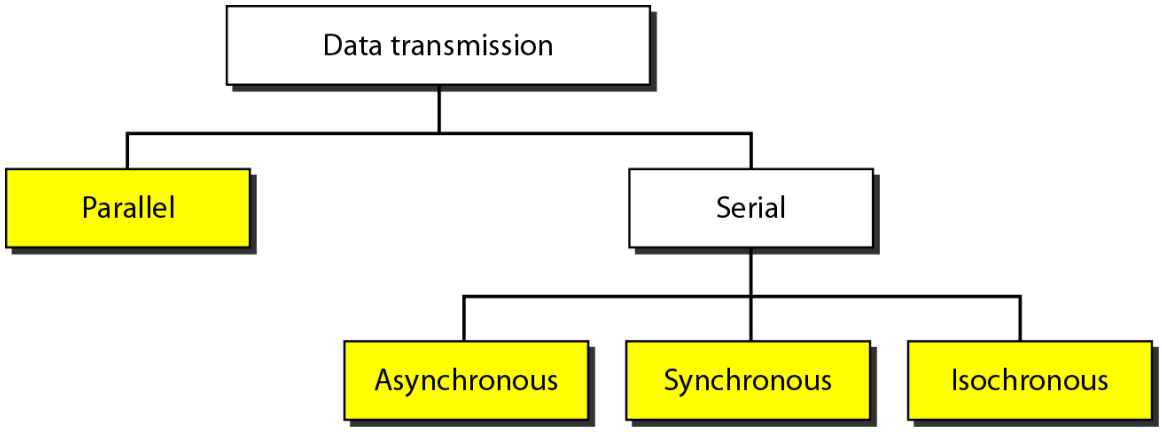
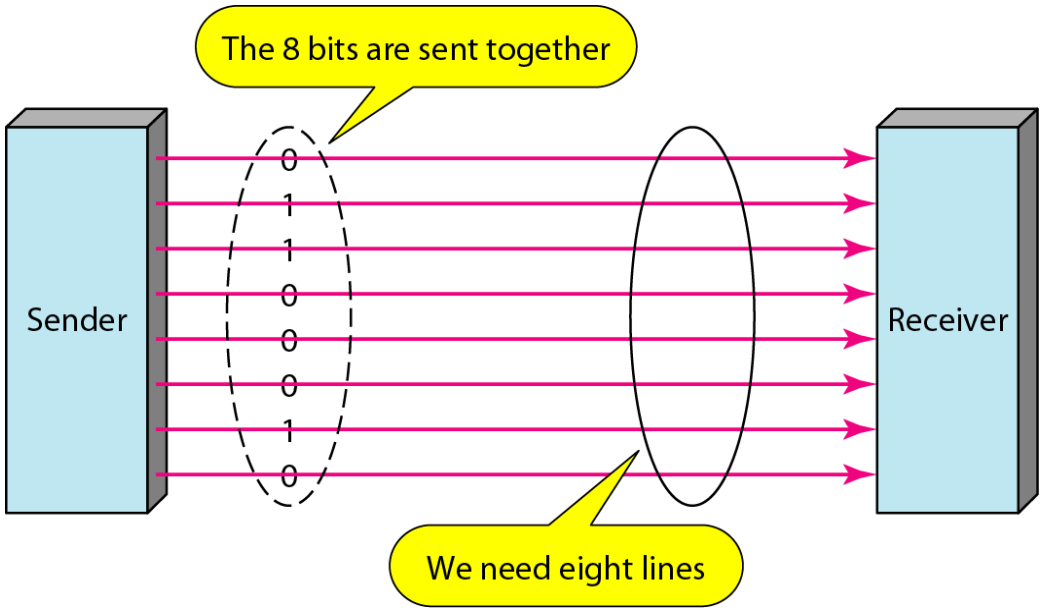
Data Transmission:

Data transmission can be either parallel or serial as shown below:



Parallel Transmission:

By grouping, we can send data (n-bits) at time instead of one bit at a time. The mechanism for parallel transmission is simple: use n wires to send n bits at one time as shown below:



