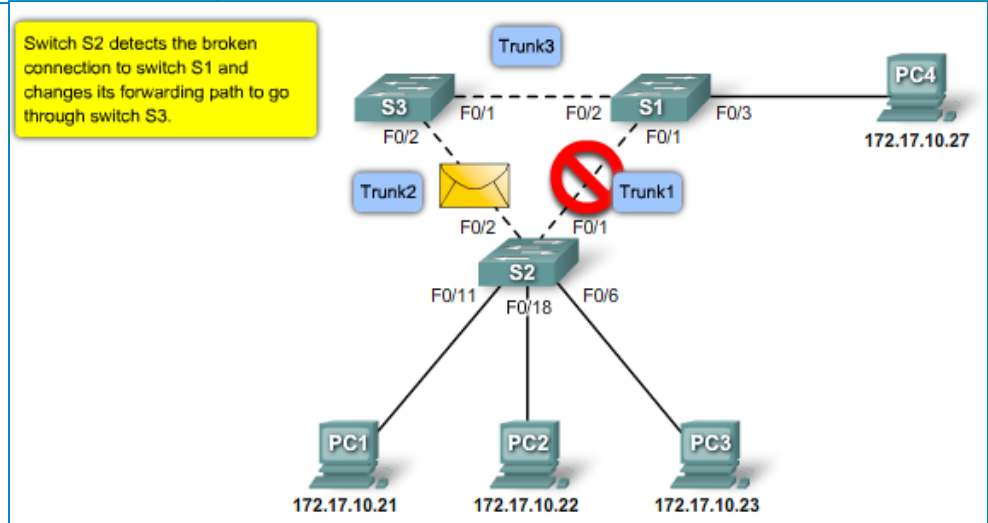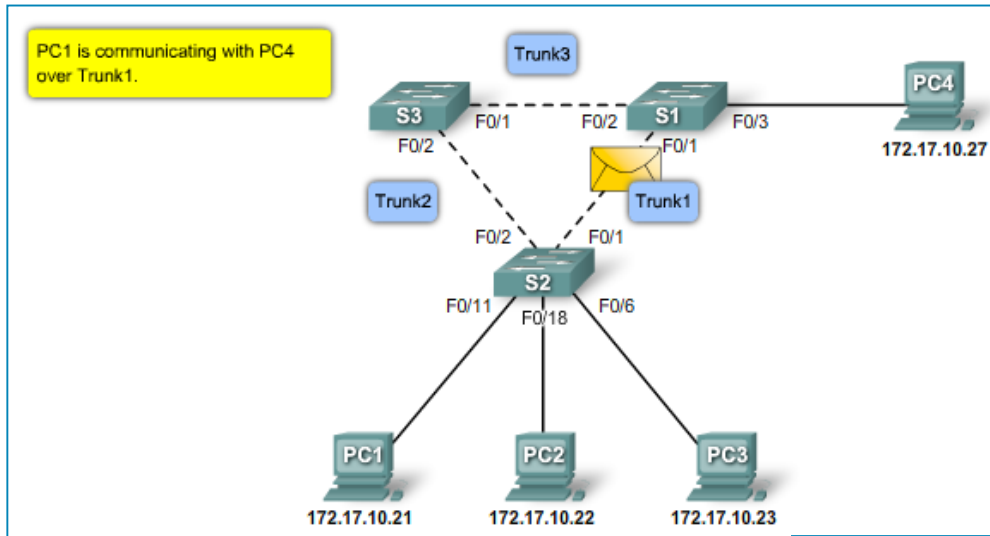# Spanning Tree Protocols

