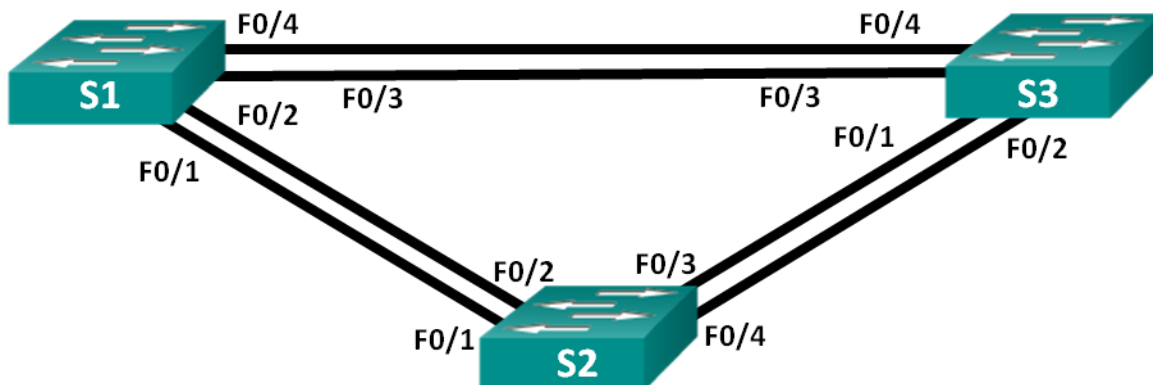


## Lab – Building a Switched Network with Redundant Links

### Topology



### 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

### Objectives

**Part 1: Build the Network and Configure Basic Device Settings**

**Part 2: Determine the Root Bridge**

**Part 3: Observe STP Port Selection Based on Port Cost**

**Part 4: Observe STP Port Selection Based on Port Priority**

### Background / Scenario

Redundancy increases the availability of devices in the network topology by protecting the network from a single point of failure. Redundancy in a switched network is accomplished through the use of multiple switches or multiple links between switches. When physical redundancy is introduced into a network design, loops and duplicate frames can occur.

The Spanning Tree Protocol (STP) was developed as a Layer 2 loop-avoidance mechanism for redundant links in a switched network. STP ensures that there is only one logical path between all destinations on the network by intentionally blocking redundant paths that could cause a loop.

In this lab, you will use the **show spanning-tree** command to observe the STP election process of the root bridge. You will also observe the port selection process based on cost and priority.

**Note:** The switches used 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.

### Required Resources

- 3 Switches (Cisco 2960 with Cisco IOS Release 15.0(2) lanbasek9 image or comparable)
- 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 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.

- Disable DNS lookup.
- Configure the device name as shown in the topology.
- Assign **class** as the encrypted privileged EXEC mode password.
- Assign **cisco** as the console and vty passwords and enable login for console and vty lines.
- Configure logging synchronous for the console line.
- Configure a message of the day (MOTD) banner to warn users that unauthorized access is prohibited.
- Configure the IP address listed in the Addressing Table for VLAN 1 on all switches.
- Copy the running configuration to the startup configuration.

#### Step 4: Test connectivity.

Verify that the switches can ping one another.

Can S1 ping S2?

Can S1 ping S3?

Can S2 ping S3?

Troubleshoot until you are able to answer yes to all questions.

### Part 2: Determine the Root Bridge

Every spanning-tree instance (switched LAN or broadcast domain) has a switch designated as the root bridge. The root bridge serves as a reference point for all spanning-tree calculations to determine which redundant paths to block.

An election process determines which switch becomes the root bridge. The switch with the lowest bridge identifier (BID) becomes the root bridge. The BID is made up of a bridge priority value, an extended system ID, and the MAC address of the switch. The priority value can range from 0 to 65,535, in increments of 4,096, with a default value of 32,768.