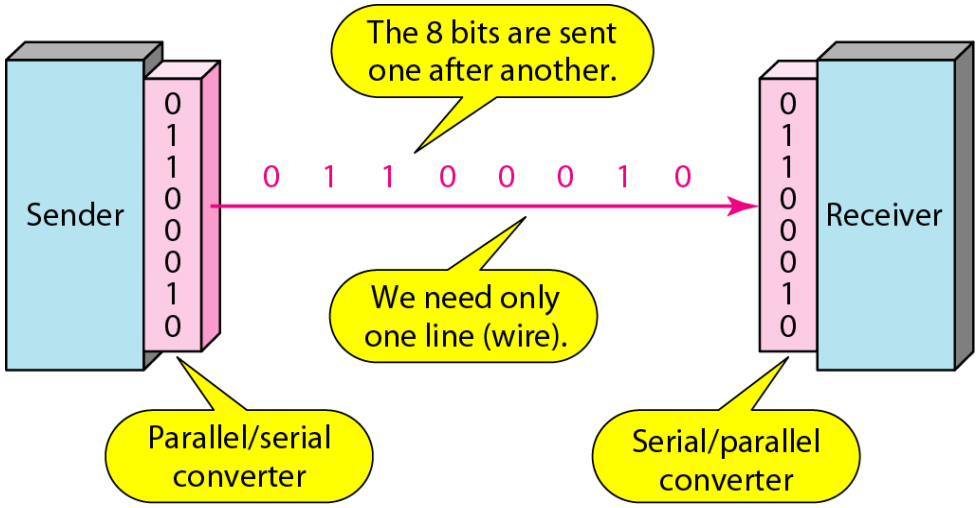
Notes:

1-The advantage of parallel transmission is speed.

2-Because parallel lines are expensive, parallel transmission is usually limited to short distances, up to maximum 25 feet.

Serial Transmission:

In this type one bit follows another, so it needs only one communication channel as shown below:

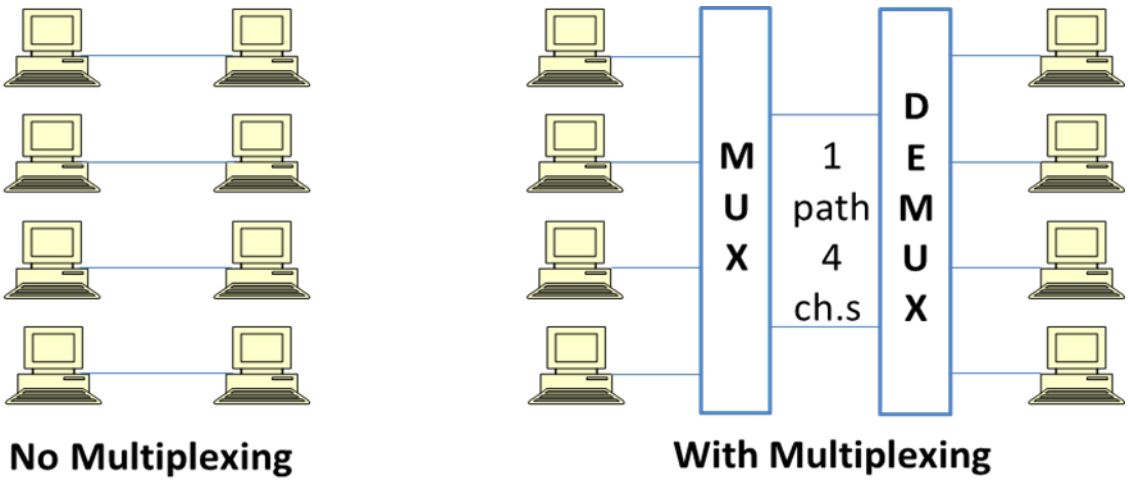


Notes:

