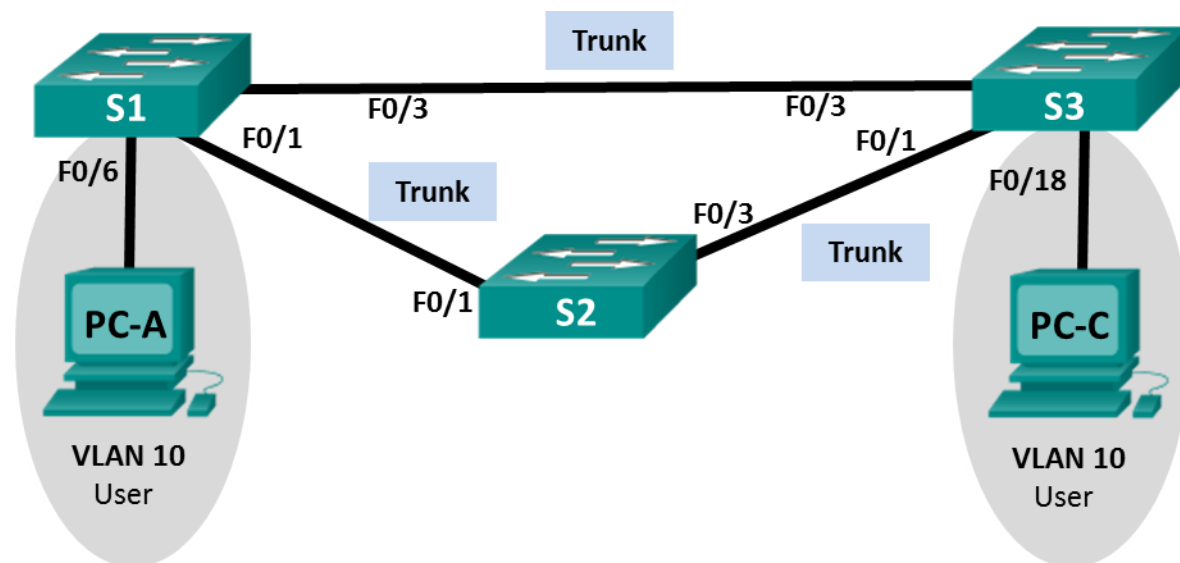


Lab – Configuring Rapid PVST+, PortFast, and BPDU Guard (Instructor Version)

Instructor Note: Red font color or Gray highlights indicate text that appears in the instructor copy only.

Topology



Addressing Table

Device	Interface	IP Address	Subnet Mask
S1	VLAN 99	192.168.1.11	255.255.255.0
S2	VLAN 99	192.168.1.12	255.255.255.0
S3	VLAN 99	192.168.1.13	255.255.255.0
PC-A	NIC	192.168.0.2	255.255.255.0
PC-C	NIC	192.168.0.3	255.255.255.0

VLAN Assignments

VLAN	Name
10	User
99	Management

Objectives

Part 1: Build the Network and Configure Basic Device Settings

Part 2: Configure VLANs, Native VLAN, and Trunks

Part 3: Configure the Root Bridge and Examine PVST+ Convergence

Part 4: Configure Rapid PVST+, PortFast, BPDU Guard, and Examine Convergence

Background / Scenario

The Per-VLAN Spanning Tree (PVST) protocol is Cisco proprietary. Cisco switches default to PVST. Rapid PVST+ (IEEE 802.1w) is an enhanced version of PVST+ and allows for faster spanning-tree calculations and convergence in response to Layer 2 topology changes. Rapid PVST+ defines three port states: discarding, learning, and forwarding, and provides multiple enhancements to optimize network performance.

In this lab, you will configure the primary and secondary root bridge, examine PVST+ convergence, configure Rapid PVST+ and compare its convergence to PVST+. In addition, you will configure edge ports to transition immediately to a forwarding state using PortFast and prevent the edge ports from forwarding BDPUs using BPDU guard.

Note: This lab provides minimal assistance with the actual commands necessary for configuration. However, the required commands are provided in Appendix A. Test your knowledge by trying to configure the devices without referring to the appendix.

Note: The switches used with CCNA hands-on labs are Cisco Catalyst 2960s with Cisco IOS Release 15.0(2) (lanbasek9 image). Other switches and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and output produced might vary from what is shown in the labs.

Note: Make sure that the switches have been erased and have no startup configurations. If you are unsure, contact your instructor.

Instructor Note: Refer to the Instructor Lab Manual for the procedures to initialize and reload devices.

Required Resources

- 3 Switches (Cisco 2960 with Cisco IOS Release 15.0(2) lanbasek9 image or comparable)
- 2 PCs (Windows 7, Vista, or XP with terminal emulation program, such as Tera Term)
- Console cables to configure the Cisco IOS devices via the console ports
- Ethernet cables as shown in the topology

Part 1: Build the Network and Configure Basic Device Settings

In Part 1, you will set up the network topology and configure basic settings, such as the interface IP addresses, device access, and passwords.

