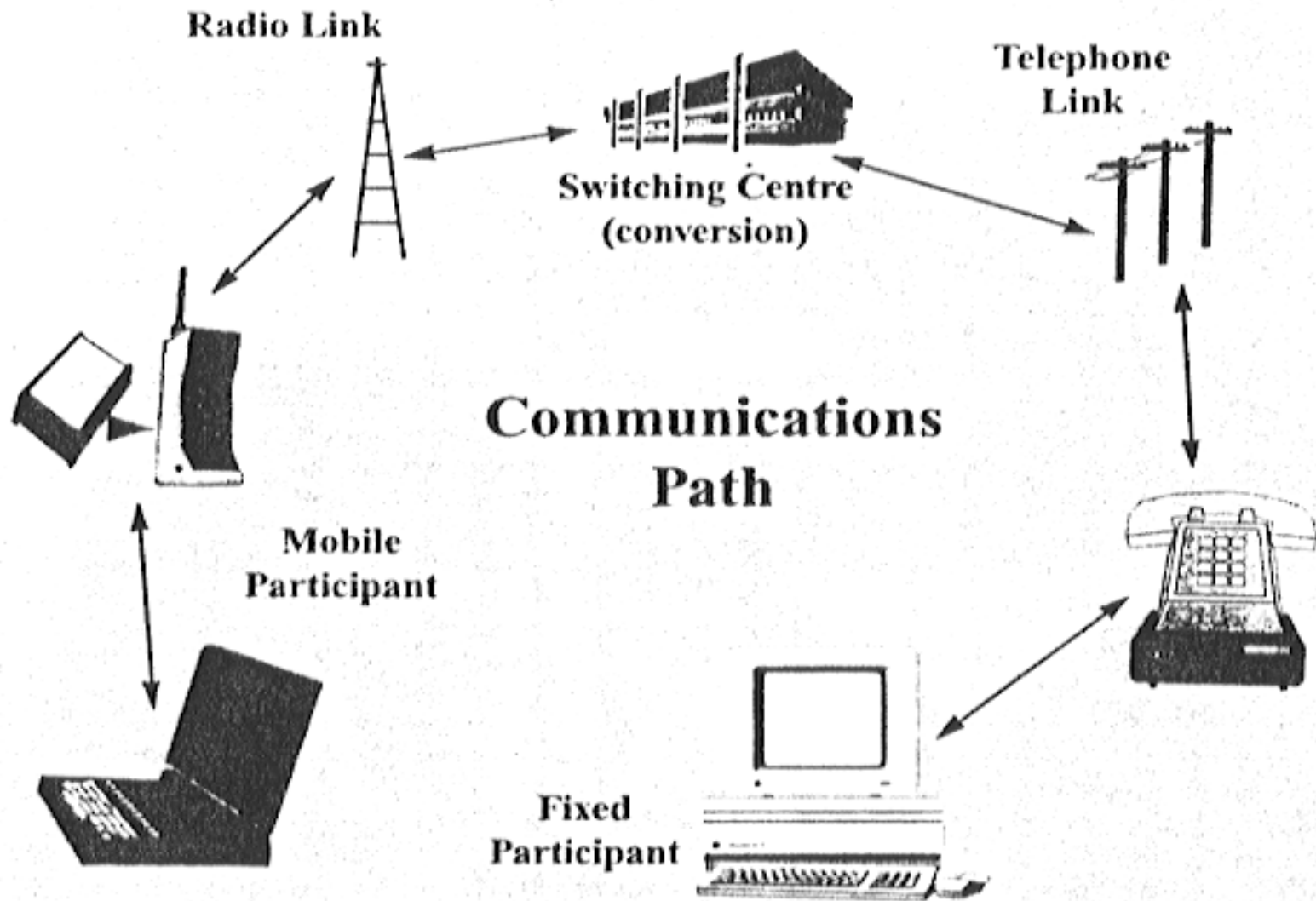


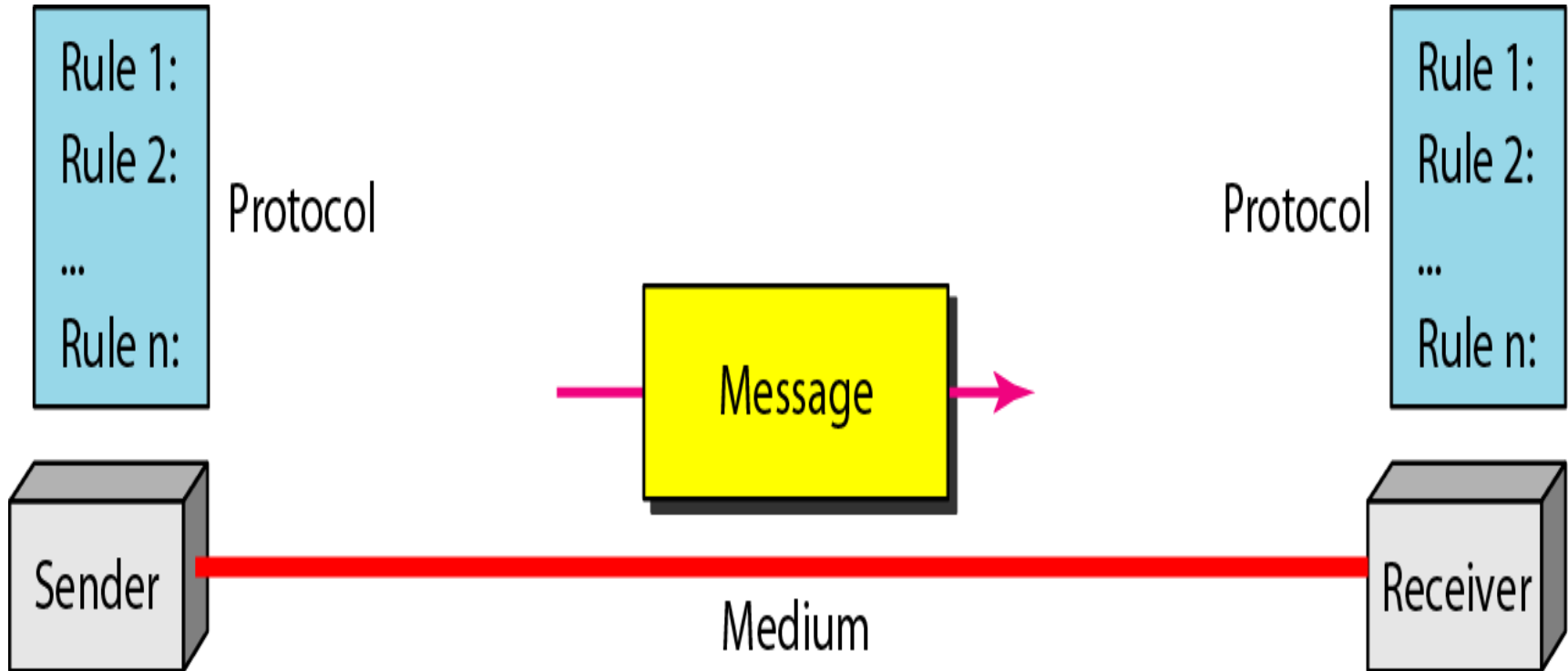
***Introduction to
Data Communication and
Networking***



DATA COMMUNICATION



- **Data Communication** are the exchange of data between two devices via some form of transmission medium such as a wire cable.



- For this data communications to occur , the communicating devices must be a part of a communication system made up of a combination of **hardware** and **software**.

❑ Components of Data Communication System:-

- **Message-** It is the information or data to be communicated.
- **Sender -** Device that sends the data message.
- **Receiver-** Device that receives the message.
- **Transmission Medium-** Physical path by which a message travels from sender to receiver.
- **Protocol-** Set of rules that govern data communication.
A protocol defines what is communicated, how it is communicated, and when it is communicated.

•Protocol and the key elements of protocol

A protocol is an agreed-upon format for transmitting data between two devices.

- ✓Syntax-** Refers to the structure or format of the data, i.e. the order in which they are presented.
- ✓ Semantics-** Refers to the meaning of each section of bits.
- ✓Timing-** Refers to two characteristics:
 - i) what or how much data should be sent.**
 - ii) how fast they can be sent.**

The protocol determines the following:-

- The type of error checking to be used**
- Data compression method (if any)**
- How the sending device will indicate that it has finished sending of a message**
- How the receiving device will indicate that it has received a message**

❑ Fundamental characteristics of Data Communications:

- Delivery- System must deliver data to the correct destination.
- Accuracy- System must deliver data accurately.
- Timeliness- System must deliver data in a timely manner.
- Jitter- Refers to the variation in the packet arrival time.

❑ Data Representation

- **Text**- Represented as a bit pattern, sequence of 0's and 1's.
- Different set of bit pattern used to represent symbols or characters.
- Each set is called code
- Process of representing symbols is called encoding
- Ex: ASCII, UNICODE

✓ **Numbers**-Also represented by bit patterns.

- Directly converted to binary form.

✓ **Images**- Composed of matrix of pixels.

Each pixel is assigned a bit pattern.

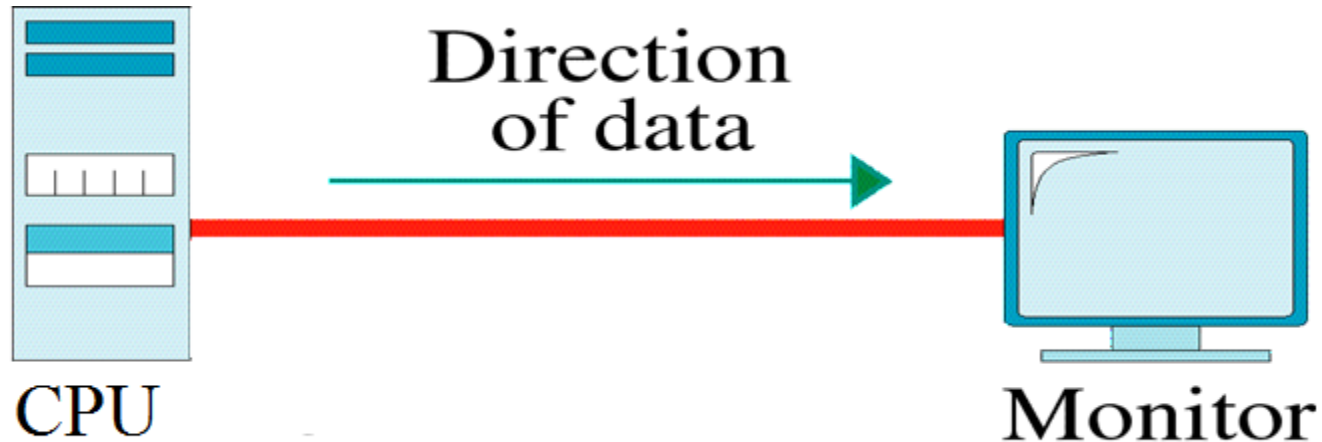
✓ **Audio** - Recording or broadcasting of sound or music.