Cisco | Networking Academy®
Mind Wide Open™
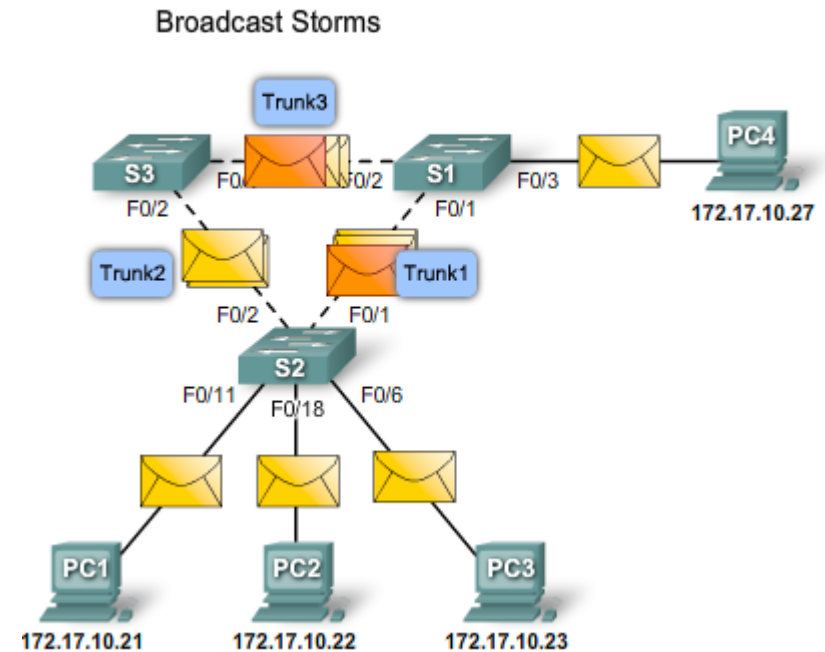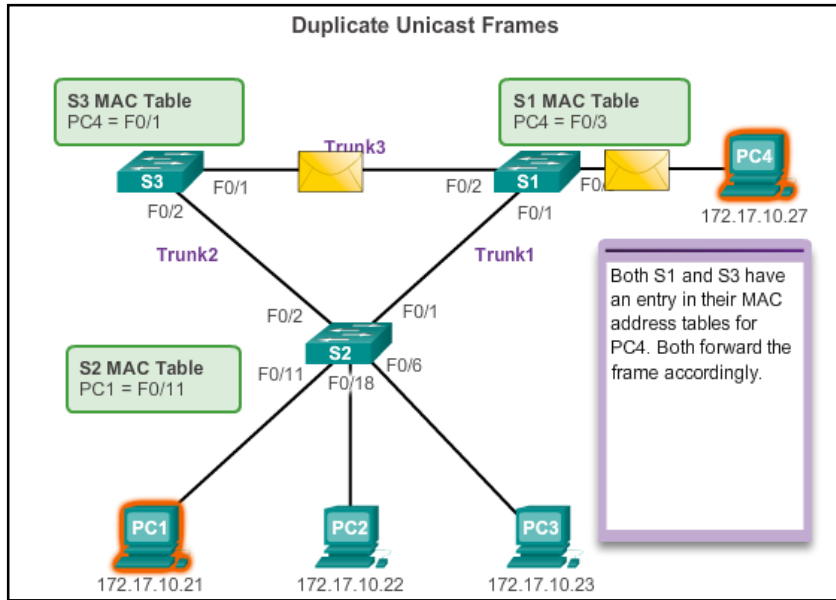
Redundancy in a Hierarchical Network

Layer 2 loops and Broadcast Storms

Duplicate Unicast Frames

S3 MAC Table
PC4 = F0/1

S1 MAC Table
PC4 = F0/3

Both S1 and S3 have an entry in their MAC address tables for PC4. Both forward the frame accordingly.
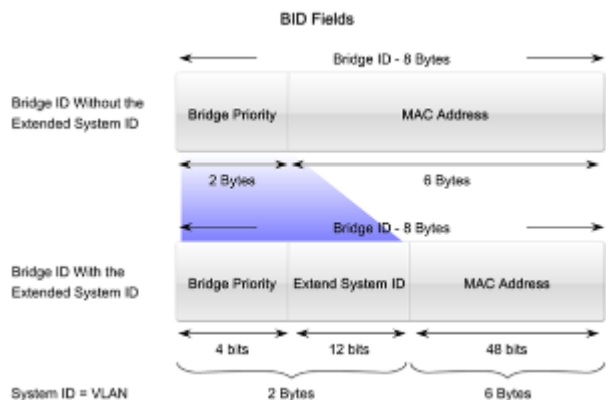
S2 MAC Table
PC1 = F0/11