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

Step 2: Configure PC hosts.

Step 3: Initialize and reload the switches as necessary.

Step 4: Configure basic settings for each switch.

- Disable DNS lookup.
- Configure the device name as shown in the Topology.
- Assign **cisco** as the console and vty passwords and enable login.
- Assign **class** as the encrypted privileged EXEC mode password.
- Configure **logging synchronous** to prevent console messages from interrupting command entry.
- Shut down all switch ports.

- g. Copy the running configuration to startup configuration.

Part 2: Configure VLANs, Native VLAN, and Trunks

In Part 2, you will create VLANs, assign switch ports to VLANs, configure trunk ports, and change the native VLAN for all switches.

Note: The required commands for Part 2 are provided in Appendix A. Test your knowledge by trying to configure the VLANs, native VLAN, and trunks without referring to the appendix.

Step 1: Create VLANs.

Use the appropriate commands to create VLANs 10 and 99 on all of the switches. Name VLAN 10 as **User** and VLAN 99 as **Management**.

```
S1(config)# vlan 10
S1(config-vlan)# name User
S1(config-vlan)# vlan 99
S1(config-vlan)# name Management
```

```
S2(config)# vlan 10
S2(config-vlan)# name User
S2(config-vlan)# vlan 99
S2(config-vlan)# name Management
```

```
S3(config)# vlan 10
S3(config-vlan)# name User
S3(config-vlan)# vlan 99
S3(config-vlan)# name Management
```

Step 2: Enable user ports in access mode and assign VLANs.

For S1 F0/6 and S3 F0/18, enable the ports, configure them as access ports, and assign them to VLAN 10.

```
S1(config)# interface f0/6
S1(config-if)# no shutdown
S1(config-if)# switchport mode access
S1(config-if)# switchport access vlan 10
```

```
S3(config)# interface f0/18
S3(config-if)# no shutdown
S3(config-if)# switchport mode access
S3(config-if)# switchport access vlan 10
```

Step 3: Configure trunk ports and assign to native VLAN 99.

For ports F0/1 and F0/3 on all switches, enable the ports, configure them as trunk ports, and assign them to native VLAN 99.

```
S1(config)# interface range f0/1,f0/3
S1(config-if)# no shutdown
S1(config-if)# switchport mode trunk
```

```
S1(config-if)# switchport trunk native vlan 99
```

```
S2(config)# interface range f0/1,f0/3
```

```
S2(config-if)# no shutdown
```

```
S2(config-if)# switchport mode trunk
```

```
S2(config-if)# switchport trunk native vlan 99
```

```
S3(config)# interface range f0/1,f0/3
```

```
S3(config-if)# no shutdown
```

```
S3(config-if)# switchport mode trunk
```

```
S3(config-if)# switchport trunk native vlan 99
```

Step 4: Configure the management interface on all switches.

Using the Addressing Table, configure the management interface on all switches with the appropriate IP address.

```
S1(config)# interface vlan 99
```

```
S1(config-if)# ip address 192.168.1.11 255.255.255.0
```

```
S2(config)# interface vlan 99
```

```
S2(config-if)# ip address 192.168.1.12 255.255.255.0
```

```
S3(config)# interface vlan 99
```

```
S3(config-if)# ip address 192.168.1.13 255.255.255.0
```

Step 5: Verify configurations and connectivity.

Use the **show vlan brief** command on all switches to verify that all VLANs are registered in the VLAN table and that the correct ports are assigned.

```
S1# show vlan brief
```

VLAN	Name	Status	Ports
1	default	active	Fa0/2, Fa0/4, Fa0/5, 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	User	active	Fa0/6
99	Management	active	
1002	fddi-default	act/unsup	
1003	token-ring-default	act/unsup	
1004	fddinet-default	act/unsup	
1005	trnet-default	act/unsup	

```
S2# show vlan brief
```

VLAN	Name	Status	Ports
1	default	active	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	User	active	
99	Management	active	
1002	fddi-default	act/unsup	
1003	token-ring-default	act/unsup	
1004	fddinet-default	act/unsup	
1005	trnet-default	act/unsup	

S3# **show vlan brief**

VLAN	Name	Status	Ports
1	default	active	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, Fa0/19 Fa0/20, Fa0/21, Fa0/22, Fa0/23 Fa0/24, Gi0/1, Gi0/2
10	User	active	Fa0/18
99	Management	active	
1002	fddi-default	act/unsup	
1003	token-ring-default	act/unsup	
1004	fddinet-default	act/unsup	
1005	trnet-default	act/unsup	

Use the **show interfaces trunk** command on all switches to verify trunk interfaces.