❑ Data Representation

- ✓ **Images**- Composed of matrix of pixels.
Each pixel is assigned a bit pattern.
- ✓ **Audio** - Recording or broadcasting of sound or music.
 - Continuous not discrete
- ✓ **Video** - Recording or broadcasting of a picture or movie.
It can be a combination of images.

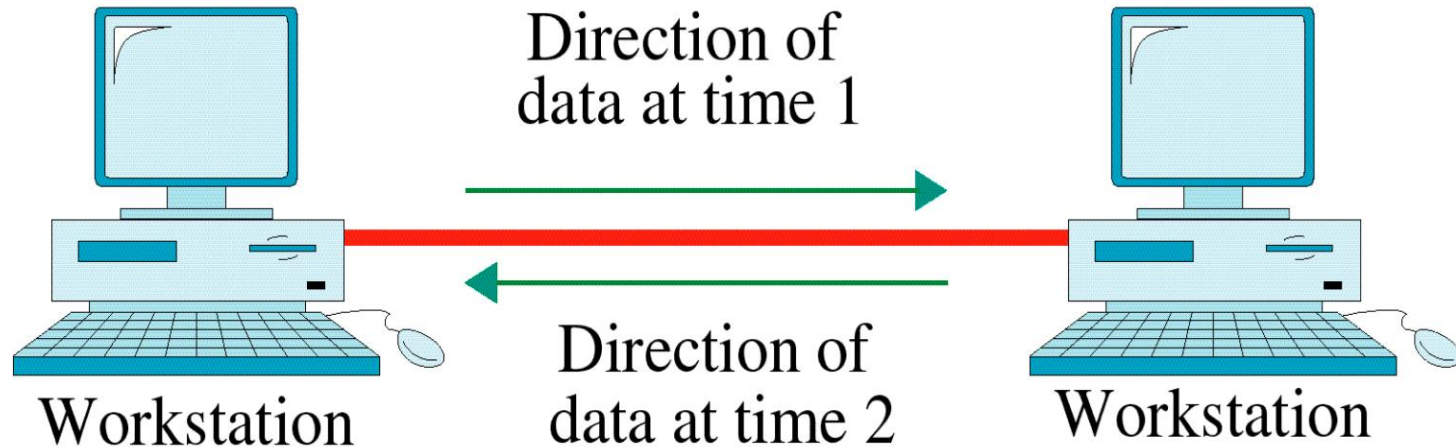
□ DATA FLOW

➤ Simplex



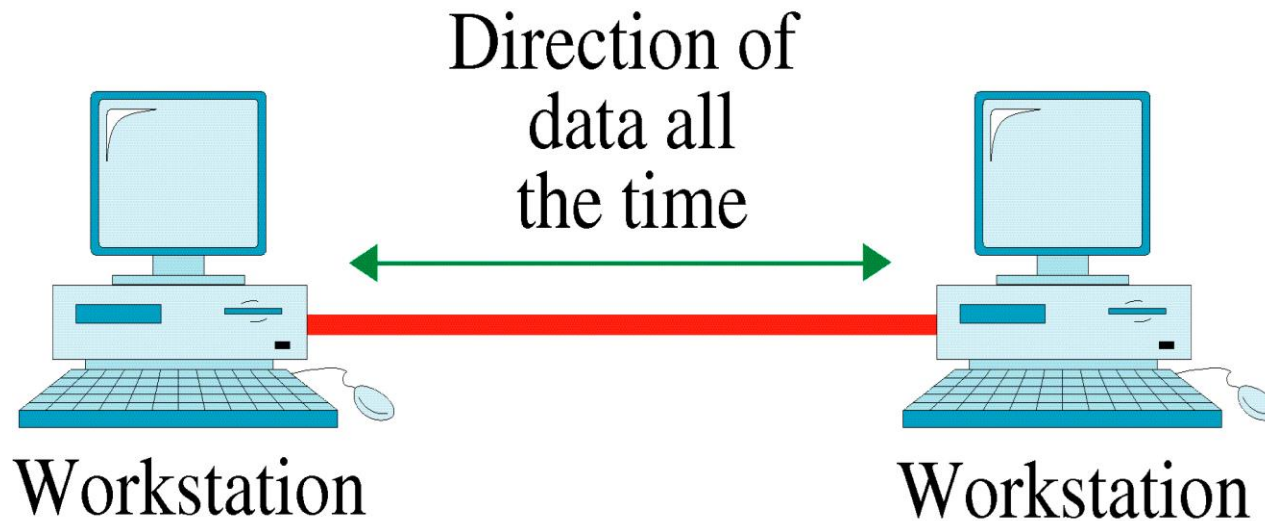
- **Communication is unidirectional.**
- **One of the two devices can transmit, and the other can receive.**
- **Example : Keyboard can only introduce input; the monitor can only accept output.**

➤ Half Duplex



- ✓ Each station can both transmit and receive, but not at the same time.
- ✓ When one is sending, the other can only receive and vice-versa.
- ✓ Walkie -Talkie is an example.

➤ Full Duplex



- ✓ **Both stations can transmit and receive simultaneously.**
- ✓ **Capacity of the links are shared by the signals.**
- ✓ **Example: Telephone network, as over telephone both parties can talk and listen at the same time.**

NETWORKS

- A **network** is set of devices (often referred to as nodes) connected by communication links.
- A node can be a computer, printer or any other devices capable of sending and/or receiving data generated by the nodes on the network.



•**Network Criteria**

✓**Performance-** Measured by transit time and response time.

➤ Measured using:

■ Transit time: time taken to travel a message from one device to another.

■ Response time: time elapsed between enquiry and response.

➤ Depends on following factors:

■ Number of users

■ Type of transmission medium

■ Efficiency of software

■ Evaluated by 2 networking metrics:

■ Throughput (high)

■ Delay (small)

•Network Criteria

✓**Reliability-**

- Measured by frequency of failure and the time the link takes to recover from failure.
- Network robustness in a disaster.

✓**Security-**

- Protecting data from unauthorized access, damage, etc.
- Implementing policies and procedures for recovery from breaches and data losses.

PHYSICAL STRUCTURES

Type of Connection

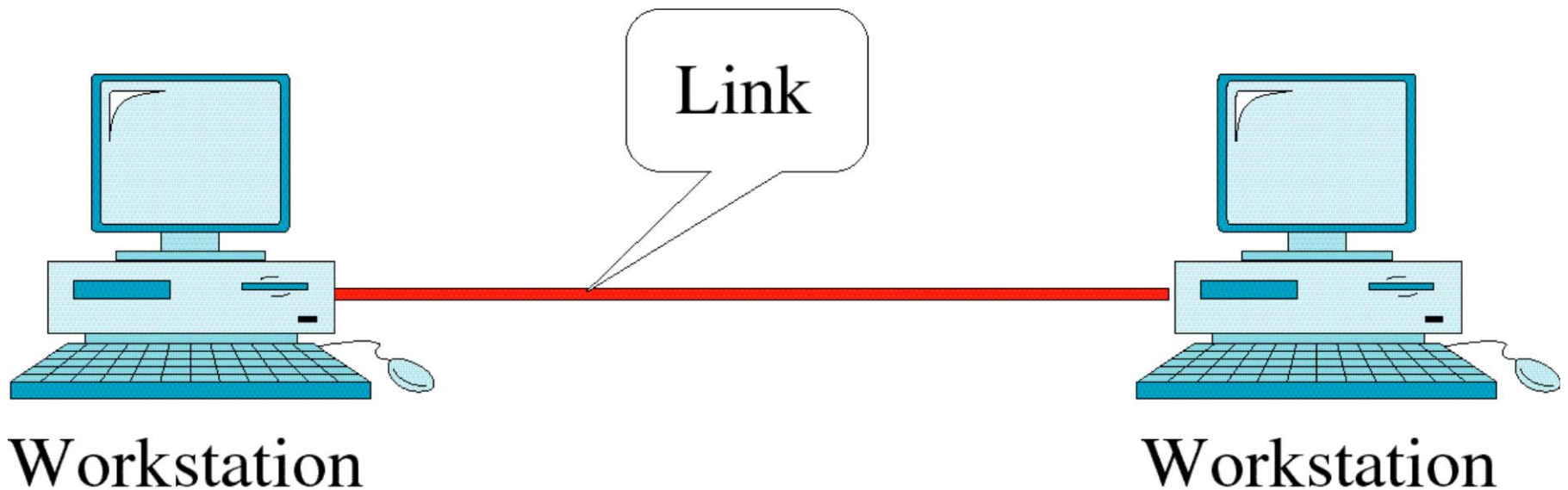
- A link in a network is a communication pathway that transfers data from one device to another.
- There are two types of possible connections:-

