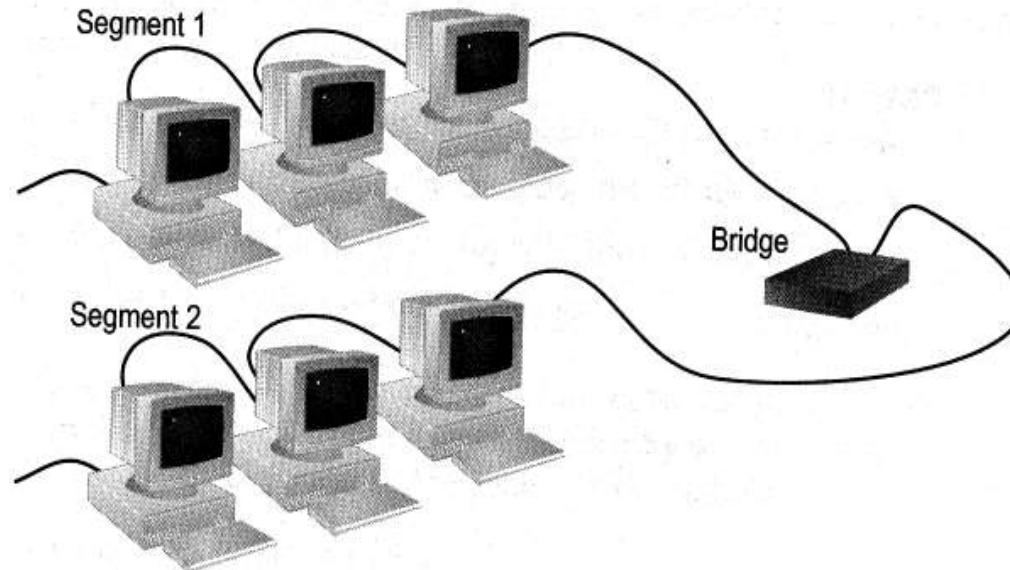


Network Devices



Network Devices

Bamma Ravind – March 2023

Network Devices

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

Network Devices

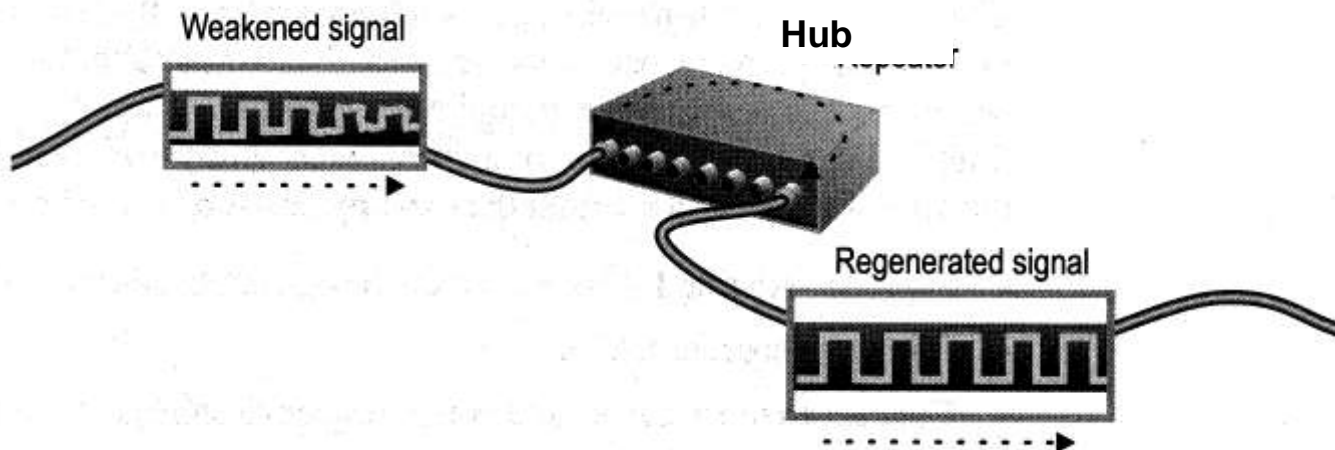
A. Expanding Network

- 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

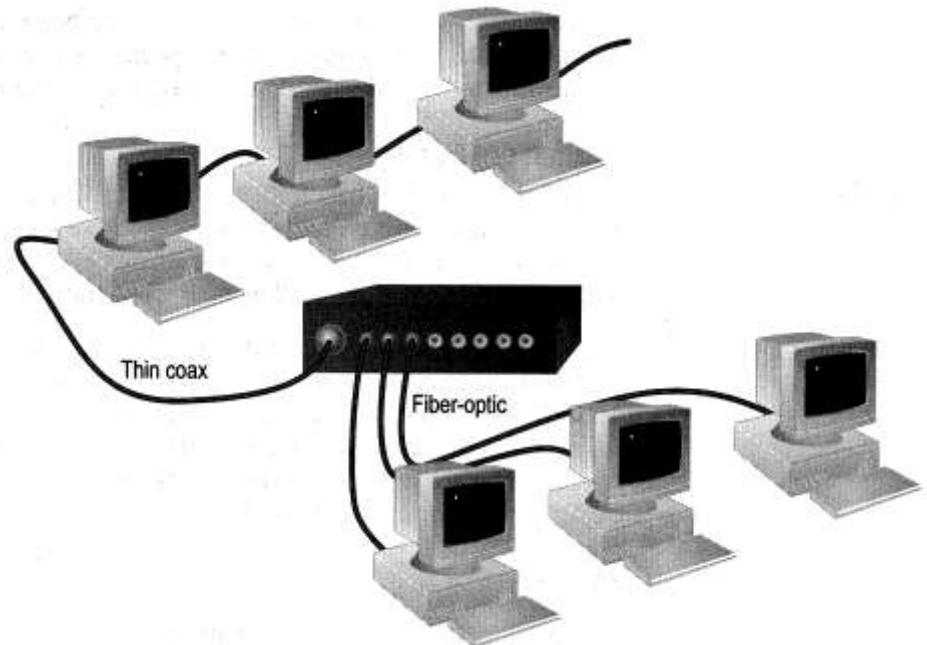
- Repeaters or hubs work at the OSI **physical layer** to **regenerate the network's signal** and resend them to other segments
