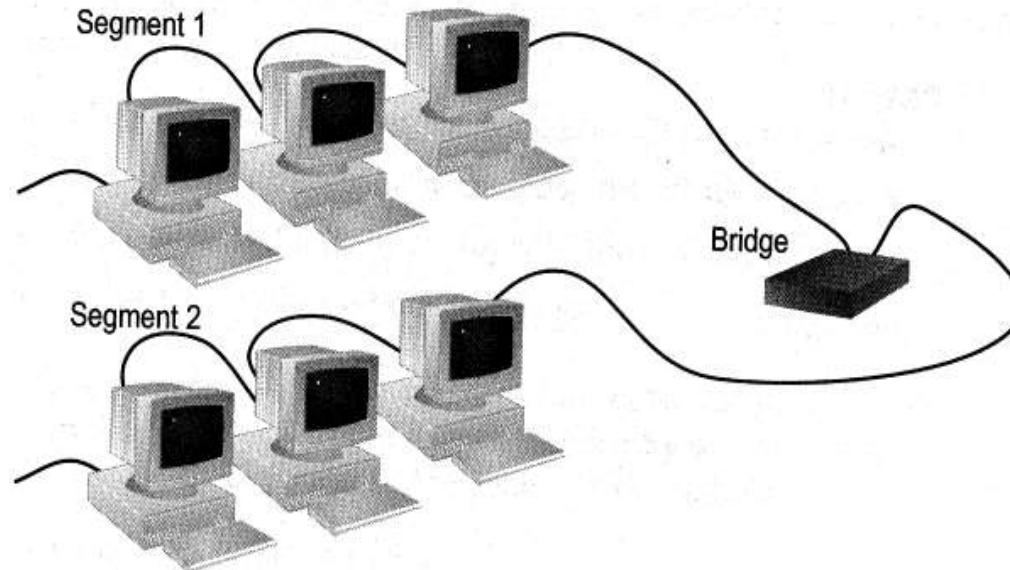# Network Devices

Bamma Ravind – March 2023

Functions of network devices

- **Separating (connecting)** networks or **expanding** network
  - e.g. repeaters, hubs, bridges, routers, brouters, switches, gateways

- **Remote access**
  - e.g. 56K Modems and ADSL modems

A. Expanding Network

- **Networks cannot be made larger by simply adding new computers and more cables**
    - **Less efficient !!**

- **Can install components to**
    - **segment (divide) large LAN to form smaller LANs**
    - **connect LANs**
- **Required components**
    - **Repeaters, bridges, routers, brouters, switches or gateways**

Network Devices

a. Repeaters and Hubs

- **Repeaters or hubs work at the OSI physical layer to regenerate the network's signal and resend them to other segments**
- **Primitive hub can be viewed as a multiport repeater**
  - **It regenerates data and broadcasts them to all ports**

Weakened signal

Hub

Repeater

Regenerated signal
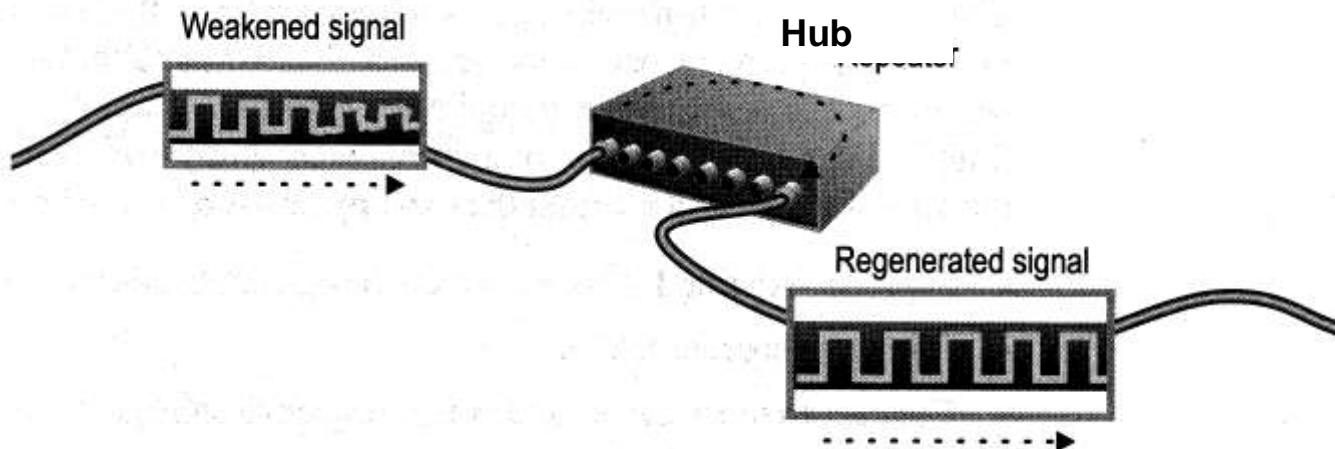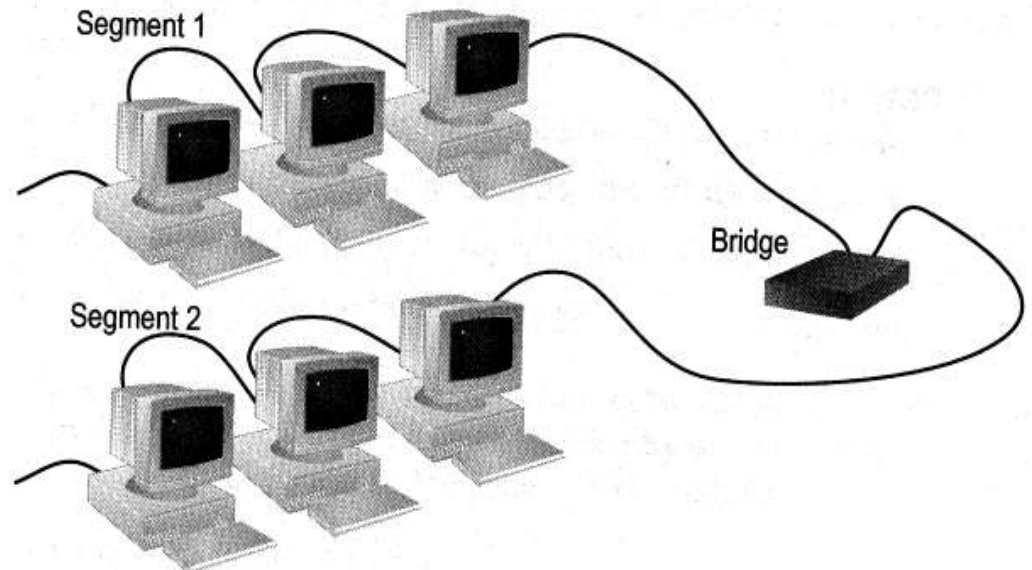
Network Devices

