S.Y.B.SC (CS) SEM-3
Information & Communication Technology-1
UNIT-4

Introduction to analog and digital data:

Analog data :

Analogue data use values that change very smoothly.

A good example of this is an analogue clock. An analogue clock shows the time with a smoothly moving seconds hand. The change is continuous.

Sound is also a good example of analogue data. Sound waves change in a very smooth way.

All analogue devices use analogue data. Examples of analogue devices include:

- **Microphone**
- **Headphones**
- **Loud Speaker**
- **Sensors (temperature, pressure etc)**

Digital data:

Digital data jumps from one value to the next in a step by step sequence

A good example of this is a digital clock. A digital clock jumps from one second to another in clear steps. The change is not smooth or continuous.

All digital devices use digital data. Examples of digital devices include:

- **Computers/Laptops/IPads**
- **Mobile Phone**
- **MP3 Player**
- **Digital Camera**

Need for conversion between analog and digital data

In the real world, most data is characterized by analog signals. In order to manipulate the data using a microprocessor, we need to convert the analog signals to the digital signals, so that the microprocessor will be able to read, understand and manipulate the data.

MODEMS:

The most familiar type of DCE (Data Circuit-Terminating Equipment) is a modem. The external or internal modem associated with your personal computer is what converts the digital signal generated by the computer into an analog signal to be carried by a public access phone line. It is also the device that converts the analog signals received over a phone line into digital signals usable by your computer.

The term *modem* is a composite word that refers to the two functional entities that make up the device: a signal *modulator* and a signal *demodulator*. The relationship of the two parts is shown in Figure 17.9.

Modem stands for MOdulator / DEModulator.

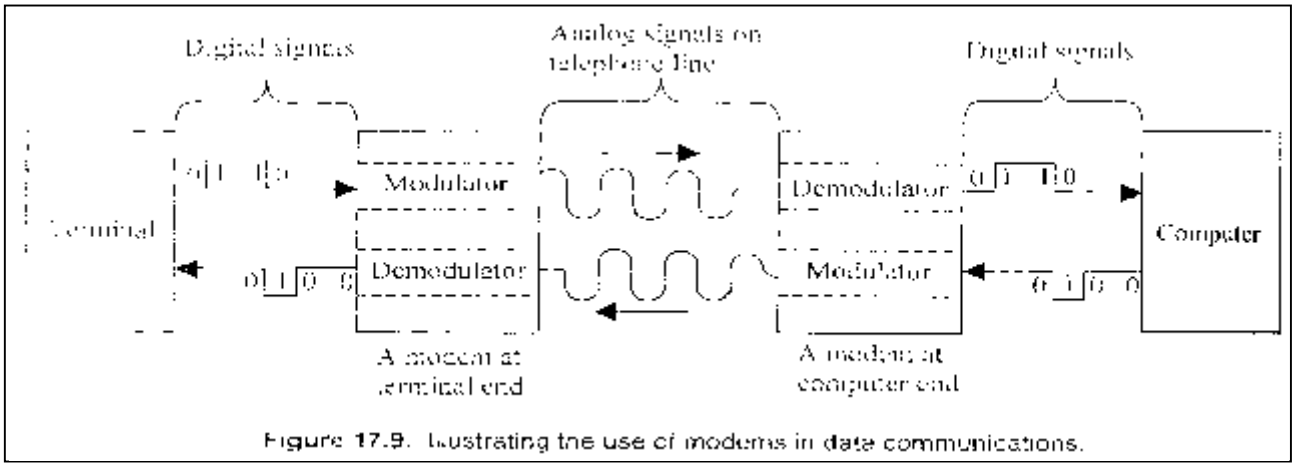


Figure 17.9. Illustrating the use of modems in data communications.

A modulator converts a digital signal into an analog signal using ASK, FSK, PSK, or QAM. A demodulator converts an analog signal into a digital signal.

As shown in Figure 17.9, the Terminal and the Computer at the ends are the DTEs (Data Terminal Equipment); the modems are the DCEs. The digital signal generated at the terminal is converted to analog form by the modulator of the modem place near it. The analog signal is transmitted through the telephone line, which is converted to digital form by the demodulator (The demodulator takes the ASK, FSK, PSK, or QAM signal and decodes it into whatever format its computer can accept.) of the modem placed near the computer. This digital data is processed by the computer. The processed digital data is modulated to analog form and returned via the telephone line to the terminal, where the analog signals are demodulated to digital form for display on the terminal. Hence, the modem is an essential piece of hardware for any application in which two digital devices (say two computers) want to communicate over an analog transmission channel (say a telephone line).

