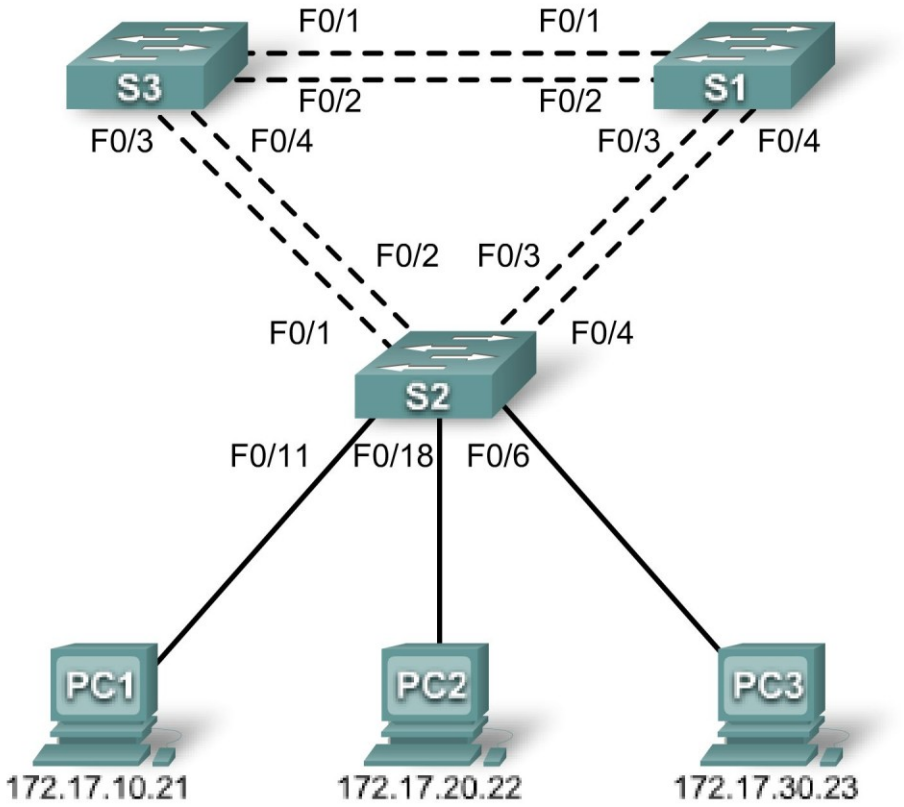
Lab 5.5.2: Challenge Spanning Tree Protocol

Topology Diagram



Addressing Table

Device (Hostname)	Interface	IP Address	Subnet Mask	Default Gateway
S1	**VLAN 99**	172.17.99.11	255.255.255.0	N/A
S2	**VLAN 99**	172.17.99.12	255.255.255.0	N/A
S3	**VLAN 99**	172.17.99.13	255.255.255.0	N/A
PC1	**NIC**	172.17.10.21	255.255.255.0	172.17.10.12
PC2	**NIC**	172.17.20.22	255.255.255.0	172.17.20.12
PC3	**NIC**	172.17.30.23	255.255.255.0	172.17.30.12

Port Assignments – Switch 2

Ports	Assignment	Network
Fa0/1 – 0/4	802.1q Trunks (Native VLAN 99)	172.17.99.0 /24
Fa0/5 – 0/10	VLAN 30 – Guest (Default)	172.17.30.0 /24
Fa0/11 – 0/17	VLAN 10 – Faculty/Staff	172.17.10.0 /24
Fa0/18 – 0/24	VLAN 20 – Students	172.17.20.0 /24

Learning Objectives

Upon completion of this lab, you will be able to:

- Cable a network according to the topology diagram
- Erase the startup configuration and reload the default configuration, setting a switch to the default state
- Perform basic configuration tasks on a switch
- Configure VLAN Trunking Protocol (VTP) on all switches
- Observe and explain the default behavior of Spanning Tree Protocol (STP, 802.1D)
- Modify the placement of the spanning tree root
- Observe the response to a change in the spanning tree topology
- Explain the limitations of 802.1D STP in supporting continuity of service
- Configure Rapid STP (802.1W)
- Observe and explain the improvements offered by Rapid STP

Task 1: Prepare the Network

Step 1: Cable a network that is similar to the one in the topology diagram.

