Implement Spanning Tree Protocols

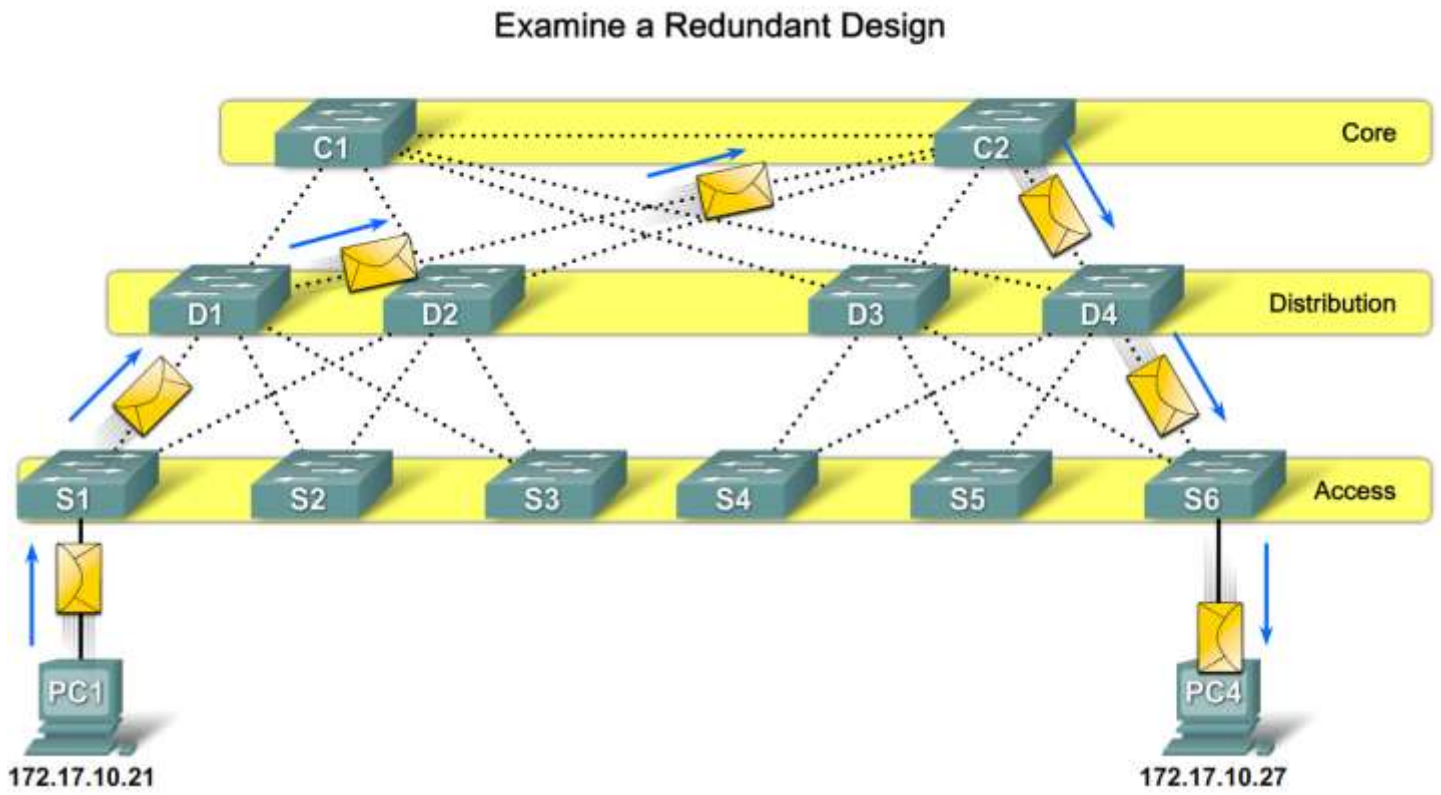
LAN Switching and Wireless – Chapter 5

Objectives

- Explain the role of redundancy in a converged network
- Summarize how STP works to eliminate Layer 2 loops in a converged network
- Explain how the STP algorithm uses three steps to converge on a loop-free topology
- Implement rapid per VLAN spanning tree (rapid PVST+) in a LAN to prevent loops between redundant switches.

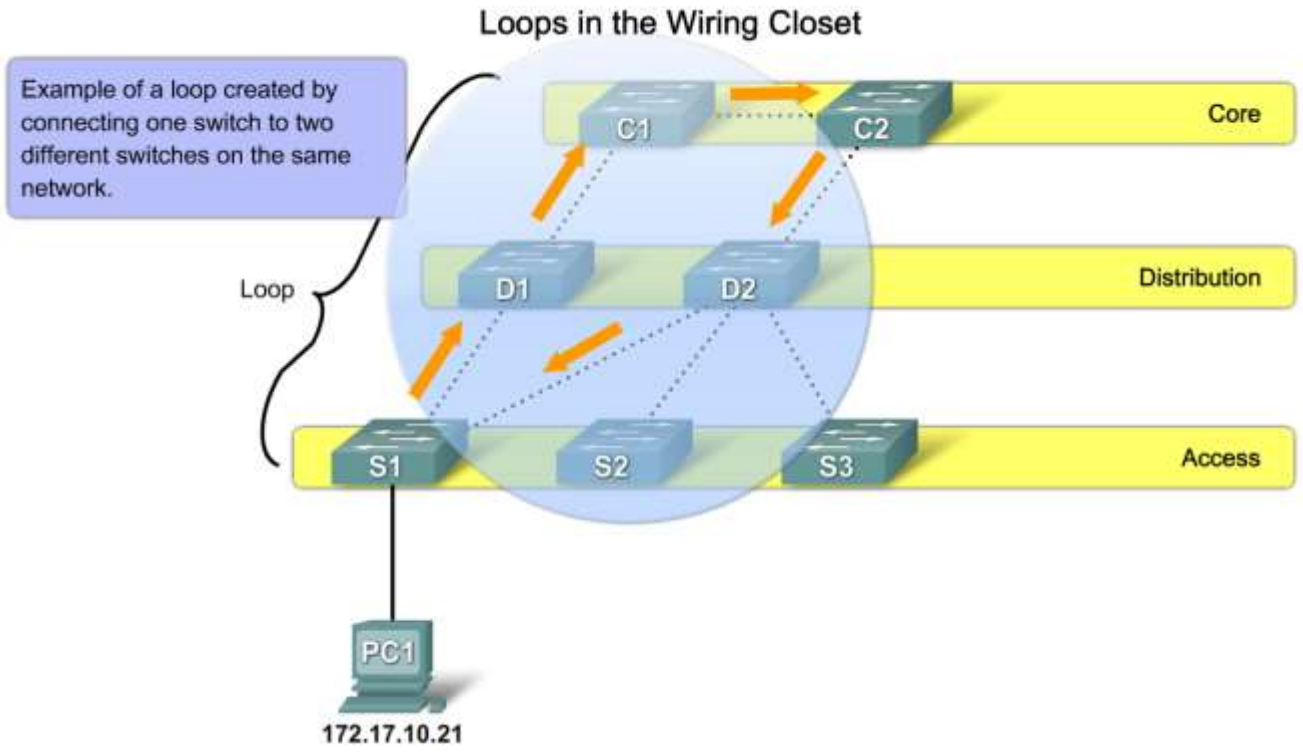
Explain the Role of Redundancy in a Converged Switched Network

