i341 - LAN Interconnection
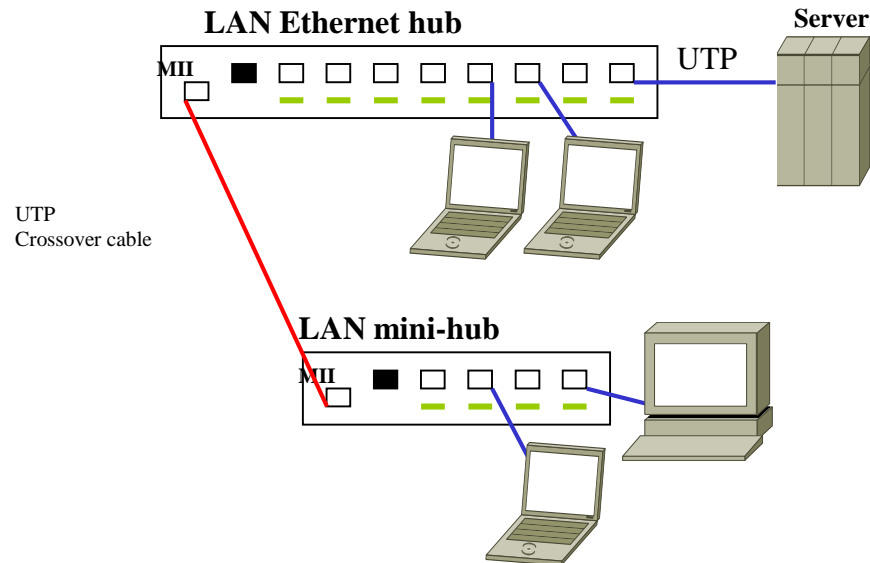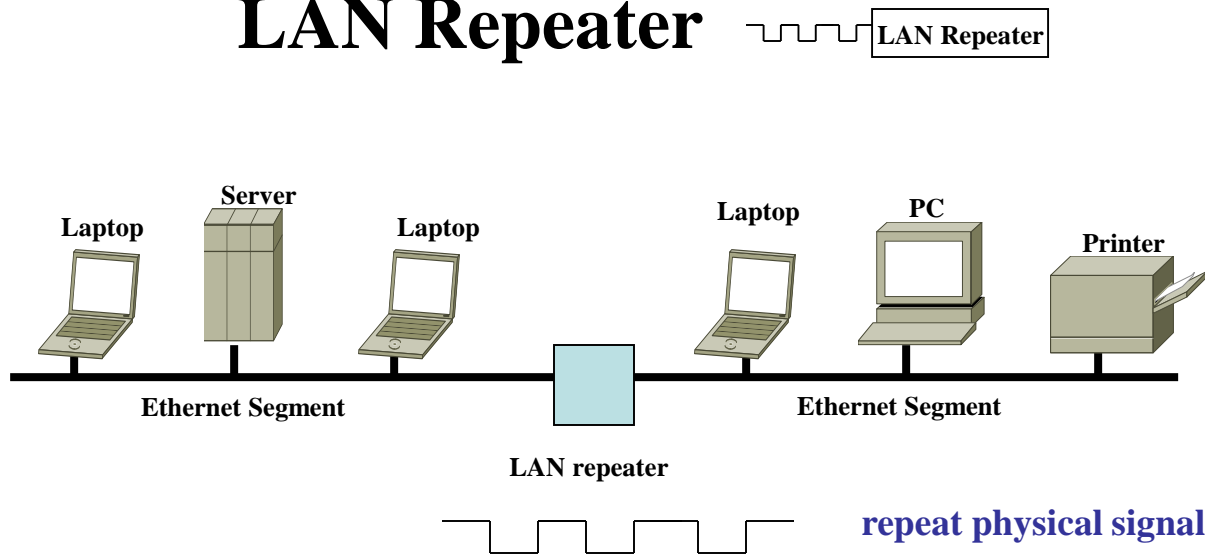
OSI Model Compared to Various Device Functions and Protocols

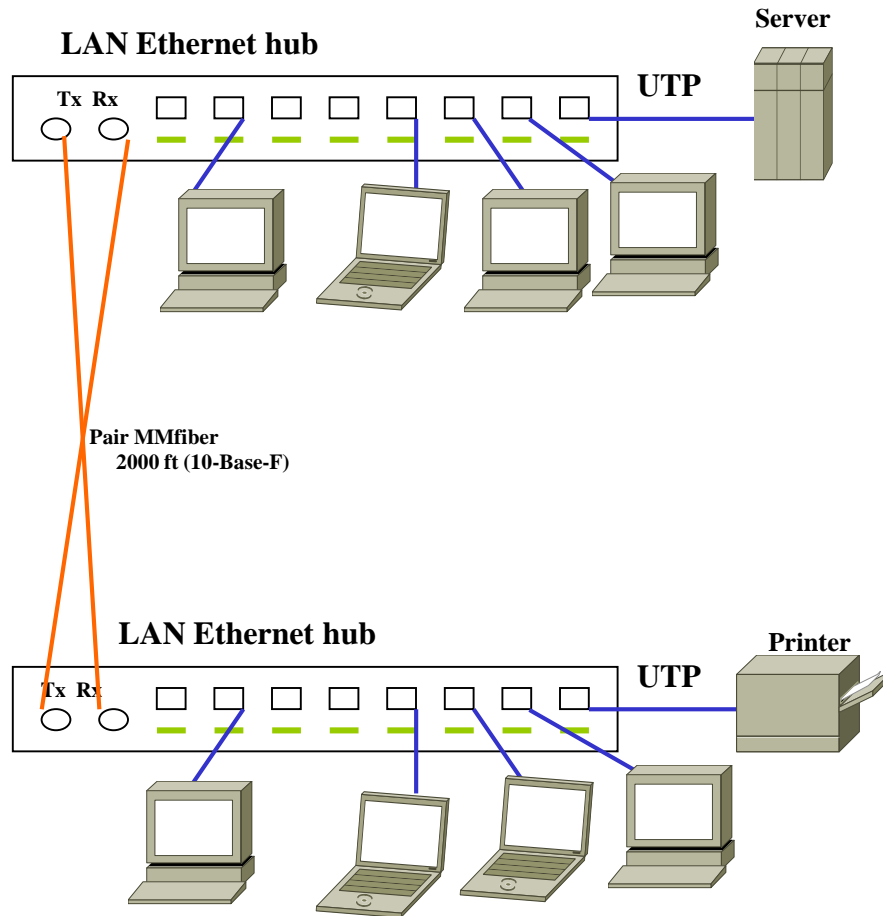### OSI Layers

Device	Layer	OSI Layer		Protocols
Gateway	7	Application		
	6	Presentation		
	5	Session		
	4	Transport		
Router	3	Network		
Bridge	2	Data Link	(a) LLC / (b) MAC	802.3 / 802.11 / Other
Repeater	1	Physical	(c)	
		Medium	(d)	

(a) Logical Link Control Sublayer

(b) Media Access Control Sublayer

(c) Signal Encoding and Interface to Medium

(d) Medium (Cable and Connectors)

LAN Repeater

LAN Repeater

Server

Laptop   **Laptop**   **Laptop**   **PC**   **Printer**

Ethernet Segment   **Ethernet Segment**

LAN repeater

repeat physical signal

LAN Ethernet hub   **Server**

MII   UTP

UTP
Crossover cable

LAN mini-hub

MII

LAN Repeater (Ethernet hub to hub)

Server

LAN Ethernet hub

Tx Rx

UTP

Pair MMfiber
2000 ft (10-Base-F)

LAN Ethernet hub

Printer

Tx Rx

UTP

LAN Repeater Scenario - Fiber LAN Extension

Fiber is connected through a patch panel.