You can use any current switch in your lab as long as it has the required interfaces shown in the topology diagram. The output shown in this lab is based on Cisco 2960 switches. Other switch models may produce different output.

Set up console connections to all three switches.

Step 2: Clear any existing configurations on the switches.

Clear NVRAM, delete the vlan.dat file, and reload the switches. Refer to Lab 2.5.1 for the procedure. After the reload is complete, use the **show vlan** privileged EXEC command to confirm that only default VLANs exist and that all ports are assigned to VLAN 1.

```
Switch#show vlan

VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
1    default                           active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                 Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                 Fa0/9, Fa0/10, Fa0/11, Fa0/12
                                                 Fa0/13, Fa0/14, Fa0/15,Fa0/16
                                                 Fa0/17, Fa0/18, Fa0/19,Fa0/20
                                                 Fa0/21, Fa0/22, Fa0/23,Fa0/24
```



```
                                                Gig1/1, Gig1/2
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active
```

Step 3: Disable all ports by using the shutdown command.

Ensure that the initial switch port states are inactive with the **shutdown** command. Use the **interface-range** command to simplify this task. Repeat these commands on each switch.

```
Switch(config)#interface range fa0/1-24
Switch(config-if-range)#shutdown
Switch(config-if-range)#interface range gi0/1-2
Switch(config-if-range)#shutdown
```

Task 2: Perform Basic Switch Configurations

Configure the S1, S2, and S3 switches according to the following guidelines:

- Configure the switch hostname.
- Disable DNS lookup.
- Configure an EXEC mode password of **class**.
- Configure a password of **cisco** for console connections.
- Configure a password of **cisco** for vty connections.

(Output for S1 shown)

```
Switch>enable
Switch#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#hostname S1
S1(config)#enable secret class
S1(config)#no ip domain-lookup
S1(config)#line console 0
S1(config-line)#password cisco
S1(config-line)#login
S1(config-line)#line vty 0 15
S1(config-line)#password cisco
S1(config-line)#login
S1(config-line)#end
%SYS-5-CONFIG_I: Configured from console by console
S1#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
```

Task 3: Configure Host PCs

Configure the Ethernet interfaces of PC1, PC2, and PC3 with the IP address, subnet mask, and gateway indicated in the addressing table at the beginning of the lab.

Task 4: Configure VLANs

Step 1: Configure VTP.

Configure VTP on the three switches using the following table. Remember that VTP domain names and passwords are case-sensitive. The default operating mode is server.

Switch Name	VTP Operating Mode	VTP Domain	VTP Password
S1	**Server**	**Lab5**	**cisco**
S2	**Client**	**Lab5**	**cisco**
S3	**Client**	**Lab5**	**cisco**

```
S1(config)#vtp mode server
Device mode already VTP SERVER.
S1(config)#vtp domain Lab5
Changing VTP domain name from NULL to Lab5
S1(config)#vtp password cisco
Setting device VLAN database password to cisco
S1(config)#end

S2(config)#vtp mode client
Setting device to VTP CLIENT mode
S2(config)#vtp domain Lab5
Changing VTP domain name from NULL to Lab5
S2(config)#vtp password cisco
Setting device VLAN database password to cisco
S2(config)#end

S3(config)#vtp mode client
Setting device to VTP CLIENT mode
S3(config)#vtp domain Lab5
Changing VTP domain name from NULL to Lab5
S3(config)#vtp password cisco
Setting device VLAN database password to cisco
S3(config)#end
```

Step 2: Configure Trunk Links and Native VLAN

Configure trunking ports and native VLAN. For each switch, configure ports Fa0/1 through Fa0/4 as trunking ports. Designate VLAN 99 as the native VLAN for these trunks. Use the **interface range** command in global configuration mode to simplify this task. Remember that these ports were disabled in a previous step and must be re-enabled using the **no shutdown** command.

```
S1(config)#interface range fa0/1-4
S1(config-if-range)#switchport mode trunk
S1(config-if-range)#switchport trunk native vlan 99
S1(config-if-range)#no shutdown
S1(config-if-range)#end

S2(config)# interface range fa0/1-4
S2(config-if-range)#switchport mode trunk
S2(config-if-range)#switchport trunk native vlan 99
S2(config-if-range)#no shutdown
S2(config-if-range)#end

S3(config)# interface range fa0/1-4
S3(config-if-range)#switchport mode trunk
```



```
S3(config-if-range)#switchport trunk native vlan 99
S3(config-if-range)#no shutdown
S3(config-if-range)#end
```

Step 3: Configure the VTP server with VLANs.