- Describe the role redundancy in a hierarchical network



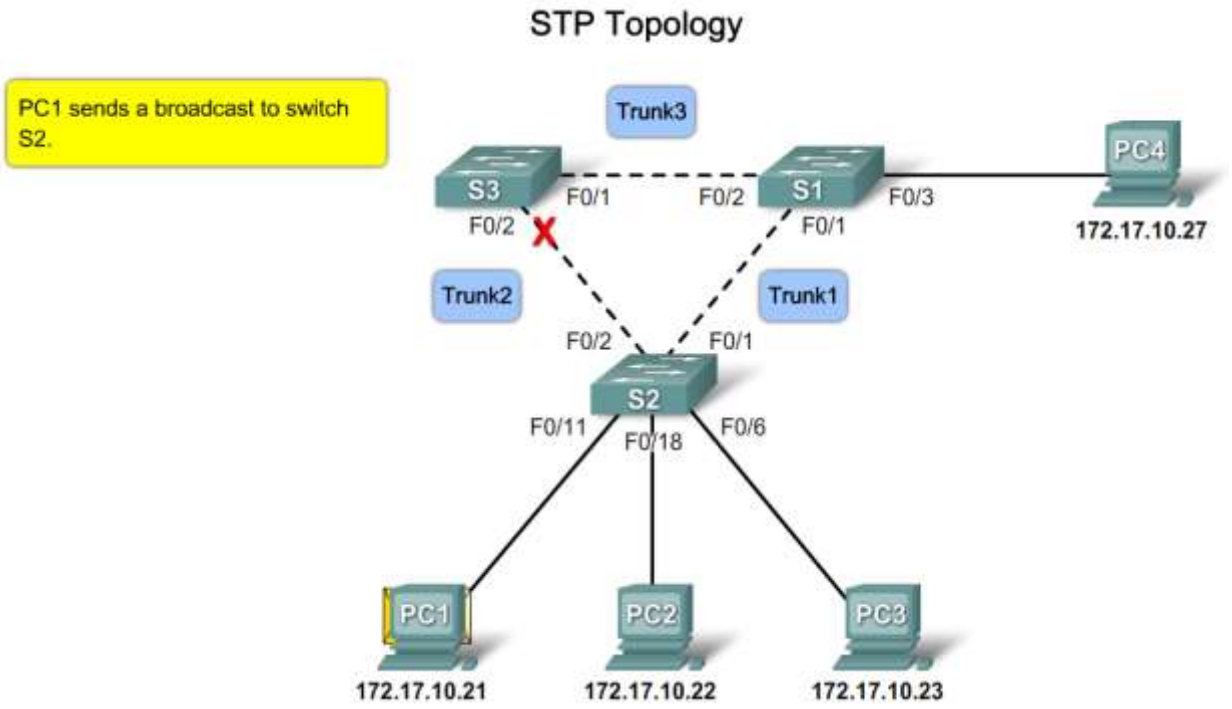
Explain the Role of Redundancy in a Converged Switched Network

- Describe how redundancy can disable a hierarchical network



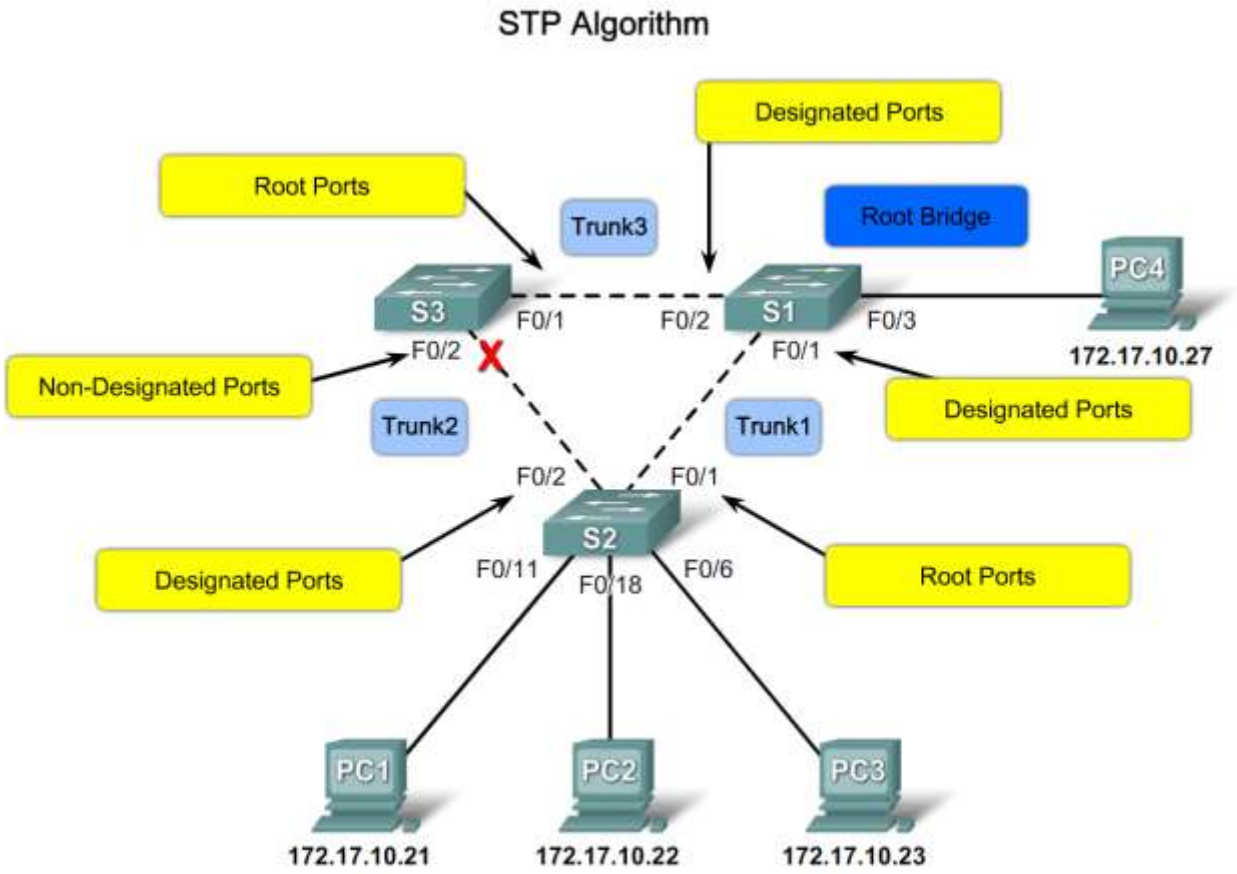
Explain the Role of Redundancy in a Converged Switched Network