- Primitive hub can be viewed as a multiport repeater
 - It regenerates data and broadcasts them to all ports



Network Devices

Limitations and Features

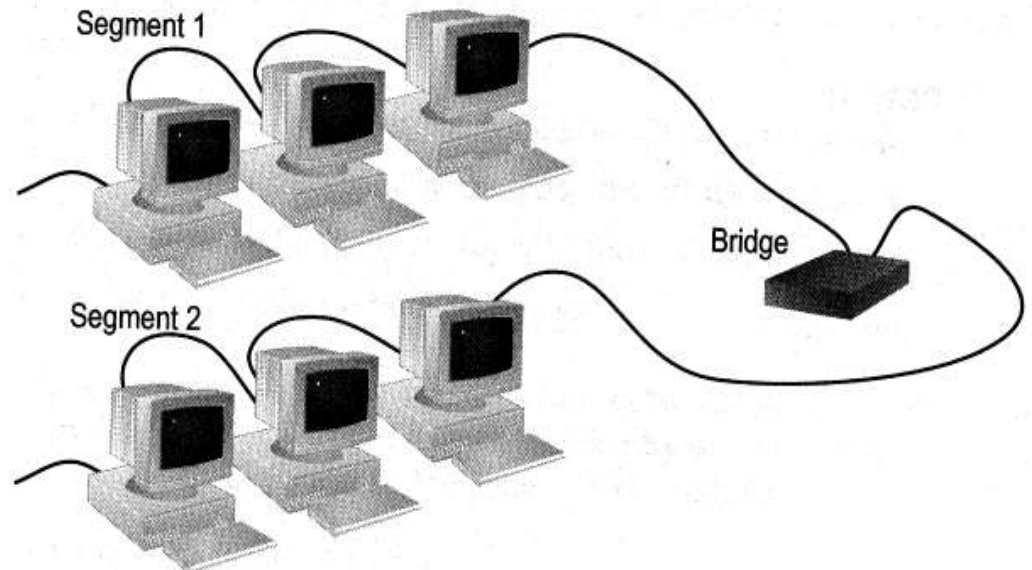
- **Cannot** link unlike segments
- **Cannot** join segments with different access methods (e.g. CSMA/CD and token passing)
- **Do not** isolate and filter packets
- **Can** connect different types of media
- The most **economic** way of expanding networks



