



Chapter 5

Spanning Tree Protocol (STP)

Part II

CCNA3-1

Chapter 5-2

Note for Instructors

- These presentations are the result of a collaboration among the instructors at St. Clair College in Windsor, Ontario.
- Thanks must go out to Rick Graziani of Cabrillo College. His material and additional information was used as a reference in their creation.
- If anyone finds any errors or omissions, please let me know at:
 - tdame@stclaircollege.ca.

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Chapter 5-2

Spanning Tree Protocol (STP)

PVST+, RTSP and Rapid PVST+

Per-VLAN Spanning Tree (PVST)

Per-VLAN Spanning Tree Plus (PVST+)

Rapid Per-VLAN Spanning Tree Plus (Rapid PVST+)

Rapid Spanning Tree (RSTP)

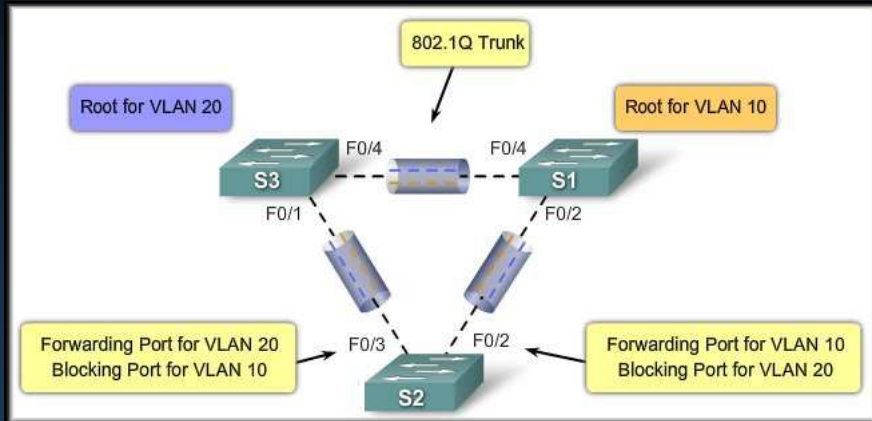
Multiple Spanning Tree Protocol (MSTP)

Cisco and IEEE STP Variants

Cisco Proprietary	PVST	<ul style="list-style-type: none">• Uses the Cisco proprietary ISL trunking protocol• Each VLAN has an instance of spanning tree• Ability to load balance traffic at layer-2• Includes extensions BackboneFast, UplinkFast, and PortFast
	PVST+	<ul style="list-style-type: none">• Supports ISL and IEEE 802.1Q trunking• Supports Cisco proprietary STP extensions• Adds BPDU guard and Root guard enhancements
	rapid-PVST+	<ul style="list-style-type: none">• Based on IEEE802.1w standard• Has faster convergence than 802.1D
IEEE Standard	RSTP	<ul style="list-style-type: none">• Introduced in 1982 provides faster convergence than 802.1D• Implements generic versions of the Cisco proprietary STP extensions• IEEE has incorporated RSTP into 802.1D, identifying the specification as IEEE 802.1D-2004
	MSTP	<ul style="list-style-type: none">• Multiple VLANs can be mapped to the same spanning-tree instance• Inspired by the Cisco Multiple Instances Spanning Tree Protocol (MISTP)• IEEE 802.1Q-2003 now includes MSTP