➢ What is Computer Network?

Computer Network means interconnected collection of autonomous computers.

- **Two computers are said to be interconnected if they are able to exchange information.**
- **Computers are connected together to share the resources like hardware, software, data.**
- **The medium of communication (or communication channel) can be copper wire, fiber optics, microwaves, radio waves and communication satellites.**
- **An autonomous system means all the computers need itself to be master.**
- **There is no slave.**
- **If one computer can forcibly start, stop or control another computer, the computers are not autonomous.**
- **A system with one control unit and many slaves is not a network.**

➢ Advantages of Computer Networks:

The following are the exciting advantages of computer network:

1. **Access to remote information**
   - **Access to remote information will come in many forms.**
   - **One area in which it is already happening is access to financial institutions.**
   - **Many people pay their bills, manage their bank accounts and handle their investments electronically.**
   - **Home shopping is also becoming popular, with the ability to inspect the online catalogs of thousands of companies.**
   - **Newspapers will go on-line and personalized.**
   - **It will be possible to tell the newspaper that you want everything about corrupt politicians, big fires, scandals involving celebrities, etc.**

2. **Person-to-Person communication**
   - **Person-to-Person communication involves electronic mail (e-mail) which is already widely used by millions of people and will soon routinely contain audio and video as well as text.**
   - **Smell in messages will take a bit longer to perfect.**
   - **This technology makes it possible to have virtual meetings, called videoconference, among far located people.**

3. **Interactive entertainment**
   - **Interactive entertainment like on-line games, hide-and-seek in a virtual dungeon, photographic quality moving pictures, etc.**

4. **Program and File sharing**
   - **Networking version of many popular software package are available in considerable cost saving when compared to buying individual licensed copies. The program and its data files are stored on a particular terminal for access by any network user.**

5. **Network resource sharing**
   - **Network resources include printers, plotters and storage devices which can be shared by any terminal which are on network. It is more efficient and economical to store application on a network drive rather than storing a copy of it on each of the user's local storage device. So it reduces the hardware cost.**

6. **Database sharing**
   - **A database program is an ideal application for a network. A network feature called record locking lets multiple users simultaneously access a file without corrupting the data. Record locking ensures that no two users edit the same record at the same time.**

7. **Economical expansion**
   - **Network provides an economical way to expand the no. of computers in an organization. Inexpensive diskless workstations that use the server's hard drive for booting and storage can be attached to the network.**

8. **Ability to use Network Software**
   - **A class of software called GroupWare is designed specifically for network.**

9. **Creation of Workgroup**
   - **Group consist of users work in a department of who are assign to special project with Netware, you can assign users to groups, and then give each group access to special directories and resources not accessible by other users.**

10. **Centralized Management**
    - **Because Netware uses dedicated servers these servers can be grouped in one location, along with the shared resources attached to them for easier management. Hardware upgrades, software backups, system maintenance and system protection are much easier to handle when those devices are in one location.**

11. **Security**
    - **Security starts with the login procedure to ensure that a user accesses the network using his or her own account. Login restriction can force a user log in at one specific station and only during a specific time-frame.**

12. **Access to more than one operating system**
    - **Network provides connections for many different operating system including DOS, OS/2, UNIX, etc. Users of these systems can store and access files on the Server.**

13. **Manufacturing**
    - **Computer networks are used today in many aspects of manufacturing including the manufacturing process itself. Two applications that use networks to provide essential services are computer-assisted design (CAD) and computer-assisted manufacturing (CAM), both of which allow multiple users to work on a project simultaneously.**

➢ Disadvantages of Computer Networks:

1. **Having network operators censor messages would probably cause them to delete everything with even the slightest possibility of their being used.**

2. **For a network to be useful, sensitive data must be protected from unauthorized access.**

3. **As the network is accessible from many points, danger of computer viruses.**

4. **The financial cost of local area networking is still high in comparison with many other alternate. If one plans to use a network to share a laser printer, the user might find it cheaper to purchase another today's networking hardware and software.**