S1# **show interfaces trunk**

Port	Mode	Encapsulation	Status	Native vlan
Fa0/1	on	802.1q	trunking	99
Fa0/3	on	802.1q	trunking	99

Port	Vlans allowed on trunk
Fa0/1	1-4094
Fa0/3	1-4094

Port	Vlans allowed and active in management domain
Fa0/1	1,10,99
Fa0/3	1,10,99

Port	Vlans in spanning tree forwarding state and not pruned
------	--

```
Fa0/1      none
Fa0/3      1,10,99
```

```
S2# show interfaces trunk
```

Port	Mode	Encapsulation	Status	Native vlan
Fa0/1	on	802.1q	trunking	99
Fa0/3	on	802.1q	trunking	99

Port	Vlans allowed on trunk
Fa0/1	1-4094
Fa0/3	1-4094

Port	Vlans allowed and active in management domain
Fa0/1	1,10,99
Fa0/3	1,10,99

Port	Vlans in spanning tree forwarding state and not pruned
Fa0/1	1,10,99
Fa0/3	1,10,99

```
S3# show interfaces trunk
```

Port	Mode	Encapsulation	Status	Native vlan
Fa0/1	on	802.1q	trunking	99
Fa0/3	on	802.1q	trunking	99

Port	Vlans allowed on trunk
Fa0/1	1-4094
Fa0/3	1-4094

Port	Vlans allowed and active in management domain
Fa0/1	1,10,99
Fa0/3	1,10,99

Port	Vlans in spanning tree forwarding state and not pruned
Fa0/1	1,10,99
Fa0/3	1,10,99

Use the **show running-config** command on all switches to verify all other configurations.

```
S1# show running-config
```

```
Building configuration...
```

```
Current configuration : 1857 bytes
!
```

```
version 15.0
no service pad
```

```
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname S1
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
system mtu routing 1500
!
no ip domain-lookup
!
spanning-tree mode pvst
spanning-tree extend system-id
!
vlan internal allocation policy ascending
!
interface FastEthernet0/1
    switchport trunk native vlan 99
    switchport mode trunk
!
interface FastEthernet0/2
    shutdown
!
interface FastEthernet0/3
    switchport trunk native vlan 99
    switchport mode trunk
!
interface FastEthernet0/4
    shutdown
!
interface FastEthernet0/5
    shutdown
!
interface FastEthernet0/6
    switchport access vlan 10
    switchport mode access
!
interface FastEthernet0/7
    shutdown
!
```

```
interface FastEthernet0/8
  shutdown
!
interface FastEthernet0/9
  shutdown
!
interface FastEthernet0/10
  shutdown
!
interface FastEthernet0/11
  shutdown
!
interface FastEthernet0/12
  shutdown
!
interface FastEthernet0/13
  shutdown
!
interface FastEthernet0/14
  shutdown
!
interface FastEthernet0/15
  shutdown
!
interface FastEthernet0/16
  shutdown
!
interface FastEthernet0/17
  shutdown
!
interface FastEthernet0/18
  shutdown
!
interface FastEthernet0/19
  shutdown
!
interface FastEthernet0/20
  shutdown
!
interface FastEthernet0/21
  shutdown
!
interface FastEthernet0/22
  shutdown
!
```



```
interface FastEthernet0/23
 shutdown
!
interface FastEthernet0/24
 shutdown
!
interface GigabitEthernet0/1
 shutdown
!
interface GigabitEthernet0/2
 shutdown
!
interface Vlan1
 no ip address
!
interface Vlan99
 ip address 192.168.1.11 255.255.255.0
!
ip http server
ip http secure-server
!
line con 0
 password cisco
 logging synchronous
 login
line vty 0 4
 password cisco
 login
line vty 5 15
 password cisco
 login
!
end
```

What is the default setting for spanning-tree mode on Cisco switches?

The default spanning-tree mode is PVST+.

Verify connectivity between PC-A and PC-C. Was your ping successful? _____ Yes.

If your ping was unsuccessful, troubleshoot the configurations until the issue is resolved.

Note: It may be necessary to disable the PC firewall to successfully ping between PCs.

Part 3: Configure the Root Bridge and Examine PVST+ Convergence

In Part 3, you will determine the default root in the network, assign the primary and secondary root, and use the **debug** command to examine convergence of PVST+.

Note: The required commands for Part 3 are provided in Appendix A. Test your knowledge by trying to configure the root bridge without referring to the appendix.

Step 1: Determine the current root bridge.

Which command allows a user to determine the spanning-tree status of a Cisco Catalyst switch for all VLANs? Write the command in the space provided.

show spanning-tree

Use the command on all three switches to determine the answers to the following questions:

Note: There are three instances of the spanning tree on each switch. The default STP configuration on Cisco switches is PVST+, which creates a separate spanning tree instance for each VLAN (VLAN 1 and any user-configured VLANs).

What is the bridge priority of switch S1 for VLAN 1? _____ **32769**

What is the bridge priority of switch S2 for VLAN 1? _____ **32769**

What is the bridge priority of switch S3 for VLAN 1? _____ **32769**

Which switch is the root bridge? _____ **Answers will vary. In this configuration, it is switch S3.**

Why was this switch elected as the root bridge?

By default, spanning tree elects the root bridge based on lowest MAC address.

