

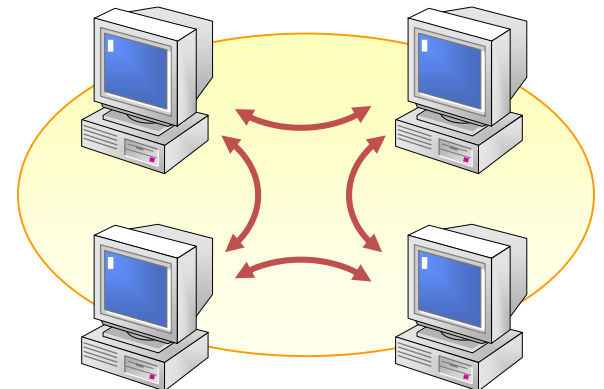
-LAN,WAN,MAN

Syllabus

- Define the terms LAN,MAN,WAN
- Difference between broadcast media access& non-broadcast media access
- LAN technologies (Ethernet , token ring)
- LAN Topologies
- Devices (NIC, Hub, [Switch](#) , [Router](#)) and their operating layers
- Effects & causes of network
- Factors of total throughput
- Transmission media ([STP](#), [UTP](#), Coaxial, [Optical fiber](#), [wireless](#))
- Typical areas covered by LAN, MAN, WAN
- MAN technologies (SDH, Leased line..)
- WAN technologies (FR, ATM)
- CSMA/CD & MAC

Computer Network

- Group of computers and other devices connected by some type of transmission media
- Communication mechanism between two or more computers using a common protocol.
- System that transmits any combination of voice, video and/or data between users.



Network Organization

- **Method by which the user's PC accesses it.**
 1. Centralized control – Client/Server
 2. Distributed control – Peer-to-peer

A Network Consists of,

- **Clients**
- **Server** (if Client/Server network is used)
- **Network components (NIC/Hub/Switch/Router)**
- **Transmission media**
- **Desktop Operating Systems** (Windows 95/98/Me, Windows 2000 Professional, Windows XP Home Edition, Windows XP Professional , Vista)
- **Network Operating System (NOS)** (If Client/Server network is used. Ex: Windows NT/2000/2003 server, Linux, Solaris etc...)
- **Peripherals** (Printers, Scanner...)

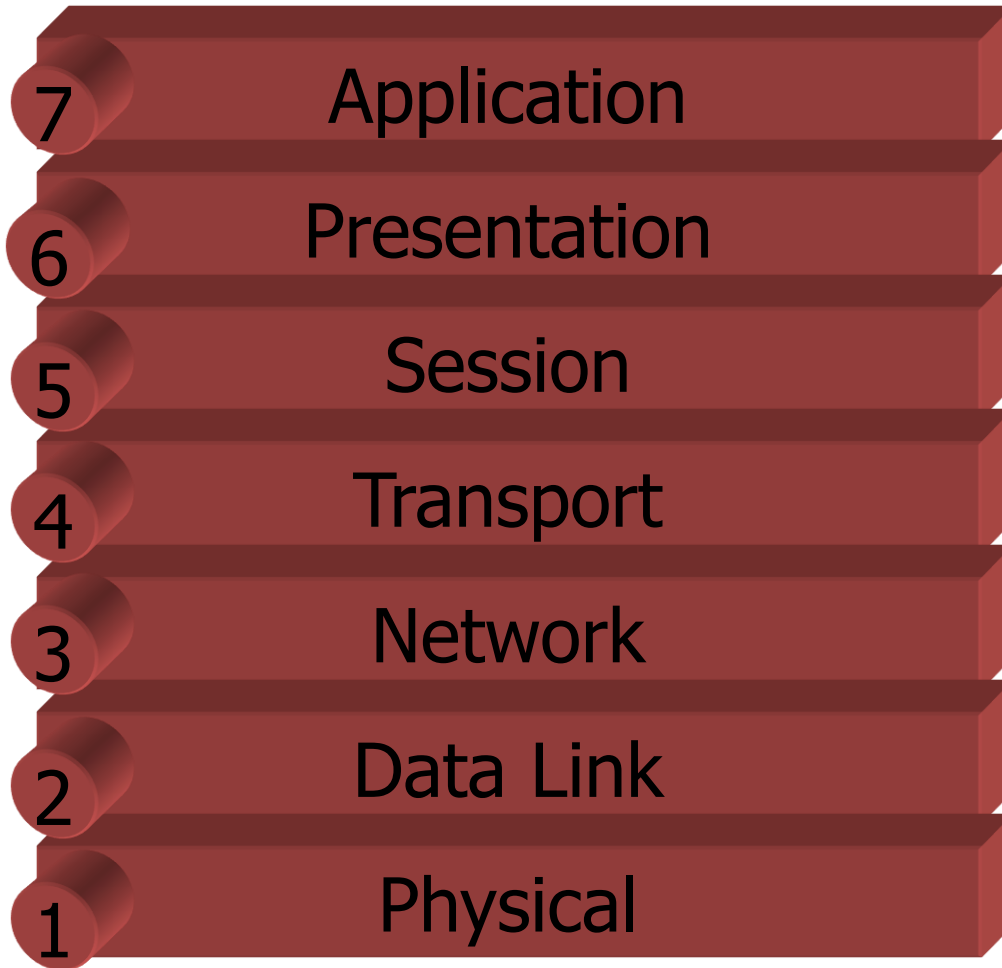
Network Components

- The network components constitute the hardware that is required to actually build your network.
- According to geographical dimension and access method of the network, the network components need to be chosen.
- Network components are:
 - Network Interface Card (NIC)
 - Hubs
 - Switches
 - Routers

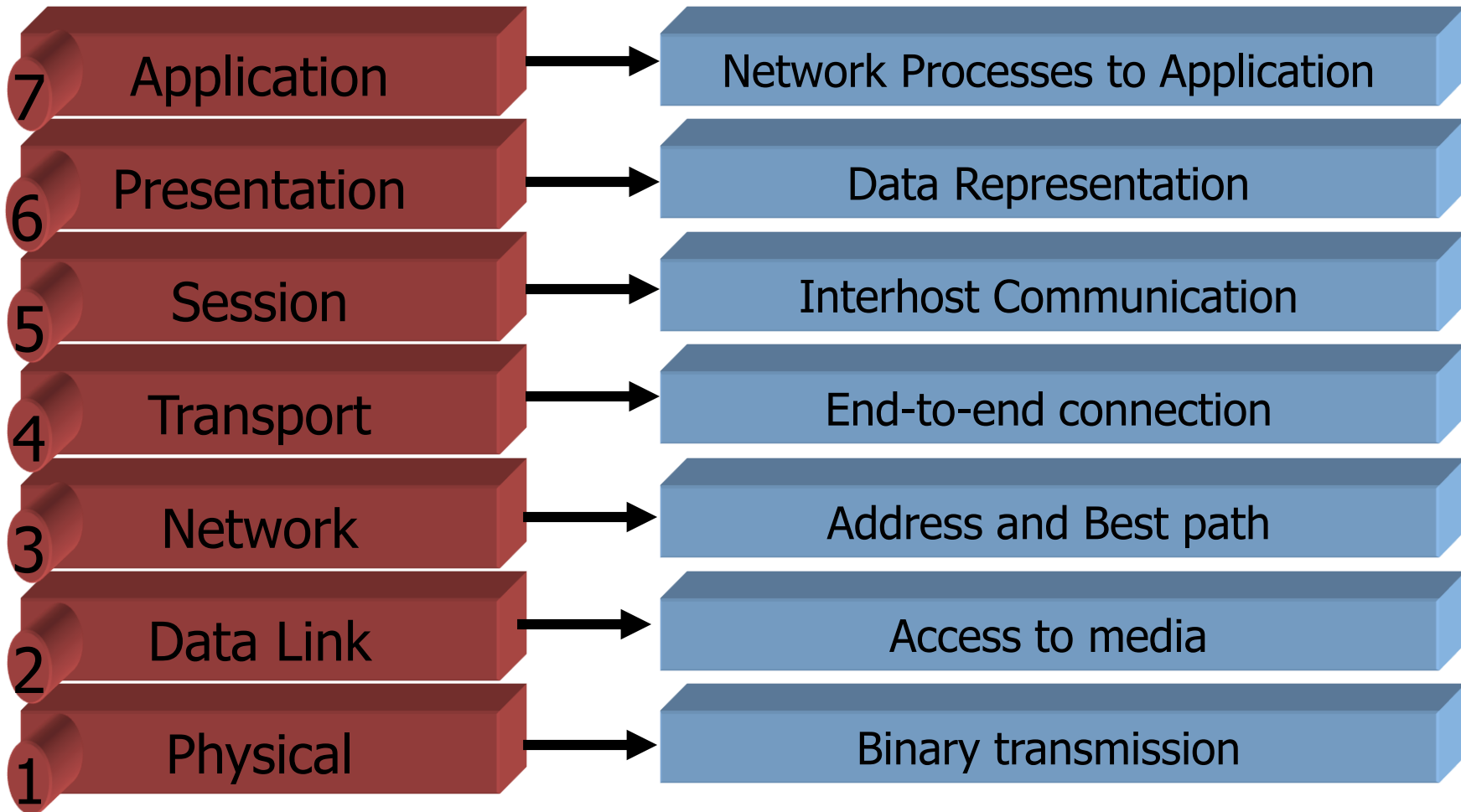
The Open Systems Interconnection (OSI) reference model



The 7 OSI Layers



OSI summery



3.Network Layer

- As the lowest three layers are network dependant their functionality varies from network to network.
- The network layer is responsible moving data through a set of networks (internetwork)
- Generally Network Layer provides routing and related functions that enable multiple data links to be combined into an internet work. It includes functionality such as network addressing and routing.
 - Routers use routing protocols to determine the best path for data transfer



2.Data Link Layer

- LAN Standards used by the data-link layer include,
 - IEEE 802.3 / Ethernet
 - IEEE 802.5 / Token Ring
 - FDDI (Fiber Distributed Data Interface)
- WAN Protocols used by the data-link layer include,
 - Frame relay,ATM,X.25
 - Point to Point Protocol (PPP)



Duplex

- A **duplex communication** system is a system composed of two connected parties or devices which can communicate with one another in both directions.

(The term *duplex* is not used when describing communication between more than two parties or devices.)

Half duplex

- A *half-duplex* system provides for communication in both directions, but only one direction at a time (not simultaneously). Typically, once a party begins receiving a signal, it must wait for the transmitter to stop transmitting, before replying.

Ex: walkie-talkie

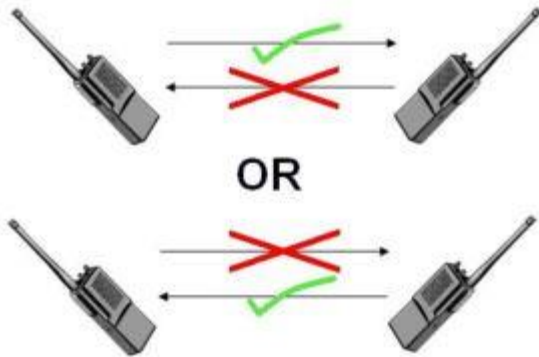
- style two-way radio, wherein one must use "Over" or another previously designated command to indicate the end of transmission, and ensure that only one party transmits at a time, because both parties transmit on the same frequency.

Full Duplex

- A *full-duplex* system allows communication in both directions, and unlike half-duplex, allows this to happen simultaneously.
- Land-line telephone networks are full-duplex since they allow both callers to speak and be heard at the same time.
- A good analogy for a *full-duplex* system would be a two lane road with one lane for each direction.
- Examples: Telephone, Mobile Phone, etc.