Broadcast Storms

Spanning Tree Algorithm

- Root Bridge

The switch with the lowest BID ends up being identified as the root bridge for the spanning-tree
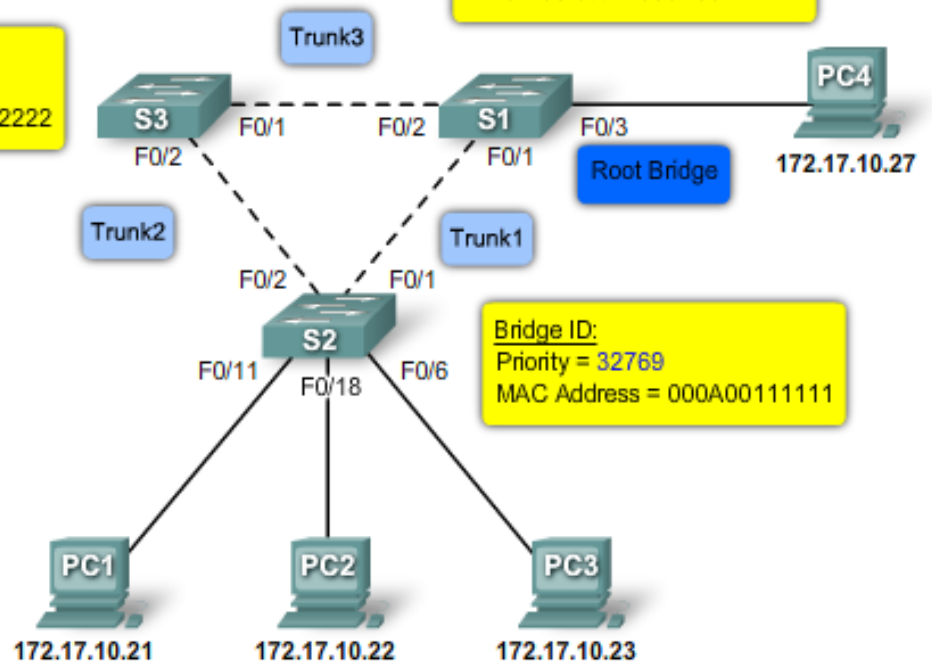
Spanning Tree Algorithm
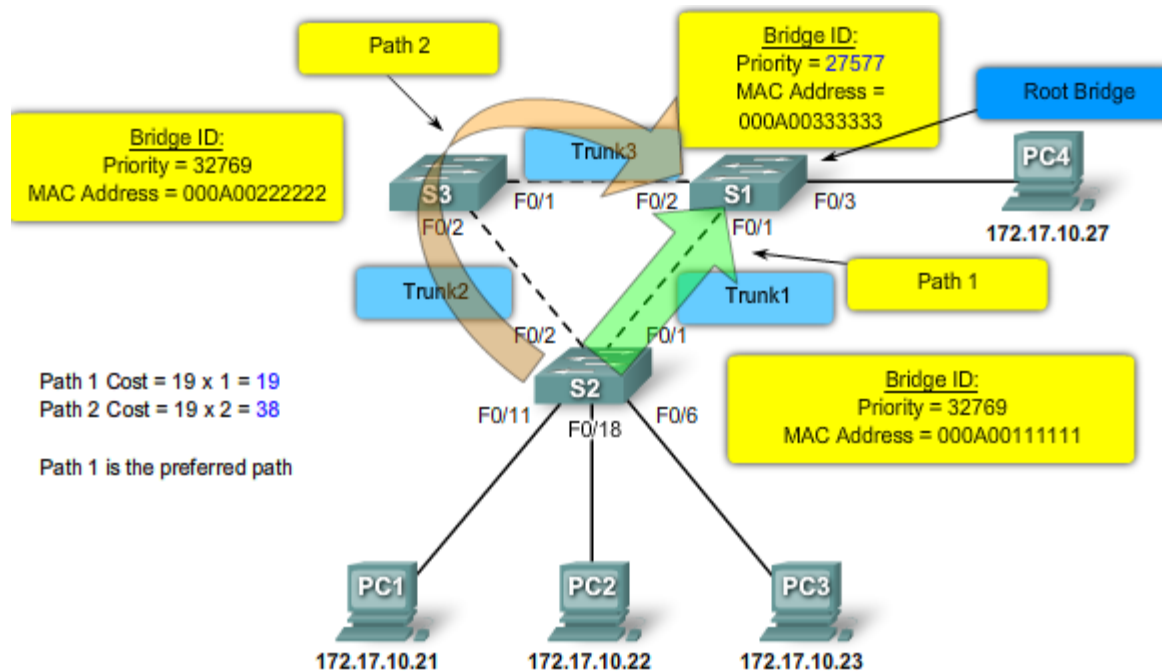
- ## Best Path to the Root Bridge

When the root bridge has been designated, starts the process of determining the best paths to the root bridge from all destinations in the broadcast domain.