Point-to-point

Multipoint

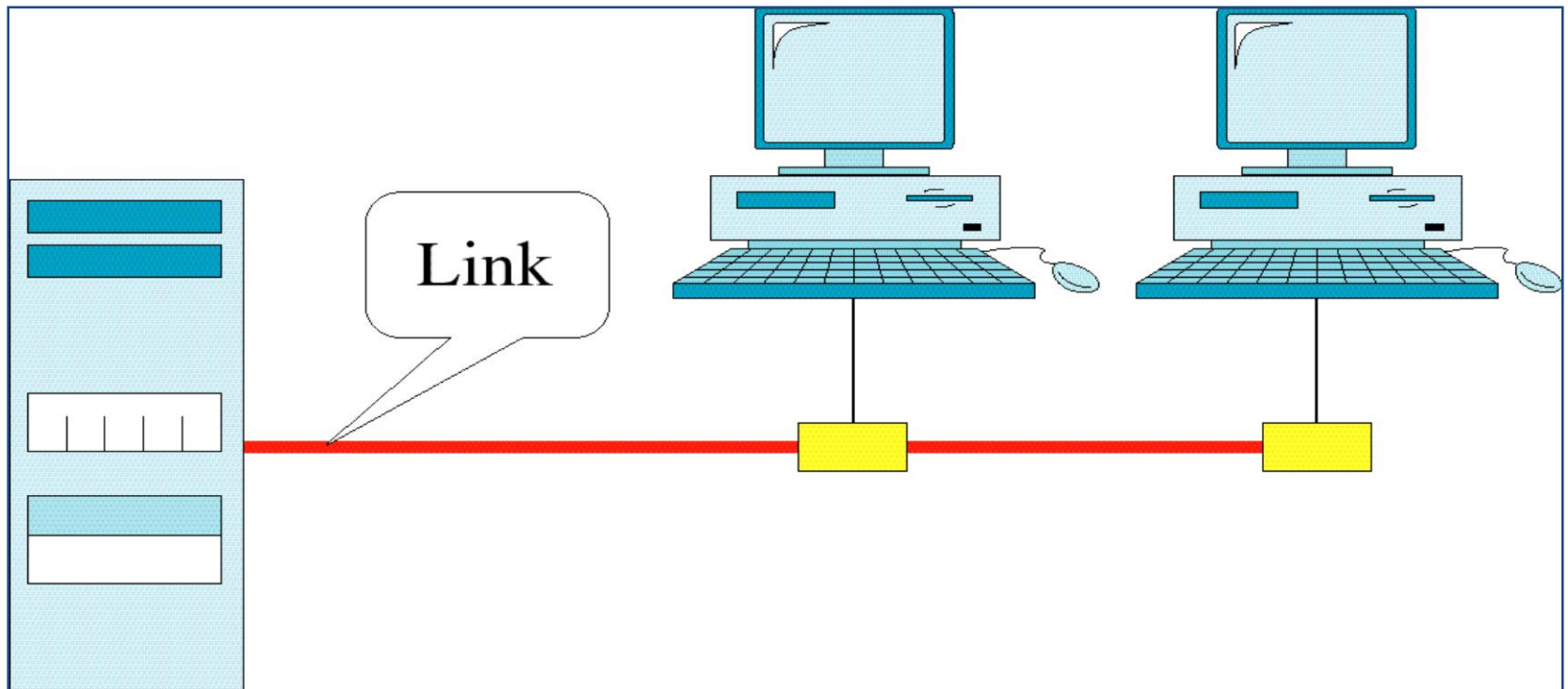
Point-to-Point Line Configuration

- Provides a dedicated link between two devices.
- Entire capacity of the link is reserved for transmission between those two devices.
- Example: Controlling the television channels by remote control.

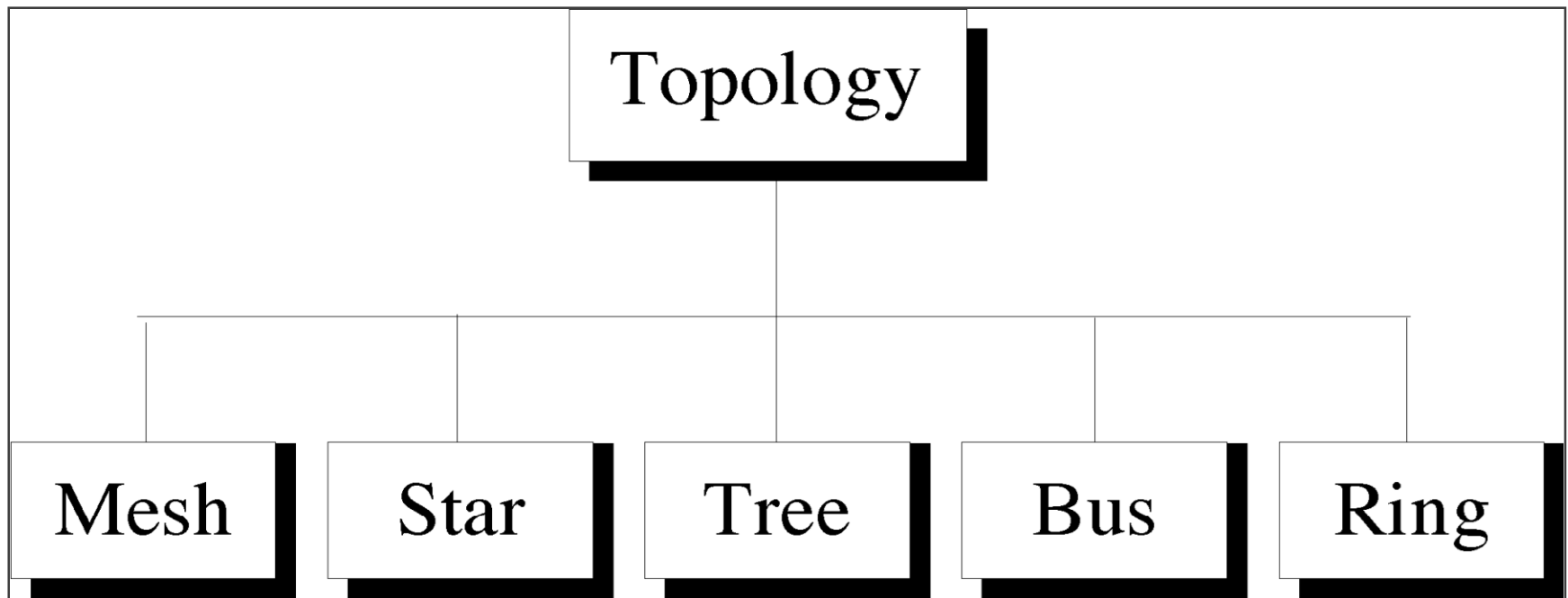


Multipoint Line Configuration

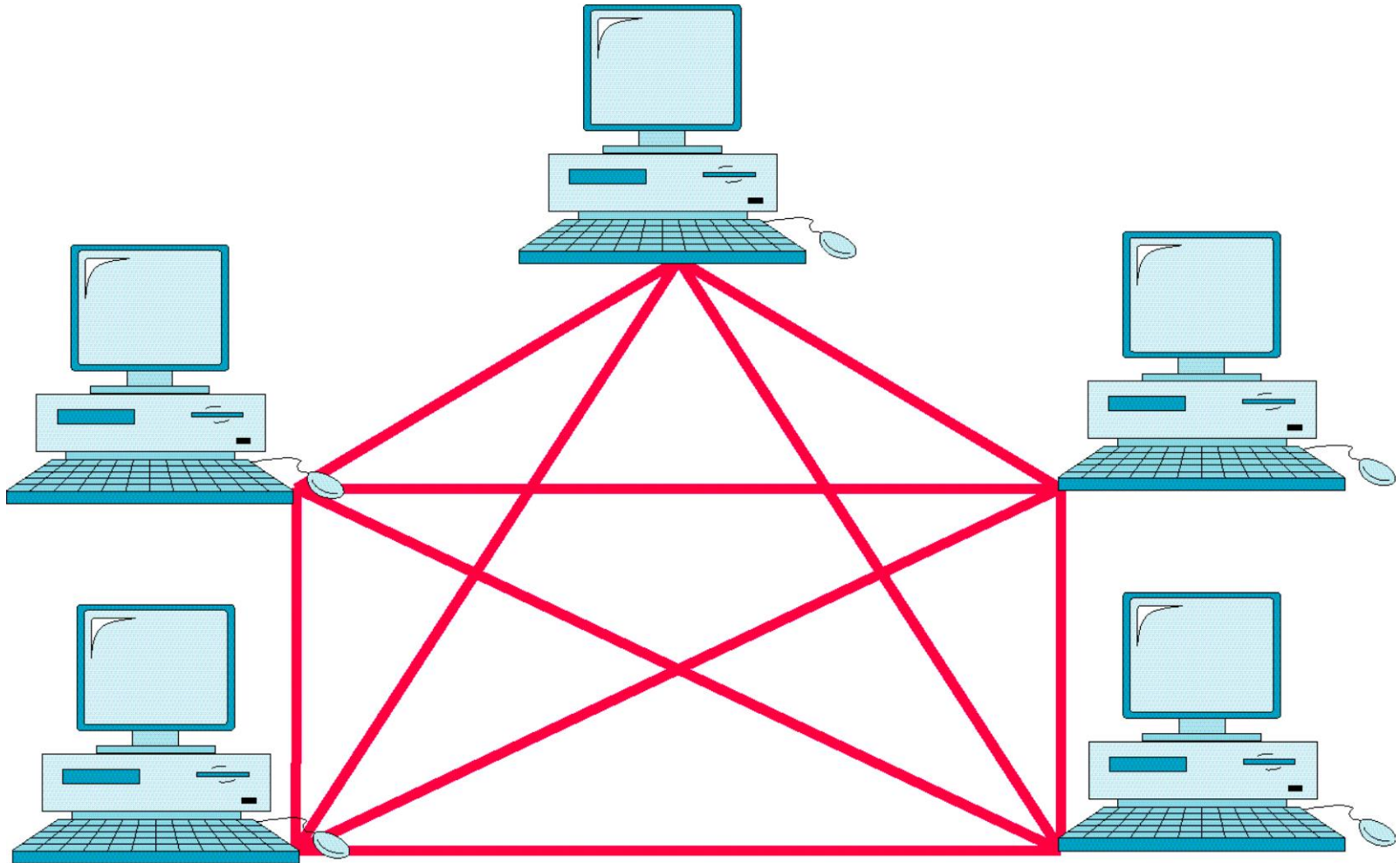
- A multipoint or multidrop connection is one in which more than two specific devices share a single link.
- Here the capacity of the channel is shared either spatially or in a timeshared manner.