- Explain how Layer 2 loops occur in well managed networks



Summarize How STP works to Eliminate Layer 2 Loops in a Converged Network

- Describe the STP algorithm



Summarize How STP works to Eliminate Layer 2 Loops in a Converged Network

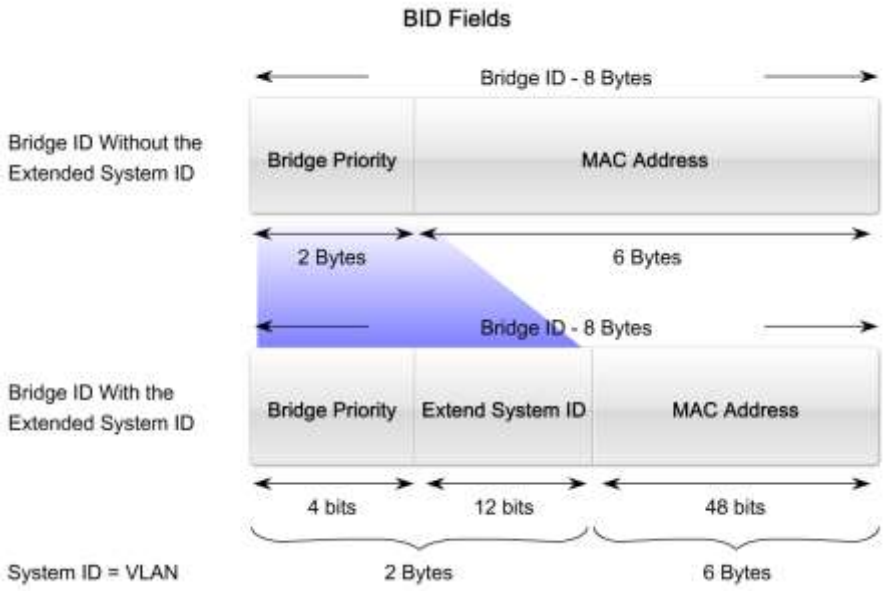
- Explain the role of the BPDU in STP

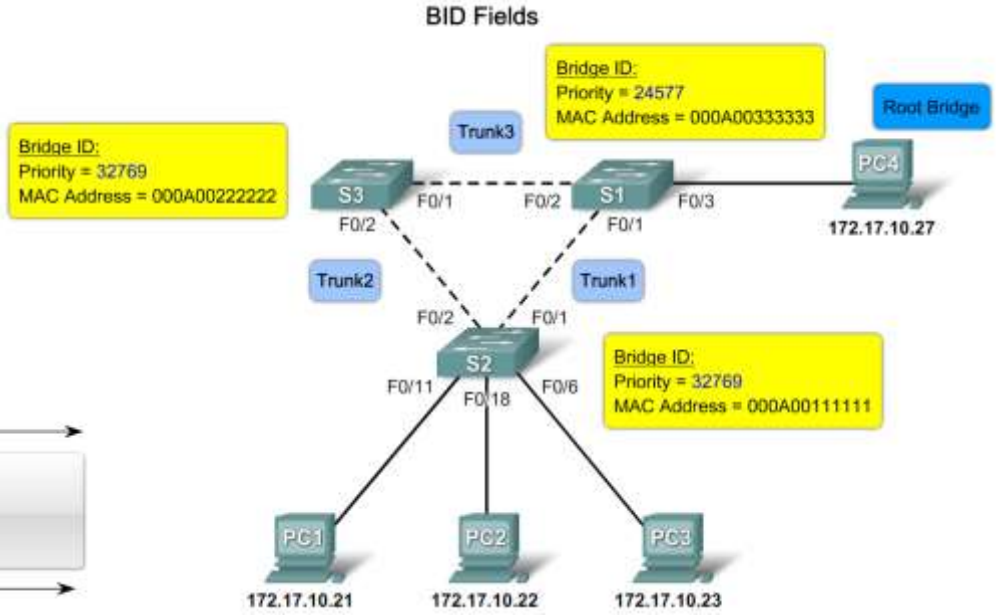
The BPDU Fields

Field #	Bytes	Field
4	2	Protocol ID
	1	Version
	1	Message type
	1	Flags
8	8	Root ID
	4	Cost of path
	8	Bridge ID
	2	Port ID
12	2	Message age
	2	Max age
	2	Hello time
	2	Forward delay

