

## Physical Structures

### Type of Connection:

A network is two or more devices connected through links. A link is a communications pathway that transfers data from one device to another.

There are two possible types of connections: point-to-point and multipoint.

**Point-to-Point:** A point-to-point connection provides a dedicated link between two devices. The entire capacity of the link is reserved for transmission between those two devices.

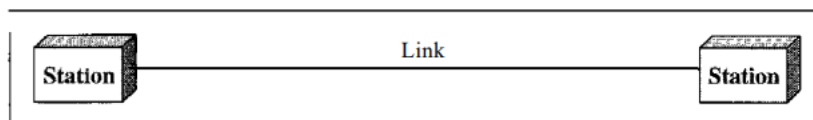
**Multipoint :** A multipoint (also called multidrop) connection is one in which more than two specific devices share a single link .

In a multipoint environment, the capacity of the channel is shared, either spatially or temporally. If several devices can use the link simultaneously, it is a spatially shared connection. If users must take turns, it is a timeshared connection.

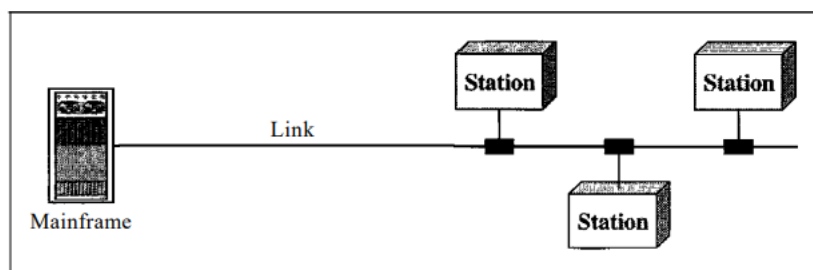
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### *Types of connections: point-to-point and multipoint*

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a. Point-to-point



b. Multipoint

## Topology:

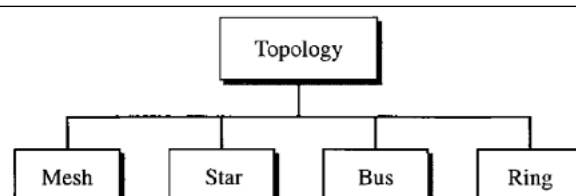
Topology defines the structure of the network of how all the components are interconnected to each other.

Different types of topology:

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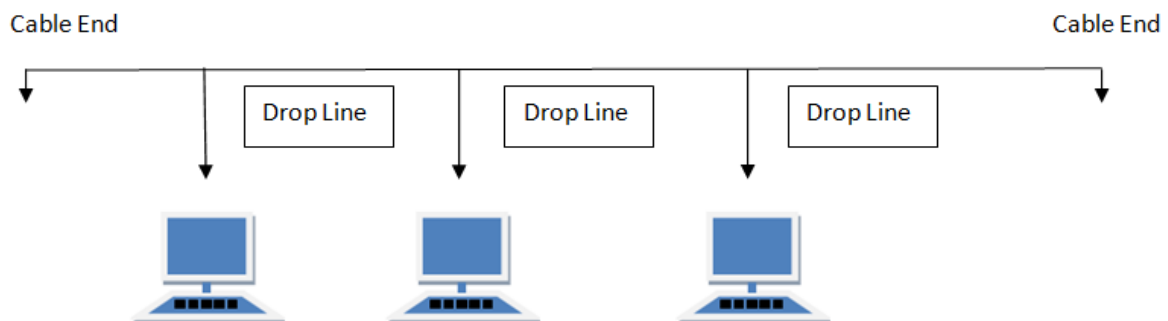
### *Categories of topology*

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### Bus Topology:

The examples (mesh, star) all are point-to-point connections. A bus topology, on the other hand, is multipoint. One long cable acts as a backbone to link all the devices in a network.



Nodes are connected to the bus cable by drop lines and taps.

A drop line is a connection running between the device and the main cable.

A tap is a connector that either splices into the main cable or punctures the sheathing of a cable to create a contact with the metallic core. As a signal travels along the backbone, some of its energy is transformed into heat. Therefore, it becomes weaker and weaker as it travels farther and farther. For this reason, there is a limit on the number of taps a bus can support and on the distance between those taps.