- **Physical topology refers to the way in which a network is laid out physically.**
- **Two or more devices connect to a link.**
- **Two or more links form a topology.**



Mesh Topology



➤ **FEATURES:-**

- Every device has a dedicated point to point link to every other device.
- Each node is connected to every other $n-1$ nodes in the network.
(Considering n nodes in the network)
- So we need $n(n-1)$ links in a mesh network.
- To accommodate that many links, every device on the network must have $n-1$ input/output ports.

➤ **ADVANTAGES:-**

- Each connection carries its own data load, thus eliminating traffic problems.
- If one link becomes unusable, it does not disturb the whole system.
- Provides privacy and security due to the presence of dedicated link.
- For point-to-point links fault isolation is easy.

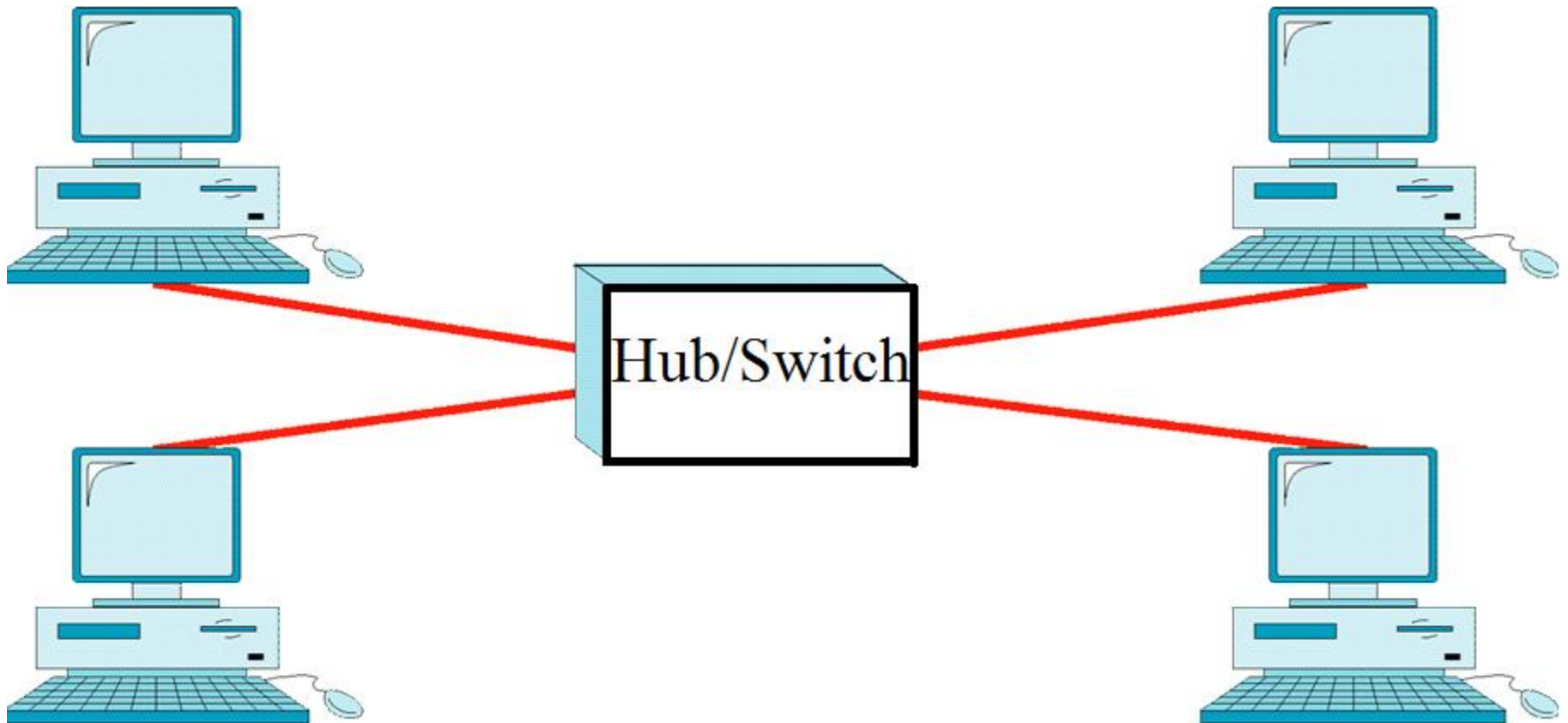
➤ **DISADVANTAGES:-**

- Huge amount of cabling is required.
- Lots of input-output ports are required.
- Very expensive: hardware required to connect each link is expensive.

➤ **EXAMPLE:-**

Practical example: connection of telephone regional offices in which each regional office needs to be connected to every other regional office.

Star Topology



If device-1 wants to send data to device-2, the device-1 sends the data to the hub, then the hub relays the data to the device-2.

➤ FEATURES:-

- Here each device has a dedicated point to point link to a central controller hub/switch.
- Here the controller acts as an exchange. Here each device send the data to the controller , which then relays it to the other connected device.

➤ ADVANTAGES:-

- **Less expensive:** Each device needs only one link & one I/O port to connect it to any devices.
- **Easy installation & reconfiguration:** Nodes can be added/removed w/o affecting the network.
- **Robustness:** If one link fails, it does not affect the entire system.
- Easy to **detect** and **troubleshoot** fault.
- **Centralized management:** The hub manages and controls the whole network.

- Easy fault isolation.

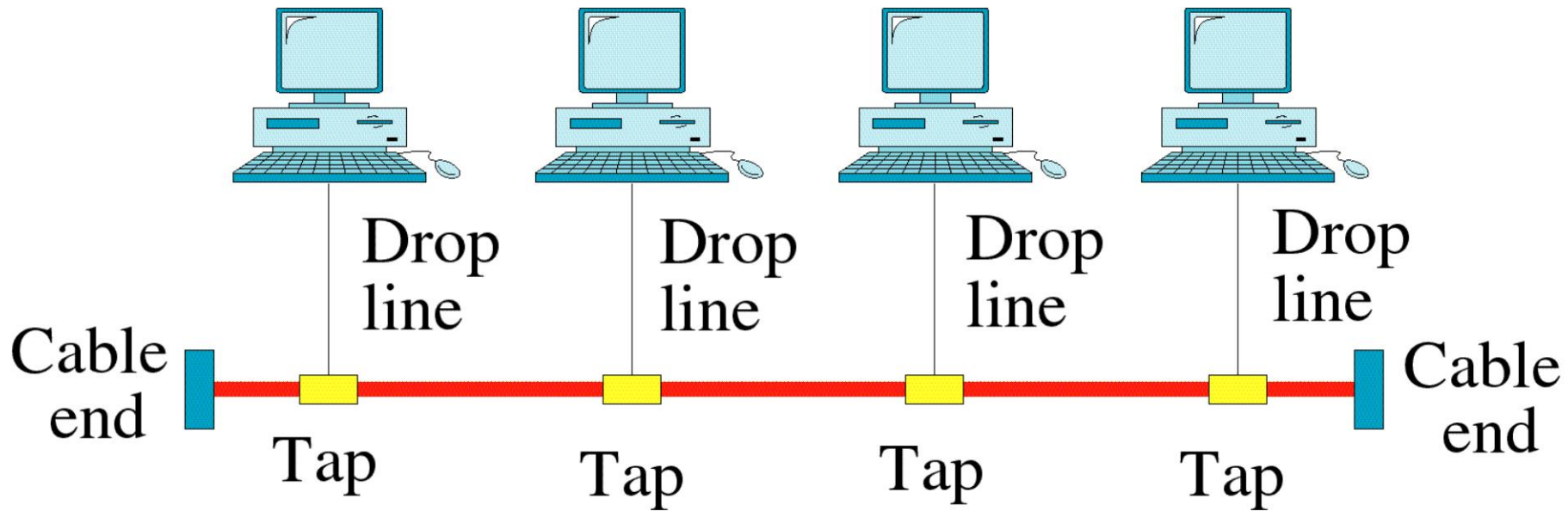
➤ **DISADVANTAGE:-**

- Dependency of the whole topology on the single point hub/switch.
- **Single point of failure:** If the hub goes down, the whole network is dead.
- Cable length required is the more compared to bus/ring topologies.
- **Number of nodes** in network depends on **capacity of hub**.

➤ **EXAMPLE:-**

- Used mostly in LANs

Bus Topology



➤ **FEATURES:-**

- A Bus topology is a multi-point connection.
- Here one long cable acts as a backbone to link all the devices in the network.
- Here nodes are connected to the bus line by drop lines and taps.
- A tap is a connector that either splices into the main cable or punctures the sheathing of the cable to create contact with metallic core.
- Here the signal travels along the backbone.