Network Devices

b. Bridges

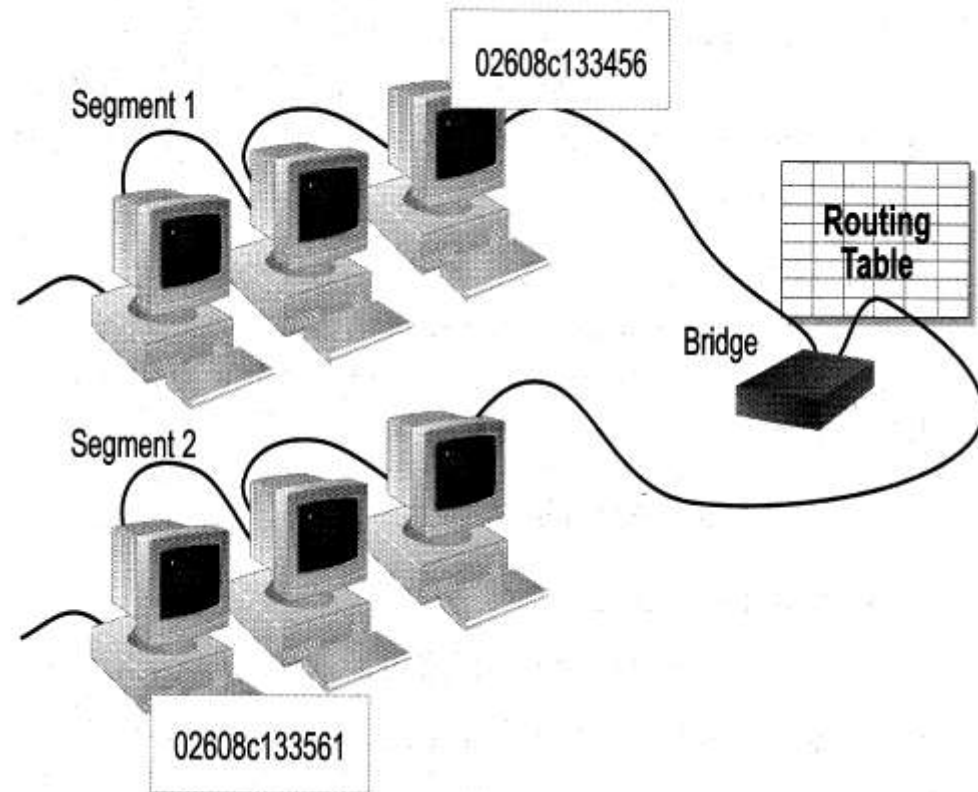
- Has one input and one output
- Used to **isolate network traffic** and computers
- Has the intelligent to examine incoming packet source and destination addresses
- But **cannot** interpret higher-level information
- Hence **cannot** filter packet according to its protocol



Network Devices

How Bridges Work

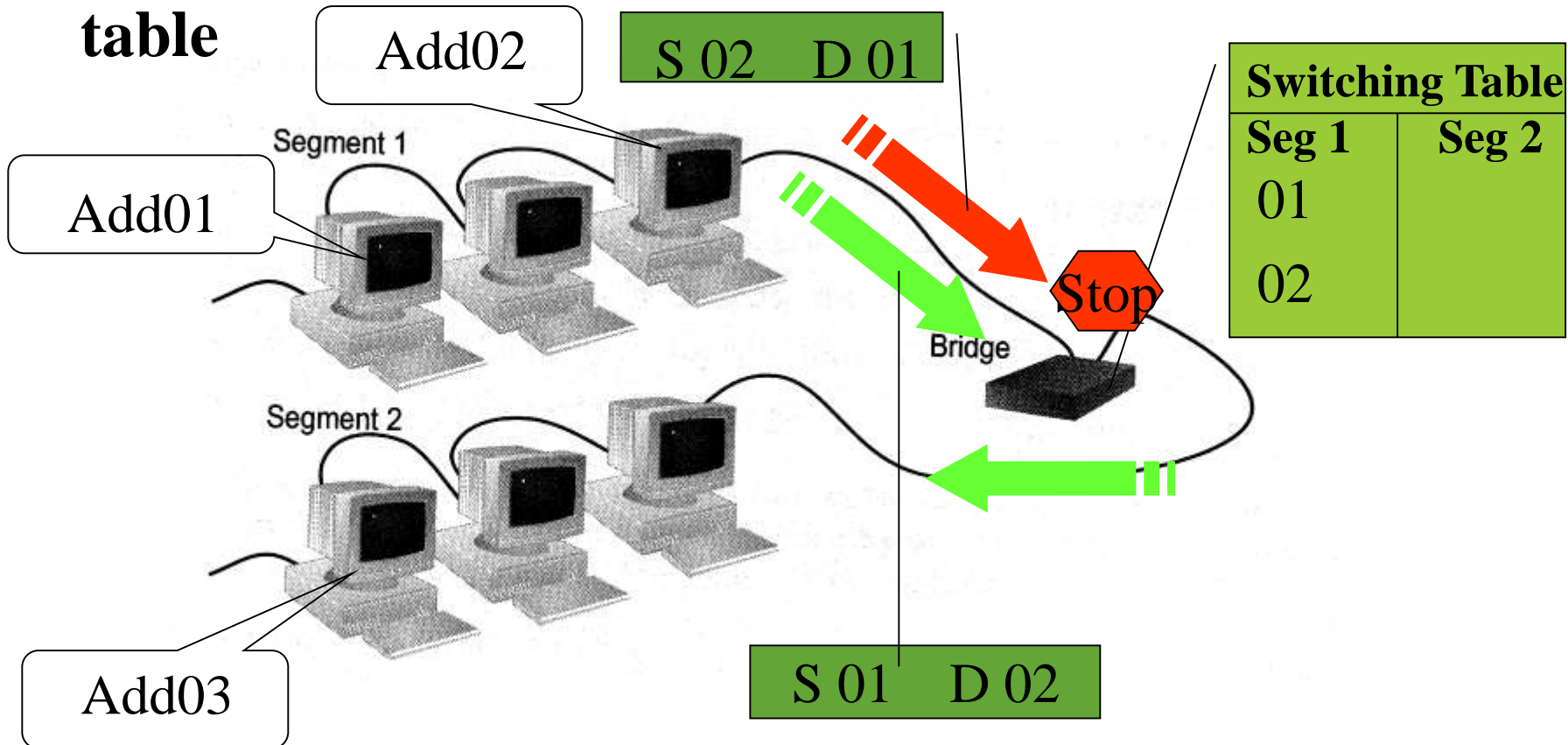
- Bridges work at the **Media Access Control Sub-layer** of the OSI model
- Routing table is built to record the segment no. of address
- If destination address is in the same segment as the source address, stop transmit
- Otherwise, forward to the other segment