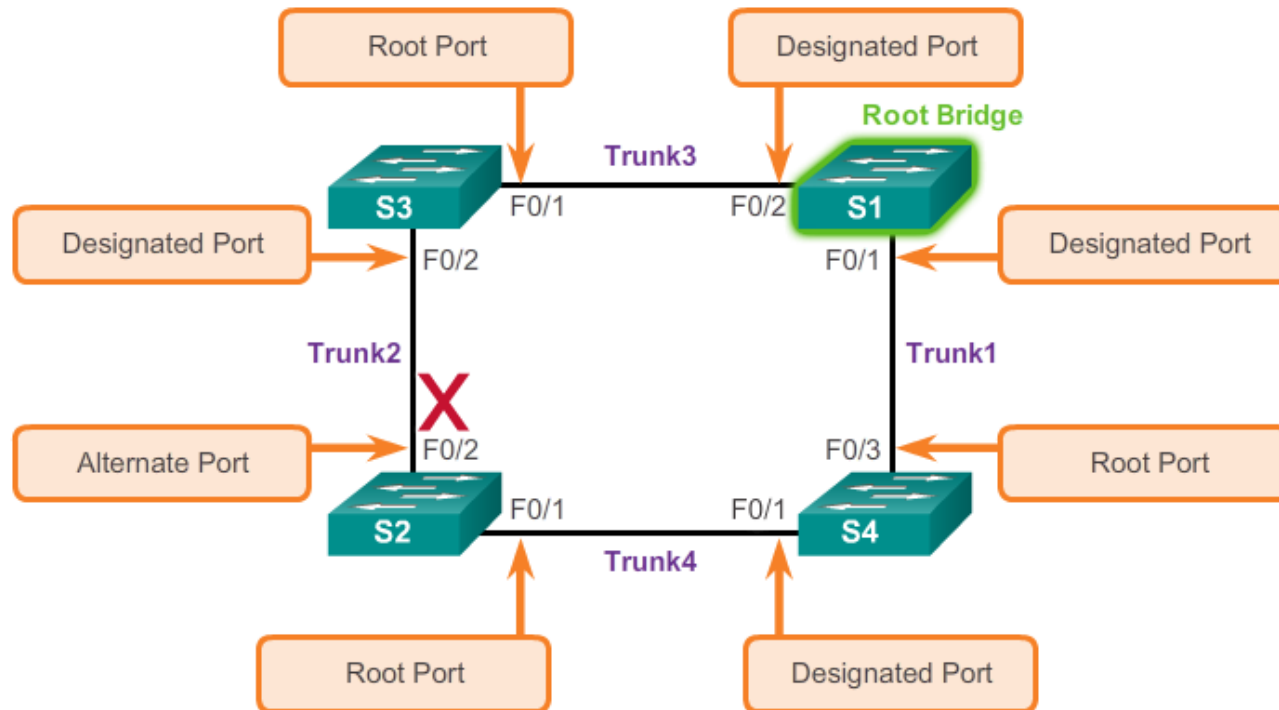| Link Speed	Cost (Revised IEEE Specification)	Cost (Previous IEEE Specification)
10 Gb/s	2	1
1 Gb/s	4	1
100 Mb/s	19	10
10 Mb/s	100	100