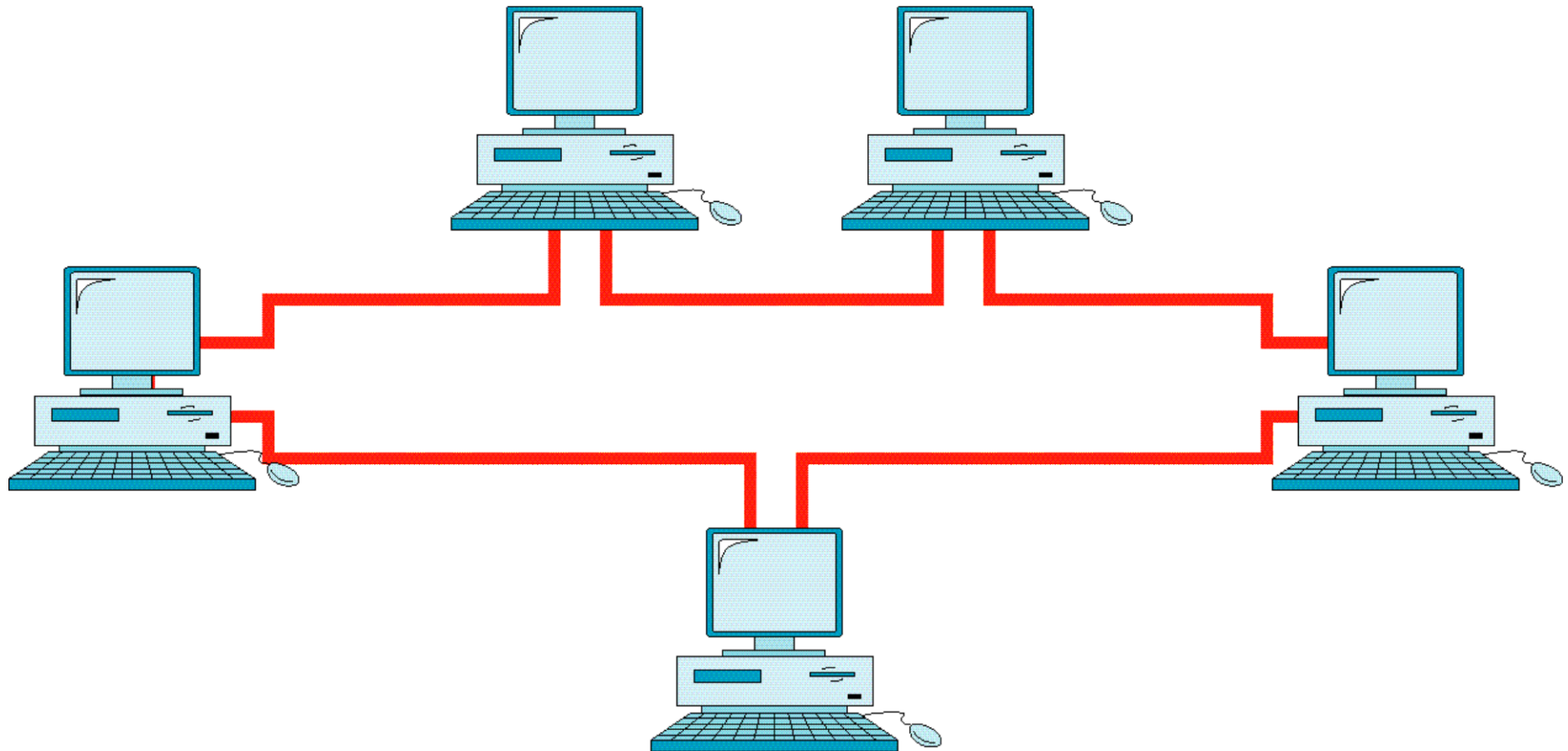
➤ **ADVANTAGE:-**

- Installation is easy.
- Less cabling is required as compared to mesh and star topologies.

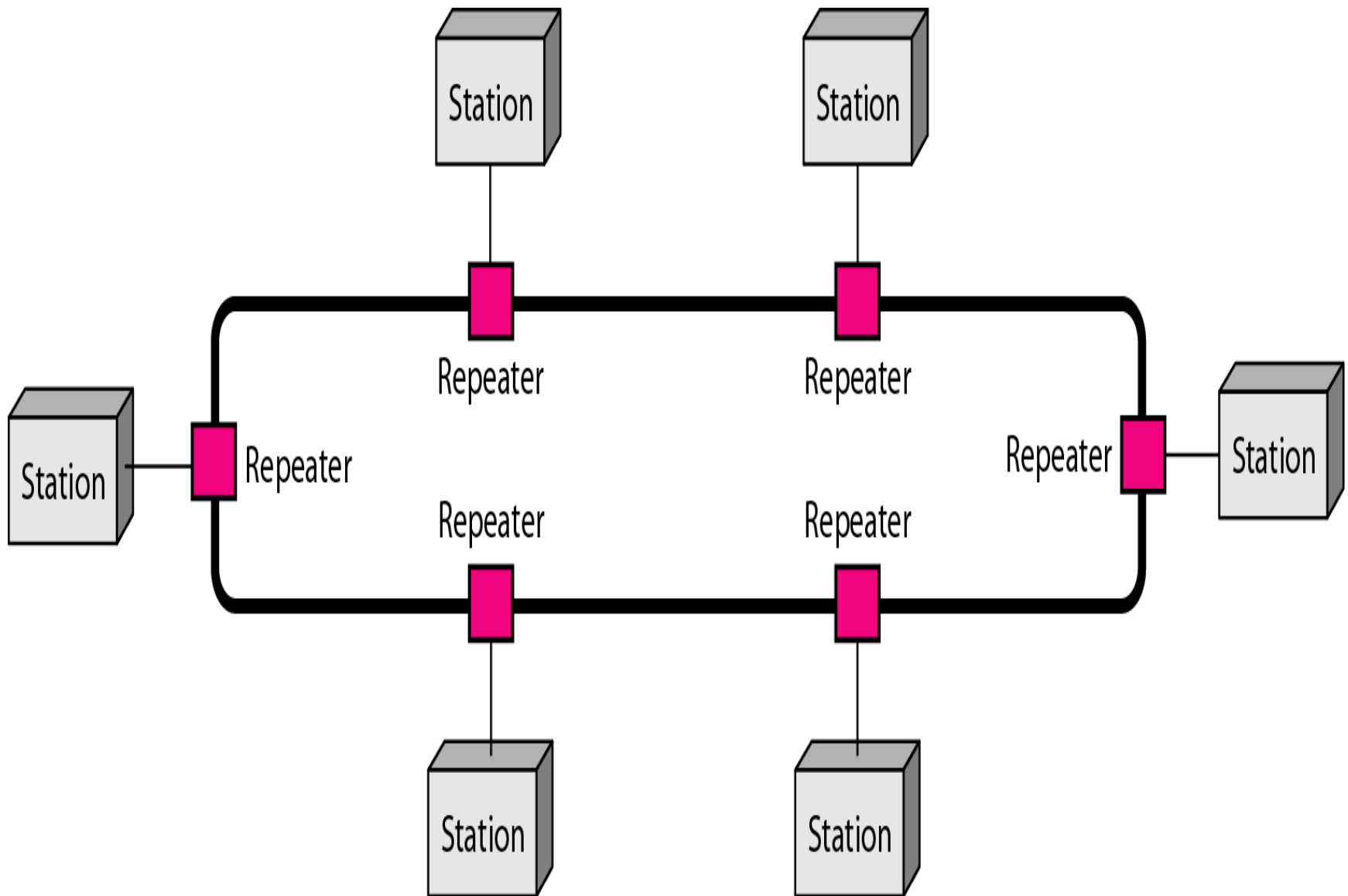
➤ **DISADVANTAGE:-**

- Fault Isolation.
- Adding up large number of nodes is not possible, as quality of the signal degrades, as it travels longer.

Ring Topology



Ring Topology



Ring Topology

- Each device is connected to the next, forming a ring.
- There are only two neighbors for each device.
- Data travels around the network in one direction till the destination is reached.
- Sending and receiving of data takes place by the help of token.
- Each device has a repeater.
- A repeater
 - receives a signal on transmission- medium &
 - regenerates & passes the signal to next device.

➤ **FEATURES:-**

- Here each device has dedicated point-to-point connection with only two devices on either side of it.
- The signal passes along in one direction until it reaches its destination.
- Each device in the ring incorporates a repeater, to regenerate the signal and pass it on. (For a bigger ring).
- Signal travelling is uni-directional.

➤ **ADVANTAGES:-**

- Easy to install and reconfigure.
- Fault isolation is easy.

➤ **DISADVANTAGE:-**

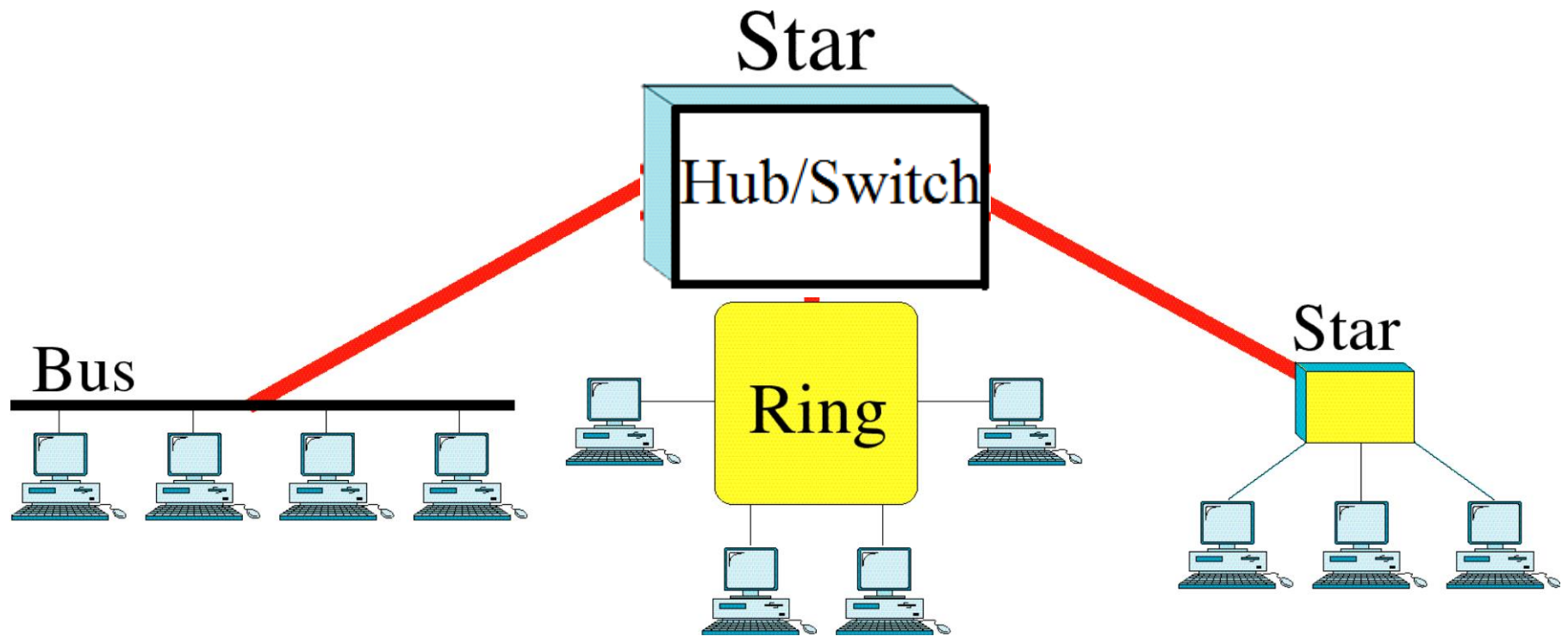
- Unidirectional traffic is sometimes a disadvantage.
- A break in the ring can disable the entire network.