Summarize How STP works to Eliminate Layer 2 Loops in a Converged Network

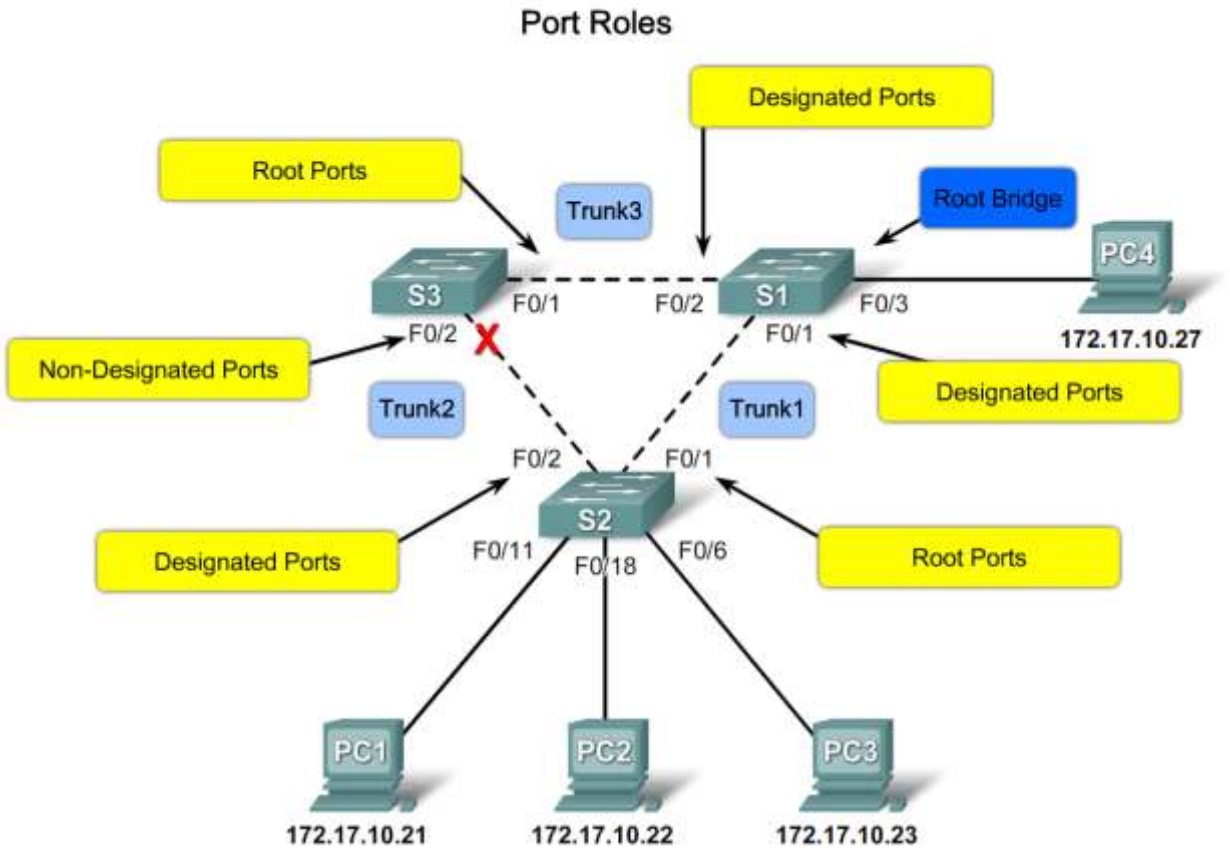
- Explain the role of the BID in STP





Summarize How STP works to Eliminate Layer 2 Loops in a Converged Network

- Describe the how port roles support the operation of STP



Summarize How STP works to Eliminate Layer 2 Loops in a Converged Network

- Describe the role of STP port states and BPDU timers in the operation of STP

Port States

Processes	Blocking	Listening	Learning	Forwarding	Disable
Receives and process BPDUs	✓	✓[1]	✓	✓	✗
Forward data frames received on interface	✗	✗	✗	✓	✗
Forward data frames switched from another interface	✗	✗	✗	✓	✗
Learn MAC addresses	✗	✗	✓	✓	✗

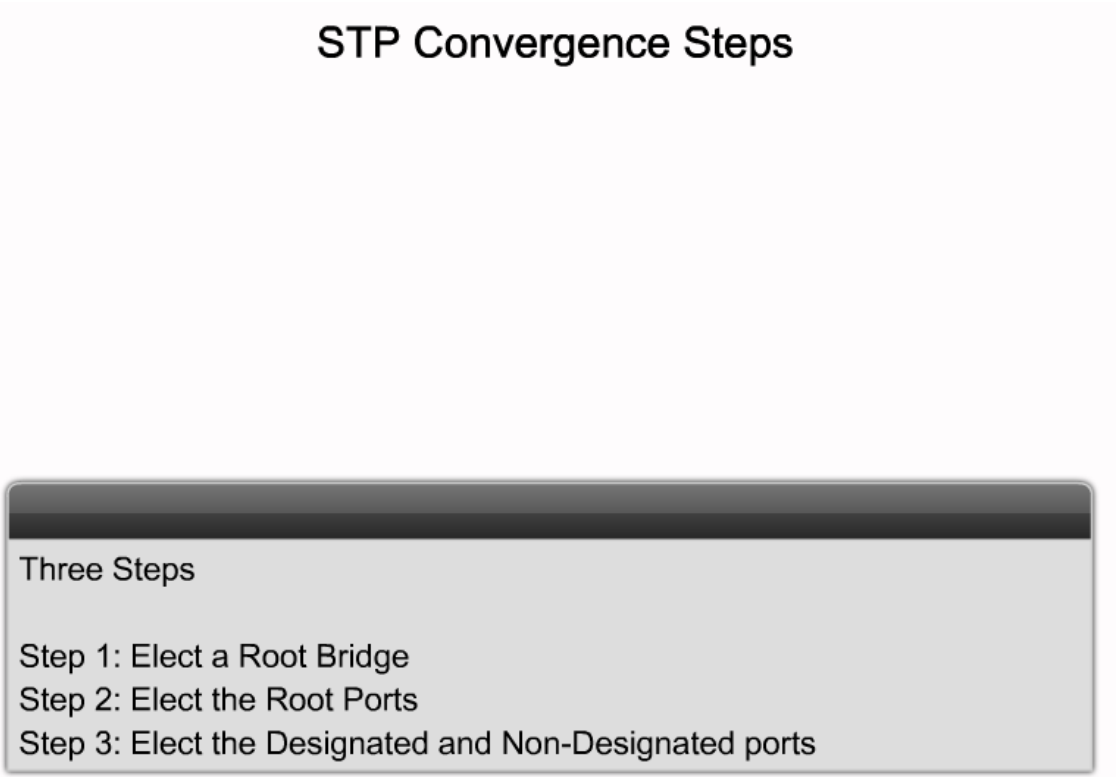
[1]Return to blocking if not lowest cost path to root bridge

BPDU Timers

Hello time	The hello time is the time between each BPDU frame that is sent on a port. This is equal to 2 seconds by default, but can be tuned to be between 1 and 10 seconds.
Forward delay	The forward delay is the time spent in the listening and learning state. This is by default equal to 15 seconds for each state, but can be tuned to be between 4 and 30 seconds.
Maximum age	The max age timer controls the maximum length of time a switch port saves configuration BPDU information. This is 20 seconds by default, but can be tuned to be between 6 and 40 seconds.

