1	32769	F0/1	FWD	32770	F0/1	FWD
		F0/2	BLK		F0/2	BLK
		F0/3	FWD		F0/3	FWD
S2	32769	F0/1	FWD	32770	F0/1	FWD
		F0/2	FWD		F0/2	FWD
		F0/4	FWD		F0/4	FWD
S3	32769	F0/3	BLK	32770	F0/3	BLK
		F0/4	FWD		F0/4	FWD

Which switch is the root bridge for VLAN 1?	S2
Which switch is the root bridge for VLAN 2?	S2

Based on these port states, which links in the topology are actively being used to forward traffic for VLAN 1?

S1: Fa0/1 and Fa0/3
S2: Fa0/1-2, Fa0/4
S3: Fa0/4

Which links are actively being used to forward traffic for VLAN 2?

S1: Fa0/1, Fa0/3
S2: Fa0/1-2, 4
S3: Fa0/4

Part 4: Implement Load Balancing using PVST+ Configuration

Because there is a separate instance of the spanning tree for every active VLAN, a separate root election is conducted for each instance. If the default switch priorities are used in root selection, the same root is elected for every spanning tree instance, as we have seen. This could lead to an inferior design. Some reasons to control the selection of the root switch include:

- The root switch is responsible for generating BPDUs for STP 802.1D and is the focal point for spanning tree to control traffic. The root switch must be capable of handling this additional load.
- The placement of the root defines the active switched paths in the network. Random placement is likely to lead to suboptimal paths. Ideally the root is in the distribution layer.

Since PVST+ creates a separate spanning tree instance per VLAN, it makes it possible to fine-tune each spanning tree to effectively balance the traffic load in the network. In Part 4, you will use PVST+ to adjust the spanning trees to create different paths for traffic of different VLANs.

Step 1: Adjust the spanning tree of each VLAN

In PVST+, the lower 12 bits of the 20-bit BPDU bridge priority field is repurposed to contain the VLAN ID of the spanning tree; hence when adjusting the bridge priority, one can only do so in increments of 4096.

Port priorities may also be adjusted to influence root port selection of a downstream switch on a per VLAN basis. By default, port priorities are set at 128 and may be adjusted in multiples of 16..

a. Influence the flow of traffic for each VLAN by manipulating the root bridge of their respective spanning trees through bridge priority adjustment. Set S1 and S2 as the primary root of VLANs 1 and 2, respectively, and S3 as the secondary root bridges of both VLANs

```
S1(config)# spanning-tree vlan 1 root primary

S2(config)# spanning-tree vlan 2 root primary

S3(config)# spanning-tree vlan 1 root secondary
S3(config)# spanning-tree vlan 2 root secondary
```

b. Fine tune the spanning trees further by manipulating the priorities of spanning tree ports to balance VLAN load between the redundant links connecting S1 and S2. The connection between Fa0/2 of these switches will be used to carry the traffic of VLAN 2. Lower the port priority of Fa0/2 for VLAN 2 on S2 to do this.

```
S2(config)# interface FastEthernet0/2
S2(config-if)# spanning-tree vlan 2 port-priority 112
```

c. Wait approximately 30 seconds for the spanning trees to recalculate then issue the **show spanning-tree** command on the switches.

Record the spanning tree information of each switch in the table below:

	VLAN 1			**VLAN 2**		
Switch	**Bridge Priority**	**Port**	**Port Status**	**Bridge Priority**	**Port**	**Port Status**
S1	24577	F0/1	FWD	32770	F0/1	FWD
		F0/2	FWD		F0/2	BLK
		F0/3	FWD		F0/3	BLK

	VLAN 1			VLAN 2		
Switch	**Bridge Priority**	**Port**	**Port Status**	**Bridge Priority**	**Port**	**Port Status**
S2	32769	F0/1	FWD	24578	F0/1	FWD
		F0/2	BLK		F0/2	FWD
		F0/4	BLK		F0/4	FWD
S3	28673	F0/3	FWD	28674	F0/3	FWD
		F0/4	FWD		F0/4	FWD

Based on the newly adjusted spanning trees, which links in the topology are actively being used to forward traffic for VLAN 1?

S1: F0/1, F0/2, and F0/3
S2: F0/1
S3: F0/3 and F0/4

Which links are actively being used to forward traffic for VLAN 2?

S1: F0/1

S2: F0/1, F0/2, and F0/4

S3: F0/3 and F0/4

Reflection

How does the use of PVST+ contribute to more efficient utilization of switch links in a network?

The usage of PVST+ conrtibute to the efficient utilization of switch links in a network by using ports more efficiently and effectively distributing the load that a switch intakes by dividing it equally.

Being able to prioritize specific VLANs properly, there will be no load sharing and the CPU utilization will be low and only one instance of STP is used or calculated.

Another reason as to why PVST+ is efficient in utilizing switch links is because of we are able to manually or automatically configure which type of port-priority for a specific VLAN, hence, optimizing the utilization in switches.