- The bus topology is designed in such a way that all the stations are

connected through a single cable known as a backbone cable.

- Each node is either connected to the backbone cable by drop cable or directly connected to the backbone cable.
- When a node wants to send a message over the network, it puts a message over the network. All the stations available in the network will receive the message whether it has been addressed or not.
- The bus topology is mainly used in 802.3 (ethernet) and 802.4 standard networks.

#### Features of Bus Topology

1. It transmits data only in one direction.
2. Every device is connected to a single cable

#### Advantages of Bus Topology

1. It is cost effective.
2. Cable required is least compared to other network topology.
3. Used in small networks.
4. It is easy to understand.
5. Easy to expand joining two cables together.

Advantages of a bus topology include **ease of installation**. Backbone cable can be laid along the most efficient path, then connected to the nodes by drop lines of various lengths. In this way, a bus uses less cabling than mesh or star topologies.

#### Disadvantages of Bus Topology

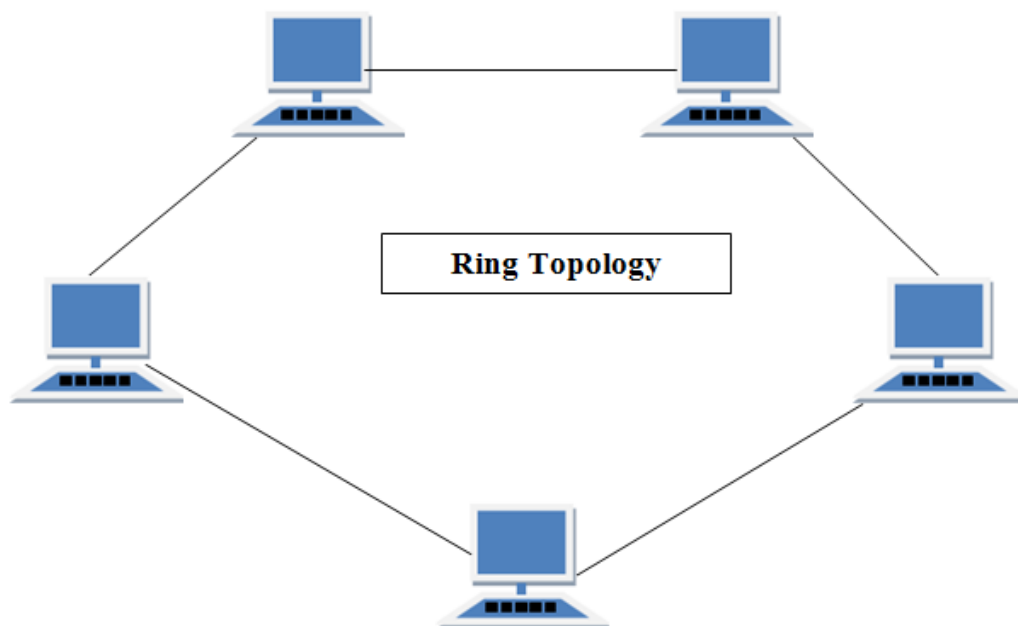
1. Cables fails then whole network fails.
2. If network traffic is heavy or nodes are more the performance of the network decreases.
3. Cable has a limited length.
4. It is slower than the ring topology.

Disadvantages include difficult reconnection and fault isolation. A bus is usually designed to be optimally efficient at installation.

Bus topology was the one of the first topologies used in the design of early local area networks. Ethernet LANs can use a bus topology.

## **RING Topology**

It is called ring topology because it forms a ring as each computer is connected to another computer, with the last one connected to the first. Exactly two neighbours for each device.



Ring Topology:

In a ring topology, each device has a dedicated point-to-point connection with only the two devices on either side of it. A signal is passed along the ring in one direction, from device to device, until it reaches its destination. Each device in the ring incorporates a repeater. When a device receives a signal intended for another device, its repeater regenerates the bits and passes them along (see Figure 1.8).

### Features of Ring Topology

1. A number of repeaters are used for Ring topology with large number of nodes, because if someone wants to send some data to the last node in the ring topology with 100 nodes, then the data will have to pass through 99 nodes to reach the 100th node. Hence to prevent data loss repeaters are used in the network.