Half duplex & Full Duplex

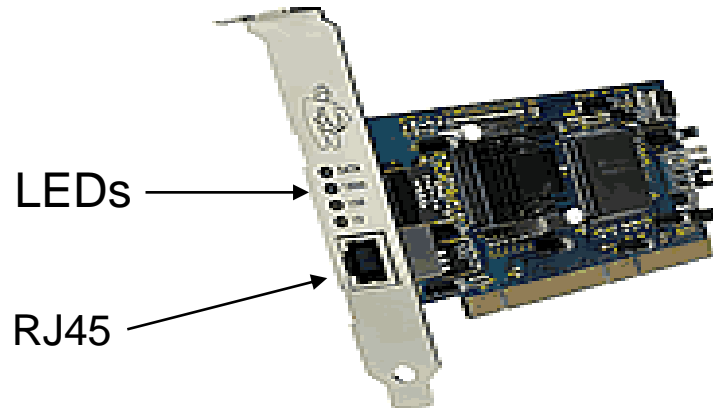
Half Duplex



Full Duplex



NIC

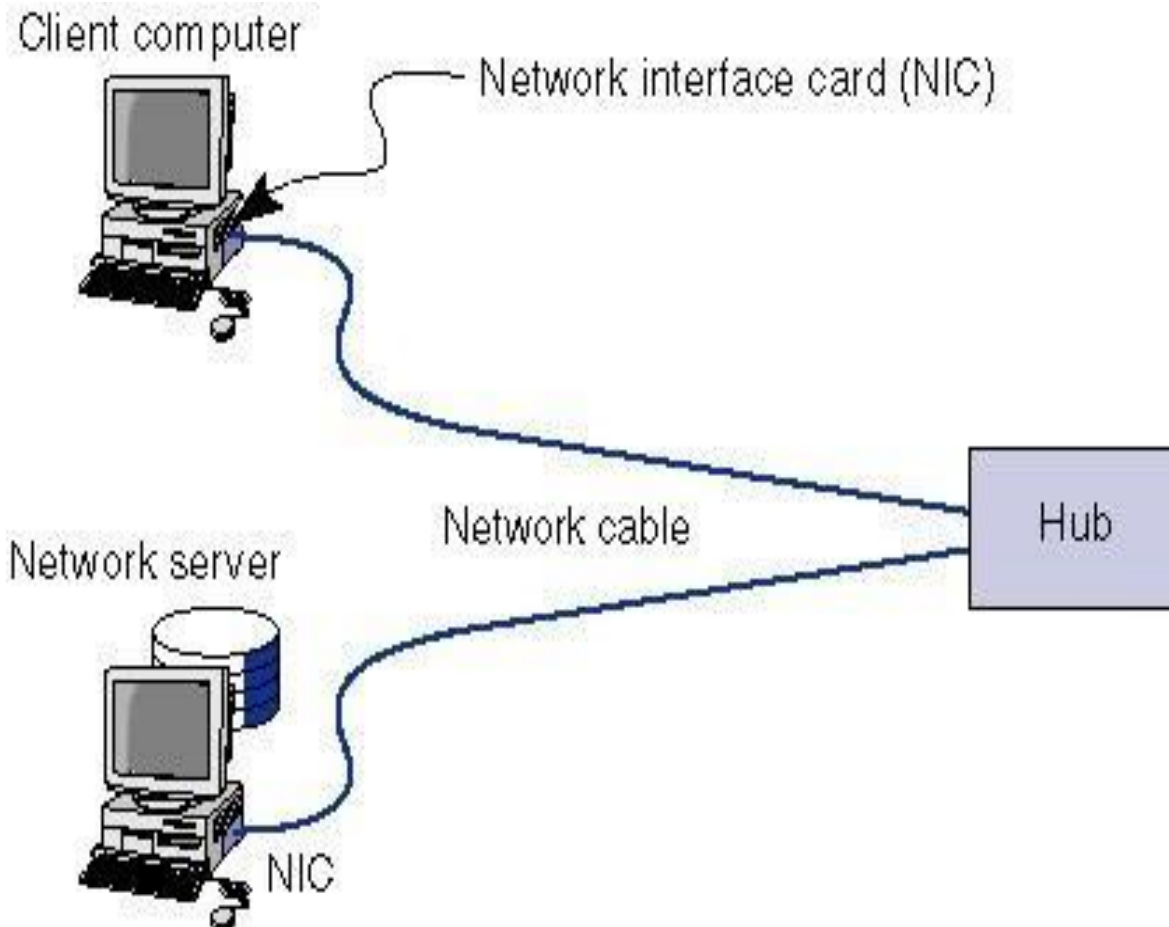


- A Network Interface Card (NIC) is a circuit board that plugs into both clients and servers and controls the exchange of data between them.
 - A specific software ("driver") must be installed (depending on the make of the NIC).

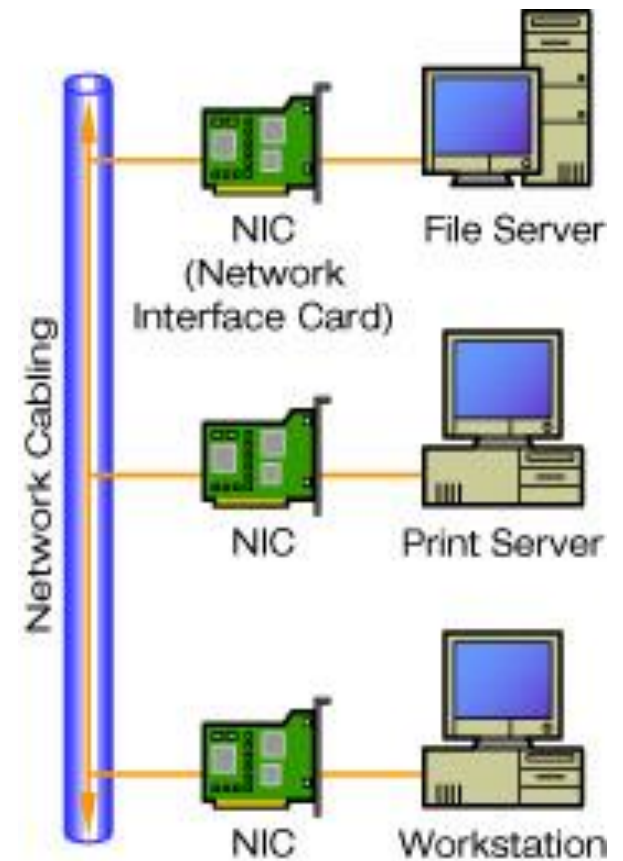
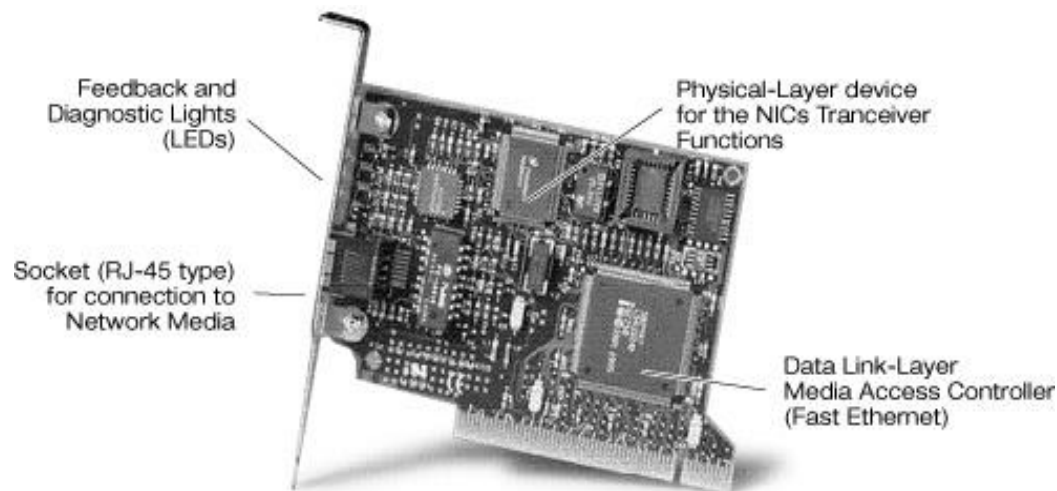
NIC..

- physical transmission medium, such as twisted pair or coaxial cable, interconnects all network interface cards to network hubs or switches.
- Ethernet and Token Ring are common network interface cards.
- Today's cards support
 - 10BaseT and
 - 100BaseT with automatic recognition.

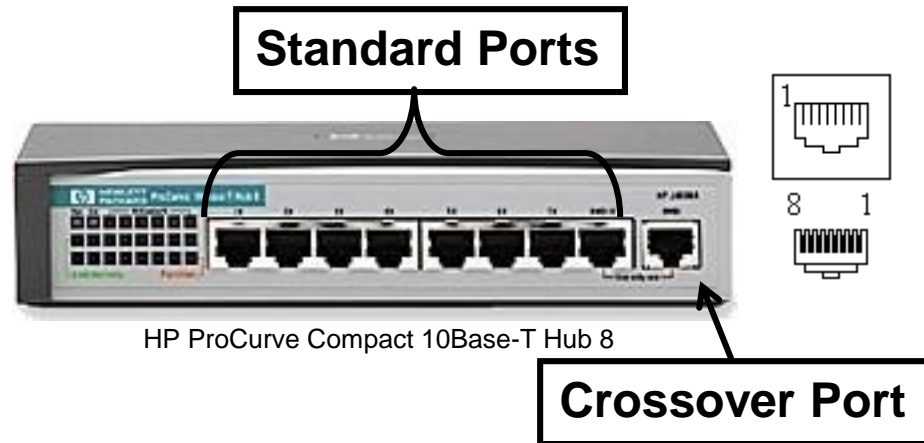
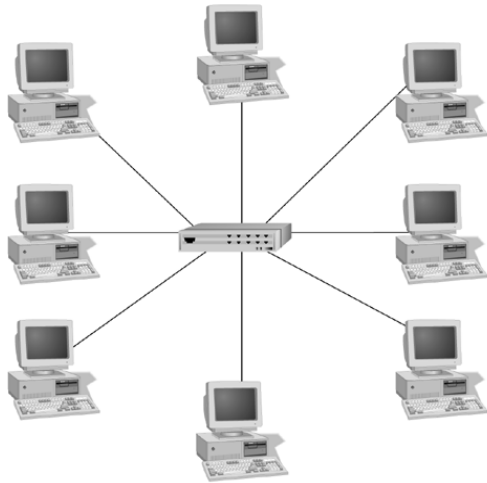
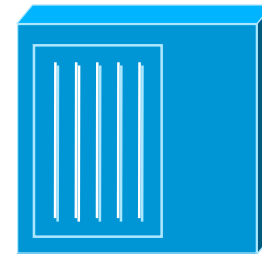
NIC Connection



NIC

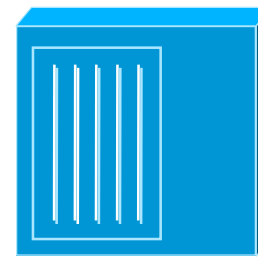


Hub



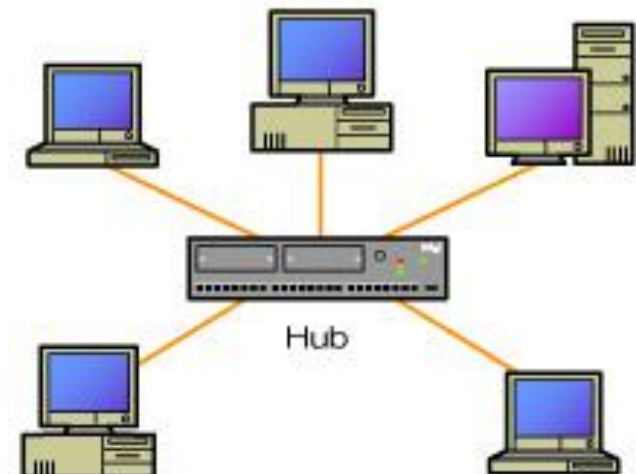
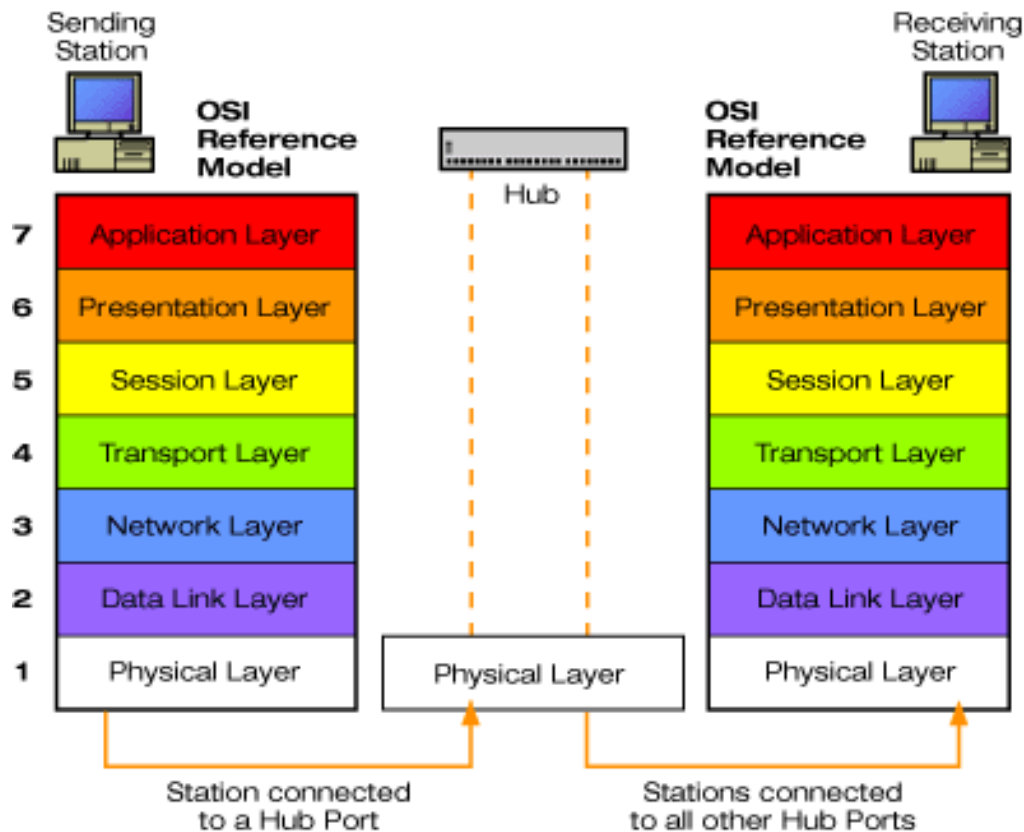
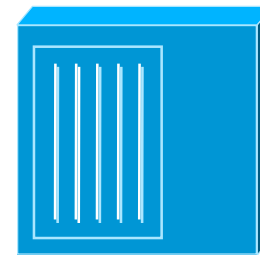
- Hubs connect all computer LAN connections into one device.
- They are nothing more than multi-port repeaters. Hubs cannot determine destinations; they merely transmit to every line attached in a **half-duplex mode**

Hub..