Limitations and Features

- **Cannot** link unlike segments
- **Cannot** join segments with different access methods (e.g. CSMA/CD and token passing)
- **Do not** isolate and filter packets

- **Can** connect different types of media
- The most **economic** way of expanding networks

Thin coax

Fiber-optic
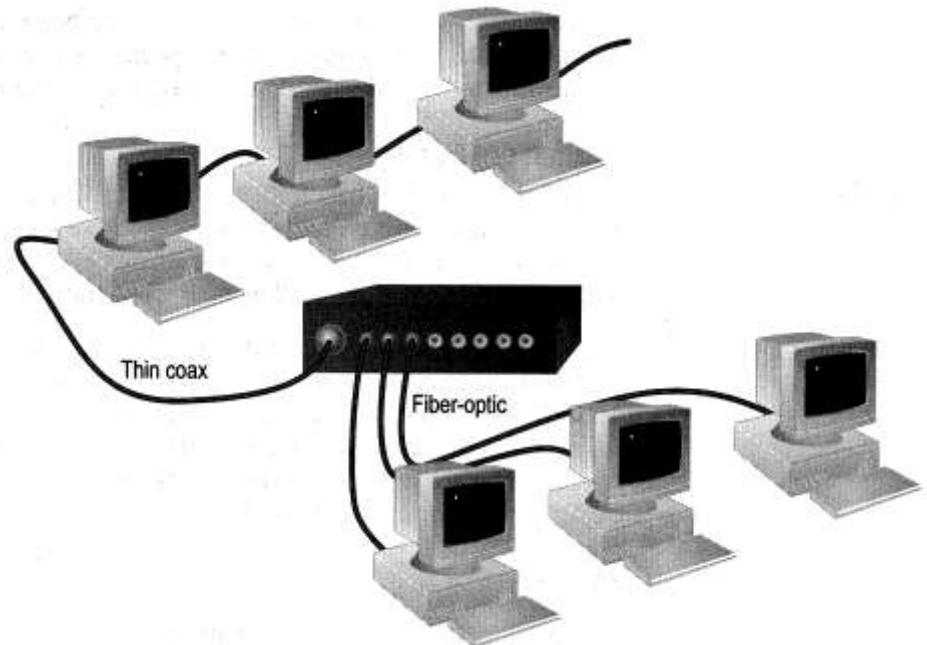
Network Devices

b. Bridges

- **Has one input and one output**
- **Used to isolate network traffic and computers**
- **Has the intelligent to examine incoming packet source and destination addresses**
- **But cannot interpret higher-level information**
- **Hence cannot filter packet according to its protocol**