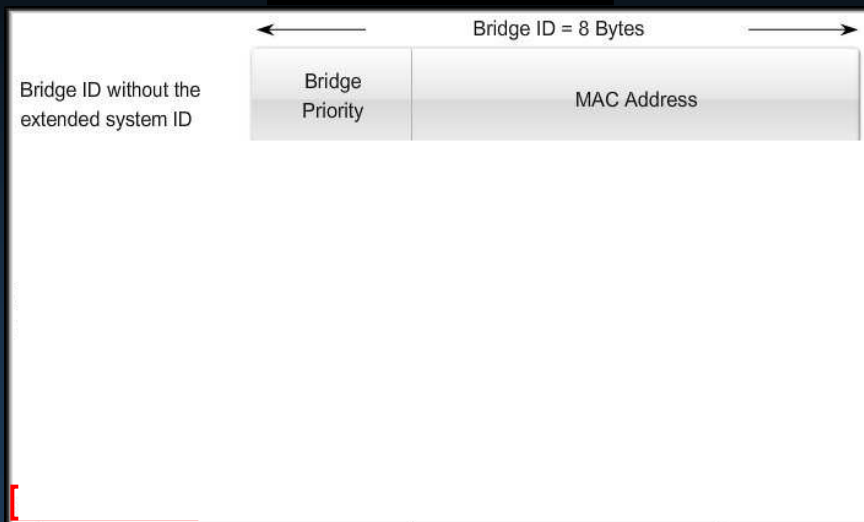
PVST+ (Cisco)

- Cisco PVST+:



PVST+ (Cisco)

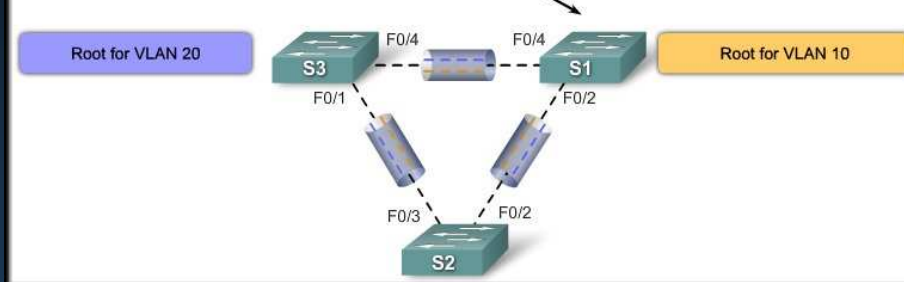
Extended System-ID



PVST+ (Cisco)

Extended System-ID

Priority + VLAN ID + MAC Address = BID
 32768 + 10 + 000A00333333 = 32778.000A00333333
 32768 + 20 + 000A00333333 = 32788.000A00333333



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

```
VLAN0001
```

```
Spanning tree enabled protocol ieee
<output omitted>
```

```
VLAN0010
```

```
Spanning tree enabled protocol ieee
Root ID    Priority    4106
Address    0060.47E0.3A67
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
```

```
Bridge ID  Priority    4106 (priority 4096 sys-id-ext 10)
Address    0060.47E0.3A67
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20
```

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

```
VLAN0020
```

```
Spanning tree enabled protocol ieee
```

```
<output omitted>
```

Rapid Spanning-Tree Protocol (RSTP)

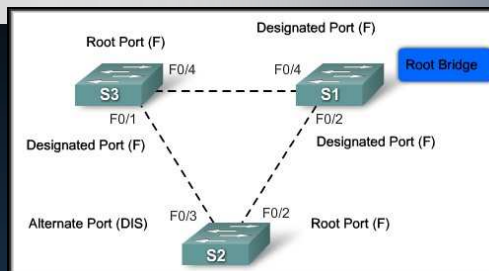
- IEEE 802.1w RSTP:
 - *What is it?*
 - Is an **evolution of the 802.1D** standard.
 - Terminology remains primarily the same.
 - Most parameters have been left unchanged.
 - **Speeds the recalculation** of the spanning tree on a topology change.
 - Much **faster convergence**.
 - **Redefines** the type of ports and their state.
 - **Alternate or backup ports can immediately change** to a forwarding state without waiting for the network to converge.