VTP allows you to configure VLANs on the VTP server and have those VLANs populated to the VTP clients in the domain. This ensures consistency in the VLAN configuration across the network.

Configure the following VLANS on the VTP server:

VLAN	VLAN Name
VLAN 99	**management**
VLAN 10	**faculty-staff**
VLAN 20	**students**
VLAN 30	**guest**

```
S1(config)#vlan 99
S1(config-vlan)#name management
S1(config-vlan)#exit
S1(config)#vlan 10
S1(config-vlan)#name faculty-staff
S1(config-vlan)#exit
S1(config)#vlan 20
S1(config-vlan)#name students
S1(config-vlan)#exit
S1(config)#vlan 30
S1(config-vlan)#name guest
S1(config-vlan)#exit
```

Step 4: Verify the VLANs.

Use the **show vlan brief** command on S2 and S3 to verify that all four VLANs have been distributed to the client switches.

```
S2#show vlan brief

VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
1    default                           active    Fa0/1, Fa0/2, Fa0/4, Fa0/5
                                                 Fa0/6, Fa0/7, Fa0/8, Fa0/9
                                                 Fa0/10, Fa0/11, Fa0/12,Fa0/13
                                                 Fa0/14, Fa0/15, Fa0/16,Fa0/17
                                                 Fa0/18, Fa0/19, Fa0/20,Fa0/21
                                                 Fa0/22, Fa0/23, Fa0/24, Gi0/1
                                                 Gi0/2
10   faculty-staff                     active
20   students                          active
30   guest                             active
99   management                        active

S3#show vlan brief
```



```
VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
1    default                           active    Fa0/1, Fa0/2, Fa0/4, Fa0/5
                                                 Fa0/6, Fa0/7, Fa0/8, Fa0/9
                                                 Fa0/10, Fa0/11, Fa0/12,Fa0/13
                                                 Fa0/14, Fa0/15, Fa0/16,Fa0/17
                                                 Fa0/18, Fa0/19, Fa0/20,Fa0/21
                                                 Fa0/22, Fa0/23, Fa0/24, Gi0/1
                                                 Gi0/2
10   faculty-staff                     active
20   students                          active
30   guest                             active
99   management                        active
```

Step 5: Configure the management interface address on all three switches.

```
S1(config)#interface vlan99
S1(config-if)#ip address 172.17.99.11 255.255.255.0
S1(config-if)#no shutdown

S2(config)#interface vlan99
S2(config-if)#ip address 172.17.99.12 255.255.255.0
S2(config-if)#no shutdown

S3(config)#interface vlan99
S3(config-if)#ip address 172.17.99.13 255.255.255.0
S3(config-if)#no shutdown
```

Verify that the switches are correctly configured by pinging between them. From S1, ping the management interface on S2 and S3. From S2, ping the management interface on S3.

Were the pings successful? _____

If not, troubleshoot the switch configurations and try again.

Step 6: Assign switch ports to the VLANs.

Assign ports to VLANs on S2. Refer to the port assignments table at the beginning of the lab.

```
S2(config)#interface range fa0/5-10
S2(config-if-range)#switchport mode access
S2(config-if-range)#switchport access vlan 30
S2(config-if-range)#interface range fa0/11-17
S2(config-if-range)#switchport mode access
S2(config-if-range)#switchport access vlan 10
S2(config-if-range)#interface range fa0/18-24
S2(config-if-range)#switchport mode access
S2(config-if-range)#switchport access vlan 20
S2(config-if-range)#end
S2#copy running-config startup-config
Destination filename [startup-config]? [enter]
Building configuration...
[OK]
S2#
```

Step 7: Re-enable the user ports on S2.