Spanning Tree Algorithm

Port Role Decisions
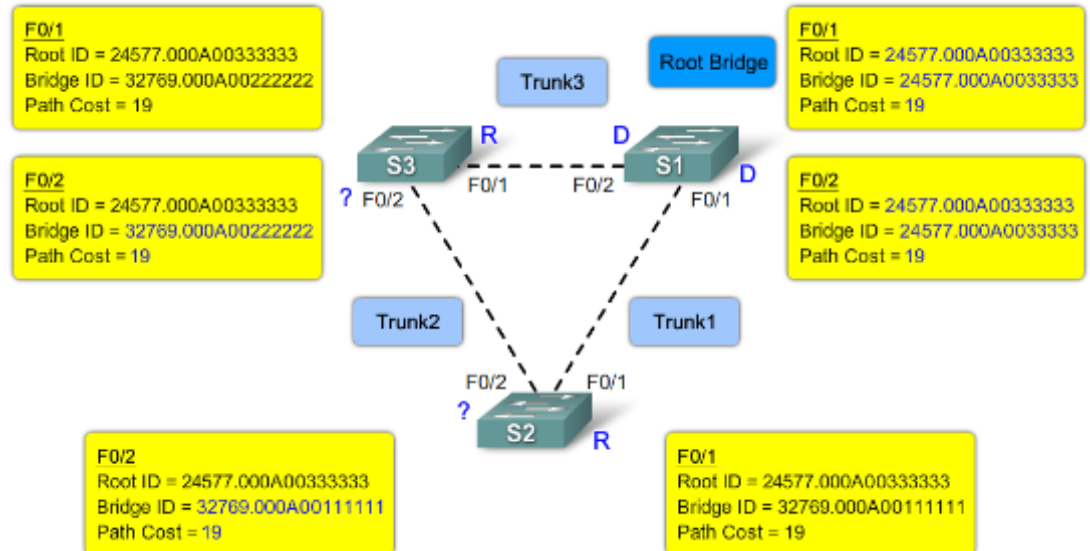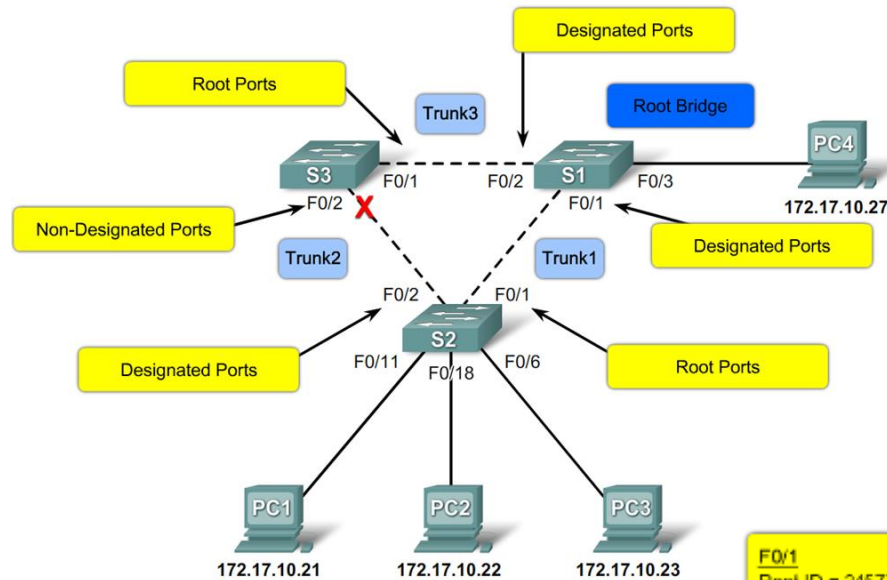
Spanning Tree Algorithm

- Port Role Decisions

Spanning Tree Algorithm Summary

1. Electing a Root Bridge
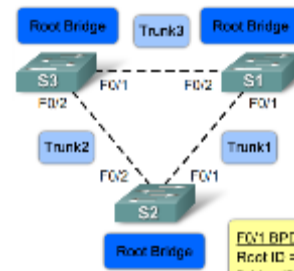
2. Electing a Root Ports
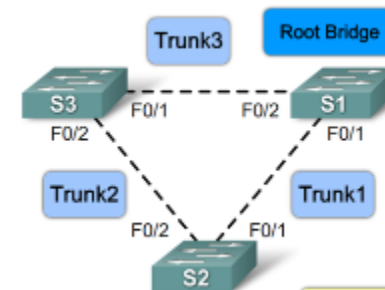
3. Electing a Designated and Non-Designated ports
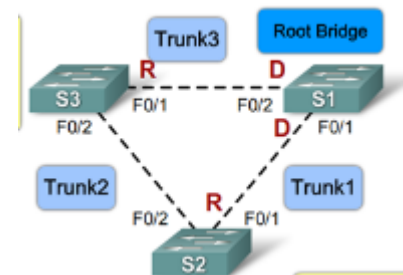
Varieties of Spanning Tree Protocols

Protocol	Standard	Resources Needed	Convergence	Tree Calculation
STP	802.1D	Low	Slow	All VLANs
PVST+	Cisco	High	Slow	Per VLAN
RSTP	802.1w	Medium	Fast	All VLANs
Rapid PVST+	Cisco	Very high	Fast	Per VLAN
MSTP	802.1s Cisco	Medium or high	Fast	Per Instance