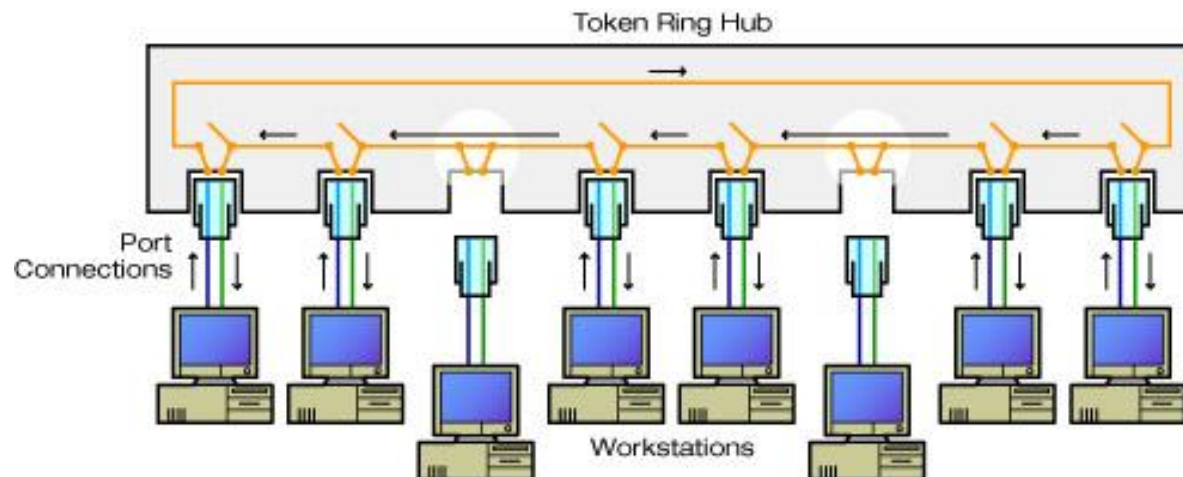
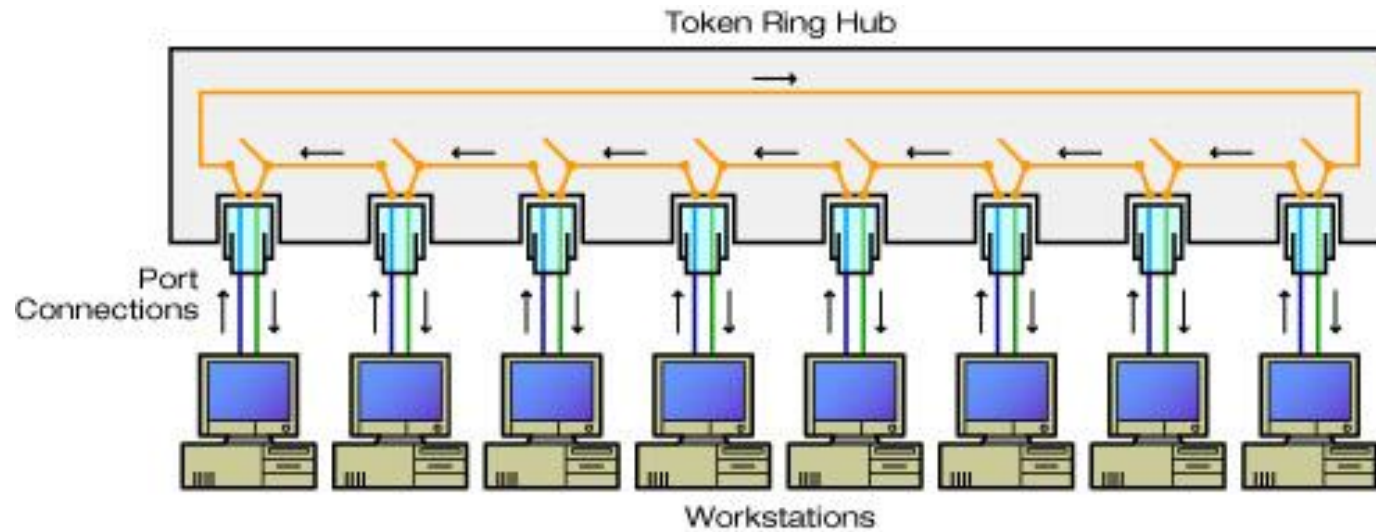


- Multi-port repeater
 - Repeater operating at bit level
 - Repeat received bits on one interface to all other interfaces
- Share the available bandwidth.
- Use CSMA/CD standard
- Forward all traffic to all hosts and is therefore inefficient.
- Each connected LAN referred to as LAN **segment**
- Hubs do not isolate collision domains: node may collide with any node residing at any segment in LAN
- Effectively a **physical layer** device

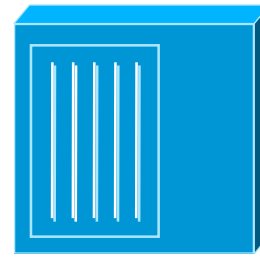
Hub..



Hub..



Hub..



- **Advantages:**
 - simple, inexpensive device
 - Provide an easy way to connect network cables and expand a network.
 - Act as repeaters or amplifiers to prevent attenuation.
 - extends maximum distance between node pairs (100m per Hub)
- **Hub Limitations:**
 - single collision domain results in no increase in max throughput
 - individual LAN restrictions limits on number of nodes in same collision domain.

Switch



- Switches connect all computer LAN connections, the same as hubs do.
- The difference is that switches can run in **full-duplex mode** and
- are able to direct and filter information to and from specific destinations.
- **Data Link Layer** devices:
 - operate on Ethernet frames, examining frame header and selectively forwarding frame based on its destination

Switch..



- Each port determines MAC addresses connected to itself
 - MAC Address List within switch determines forwarding behavior
- Switches are intelligent hubs
 - providing dedicated connection and bandwidth between clients on a LAN.
- A switch gives any device on the network the full bandwidth instead of sharing the available bandwidth.

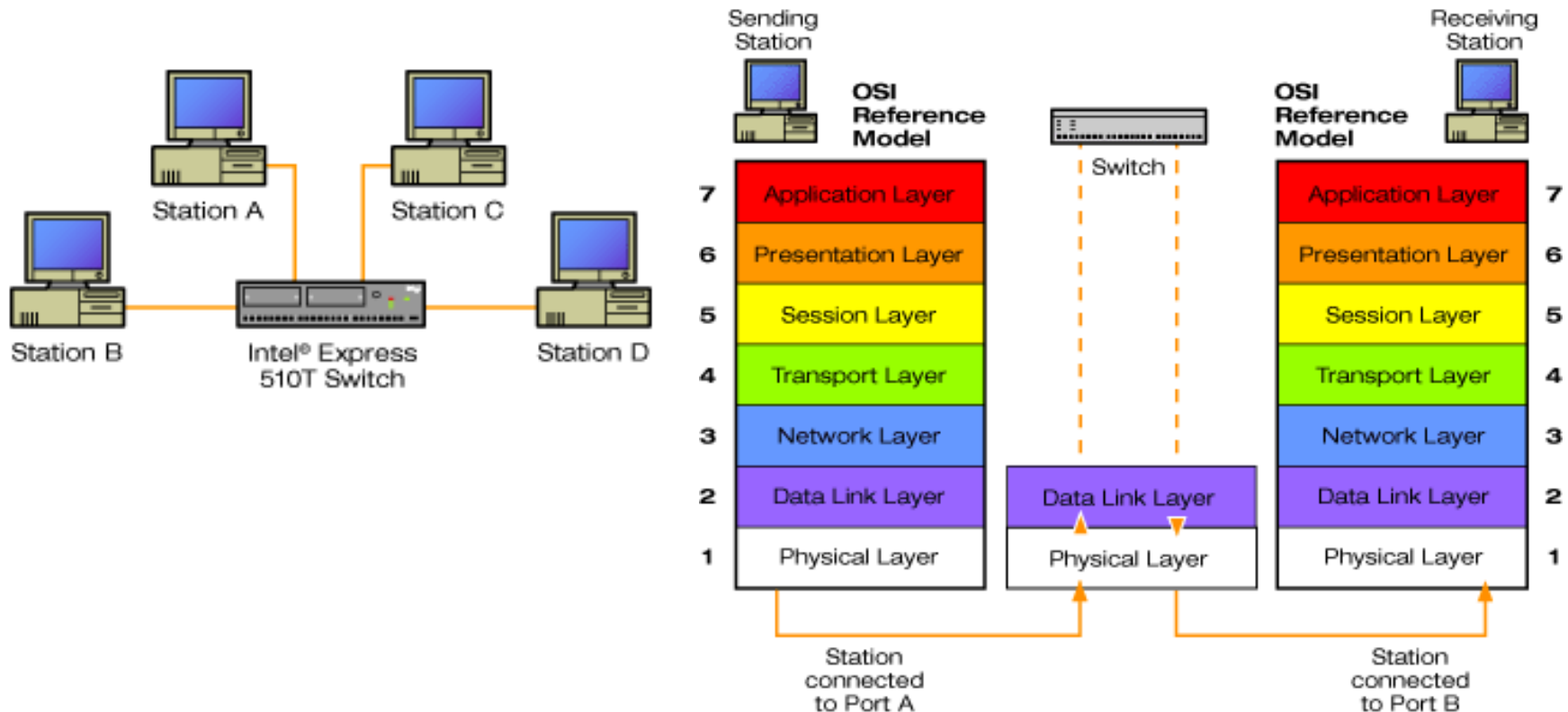
Switch..



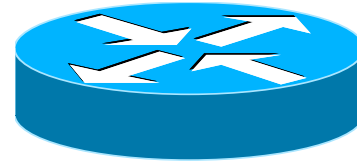
Advantages:

- Isolates collision domains resulting in higher total max throughput.
- Can connect different type Ethernet since it is a store and forward device
- layer 2 (frame) forwarding, filtering using LAN addresses
- Individual hosts, star-connected into switch
 - Ethernet, but no collisions!

Switch..