Refer to the topology diagram to determine which switch ports on S2 are activated for end-user device

access. These three ports will be enabled with the **no shutdown** command.

```
S2(config)#interface range fa0/6, fa0/11, fa0/18
S2(config-if-range)#no shutdown
```

Task 5: Configure Spanning Tree

Step 1: Examine the default configuration of 802.1D STP.

On each switch, display the spanning tree table with the **show spanning-tree** command. The output is shown for S1 only. Root selection varies depending on the BID of each switch in your lab.

```
S1#show spanning-tree

VLAN0001
  Spanning tree enabled protocol ieee
  Root ID     Priority    32769
              Address     0019.068d.6980
              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     0019.068d.6980
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/1            Desg FWD 19        128.3    P2p
Fa0/2            Desg FWD 19        128.4    P2p
Fa0/3            Desg FWD 19        128.5    P2p
Fa0/4            Desg FWD 19        128.6    P2p

VLAN0010
  Spanning tree enabled protocol ieee
  Root ID     Priority    32778
              Address     0019.068d.6980
              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     0019.068d.6980
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/1            Desg FWD 19        128.3    P2p
Fa0/2            Desg FWD 19        128.4    P2p
Fa0/3            Desg FWD 19        128.5    P2p
Fa0/4            Desg FWD 19        128.6    P2p

VLAN0020
  Spanning tree enabled protocol ieee
  Root ID     Priority    32788
              Address     0019.068d.6980
```



```
             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     0019.068d.6980
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/1            Desg FWD 19        128.3    P2p
Fa0/2            Desg FWD 19        128.4    P2p
Fa0/3            Desg FWD 19        128.5    P2p
Fa0/4            Desg FWD 19        128.6    P2p

VLAN0030
  Spanning tree enabled protocol ieee
  Root ID    Priority    32798
             Address     0019.068d.6980
             This bridge is the root
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32798  (priority 32768 sys-id-ext 30)
             Address     0019.068d.6980
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/1            Desg FWD 19        128.3    P2p
Fa0/2            Desg FWD 19        128.4    P2p
Fa0/3            Desg FWD 19        128.5    P2p
Fa0/4            Desg FWD 19        128.6    P2p

VLAN0099
  Spanning tree enabled protocol ieee
  Root ID    Priority    32867
             Address     0019.068d.6980
             This bridge is the root
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32867  (priority 32768 sys-id-ext 99)
             Address     0019.068d.6980
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/1            Desg FWD 19        128.3    P2p
Fa0/2            Desg FWD 19        128.4    P2p
Fa0/3            Desg FWD 19        128.5    P2p
Fa0/4            Desg FWD 19        128.6    P2p
```

Note that there are five instances of the spanning tree on each switch. The default STP configuration on Cisco switches is Per-VLAN Spanning Tree (PVST+), which creates a separate spanning tree for each

VLAN (VLAN 1 and any user-configured VLANs).

Examine the VLAN 99 spanning tree for all three switches:

```
S1#show spanning-tree vlan 99

VLAN0099
  Spanning tree enabled protocol ieee
  Root ID     Priority    32867
              Address     0019.068d.6980
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32867  (priority 32768 sys-id-ext 99)
              Address     0019.068d.6980
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/1            Desg FWD 19        128.3    P2p
Fa0/2            Desg FWD 19        128.4    P2p
Fa0/3            Desg FWD 19        128.5    P2p
Fa0/4            Desg FWD 19        128.6    P2p

S2#show spanning-tree vlan 99

VLAN0099
  Spanning tree enabled protocol ieee
  Root ID     Priority    32867
              Address     0019.068d.6980   This is the MAC address of the root switch (S1 in
this case)
              Cost        19
              Port        3 (FastEthernet0/3)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32867  (priority 32768 sys-id-ext 99)
              Address     001b.0c68.2080
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 15

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/1            Desg FWD 19        128.1    P2p
Fa0/2            Desg FWD 19        128.2    P2p
Fa0/3            Root FWD 19        128.3    P2p
Fa0/4            Altn BLK 19        128.4    P2p

S3#show spanning-tree vlan 99

VLAN0099
  Spanning tree enabled protocol ieee
  Root ID     Priority    32867
              Address     0019.068d.6980   This is the MAC address of the root switch (S1 in
this case)
              Cost        19
              Port        1 (FastEthernet0/1)
```



```
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority     32867  (priority 32768 sys-id-ext 99)
             Address     001b.5303.1700
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300

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
Fa0/4            Altn BLK 19        128.4    P2p
```

Step 2: Examine the output.

