LAN Switching Basics
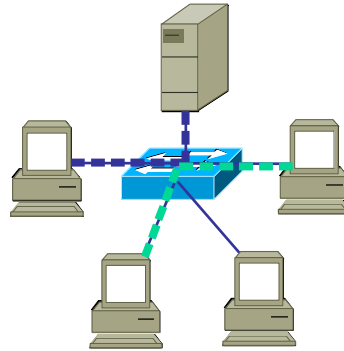
- Enables dedicated access
- Eliminates collisions and increases capacity
- Supports multiple conversations at the same time

LAN Switch Operation

- Forwards packets based on a forwarding table
  - Forwards based on the MAC (Layer 2) address
- Operates at OSI Layer 2
- Learns a station's location by examining source address
  - Sends out all ports when destination address is broadcast, multicast, or unknown address
  - Forwards when destination is located on different interface

10 Mbps

A   C

3   2   1

Data from B to A   **10 Mbps**

4

B

Interface

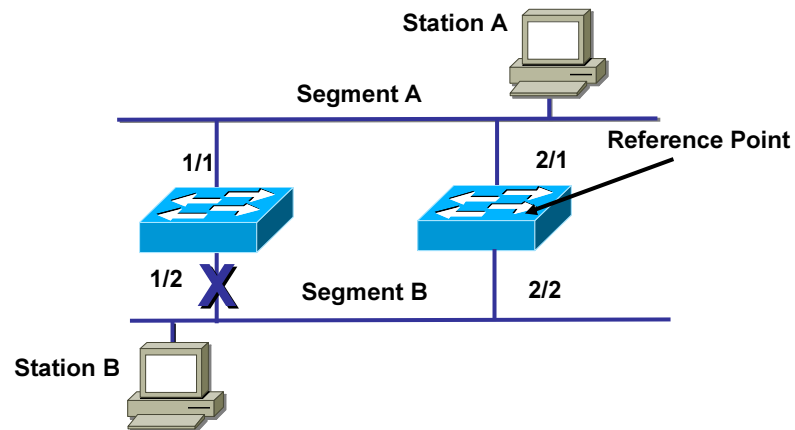| Stations	1	2	3	4
A			X	
B				X
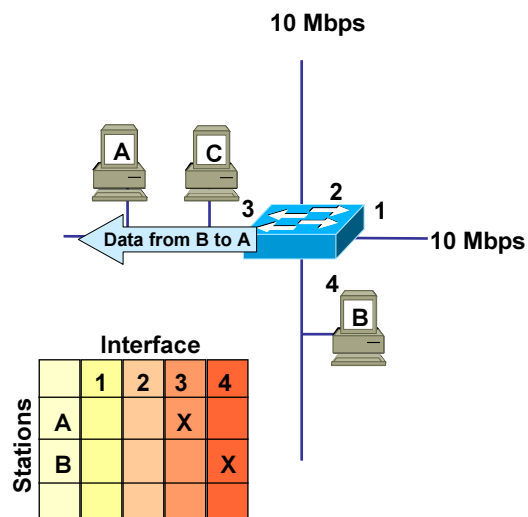
Ensuring Network Availability
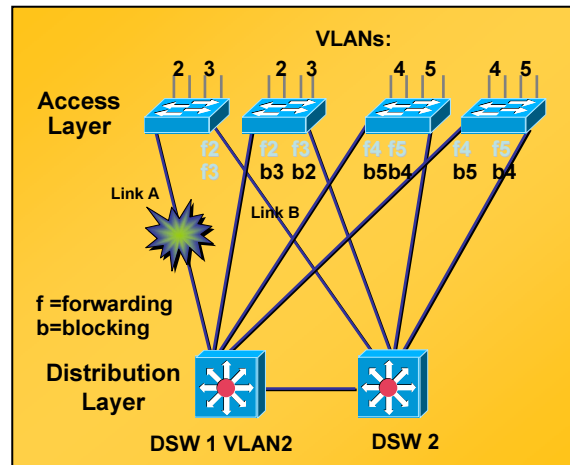
What Is a Bridging Loop?
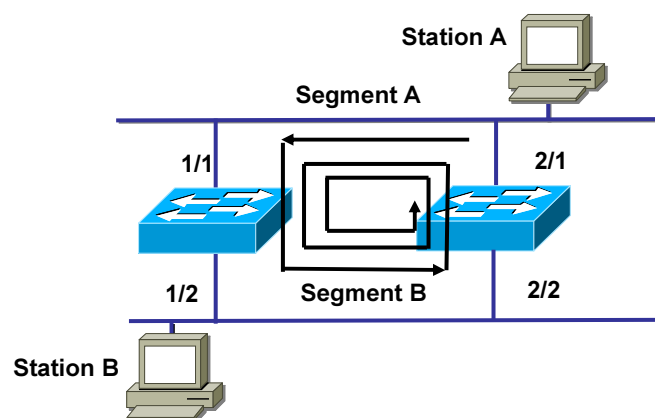
- **Bridging loops occur any time there is a redundant path or loop in the bridge network**