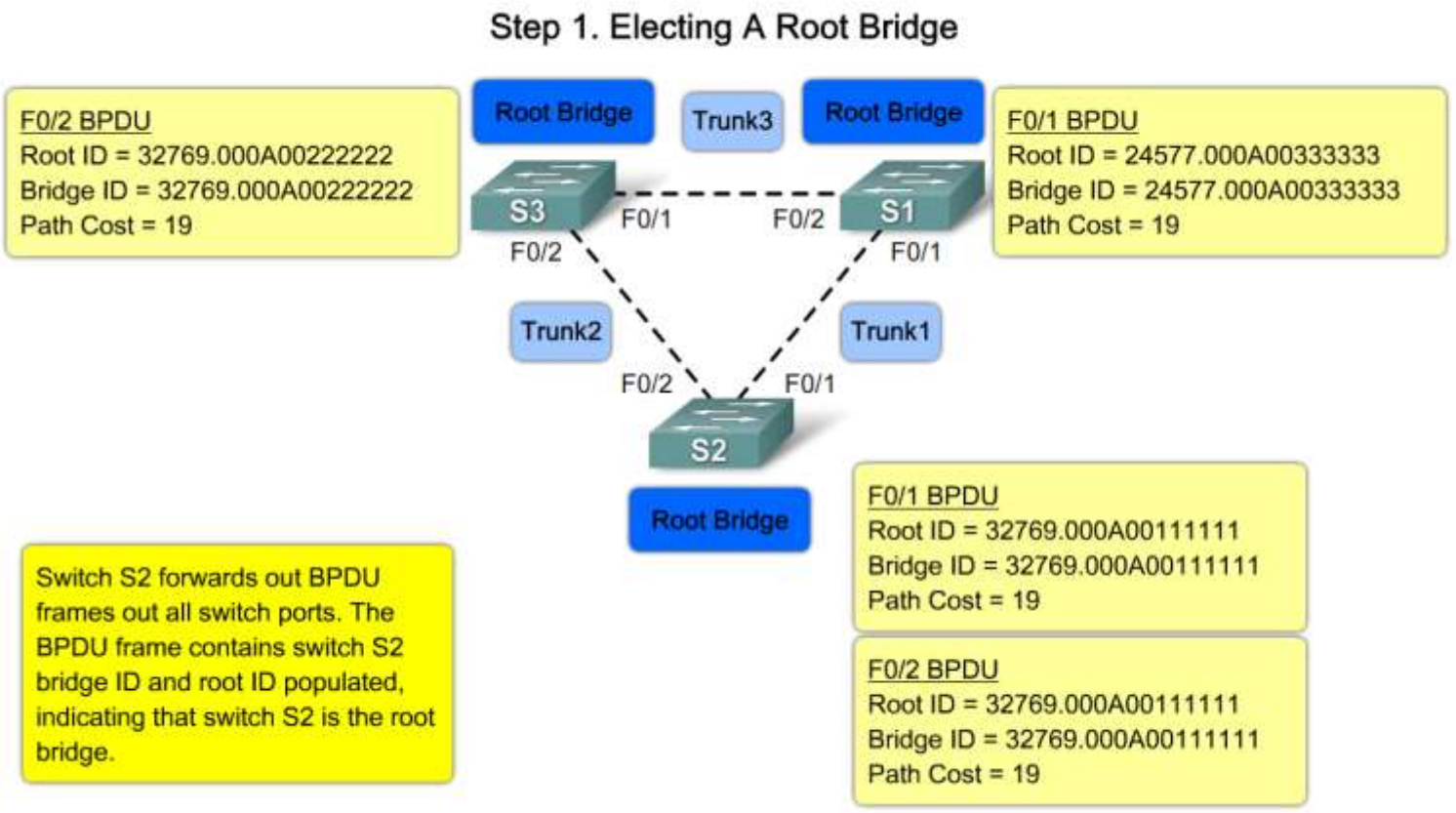
Explain How the STP Algorithm Uses Three Steps to Converge on a Loop-Free Topology

- Define convergence for a switched network and summarize the 3 step process STP uses to create a loop free topology