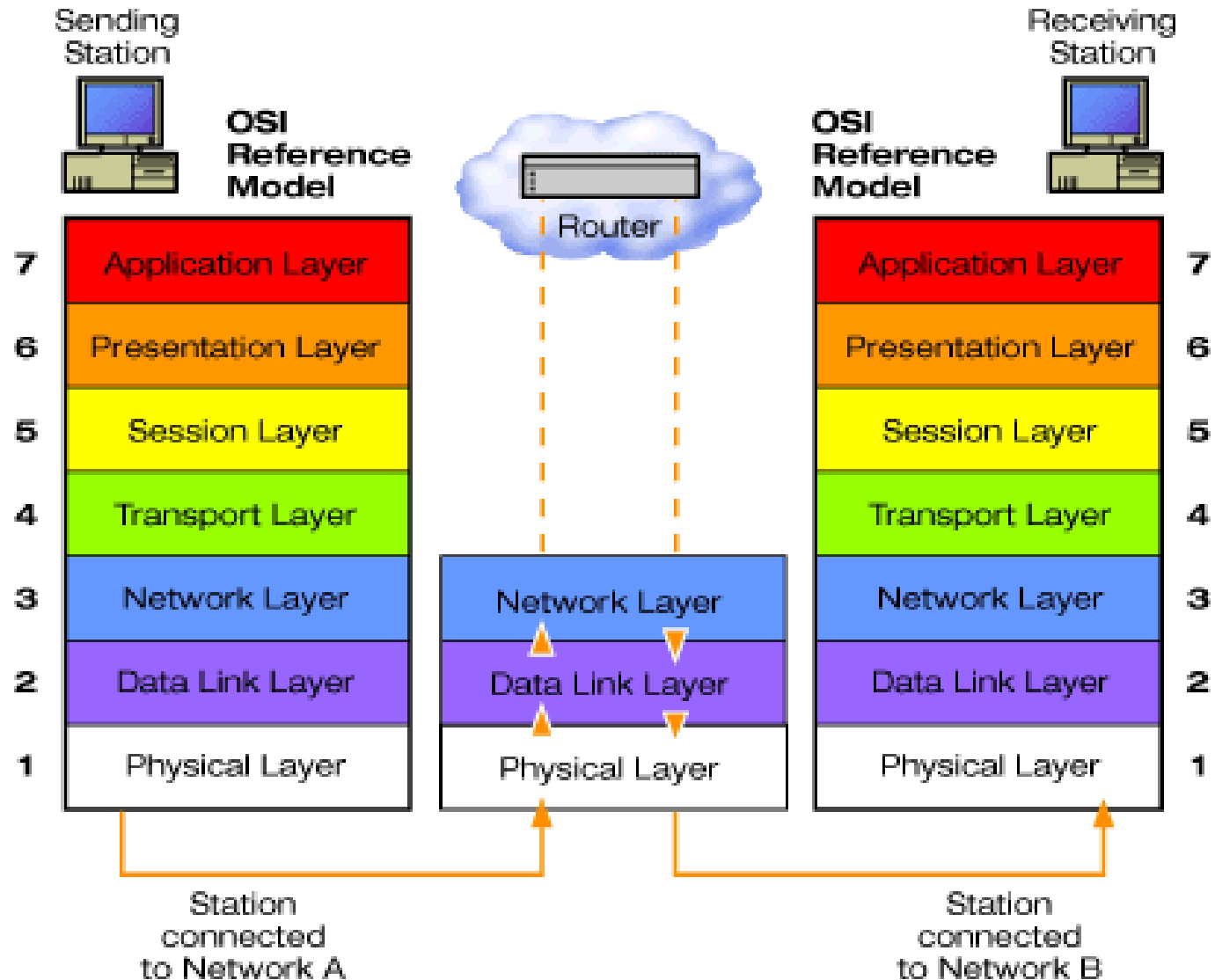


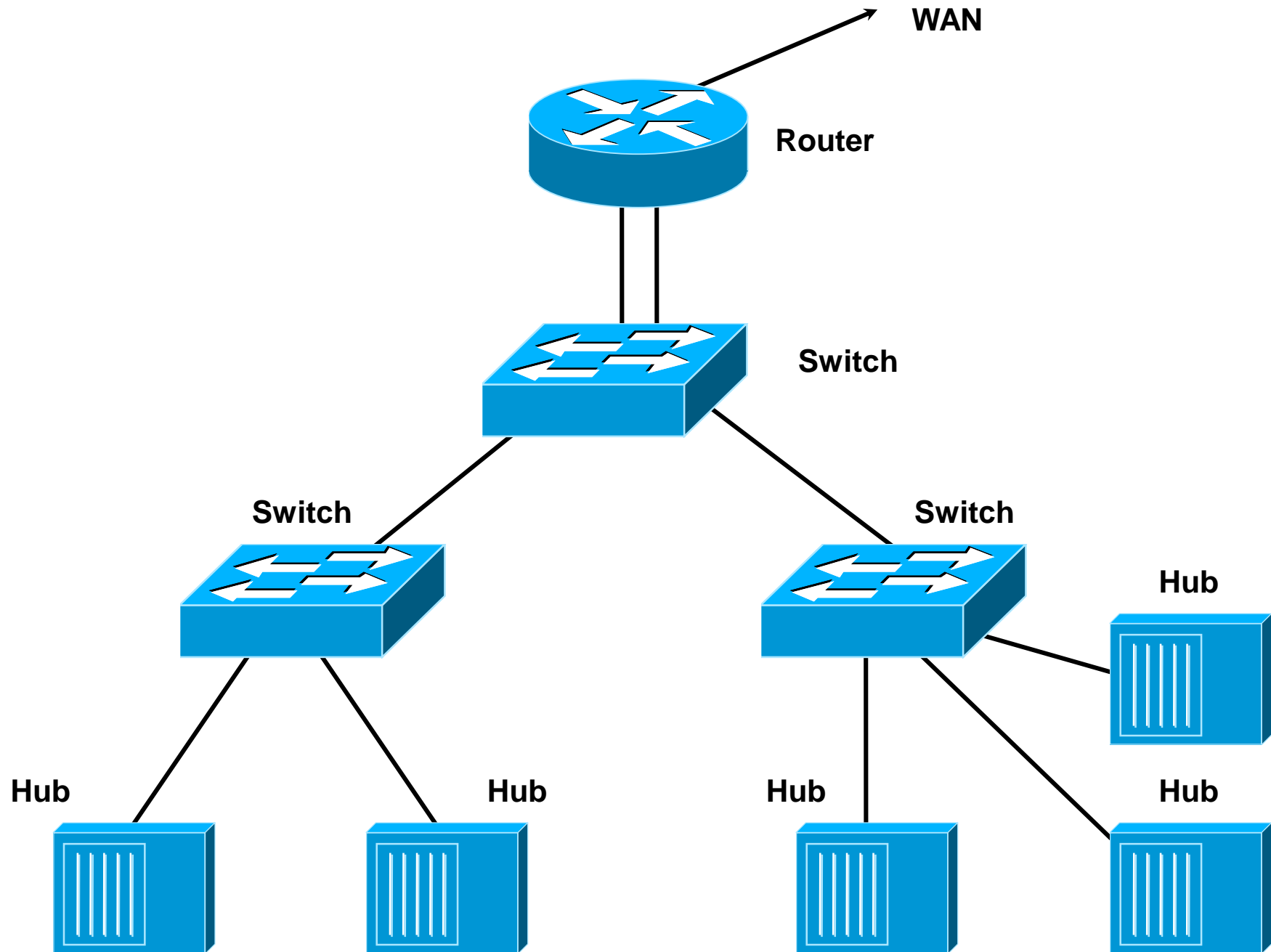
Router

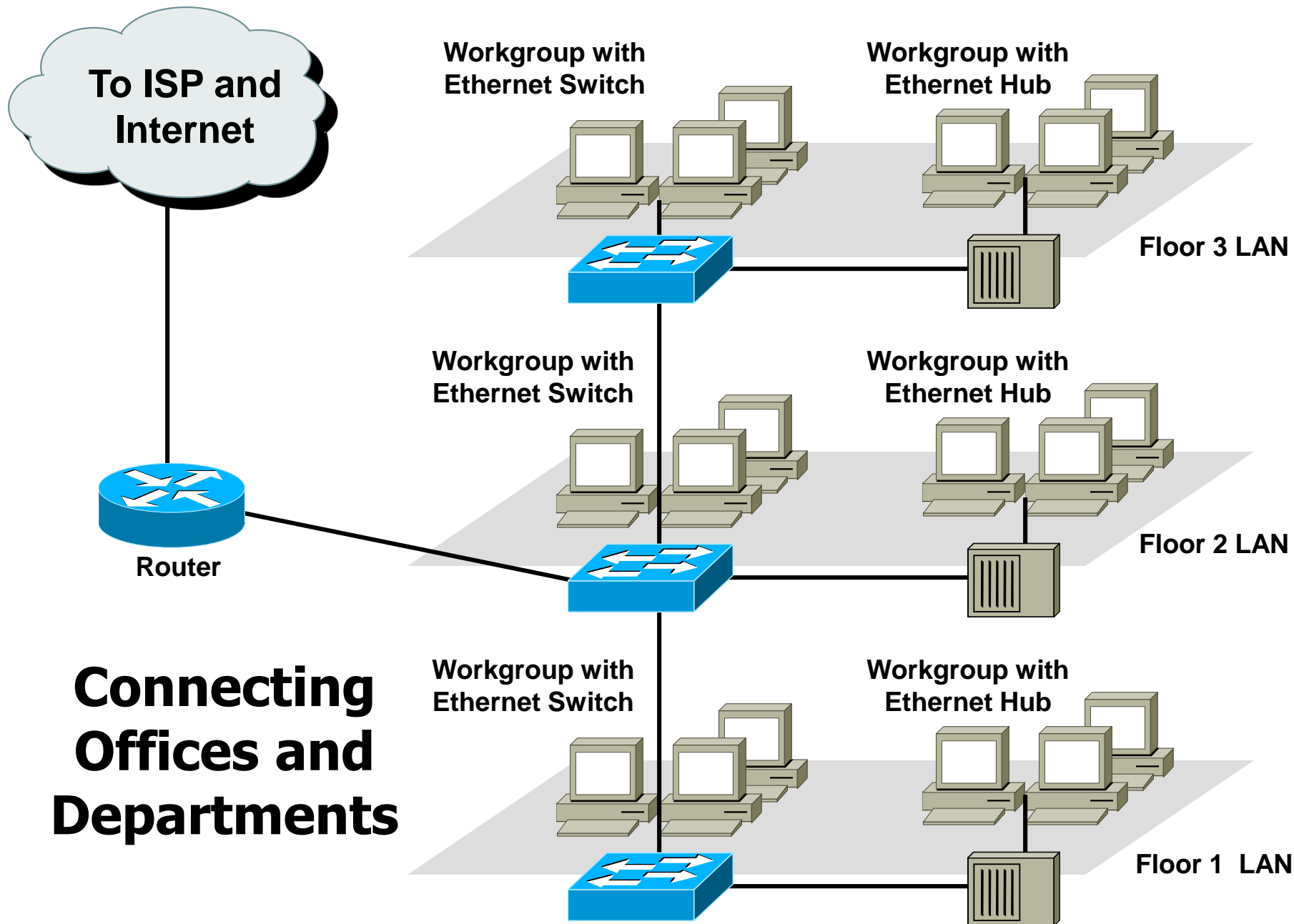


- A router is a device that forwards data packets from one network to another.
- Routers are able to route and filter information to different networks.
 - Convert data structure from one media to another, for example Ethernet <=> ISDN.
- Mainly used for interconnecting similar or different types of LANs.
 - For example two different networks like a LAN and the Internet
- Some routers can automatically detect problems and redirect information around the problem area. These are called "**intelligent routers.**"
- **Network Layer** devices:

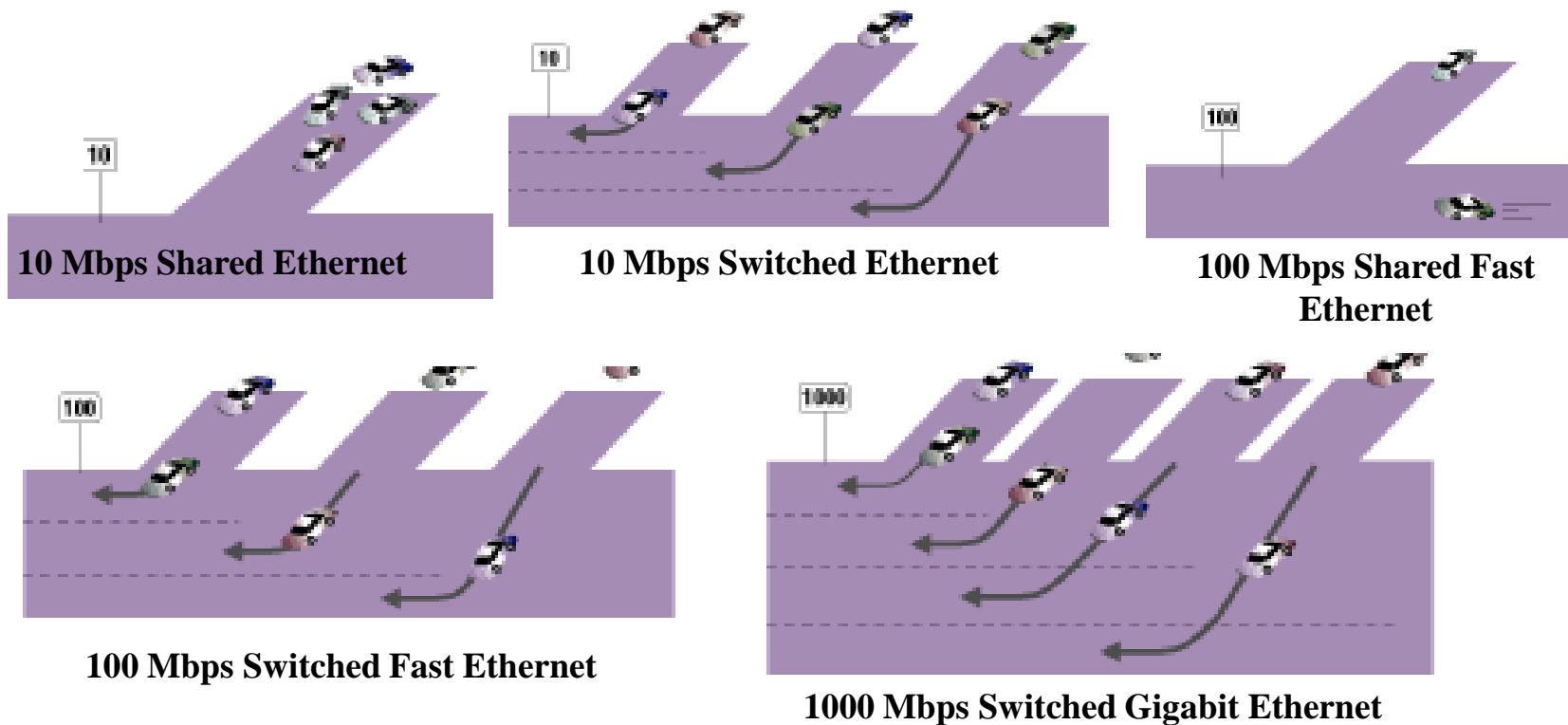
Router..







HUB Vs SWITCH

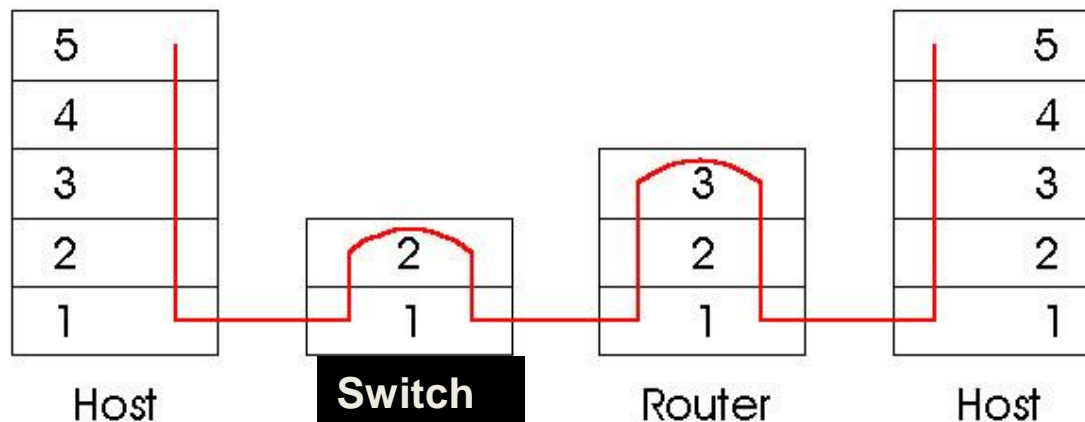


Advantages of Switches

- Dedicated bandwidth and full-duplex operation
- Reduce data latency
- Increasing distance
- Improved network performance
- Network security
- Special ports for connecting servers and cascading switches

Switches vs. Routers

- both store-and-forward devices
 - routers: network layer devices (examine network layer headers)
 - switches are Data Link Layer devices
- routers maintain routing tables, implement routing algorithms
- switches maintain MAC address tables, implement filtering, learning and spanning tree algorithms



Network Overview

- A network can be defined by its geographical dimension and
- by the method by which the user's PC accesses it.