Preventing Bridging Loops

Station A

Segment A

1/1   **2/1**   **Reference Point**

1/2   **Segment B**   **2/2**

Station B

- **Bridging loops can be prevented by disabling the redundant path**

Bridge Protocol Data Unit (BPDU)

Bytes	Field
2	Protocol ID
1	Version
1	Message Type
1	Flags
8	Root ID
4	Cost of Path
8	Bridge ID
2	Port ID
2	Message Age
2	Maximum Time
2	Hello Time
2	Forward Delay

The BPDU is responsible for:
- **Electing a root bridge**
- **Determining location of loops**
- **Blocking to prevent loops**
- **Notifying network of changes**
- **Monitoring state of the spanning tree**

Calculating Path Cost

Switch A — 100 — **Root** — 100 — **Switch C**

Cost to the Root from Switch D is 20
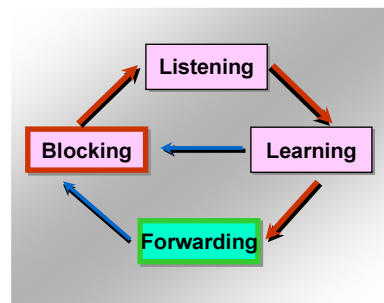
10

10

Switch D — **Switch B**
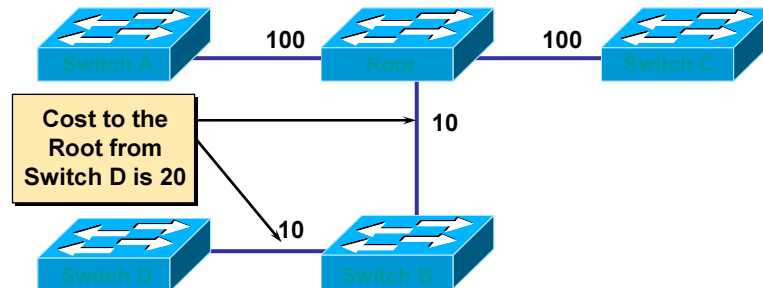
- **Path cost is a function of bandwidth of each path**
- **Can be changed by a switch port cost parameter**
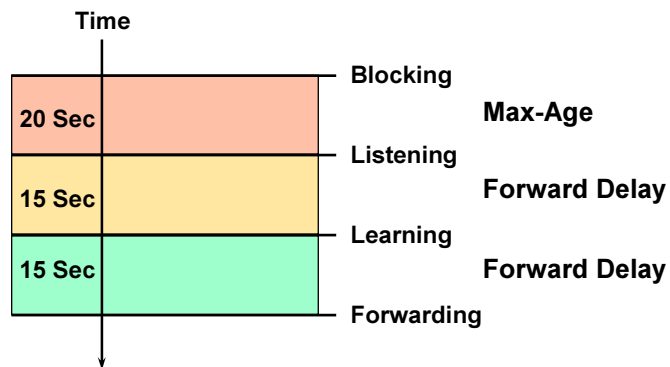- **Is determined by the sum of path costs between source and destination**

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STP Port States

- **Blocking**
- **Listening**
- **Learning**
- **Forwarding**
- **Disabled (off)**

Listening

Blocking → Learning

Forwarding

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VLAN STP Timer Operation
Using Default Values