**Step 1: Deactivate all ports on the switches.**

**Step 2: Configure connected ports as trunks.**

**Step 3: Activate ports F0/2 and F0/4 on all switches.**

**Step 4: Display spanning tree information.**

Issue the **show spanning-tree** command on all three switches. The Bridge ID Priority is calculated by adding the priority value and the extended system ID. The extended system ID is always the VLAN number. In the example below, all three switches have equal Bridge ID Priority values ( $32769 = 32768 + 1$ , where default priority = 32768, VLAN number = 1); therefore, the switch with the lowest MAC address becomes the root bridge (S2 in the example).

```
S1# show spanning-tree
```

```
VLAN0001
```

```
Spanning tree enabled protocol ieee
```

```
Root ID    Priority    32769
Address    0cd9.96d2.4000
Cost       19
Port       2 (FastEthernet0/2)
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  300 sec
```

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

```
S2# show spanning-tree
```

```
VLAN0001
```

```
Spanning tree enabled protocol ieee
```

```
Root ID    Priority    32769
Address    0cd9.96d2.4000
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    0cd9.96d2.4000
Hello Time  2 sec    Max Age 20 sec    Forward Delay 15 sec
Aging Time  300 sec
```

## Lab – Building a Switched Network with Redundant Links

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/2	Desg	FWD	19	128.2	P2p
Fa0/4	Desg	FWD	19	128.4	P2p

S3# **show spanning-tree**

VLAN0001

Spanning tree enabled protocol ieee

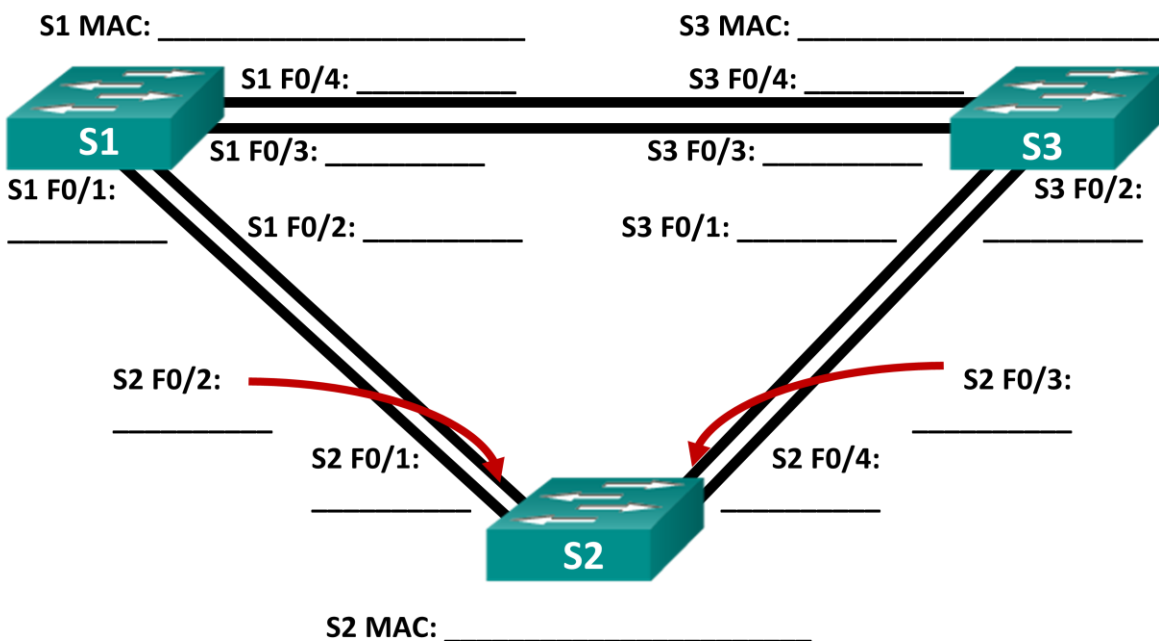
Root ID	Priority	Address	Cost	Port	Hello Time	Max Age	Forward Delay
	32769	0cd9.96d2.4000	19	2 (FastEthernet0/2)	2 sec	20 sec	15 sec

Bridge ID	Priority	Address	Hello Time	Max Age	Forward Delay	Aging Time
	32769 (priority 32768 sys-id-ext 1)	0cd9.96e8.7400	2 sec	20 sec	15 sec	300 sec

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/2	Root	FWD	19	128.2	P2p
Fa0/4	Desg	FWD	19	128.4	P2p

**Note:** The default STP mode on the 2960 switch is Per VLAN Spanning Tree (PVST).

In the diagram below, record the Role and Status (Sts) of the active ports on each switch in the Topology.



Based on the output from your switches, answer the following questions.

Which switch is the root bridge?

Why did spanning tree select this switch as the root bridge?

Which ports are the root ports on the switches?

Which ports are the designated ports on the switches?

What port is showing as an alternate port and is currently being blocked?

Why did spanning tree select this port as the non-designated (blocked) port?

