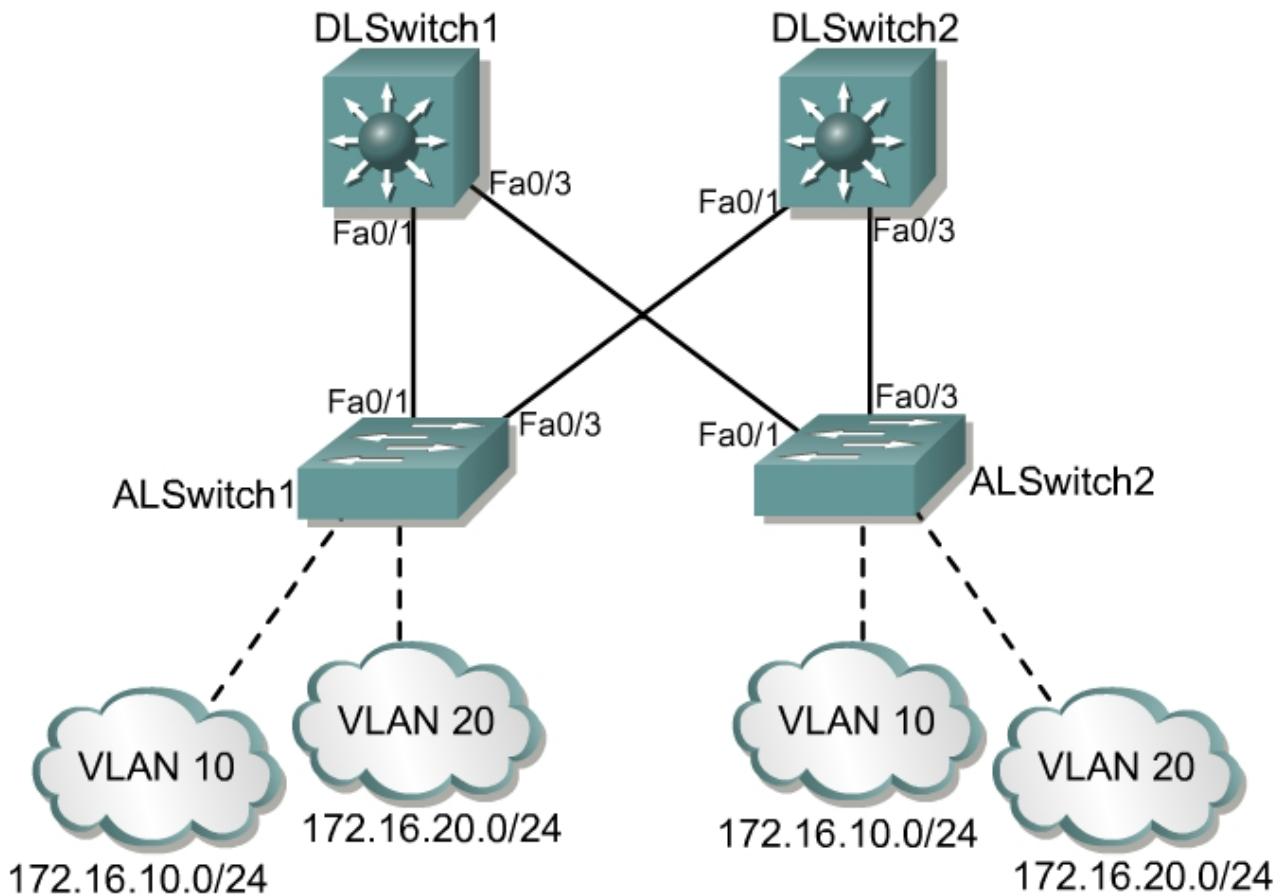


Lab 3.10.6 Per-VLAN Spanning-Tree Load Balancing



Objective

The purpose of this lab is to modify the default behavior of spanning tree for VLAN load balancing using Cisco IOS commands.

Scenario

Two distribution layers and two access layer switches have been installed. The network administrator wants to ensure that the access layer switches do not become the root bridge for spanning-tree. The distribution layer switch will serve this function. The network administrator also wants to provide per VLAN load balancing. DLSwitch1 will need to become the root bridge for VLAN 10 and DLSwitch2 will need to become the root bridge for VLAN 20.

The network design is as follows.

Catalyst Type	Switch	VTP Domain	VTP Mode
3550	DLSwitch1	CORP	Server
3550	DLSwitch2	CORP	Client
2950	ALSwitch1	CORP	Client
2950	ALSwitch2	CORP	Client

The VLAN configuration information is as follows.