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Rapid Spanning-Tree Protocol (RSTP)

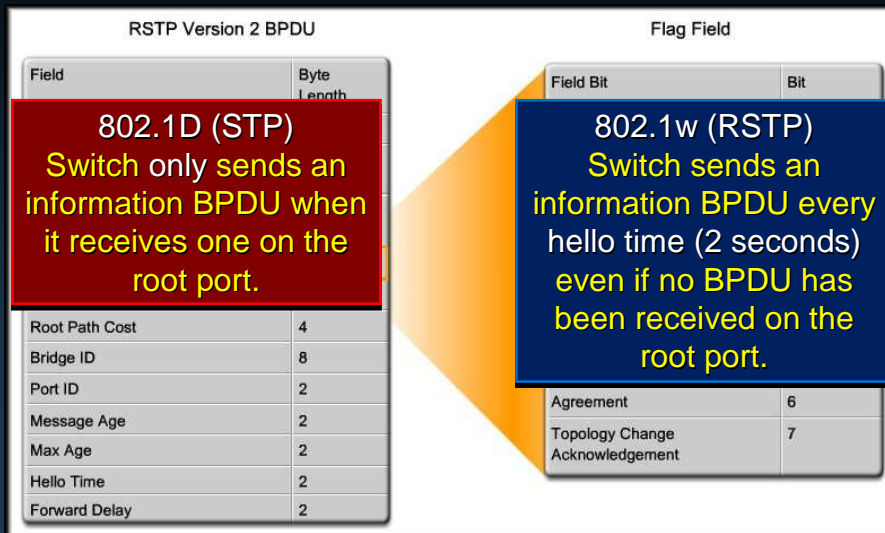
- IEEE 802.1w RSTP:
 - *Characteristics:*
 - **Preferred protocol** for preventing Layer 2 loops.
 - **Cisco-proprietary enhancements**, such as UplinkFast and BackboneFast, are not compatible with RSTP.
 - Retains **backward compatibility** to 802.1D.
 - Keeps the **same BPDU format** as IEEE 802.1D with the **version field is set to 2** to indicate RSTP.
 - Port can safely transition to the **forwarding state** without having to rely on any timer configuration.



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Rapid Spanning-Tree Protocol (RSTP)



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Rapid Spanning-Tree Protocol (RSTP)

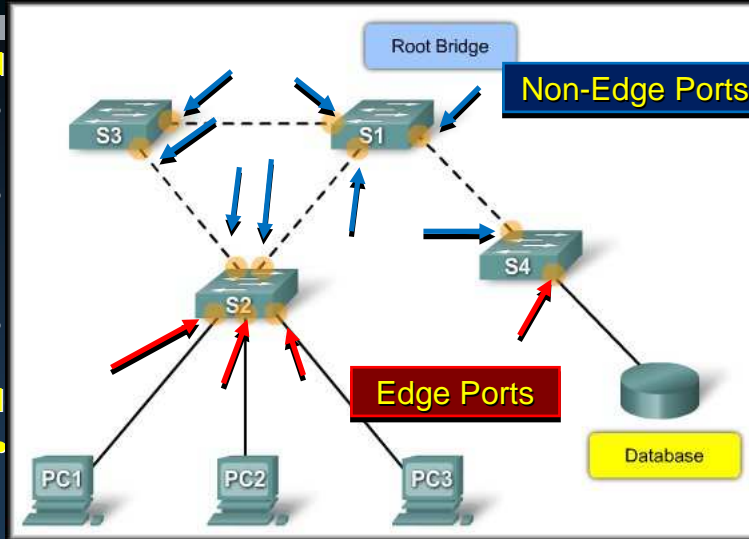
- **Rapid Transition to Forwarding State:**
 - *Rapid transition is the most important feature introduced by 802.1w.*
 - The legacy STA passively waited for the network to converge before it turned a port into the forwarding state.
 - The new rapid STP is able to actively confirm that a port can safely transition to the forwarding state **without having to rely on any timer configuration.**
 - In order to achieve fast convergence on a port, the protocol **relies upon two new variables:**
 - Edge Ports
 - Link Type.