PVST – Per VLAN Spanning Tree

PVST+

Root for VLAN 20   802.1Q Trunk   Root for VLAN 10

S3   F0/4 .... F0/4   S1

F0/1   F0/2

Forwarding Port for VLAN 20
Blocking Port for VLAN 10

F0/3   S2   F0/2

Forwarding Port for VLAN 10
Blocking Port for VLAN 20

VLAN 10 ━ ━ ━ ━ ━
VLAN 20 ·············
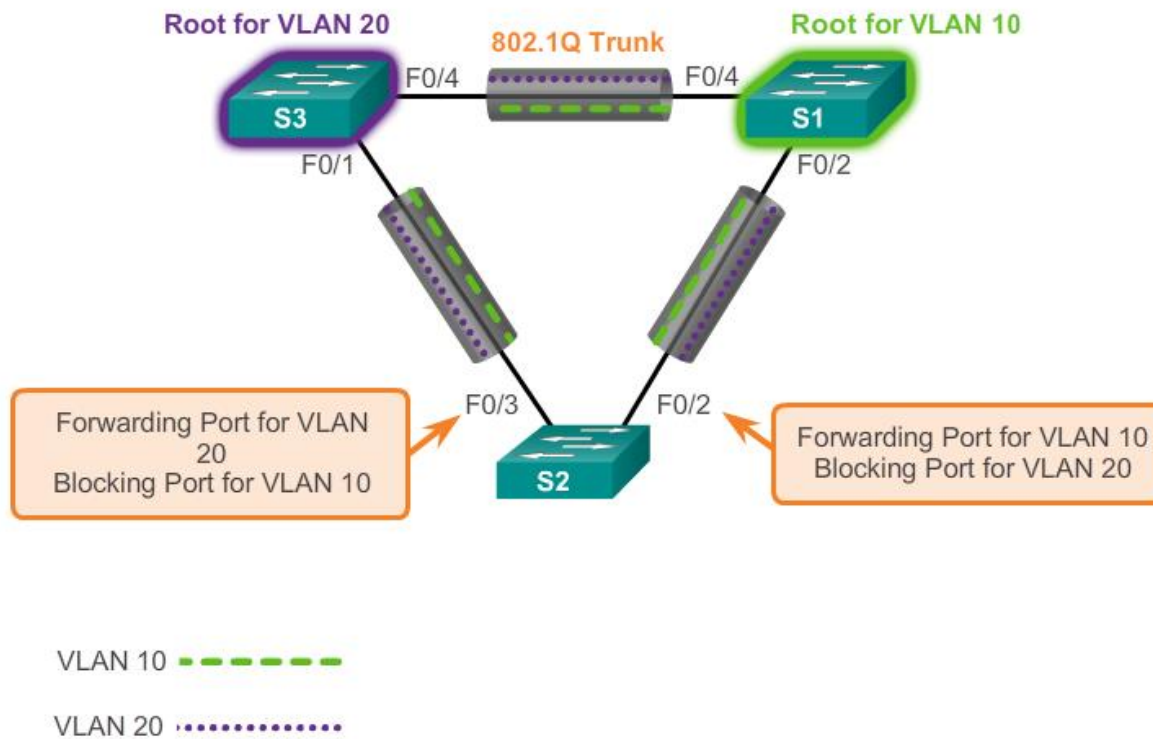
PortFast and BPDU Guard

PortFast
- port transitions from blocking to forwarding state immediately, bypassing the usual 802.1D STP transition states