Network Devices

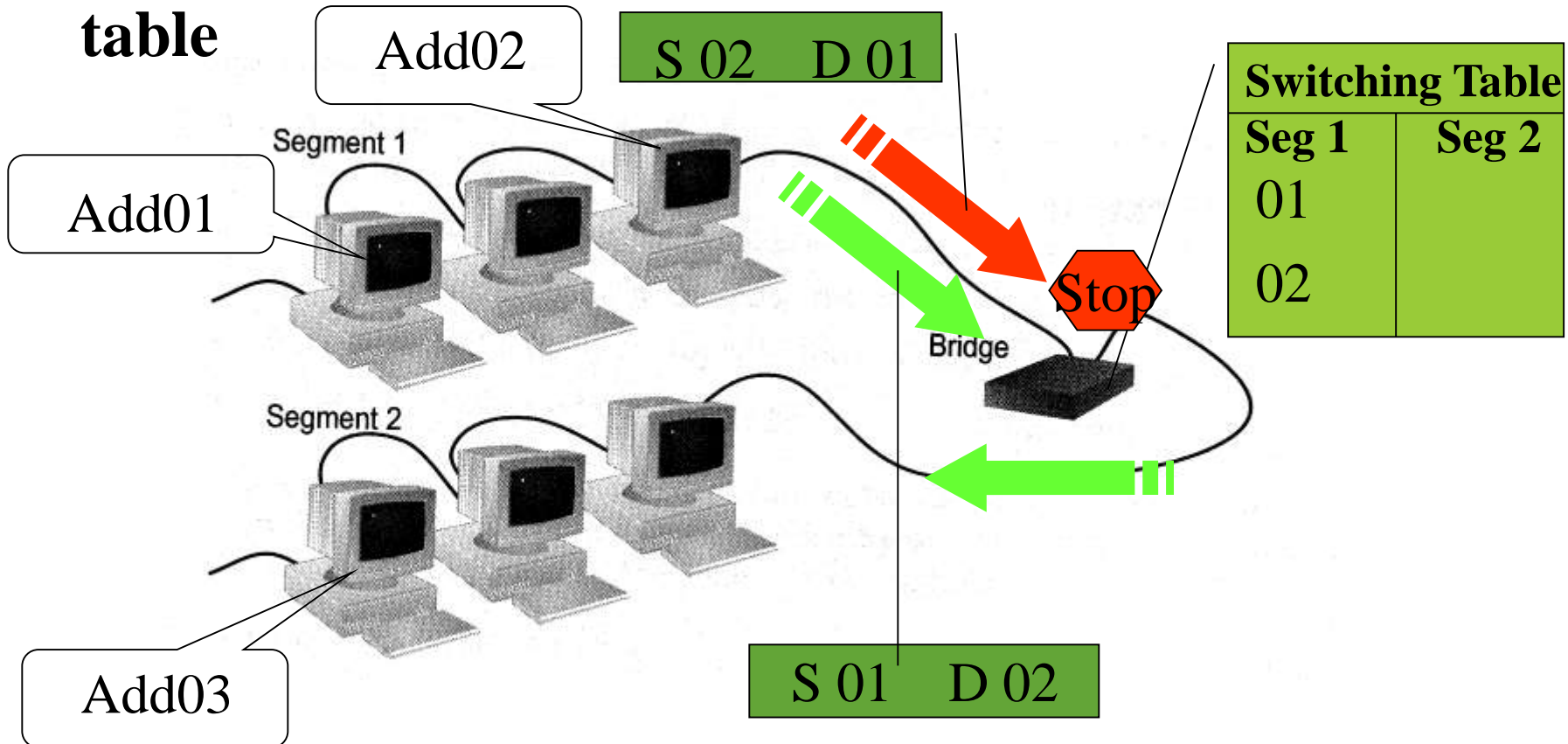## How Bridges Work

- **Bridges work at the Media Access Control Sub-layer of the OSI model**
- **Routing table is built to record the segment no. of address**
- **If destination address is in the same segment as the source address, stop transmit**
- **Otherwise, forward to the other segment**

02608c133456

Segment 1

Routing Table

Bridge

Segment 2

02608c133561
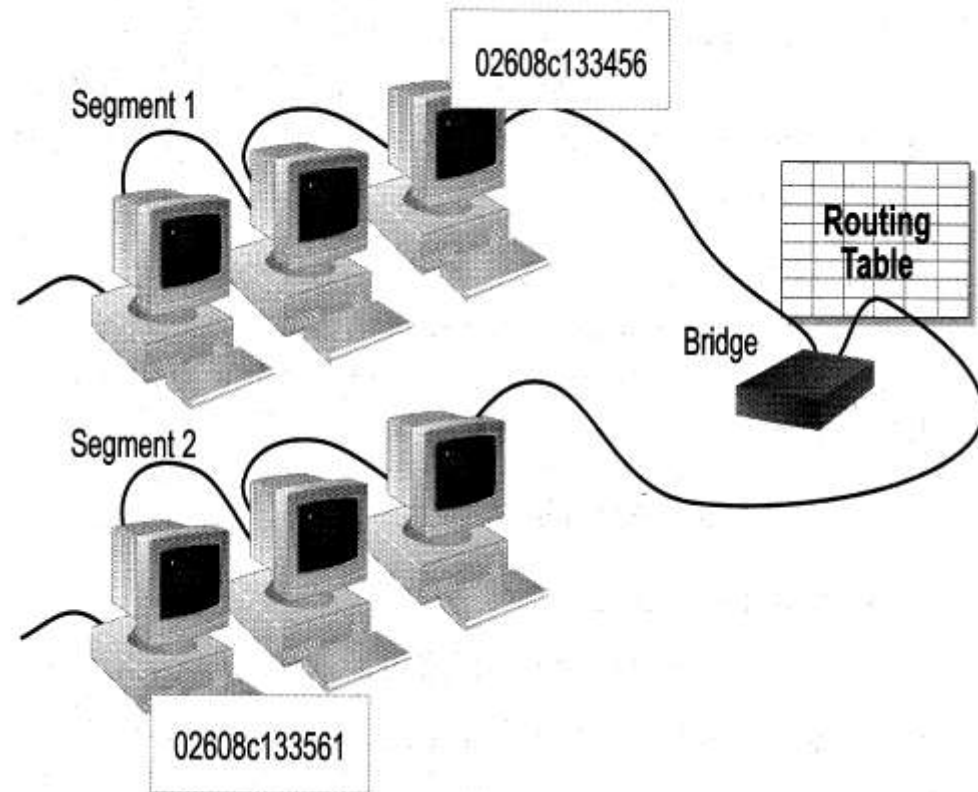
Creating a Switching Table

- **Based on the addresses of the sending computers**
- **New addresses are added if they are not in the table**

Add02

S 02   D 01

Add01

Segment 1

Bridge

Stop

Segment 2

Add03

S 01   D 02

Switching Table	
Seg 1	**Seg 2**
01	
02	

Network Devices

Remote Bridges

- **Bridges are often used in large networks that have widely dispersed segments**
- **Remote bridges can be used to connect remote segments via data-grade telephone line**