5. **Networking software requires memory space in each of the computers used on the networks. This reduces the memory space available for the user's program.**

6. **Networking adds another level of complexity to the computer operation. Users may have difficulty in learning the network commands.**

7. **Some control on the part of the user is lost. You may have to share a printer with other users. You may face situation like entire network suddenly locking up because one user has made a mistake.**

8. **Many current application programs will not run in a network environment. The program may require too much memory or have other technical constraints. In other cases the program may run, but the execution leaves too little memory for data. Memory intensive programs, such as spreadsheets and expert system particularly difficult for networking.**

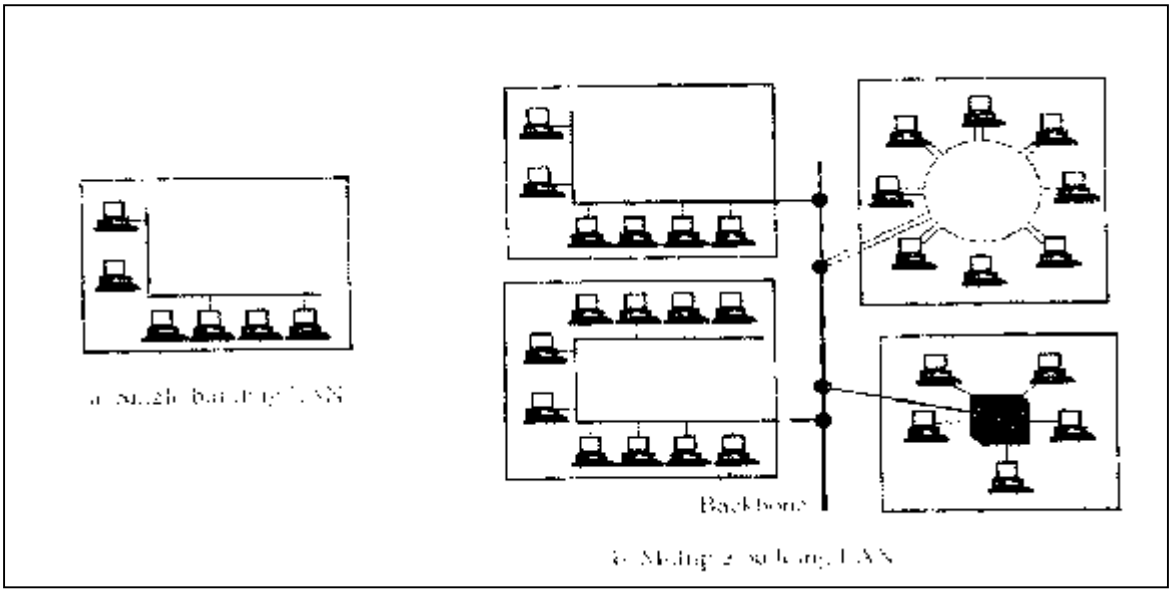
➢ Categories of Networks:

Into which category a network falls is determined by its size, its ownership, the distance it covers, and its physical architecture.
Three primary categories:

1. **Local Area Network (LAN)**
2. **Metropolitan Area Network (MAN)**
3. **Wide Area Network (WAN)**

➢ Local Area Network (LAN):

- **A local area network (LAN) is usually privately owned network and links the devices in a single office, building, or campus of up to a few kilometres in size.**
- **They are widely used to connect personal computers and workstations in company offices and factories to share resources and exchange information.**
- **LANs are distinguished from other kinds of networks by three characteristics:**
  1. **Their size**
  2. **Transmission technology**
  3. **Topology**
- **LANs are restricted in size, which means that the worst-case transmission time is bounded and known in advance.**
- **LANs use a transmission technology consisting of a single cable to which all the machine are attached.**
- **The most common LAN topologies are bus, ring and star.**
- **Traditional LANs run at speeds of 10 to 100 Mbps, have low delay and make very few errors. Newer LANs may operate at higher speeds, up to 100 Mbps.**



- **LAN uses two types of transmission technology:**
  1) **Broadcast Networks**
     - **Broadcast networks have a single communication channel that is shared by all the machines on the network.**
     - **Short messages, called packets in certain contexts, sent by any machine are received by all the others.**
     - **An address field within the packet specifies for whom it is intended. Upon receiving a packet, a machine checks the address field. If the packet is intended for itself, it processes the packet; otherwise it is just ignored.**
     - **Broadcast systems generally also allow the possibility of addressing a packet to all destinations by using a special code in the address field.**
     - **When a packet with this code is transmitted, it is received and processed by every machine on the network. This mode of operation is called broadcasting.**
     - **Some broadcast systems also support transmission to a subset of the machines, something known as multicasting.**

  Broadcast networks can be further divided into static and dynamic, depending on how the channel is allocated.

