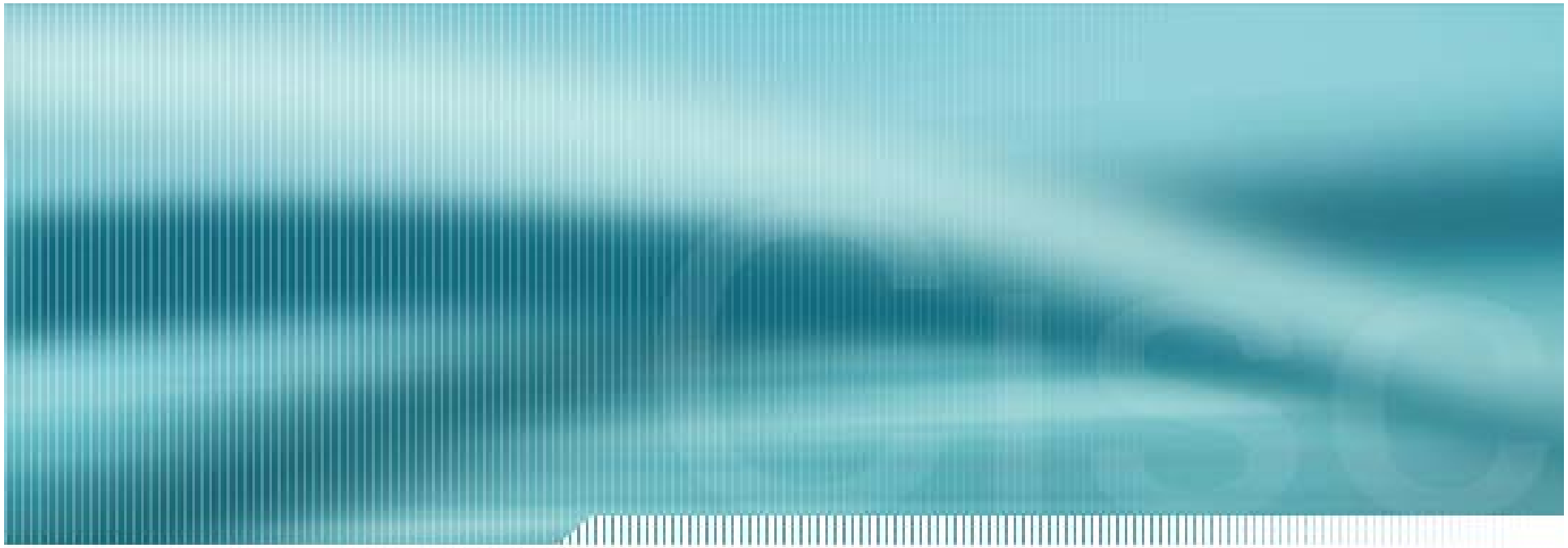

Spanning-Tree Protocol

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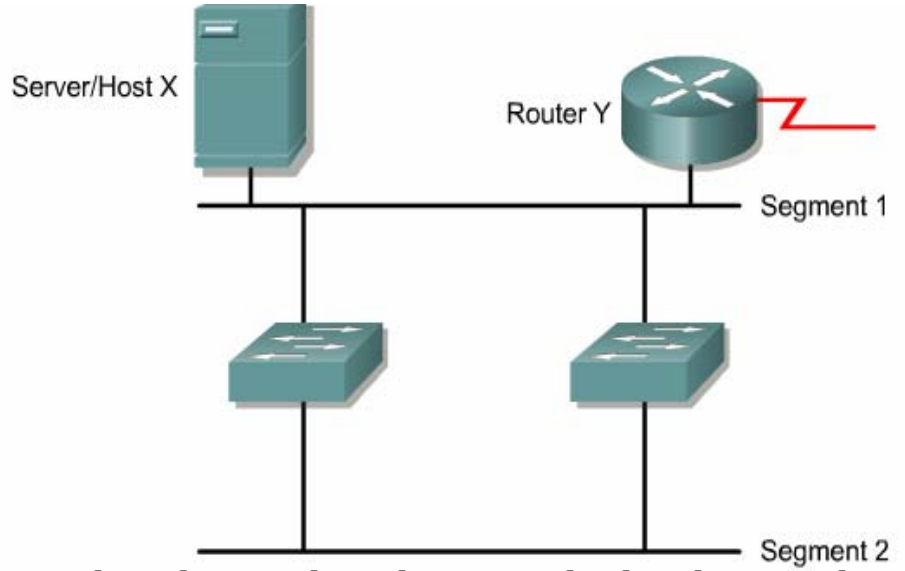
Objectives