VLAN ID	VLAN Name	VLAN Subnet	DLSwitch1	DLSwitch2	ALSwitch1	ALSwitch2
1	Native	172.16.1.0	Fa0/1-10	Fa0/1-10	Fa0/1-4 Fa0/13 – 24	Fa0/1-4 Fa0/13 - 24
10	Accounting	172.16.10.0	Fa0/11-20	Fa0/11-20	Fa0/5-8	Fa0/5-8
20	Marketing	172.16.20.0	Fa0/21-24	Fa0/21-24	Fa0/9-12	Fa0/9-12
Trunk		802.1Q	802.1Q	802.1Q	802.1Q	802.1Q

Step 1

Do not cable the lab until all switch configurations and vlan.dat files have been erased.

If the VLAN database exists, delete it on all switches and clear the configuration.

```

switch#show flash
Directory of flash:/

2  -rwx          0  Jan  01 1970 00:01:22  env_vars
3  -rwx         342  Jan  01 1970 00:01:22  system_env_vars
4  -rwx         720  Mar  01 1993 00:00:47  vlan.dat
9  drwx        192  Mar  01 1993 00:03:39  c3550-i5q3l2-mz.121-8.EA1c

switch#delete flash:vlan.dat
Delete filename [vlan.dat]?
Delete flash:vlan.dat? [confirm]
switch#
switch#erase startup-config
Erasing the nvram filesystem will remove all files! Continue? [confirm]
DLSwitchA#reload

System configuration has been modified. Save? [yes/no]:n
Proceed with reload? [confirm]

```

Cable the lab according to the diagram.

Configure the hostname, passwords, and Telnet access on all the switches. Configure the interface VLAN 1 IP address on each switch.

Observe the default behavior of Spanning-Tree (STP) using the **show spanning-tree** command on all switches.

1. Which switch became the root bridge and why?

2. What command was used to view the root bridge?

Step 2

Configure the trunking interfaces to create a trunk link between the switches. Set the port to trunking with 802.1q encapsulation on DLSwitch1 and DLSwitch2.

Note: If an error is received because the port is set to auto encapsulation, enter the **switchport mode trunk** command after the **switchport trunk encapsulation dot1q** command.

```
DLSwitch1(config)#interface range fastethernet 0/1 , fastethernet 0/3
DLSwitch1(config-if-range)#switchport trunk encapsulation dot1q
DLSwitch1(config-if-range)#switchport mode trunk
DLSwitch1(config-if-range)#^z

DLSwitch2(config)#interface range fastethernet 0/1 , fastethernet 0/3
DLSwitch2(config-if-range)#switchport trunk encapsulation dot1q
DLSwitch2(config-if-range)#switchport mode trunk
DLSwitch2(config-if-range)#^z
```

The 2950 switches do not need the encapsulation configured. These switches default to 802.1q. Some IOS versions do not offer any other options. Console into each access level switch and configure trunking.

```
ALSwitch1(config)#interface range fastethernet 0/1 , fastethernet 0/3
ALSwitch1(config-if-range)#switchport mode trunk
ALSwitch1(config-if-range)#^z

ALSwitch2(config)#interface range fastethernet 0/1 , fastethernet 0/3
ALSwitch2(config-if-range)#switchport mode trunk
ALSwitch2(config-if-range)#^z
```

Step 3

Console into DLSwitch1 and configure the vtp domain CORP, server mode, and the appropriate VLANs and names as shown below.

```
DLSwitch1#vlan database
DLSwitch1(vlan)#vtp domain CORP
DLSwitch1(vlan)#vtp server
DLSwitch1(vlan)#vlan 10 name Accounting
DLSwitch1(vlan)#vlan 20 name Marketing
DLSwitch1(vlan)#exit
```

Verify the trunk configuration with the **show vtp status** and **show vtp counters** command.

```
DLSwitch1#show vtp status
VTP Version : 2
Configuration Revision : 1
Maximum VLANs supported locally : 1005
Number of existing VLANs : 7
VTP Operating Mode : Server
VTP Domain Name : CORP
VTP Pruning Mode : Disabled
```

```

VTP V2 Mode : Disabled
VTP Traps Generation : Disabled
MD5 digest : 0xB4 0x57 0x1A 0x95 0x99 0x85 0x6D 0x49
Configuration last modified by 0.0.0.0 at 3-1-93 00:13:27
Local updater ID is 0.0.0.0 (no valid interface found)

DLSwitch1#show vtp counters
VTP statistics:
Summary advertisements received : 32
Subset advertisements received : 2
Request advertisements received : 3
Summary advertisements transmitted : 44
Subset advertisements transmitted : 3
Request advertisements transmitted : 0
Number of config revision errors : 0
Number of config digest errors : 0
Number of V1 summary errors : 0

VTP pruning statistics:

Trunk      Join Transmitted Join Received   Summary advts received from
non-pruning-capable device
-----  -----  -----  -----
Fa0/1          0            0            0
Fa0/3          0            1            0