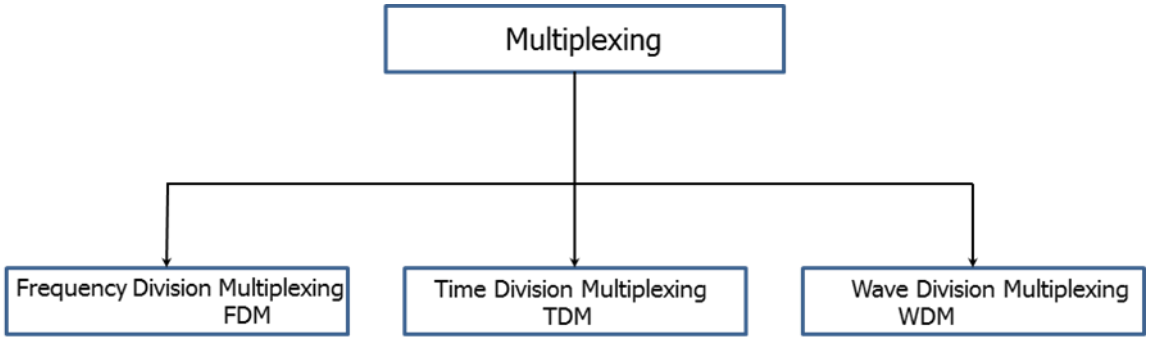
1- The advantage of serial over parallel transmission that it reduces the cost.
2- It is slower than parallel by n times.
3- Since communication within devices is parallel, conversion devices are required at interfaces.

Multiplexing:

Multiplexing is the set of techniques that allows the simultaneous transmission of multiple signals across a single data link. In multiplexed system, (n) devices share the capacity of one link as shown in figure below:



Types of Multiplexing:



Frequency Division Multiplexing (FDM):

FDM is an analogue technique that can be applied when the band width of a link is greater than the combined bandwidths of signals to be transmitted.

Wave Division Multiplexing (WDM):

WDM is the same as FDM, except that the multiplexing and demultiplexing involve light signals transmitted through fiber optic channels.

Time Division Multiplexing (TDM):

TDM is a digital process that can be applied when the data rate capacity of transmission medium is greater than the data rate required by the sending and receiving devices.

Note that the same link used as in FDM, however the link was previously shown sectioned by time rather than frequency.

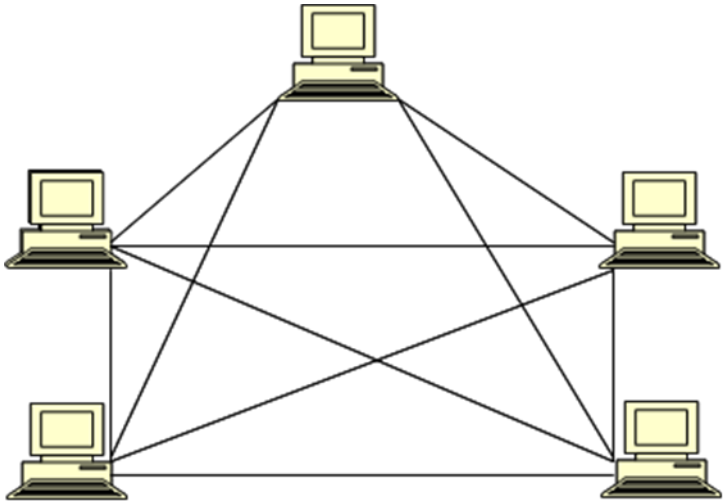
Computer Networks

computer network is the infrastructure that allows two or more computers (called hosts) to communicate with each other. The network achieves this by providing a set of rules for communication, called protocols, which should be observed by all participating hosts. The need for a protocol should be obvious: it allows different computers from different vendors and with different operating characteristics to 'speak the same language'.