Time

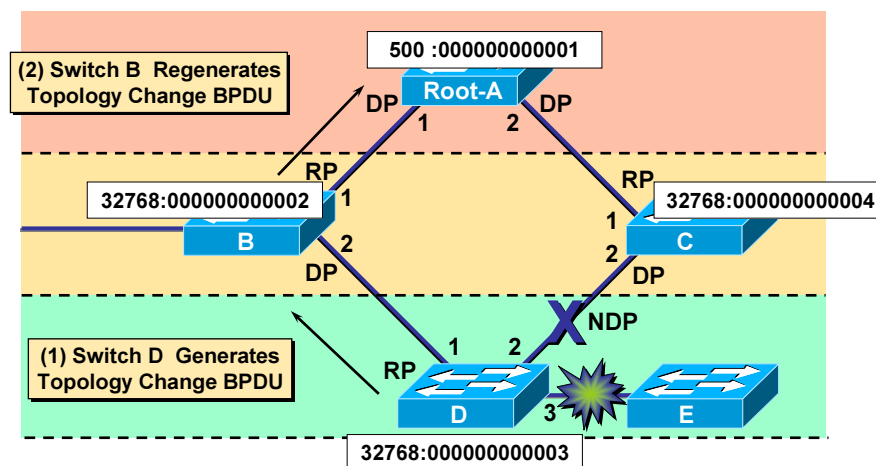|	
20 Sec	Blocking
	Max-Age
	Listening
15 Sec	**Forward Delay**
	Learning
15 Sec	**Forward Delay**
	Forwarding

- **Spanning Tree uses the timers as it passes through the Spanning-Tree Protocol states**

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A Network Topology Change

500 :000000000001

Root-A

(2) Switch B Regenerates Topology Change BPDU

DP 1   2 DP

RP 1   RP 1

32768:000000000002   **32768:000000000004**

B   C

2   2

DP   DP

NDP

(1) Switch D Generates Topology Change BPDU

RP 1   2

D   3   E

32768:000000000003
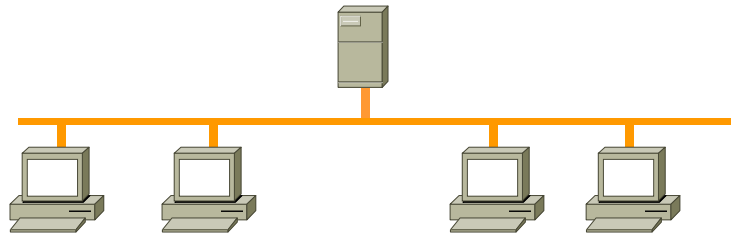
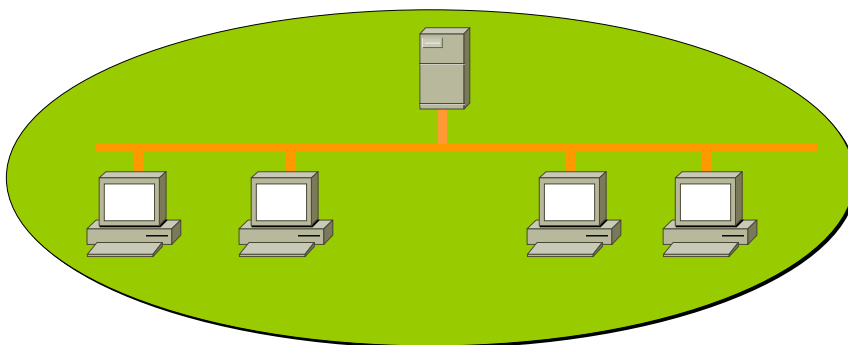9/8/2005   10
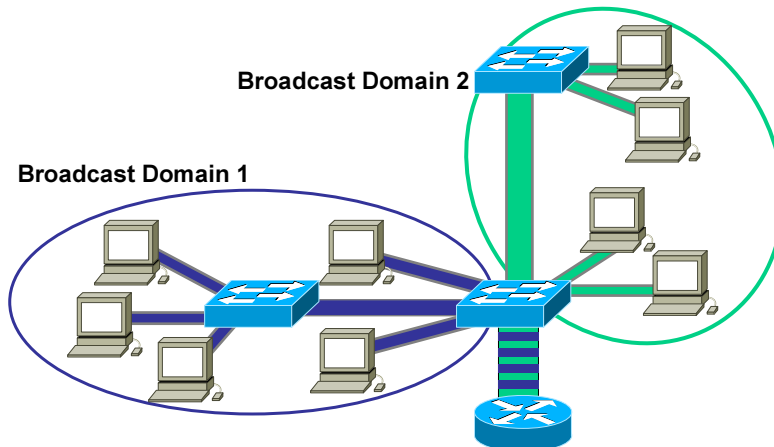
Ethernet Broadcast Domain