### Part 3: Observe STP Port Selection Based on Port Cost

The spanning tree algorithm (STA) uses the root bridge as the reference point and then determines which ports to block, based on path cost. The port with the lower path cost is preferred. If port costs are equal, then spanning tree compares BIDs. If the BIDs are equal, then the port priorities are used to break the tie. Lower values are always preferred. In Part 3, you will change the port cost to control which port is blocked by spanning tree.

#### Step 1: Locate the switch with the blocked port.

With the current configuration, only one switch should have a port that is blocked by STP. Issue the **show spanning-tree** command on both non-root switches. In the example below, spanning tree is blocking port F0/4 on the switch with the highest BID (S1).

```
S1# show spanning-tree
```

```
VLAN0001
```

```
Spanning tree enabled protocol ieee
```

```
Root ID    Priority    32769
           Address    0cd9.96d2.4000
           Cost      19
           Port      2 (FastEthernet0/2)
           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 300 sec
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/2	Root	FWD	19	128.2	P2p
Fa0/4	Altn	BLK	19	128.4	P2p

```
S3# show spanning-tree
```

```
VLAN0001
```

```
Spanning tree enabled protocol ieee
```

```
Root ID    Priority    32769
           Address    0cd9.96d2.4000
           Cost       19
           Port       2 (FastEthernet0/2)
           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  15 sec
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/2	Root	FWD	19	128.2	P2p
Fa0/4	Desg	FWD	19	128.4	P2p

**Note:** Root bridge and port selection may differ in your topology.

### Step 2: Change port cost.

In addition to the blocked port, the only other active port on this switch is the port designated as the root port. Lower the cost of this root port to 18 by issuing the **spanning-tree cost 18** interface configuration mode command.

```
S1(config)# interface f0/2
S1(config-if)# spanning-tree cost 18
```

### Step 3: Observe spanning tree changes.

Re-issue the **show spanning-tree** command on both non-root switches. Observe that the previously blocked port (S1 - F0/4) is now a designated port and spanning tree is now blocking a port on the other non-root switch (S3 - F0/4).

```
S1# show spanning-tree
```

```
VLAN0001
```

```
Spanning tree enabled protocol ieee
```

```
Root ID    Priority    32769
           Address    0cd9.96d2.4000
           Cost       18
           Port       2 (FastEthernet0/2)
           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  300 sec
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
-----	----	---	-----	-----	-----
Fa0/2	Root	FWD	18	128.2	P2p
Fa0/4	Desg	FWD	19	128.4	P2p

S3# **show spanning-tree**

VLAN0001

Spanning tree enabled protocol ieee

Root ID      Priority      32769  
              Address      0cd9.96d2.4000  
              Cost          19  
              Port          2 (FastEthernet0/2)  
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
-----	----	---	-----	-----	-----
Fa0/2	Root	FWD	19	128.2	P2p
Fa0/4	Altn	BLK	19	128.4	P2p

Why did spanning tree change the previously blocked port to a designated port, and block the port that was a designated port on the other switch?

### Step 4: Remove port cost changes.

- Issue the **no spanning-tree cost 18** interface configuration mode command to remove the cost statement that you created earlier.  

```
S1(config)# interface f0/2  
S1(config-if)# no spanning-tree cost 18
```
- Re-issue the **show spanning-tree** command to verify that STP has reset the port on the non-root switches back to the original port settings. It takes approximately 30 seconds for STP to complete the port transition process.

## Part 4: Observe STP Port Selection Based on Port Priority

If port costs are equal, then spanning tree compares BIDs. If the BIDs are equal, then the port priorities are used to break the tie. The default port priority value is 128. STP aggregates the port priority with the port number to break ties. Lower values are always preferred. In Part 4, you will activate redundant paths to each switch to observe how STP selects a port using the port priority.

- Activate ports F0/1 and F0/3 on all switches.
- Wait 30 seconds for STP to complete the port transition process, and then issue the **show spanning-tree** command on the non-root switches. Observe that the root port has moved to the lower numbered port linked to the root switch, and blocked the previous root port.

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
Fa0/4	Altn	BLK	19	128.4	P2p

S3# **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      0cd9.96e8.7400  
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	Desg	FWD	19	128.3	P2p
Fa0/4	Desg	FWD	19	128.4	P2p

What port did STP select as the root port on each non-root switch?

Why did STP select these ports as the root port on these switches?



### Reflection

1. After a root bridge has been selected, what is the first value STP uses to determine port selection?
2. If the first value is equal on the two ports, what is the next value that STP uses to determine port selection?
3. If both values are equal on the two ports, what is the next value that STP uses to determine port selection?