Network Topology:

The term topology refers to the way a network is laid out, either physically or logically. The topology of network is the geometric representation of relationship of all the links and linking devices (usually called nodes) to each other. Network topology can be divided into the following types:

1- Mesh Topology:



In a mesh topology every device has a dedicated point to point link to every other device. A fully connected mesh network has $\frac{n(n-1)}{2}$ physical channels to link n devices. Mesh topology offers several advantages such as:

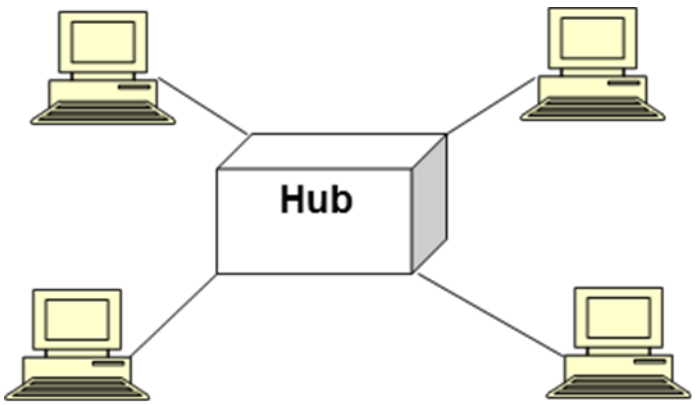
1- Use of dedicated links guarantees that each connection can carry its data load, thus eliminating the traffic problems that can occur when links must be shared by multiple devices.
2- It is robust, if one link becomes unstable it does not destroy the entire system.
3- Privacy or security. When every message sent travels along a dedicated line, only the intended recipient see it.
4- Point to point links make fault identification and fault isolation easy.

Mesh topology also has some disadvantages such as:

1- The amount of cabling.
2- The number of input/output ports required.
3- Installation and reconfiguration are difficult.
4- Hardware required to connect each link is expensive.

For these reasons mesh topology is usually implemented in a limited fashion.

2-Star Topology:



In star topology, each device has a dedicated point to point link only to a central controller usually called a hub. The devices are not linked to each other. Star topology offers some advantages such as:

1- Star topology is less expensive than mesh topology.
2- Each device needs only one link and one input/output port.

3- Robustness, if one link fails only that link is affected. All other links remain active.

4- Easy to install and reconfigure.

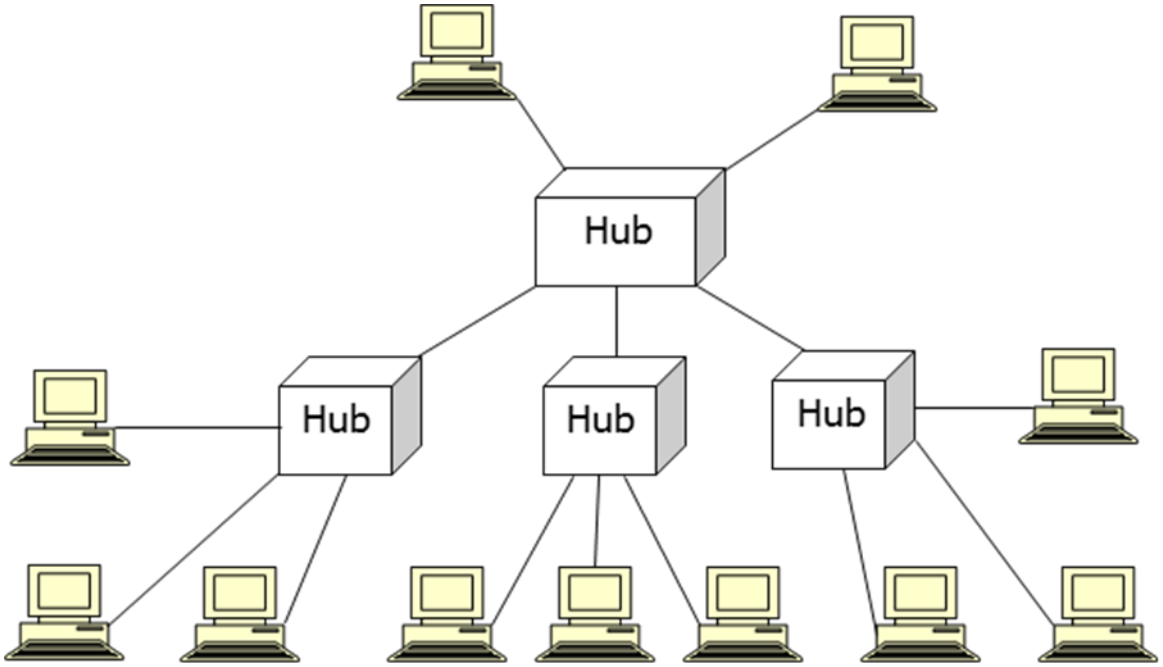
5- Less cabling than mesh topology.