- **In a flat network, every device sees every transmitted packet**

VLANs

- **A VLAN is a broadcast domain**

VLANs Establish Broadcast Domains

Broadcast Domain 2
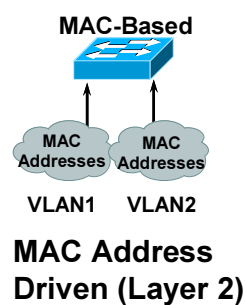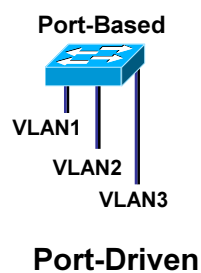
Broadcast Domain 1

– VLANs plus routers limit broadcasts to the domain of origin

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Establishing VLAN Membership

Approaches Can Affect Performance

Port-Based
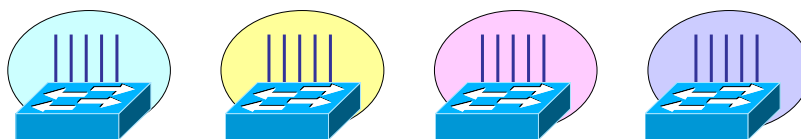
MAC-Based

VLAN1

VLAN2

VLAN3

MAC Addresses

MAC Addresses

VLAN1

VLAN2

Port-Driven

MAC Address Driven (Layer 2)

• **VLAN membership can either be static or dynamic**

Configuring Static VLANs

**Routing Function
Interconnects VLANs**

Network Layer — 192.20.21.0 192.20.24.0 192.30.20.0

**Data Link Layer
Broadcast
Domains** — Engineering VLAN Marketing VLAN Sales VLAN

**Physical Layer
LAN Switch**

Human Layer

Floor #1   Floor #2   Floor #3

- **All users attached to same switch port must be in the same VLAN**
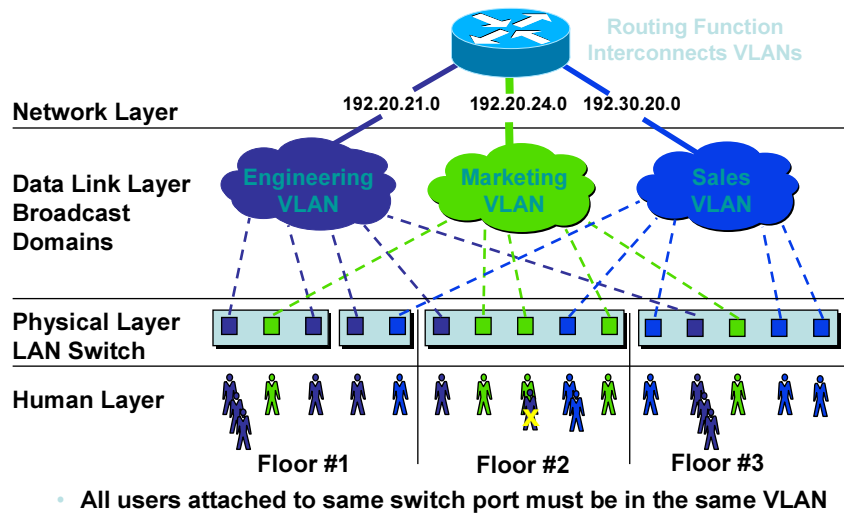
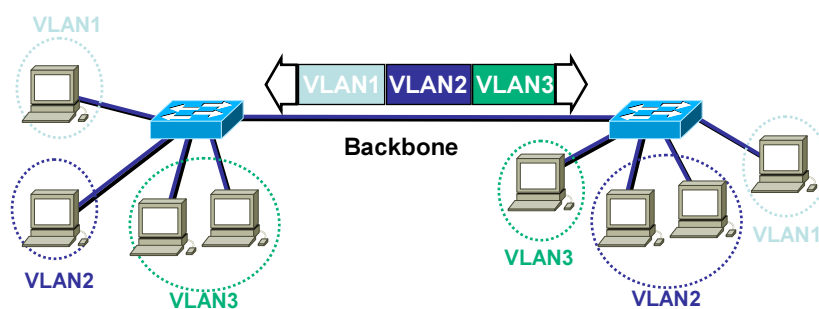
Link Types