```

Assign ports to the respective VLANs in DLSwitch1 as shown below. The **interface range** command can be used to configure several interfaces at the same time.

```

DLSwitch1(config)#interface range fastethernet 0/11 - 20
DLSwitch1(config-if-range)#switchport mode access
DLSwitch1(config-if-range)#switchport access vlan 10
DLSwitch1(config)#interface range fastethernet 0/21 - 24
DLSwitch1(config-if-range)#switchport mode access
DLSwitch1(config-if-range)#switchport access vlan 20

```

Configure DLSwitch2 as a VTP client and assign ports to the respective VLANs as shown below. The **interface range** command can be used to configure several interfaces at the same time.

```

DLSwitch2#vlan database
DLSwitch2(vlan)#vtp client
DLSwitch2(vlan)#exit
DLSwitch2#config terminal
DLSwitch2(config)#interface range fastethernet 0/11 - 20
DLSwitch2(config-if-range)#switchport mode access
DLSwitch2(config-if-range)#switchport access vlan 10
DLSwitch2(config-if-range)#interface range fastethernet 0/21 - 24
DLSwitch2(config-if-range)#switchport mode access
DLSwitch2(config-if-range)#switchport access vlan 20
DLSwitch2(config-if-range)#^z

```

Step 4

Configure ALSwitch1 and ALSwitch2 as VTP clients and assign ports to the respective VLANs in each switch as shown below. The **interface range** command can be used to configure several interfaces at the same time.

```

ALSwitch1#vlan database
ALSwitch1(vlan)#vtp client
ALSwitch1(vlan)#exit

```

```

ALSwitch1#config terminal
ALSwitch1(config)#interface range fastethernet 0/5 - 8
ALSwitch1(config-if-range)#switchport mode access
ALSwitch1(config-if-range)#switchport access vlan 10
ALSwitch1(config-if-range)#interface range fastethernet 0/9 - 12
ALSwitch1(config-if-range)#switchport mode access
ALSwitch1(config-if-range)#switchport access vlan 20
ALSwitch1(config-if-range)^z

ALSwitch2#vlan database
ALSwitch2(vlan)#vtp client
ALSwitch2(vlan)#exit
ALSwitch2#config terminal
ALSwitch2(config)#interface range fastethernet 0/5 - 8
ALSwitch2(config-if-range)#switchport mode access
ALSwitch2(config-if-range)#switchport access vlan 10
ALSwitch2(config-if-range)#interface range fastethernet 0/9 - 12
ALSwitch2(config-if-range)#switchport mode access
ALSwitch2(config-if-range)#switchport access vlan 20
ALSwitch2(config-if-range)^z

```

Console into each switch and verify the VTP and VLAN configurations with the `show vtp status` and `show vlan` commands.

Step 5

Verify the default behavior of STP. Use the `show spanning-tree` command on all the switches.

```

ALSwitch2#show spanning-tree

VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    32769
              Address     0009.430f.a400
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32769  (priority 32768 sys-id-ext 1)
              Address     0009.430f.a400
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time  300

  Interface  Port ID      Designated          Port ID
Name        Prio.Nbr    Cost  Sts       Cost Bridge ID  Prio.Nbr
-----+-----+-----+-----+-----+-----+-----+
  Fa0/1      128.1        19 FWD           0 32769 0009.430f.a400  128.1
  Fa0/3      128.3        19 FWD           0 32769 0009.430f.a400  128.3

VLAN0010
  Spanning tree enabled protocol ieee
  Root ID    Priority    32778
              Address     0009.430f.a400
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32778  (priority 32768 sys-id-ext 10)
              Address     0009.430f.a400
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time  300

  Interface  Port ID      Designated          Port ID
Name        Prio.Nbr    Cost  Sts       Cost Bridge ID  Prio.Nbr
-----+-----+-----+-----+-----+-----+-----+
  Fa0/1      128.1        19 FWD           0 32778 0009.430f.a400  128.1

```

```

Fa0/3           128.3          19 FWD          0 32778 0009.430f.a400 128.3

VLAN0020
  Spanning tree enabled protocol ieee
  Root ID    Priority    32788
  Address    0009.430f.a400
  This bridge is the root
  Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32788 (priority 32768 sys-id-ext 20)
  Address    0009.430f.a400
  Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec
  Aging Time 300

  Interface      Port ID      Designated      Port ID
  Name          Prio.Nbr     Cost  Bridge ID   Prio.Nbr
  -----          -----        -----  -----
  Fa0/1          128.1        19 FWD          0 32788 0009.430f.a400 128.1
  Fa0/3          128.3        19 FWD          0 32788 0009.430f.a400 128.3

```

1. Which switch became the root bridge and why?

2. Did all the VLANs have the same root bridge?

This is not the most efficient behavior of spanning tree. In the sample output above, ALSwitch2 became the root bridge. All traffic will go through ALSwitch2 even if it is not the best path to the destination. It would be more efficient to set a distribution layer switch as the root bridge.