S1# show spanning-tree

VLAN0001

Spanning tree enabled protocol ieee

Root ID	Priority	32769
Address	0cd9.96d2.5100	
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	0cd9.96e2.3d80	
Hello Time	2 sec	Max Age 20 sec Forward Delay 15 sec
Aging Time	300 sec	

Interface	Role	Sts	Cost	Prio.Nbr	Type
-----	----	---	-----	-----	-----
Fa0/1	Desg	FWD	19	128.1	P2p
Fa0/3	Root	FWD	19	128.3	P2p

VLAN0010

Spanning tree enabled protocol ieee

Root ID	Priority	32778
Address	0cd9.96d2.5100	
Cost	19	
Port	3 (FastEthernet0/3)	

```

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

Bridge ID Priority    32778  (priority 32768 sys-id-ext 10)
Address       0cd9.96e2.3d80
Hello Time    2 sec  Max Age 20 sec  Forward Delay 15 sec
Aging Time    300 sec

Interface      Role Sts Cost      Prio.Nbr Type
-----
Fa0/1          Desg FWD 19        128.1   P2p
Fa0/3          Root FWD 19        128.3   P2p
Fa0/6          Desg FWD 19        128.6   P2p

VLAN0099
Spanning tree enabled protocol ieee
Root ID      Priority    32867
Address      0cd9.96d2.5100
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      0cd9.96e2.3d80
Hello Time    2 sec  Max Age 20 sec  Forward Delay 15 sec
Aging Time    300 sec

Interface      Role Sts Cost      Prio.Nbr Type
-----
Fa0/1          Desg FWD 19        128.1   P2p
Fa0/3          Root FWD 19        128.3   P2p

S2# show spanning-tree

VLAN0001
Spanning tree enabled protocol ieee
Root ID      Priority    32769
Address      0cd9.96d2.5100
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      0cd9.96e8.6f80
Hello Time    2 sec  Max Age 20 sec  Forward Delay 15 sec
Aging Time    300 sec

Interface      Role Sts Cost      Prio.Nbr Type
-----
Fa0/1          Altn BLK 19        128.1   P2p
```

Fa0/3 Root FWD 19 128.3 P2p

VLAN0010

Spanning tree enabled protocol ieee

Root ID Priority 32778
 Address 0cd9.96d2.5100
 Cost 19
 Port 3 (FastEthernet0/3)
 Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32778 (priority 32768 sys-id-ext 10)
 Address 0cd9.96e8.6f80
 Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
 Aging Time 300 sec

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

VLAN0099

Spanning tree enabled protocol ieee

Root ID Priority 32867
 Address 0cd9.96d2.5100
 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 0cd9.96e8.6f80
 Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
 Aging Time 300 sec

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

S3# **show spanning-tree**

VLAN0001

Spanning tree enabled protocol ieee

Root ID Priority 32769
 Address 0cd9.96d2.5100
 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 0cd9.96d2.5100

```
Hello Time    2 sec  Max Age 20 sec  Forward Delay 15 sec
Aging Time   300 sec
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
-----	----	---	-----	-----	-----
Fa0/1	Desg	FWD	19	128.1	P2p
Fa0/3	Desg	FWD	19	128.3	P2p

VLAN0010

```
Spanning tree enabled protocol ieee
```

```
Root ID    Priority    32778
           Address    0cd9.96d2.5100
```

```
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    0cd9.96d2.5100
```

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

```
Aging Time   300 sec
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
-----	----	---	-----	-----	-----
Fa0/1	Desg	FWD	19	128.1	P2p
Fa0/3	Desg	FWD	19	128.3	P2p
Fa0/18	Desg	FWD	19	128.18	P2p

VLAN0099

```
Spanning tree enabled protocol ieee
```

```
Root ID    Priority    32867
           Address    0cd9.96d2.5100
```

```
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    0cd9.96d2.5100
```

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

```
Aging Time   300 sec
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
-----	----	---	-----	-----	-----
Fa0/1	Desg	FWD	19	128.1	P2p
Fa0/3	Desg	FWD	19	128.3	P2p

Step 2: Configure a primary and secondary root bridge for all existing VLANs.

Having a root bridge (switch) elected by MAC address may lead to a suboptimal configuration. In this lab, you will configure switch S2 as the root bridge and S1 as the secondary root bridge.

- Configure switch S2 to be the primary root bridge for all existing VLANs. Write the command in the space provided.

```
S2(config)# spanning-tree vlan 1,10,99 root primary
```

- b. Configure switch S1 to be the secondary root bridge for all existing VLANs. Write the command in the space provided.