telco rack

Fiber
Patch Panel

LAN Ethernet hub

Server

Tx Rx

UTP

**Conduit for
building fiber
distribution**

telco rack

Fiber
Patch Panel

LAN Ethernet hub

Printer

Tx Rx

UTP
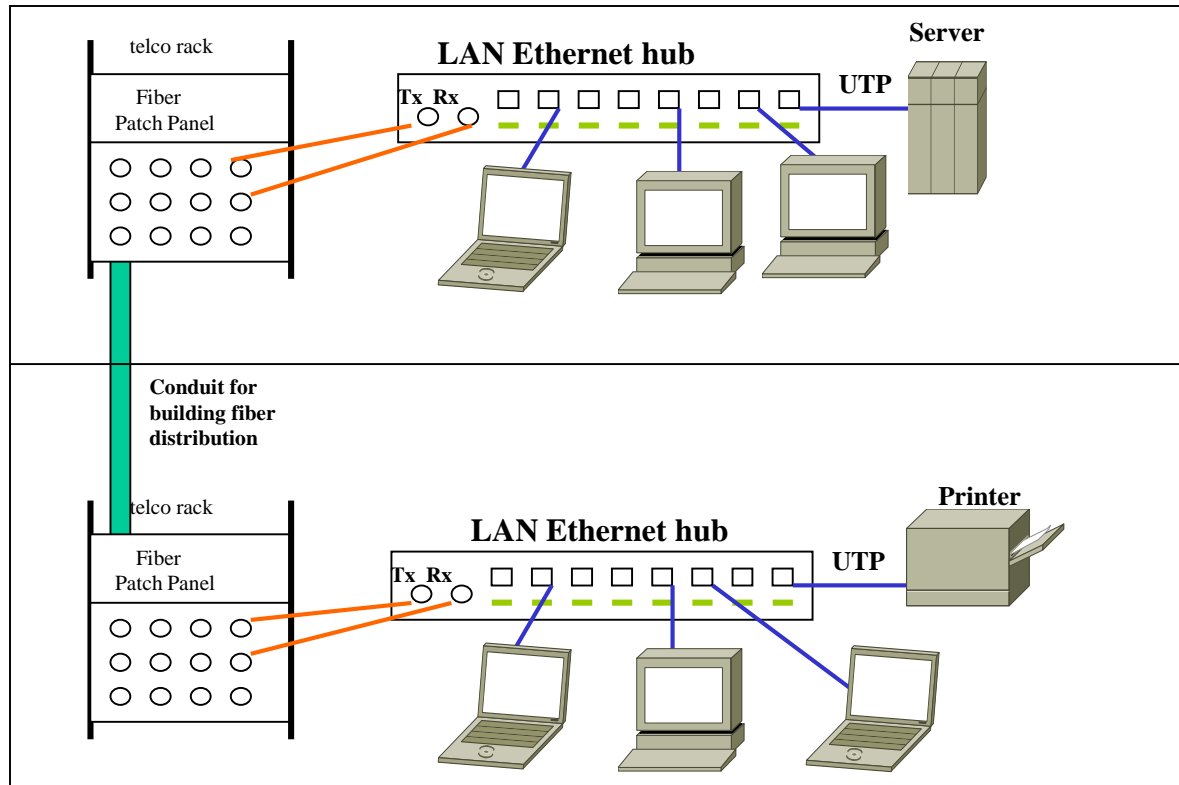
LAN Repeater Scenario - Fiber LAN Extension

Ethernet LAN Hub/Switch Repeater.

Server

LAN Ethernet hub

Tx Rx

UTP

**Pair MMfiber
2000 ft (10-Base-F)**

Printer

LAN Ethernet hub

Tx Rx

UTP
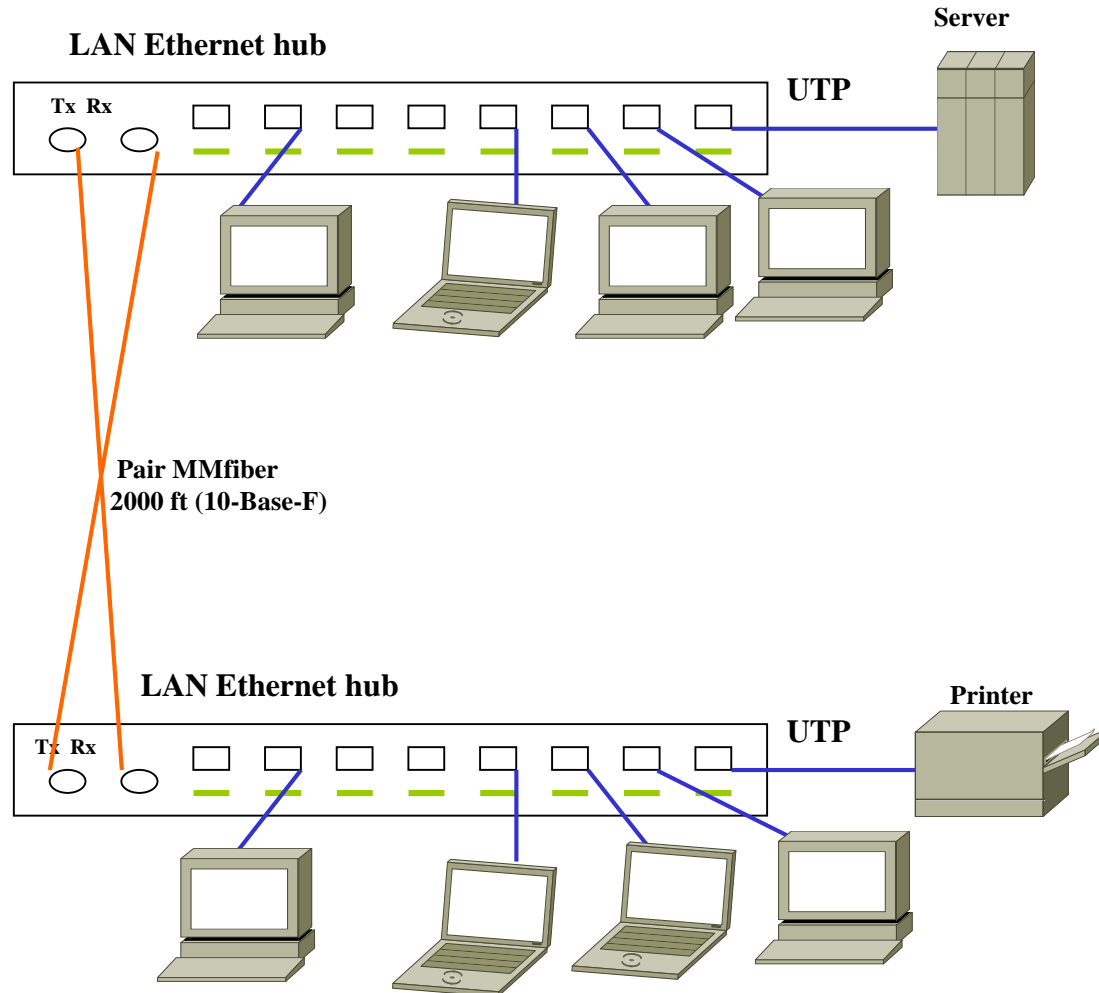
LAN Bridges
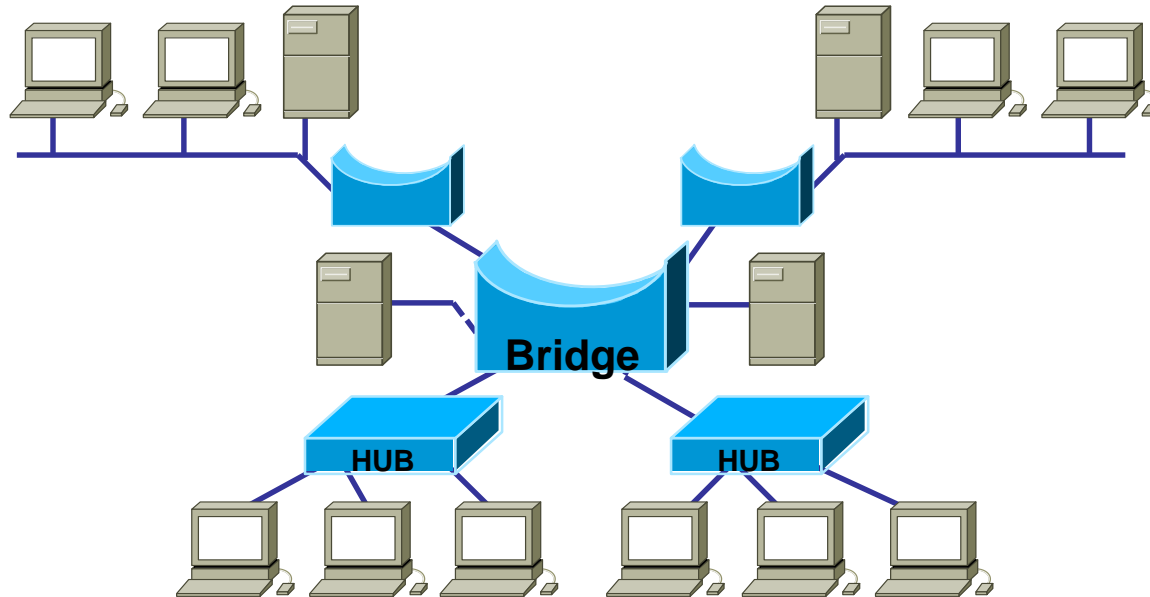
Three basic functions a bridge has to perform:

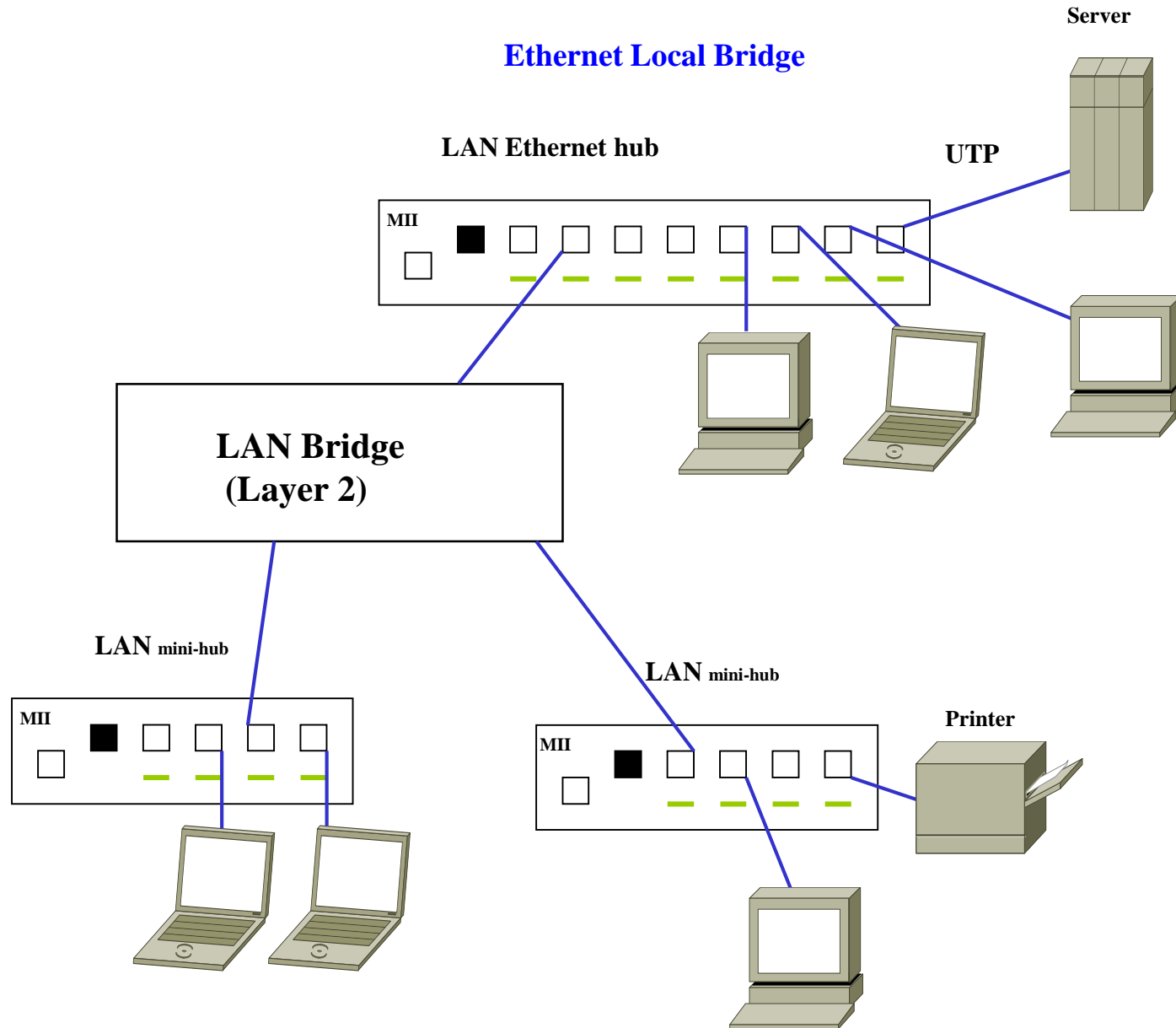Build a table listing all layer 2 address and source port

Make forwarding decisions based on destination address

Filter is source and destination are on the same port

Forward if source and destination are on different ports
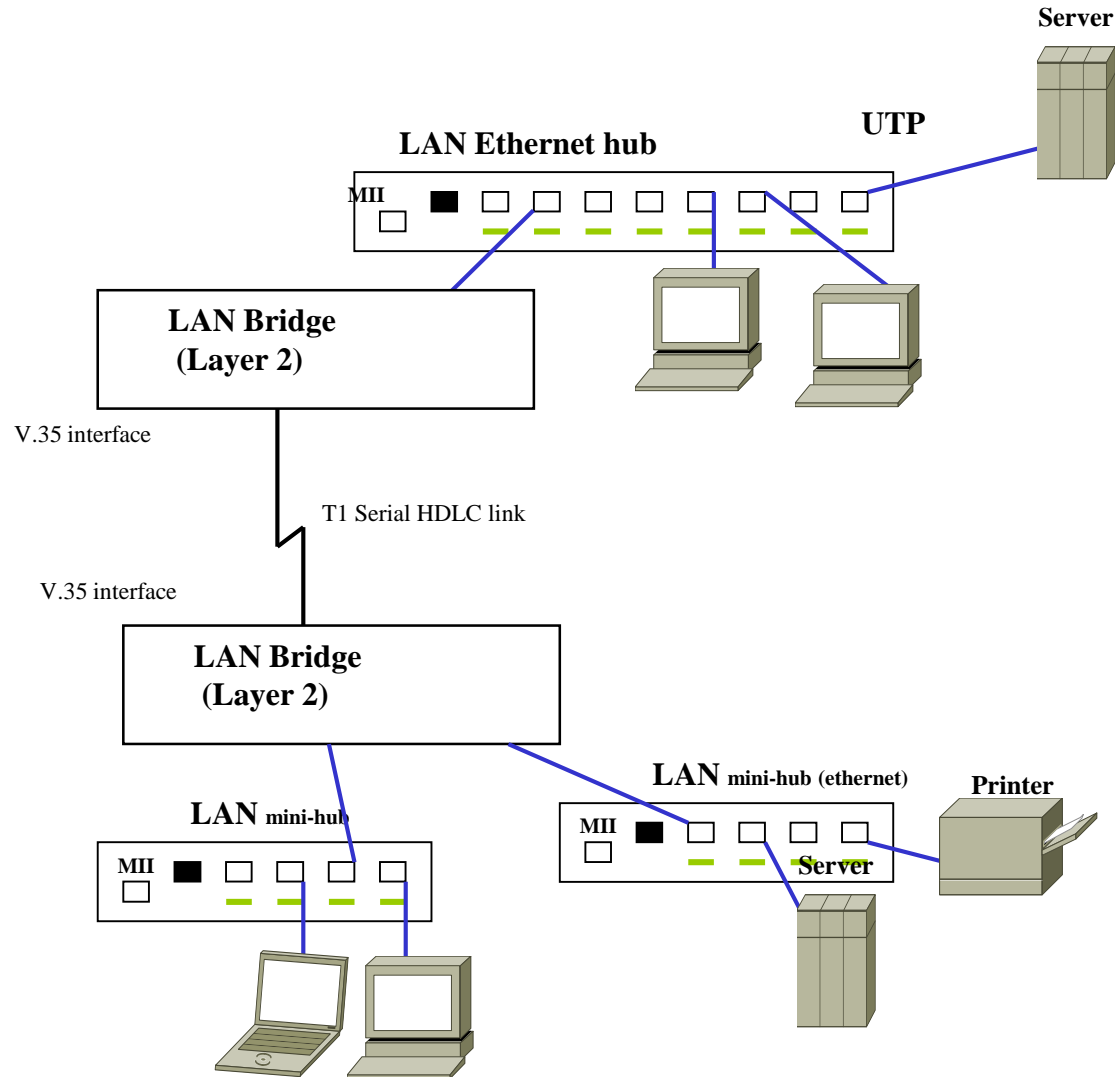
Break loops (Spanning Tree)

LAN Interconnection – LAN Bridge

Ethernet Local Bridge

Server

LAN Ethernet hub

UTP

MII

LAN Bridge (Layer 2)

LAN mini-hub

MII

LAN mini-hub

Printer

MII

LAN Interconnection – LAN Bridge

Pair Ethernet Remote Bridges

Server

LAN Ethernet hub

UTP

MII

LAN Bridge
(Layer 2)

V.35 interface

T1 Serial HDLC link

V.35 interface

LAN Bridge
(Layer 2)

LAN mini-hub (ethernet)

Printer

LAN mini-hub

MII

MII

Server

LAN Interconnection – LAN Bridge

Ethernet Transparent (Learning) Bridge

MAC add 0C00042C1020

ether port 0

LAN Bridge

ether port 1

MAC add 120C3ADA0210

Bridge Table

MAC add	Bridge Port
0C00042C1020	ether port 0
120C3ADA0210	ether port 1
0C0AA12C332D	ether port 0
045C332175BB	ether port 1

LAN Interconnection – LAN Bridge

Ethernet LAN Redundancy & Load Balancing (Transparent Bridge)

My Job As Bridge is to ??

Forward all:

Broadcast frames
Multicast frames
Unicast frames (based on learned topology)

LAN Interconnection – LAN Bridge

Ethernet LAN Redundancy & Load Balancing (Transparent Bridge)

JF PC
IP 192.132.42.65

JF PC wants to transfer files to PF dev

My Job As Bridge is to ??