Star topology also has some disadvantages such as:

1- Depending on hub.

2- More cabling is required in star than in some other topologies (tree, ring, and bus).

3-Tree Topology:

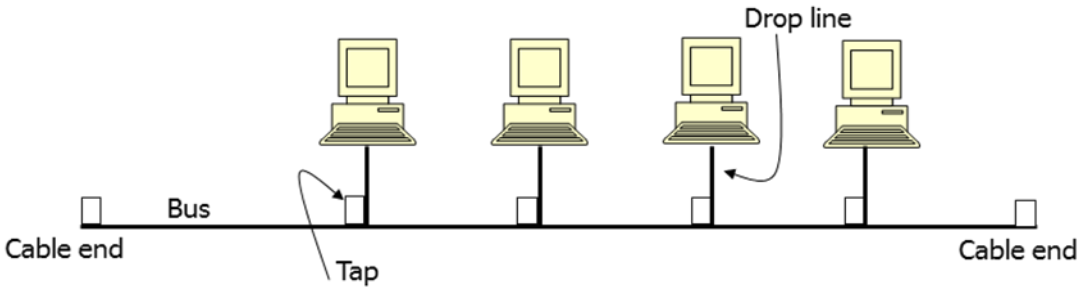


A Tree topology is a variation of a star. Nodes are linked to a central hub that controls the traffic to the network. However, not every device plugs directly into the central hub. The majority of devices are connected to a secondary hub, that in turn is connected to the central hub.

The advantages and disadvantages of a Tree topology are generally the same as those of a star topology.

4-Bus Topology:

Bus topology is multipoint. One long cable acts as a backbone to link all the devices in the network. Nodes are connected to the cable by drop lines and taps.



Drop line: It is a connection running between the device and the main cable.

Tap: It is a connecter that splices into the main cable to create a contact with the metallic core.

Advantages of Bus topology:

1- Ease of installation.

2- Less cabling than mesh, star, or tree (cable redundancy is eliminated).

Disadvantages of Bus topology:

1- Difficult reconfiguration.

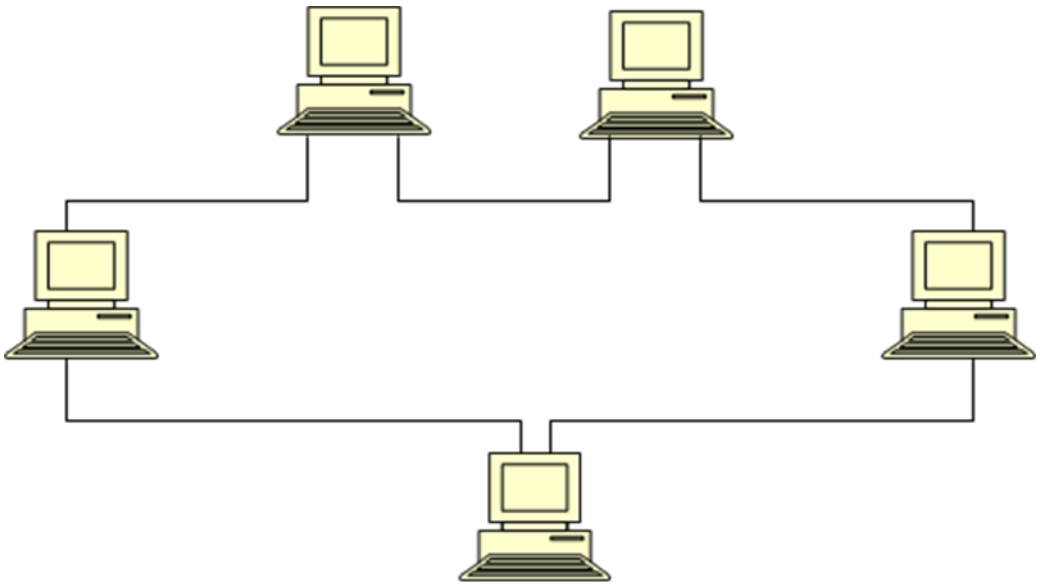
2- Difficult to add new devices(requires modifications of the net).