```
S1(config)# spanning-tree vlan 1,10,99 root secondary
```

Use the **show spanning-tree** command to answer the following questions:

What is the bridge priority of S1 for VLAN 1? _____ 28673

What is the bridge priority of S2 for VLAN 1? _____ 24577

Which interface in the network is in a blocking state? _____

Interface F0/3 on switch S3

```
S1# show spanning-tree vlan 1
```

```
VLAN0001
```

```
Spanning tree enabled protocol ieee
```

```
Root ID    Priority    24577
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    28673 (priority 28672 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
Fa0/3	Desg	FWD	19	128.3	P2p

```
S2# show spanning-tree vlan 1
```

```
VLAN0001
```

```
Spanning tree enabled protocol ieee
```

```
Root ID    Priority    24577
Address     0cd9.96d2.4000
This bridge is the root
Hello Time   2 sec    Max Age 20 sec    Forward Delay 15 sec
```

```
Bridge ID  Priority    24577 (priority 24576 sys-id-ext 1)
Address     0cd9.96d2.4000
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          Desg FWD 19          128.1    P2p  
Fa0/3          Desg FWD 19          128.3    P2p
```

S3# **show spanning-tree vlan 1**

VLAN0001

Spanning tree enabled protocol ieee

```
Root ID      Priority    24577  
              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      0cd9.96e8.7400  
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec  
              Aging Time  300 sec
```

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

Step 3: Change the Layer 2 topology and examine convergence.

To examine PVST+ convergence, you will create a Layer 2 topology change while using the **debug** command to monitor spanning-tree events.

- Enter the **debug spanning-tree events** command in privileged EXEC mode on switch S3.

S3# **debug spanning-tree events**

Spanning Tree event debugging is on

- Create a topology change by disabling interface F0/1 on S3.

S3(config)# **interface f0/1**

S3(config-if)# **shutdown**

*Mar 1 00:58:56.225: STP: VLAN0001 new root port Fa0/3, cost 38

*Mar 1 00:58:56.225: STP: VLAN0001 Fa0/3 -> listening

*Mar 1 00:58:56.225: STP[1]: Generating TC trap for port FastEthernet0/1

*Mar 1 00:58:56.225: STP: VLAN0010 new root port Fa0/3, cost 38

*Mar 1 00:58:56.225: STP: VLAN0010 Fa0/3 -> listening

*Mar 1 00:58:56.225: STP[10]: Generating TC trap for port FastEthernet0/1

*Mar 1 00:58:56.225: STP: VLAN0099 new root port Fa0/3, cost 38

*Mar 1 00:58:56.225: STP: VLAN0099 Fa0/3 -> listening

*Mar 1 00:58:56.225: STP[99]: Generating TC trap for port FastEthernet0/1

*Mar 1 00:58:56.242: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to down

*Mar 1 00:58:56.242: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan99, changed state to down

*Mar 1 00:58:58.214: %LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down

```
*Mar 1 00:58:58.230: STP: VLAN0001 sent Topology Change Notice on Fa0/3
*Mar 1 00:58:58.230: STP: VLAN0010 sent Topology Change Notice on Fa0/3
*Mar 1 00:58:58.230: STP: VLAN0099 sent Topology Change Notice on Fa0/3
*Mar 1 00:58:59.220: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1,
changed state to down
*Mar 1 00:59:11.233: STP: VLAN0001 Fa0/3 -> learning
*Mar 1 00:59:11.233: STP: VLAN0010 Fa0/3 -> learning
*Mar 1 00:59:11.233: STP: VLAN0099 Fa0/3 -> learning
*Mar 1 00:59:26.240: STP[1]: Generating TC trap for port FastEthernet0/3
*Mar 1 00:59:26.240: STP: VLAN0001 Fa0/3 -> forwarding
*Mar 1 00:59:26.240: STP[10]: Generating TC trap for port FastEthernet0/3
*Mar 1 00:59:26.240: STP: VLAN0010 sent Topology Change Notice on Fa0/3
*Mar 1 00:59:26.240: STP: VLAN0010 Fa0/3 -> forwarding
*Mar 1 00:59:26.240: STP[99]: Generating TC trap for port FastEthernet0/3
*Mar 1 00:59:26.240: STP: VLAN0099 Fa0/3 -> forwarding
*Mar 1 00:59:26.248: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed
state to up
*Mar 1 00:59:26.248: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan99, changed
state to up
```

Note: Before proceeding, use the **debug** output to verify that all VLANs on F0/3 have reached a forwarding state then use the command **no debug spanning-tree events** to stop the **debug** output.

Through which port states do each VLAN on F0/3 proceed during network convergence?

Listening, learning, and forwarding

Using the time stamp from the first and last STP debug message, calculate the time (to the nearest second) that it took for the network to converge. **Hint:** The debug timestamp format is date hh.mm.ss:msec.

Answers may vary slightly but convergence time should be approximately 30 seconds.

Part 4: Configure Rapid PVST+, PortFast, BPDU Guard, and Examine Convergence

In Part 4, you will configure Rapid PVST+ on all switches. You will configure PortFast and BPDU guard on all access ports, and then use the **debug** command to examine Rapid PVST+ convergence.

Note: The required commands for Part 4 are provided in Appendix A. Test your knowledge by trying to configure the Rapid PVST+, PortFast, and BPDU guard without referring to the appendix.

Step 1: Configure Rapid PVST+.