The above 2 drawbacks can be overcome by using dual ring.

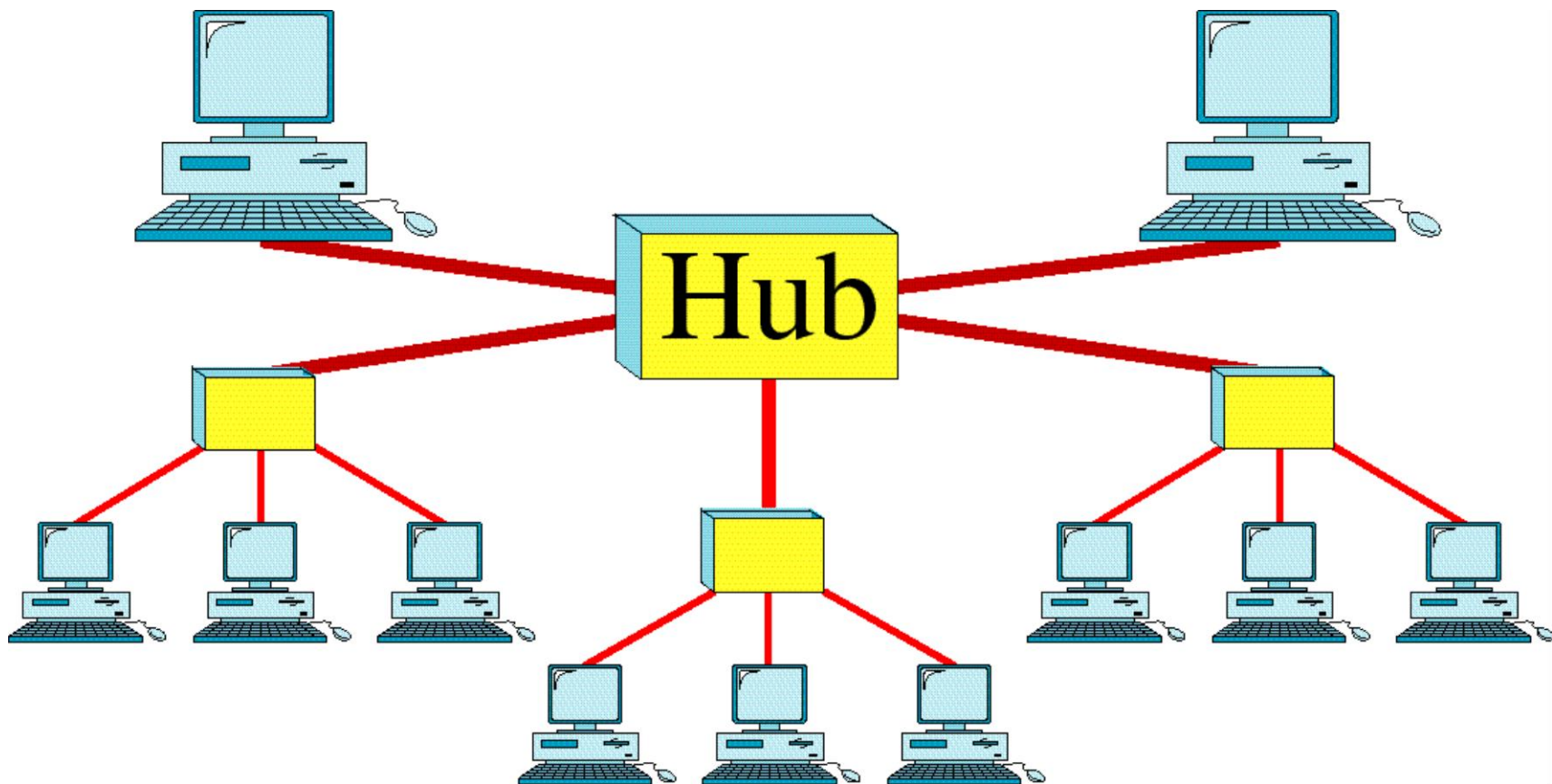
➤ **EXAMPLE:-**

- In bigger networks.

Hybrid Topology

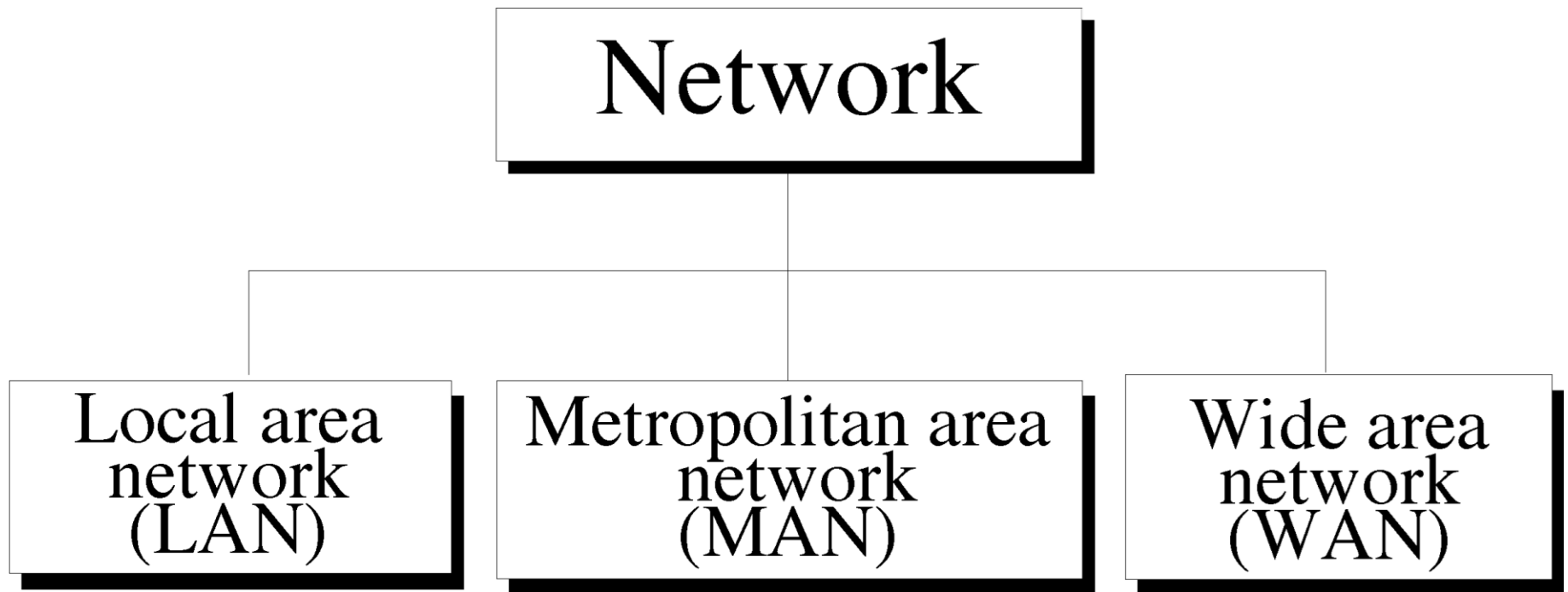


Tree Topology



NETWORK CATEGORIES

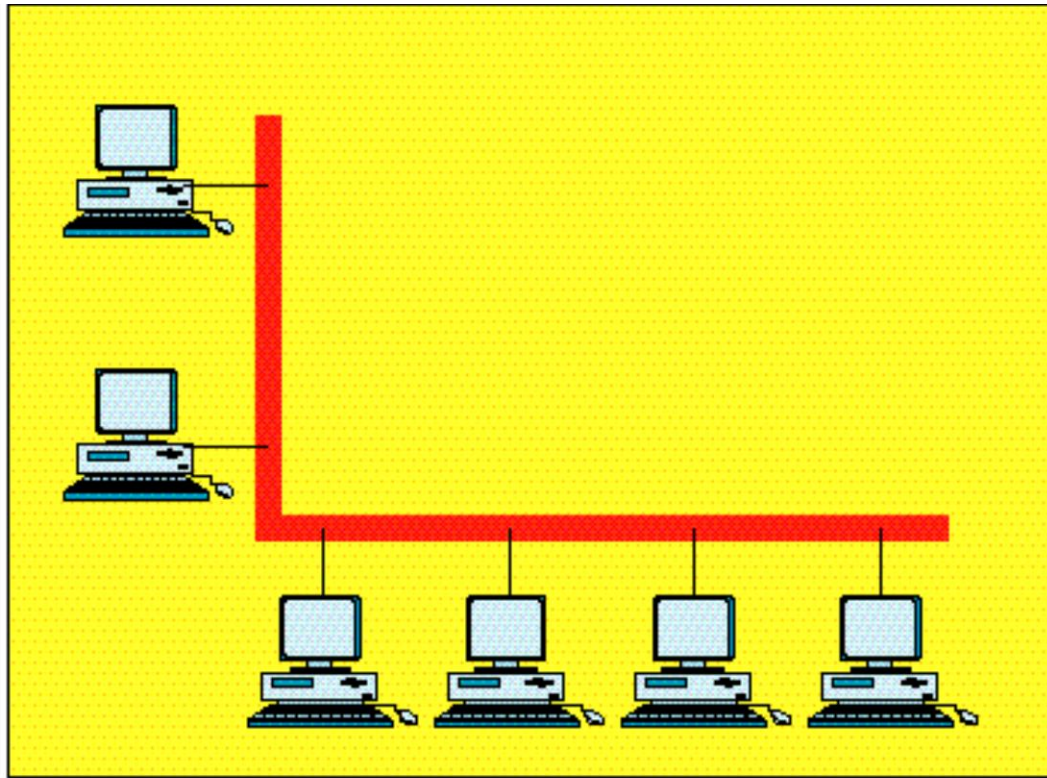
❑ The primary categories of networks are:-