- **Redundancy in a converged network**
- **Spanning-Tree Protocol (STP)**
- **STP Operation**
- **Extensions to STP**

Redundant Topologies

- Layer 2 redundancy improves the availability
- Implementing alternate paths by adding equipment and cabling
- Goal to eliminate network outages caused by a single point of failure
- All networks need redundancy for enhanced reliability

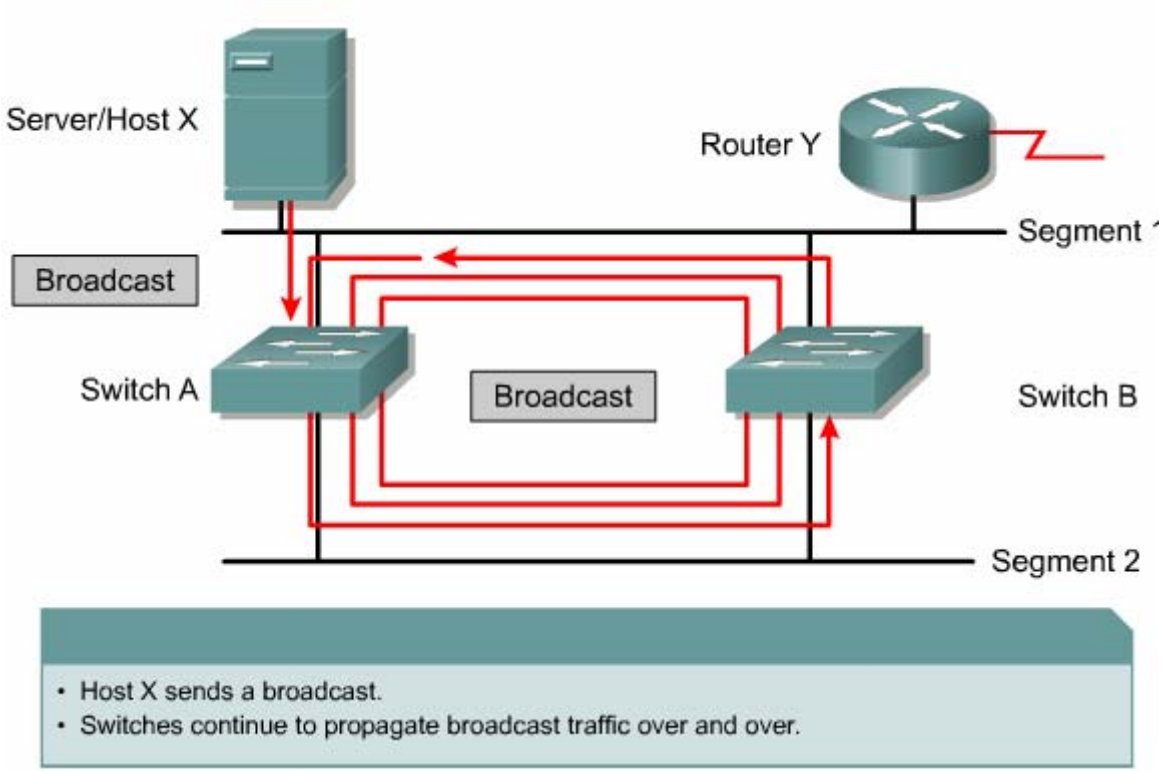


Simple Redundant Switched Topology

Issues with Redundancy

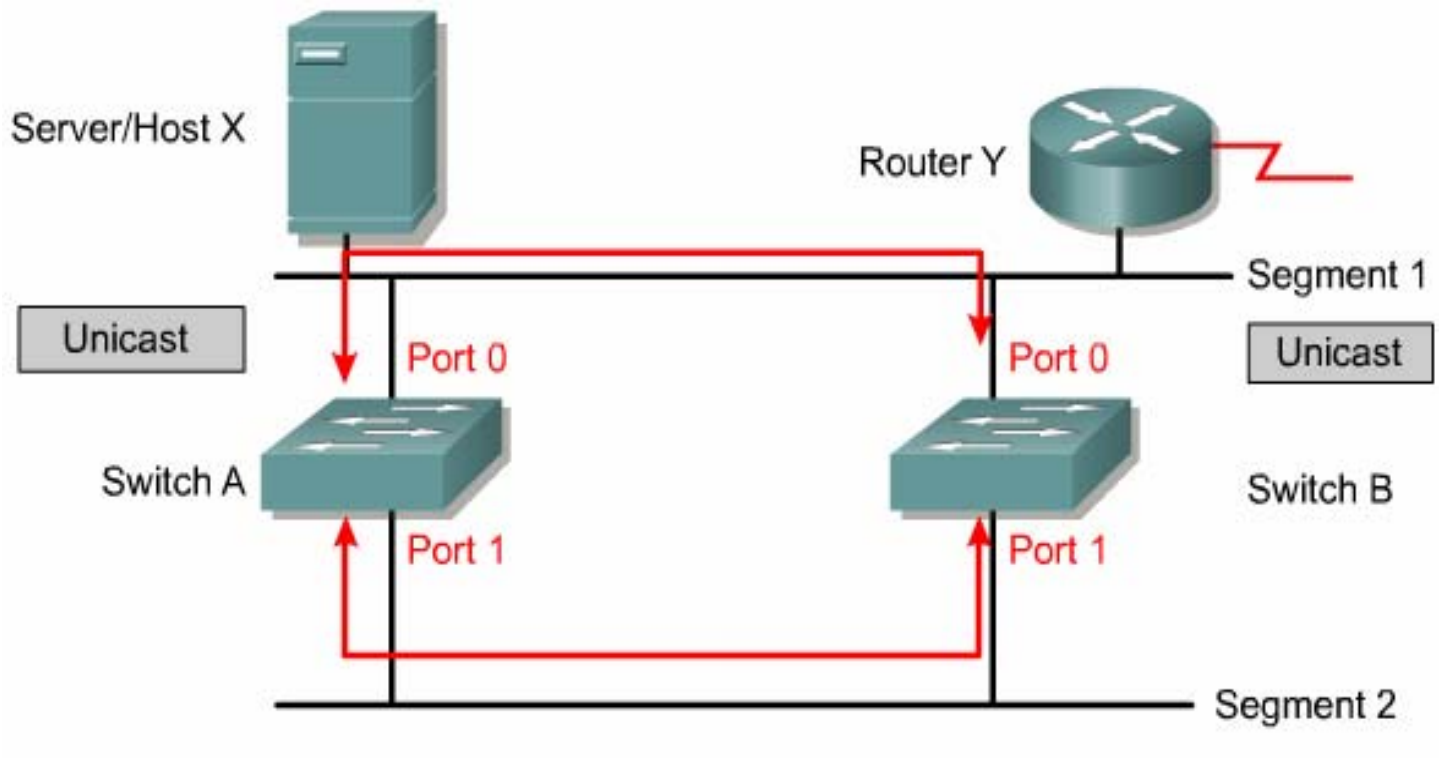
- **Layer 2 loops**
- **Broadcast storms**
- **Duplicate unicast frames**
- **MAC database instability**