- Configure S1 for Rapid PVST+. Write the command in the space provided.

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

- Configure S2 and S3 for Rapid PVST+.

```
S2(config)# spanning-tree mode rapid-pvst
```

```
S3(config)# spanning-tree mode rapid-pvst
```


- c. Verify configurations with the **show running-config | include spanning-tree mode** command.

```
S1# show running-config | include spanning-tree mode
spanning-tree mode rapid-pvst
```

```
S2# show running-config | include spanning-tree mode
spanning-tree mode rapid-pvst
```

```
S3# show running-config | include spanning-tree mode
spanning-tree mode rapid-pvst
```

Step 2: Configure PortFast and BPDU Guard on access ports.

PortFast is a feature of spanning tree that transitions a port immediately to a forwarding state as soon as it is turned on. This is useful in connecting hosts so that they can start communicating on the VLAN instantly, rather than waiting on spanning tree. To prevent ports that are configured with PortFast from forwarding BPDUs, which could change the spanning tree topology, BPDU guard can be enabled. At the receipt of a BPDU, BPDU guard disables a port configured with PortFast.

- a. Configure interface F0/6 on S1 with PortFast. Write the command in the space provided.

```
S1(config)# interface f0/6
S1(config-if)# spanning-tree portfast
```

- b. Configure interface F0/6 on S1 with BPDU guard. Write the command in the space provided.

```
S1(config)# interface f0/6
S1(config-if)# spanning-tree bpduguard enable
```

- c. Globally configure all non-trunking ports on switch S3 with PortFast. Write the command in the space provided.

```
S3(config)# spanning-tree portfast default
```

- d. Globally configure all non-trunking PortFast ports on switch S3 with BPDU guard. Write the command in the space provided.

```
S3(config)# spanning-tree portfast bpduguard default
```

Step 3: Examine Rapid PVST+ convergence.

- a. Enter the **debug spanning-tree events** command in privileged EXEC mode on switch S3.
b. Create a topology change by enabling interface F0/1 on switch S3.

```
S3(config)# interface f0/1
S3(config-if)# no shutdown
*Mar  1 01:28:34.946: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar  1 01:28:37.588: RSTP(1): initializing port Fa0/1
*Mar  1 01:28:37.588: RSTP(1): Fa0/1 is now designated
*Mar  1 01:28:37.588: RSTP(10): initializing port Fa0/1
*Mar  1 01:28:37.588: RSTP(10): Fa0/1 is now designated
```

```
*Mar 1 01:28:37.588: RSTP(99): initializing port Fa0/1
*Mar 1 01:28:37.588: RSTP(99): Fa0/1 is now designated
*Mar 1 01:28:37.597: RSTP(1): transmitting a proposal on Fa0/1
*Mar 1 01:28:37.597: RSTP(10): transmitting a proposal on Fa0/1
*Mar 1 01:28:37.597: RSTP(99): transmitting a proposal on Fa0/1
*Mar 1 01:28:37.597: RSTP(1): updt roles, received superior bpdu on Fa0/1
*Mar 1 01:28:37.597: RSTP(1): Fa0/1 is now root port
*Mar 1 01:28:37.597: RSTP(1): Fa0/3 blocked by re-root
*Mar 1 01:28:37.597: RSTP(1): synced Fa0/1
*Mar 1 01:28:37.597: RSTP(1): Fa0/3 is now alternate
*Mar 1 01:28:37.597: RSTP(10): updt roles, received superior bpdu on Fa0/1
*Mar 1 01:28:37.597: RSTP(10): Fa0/1 is now root port
*Mar 1 01:28:37.597: RSTP(10): Fa0/3 blocked by re-root
*Mar 1 01:28:37.597: RSTP(10): synced Fa0/1
*Mar 1 01:28:37.597: RSTP(10): Fa0/3 is now alternate
*Mar 1 01:28:37.597: RSTP(99): updt roles, received superior bpdu on Fa0/1
*Mar 1 01:28:37.605: RSTP(99): Fa0/1 is now root port
*Mar 1 01:28:37.605: RSTP(99): Fa0/3 blocked by re-root
*Mar 1 01:28:37.605: RSTP(99): synced Fa0/1
*Mar 1 01:28:37.605: RSTP(99): Fa0/3 is now alternate
*Mar 1 01:28:37.605: STP[1]: Generating TC trap for port FastEthernet0/1
*Mar 1 01:28:37.605: STP[10]: Generating TC trap for port FastEthernet0/1
*Mar 1 01:28:37.605: STP[99]: Generating TC trap for port FastEthernet0/1
*Mar 1 01:28:37.622: RSTP(1): transmitting an agreement on Fa0/1 as a response to a
proposal
*Mar 1 01:28:37.622: RSTP(10): transmitting an agreement on Fa0/1 as a response to a
proposal
*Mar 1 01:28:37.622: RSTP(99): transmitting an agreement on Fa0/1 as a response to a
proposal
*Mar 1 01:28:38.595: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1,
changed state to up
```

Using the time stamp from the first and last RSTP debug message, calculate the time that it took for the network to converge.