Answer the following questions based on the output.

1. What is the bridge ID priority for switches S1, S2, and S3 on VLAN 99?
   a. S1 _____
   b. S2 _____
   c. S3 _____
2. What is the bridge ID priority for S1 on VLANs 10, 20, 30, and 99?
   a. VLAN 10 _____
   b. VLAN 20_____
   c. VLAN 30_____
   d. VLAN 99_____
3. Which switch is the root for the VLAN 99 spanning tree? _____
4. On VLAN 99, which spanning tree ports are in the blocking state on the root switch?
   _____
5. On VLAN 99, which spanning tree ports are in the blocking state on the non-root switches?
   _____
6. How does STP elect the root switch? _____
7. Since the bridge priorities are all the same, what else does the switch use to determine the root?
   _____

Task 6: Optimizing STP

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, 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 in STP 802.1D and is the focal point for spanning tree control traffic. The root switch must be capable of handling this additional processing 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.

- Consider the topology used in this lab. Of the six trunks configured, only two are carrying traffic. While this prevents loops, it is a waste of resources. Because the root can be defined on the basis of the VLAN, you can have some ports blocking for one VLAN and forwarding for another. This is demonstrated below.

In this example, it has been determined that the root selection using default values has led to under-utilization of the available switch trunks. Therefore, it is necessary to force another switch to become the root switch for VLAN 99 to impose some load-sharing on the trunks.

Selection of the root switch is accomplished by changing the spanning-tree priority for the VLAN. Because the default root switch may vary in your lab environment, we will configure S1 and S3 to be the root switches for specific VLANs. The default priority, as you have observed, is 32768 plus the VLAN ID. The lower number indicates a higher priority for root selection. Set the priority for VLAN 99 on S3 to 4096.

```
S3(config)#spanning-tree vlan 99 ?
  forward-time  Set the forward delay for the spanning tree
  hello-time    Set the hello interval for the spanning tree
  max-age       Set the max age interval for the spanning tree
  priority      Set the bridge priority for the spanning tree
  root          Configure switch as root
  <cr>

S3(config)#spanning-tree vlan 99 priority ?
  <0-61440>  bridge priority in increments of 4096

S3(config)#spanning-tree vlan 99 priority 4096
S3(config)#exit
```

Set the priority for VLANs 1, 10, 20, and 30 on S1 to 4096. Once again, the lower number indicates a higher priority for root selection.

```
S1(config)#spanning-tree vlan 1 priority 4096
S1(config)#spanning-tree vlan 10 priority 4096
S1(config)#spanning-tree vlan 20 priority 4096
S1(config)#spanning-tree vlan 30 priority 4096
S1(config)#exit
```

Give the switches a little time to recalculate the spanning tree and then check the tree for VLAN 99 on switch S1 and switch S3.

```
S1#show spanning-tree vlan 99

VLAN0099
  Spanning tree enabled protocol ieee
  Root ID     Priority    4195
              Address     001b.5303.1700   This is now the MAC address of S3, (the new root switch)
              Cost        19
              Port        3 (FastEthernet0/1)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32867  (priority 32768 sys-id-ext 99)
              Address     0019.068d.6980
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300
```



```
Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/1            Root FWD 19        128.3    P2p
Fa0/2            Altn BLK 19        128.4    P2p
Fa0/3            Desg FWD 19        128.5    P2p
Fa0/4            Desg FWD 19        128.6    P2p
```

```
S3#show spanning-tree vlan 99

VLAN0099
  Spanning tree enabled protocol ieee
  Root ID     Priority    4195
              Address     001b.5303.1700
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    4195   (priority 4096 sys-id-ext 99)
              Address     001b.5303.1700
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/1            Desg FWD 19        128.1    P2p
Fa0/2            Desg FWD 19        128.2    P2p
Fa0/3            Desg FWD 19        128.3    P2p
Fa0/4            Desg FWD 19        128.4    P2p
```