LAN Bridge
(Layer 2)

LAN Bridge
(Layer 2)

1. JF PC 192.132.42.65 initiates FTP with PF dev 192.132.42.65

Forward all:

Broadcast frames
Multicast frames
Unicast frames (based on learned topology)

IP 192.132.42.112
PF Laptop

LAN Interconnection – LAN Bridge

Ethernet LAN Redundancy & Load Balancing (Transparent Bridge)

JF PC

IP 192.132.42.65

JF PC wants to transfer files to PF dev

My Job As Bridge is to ??

| **LAN Bridge (Layer 2)** | **LAN Bridge (Layer 2)** |

2. IP 192.132.42.65 initiates FTP with 192.132.42.65

Forward all:

Broadcast frames
Multicast frames
Unicast frames (based on learned topology)

IP 192.132.42.112

PF Laptop

LAN Interconnection – LAN Bridge

192.132.42.112	192.132.42.65	FTP Req

Ethernet LAN Redundancy & Load Balancing (Transparent Bridge)

FFFF	SA	ARP Frame

JF PC
IP 192.132.42.65

3. ARP Cmd

My Job As Bridge is to ??

LAN Bridge
(Layer 2)

LAN Bridge
(Layer 2)

Forward all:

Broadcast frames
Multicast frames
Unicast frames (based on learned topology)

PF Laptop

IP 192.132.42.112

What Is a Bridging Loop ?

Station A

Segment A

1/1

**LAN Bridge
(Layer 2)**

2/1
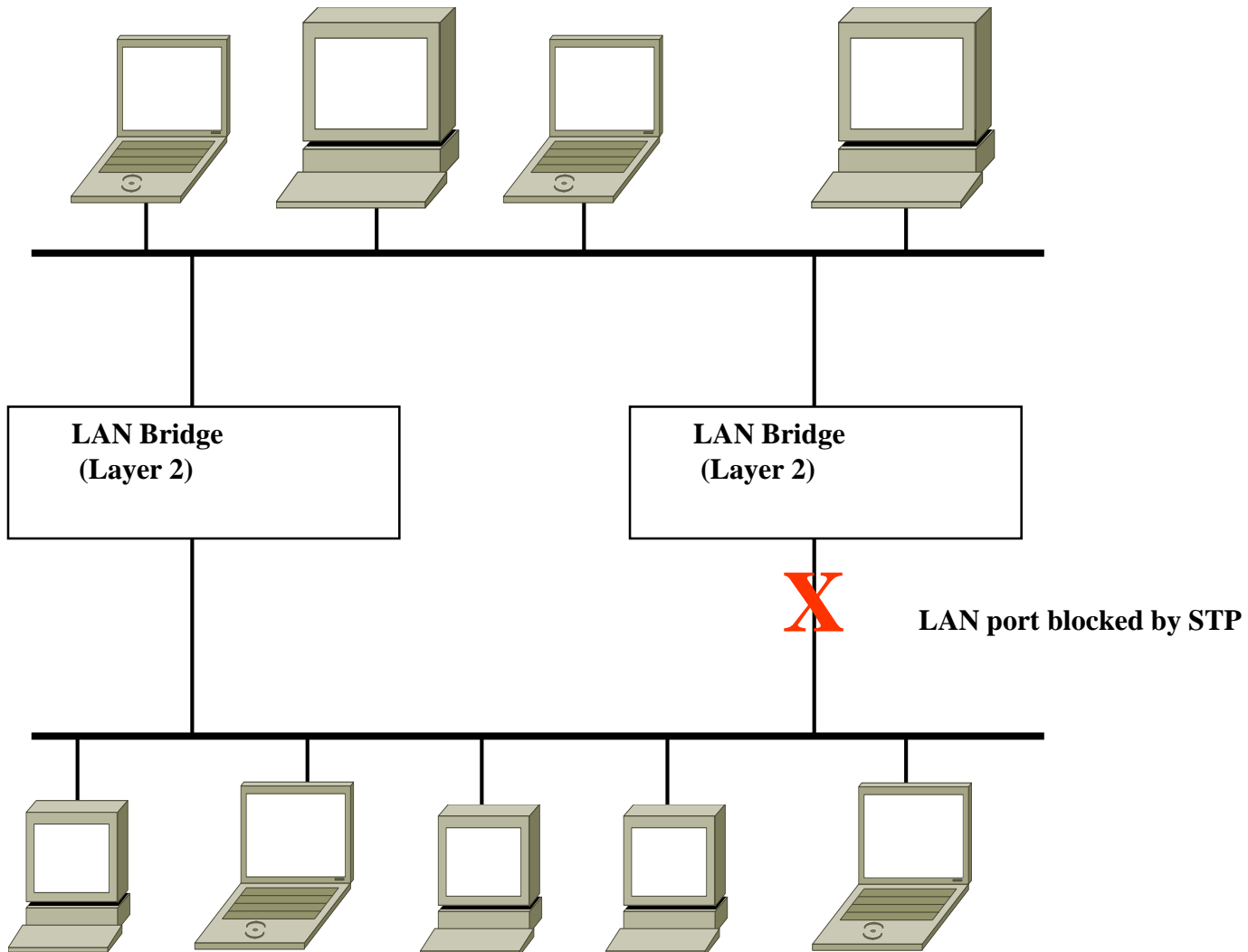
**LAN Bridge
(Layer 2)**

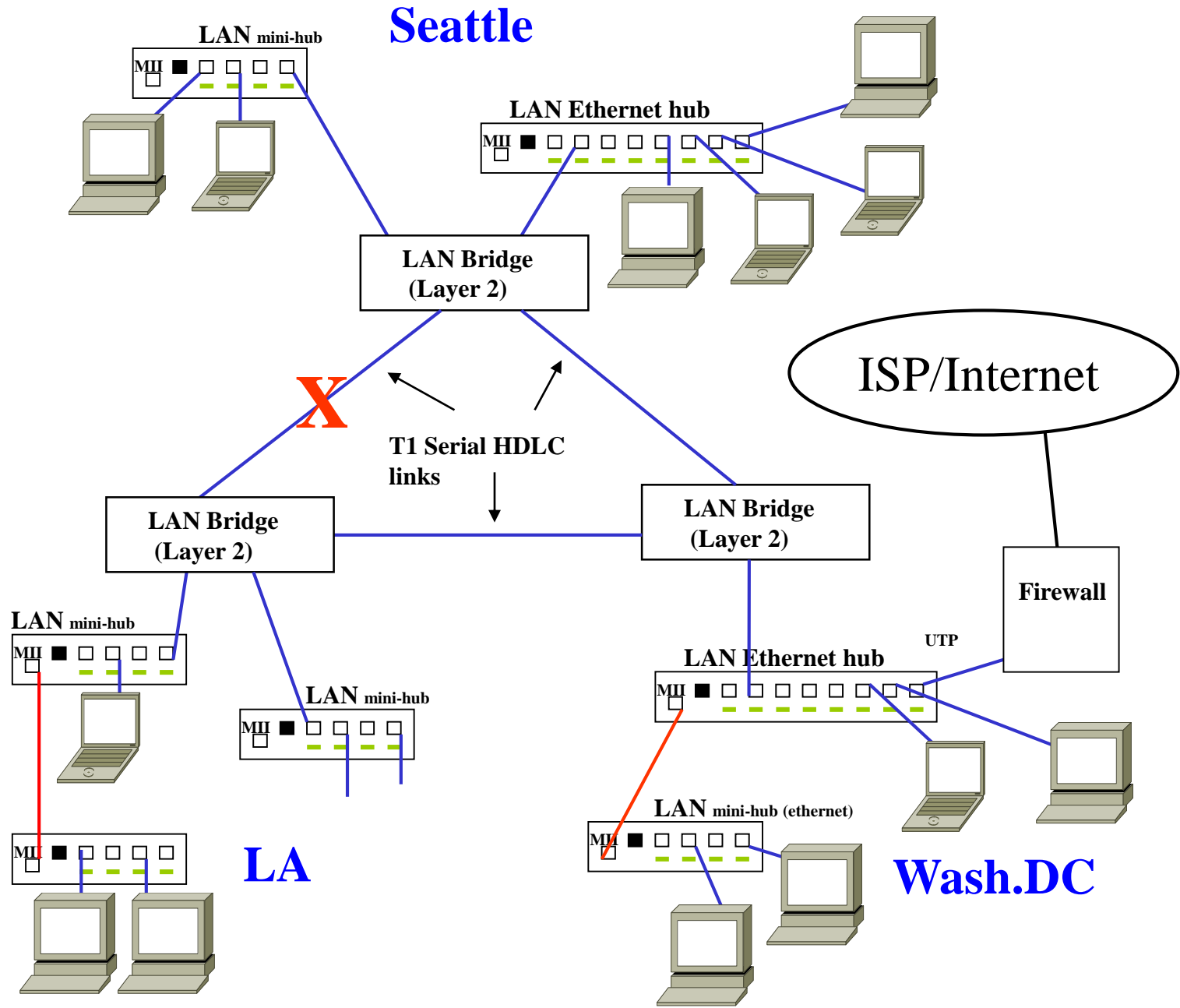**1/2**

Segment B

2/2

Station B

*Bridging loops occur any time there is a redundant path or loop in the
bridge network*