Answers may vary slightly but convergence time should be under a second.

Reflection

1. What is the main benefit of using Rapid PVST+?

Rapid PVST+ decreases the time of Layer 2 convergence significantly over PVST+.

2. How does configuring a port with PortFast allow for faster convergence?

PortFast allows for an access port to immediately transition into a forwarding state which decreases Layer 2 convergence time.

3. What protection does BPDU guard provide?
-

BPDU guard protects the STP domain by disabling access ports that receive a BPDU. BPDUs can be used in a denial of service attack that changes a domain's root bridge and forces an STP recalculation.

Appendix A – Switch Configuration Commands

Switch S1

```
S1(config)# vlan 10
S1(config-vlan)# name User
S1(config-vlan)# vlan 99
S1(config-vlan)# name Management
S1(config-vlan)# exit
S1(config)# interface f0/6
S1(config-if)# no shutdown
S1(config-if)# switchport mode access
S1(config-if)# switchport access vlan 10
S1(config-if)# interface f0/1
S1(config-if)# no shutdown
S1(config-if)# switchport mode trunk
S1(config-if)# switchport trunk native vlan 99
S1(config-if)# interface f0/3
S1(config-if)# no shutdown
S1(config-if)# switchport mode trunk
S1(config-if)# switchport trunk native vlan 99
S1(config-if)# interface vlan 99
S1(config-if)# ip address 192.168.1.11 255.255.255.0
S1(config-if)# exit
S1(config)# spanning-tree vlan 1,10,99 root secondary
S1(config)# spanning-tree mode rapid-pvst
S1(config)# interface f0/6
S1(config-if)# spanning-tree portfast
S1(config-if)# spanning-tree bpduguard enable
```

Switch S2

```
S2(config)# vlan 10
S2(config-vlan)# name User
S2(config-vlan)# vlan 99
S2(config-vlan)# name Management
S2(config-vlan)# exit
S2(config)# interface f0/1
S2(config-if)# no shutdown
S2(config-if)# switchport mode trunk
S2(config-if)# switchport trunk native vlan 99
S2(config-if)# interface f0/3
S2(config-if)# no shutdown
S2(config-if)# switchport mode trunk
```

```
S2(config-if)# switchport trunk native vlan 99
S2(config-if)# interface vlan 99
S2(config-if)# ip address 192.168.1.12 255.255.255.0
S2(config-if)# exit
S2(config)# spanning-tree vlan 1,10,99 root primary
S2(config)# spanning-tree mode rapid-pvst
```

Switch S3

```
S3(config)# vlan 10
S3(config-vlan)# name User
S3(config-vlan)# vlan 99
S3(config-vlan)# name Management
S3(config-vlan)# exit
S3(config)# interface f0/18
S3(config-if)# no shutdown
S3(config-if)# switchport mode access
S3(config-if)# switchport access vlan 10
S3(config-if)# spanning-tree portfast
S3(config-if)# spanning-tree bpduguard enable
S3(config-if)# interface f0/1
S3(config-if)# no shutdown
S3(config-if)# switchport mode trunk
S3(config-if)# switchport trunk native vlan 99
S3(config-if)# interface f0/3
S3(config-if)# no shutdown
S3(config-if)# switchport mode trunk
S3(config-if)# switchport trunk native vlan 99
S3(config-if)# interface vlan 99
S3(config-if)# ip address 192.168.1.13 255.255.255.0
S3(config-if)# exit
S3(config)# spanning-tree mode rapid-pvst
```

Device Configs – Final

Switch S1

```
S1#show run
Building configuration...

Current configuration : 1963 bytes
!
version 15.0
no service pad
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname S1
!
```

Lab – Configuring Rapid PVST+, PortFast, and BPDU Guard

```
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
system mtu routing 1500
!
no ip domain-lookup
!
spanning-tree mode rapid-pvst
spanning-tree extend system-id
spanning-tree vlan 1,10,99 priority 28672
!
vlan internal allocation policy ascending
!
interface FastEthernet0/1
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/2
 shutdown
!
interface FastEthernet0/3
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/4
 shutdown
!
interface FastEthernet0/5
 shutdown
!
interface FastEthernet0/6
 switchport access vlan 10
 switchport mode access
 spanning-tree portfast
 spanning-tree bpduguard enable
!
interface FastEthernet0/7
 shutdown
!
interface FastEthernet0/8
 shutdown
!
interface FastEthernet0/9
 shutdown
!
interface FastEthernet0/10
 shutdown
!
interface FastEthernet0/11
 shutdown
!
interface FastEthernet0/12
 shutdown
!
```

```
interface FastEthernet0/13
shutdown
!
interface FastEthernet0/14
shutdown
!
interface FastEthernet0/15
shutdown
!
interface FastEthernet0/16
shutdown
!
interface FastEthernet0/17
shutdown
!
interface FastEthernet0/18
shutdown
!
interface FastEthernet0/19
shutdown
!
interface FastEthernet0/20
shutdown
!
interface FastEthernet0/21
shutdown
!
interface FastEthernet0/22
shutdown
!
interface FastEthernet0/23
shutdown
!
interface FastEthernet0/24
shutdown
!
interface GigabitEthernet0/1
shutdown
!
interface GigabitEthernet0/2
shutdown
!
interface Vlan1
no ip address
!
interface Vlan99
ip address 192.168.1.11 255.255.255.0
!
ip http server
ip http secure-server
!
line con 0
password cisco
logging synchronous
login
line vty 0 4
password cisco
```