Redundant Topologies



- **Layer 2 loops**
- **Broadcast storm**

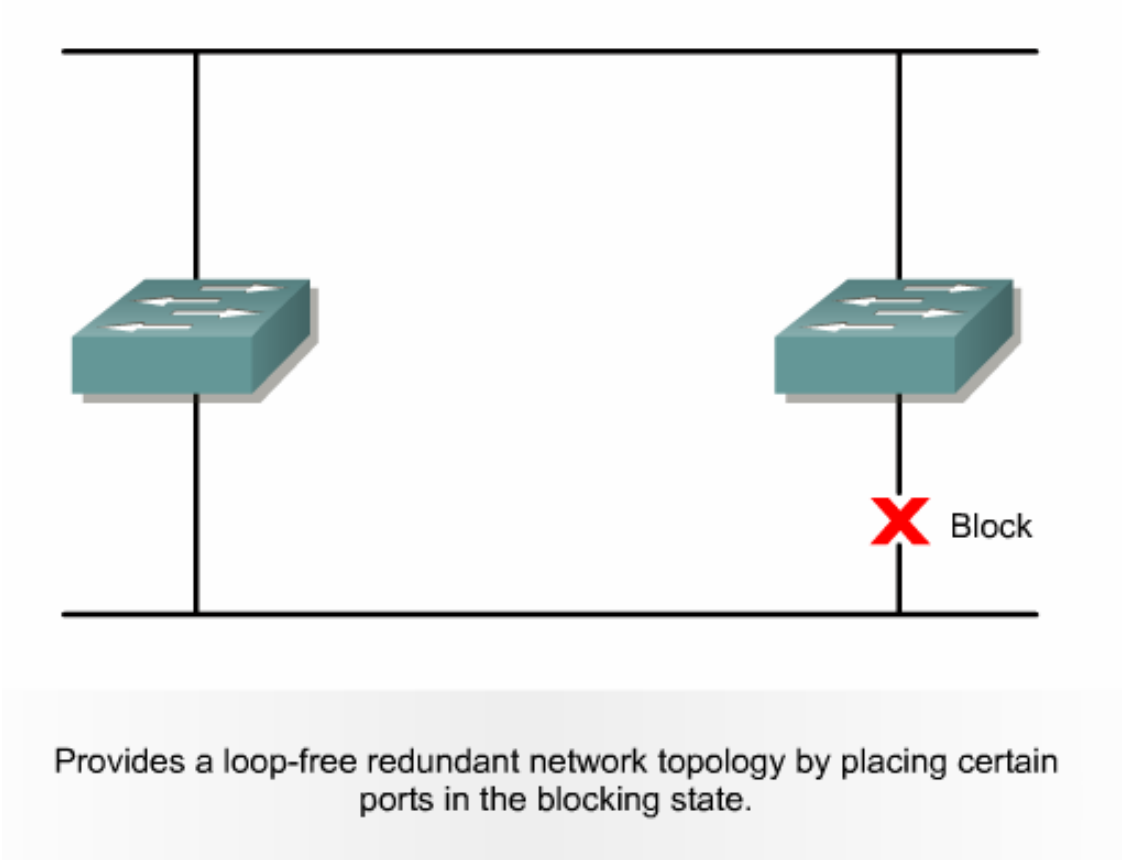
Redundant Topologies



- **Duplicate unicast frames**
- **MAC Database Instability**

Spanning-Tree Protocol (STP)

- **Can be used to reduce switching loops, but still have redundancy in the network**



STP Algorithm (STA)

- Used to determine which switch ports needs to be blocked
- One single switch is elected as the root bridge, used as a reference point for the path calculations
- STA calculates the shortest path to the root bridge
- STA chooses the path with the lowest path cost, and the switch ports will be configured with different roles