3- Signal reflection at the taps can cause degradation.

4- Fault in the bus cable stops all transmission.

5-Ring Topology:

In Ring topology, each device has a dedicated point to point line configuration.



A signal is passed along the ring in one direction from device to device, until it reaches its destination.

Advantages of Ring topology:

1-Easy to install and reconfigure.

2- To add or delete a device requires moving only two connections.

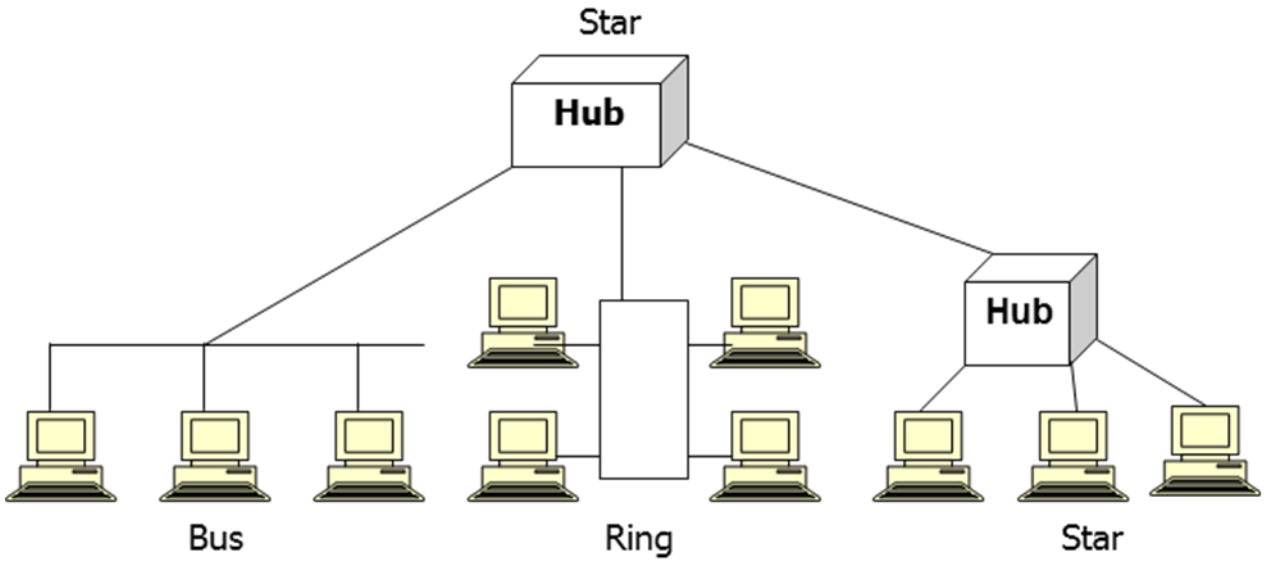
Disadvantages of Ring topology:

1- Traffic unidirectional.

2- Fault in the ring can disable the entire network.

6- Hybrid Topology:

Often a network combines several topologies as subnetworks linked together in alarger topology.



Network Hardware:

Computer networks can be classified according to transmission and scale.