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

Switch S2

```
S2#show run
Building configuration...

Current configuration : 1864 bytes
!
version 15.0
no service pad
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname S2
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
system mtu routing 1500
!
no ip domain-lookup
!
spanning-tree mode rapid-pvst
spanning-tree extend system-id
spanning-tree vlan 1,10,99 priority 24576
!
vlan internal allocation policy ascending
!
interface FastEthernet0/1
switchport trunk native vlan 99
switchport mode trunk
!
interface FastEthernet0/2
shutdown
!
interface FastEthernet0/3
switchport trunk native vlan 99
switchport mode trunk
!
interface FastEthernet0/4
shutdown
```

```
!  
interface FastEthernet0/5  
shutdown  
!  
interface FastEthernet0/6  
shutdown  
!  
interface FastEthernet0/7  
shutdown  
!  
interface FastEthernet0/8  
shutdown  
!  
interface FastEthernet0/9  
shutdown  
!  
interface FastEthernet0/10  
shutdown  
!  
interface FastEthernet0/11  
shutdown  
!  
interface FastEthernet0/12  
shutdown  
!  
interface FastEthernet0/13  
shutdown  
!  
interface FastEthernet0/14  
shutdown  
!  
interface FastEthernet0/15  
shutdown  
!  
interface FastEthernet0/16  
shutdown  
!  
interface FastEthernet0/17  
shutdown  
!  
interface FastEthernet0/18  
shutdown  
!  
interface FastEthernet0/19  
shutdown  
!  
interface FastEthernet0/20  
shutdown  
!
```



```
interface FastEthernet0/21
shutdown
!
interface FastEthernet0/22
shutdown
!
interface FastEthernet0/23
shutdown
!
interface FastEthernet0/24
shutdown
!
interface GigabitEthernet0/1
shutdown
!
interface GigabitEthernet0/2
shutdown
!
interface Vlan1
no ip address
!
interface Vlan99
ip address 192.168.1.12 255.255.255.0
!
ip http server
ip http secure-server
!
!
line con 0
password cisco
logging synchronous
login
line vty 0 4
password cisco
login
line vty 5 15
password cisco
login
!
end
```

Switch S3

```
S3#show run
Building configuration...

Current configuration : 1935 bytes
!
version 15.0
no service pad
```

Lab – Configuring Rapid PVST+, PortFast, and BPDU Guard

```
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname S3
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
system mtu routing 1500
!
no ip domain-lookup
!
spanning-tree mode rapid-pvst
spanning-tree portfast default
spanning-tree portfast bpduguard default
spanning-tree extend system-id
!
vlan internal allocation policy ascending
!
interface FastEthernet0/1
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/2
 shutdown
!
interface FastEthernet0/3
 switchport trunk native vlan 99
 switchport mode trunk
!
interface FastEthernet0/4
 shutdown
!
interface FastEthernet0/5
 shutdown
!
interface FastEthernet0/6
 shutdown
!
interface FastEthernet0/7
 shutdown
!
interface FastEthernet0/8
 shutdown
!
```

```
interface FastEthernet0/9
shutdown
!
interface FastEthernet0/10
shutdown
!
interface FastEthernet0/11
shutdown
!
interface FastEthernet0/12
shutdown
!
interface FastEthernet0/13
shutdown
!
interface FastEthernet0/14
shutdown
!
interface FastEthernet0/15
shutdown
!
interface FastEthernet0/16
shutdown
!
interface FastEthernet0/17
shutdown
!
interface FastEthernet0/18
switchport access vlan 10
switchport mode access
!
interface FastEthernet0/19
shutdown
!
interface FastEthernet0/20
shutdown
!
interface FastEthernet0/21
shutdown
!
interface FastEthernet0/22
shutdown
!
interface FastEthernet0/23
shutdown
!
interface FastEthernet0/24
shutdown
!
```

Lab – Configuring Rapid PVST+, PortFast, and BPDU Guard

```
interface GigabitEthernet0/1
 shutdown
!
interface GigabitEthernet0/2
 shutdown
!
interface Vlan1
 no ip address
!
interface Vlan99
 ip address 192.168.1.13 255.255.255.0
!
ip http server
ip http secure-server
!
line con 0
 password cisco
 logging synchronous
 login
line vty 0 4
 password cisco
 login
line vty 5 15
 password cisco
 login
!
end
```