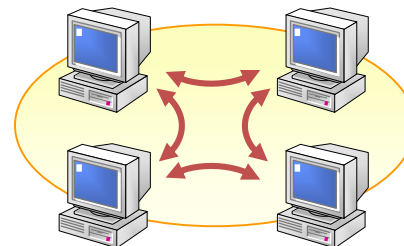


Network Organization

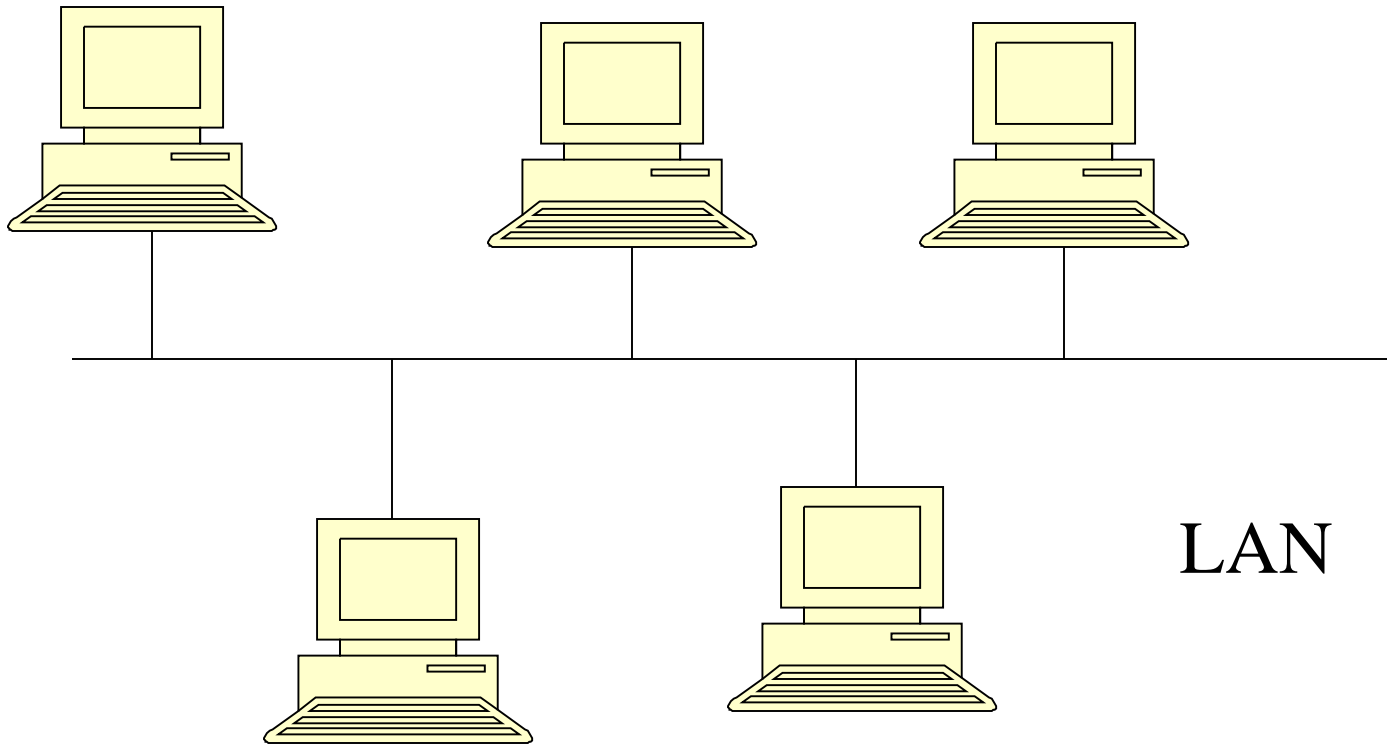
- **by its geographical dimension**
 - Local Area Networks (LAN),
 - Metropolitan Area Networks (MAN),
 - Wide Area Networks (WAN)

Local Area Network (LAN)

- Network of computers and other devices confined to relatively small space
- LANs involving many computers are usually client/server based
- A connection between a small group of workstations and peripherals
- LANs are the basic building block of networks



Local Area Network (LAN)



Metropolitan Area Network(MAN)

- MANs are hybrids between LANs and WANs
- Use WAN technology to connect the LANs
- Allows internetworks to span whole cities, rather than just buildings

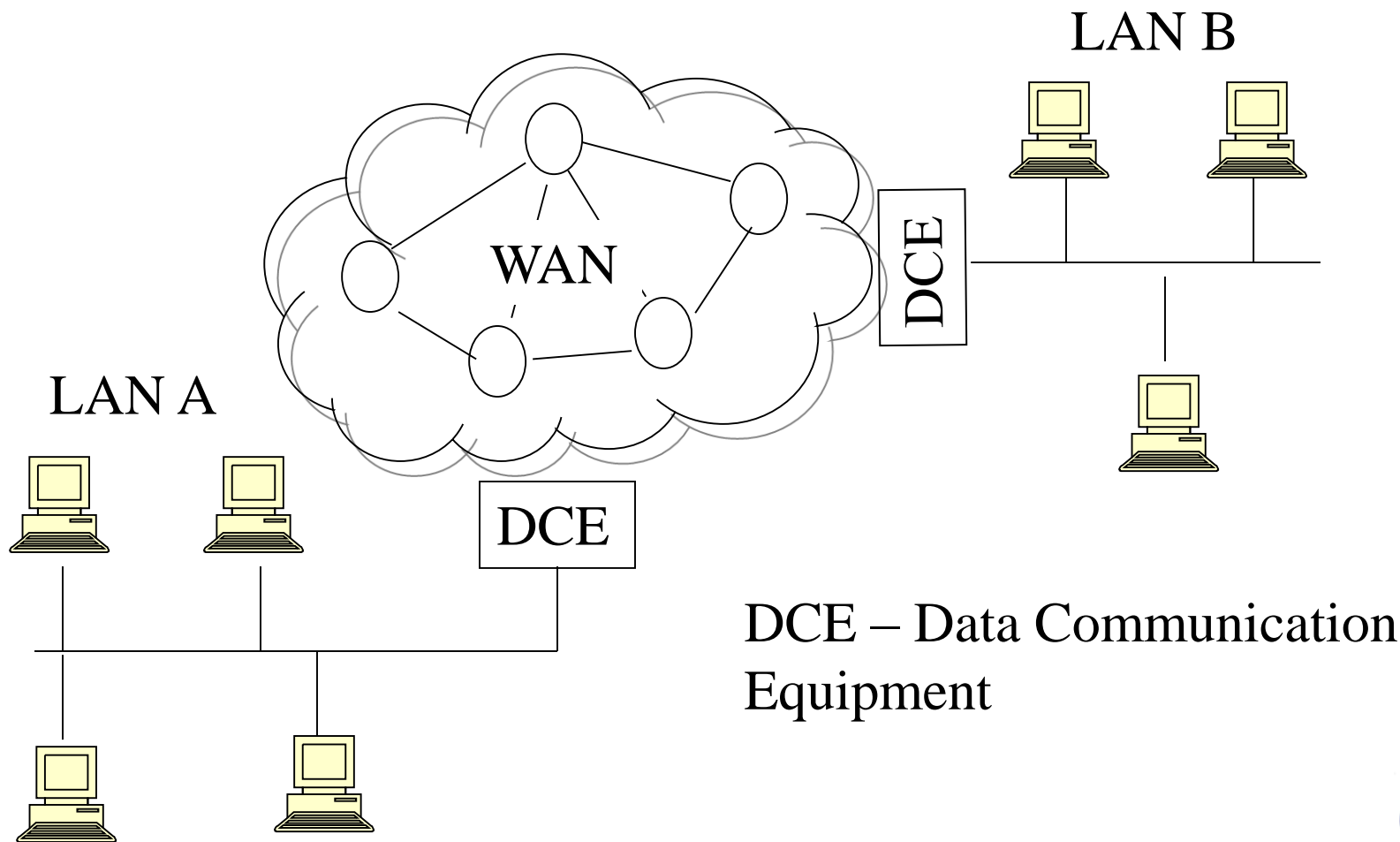


Wide Area Network(WAN)

- WANs span countries, continents, and the world
 - High capacity and High capital costs
- WANs are shared between thousands of customers
 - Similar to the Telephone network.



Wide Area Network (WAN)

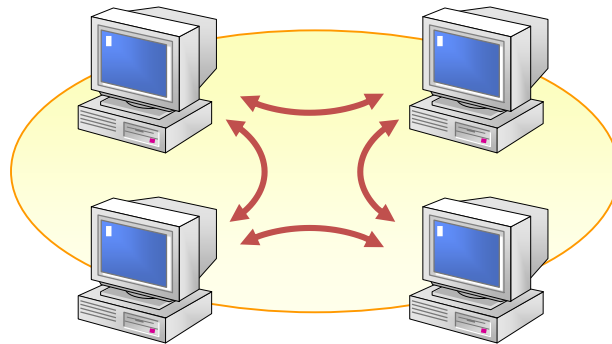


LAN (Local Area Network)

- Typical areas covered by LAN
- Transmission media deployed in LAN
- LAN Topologies
- Technologies used in LAN
- LAN Access Control
- Advantages & Disadvantages

Typical areas covered by LAN

- Network of computers and other devices confined to relatively small space like,
 - » A company site
 - » A home
 - » An office & etc



LAN Topologies

- Topology Describes the physical layout of a network
- It shows how are the computers and devices connected?
- Issues of use of different LAN Topologies
- Basic shape of design
 - Building/Physical constraints
 - Multiple floors
 - Distances

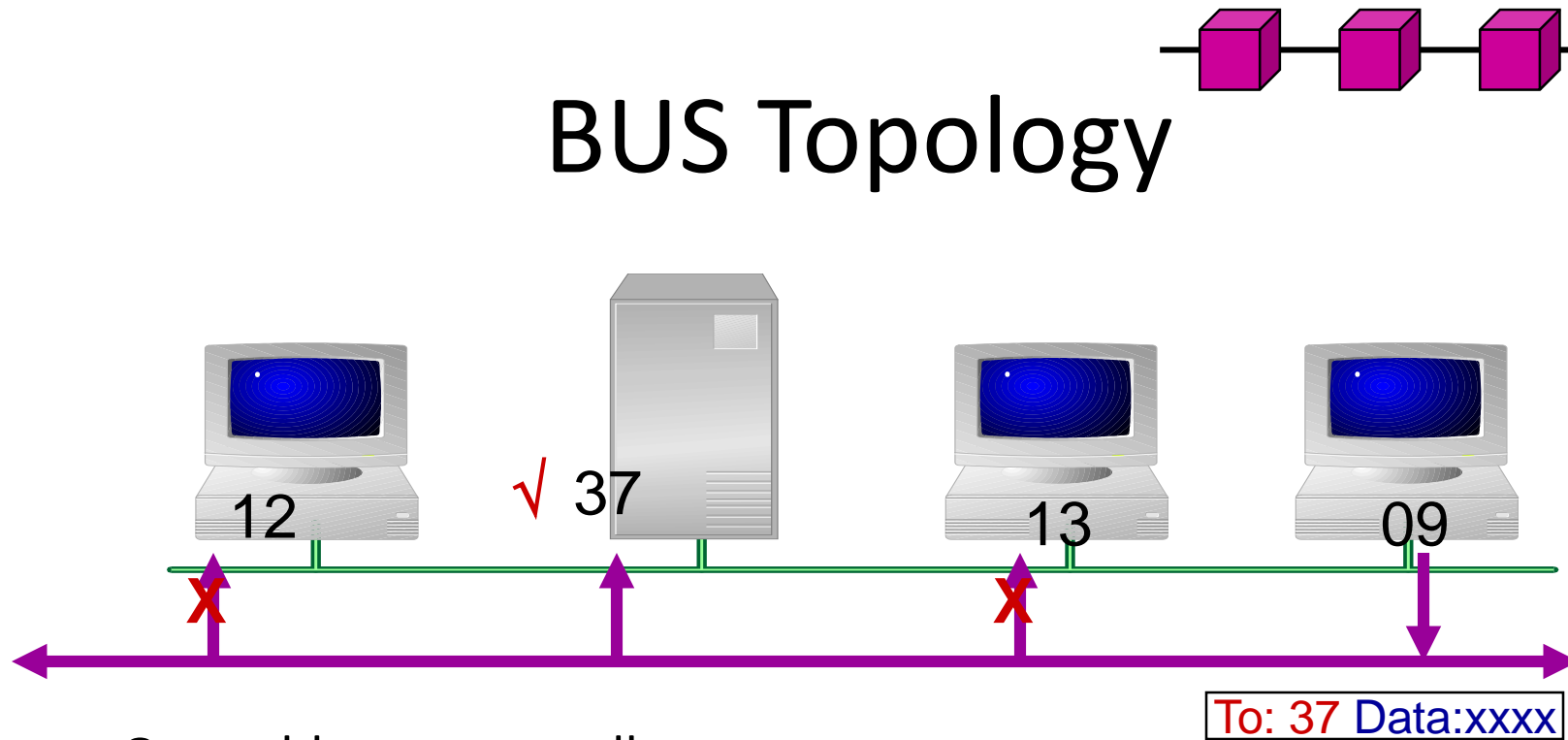


LAN Topologies..

The common topologies for LANs are (Basic shape of design),

- BUS Topology
- RING Topology
- TREE Topology
- STAR Topology
- Extended STAR Topology

BUS Topology



- One cable connects all components
Cable may be straight or “snake” through the building
Individual devices are connected on branches of the **backbone**
- Each message is sent to all computers
- Only the addressed computer responds to the message



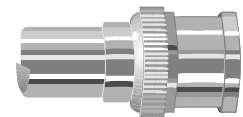
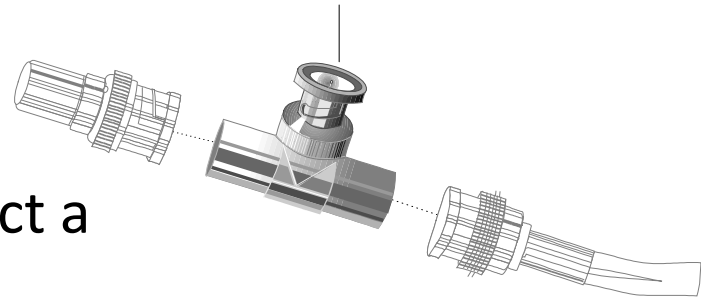
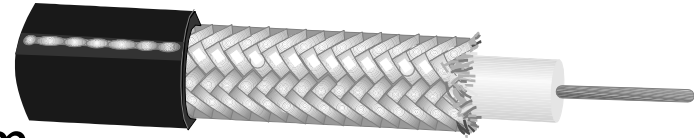
BUS Topology..