Access Links

- **An access link is a link that is a member of only one VLAN**

Link Types (Cont.)
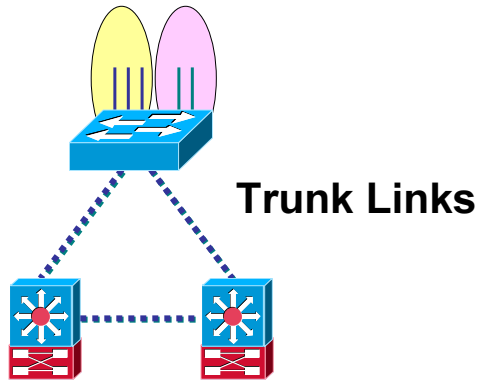
Trunk Links

- **A trunk link is capable of carrying multiple VLANs**

VLAN Frame Identification

VLAN1

VLAN1 VLAN2 VLAN3

Backbone

VLAN2

VLAN3

VLAN3

VLAN1

VLAN2

– Specifically developed for multi-VLAN, inter-switch communications
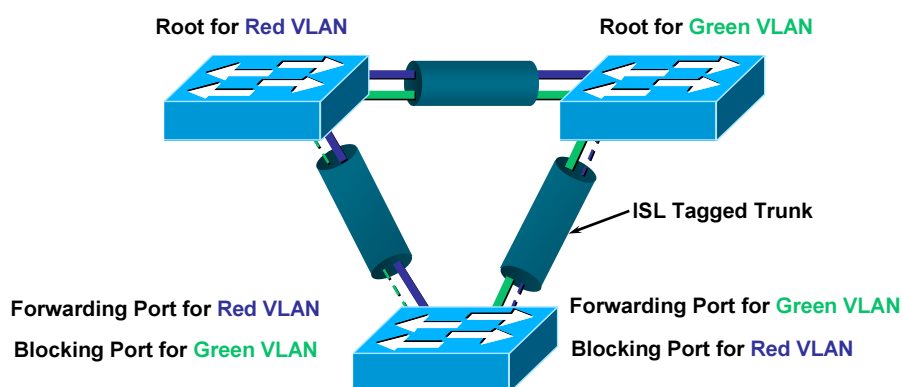– Places a unique identifier in header of each frame
– Functions at Layer 2

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VLAN Identification Using IEEE 802.1Q

| Initial MAC Address	2-Byte TPID 2-Byte TCI	Initial Type/Data	New CRC

- 2-byte tag protocol identifier (TPID)
  - A fixed value of 0x8100. This TPID value indicates that the frame carries the 802.1Q/802.1p tag information.
- 2-byte tag control information (TCI)

PVST

Root for Red VLAN

Root for Green VLAN

ISL Tagged Trunk

Forwarding Port for Red VLAN

Blocking Port for Green VLAN

Forwarding Port for Green VLAN

Blocking Port for Red VLAN

- Allows control of forwarding paths on a subnet basis
- Creates flexible design tools for traffic management
- Provides simple techniques for Layer 2 redundancy