BPDU Guard
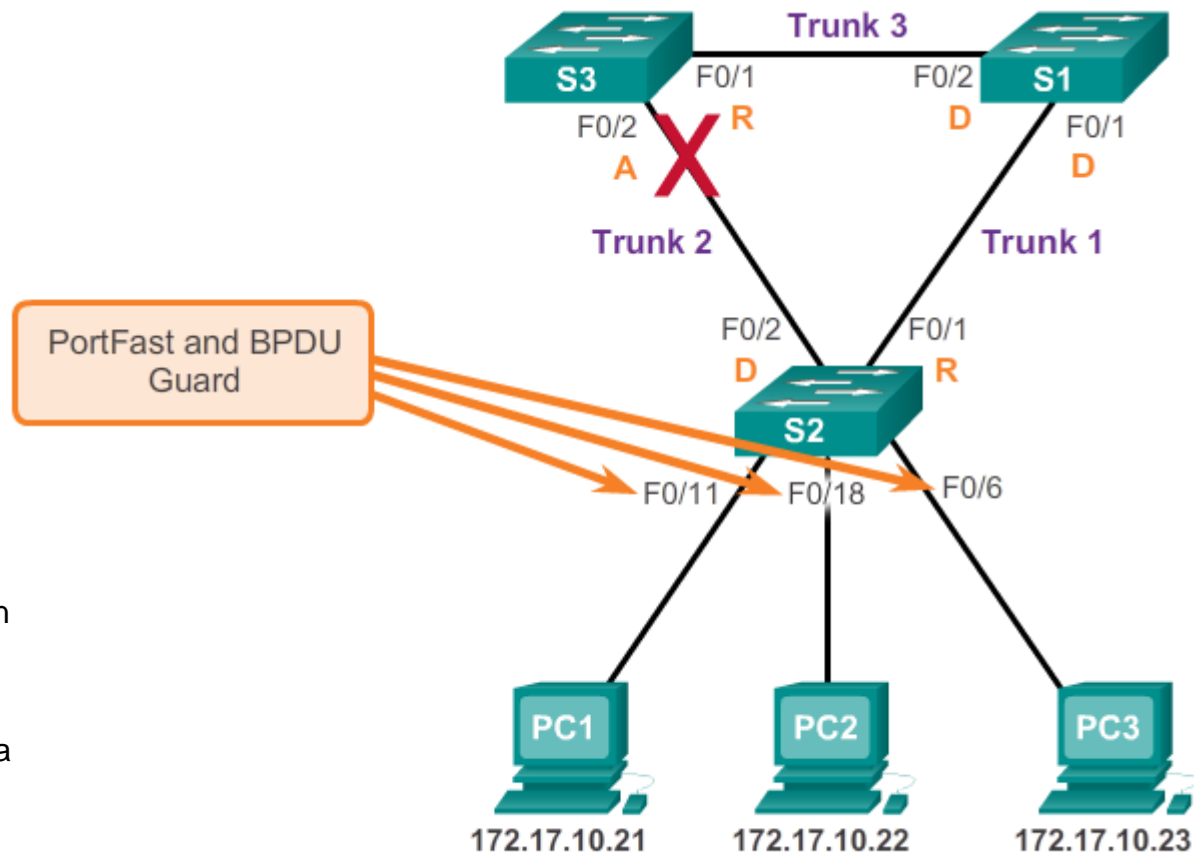- The BPDU guard provides a secure response to invalid configurations because you must manually put the interface back into service

Default switch configuration

Feature	Default Setting
Enable state	Enabled on VLAN 1
Spanning-tree mode	PVST+ (Rapid PVST+ and MSTP are disabled.)
Switch priority	32768
Spanning-tree port priority (configurable on a per-interface basis)	128
Spanning-tree port cost (configurable on a per-interface basis)	1000 Mb/s: 4 100 Mb/s: 19 10 Mb/s: 100
Spanning-tree VLAN port priority (configurable on a per-VLAN basis)	128
Spanning-tree VLAN port cost (configurable on a per-VLAN basis)	1000 Mb/s: 4 100 Mb/s: 19 10 Mb/s: 100
Spanning-tree timers	Hello time: 2 seconds Forward-delay time: 15 seconds Maximum-aging time: 20 seconds Transmit hold count: 6 BPDUs

3.3 Spanning Tree Configuration

Cisco Confidential
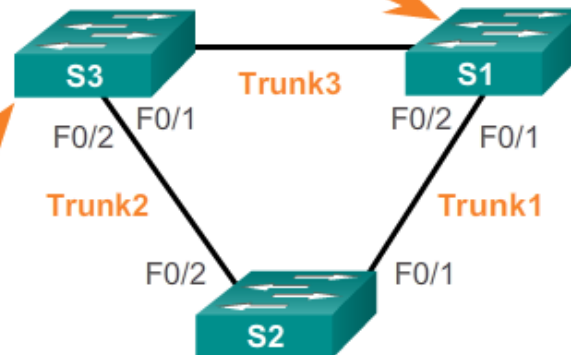
Configure BID

Method 1

```
s1(config)# spanning-tree VLAN 1 root primary
s1(config)# end
```

Method 2

```
s3(config)# spanning-tree VLAN 1 priority 24576
s3(config)# end
```

Method 1

```
s2(config)# spanning-tree VLAN 1 root secondary
s2(config)# end
```

PVST+ Configuration

- ## PortFast and BPDU Guard

  - PortFast immediately transitions an access port from blocking to forwarding state while BPDU guard puts an access port in an errdisabled (error-disabled) state if it receives a BPDU.