- All stations attach, through appropriate hardware interfacing known as a **tap**, directly to a linear transmission medium called **BUS**.
- A full duplex operation between the station and the tap allows data to be transmitted on to the bus and receives data from the bus.
- A transmission from any station propagates the length of the medium in both directions and can be received by all other stations.



10Base-2 Bus LANs

- Most Bus LANs are connected using 10Base-2 Coaxial Cable
 - 10Mbps, baseband transmission, 200m max
- **BNC-type connections**
 - Use a 'T' to make a spur to connect a workstation
- **Terminators**
 - All cable ends must be terminated (50W) to prevent reflections



Bus Pros and Cons

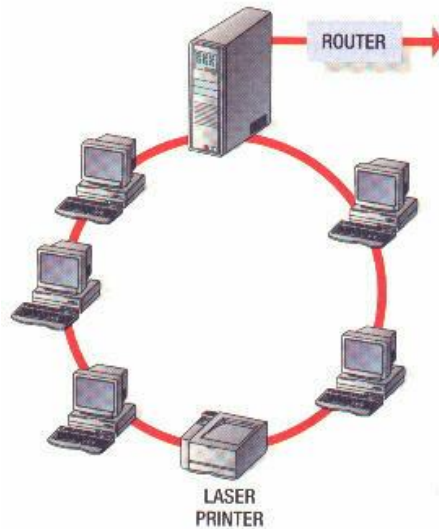
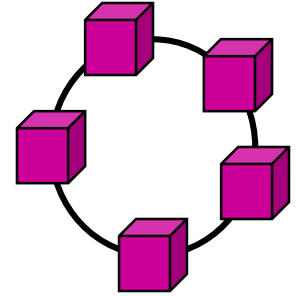
Advantages

- **Simple**
 - “Plug and play”
- **Cheap**
 - Mostly all cables
 - Cables are relatively inexpensive
- **Linear arrangement**
 - Just run your backbone in a path that goes near the workstations

Disadvantages

- **Many single-point failure modes**
 - Broken backbone
 - Any unplugged computer that isn't terminated
- **Difficult to trace errors**
 - All one big “wire”
 - Problem could be anywhere
- **Limits on cable length** seriously constrain size
 - Repeaters needed

RING Topology



- Here the network consists of a set of **repeaters** joint **by point-to-point links in a closed loops**. (The repeater is a device, which receive data from one link and transmit to the other link without buffering.)

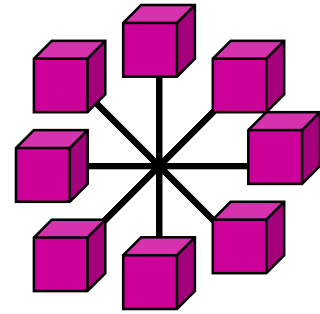
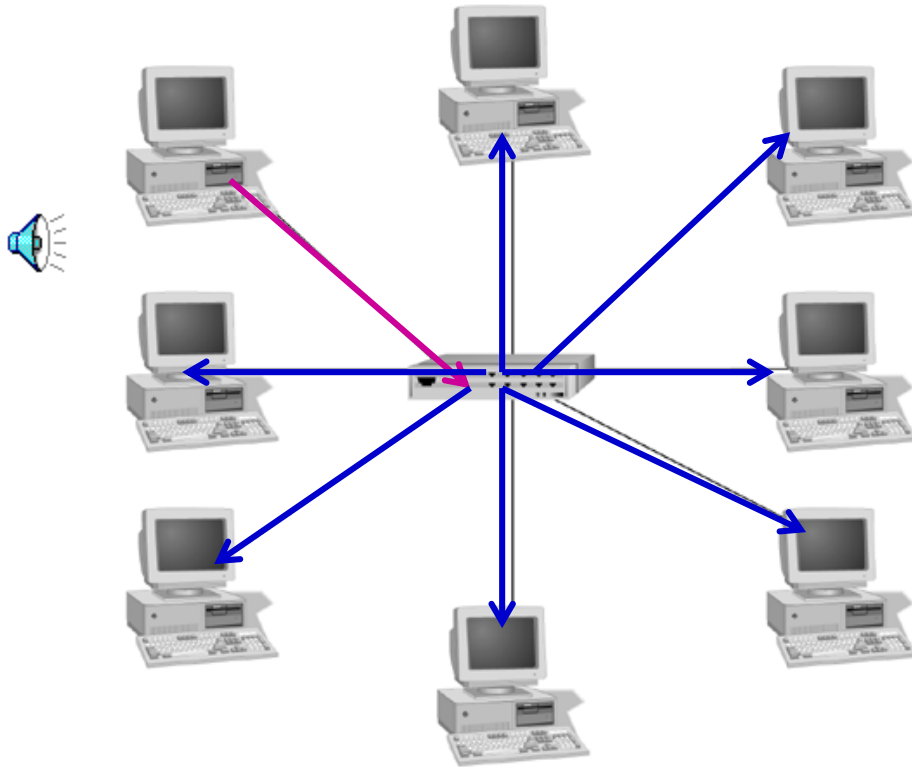


RING Topology..

- Links are unidirectional;
 - hence the data circulate in only one direction.
 - Each station attached to the repeater can transmit data into the network.
- As a frame circulates past all the other stations, the destination station recognizes its address and copies the frame into a local buffer as it goes by.
- The frame continues to circulate until it returns to the source station, where it is removed.

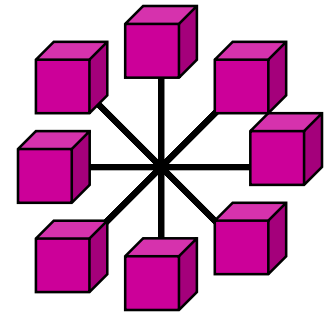


STAR (Hub) Topologies



- Logically, the same as a bus
 - Medium is still shared by all stations at all times

STAR Topology..

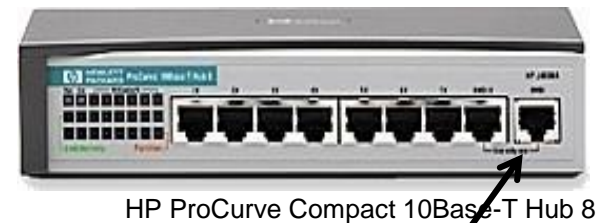
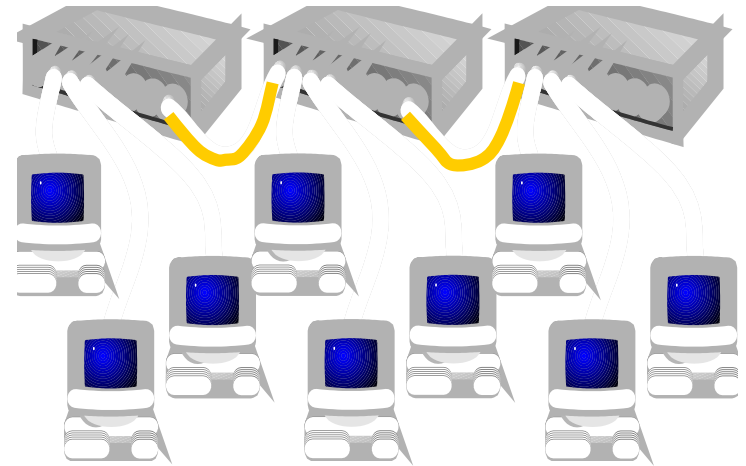


- Here each station is directly connected to a common central node referred to as a star coupler.
- Each station attaches to the central node via two point-to-point unidirectional links,
 - one for transmission and
 - one for reception in opposite directions.
- There are two modes of operations, that is Central node can operate either broadcast mode or switching mode. Broadcast mode is considered logically as a bus.

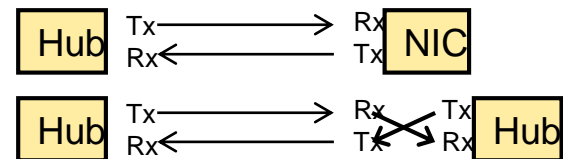


Extended STAR Topology (Star-Bus)

- Connect multiple stars (hubs) together in a bus
 - Isolates individual groups from each other
 - Hierarchical
- Logically, still **one single shared medium**
- Need to use **crossover port** or **crossover cable** for Hub-to-Hub link



Crossover Port



Star (Hub) Pros and Cons

Advantages

- Termination is no longer an issue
 - An un-terminated line only effects communication to one device
 - Can't bring the network down by unplugging your network connection
- Expansion is easier
 - Active hubs reduce loading limitations
- Easier troubleshooting
 - Isolated connections

Disadvantages

- Single-point failure
 - If the hub goes down, all is lost
- More cable needed
 - All cables must reach from workstations to the hub



Shared media LAN Technologies

According to the technology used in LAN
there are several types,

1. Ethernet (*CSMA/CD, BUS*)

Standard IEEE 802.3

2. Token Ring (*control token*)

Standard IEEE 802.5

3. FDDI (*Fiber Distributed Data Interface*)

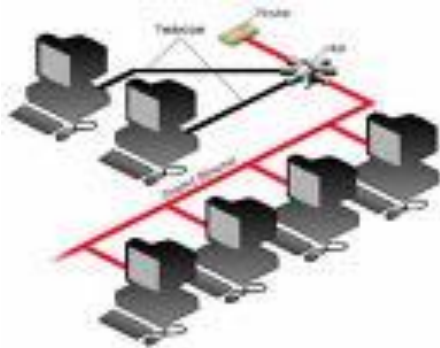
Also,

- *Fast Ethernet*
- *Gigabit Ethernet*
- *Fiber channel*
- *Wireless LAN*



Technologies used in LAN

Ethernet



Token ring



1. Ethernet

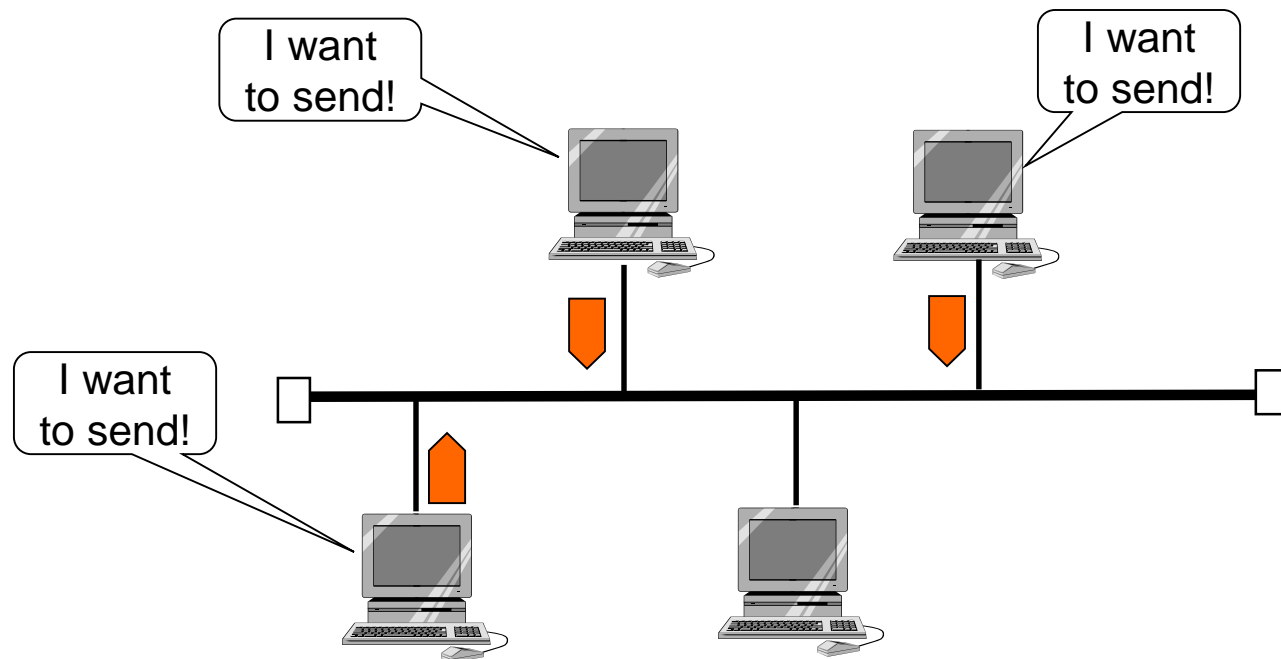
- Is a contention **media access method** that allows all hosts on a network to share the same bandwidth of a link
 - Is a very common LAN technology
 - IEEE 802.3 defines a bus topology
 - The Ethernet specification describes a carrier sense multiple access/collision detect (CSMA/CD) LAN
 - **Ethernet** is a family of **frame-based computer networking technologies** for local area networks (LANs). It defines a number of wiring and signaling standards for the physical layer, through means of network access at the Media Access Control (MAC)/Data Link Layer, and a common addressing format.

Ethernet..