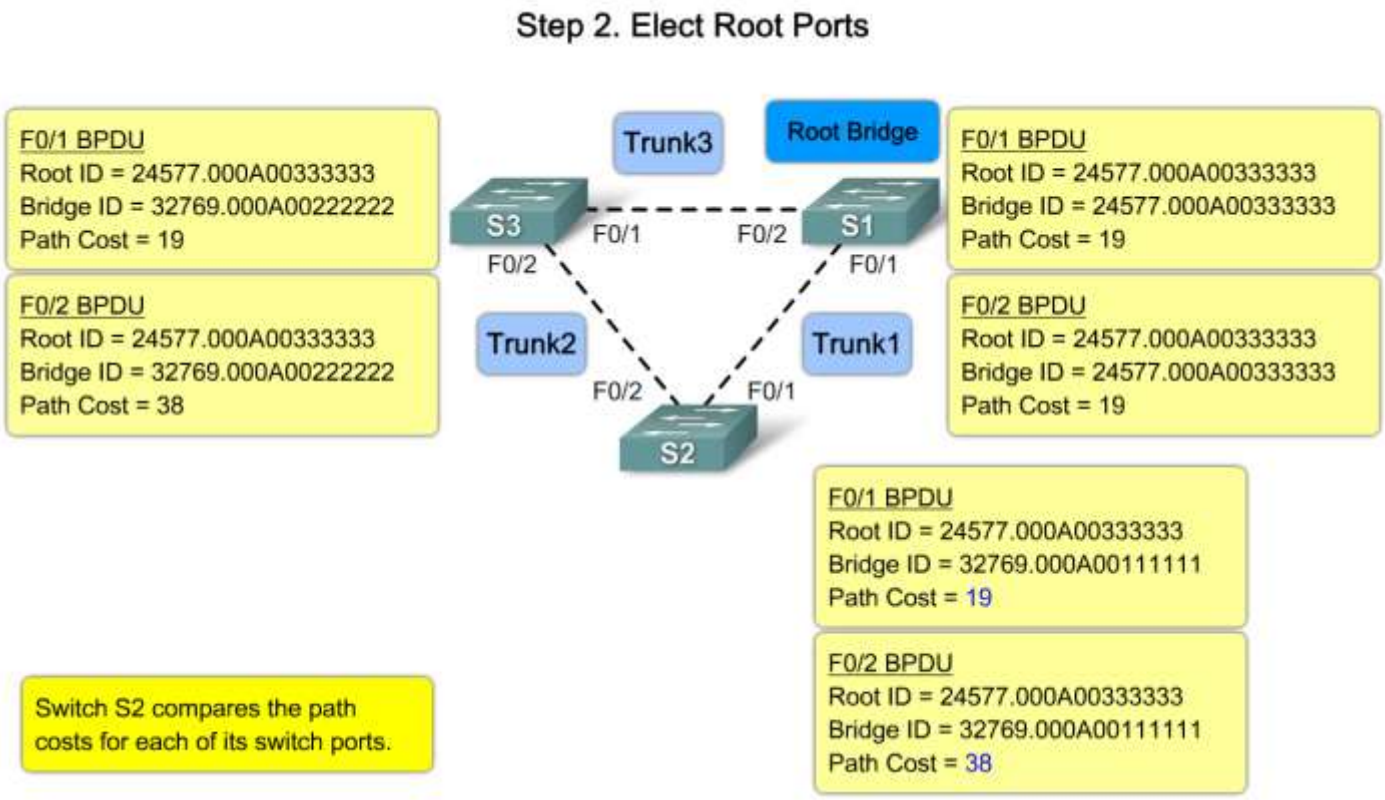
Explain How the STP Algorithm Uses Three Steps to Converge on a Loop-Free Topology

- Explain the STP decision sequence is used to elect a root bridge for a network



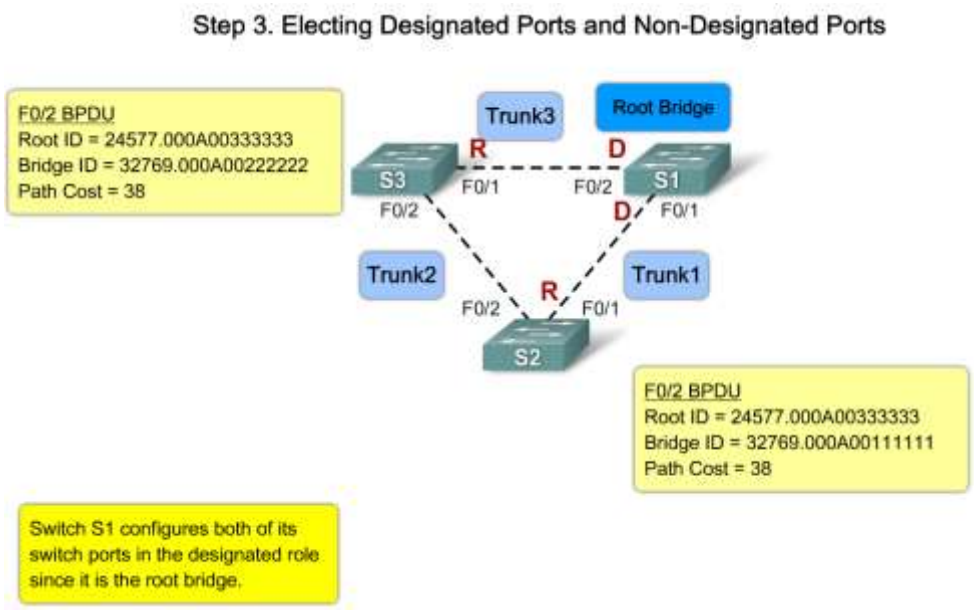
Explain How the STP Algorithm Uses Three Steps to Converge on a Loop-Free Topology

- Describe the process of electing a root port on a switch



Explain How the STP Algorithm Uses Three Steps to Converge on a Loop-Free Topology

- Describe the process of electing designated ports and non-designated ports on a switch



Implement Rapid per VLAN Spanning Tree (rapid PVST+) in a LAN

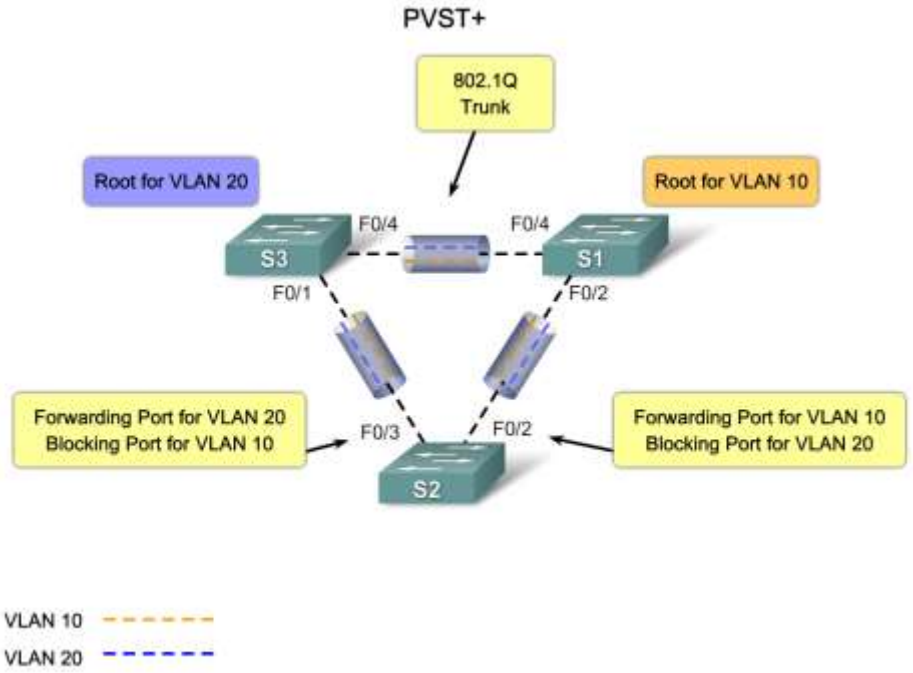
- Summarize the features of the PVST+, RSTP and rapid PVST+ variants of STP