Dedicated phone line

Synchronous modem

Synchronous modem

Remote bridge

Remote bridge

Segment 1

Segment 2
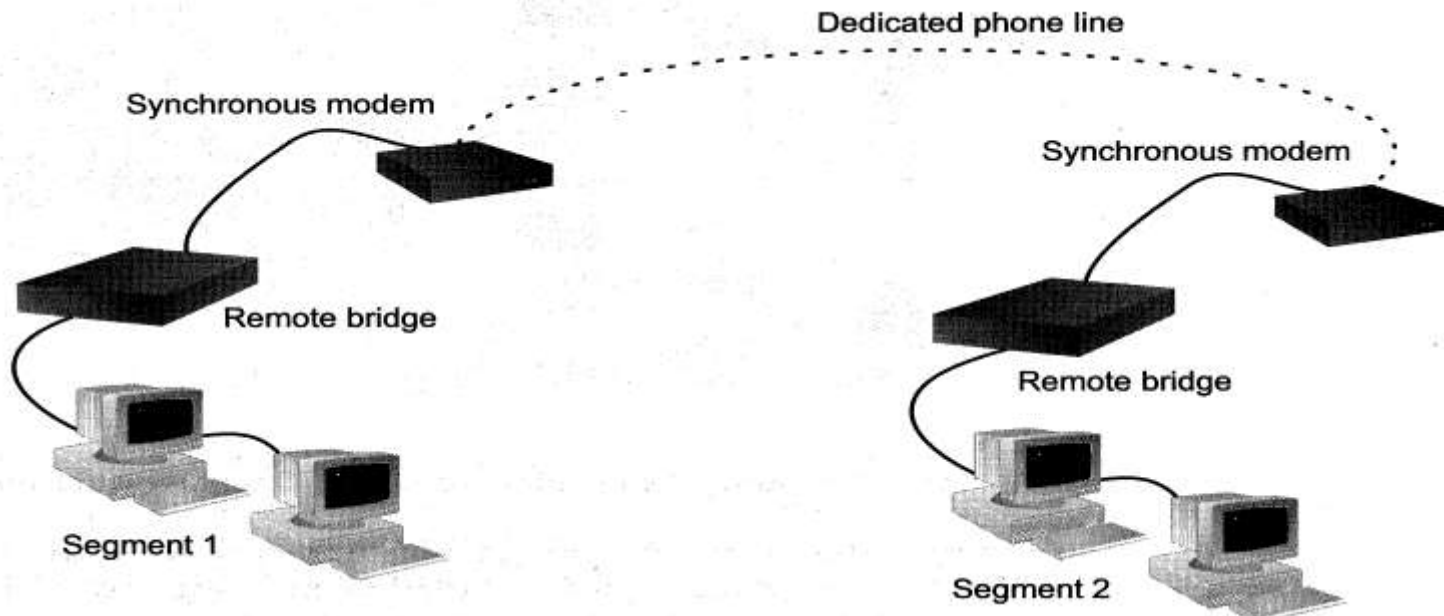
Network Devices

Differences Between Bridges and Repeaters

|	*Repeaters*	*Bridges*
OSI layer	Physical layer	Data link layer
Data regeneration	Regenerate data at the signal level	Regenerate data at the packet level
Reduce network traffic	No	Yes

Network Devices

c. Switches

- **Switches operate at the Data Link layer (layer 2) of the OSI model**
- **Can interpret address information**
- **Switches resemble bridges and can be considered as multiport bridges**
- **By having multiports, can better use limited bandwidth and prove more cost-effective than bridge**

Network Devices

- **Switches divide a network into several isolated channels**
- **Packets sending from 1 channel will not go to another if not specify**
- **Each channel has its own capacity and need not be shared with other channels**