Which switch is the root for VLAN 99? _____

On VLAN 99, which spanning tree ports are in the blocking state on the new root switch? _____

On VLAN 99, which spanning tree ports are in the blocking state on the old root switch? _____

Compare the S3 VLAN 99 spanning tree above with the S3 VLAN 10 spanning tree.

```
S3#show spanning-tree vlan 10

VLAN0010
  Spanning tree enabled protocol ieee
  Root ID     Priority    4106
              Address     0019.068d.6980
              Cost        19
              Port        1 (FastEthernet0/1)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32778  (priority 32768 sys-id-ext 10)
              Address     001b.5303.1700
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

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
Fa0/4            Altn BLK 19        128.4    P2p
```


Note that S3 can now use all four ports for VLAN 99 traffic as long as they are not blocked at the other end of the trunk. However, the original spanning tree topology, with three of four S3 ports in blocking mode, is still in place for the four other active VLANs. By configuring groups of VLANs to use different trunks as their primary forwarding path, we retain the redundancy of failover trunks, without having to leaves trunks totally unused.

Task 7: Observe the response to the topology change in 802.1D STP

To observe continuity across the LAN during a topology change, first reconfigure PC3, which is connected to port S2 Fa0/6, with IP address 172.17.99.23 255.255.255.0. Then reassign S2 port Fa0/6 to VLAN 99. This allows you to continuously ping across the LAN from the host.

```
S2(config)# interface fa0/6
S2(config-if)#switchport access vlan 99
```

Verify that the switches can ping the host.

```
S2#ping 172.17.99.23
Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 172.17.99.23, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/202/1007 ms

S1#ping 172.17.99.23

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.17.99.23, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/202/1007 ms
```

Put S1 in spanning-tree event debug mode to monitor changes during the topology change.

```
S1#debug spanning-tree events
Spanning Tree event debugging is on
```

Open a command window on PC3 and begin a continuous ping to the S1 management interface with the command **ping –t 172.17.99.11**. Now disconnect the trunks on S1 Fa0/1 and Fa0/3. Monitor the pings. They will begin to time out as connectivity across the LAN is interrupted. As soon as connectivity has been re-established, terminate the pings by pressing Ctrl-C.

Below is a shortened version of the debug output you will see on S1 (several TCNs are omitted for brevity).

```
S1#debug spanning-tree events
Spanning Tree event debugging is on
S1#
6d08h: STP: VLAN0099 new root port Fa0/2, cost 19
6d08h: STP: VLAN0099 Fa0/2 -> listening
6d08h: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1,
changed state to down
6d08h: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to down
6d08h: STP: VLAN0099 sent Topology Change Notice on Fa0/2
6d08h: STP: VLAN0030 Topology Change rcvd on Fa0/2
6d08h: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3,
changed state to down
6d08h: %LINK-3-UPDOWN: Interface FastEthernet0/3, changed state to down
6d08h: STP: VLAN0001 Topology Change rcvd on Fa0/4
6d08h: STP: VLAN0099 Fa0/2 -> learning
6d08h: STP: VLAN0099 sent Topology Change Notice on Fa0/2
6d08h: STP: VLAN0099 Fa0/2 -> forwarding
```



```
6d08h: STP: VLAN0001 Topology Change rcvd on Fa0/4
```

Recall that when the ports are in listening and learning mode, they are not forwarding frames, and the LAN is essentially down. The spanning tree recalculation can take up to 50 seconds to complete – a significant interruption in network services. The output of the continuous pings shows the actual interruption time. In this case, it was about 30 seconds. While 802.1D STP effectively prevents switching loops, this long restoration time is considered a serious drawback in the high availability LANs of today.