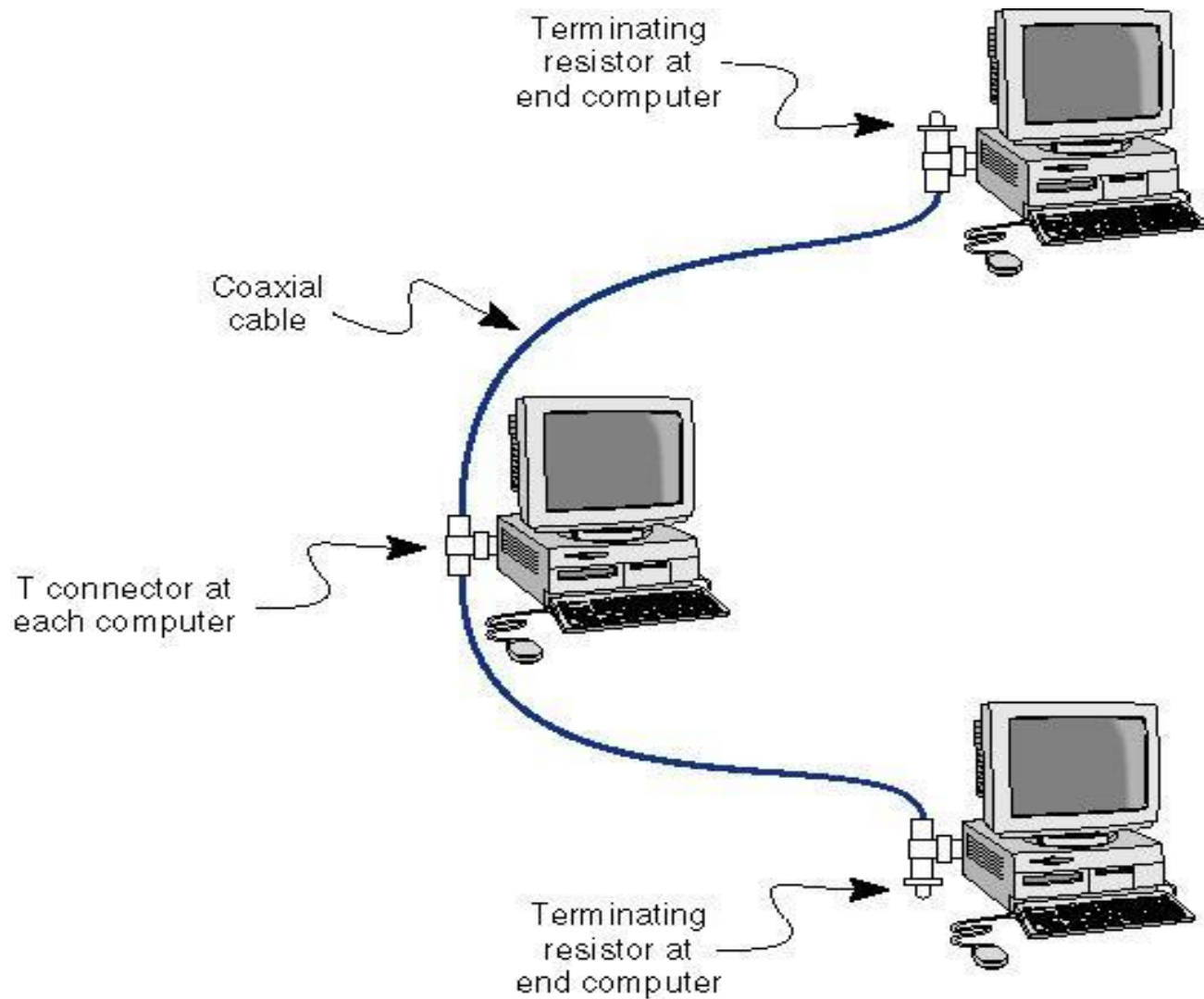
- It has been in use from the 1990s to the present, largely replacing competing LAN standards such as token ring, FDDI.
- Ethernet is a LAN technology, which uses CSMA/CD medium access control mechanism in a physical or logical bus topology.
- In recent years, Wi-Fi, the wireless LAN standardized by IEEE 802.11, is prevalent in home and small office networks

Ethernet (*CSMA/CD, BUS*)..

- World's most popular LAN technology (over 85% of ports)
- **25** years old and still evolving
- Shared access media -- stations compete for access



Ethernet (*CSMA/CD, BUS*)..

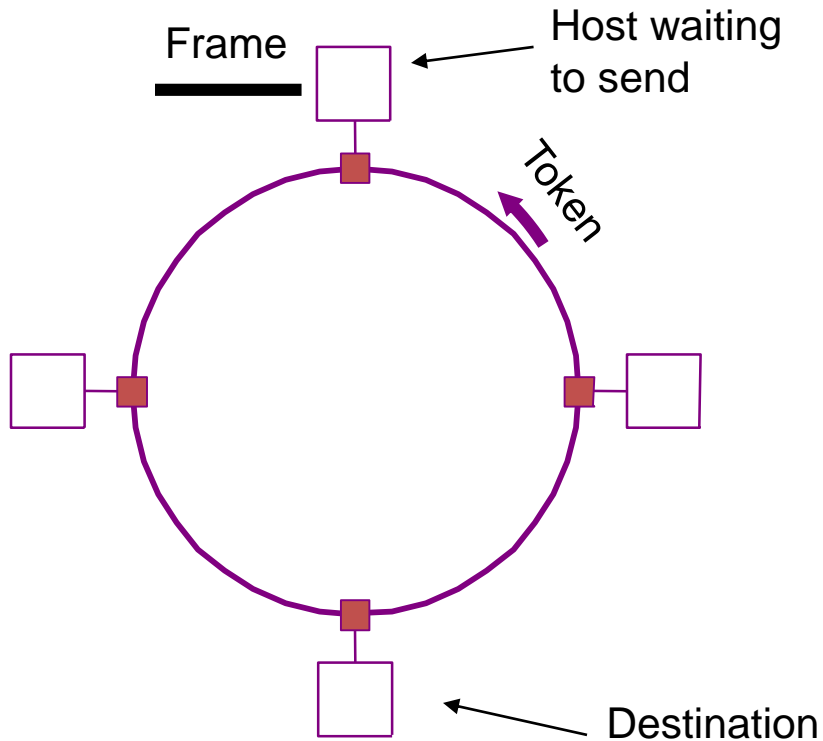


2. Token Ring

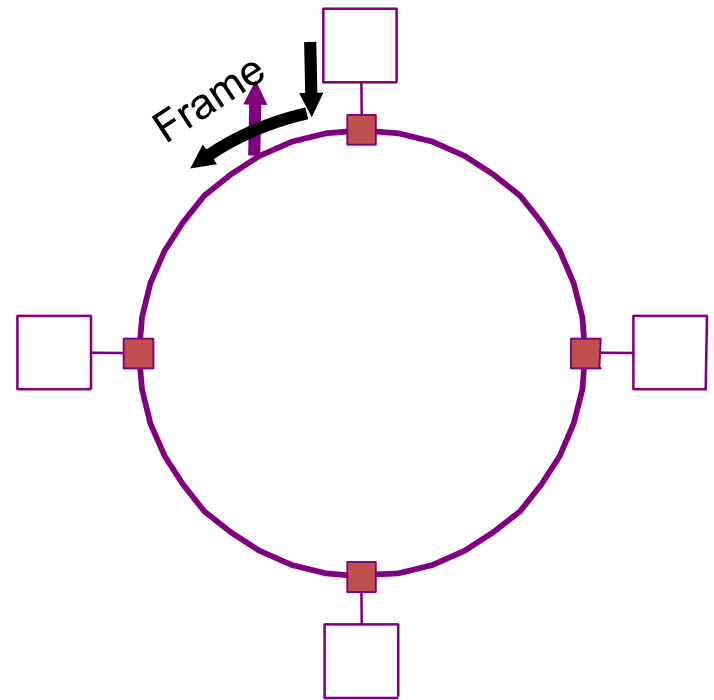
- Token ring is the most commonly used LAN technology for ring topology LANs, which is based on the use of a small frame, called a token.
- Token ring uses Control Token as the medium access control mechanism and it refers the IEEE 802.5 standards.

Token Ring Operation

A host with data to transmit must wait for token before sending.



Host seizes the token and sends data frame.



3. FDDI

(Fiber Distributed Data Interface)

- FDDI is an extension to token ring technology, which is design for both LAN and WAN application using fiber as the medium of transmission.
- The basic difference with Token ring is FDDI uses two rings known as primary and secondary, where secondary is activated in a failure of the primary.

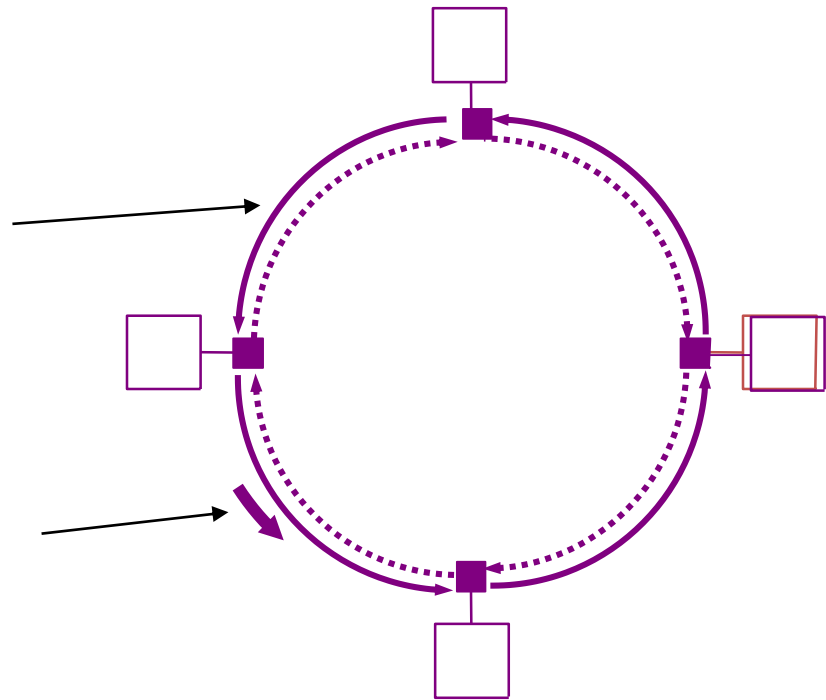


FDDI.. (*Fiber Distributed Data Interface*)

- FDDI is a token ring network designed for reliable LAN or WAN use

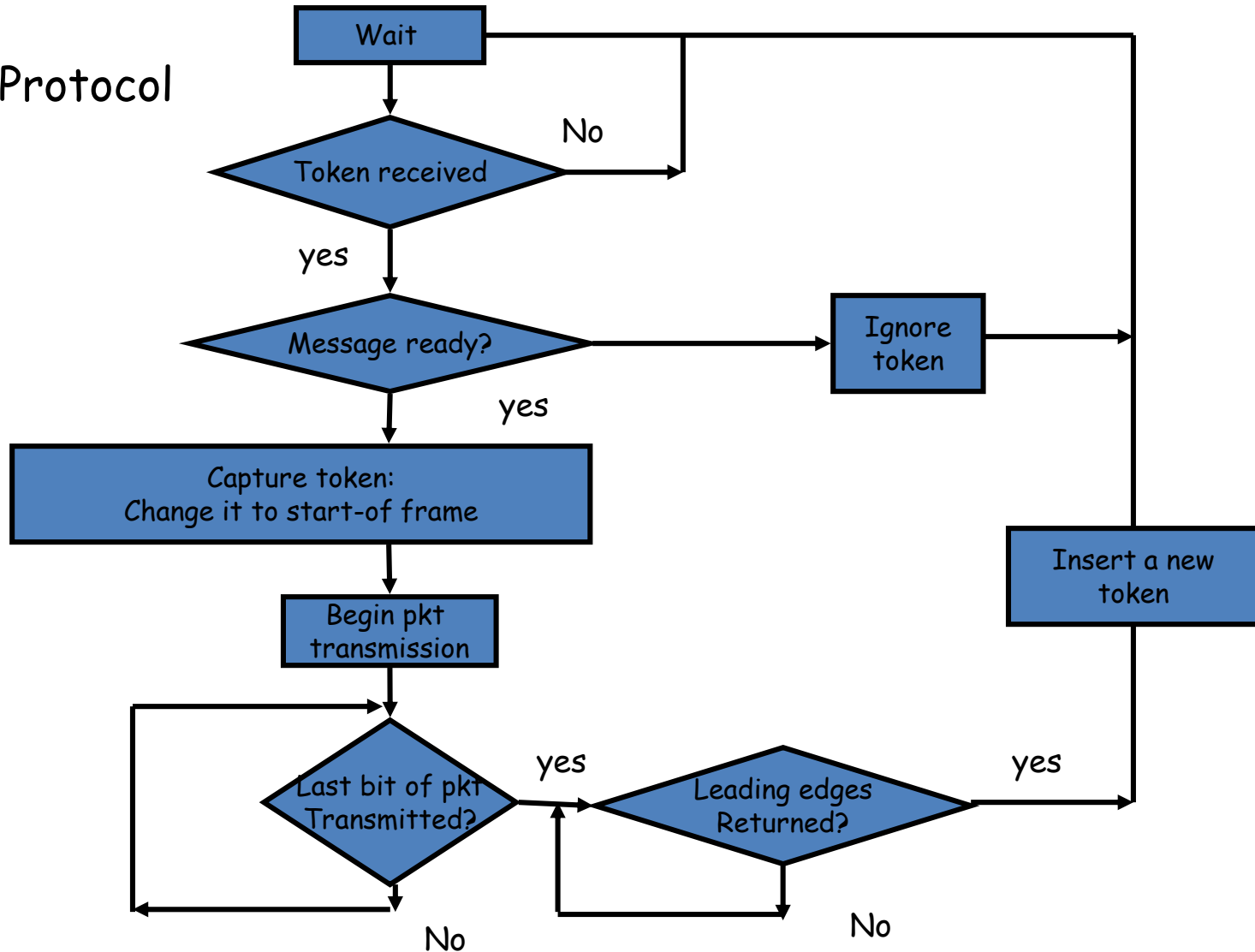
FDDI has **2** rings oriented in opposite directions. In normal operation only one ring is used.