Hub

Switch

10Mbps

3.3Mbps

3.3Mbps

3.3Mbps

10Mbps

10Mbps

10Mbps
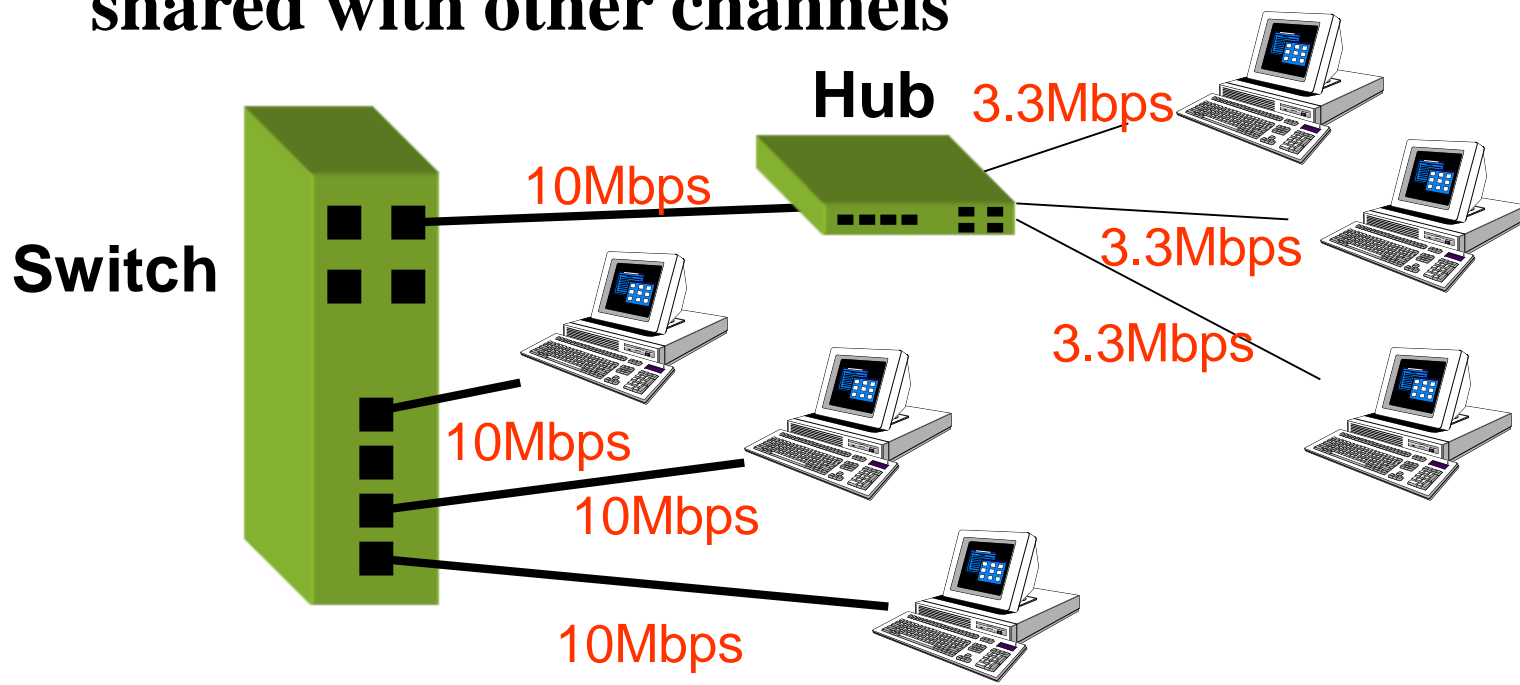
Network Devices

Advantages of Switches

- **Switches divide a network into several isolated channels (or collision domains)**
  - **Reduce the possibility of collision**
    - Collision only occurs when two devices try to get access to one channel
    - Can be solved by buffering one of them for later access
  - **Each channel has its own network capacity**
    - Suitable for real-time applications, e.g. video conferencing
  - **Since isolated, hence secure**
    - Data will only go to the destination, but not others

Network Devices

Limitations of Switches

- **Although contains buffers to accommodate bursts of traffic, can become overwhelmed by heavy traffic**
  - **Device cannot detect collision when buffer full**
    - **CSMA/CD scheme will not work since the data channels are isolated, not the case as in Ethernet**
  - **Some higher level protocols do not detect error**
    - **E.g. UDP**
  - **Those data packets are continuously pumped to the switch and introduce more problems**

Network Devices

## Method of Switching - Cut Through Mode

Preamble		Des. Add	Sour. Add	Length	Data	FCS
7 Bytes	1 Byte	2/6 Bytes	2/6 Bytes	2 Bytes	46 - 1500 Bytes	4 Bytes

- **Read the first 14 bytes of each packet, then transmit**
- **Much faster**
- **Cannot detect corrupt packets**
- **Can propagate the corrupt packets to the network**
- **Best suited to small workgroups**

Network Devices

## Method of Switching - Store and Forward Mode

- **Read the whole packet before transmit**
- **Slower than the cut-through mode**
- **More accurate since corrupt packets can be detected using the FCS**
- **More suit to large LAN since they will not propagate error packets**
- **Facilitate data transfer between segments of different speed**