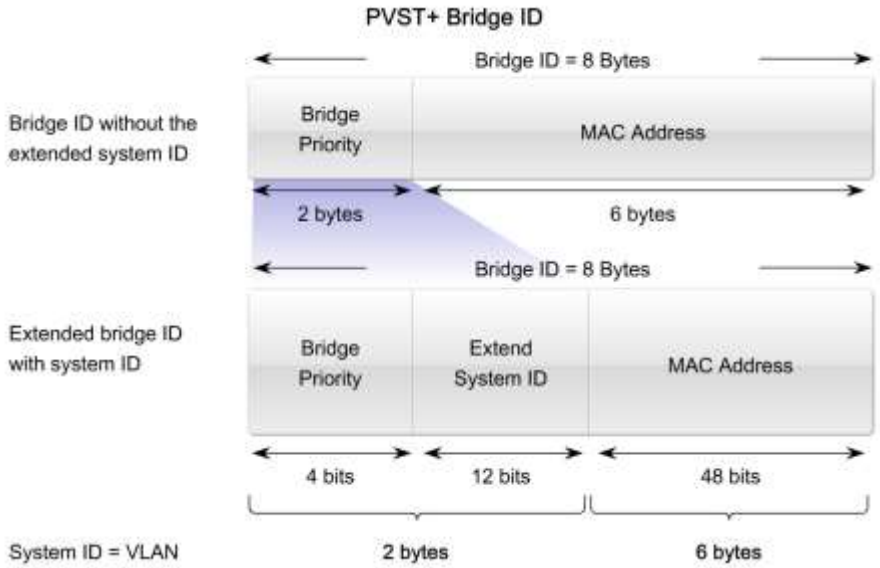
Cisco and STP Variants

Cisco Proprietary	PVST • 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+ • Supports ISL and IEEE 802.1Q trunking • Supports Cisco proprietary STP extensions • Adds BPDU guard and Root guard enhancements
	rapid-PVST+ • Based on IEEE802.1w standard • Has faster convergence than 802.1D
IEEE Standard	RSTP • 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 • 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

Implement Rapid per VLAN Spanning Tree (rapid PVST+) in a LAN

- Describe the features of PVST+





Implement Rapid per VLAN Spanning Tree (rapid PVST+) in a LAN

- Describe the features of RSTP

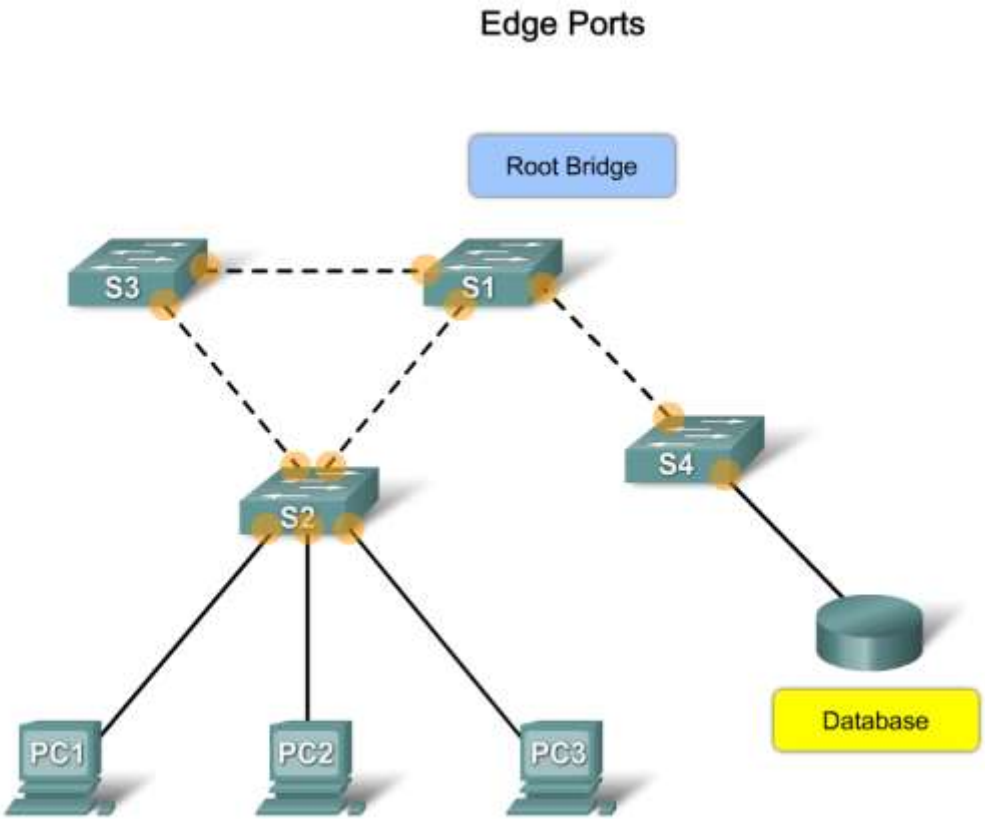
What is RSTP?

Characteristics of RSTP:

- Is the preferred protocol for preventing Layer 2 loops in a switched network
- Transparently integrates Cisco-proprietary enhancements
- Performs better than the Cisco-proprietary enhancements
- Not compatible with Cisco-proprietary enhancements
- Defines different port states and port roles
- Is backward compatible with 802.1D
- Has kept most configuration parameters unchanged
- Has the same BPDU format as the IEEE 802.1D BPDU
- Does not need 802.1D timers