LAN

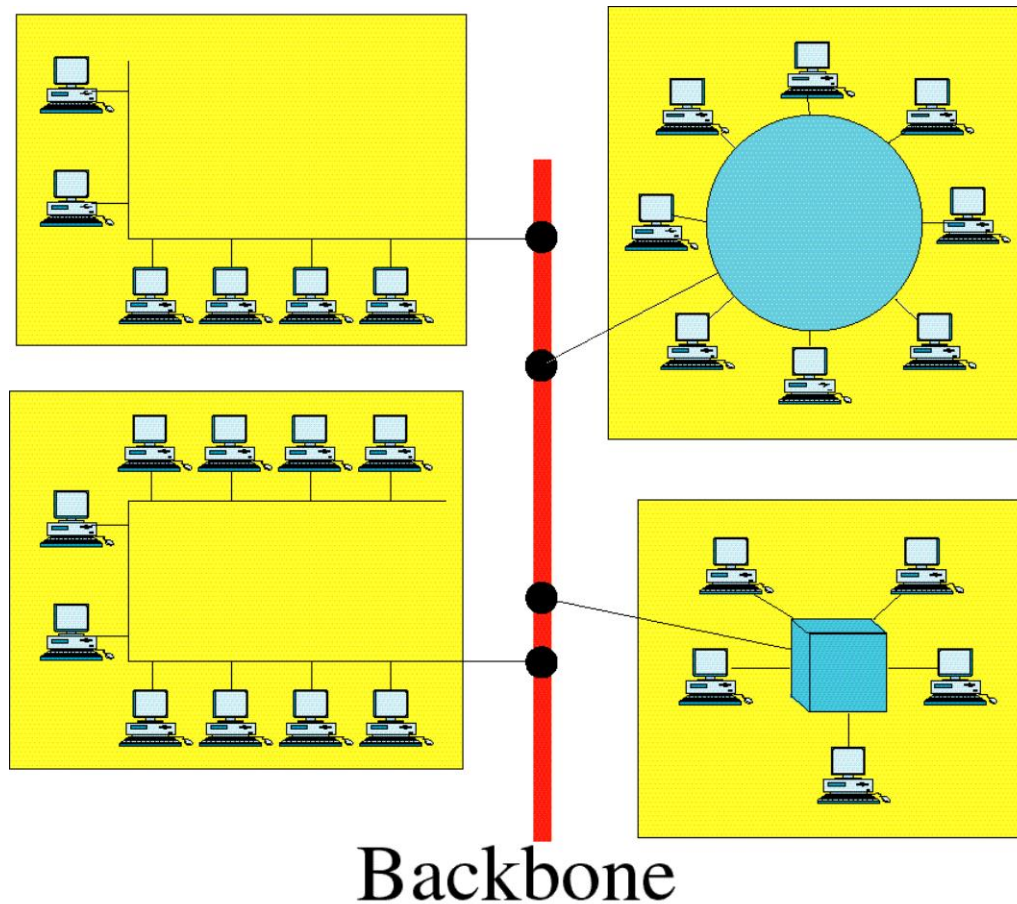
- Local Area Networks are generally privately owned networks
- Designed to connect devices in a single office, building or campus.
- Limited to few Kilometers.
- Designed to allow resources (both hardware and software or data) to be shared between personal computers.
- Most common LAN topologies are Ring and Star topologies.
- Speeds in LAN are normally 100 to 1000 Mbps

Local Area Network



Single building LAN

Local Area Network

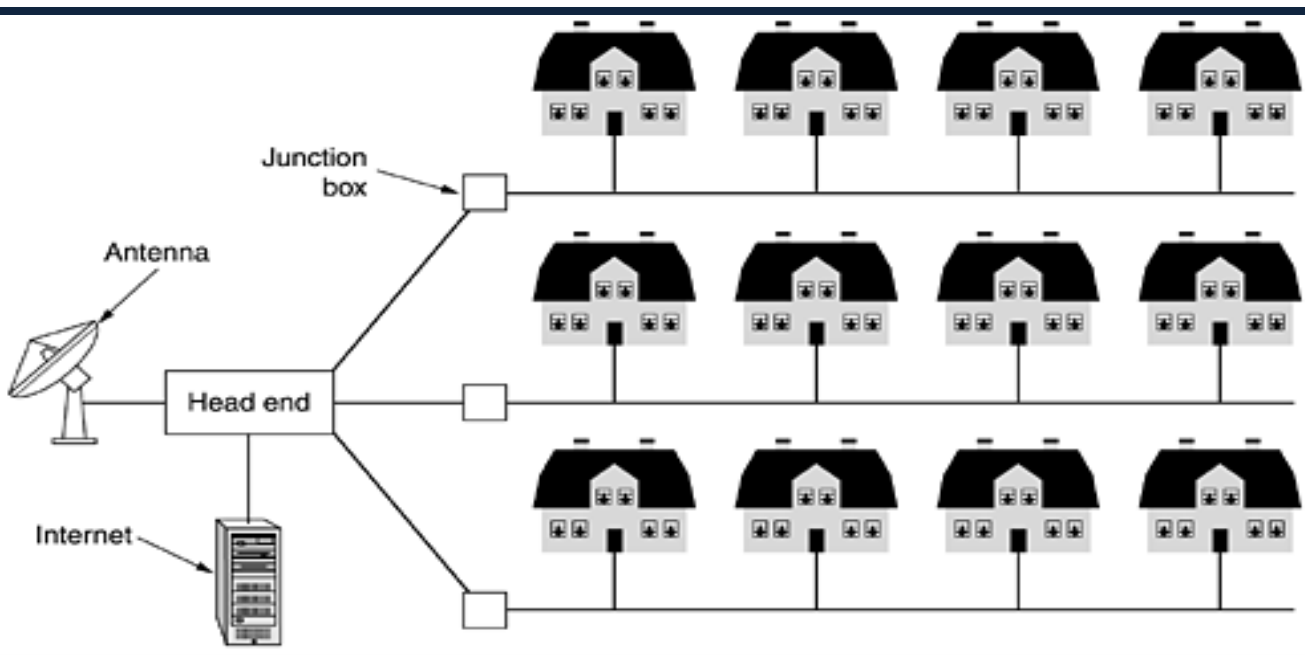
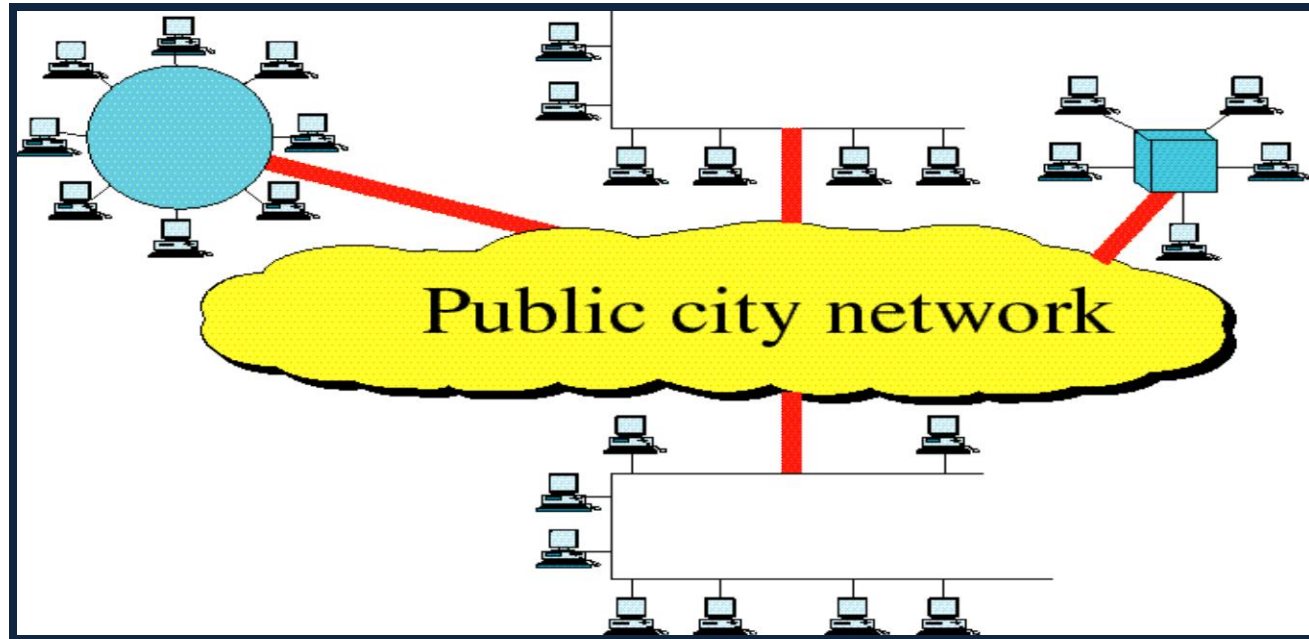


Multiple building LAN

MAN

- Metropolitan Area Network normally covers the area inside a town or a city.
- Size of a MAN is between a LAN and a WAN.
- The best known example is a cable television network available in the cities.
- Recent developments in wireless Internet Access is also another example of MAN.