DB
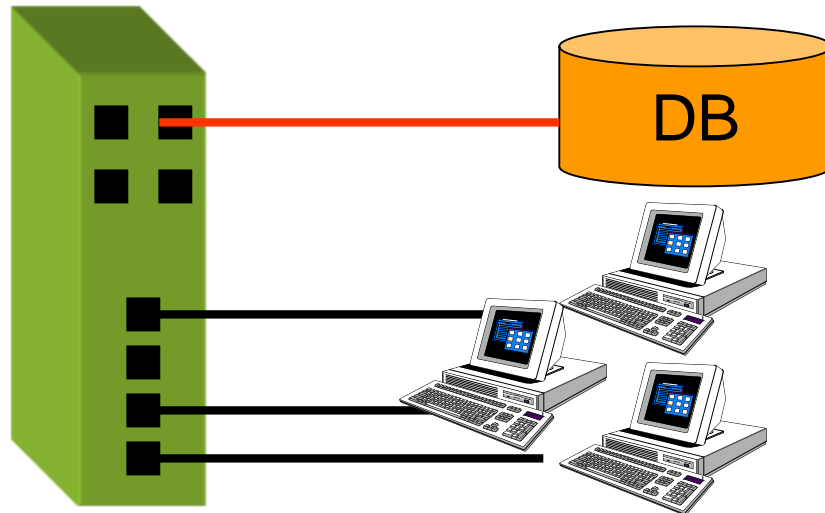
Network Devices

Using Switches to Create VLANs

- **Switches can logically group together some ports to form a virtual local area network (VLAN)**
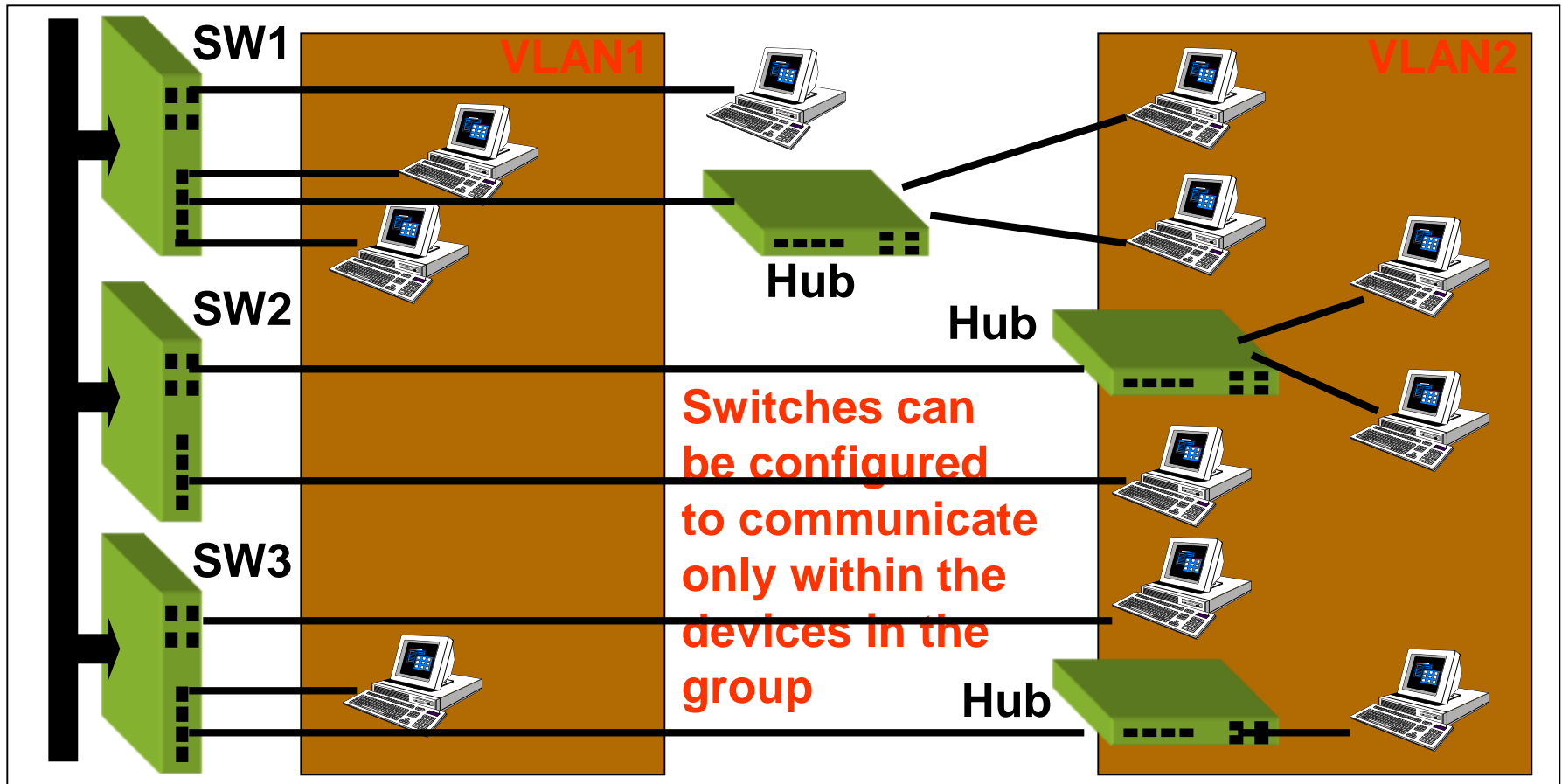
d. Routers

- **Layer 2 Switches cannot take advantage of multiple paths**
- **Routers work at the OSI layer 3 (network layer)**
- **They use the "logical address" of packets and routing tables to determine the best path for data delivery**