Network Devices

Creating a Switching Table

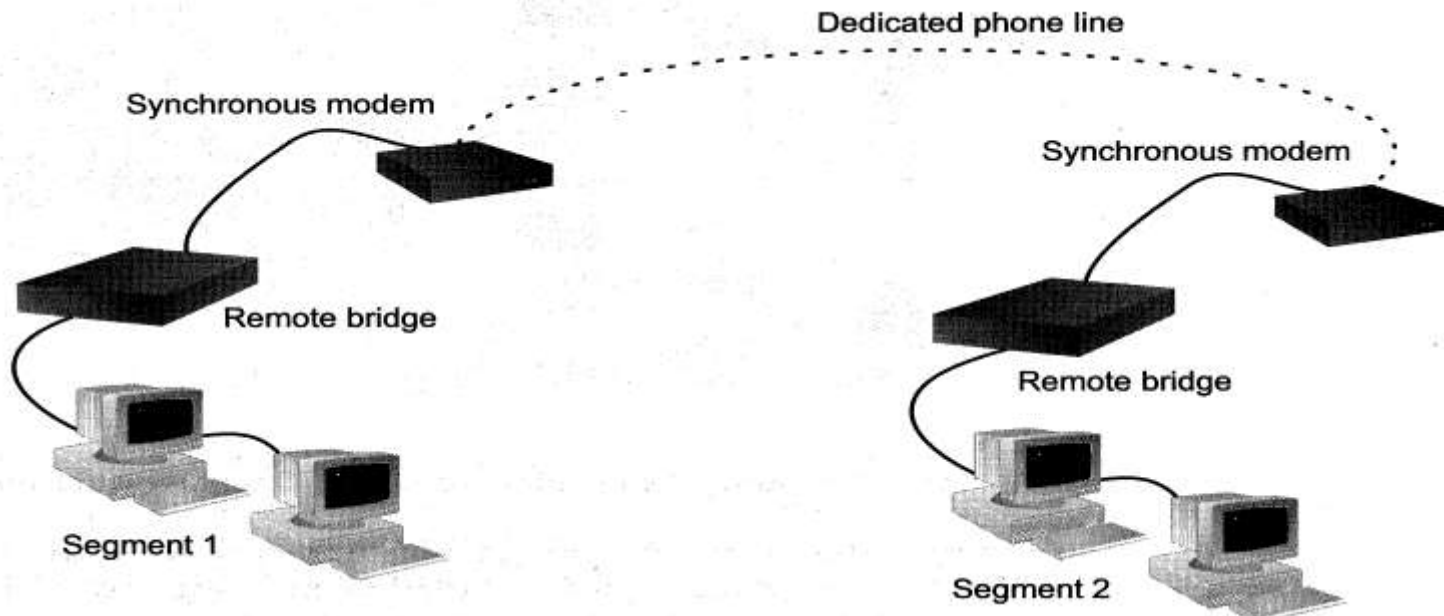
- Based on the addresses of the sending computers
- New addresses are added if they are not in the table



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



Network Devices

Differences Between Bridges and Repeaters

	<i>Repeaters</i>	<i>Bridges</i>
<i>OSI layer</i>	Physical layer	Data link layer
<i>Data regeneration</i>	Regenerate data at the signal level	Regenerate data at the packet level
<i>Reduce network traffic</i>	No	Yes