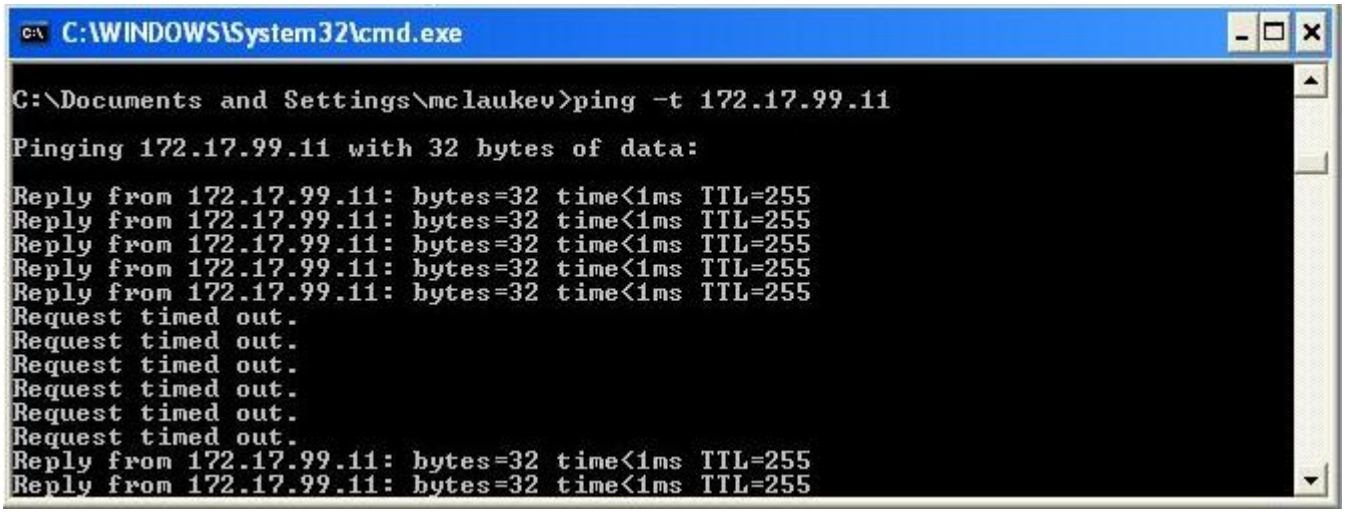


Figure 1. These pings show a 30-second lapse in connectivity while the spanning tree is recalculated.

Task 8: Configure PVST Rapid Spanning Tree Protocol

Cisco has developed several features to address the slow convergence times associated with standard STP. PortFast, UplinkFast, and BackboneFast are features that, when properly configured, can dramatically reduce the time required to restore connectivity. Incorporating these features requires manual configuration, and care must be taken to do it correctly. The longer term solution is Rapid STP (RSTP), 802.1w, which incorporates these features among others. RSTP-PVST is configured as follows:

```
S1(config)#spanning-tree mode rapid-pvst
```

Configure all three switches in this manner.

Use the command **show spanning-tree summary** to verify that RSTP is enabled.

Task 9: Observe the convergence time of RSTP

Begin by restoring the trunks you disconnected in Task 7, if you have not already done so (ports Fa0/1 and Fa0/3 on S1). Then follow these steps in Task 7:

- Set up host PC3 to continuously ping across the network.
- Enable spanning-tree event debugging on switch S1.
- Disconnect the cables connected to ports Fa0/1 and Fa0/3.
- Observe the time required to re-establish a stable spanning tree.

Below is the partial debug output:

```
S1#debug spanning-tree events
Spanning Tree event debugging is on
S1#
6d10h: RSTP(99): updt rolesroot port Fa0/3 is going down
```



```
6d10h: RSTP(99): Fa0/2 is now root port
```
Connectivity has been restored; less than 1 second interruption

```
6d10h: RSTP(99): syncing port Fa0/1
6d10h: RSTP(99): syncing port Fa0/4
6d10h: RSTP(99): transmitting a proposal on Fa0/1
6d10h: RSTP(99): transmitting a proposal on Fa0/4
6d10h: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3,
changed state to down
6d10h: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1,
changed state to down
```

The restoration time with RSTP enabled was less than a second, and not a single ping was dropped.

Task 10: Clean Up

Erase the configurations and reload the default configurations for the switches. Disconnect and store the cabling. For PC hosts that are normally connected to other networks (such as the school LAN or to the Internet), reconnect the appropriate cabling and restore the TCP/IP settings.