Dest.	Adjacent router	Hops
H	B	2
H	F	4

A's routing table
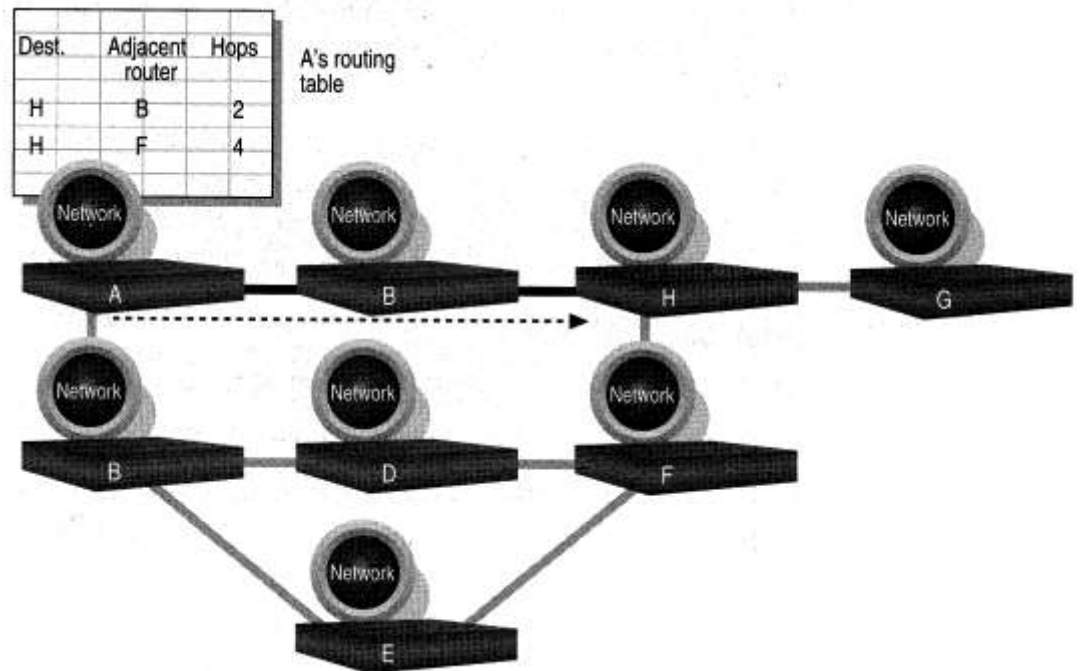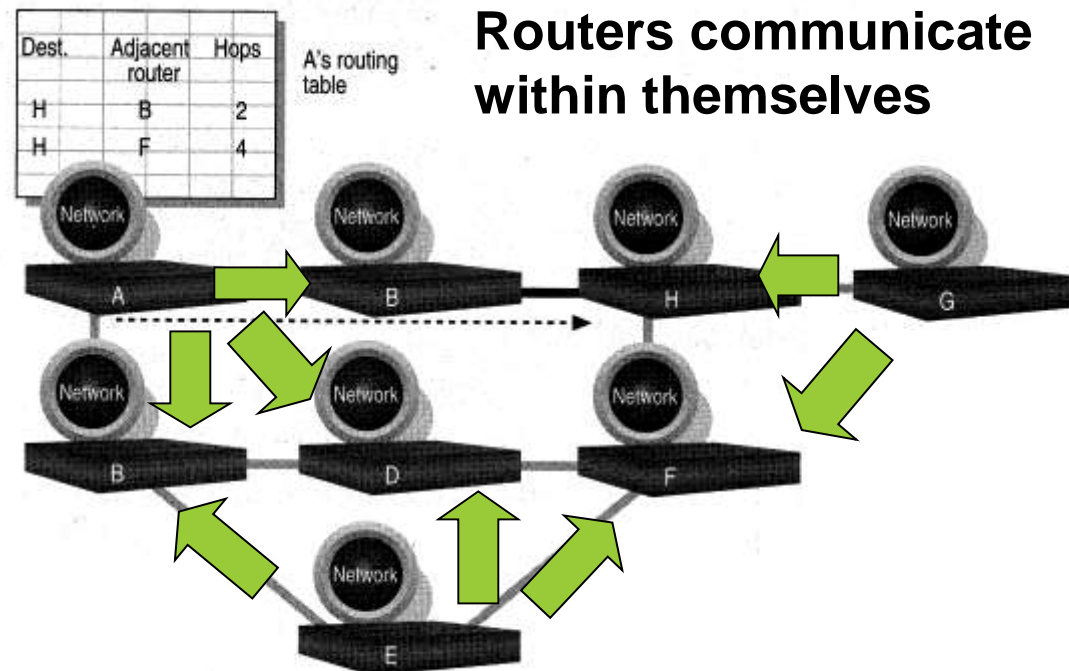
Network Devices

How Routers Work

- **As packets are passed from routers to routers, Data Link layer source and destination addresses are stripped off and then recreated**

- **Enables a router to route a packet from a TCP/IP Ethernet network to a TCP/IP token ring network**

- **Only packets with known network addresses will be passed** **- hence reduce traffic**

- **Routers can listen to a network and identify its busiest part**

- **Will select the most cost effective path for transmitting packets**

Network Devices

How Routing Table is formed

- **Routing table is formed based on communications between routers using "Routing Protocols"**

    - **Routing Protocols ≠ Routable Protocol**

- **Routing Protocols collect data about current network status and contribute to selection of the best path**

Routers communicate within themselves

Network Devices

Routing Protocol Example - RIP for IP Routing

- **RIP** (**Routing Information Protocol**) **— the oldest one**

- **Use no. of hops between nodes to determine best path**

- **Does not consider the network congestion condition**

- **Broadcast every 30 sec the routing table to neighbouring routers to convey routing information**

- **RIP is limited to interpreting a maximum of 16 hops**

- **Not suitable for large network (e.g. Internet)**

- **Can create excessive network traffic due to broadcasting**

- **May take a long time to reach the far reaches**

Network Devices

Routing Protocol Example - OSPF for IP

- **OSPF - Open Shortest Path First**

- **Make up the limitations of RIP - can coexist with RIP**

- **In general case, best path refers to the shortest path**

- **In case of traffic congestion, can go a longer path**

- **Each router maintains a database of other router's links**

- **If link failure notice is received, router can rapidly compute an alternate path**

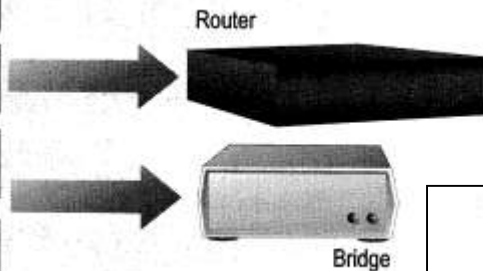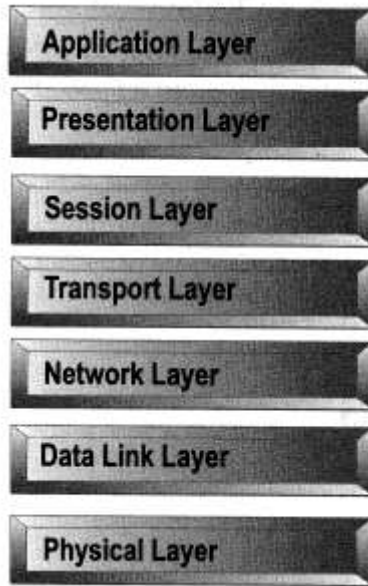- **Require more memory and CPU power**