A ring is relatively easy to install and reconfigure. Each device is linked to only its immediate neighbors (either physically or logically). To add or delete a device requires changing only two connections.

Ring topology was prevalent when IBM introduced its local-area network Token Ring. Today, the need for higher-speed LANs has made this topology less popular.

### Advantages of Ring Topology

1. Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data.
2. Cheap to install and expand

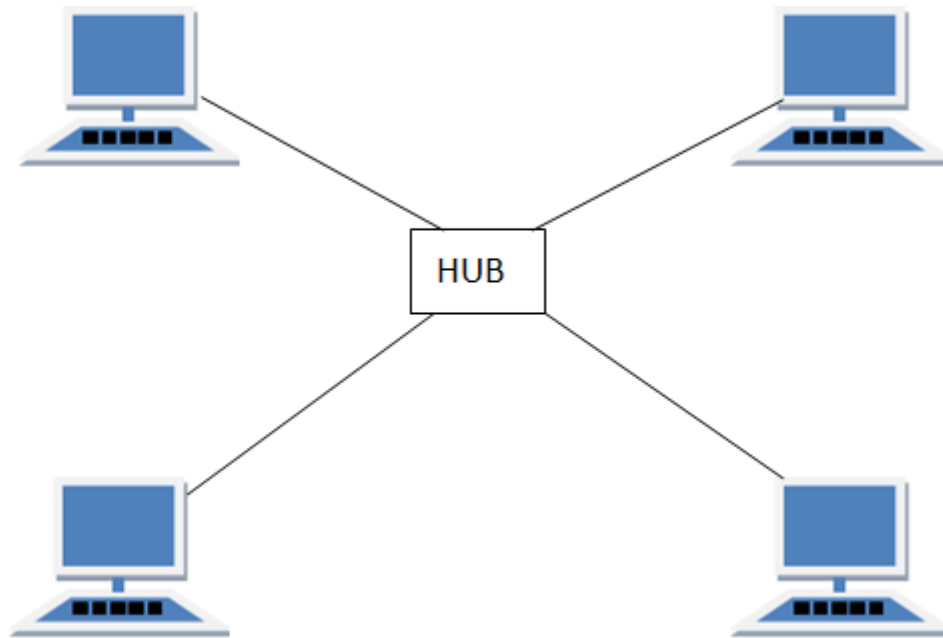
### Disadvantages of Ring Topology

1. Troubleshooting is difficult in ring topology.
2. Adding or deleting the computers disturbs the network activity.
3. Failure of one computer disturbs the whole network.

## Star Topology:

In a star topology, each device has a dedicated point-to-point link only to a central controller, usually called a hub. **The devices are not directly linked to one another.**

Unlike a mesh topology, a star topology does not allow direct traffic between devices. The controller acts as an exchange: If one device wants to send data to another, it sends the data to the controller, which then relays the data to the other connected device .



A star topology is less expensive than a mesh topology. In a star, each device needs only one link and one I/O port to connect it to any number of others. This factor also makes it easy to install and reconfigure. Far less cabling needs to be housed, and additions, moves, and deletions involve only one connection: between that device and the hub.

#### Features of Star Topology

1. Every node has its own dedicated connection to the hub.
2. Hub acts as a repeater for data flow.
3. Can be used with twisted pair, Optical Fibre or coaxial cable.

#### Advantages of Star Topology

1. Fast performance with few nodes and low network traffic.
2. Hub can be upgraded easily.
3. Easy to troubleshoot.
4. Easy to setup and modify.
5. Only that node is affected which has failed, rest of the nodes can work smoothly.

Other advantages include robustness. If one link fails, only that link is affected. All other links remain active.

Although a star requires far less cable than a mesh, each node must be linked to a central hub.

#### Disadvantages of Star Topology

1. Cost of installation is high.
2. Expensive to use.
3. If the hub fails then the whole network is stopped because all the nodes depend on the hub.
4. Performance is based on the hub that is it depends on its capacity

#### Mesh:

In a mesh topology, every device has a dedicated point-to-point link to every other device. The term dedicated means that the link carries traffic only between the two devices it connects.

To find the number of physical links in a fully connected mesh network with  $n$  nodes, we first consider that each node must be connected to every other node.