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Rapid Spanning-Tree Protocol (RSTP)

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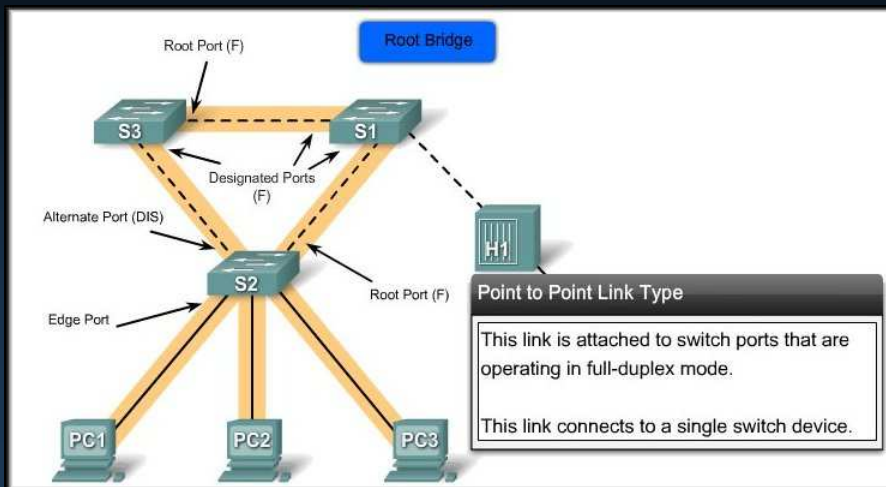


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Rapid Spanning-Tree Protocol (RSTP)

- Link Types:



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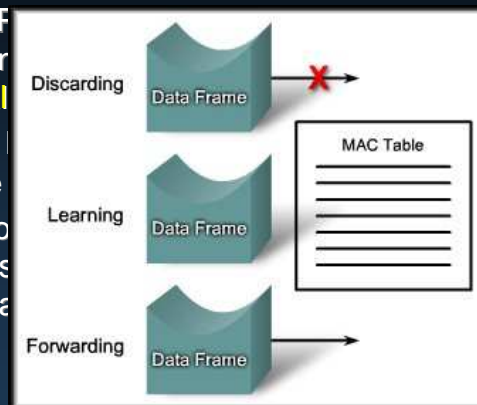
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Rapid Spanning-Tree Protocol (RSTP)

- **Link Types:**
 - *However, before the link type parameter is considered, RSTP must determine the port role.*
 - **Root Ports:**
 - **Do not** use the link type parameter.
 - **Alternate and Backup Ports:**
 - **Do not** use the link type parameter in most cases.
 - **Designated Ports:**
 - Make the most use of the link type parameter only if it is a point-to-point link.

Rapid Spanning-Tree Protocol (RSTP)

- **Port States:**
 - An RSTP forwarding proposal is discarded from the MAC Table.
 - With the discarding state, a Data Frame should be in the discarding state through its final destination to the network.
 - Forwarding state is used for synchronization.



Rapid Spanning-Tree Protocol (RSTP)

- **Port States:**
 - **Discarding:**
 - Prevents the forwarding of data frames.
 - **Learning:**
 - Accepts data frames to populate the MAC table.
 - **Forwarding:**
 - Forwards data frames and determines the topology.

Rapid Spanning-Tree Protocol (RSTP)

STP

Processes	Blocking	Listening	Learning	Forwarding	Disable
Receives and process BPDUs	YES	YES	YES	YES	NO
Forward data frames received on interface	NO	NO	NO	YES	NO
Forward data frames switched from another interface	NO	NO	NO	YES	NO
Learn MAC addresses	NO	NO	YES	YES	NO

RSTP

Operational Port State	STP Port State	RSTP Port State
Enabled	Blocking	Discarding
Enabled	Listening	Discarding
Enabled	Learning	Learning
Enabled	Forwarding	Forwarding
Disabled	Disabled	Discarding

Rapid Spanning-Tree Protocol (RSTP)