Network Devices

Static and Dynamic Routers

| Static Routers	Dynamic Routers
Manual configuration of routes	Manual configuration of the first route. Automatic discovery of new routes
Always use the same route	Can select the best route
More secure	Need manual configuration to improve security

Network Devices

Application Layer

Presentation Layer

Session Layer

Transport Layer

Network Layer

Data Link Layer

Physical Layer

Distinguishing Between Bridges and Routers

Router

Bridge

- **Bridges** forward everything they don't recognize
- **Routers** select the best path

- **Routers** are layer 3 devices which recognize network address
- **Bridges** are layer 2 devices which look at the MAC sublayer node address
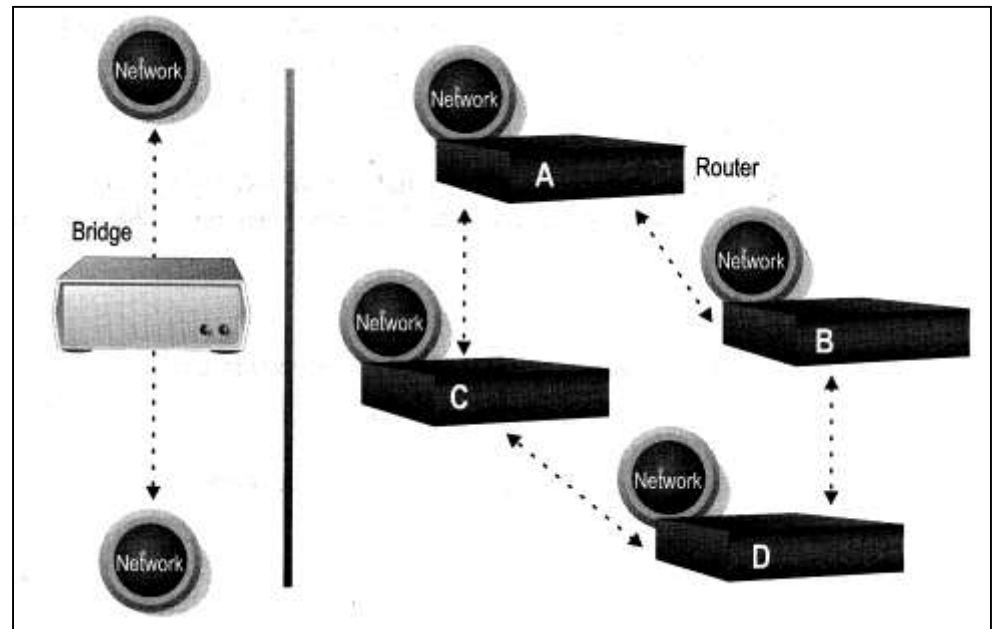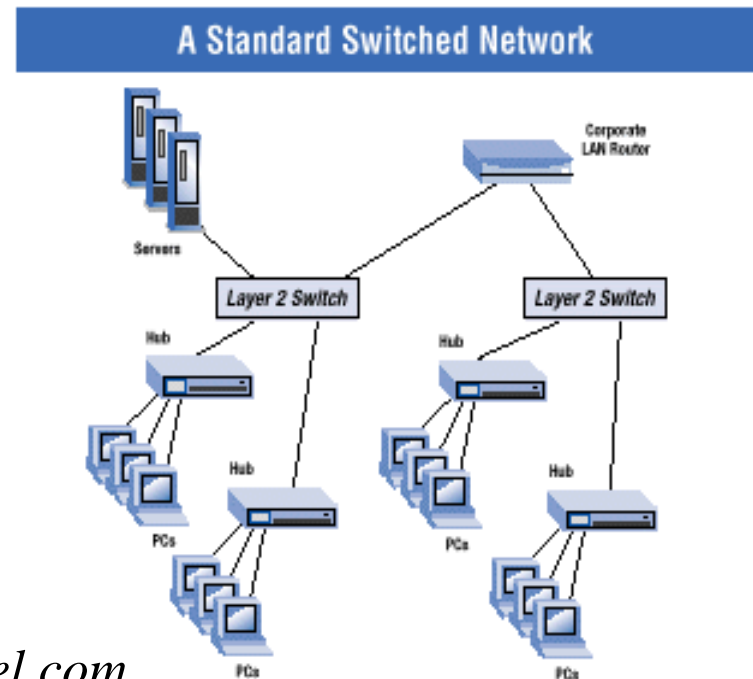
Network Devices

Layer-3 Switches

- **Layer-3 switches operate in both layer 2 (data link layer) and 3 (network layer)**
- **Can perform both MAC switching and IP routing**
- **A combination of switch and router but much faster and easier to configure than router**

Why Layer-3 switches?

- **Traffic of LAN is no longer local**
- **Speed of LAN is much faster**
- **Need a much faster router, however, very expensive**

A Standard Switched Network

Excerpt from www.intel.com

Network Devices

Summary

- **Repeaters** are the least expensive way to expand a network, but they are limited to connecting two segments

- **Bridges** function similar to repeaters, but can understand the node addresses

- **Switches** can be considered as multiport bridges, can divide a network into some logical channels

- **Routers** interconnect networks and provide filtering functions. They can determine the best route

Network Devices