Final Configurations

Switch S1

```
hostname S1
!
enable secret class
!
no ip domain-lookup
!
spanning-tree mode rapid-pvst
spanning-tree extend system-id
spanning-tree vlan 1 priority 4096
spanning-tree vlan 10 priority 4096
spanning-tree vlan 20 priority 4096
spanning-tree vlan 30 priority 4096
!
interface FastEthernet0/1
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/2
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/3
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/4
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/5
 shutdown
!
```



```
interface FastEthernet0/6
 shutdown
!
interface FastEthernet0/7
 shutdown
!
(remaining port configuration ommitted - all non-used ports are shutdown)
!
!
interface Vlan1
 no ip address
 no ip route-cache
!
interface Vlan99
 ip address 172.17.99.11 255.255.255.0
 no ip route-cache
!
line con 0
 password cisco
 login
line vty 0 4
 password cisco
 login
line vty 5 15
 password cisco
 login
!
end
```

Switch S2

```
hostname S2
!
enable secret class
!
no ip domain-lookup
!
interface FastEthernet0/1
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/2
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/3
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/4
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/5
 switchport access vlan 30
```



```
 switchport mode access
 shutdown
!
interface FastEthernet0/6
 switchport access vlan 30
 switchport mode access
!
interface FastEthernet0/7
 switchport access vlan 30
 switchport mode access
 shutdown
!
interface FastEthernet0/8
 switchport access vlan 30
 switchport mode access
 shutdown
!
interface FastEthernet0/9
 switchport access vlan 30
 switchport mode access
 shutdown
!
interface FastEthernet0/10
 switchport access vlan 30
 switchport mode access
 shutdown
!
interface FastEthernet0/11
 switchport access vlan 10
 switchport mode access
!
interface FastEthernet0/12
 switchport access vlan 10
 switchport mode access
 shutdown
!
interface FastEthernet0/13
 switchport access vlan 10
 switchport mode access
 shutdown
!
interface FastEthernet0/14
 switchport access vlan 10
 switchport mode access
 shutdown
!
interface FastEthernet0/15
 switchport access vlan 10
 switchport mode access
 shutdown
!
interface FastEthernet0/16
 switchport access vlan 10
 switchport mode access
 shutdown
!
```



```
interface FastEthernet0/17
 switchport access vlan 10
 switchport mode access
 shutdown
!
interface FastEthernet0/18
 switchport access vlan 20
 switchport mode access
!
interface FastEthernet0/19
 switchport access vlan 20
 switchport mode access
 shutdown
!
interface FastEthernet0/20
switchport access vlan 20
 switchport mode access
 shutdown
!
interface FastEthernet0/21
 switchport access vlan 20
 switchport mode access
 shutdown
!
interface FastEthernet0/22
 switchport access vlan 20
 switchport mode access
 shutdown
!
interface FastEthernet0/23
 switchport access vlan 20
 switchport mode access
 shutdown
!
interface FastEthernet0/24
 switchport access vlan 20
 switchport mode access
 shutdown
!
interface GigabitEthernet0/1
 shutdown
!
interface GigabitEthernet0/2
 shutdown
!
interface Vlan1
 no ip address
 no ip route-cache
!
interface Vlan99
 ip address 172.17.99.12 255.255.255.0
 no ip route-cache
!
line con 0
line vty 0 4
 password cisco
```



```
 login
line vty 5 15
 password cisco
 login
!
end
```

Switch S3

```
hostname S3
!
enable secret class
!
no ip domain-lookup
!
spanning-tree mode rapid-pvst
spanning-tree extend system-id
spanning-tree vlan 99 priority 4096
!
interface FastEthernet0/1
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/2
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/3
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/4
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/5
 shutdown
!
interface FastEthernet0/6
 shutdown
!
interface FastEthernet0/7
 shutdown
!
(remaining port configuration ommitted - all non-used ports are shutdown)
!
interface Vlan1
 no ip address
 no ip route-cache
 shutdown
!
interface Vlan99
 ip address 172.17.99.13 255.255.255.0
 no ip route-cache
!
```



```
line con 0
 password cisco
 login
line vty 0 4
 password cisco
 login
line vty 5 15
 password cisco
 login
!
end
```