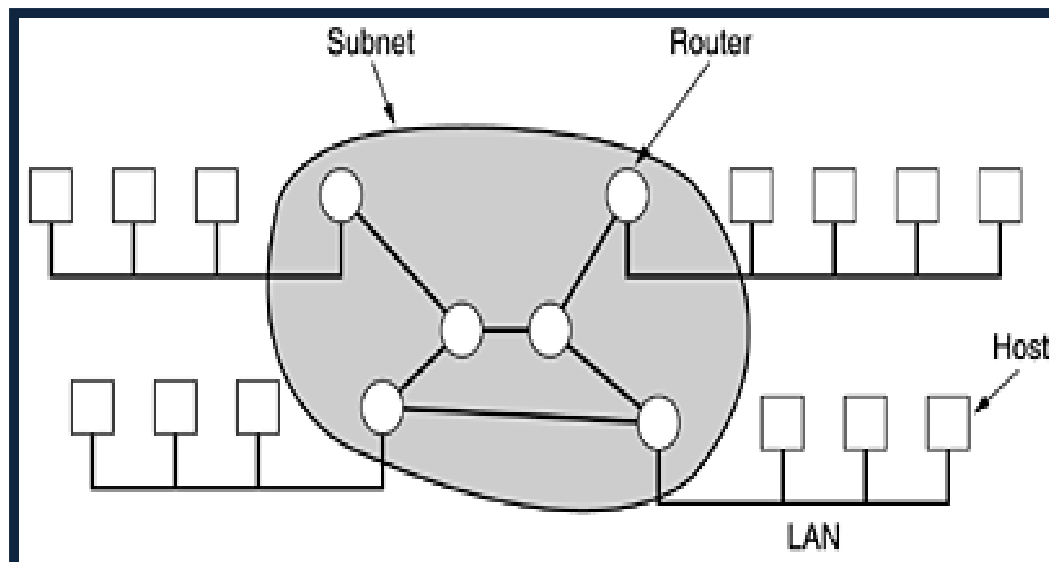
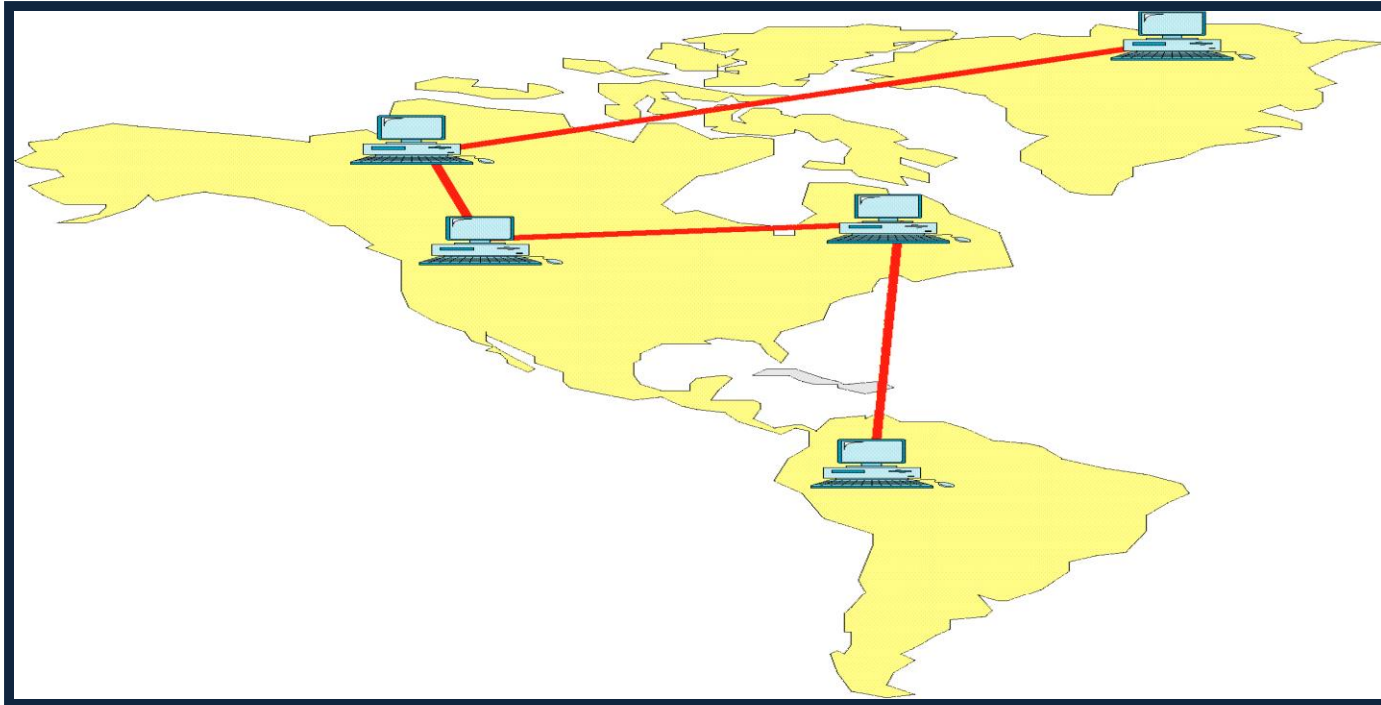
Metropolitan Area Network



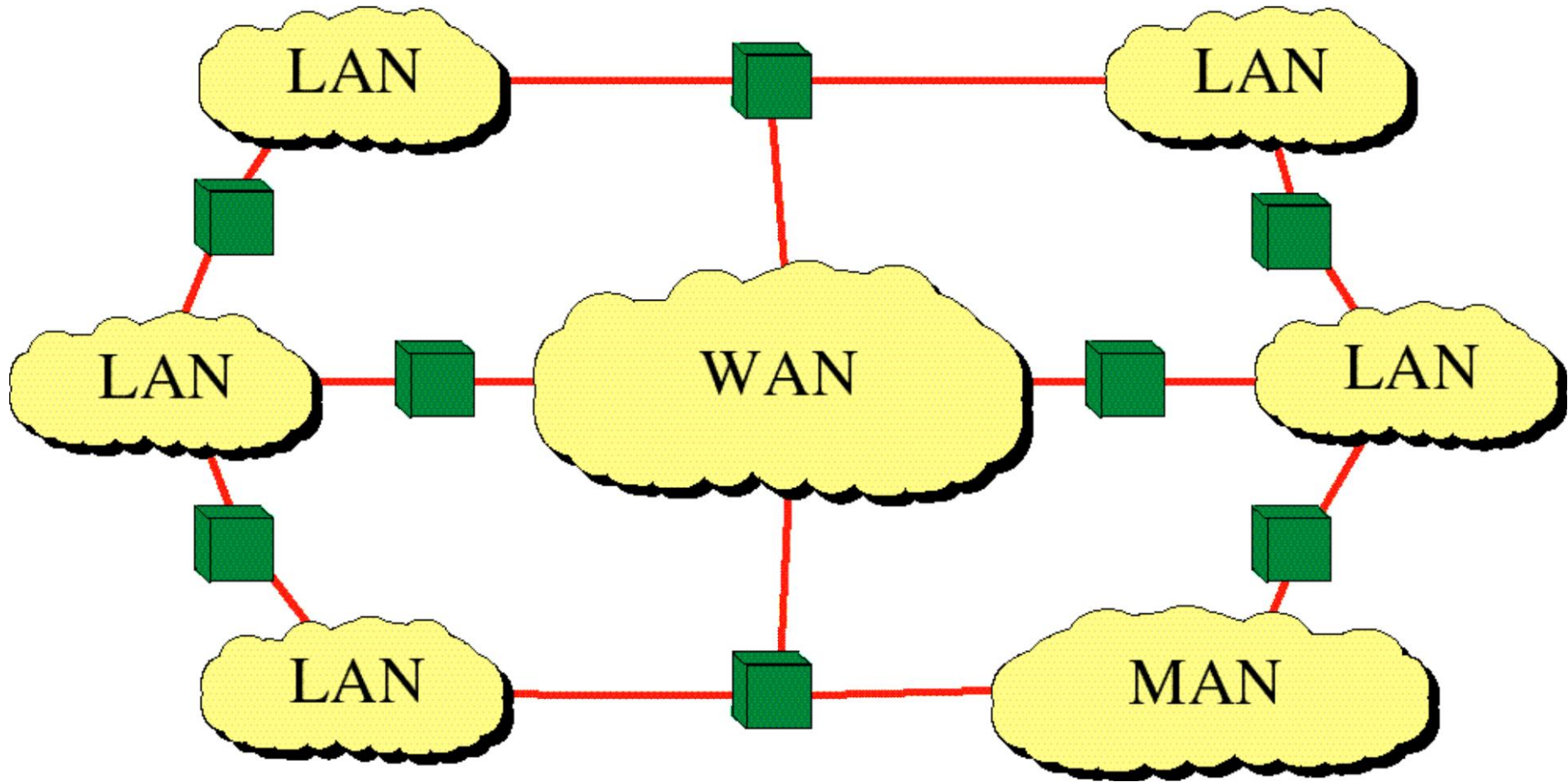
WAN

- Wide Area network provides long distance transmission of data, image, audio, video, etc.
- There are two types of WAN connection: Switched WAN and Point-to-Point WAN.
- Switched WAN's connect the end systems, which usually comprise a router , that connects to another LAN or WAN.
- Point-to-Point WAN is normally a leased line from a telephone or a cable TV provider that connects a home computer or a small LAN to an ISP(Internet Service Provider).

Wide Area Network



Internetwork (Internet)



Network Architecture

- The term network architecture can refer to either hardware or software or a combination of hardware and software.
- An open architecture allows the system to be connected easily to devices and programs made by other manufacturers.
- A system with closed architecture on the other hand is one whose design is proprietary making it difficult to connect the system to other systems.

Peer-to-Peer architecture

- In this type of network, each workstation has equivalent capabilities and responsibilities.
- Peer-to-peer networks are generally simpler and less expensive but they usually do not offer the same performance under heavy loads.

Client/Server architecture

- This is a network architecture in which each computer or process on the network is either a client or a server. Servers are more powerful computers or processors dedicated to managing disk drives, printers or network traffic.
- Clients are less powerful PCs or workstations on which users run applications.

- **Internet (With capital I) –**

Collaboration of more than hundreds and thousands of interconnected network.

- **internet (With small i)-**

It is two or more networks that communicate with each other.

Internet Service Providers

- **Today the Internet is run by private companies generally . They are called the Internet Service Providers.**
- **There are several types of Internet Service Providers. They are:**
 - a) International Service Providers**
 - b) National Service Providers**
 - c) Regional Service Providers**
 - d) Local Service Providers**

Hierarchical Organization of Internet