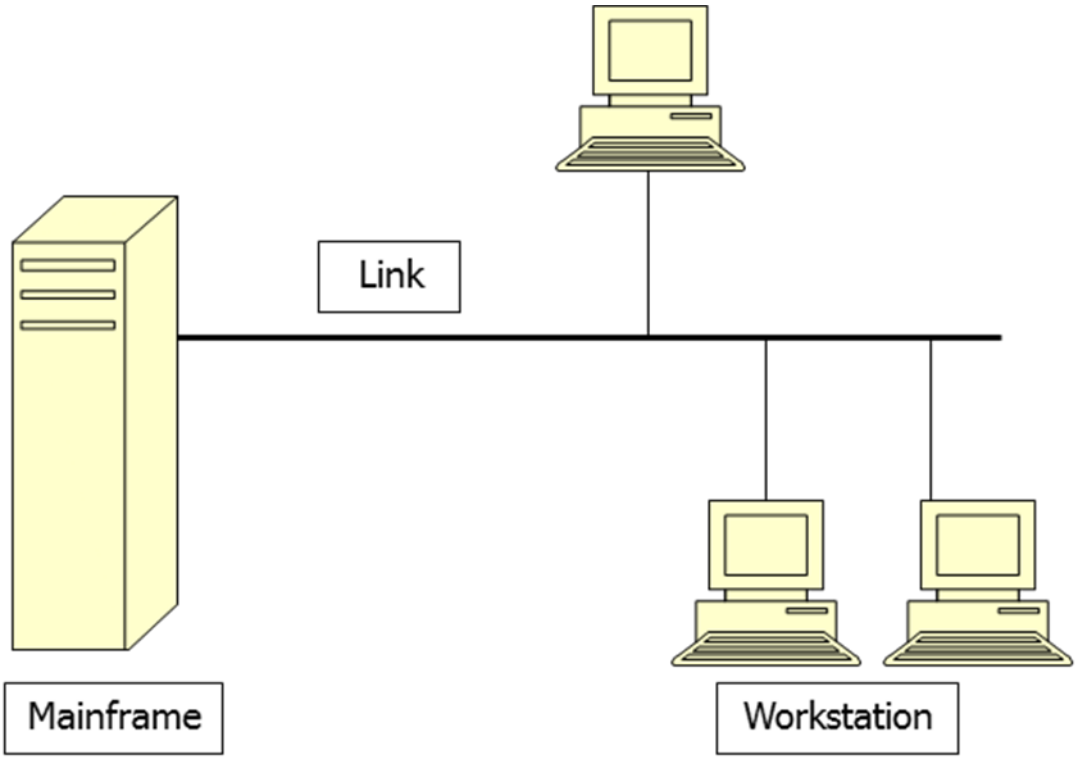
1-**Computer Networks According to Transmission Technology:**

a- Broadcast (Multipoint) (Multi drop) Networks:

These are networks that have a single communication channel that is shared by all the machines on the network using broadcasting.

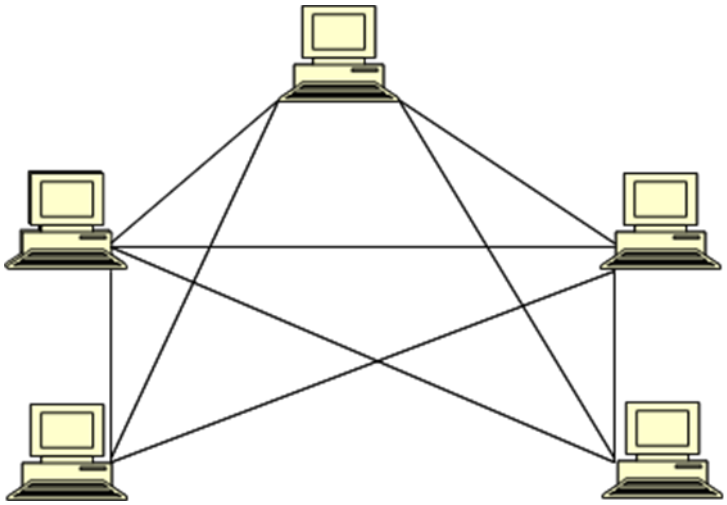
Broadcasting: When a packet is transmitted by one machine and received and processed by other machines in the network is called broadcasting.

Packet: Short message is sent by any machine and received by all machines. Packet has an address field which specifies for whom it is.



b- Point-to-point Networks:

These are networks that consist of many connections between individual pairs of machines. In this type routing algorithms play an important role.



*Note***:** small geographical size network uses broadcast network, while large geographical size network uses point to point network.