LAN Interconnection – LAN Bridge

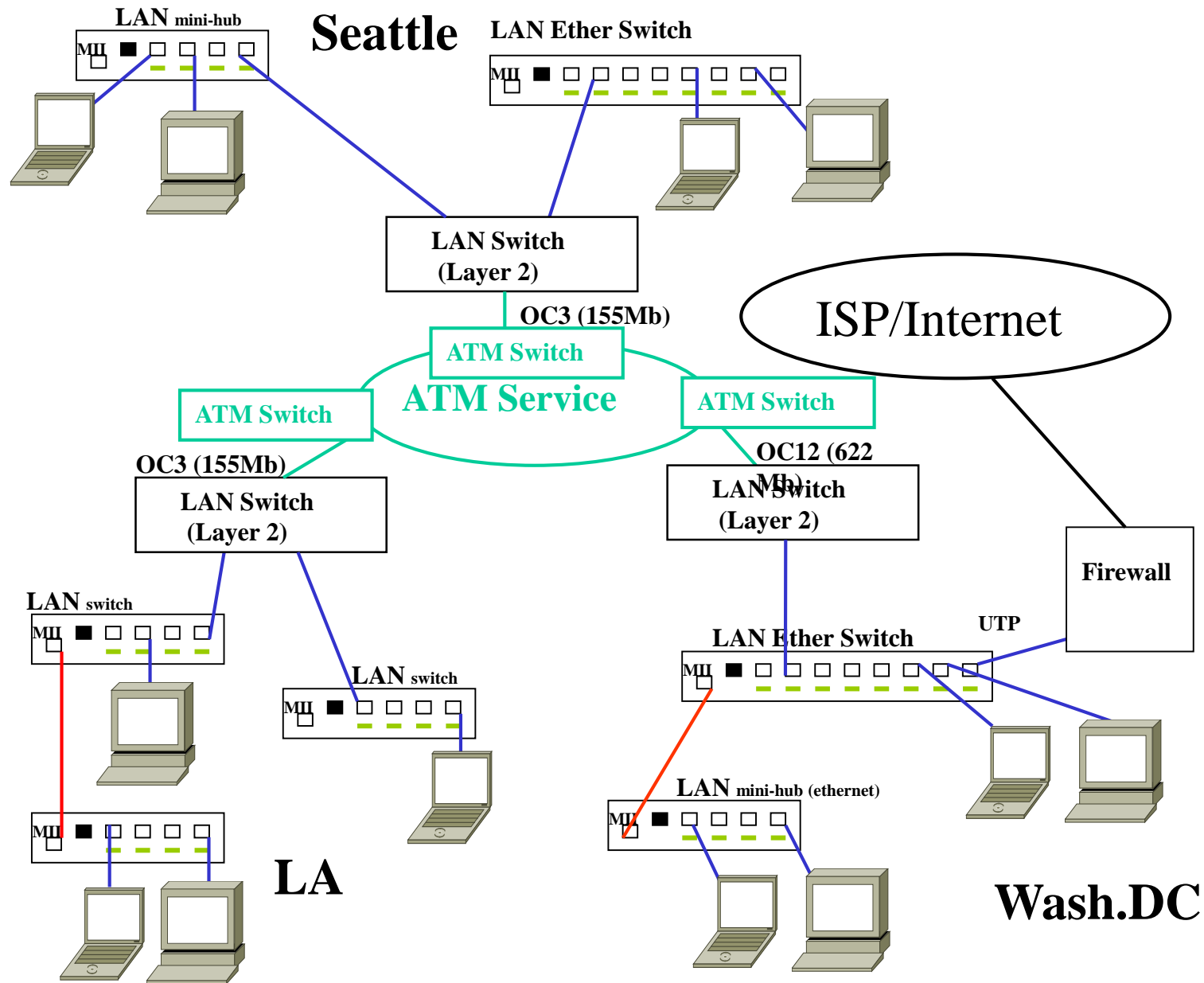**Spanning Tree Protocol (Transparent Bridging)**

LAN Bridge
(Layer 2)

LAN Bridge
(Layer 2)

X LAN port blocked by STP

LAN Interconnection – Layer 2 WAN (STP)

Seattle

LAN mini-hub

MII

LAN Ethernet hub

MII

LAN Bridge
(Layer 2)

ISP/Internet

X

T1 Serial HDLC
links

LAN Bridge
(Layer 2)

LAN Bridge
(Layer 2)

Firewall

LAN mini-hub

MII

LAN mini-hub

MII

LAN Ethernet hub

UTP

MII

LAN mini-hub (ethernet)

MII

LA

Wash.DC

LAN Interconnection – Layer 2 WAN (STP)

Seattle

LAN mini-hub

MII

LAN Ether Switch

MII

**LAN Switch
(Layer 2)**

OC3 (155Mb)

ATM Switch

ISP/Internet

ATM Switch

ATM Service

ATM Switch

OC3 (155Mb)

OC12 (622 Mb)

**LAN Switch
(Layer 2)**

**LAN Switch
(Layer 2)**

Firewall

LAN switch

MII

LAN switch

MII

LAN Ether Switch

UTP

MII

MII

MII

LAN mini-hub (ethernet)

MII

LA

Wash.DC

Routers Forward Traffic

Routing protocols maintain neighbor relationships with adjacent (connected) routers

Neighboring routers and routing protocols exchange frames containing either:

    Hello packets

    Routing update packets

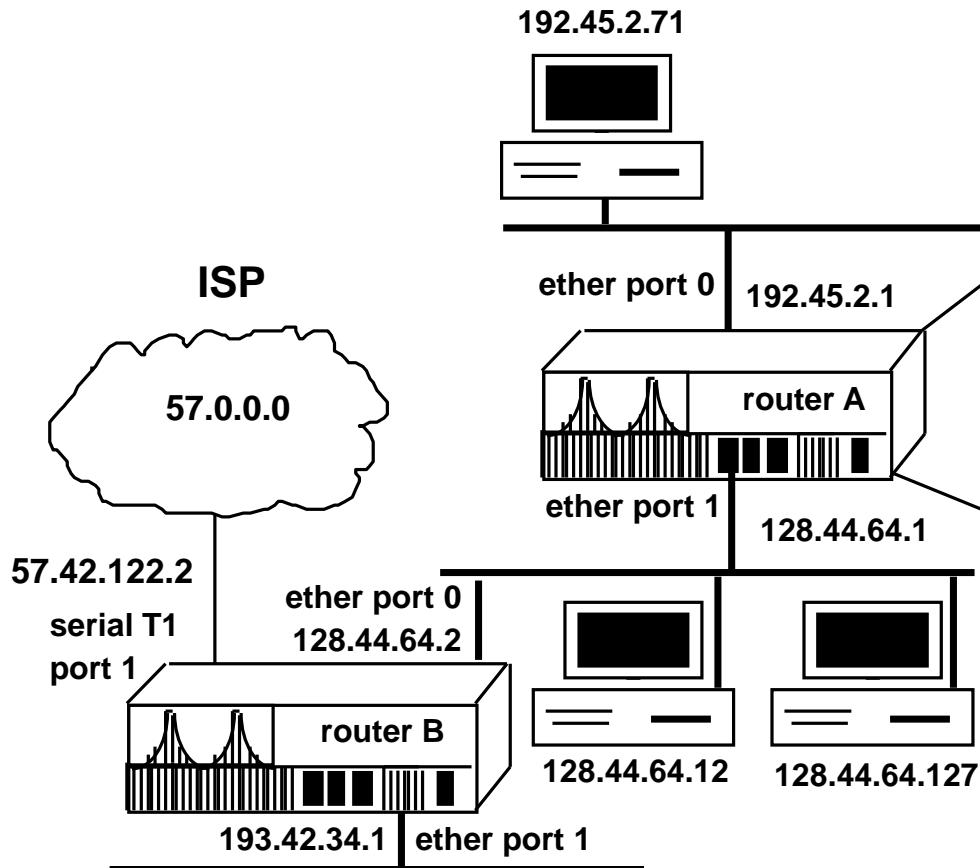**Routing tables contain routes learned from neighboring routers**

Routers forward traffic to the destination network by passing packets to the next-hop logical device (router) in the delivery path

Benefits of Routing

- **Broadcast control**
- **Multicast control**
- **Optimal path determination**
- **Traffic management**
- **Logical addressing**
- **Layer 3 security**