Network Devices

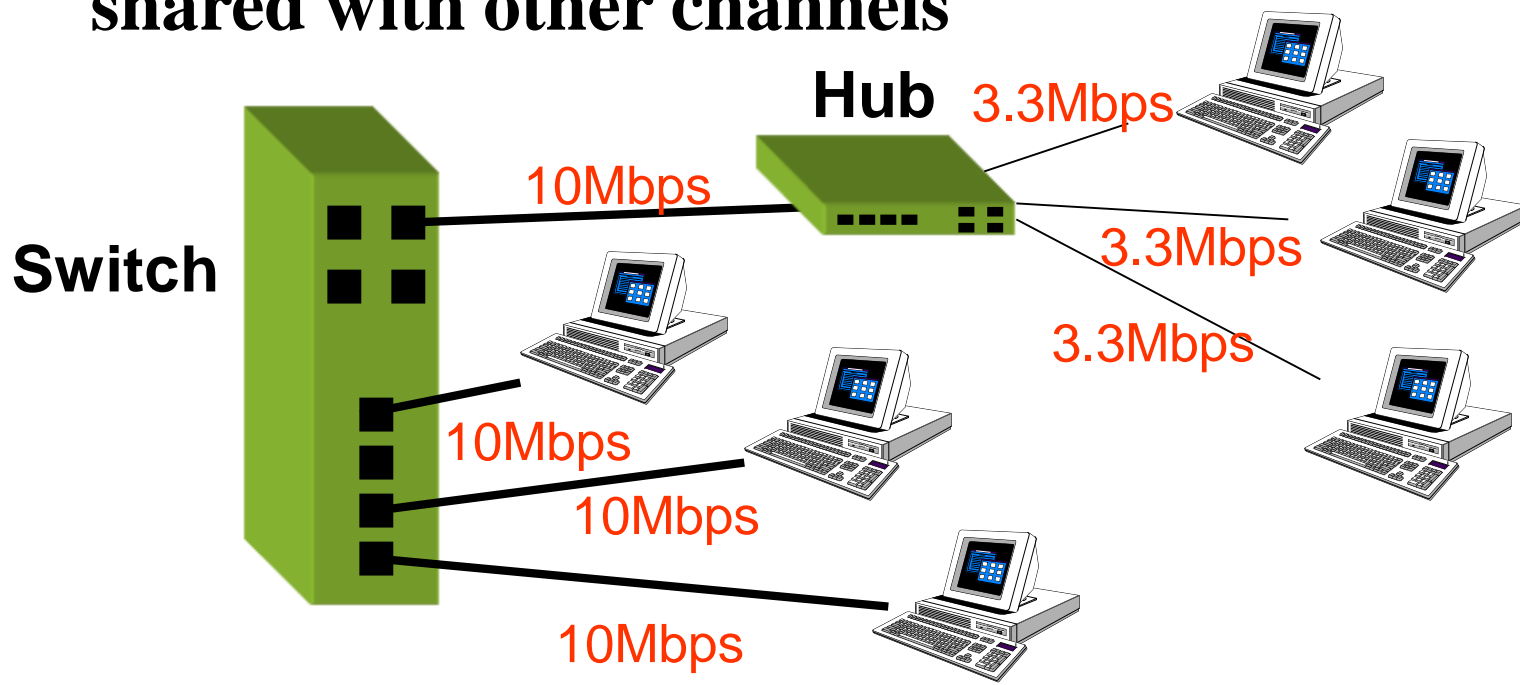
c. Switches

- 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



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

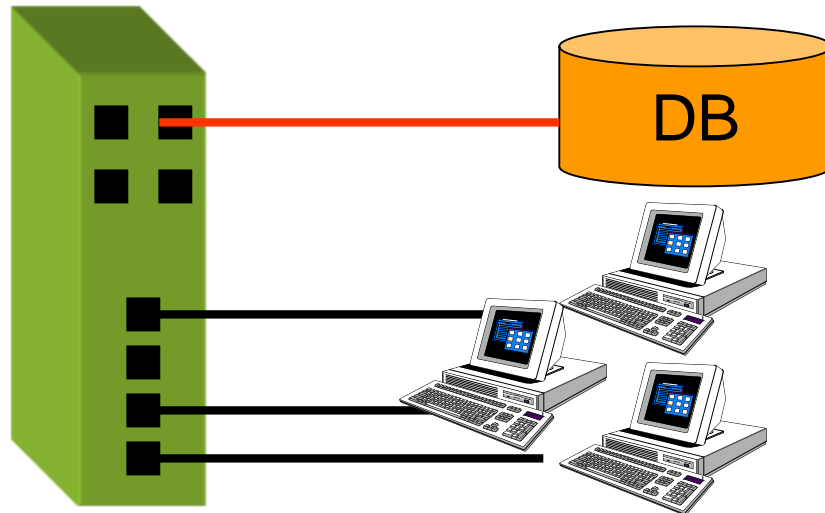
Preamble		Des. Add	Sour. Add	Length	Data	FCS
7 Bytes	1 Byte	2/6 Bytes	2/6 Bytes	2 Bytes	46 - 1500 Bytes	4 Bytes