- **Port Roles:**

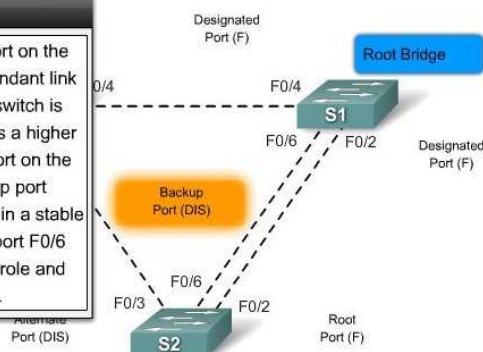
- The port role defines the ultimate purpose of a switch port and how it handles data frames. Port roles and port states are able to transition independently of each other.
 - **Root Port**
 - **Designated Port**
 - **Alternate Port**
 - **Backup Port**
- Creating the additional port roles allows RSTP to define a standby switch port **before a failure** or topology change.

Rapid Spanning-Tree Protocol (RSTP)

- **Port Roles:**

Backup port

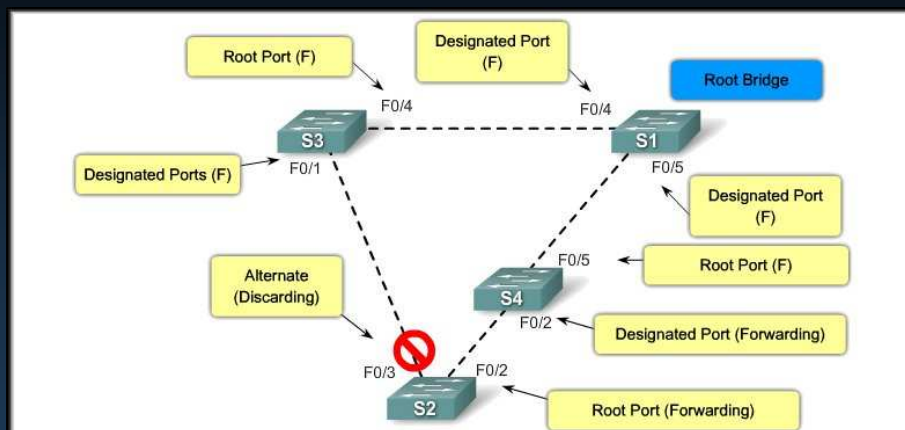
This is an additional switch port on the designated switch with a redundant link to the segment for which the switch is designated. A backup port has a higher port ID than the designated port on the designated switch. The backup port assumes the discarding state in a stable active topology. In the figure port F0/6 on switch S2 is in the backup role and has assumed the discard role.



RSTP Proposal and Agreement Process

- In IEEE 802.1D STP:
 - A **designated port must wait** two times the forward delay before transitioning the port to the forwarding state.
- **RSTP:**
 - Significantly speeds up the recalculation process after a topology change.
 - It **converges on a link-by-link basis** and **does not rely on timers** expiring before ports can transition.
 - Only on **edge ports** and **point-to-point links**.

RSTP Proposal and Agreement Process



Configuring Rapid-PVST+

- Rapid PVST+ is a Cisco implementation of RSTP.
 - Supports spanning tree for **each VLAN**.
 - **Rapid STP variant** to use in Cisco-based networks.

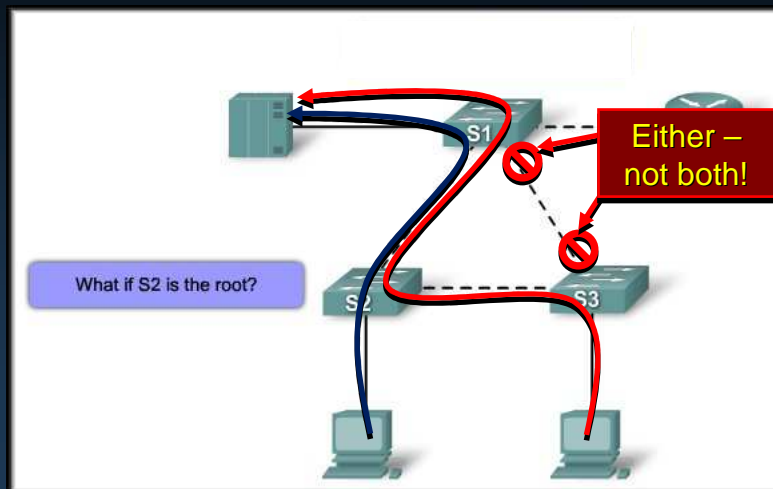
```
S1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
S1 (conf) S1#show run
S1 (conf) Building configuration...
S1 (conf) <output omitted>
S1 (conf) !
S1#clear !
S1# spanning-tree mode rapid-pvst
spanning-tree vlan 1 priority 24576
spanning-tree vlan 10 priority 4096
spanning-tree vlan 20 priority 28672
!
```