  - Use the **spanning-tree portfast** interface configuration mode command to enable PortFast on a switch port.

  - Use the **spanning-tree bpduguard enable** interface configuration mode command to enable BPDU guard on a Layer 2 access port.

```
S2(config)# interface FastEthernet 0/11
S2(config-if)# spanning-tree portfast
%Warning: portfast should only be enabled on ports connected to
a single host. Connecting hubs, concentrators, switches,
bridges, etc... to this interface  when portfast is enabled,
can cause temporary bridging loops.
 Use with CAUTION

%Portfast has been configured on FastEthernet0/11 but will only
 have effect when the interface is in a non-trunking mode.
S2(config-if)# spanning-tree bpduguard enable
S2(config-if)# end
```

Rapid PVST+ Configuration

- ## Spanning Tree Mode

  - Rapid PVST+ is the Cisco implementation of RSTP.

  - It supports RSTP on a per-VLAN basis.

```
S1# configure terminal
S1(config)# spanning-tree mode rapid-pvst
S1(config)# interface f0/2
S1(config-if)# spanning-tree link-type point-to-point
S1(config-if)# end
S1# clear spanning-tree detected-protocols
```

```
S1# show spanning-tree vlan 10

VLAN0010
  Spanning tree enabled protocol rstp
  Root ID    Priority    4106
             Address     0019.aa9e.b000
             This bridge is the root
             Hello Time   2 sec  Max Age 20 sec   Forward Delay 15 sec
```
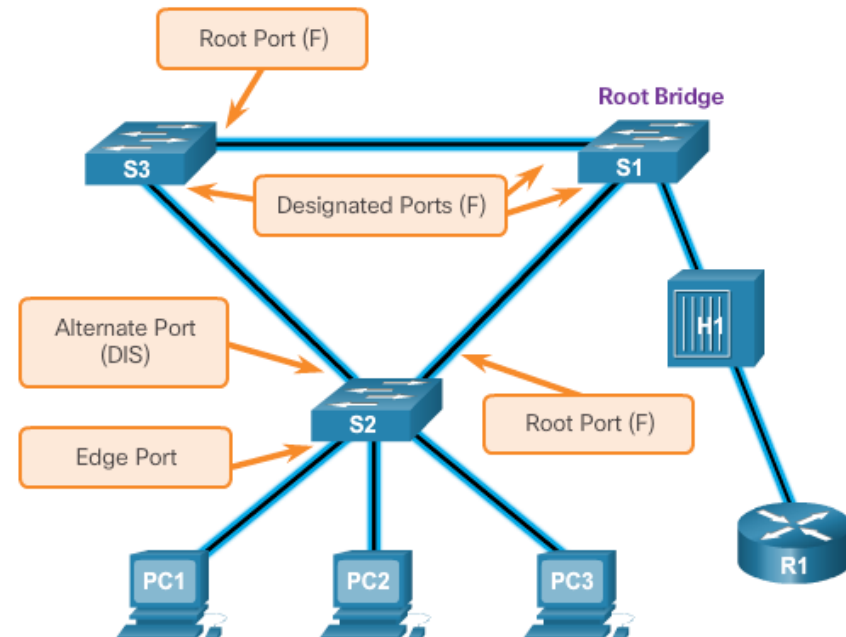
Rapid PVST+

- ## Link Types

  - **Point-to-Point** - A port operating in full-duplex mode typically connects a switch to a switch and is a candidate for a rapid transition to a forwarding state.

  - **Shared** - A port operating in half-duplex mode connects a switch to a legacy hub that attaches multiple devices.

STP Configuration Issues

- ## Overview of STP Status

  - Use the **show spanning-tree** command without specifying any additional options provides a quick overview of the status of STP for all VLANs that are defined on a switch.

  - Use the **show spanning-tree vlan** *vlan_id* command to get STP information for a particular VLAN.

Cisco Confidential