- 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

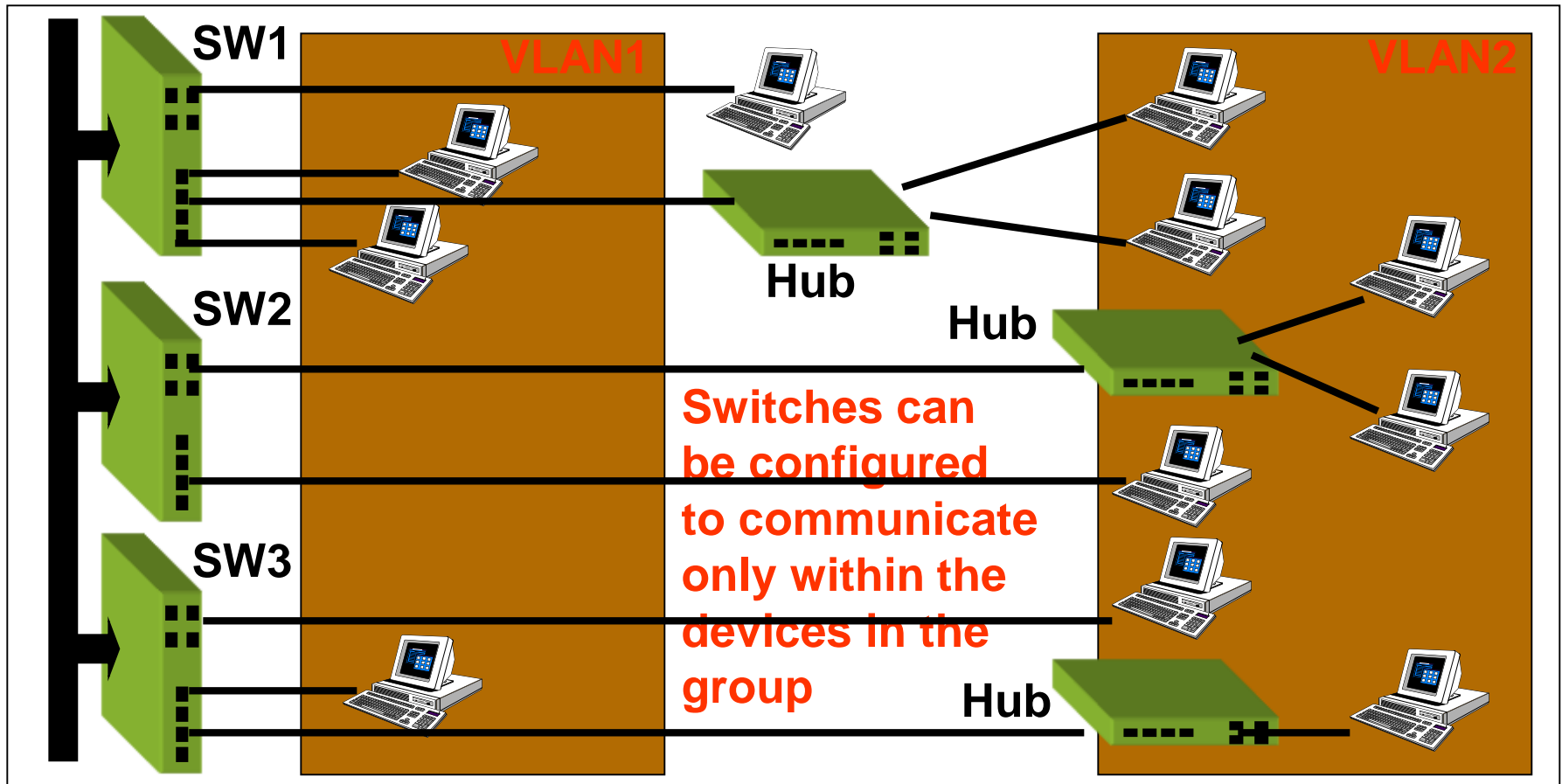
- **Read the whole packet before transmit**
- **Slower than the cut-through mode**
- **More accurate since corrupt packets can be detected using the FCS**
- **More suit to large LAN since they will not propagate error packets**
- **Facilitate data transfer between segments of different speed**