2- Computer Networks According to Scale:

An alternative criterion for classifying networks is their scale as shown in table below:

Distance	**Processors located in same**	**Example**
0.1m	Circuit board	Data flow machine
1m	System	Multicomputer
10m 100m 1000m	Room Building Campus	Local Area Network (LAN)
10Km	City	Metropolitan Area Network (MAN)
100Km 1000Km	Country Continent	Wide Area Network (WAN)
10000Km	Planet	The Internet

LANs (Local Area Networks):

LANs have been widely used to link PCs. LAN has maximum transmission capacity of 100 Mb/s. LANs are distinguished from other kinds of networks by three characteristics:

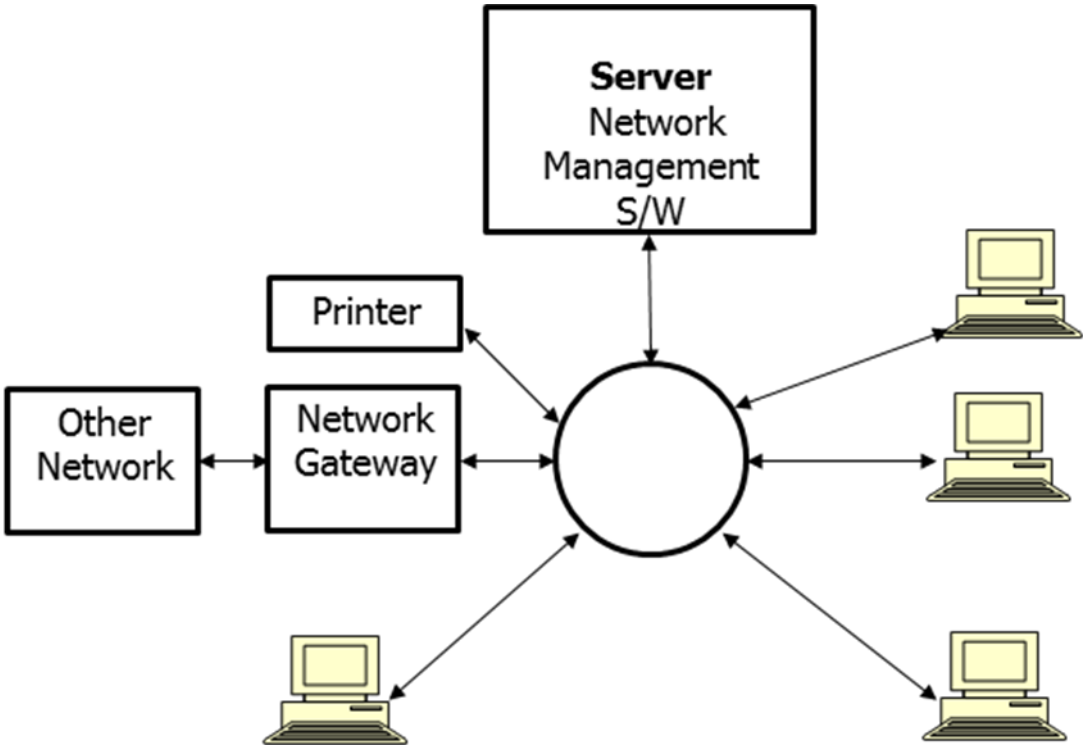
1-*Size*: LANs usually limited by one building or several buildings in close within 2000 feet radius.

2-*Transmission Technology*: LANs often use a transmission technology consisting of a single cable (Broadcasting).

3-*Topology*: Various topologies are possible for broadcast LANs, such as:

a-Bus network: At any instant one machine is the master and is allowed to transmit. In this network a mechanism is needed to resolve conflicts when two or more machines want to transmit simultaneously. This mechanism is called Ethernet: Computers on Ethernet can transmit whenever they want; if two or more packets collide, each computer just waits a random time and tries again later.

b-Ring network: In ring network, each bit propagates around, do not wait for the rest of the packet to which it belongs as shown in figure below:



Server: It is a computer in anetwork that stores variuos programs for users, and determines access and availability in the network. Server typically contains the LAN's network operating system which routs and manages communications on the network.