Port Roles

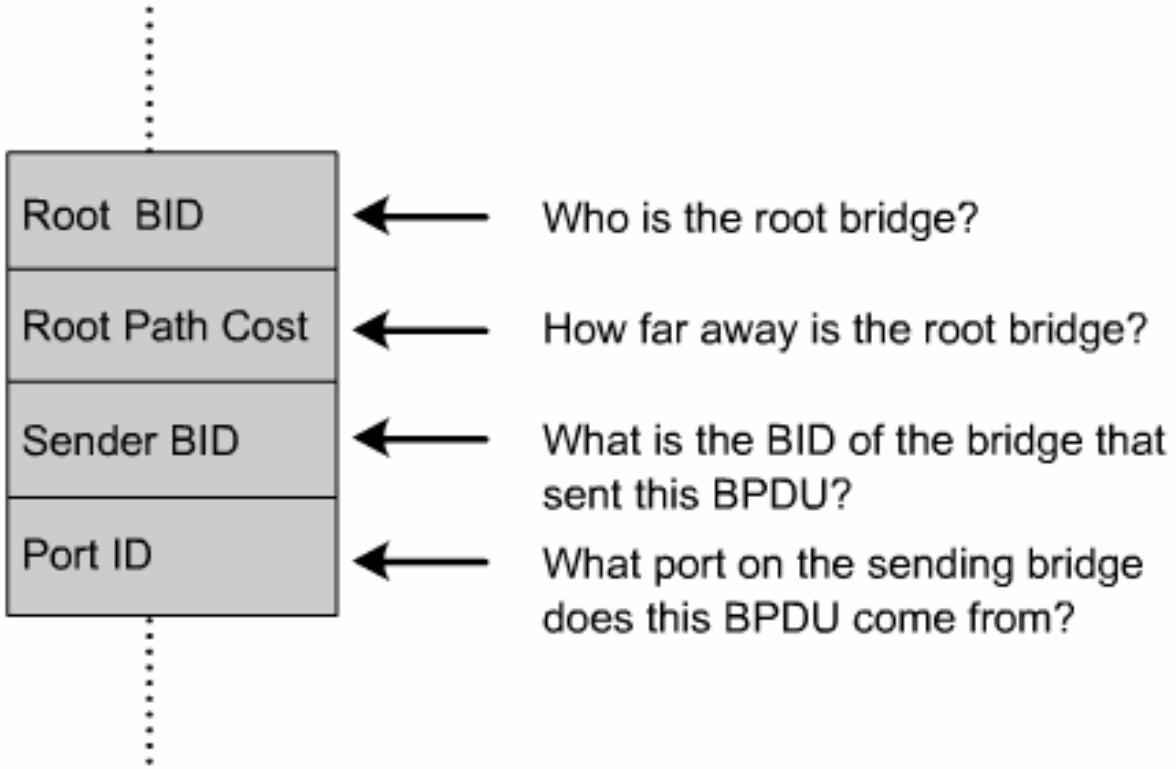
- **Root port**
  - **Switch port closest to the root bridge**
- **Designated port**
  - **All non-root ports that are still permitted to forward traffic**
- **Non-designated port**
  - **All ports configured to be in blocking state to prevent loops**

Spanning-Tree Operation

- **Electing a root bridge**
- **Selecting the root port on the non-root bridges**
- **Selecting the designated port on each segment**

How do the switches do this election?

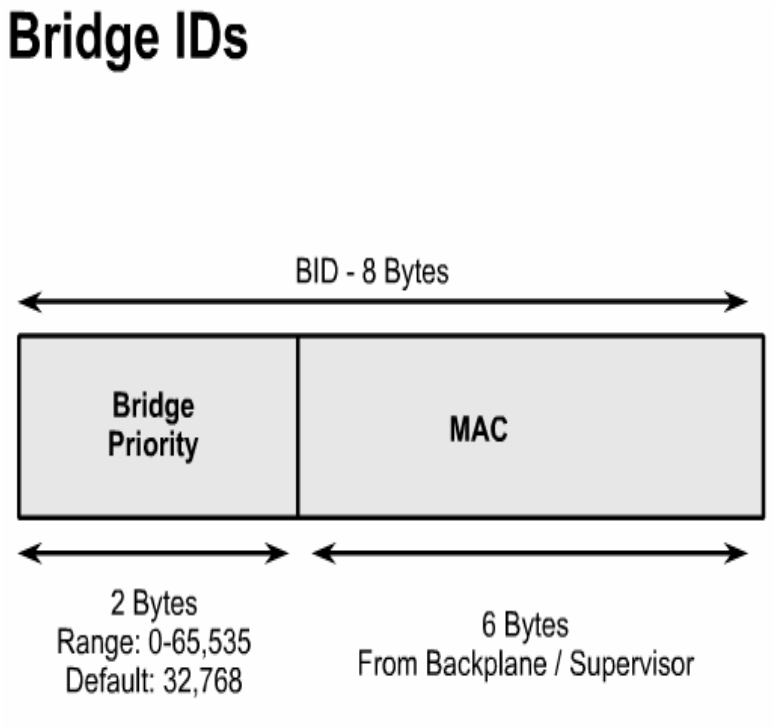
Bridge PDU (Protocol Data Unit)