Common or Mono-Spanning Tree

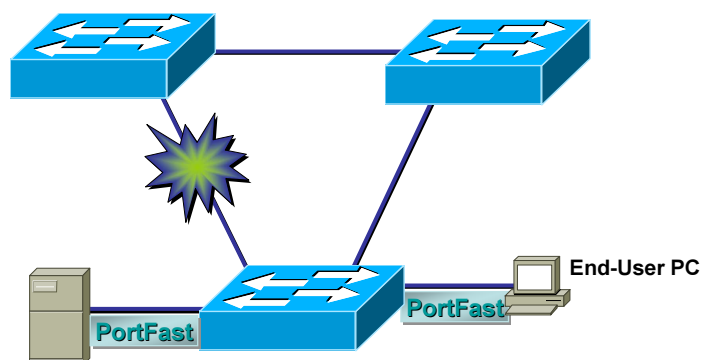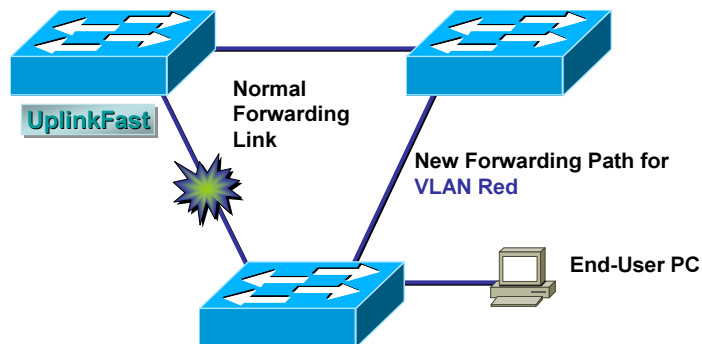|	
▬▬ = Forwarding Path	
▬▬ = Backup Link	
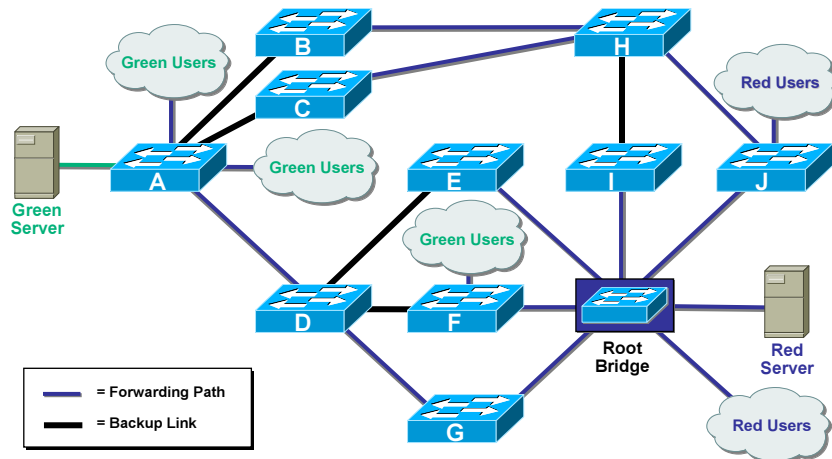
– Single spanning tree is not optimal for scalability or stability

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What Is PortFast?

– Minimize server or workstation downtime
– PortFast for switched-user dedicated ports

What Is UplinkFast?

UplinkFast

Normal Forwarding Link

New Forwarding Path for VLAN Red

End-User PC

- Minimize network downtime
- UplinkFast is for fast spanning-tree uplink convergence in < 5 seconds for inter-switch connections
- PortFast for switched-user dedicated ports