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Design STP for Trouble Avoidance

- Know where the root is:

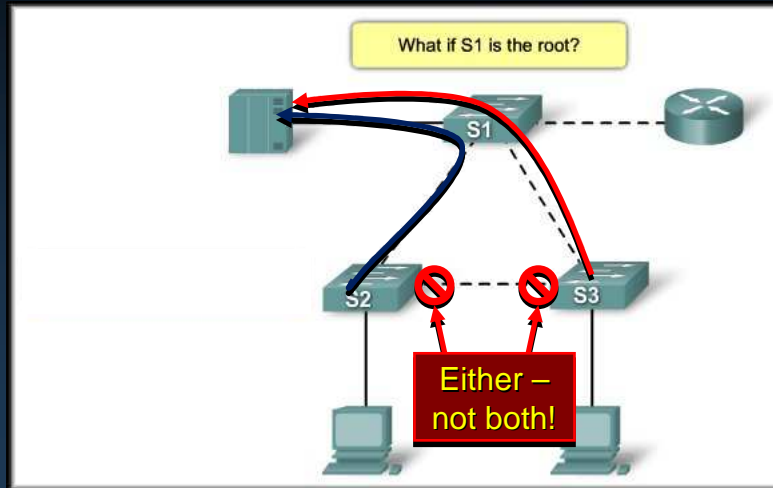


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Design STP for Trouble Avoidance

- Know where the root is:



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Design STP for Trouble Avoidance

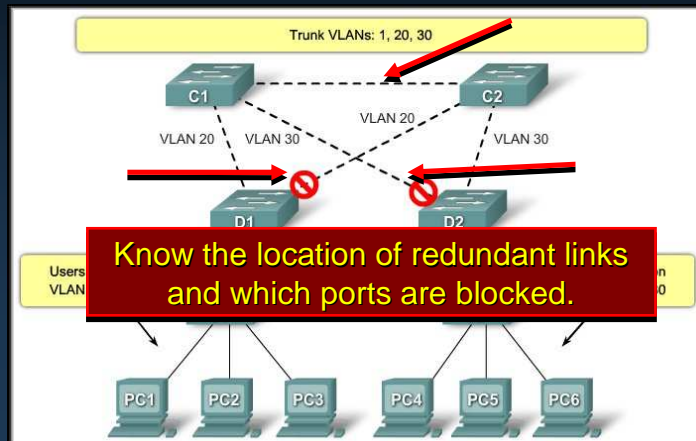
- **Minimize the Number of Blocked Ports:**
 - The only critical action that STP takes is the blocking of ports.
 - A good way to limit the risk inherent in the use of STP is to reduce the number of blocked ports as much as possible.
 - In non-hierarchical networks you might need to tune the STP cost parameter to **decide which ports to block**.

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Design STP for Trouble Avoidance

- **Minimize the Number of Blocked Ports:**
 - You do not need more than two redundant links between two nodes in a switched network.