Node 1 must be connected to  $n - 1$  nodes, node 2 must be connected to  $n - 1$  nodes, and finally node  $n$  must be connected to  $n - 1$  nodes. We need  $n(n - 1)$  physical links.

However, if each physical link allows communication in both directions (duplex mode), we can divide the number of links by 2. In other words, we can say that in a mesh topology, we need  $n(n - 1) / 2$  duplex-mode links.

#### Advantages:

#### **Advantages of Mesh topology:**

**Reliable:** The mesh topology networks are very reliable as if any link breakdown will not affect the communication between connected computers.



**Fast Communication:** Communication is very fast between the nodes.

**Easier Reconfiguration:** Adding new devices would not disrupt the communication between other devices.

Disadvantages:

The main disadvantages of a mesh are related to the amount of cabling and the number of I/O ports required.

First, because every device must be connected to every other device, installation and reconnection are difficult.

### **Disadvantages of Mesh topology**

- **Cost:** A mesh topology contains a large number of connected devices such as a router and more transmission media than other topologies.
- **Management:** Mesh topology networks are very large and very difficult to maintain and manage. If the network is not monitored carefully, then the communication link failure goes undetected.
- **Efficiency:** In this topology, redundant connections are high that reduces the efficiency of the network.

One practical example of a mesh topology is the connection of telephone regional offices in which each regional office needs to be connected to every other regional office.

**Hybrid Topology** A network can be hybrid. For example, we can have a main star topology with each branch connecting several stations in a bus topology as shown in Figure 1.9.

#### Features of Hybrid Topology

1. It is a combination of two or more topologies
2. Inherits the advantages and disadvantages of the topologies included

#### Advantages of Hybrid Topology

1. Reliable as Error detecting and troubleshooting is easy.
2. Effective.
3. Scalable as size can be increased easily.
4. Flexible.

#### Disadvantages of Hybrid Topology

1. Complex in design.
2. Costly.

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### Categories of Networks:

Today when we speak of networks, we are generally referring to two primary categories: local-area networks and wide-area networks.

The category into which a network falls is determined by its size.

A LAN normally covers an area less than 2 mi; a WAN can be worldwide. Networks of a size in between are normally referred to as metropolitan area networks and span tens of miles.

### Local Area Network:

A local area network (LAN) is usually privately owned and links the devices in a single office, building, or campus (see Figure 1.10). Depending on the needs of an organization and the type of technology used, a LAN can be as simple as two PCs and a printer in someone's home office; or it can extend throughout a company and include audio and video peripherals. Currently, LAN size is limited to a few kilometers.

LANs are designed to allow resources to be shared between personal computers or workstations. The resources to be shared can include hardware (e.g., a printer), software (e.g., an application program), or data.

A common example of a LAN, found in many business environments, links a workgroup of task-related computers, for example, engineering workstations or accounting PCs.

One of the computers may be given a large capacity disk drive and may become a server to clients. Software can be stored on this central server and used as needed by the whole group. In this example, the size of the LAN may be determined by licensing restrictions on the number of users per copy of software, or by restrictions on the number of users licensed to access the operating system. In addition to size, LANs are distinguished from other types of networks by their transmission media and topology.

In general, a given LAN will use only one type of transmission medium. The most common LAN topologies are bus, ring, and star.

Early LANs had data rates in the 4 to 16 megabits per second (Mbps) range. Today, however, speeds are normally 100 or 1000 Mbps.

### Wide Area Network :

A wide area network (WAN) provides long-distance transmission of data, image, audio, and video information over large geographic areas that may comprise a country, a continent, or even the whole world.

A WAN can be as complex as the backbones that connect the Internet or as simple as a dial-up line that connects a home computer to the Internet.

### Metropolitan Area Networks:

A metropolitan area network (MAN) is a network with a size between a LAN and a WAN. It normally covers the area inside a town or a city. It is designed for customers who need a high-speed connectivity, normally to the Internet, and have endpoints spread over a city or part of city.

A good example of a MAN is the part of the telephone company network that can provide a high-speed DSL line to the customer.

Another example is the cable TV network that originally was designed for cable TV, but today can also be used for high-speed data connection to the Internet.

#### Interconnection of Networks:

Internetwork Today, it is very rare to see a LAN, a MAN, or a WAN in isolation; they are connected to one another. When two or more networks are connected, they become an internetwork, or internet.