E0	**10.1.1.1**
E1	**10.2.2.2**

10.1.1.1   **E0**   router   **E1**   **10.2.2.2**

LAN Interconnection – Routing

192.45.2.71

ISP

57.0.0.0

ether port 0 | **192.45.2.1**

router A

ether port 1 | **128.44.64.1**

57.42.122.2

serial T1 port 1

ether port 0 | **128.44.64.2**

router B

193.42.34.1 | **ether port 1**

128.44.64.12 | **128.44.64.127**
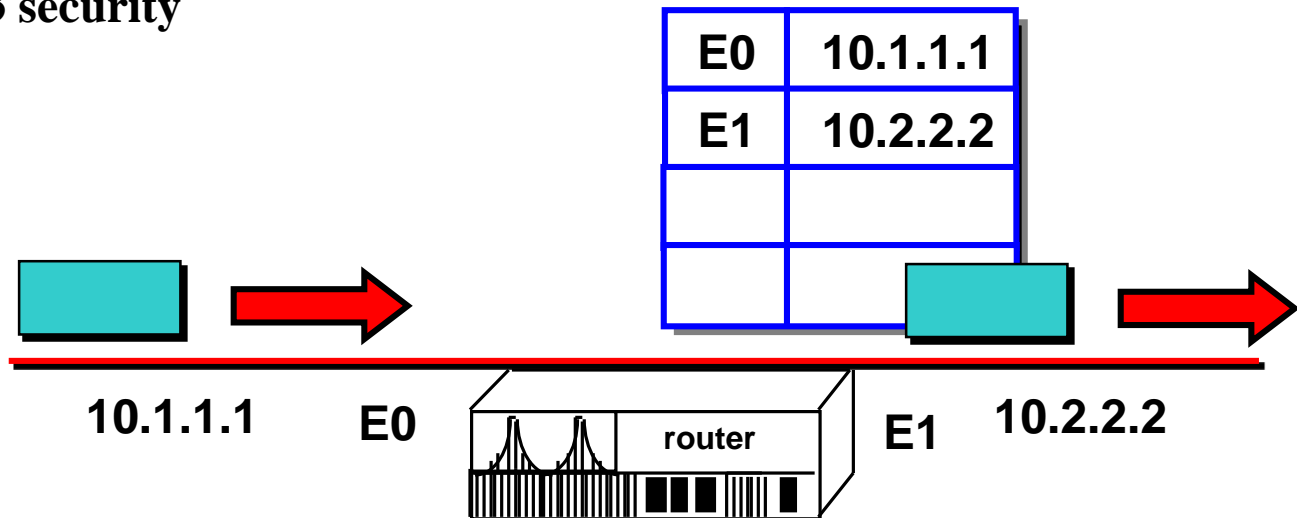
Route Table (Router A)

network add	router port
192.45.2.0	ether port 0
128.144.0.0	ether port 1
57.0.0.0	ether port 0
193.42.34.0	ether port 1

ARP Table   Router A

IP Address	MAC Address
192.45.2.1	000c42310bb1
192.45.2.71	00c3445602da
128.44.64.1	000c75240ca1
128.44.64.2	00ca545402ca
128.44.64.12	aa0c23546767
128.44.64.127	00c405061abb2

LAN Interconnection – Routing
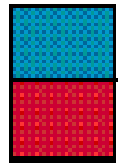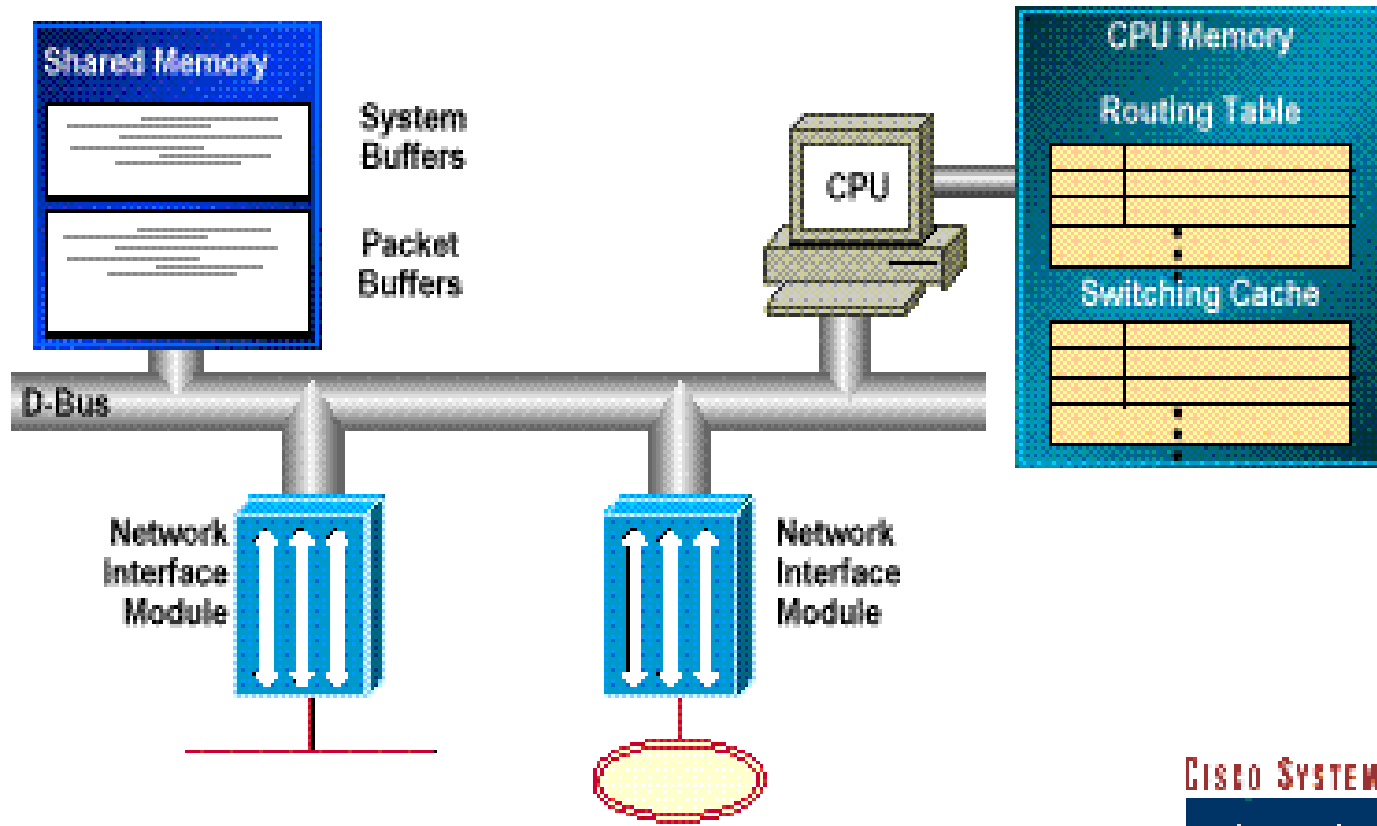
Multiprotocol Router topology
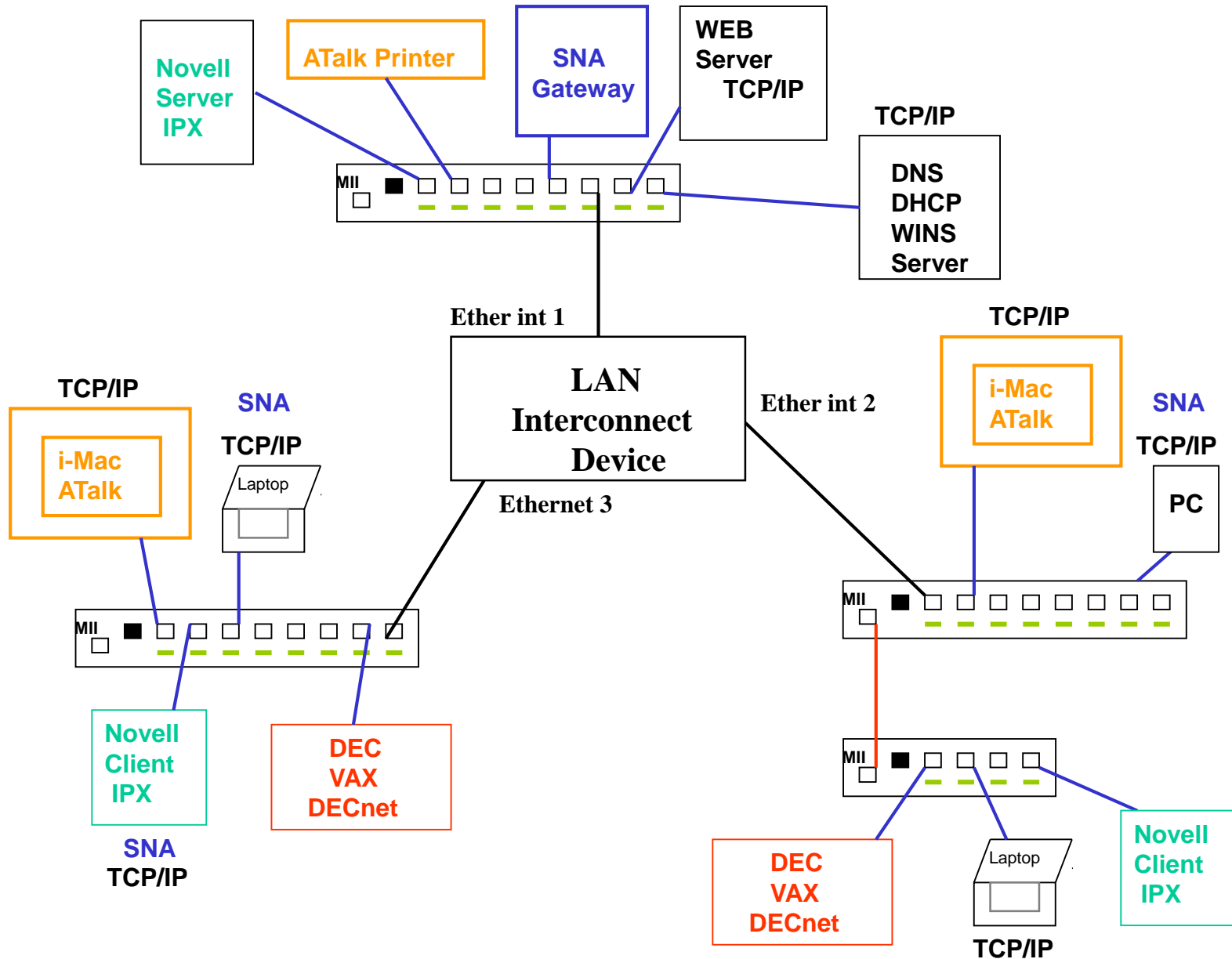
Sample Multiprotocol Router Configuration (to support the : (how the magic works !)