Token or Data frame circulates ring.



Token Ring & FDDI Operation

-MAC Protocol



Other Technologies

- Fast Ethernet & Gigabit Ethernet
 - The extension of 10 Mbps CSMA/CD to higher speeds is a logical strategy.
- Fiber channel
 - This provides low cost, easily scalable approach to achieving very high data rates in local user
- High speed wireless LANs
 - Wireless LAN technology and standards have at last come of age, and high speed standards.

Operating speeds of LAN Tech.

Ethernet	10Mbps
Fast Ethernet	100Mbps
Gigabit Ethernet	1Gbps, 10Gbps
Fibre Channel	100Mbps-3.2 Gbps
Wireless	1 Mbps-54 Mbps

Congestion on a network

- Cause

- Increased traffic
- High demand for access

- Effect

- Increased collisions
- Slow response
- Time-outs

Cause of Congestion on a network

- Increased traffic
 - When downloading or uploading files
- High demand for access
 - increasing no. of users at a time

Effect of Congestion on a network

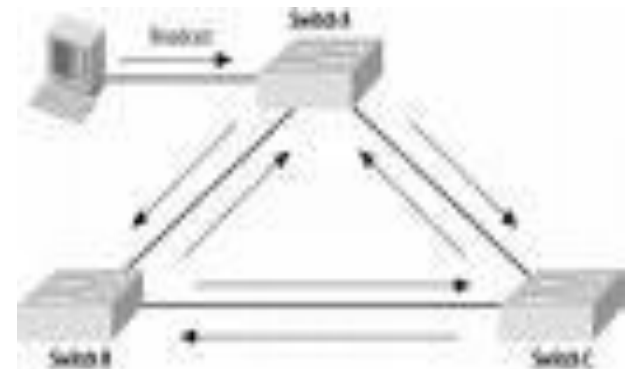
- Increased collisions
 - due to high traffic
- Slow response
 - Mean no. of repeat transmitting increased
 - once request something, can get answer late
- Time-outs
 - Due to discarding of packets when high traffic

Effective Factors to reduce total throughput / BW available within a LAN

- Ethernet collisions
- High volume of users
- Broadcast storms
- Inadequate physical segmentation
- Increased traffic
- Data backup procedures
- Faulty cable
- EMI (Electro Magnetic Interference)

Broadcast storms

A state in which a message that has been broadcast across a network results in even more responses, and each response results in still more responses in a snowball effect. A severe broadcast storm can block all other network traffic, resulting in a *network meltdown*. Broadcast storms can usually be prevented by carefully configuring a network to block illegal broadcast messages.



Inadequate physical segmentation

- A **network segment** is a portion of a computer network where in every device communicates using the same physical layer.
- Devices that extend the physical layer, such as repeaters or network hubs, are also considered to extend the segment.
- However, devices that operate at the data link layer level or higher create new physical layers and thus create rather than extend segments.

EMI (Electro Magnetic Interference)

- EMI is the intrusion of outside electromagnetic signals that affect the signal being sent over the network media
- When outside interference encroaches on the network signal, the receiving computer has difficulty interpreting the signals.
 - Copper wire is specially susceptible for EMI
 - Coaxial cable's thick outer jacket offers some protection from EMI as done by STP
 - UTP fairly vulnerable to EMI, but twisting of the wire pairs inside the cable helps to reduce it.(best choice)

LAN Access control

- There are two types of LAN access control Standards according to the IEEE 802 Standards they are,

- MAC

- (Medium Access Control (Media Access Control)

- CSMA/CD

- (Carrier Sensing Multiple Access/ Collision Detection)

MAC

- There are two types of Media access control methods, they are,
 - CSMA/CD
 - Supported to Ethernet Technology
 - Control token
 - Supported to Token ring, FDDI Technology

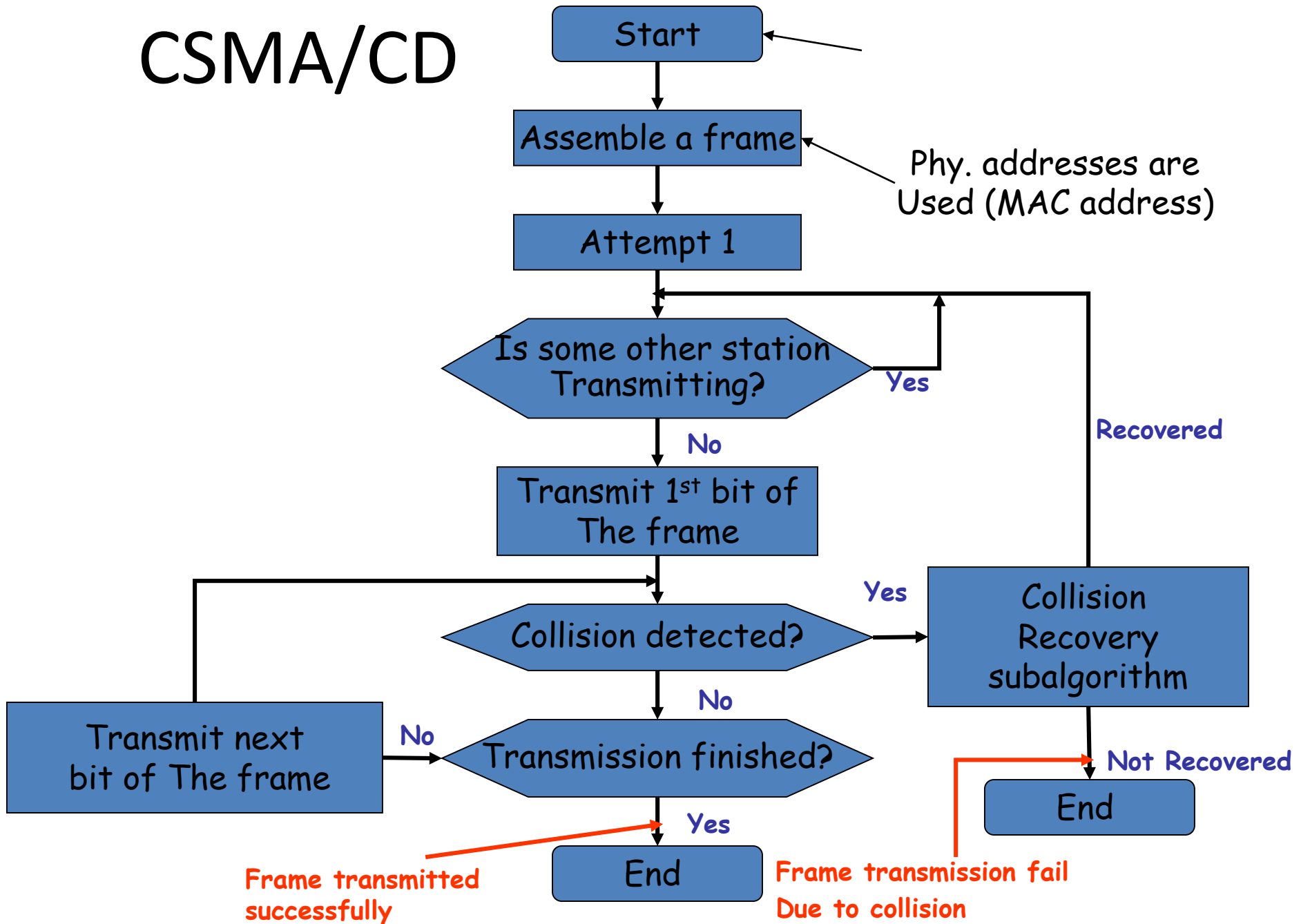
MAC

- Media Access Control technology provides unique identification and access control for computers on an Internet Protocol (IP) network.
- In wireless networking, MAC is the radio control protocol on the wireless network adapter.
- MAC works at the lower sub layer of the data link layer (Layer 2) of the OSI model.
- It provides addressing and channel access control mechanisms that make it possible for several terminals or network nodes to communicate within a multipoint network, typically a (LAN) or (MAN).

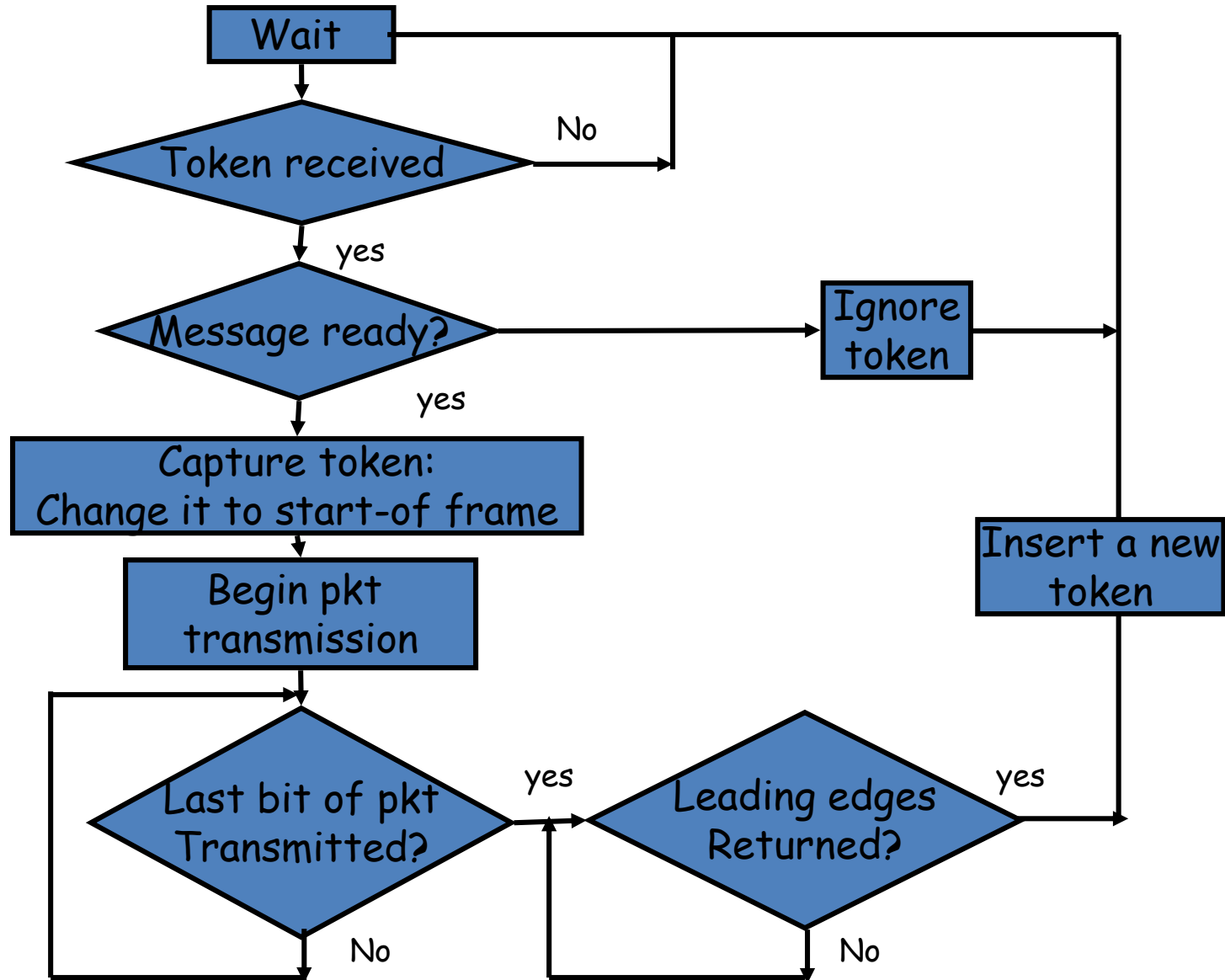
CSMA/CD

- A carrier sensing scheme is used by CSMA/CD. The method of operation of CSMA/CD is,
 - A transmitting data station that detects another signal while transmitting a frame,
 - Stops transmitting that frame, transmits a jam signal,
 - And then waits for a random time interval (known as "backoff delay" and
 - determined using the truncated binary exponential backoff algorithm) before trying to send that frame again.

CSMA/CD



Control token Operation



Metropolitan Area Network (MAN)

- Allows internetworks to span whole cities, rather than just buildings
- It serves network in multiple sites within the city's limits or metropolitan boundary.

Eg: University

 local government office

- Use WAN technology to connect the LANs

Technologies used in implementing MAN

- Line- of –sight microwave
- Synchronous Digital Hierarchy (SDH)
- Leased line

Wide Area Network (WAN)



- WANs span countries, continents, and the world
 - High capacity and High capital costs
- WANs are shared between thousands of customers

Eg: -Internet

-a network in a international company with
offices in several countries

Technologies used in implementing WAN

- Frame Relay (FR)
- Asynchronous Transfer Mode (ATM)
- Circuit switching
- Packet switching

Circuit Switching

- Dedicated communications path established for the duration of the conversation
- e.g. telephone network

Packet Switching

- Data sent out of sequence
- Small chunks (packets) of data at a time
- Packets passed from node to node between source and destination
- Used for terminal to computer and computer to computer communications

Frame Relay

- Packet switching systems have large overheads to compensate for errors
- Modern systems are more reliable
- Errors can be caught in end system
- Most overhead for error control is stripped out

Frame Relay (FR)

- The designers of frame relay aimed at a telecommunication service for cost-efficient data transmission for intermittent traffic between (LANs) and between end-points in a (WAN). Frame relay puts data in variable-size units called "frames" and leaves any necessary error-correction (such as re-transmission of data) up to the end-points. This speeds up overall data transmission.

Asynchronous Transfer Mode (ATM)

- Evolution of frame relay
- Little overhead for error control
- Fixed packet (called cell) length
- Anything from 10Mbps to Gbps
- Constant data rate using packet switching technique