Step 6

Set a distribution layer switch as the root bridge to increase network efficiency. To further increase efficiency, split the load between the two distribution layer switches. DLSwitch1 will become the root bridge for VLAN 10 and DLSwitch2 will become the root bridge for VLAN 20.

Cisco switches use per-VLAN spanning tree (PVST) by default. The range for the priority value is 0 to 61440 in increments of 4096. The default value is 32768. The lower the number, the more likely the switch will be chosen as the root bridge. Valid priority values are 0, 4096, 8192, 12288, 16384, 20480, 24576, 28672, 32768, 36864, 40960, 45056, 49152, 53248, 57344, and 61440. All other values are rejected.

Change to root bridge priority for DLSwitch1 on VLAN 10 to 4096 to force DLSwitch1 to be the root bridge.

```
DLSwitch1(config)#spanning-tree vlan 10 priority 4096
```

Use the `show spanning-tree` command to verify which switch is the root bridge.

```

DLSwitch1#show spanning-tree

VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    32769
  Address    0009.430f.a400
  Cost       19
  Port       3 (FastEthernet0/3)
  Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32769 (priority 32768 sys-id-ext 1)

```

```

Address      000a.b701.f700
Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
Aging Time  300

Interface      Port ID          Designated
Name           Prio.Nbr        Cost Sts  Cost Bridge ID
-----          -----          -----
Fa0/1          128.1           19 FWD    19 32769 000a.b701.f700 128.1
Fa0/3          128.3           19 FWD    0 32769 0009.430f.a400 128.1

VLAN0010
Spanning tree enabled protocol ieee
Root ID       Priority      4106
              Address      000a.b701.f700
              This bridge is the root
Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

Bridge ID     Priority      4106  (priority 4096 sys-id-ext 10)
              Address      000a.b701.f700
Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
Aging Time  300

Interface      Port ID          Designated
Name           Prio.Nbr        Cost Sts  Cost Bridge ID
-----          -----          -----
Fa0/1          128.1           19 FWD    0 4106 000a.b701.f700 128.1
Fa0/3          128.3           19 FWD    0 4106 000a.b701.f700 128.3

VLAN0020
Spanning tree enabled protocol ieee
Root ID       Priority      32788
              Address      0009.430f.a400
              Cost         19
              Port         3 (FastEthernet0/3)
Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

Bridge ID     Priority      32788  (priority 32768 sys-id-ext 20)
              Address      000a.b701.f700
Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
Aging Time  300

Interface      Port ID          Designated
Name           Prio.Nbr        Cost Sts  Cost Bridge ID
-----          -----          -----
Fa0/1          128.1           19 FWD    19 32788 000a.b701.f700 128.1
Fa0/3          128.3           19 FWD    0 32788 0009.430f.a400 128.1

```

Notice that the root bridge priority only changed for VLAN 10 and DLSwitch1 is the root bridge.

DLSwitch2 will be configured as the root bridge for VLAN 20. A switch to root should be set with the **spanning-tree vlan vlan-id root primary** command. This will set the default root priority to 24576. If a switch has a lower priority than 24576, the root command must set the priority to 4096 lower than the lowest priority to guarantee that the switch will become root.

```

DLSwitch2(config)#spanning-tree vlan 20 root primary
vlan 20 bridge priority set to 24576
vlan 20 bridge max aging time unchanged at 20
vlan 20 bridge hello time unchanged at 2
vlan 20 bridge forward delay unchanged at 15

```

Verify the change with the **show spanning-tree vlan 20** command.

```
DLSwitch2#show spanning-tree vlan 20
```

```

VLAN0020
  Spanning tree enabled protocol ieee
  Root ID      Priority    24596
  Address      000a.b702.a200
  This bridge is the root
  Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    24596  (priority 24576 sys-id-ext 20)
  Address      000a.b702.a200
  Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
  Aging Time  300

  Interface       Port ID      Designated
  Name           Prio.Nbr     Cost  Bridge ID
  -----          -----        -----
  Fa0/1           128.1        19   FWD      0 24596 000a.b702.a200 128.1
  Fa0/3           128.3        19   FWD      0 24596 000a.b702.a200 128.3

```

The root bridge priority has changed to 24576 and DLSwitch2 has become the root bridge.

All traffic that originates from VLAN 10 and crosses the distribution layer will be forwarded to DLSwitch1. All traffic from VLAN 20 that crosses the Distribution Layer will be forwarded to DLSwitch2.