Each switch in the broadcast domain initially assumes that it is the root bridge

Bridge ID

- **Lower BID values are preferred**
- **Default priority = 32768**

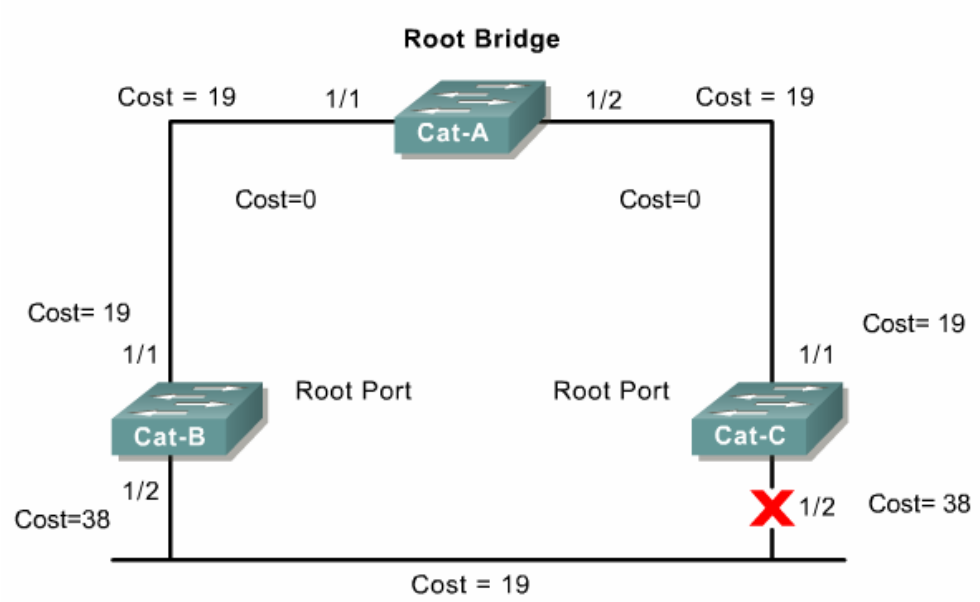


BPDU Process

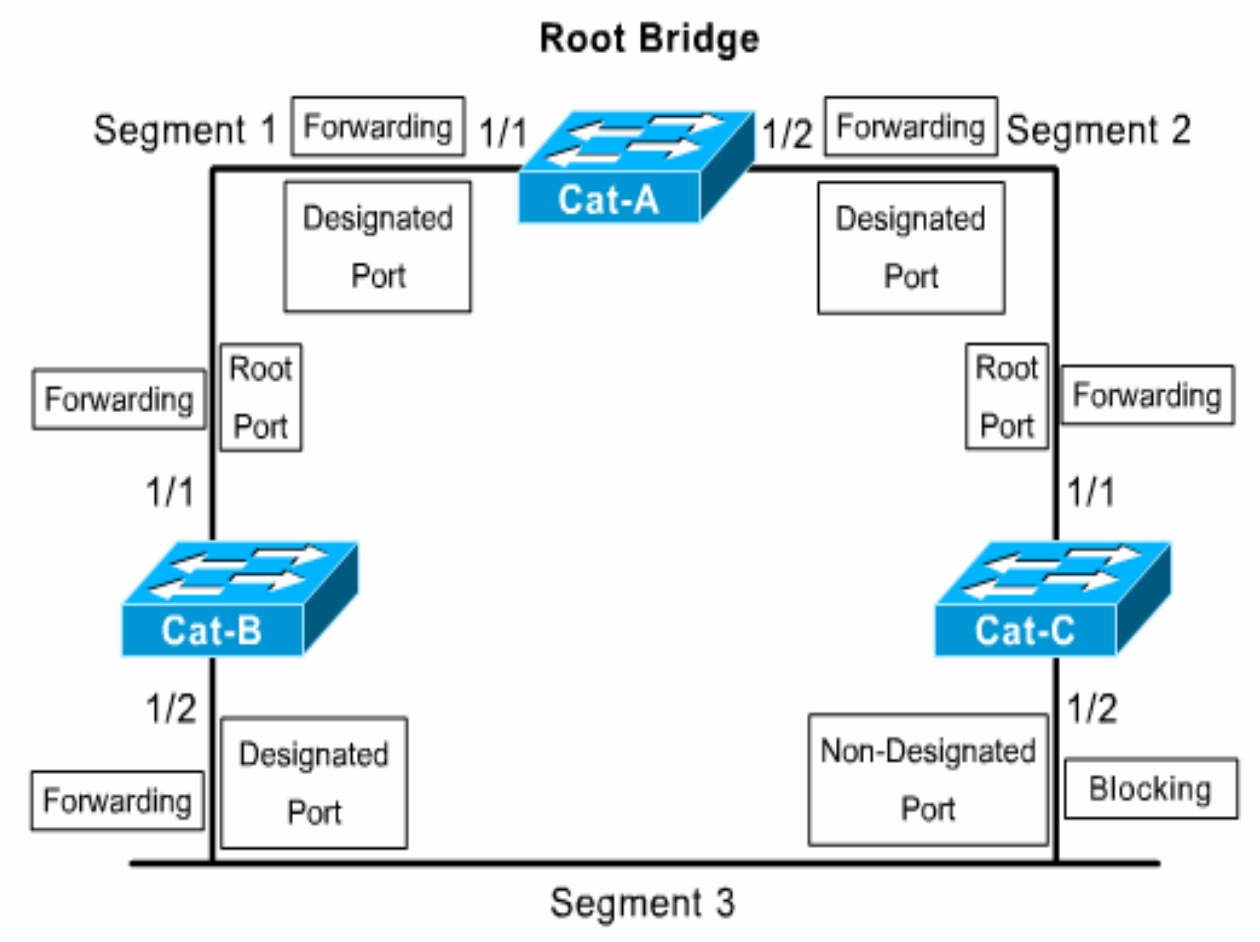
- **Electing a root bridge**
  - **BPDUs are sent in the broadcast domain**
  - **Compare Bridge IDs**
- **One root port is elected on each switch**
  - **Compares the path costs on all switch ports**
  - **Lowest overall path cost to the root is automatically assigned the root port role**
- **Assign designated and non-designated ports**
  - **All switch ports in the root bridge will be designated**
  - **Two switches connected to the same segment sends BPDUs, and the lowest will become designated**

Spanning-Tree Operation

- One Root Bridge per network
- One Root Port per non-root bridge
- One Designated port per segment
- Non-designated ports are unused