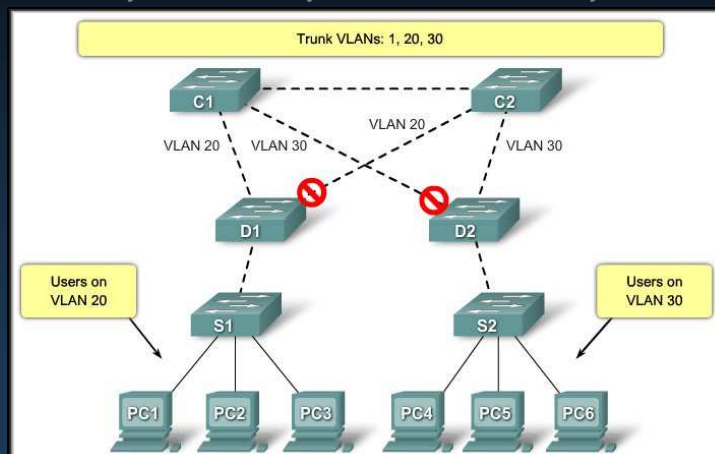


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Design STP for Trouble Avoidance

- **VTP or Manual Pruning:**
 - Prune any VLAN that you do not need off your trunks.



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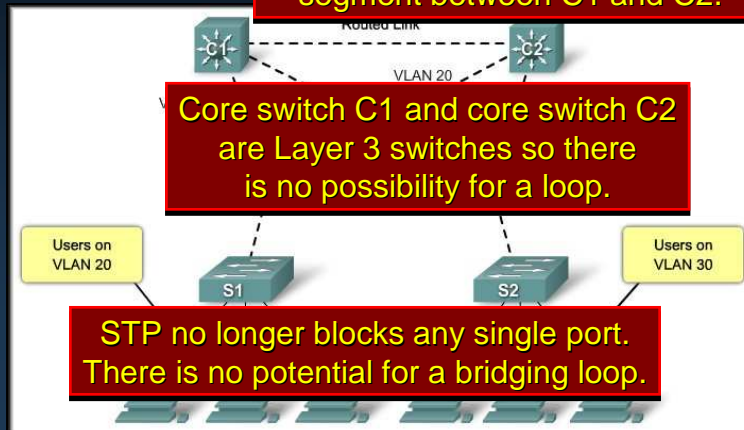
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Design STP for Trouble Avoidance

- Use Layer 3 Switching

- Layer 3 switching is faster than the speed of switching

There is no speed penalty with the routing hop and an additional segment between C1 and C2.



Design STP for Trouble Avoidance

- Final Points:

Keep STP Even If It Is Unnecessary

- Do not disable STP.
- STP is not very processor-intensive.
- The few BPDUs sent on each link do not reduce bandwidth.
- But a bridge network without STP can go down in a fraction of a second.

Keep Traffic off the Administrative VLAN.

- A high rate of broadcast or multicast traffic on the administrative VLAN adversely affects the CPU's ability to process vital BPDUs.
- Keep user traffic off the administrative VLAN.

Do Not Have a Single VLAN Span the Entire Network.

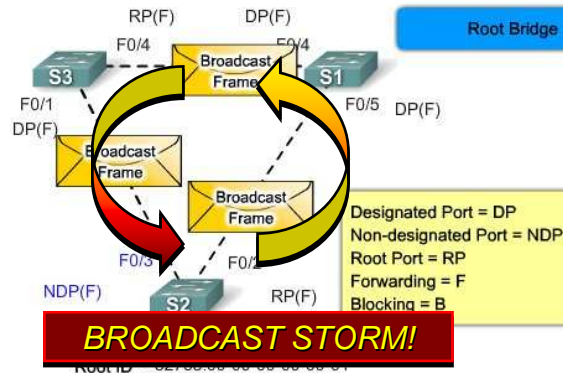
- VLAN 1 serves as an administrative VLAN, where all switches are accessible in the same IP subnet.
- A bridging loop on VLAN 1 affects all trunks and can bring down the network.
- Segment the bridging domains using high-speed Layer 3 switches.