Network Devices

Using Switches to Create VLANs

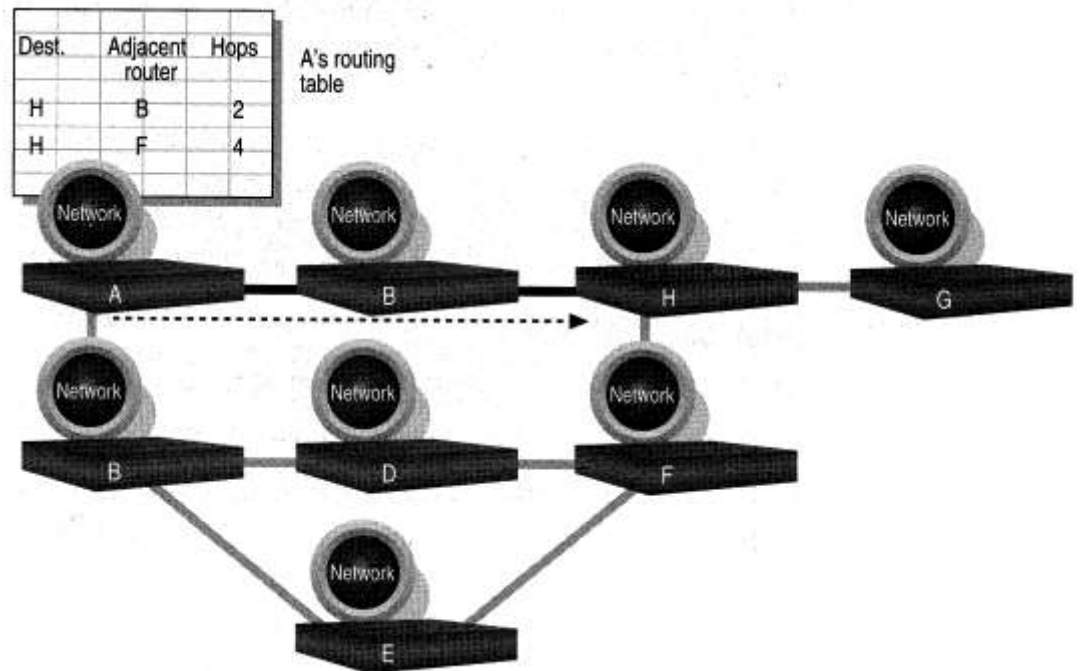
- Switches can logically group together some ports to form a virtual local area network (VLAN)