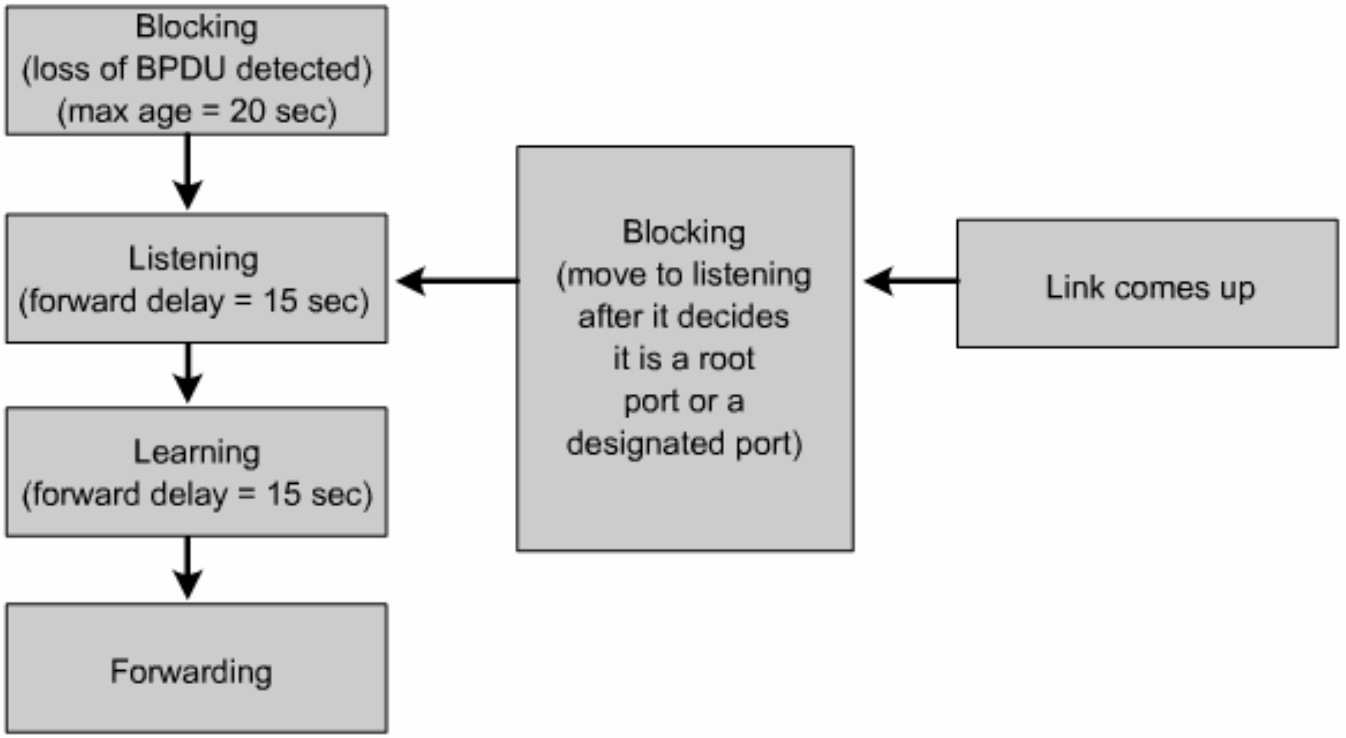
Spanning-Tree Operation



Spanning-Tree Port States

State	Purpose
Forwarding	Sending / receiving user data
Learning	Building bridging table
Listening	Building "active" topology
Blocking	Receives BPDUs only
Disabled	Administratively down

Spanning-Tree Port States



Spanning tree transits each port through several different states.

PortFast technology

- Cisco technology
- The port transitions from blocking to forwarding state immediately, bypassing the listening and learning states
- The purpose is to minimize the time that access ports must wait for spanning-tree to converge
- Can only be used on access ports connected to a single workstation or server, otherwise a loop can be created

Cisco Proprietary Extensions of STP

- **Per-VLAN Spanning-Tree Protocol (PVST)**
  - **Maintains a spanning-tree instance for each VLAN configured in the network**
  - **Uses ISL trunking protocol**
- **PVST+**
  - **Same as PVST, but supports IEEE 802.1Q trunking**
- **Rapid PVST+**
  - **Faster convergence than STP**

IEEE Standard Extensions of STP

- **Rapid STP (RSTP)**
  - **Provides faster convergence after a topology change**
  - **Redefines the port states, and an alternate or backup port can immediately change to forwaring port**
- **Multiple STP (MSTP)**
  - **Multiple VLANs can be mapped to the same spanning-tree instance**
  - **Reduces the number of instances needed to support a large number of VLANs**

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**