Troubleshoot STP Operation

- **STP Failure:**

Bridge ID = 32768.00-00-00-00-00-02
Root ID = 32768.00-00-00-00-00-01

Bridge ID = 32768.00-00-00-00-00-01
Root ID = 32768.00-00-00-00-00-01

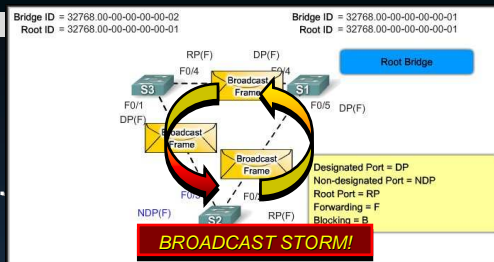


DPs within the age time of 20 seconds.
TRANSITIONS TO THE FORWARDING STATE

Troubleshoot STP Operation

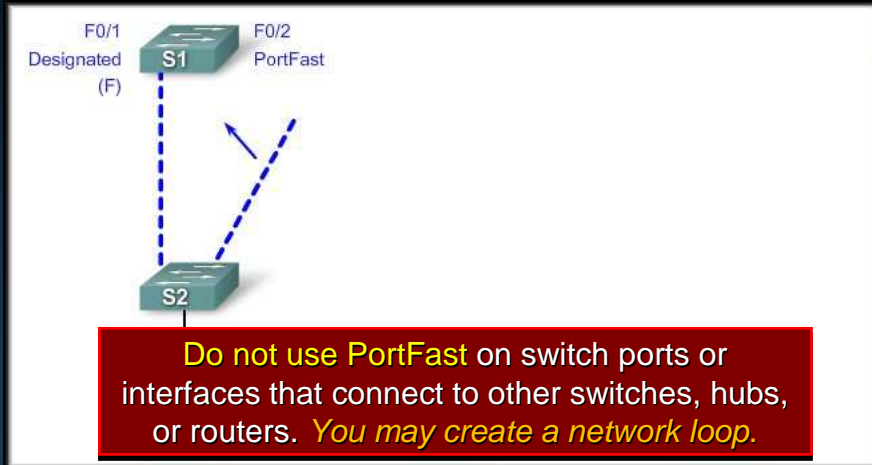
- **STP Failure:**

- Unfortunately, there is no procedure to deal with this type of failure.
- In-band access may not be available during a bridging loop...**console access may be required.**
- Before you can troubleshoot a bridging loop, you need to **know how the network is set up when it works properly.**
 - Topology of the bridge network.
 - Location of the root bridge.
 - Location of the blocked ports and the redundant links.



Troubleshoot STP Operation

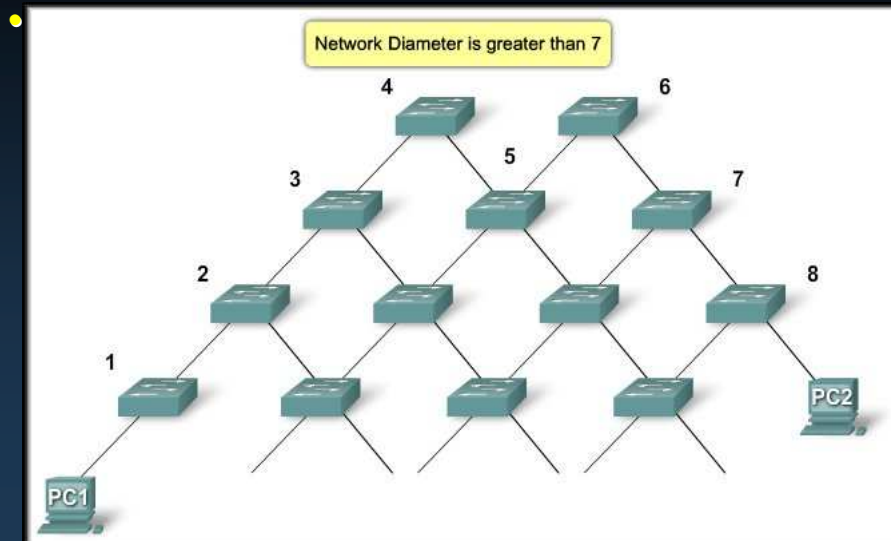
- PortFast Configuration Error:



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Troubleshoot STP Operation



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