Network Devices

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



Network Devices

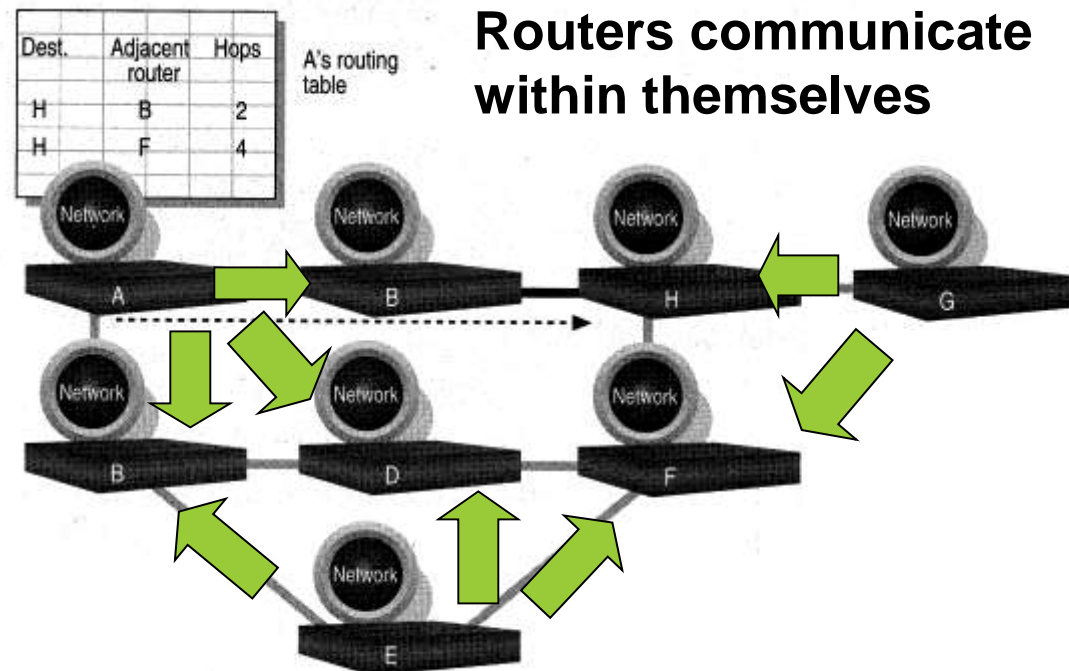
How Routers Work

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



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**

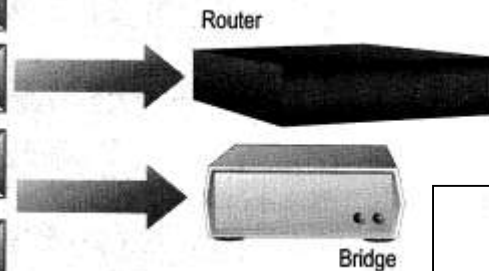
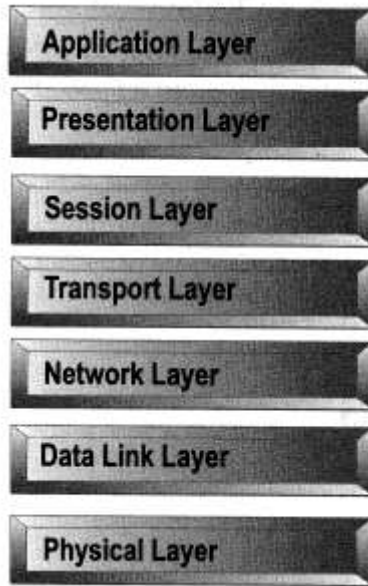
Network Devices

Static and Dynamic Routers

<i>Static Routers</i>	<i>Dynamic Routers</i>
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

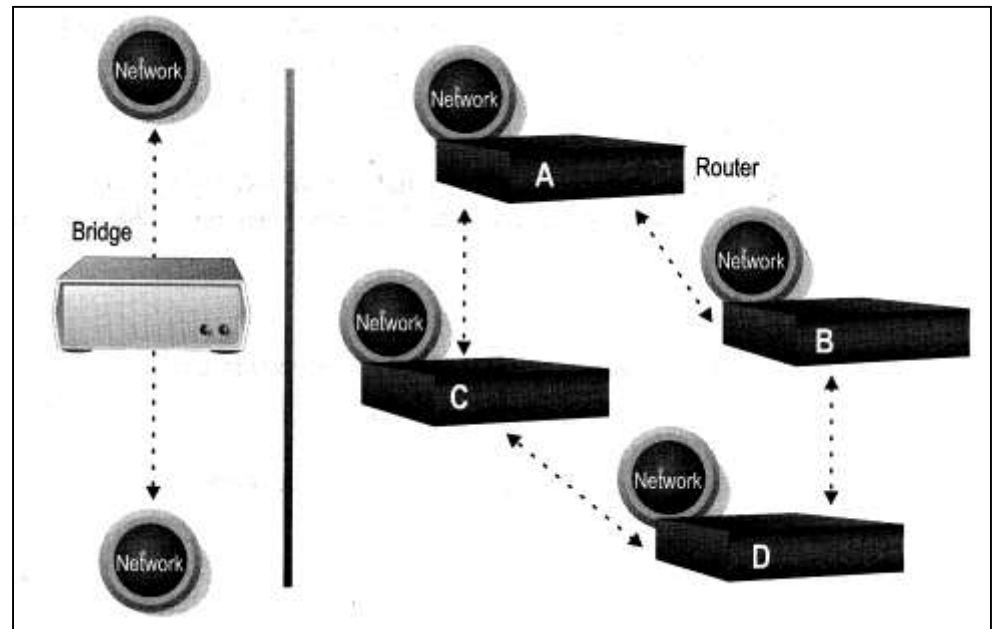
Network Devices

Distinguishing Between Bridges and Routers



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

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



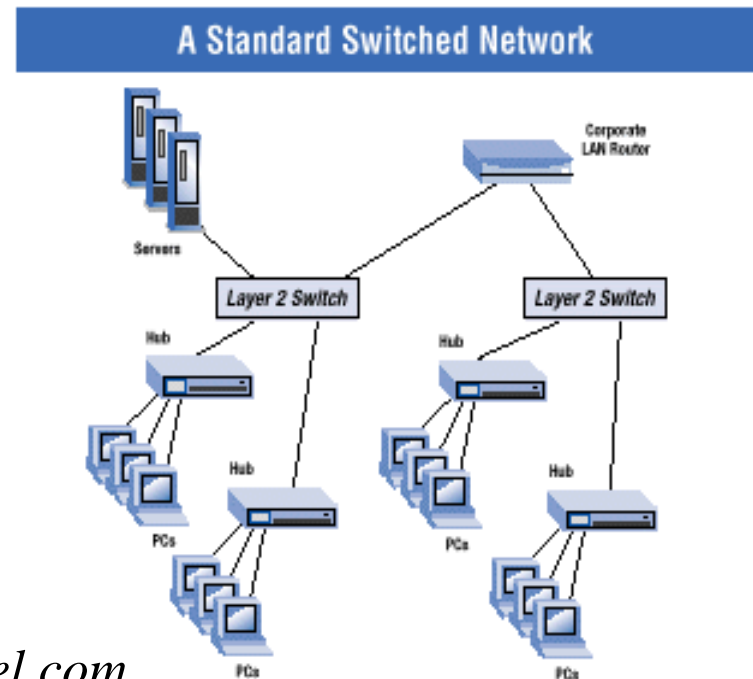
Network Devices

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



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