Ethernet 1
IP address 172.25.1.1 255.255.255.0
IP Broadcast-Add 172.25.1.255
Novell Network E0101010
Appletalk Network 12.654

Ethernet 2
IP address 192.168.1.1 255.255.255.0
IP Broadcast-Add 192.168.1.255
Novell Network E0202020
Appletalk Network 12.323
DECNet Routing

Ethernet 3
IP address 192.168.21.1 255.255.255.0
IP Broadcast-Add 192.168.21.255
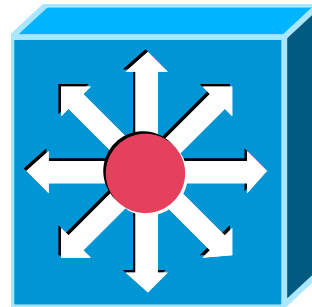Novell Network E0303030
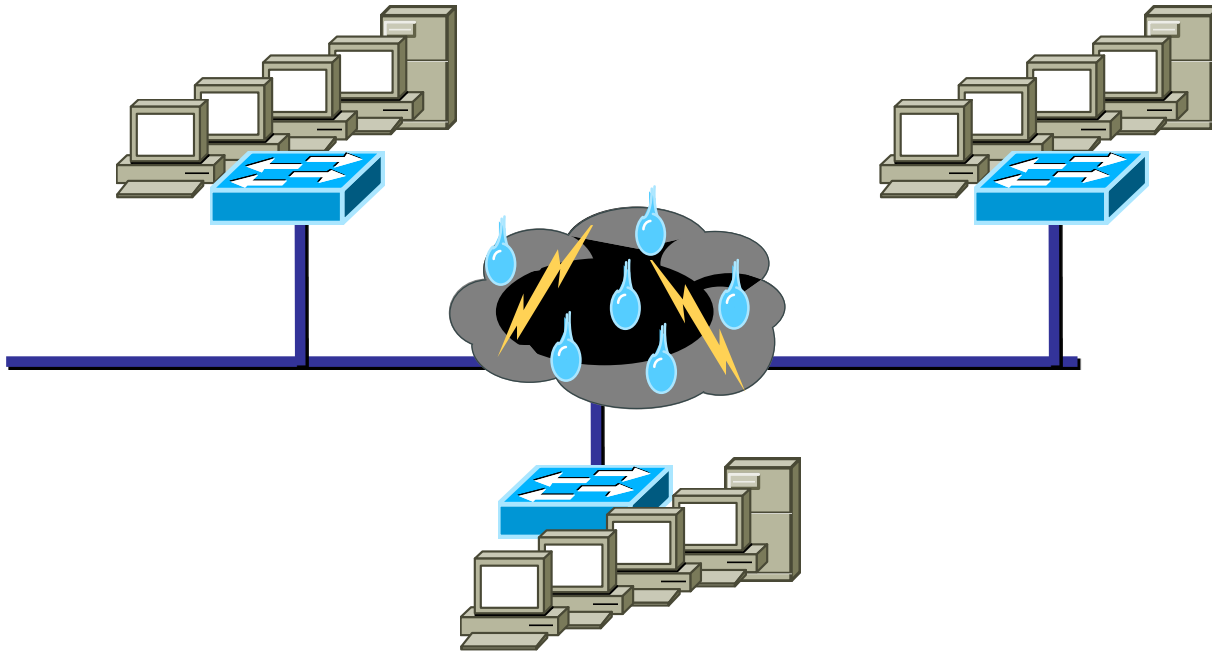Appletalk Network 12.412
DECNet Routing

Layer 2 Switching & VLAN Slides

Layer 2 Switching

- **Hardware-based bridging**
- **Wire-speed performance**
- **High-speed scalability**
- **Low latency**
- **MAC address**
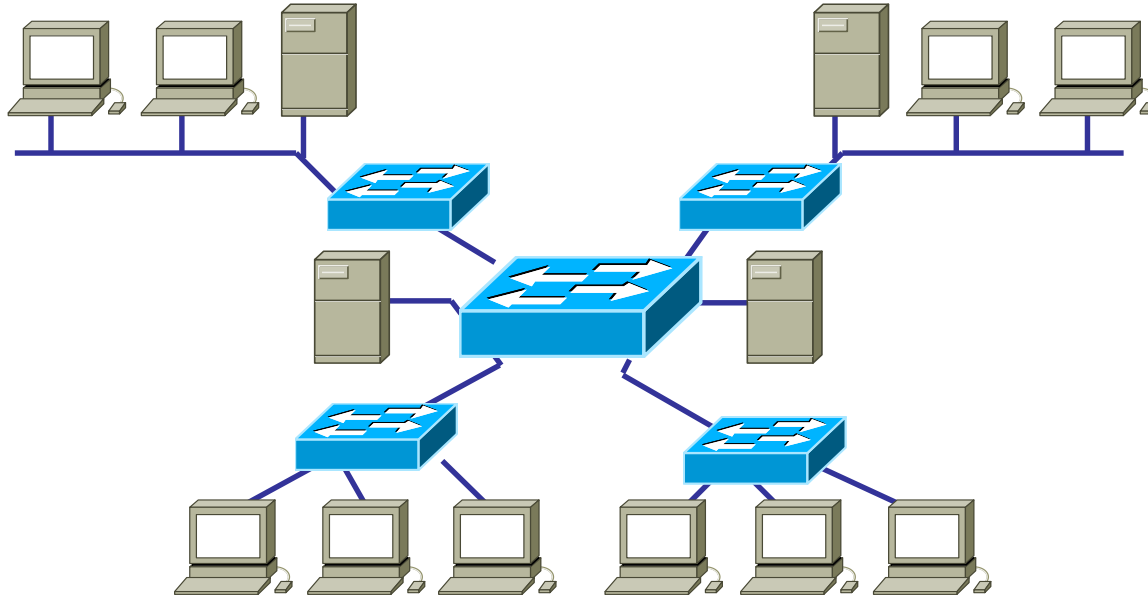- **Low cost**

Data Link

7
6
5
4
3
2
1
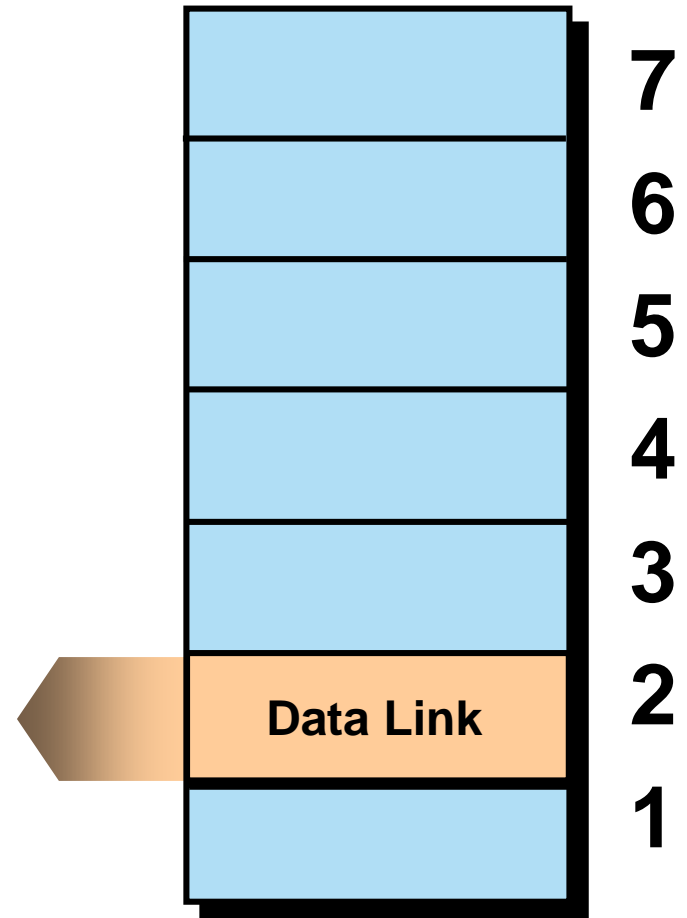
Impact of Layer 2 Switching