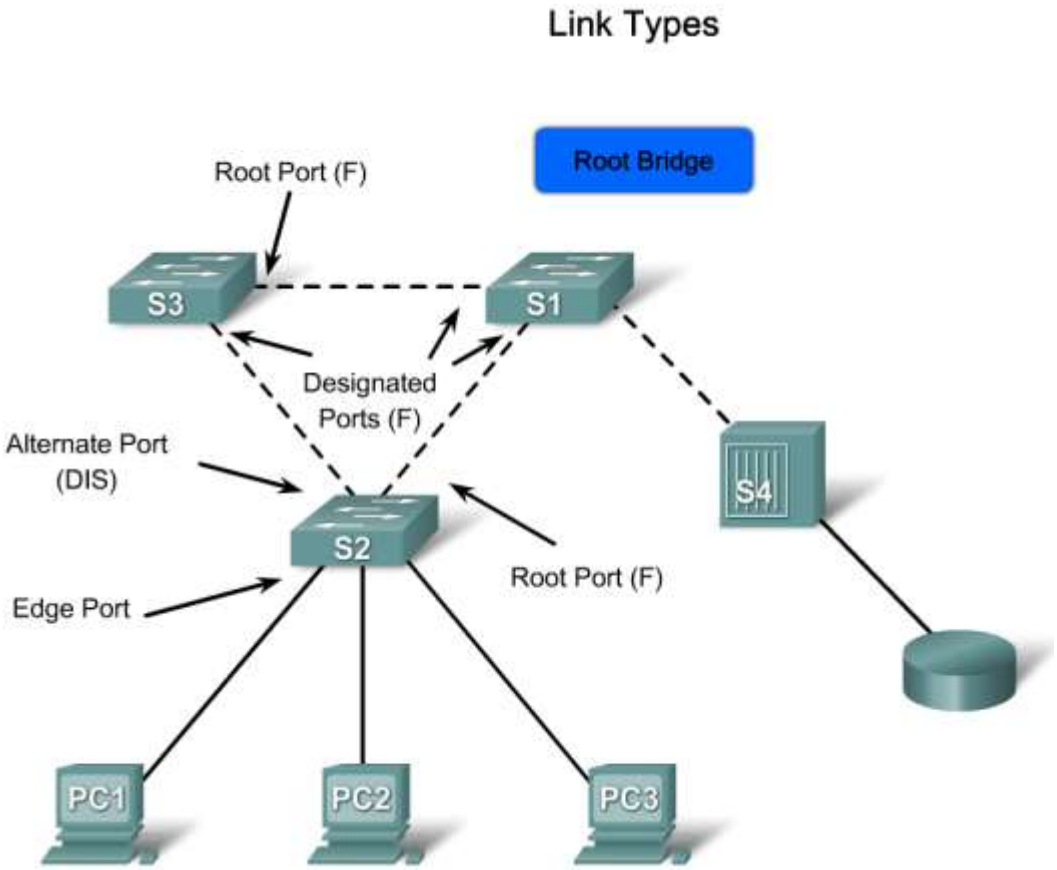
Implement Rapid per VLAN Spanning Tree (rapid PVST+) in a LAN

- Describe RSTP edge ports



Implement Rapid per VLAN Spanning Tree (rapid PVST+) in a LAN

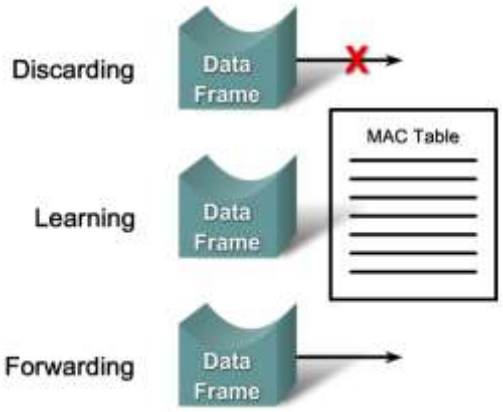
- Describe the RSTP link types



Implement Rapid per VLAN Spanning Tree (rapid PVST+) in a LAN

- Describe the RSTP port states and port roles

RSTP Port States



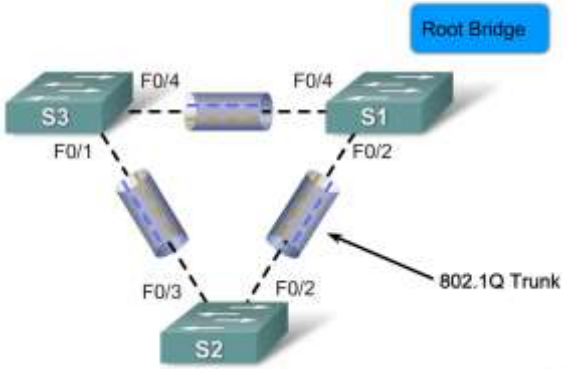
RSTP Port States

Port State	Action
Discarding	This state is seen in both a stable active topology and during topology synchronization and changes. The discarding state prevents the forwarding of data frames, thus "breaking" the continuity of a layer 2 loop.
Learning	This state is seen in both a stable active topology and during topology synchronization and changes. The learning state accepts data frames to populate the MAC table in an effort to limit flooding of unknown unicast frames.
Forwarding	This state is seen only in stable active topologies. The forwarding switch ports determine the topology. Following a topology change, or during synchronization, the forwarding of data frames occurs only after a proposal and agreement process.

Implement Rapid per VLAN Spanning Tree (rapid PVST+) in a LAN

- Describe how to configure rapid PVST+

Configure rapid-PVST+



Cisco IOS Command Syntax	
Enter global configuration mode.	`configure terminal`
Configure rapid PVST+ spanning-tree mode.	`spanning-tree mode rapid-pvst`
Specify an interface to configure, and enter interface configuration mode. The VLAN ID range is 1 to 4094. The port-channel range is 1 to 6.	`interface`
Specify that the link type for this port is point-to-point.	`spanning-tree link-type point-to-point`
Return to privileged EXEC mode.	`end`
Clear all detected STP.	`clear spanning-tree detected-protocols`

Implement Rapid per VLAN Spanning Tree (rapid PVST+) in a LAN

- Describe how to design STP to avoid problems

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 effects 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.

Implement Rapid per VLAN Spanning Tree (rapid PVST+) in a LAN

- Describe how to identify and solve the key STP configuration issues

Troubleshoot a Failure

To troubleshoot a bridging loop, you need to know:

- The topology of the bridge network
- The location of the root bridge
- The location of the blocked ports and the redundant links

Summary

- Spanning Tree Protocol (STP) is used to prevent loops from being formed on redundant networks
- STP uses different port states & timers to logically prevent loops
- There is at least one switch in a network that serves as the root bridge

  Root bridge is elected using information found in BPDU frames
- Root ports are determined by the spanning tree algorithm and are closest to the root bridge

Summary

- STP lengthy convergence time (50 seconds) facilitated the development of:

  RSTP

  convergence time is slightly over 6 seconds

  Rapid PVST+

  adds VLAN support to RSTP

  is the preferred spanning-tree protocol on a Cisco switch

  netowrk