BackboneFast Overview

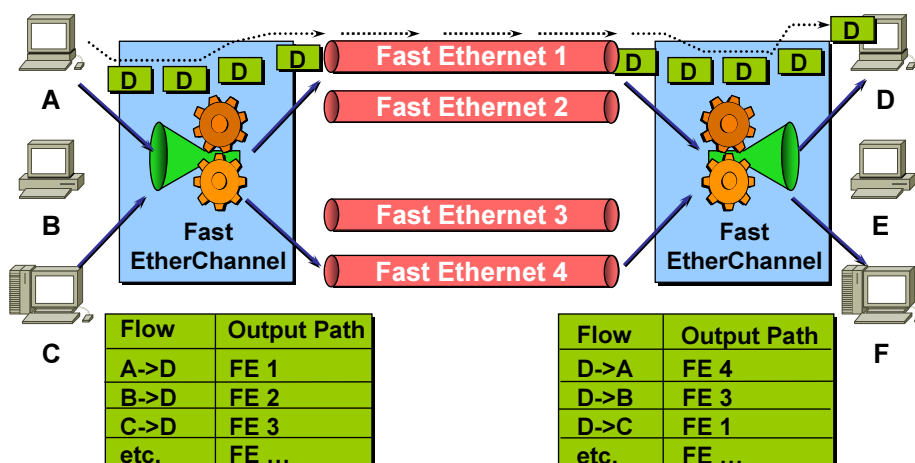**Traditional STP**

STP Root

Normal Forwarding Link

STP Blocked for Red

STP with BackboneFast

STP Root

RLQ Inquiry & Response

Link Failure

BackboneFast: Receipt of Inferior BPDUs Triggers Root Link Query PDU
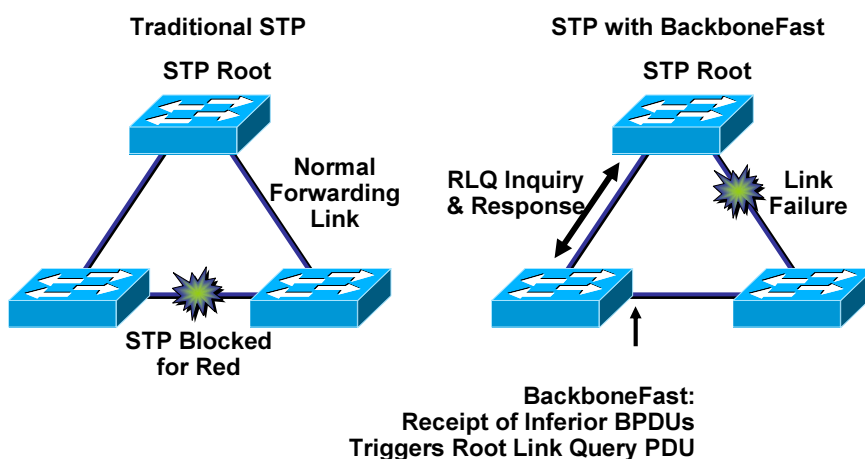
Parallel Fast Ethernet Links

A
B
C

Fast EtherChannel

Fast Ethernet 1
Fast Ethernet 2
Fast Ethernet 3
Fast Ethernet 4

Fast EtherChannel

D
E
F
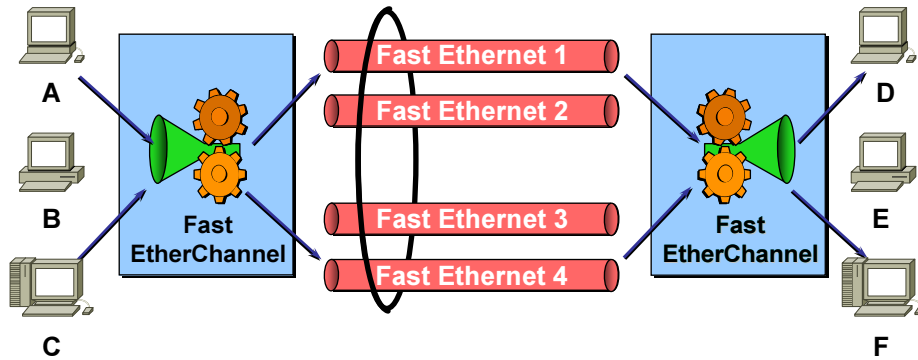
- **Fast and Gigabit EtherChannel allow for redundant links in a spanning tree environment by allowing the links to be treated as one link**

Load Distribution Algorithm(s)

A
B
C

Fast EtherChannel

D D D D

Fast Ethernet 1
Fast Ethernet 2
Fast Ethernet 3
Fast Ethernet 4

D D D D

Fast EtherChannel

D
E
F

Flow	Output Path
A->D	FE 1
B->D	FE 2
C->D	FE 3
etc.	FE …

Flow	Output Path
D->A	FE 4
D->B	FE 3
D->C	FE 1
etc.	FE …

- **Fast EtherChannel uses load distribution to share the links**