- *Layer 2 switched networks have the same characteristics as bridged networks*

Layer 2 LAN Switches

Three basic functions a Switch has to perform:
Build a table listing all layer 2 address and source port
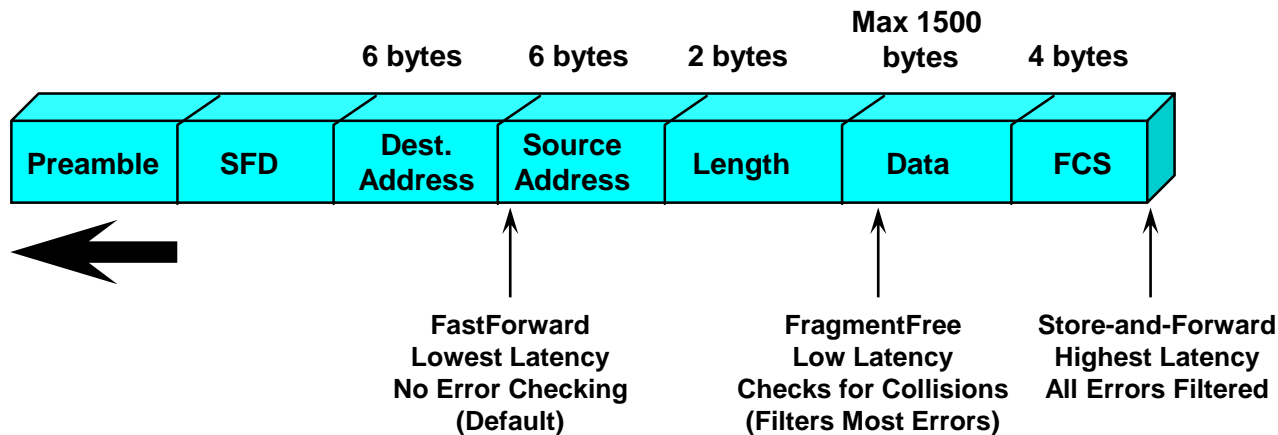Make forwarding decisions based on destination address
Filter is source and destination are on the same port
Forward if source and destination are on different ports
Break loops (Spanning Tree)

Switching Modes

➤ Three switching modes supported

– FastForward (cut-through)

– FragmentFree (modified cut-through)

– Store-and-Forward

		6 bytes	6 bytes	2 bytes	Max 1500 bytes	4 bytes
Preamble	SFD	Dest. Address	Source Address	Length	Data	FCS

FastForward
Lowest Latency
No Error Checking
(Default)

FragmentFree
Low Latency
Checks for Collisions
(Filters Most Errors)

Store-and-Forward
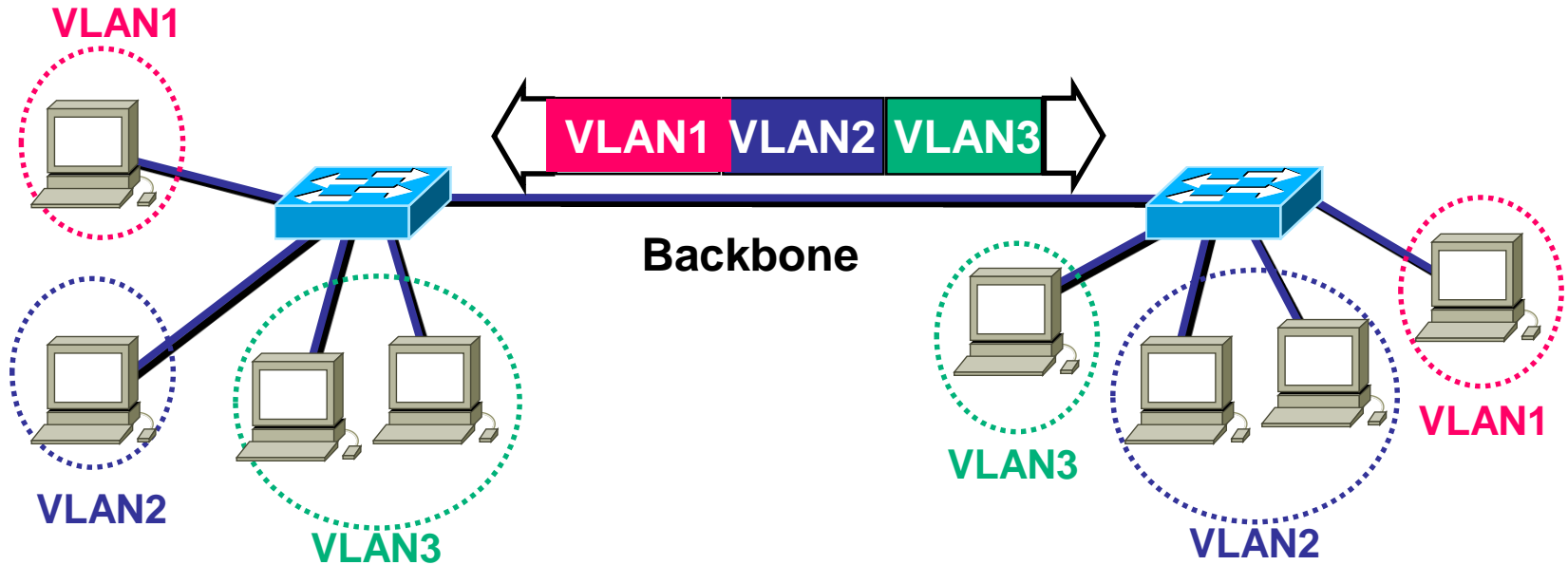**Highest Latency**
All Errors Filtered

Layer 3 Switching

- **Hardware-based packet forwarding**
- **High-performance packet switching**
- **High-speed scalability**
- **Low latency**
- **Lower per-port cost**
- **Flow accounting**
- **Security**
- **QoS**

Network Layer

7
6
5
4
3
2
1
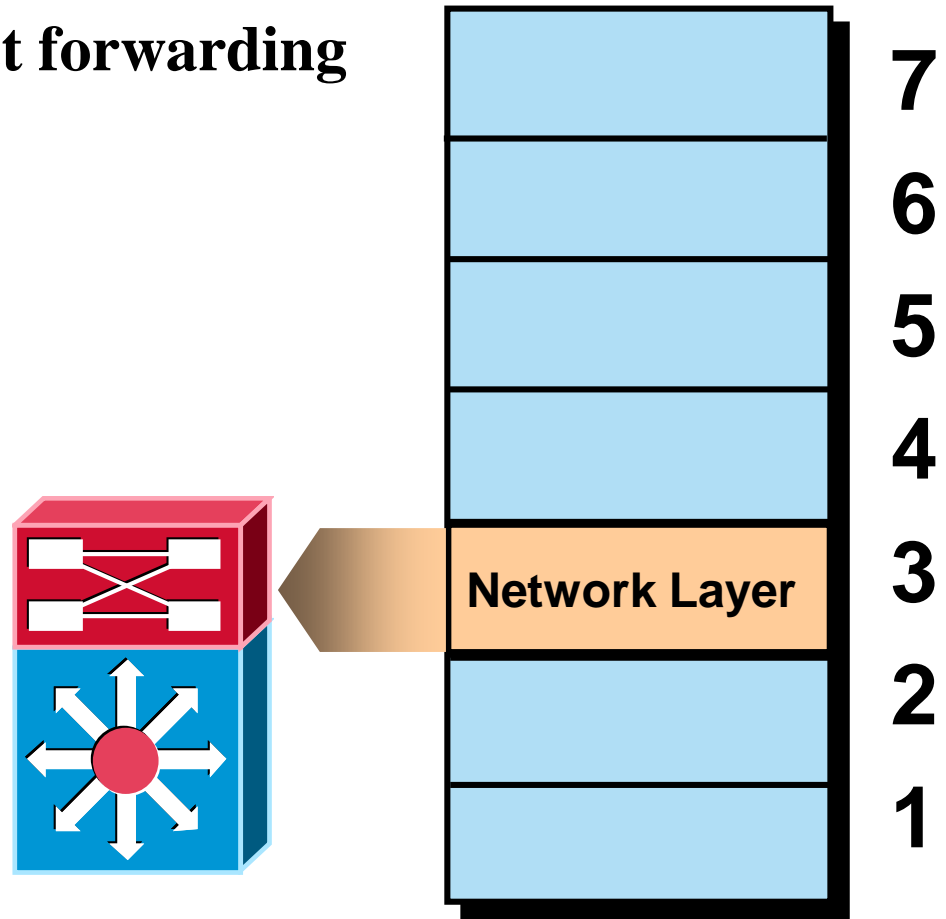
VLAN Frame Identification

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

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)