     - **A typical Static allocation would be to divide up time into discrete intervals and run a round robin algorithm, allowing each machine to broadcast only when its time slot comes up. Static allocation wastes channels capacity when a machine has nothing to say during its allocated slot, so most systems attempt to allocate channel dynamically.**

     - **Dynamic allocation methods for a common channel are Centralized or Decentralized.**
       - ✓ **In Centralized channel allocation method, there is a single entity, for example a bus arbitration unit, which determines who goes next. It might do this by accepting requests and making a decision according to some internal algorithm.**

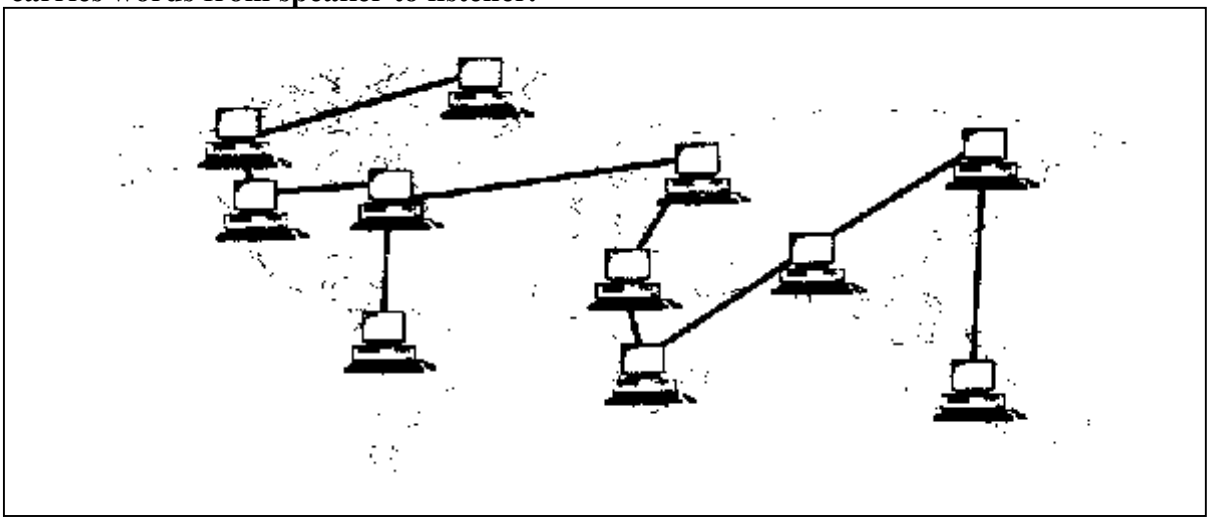
- ✓ **In Decentralized channel allocation method, there is no central entity; each machine must decide for itself whether or not to transmit.**

2) Point-to-Point Networks

- **In Point-to-Point, there is a dedicated channel available between source and destination.**
- **Many connections exist between individual pair of machines. To go from source to destination, a data packet may have to pass through many intermediate machines.**
- **Smaller, geographically localized networks tend to use broadcasting, whereas larger networks usually are point-to-point.**

➢ Wide Area Network (WAN):

- **A WAN spans a large geographical area, often a country or continent.**
- **It provides long-distance transmission of data, voice, image and video information over large geographical areas.**
- **WANs may utilize public, leased or private communication devices, usually in combinations and therefore span an unlimited number of miles.**
- **An Enterprise Network: - A WAN that is wholly owned and used by a single company is often referred to as an enterprise network.**
- **It contains a collection of machines intended for running user programs (application) called hosts.**
- **All the hosts are connected by a communication subnet or subnet. The job of the subnet is to carry messages from host to host, just as the telephone system carries words from speaker to listener.**



- **The subnet consists of two distinct components:**

I. Transmission Lines:

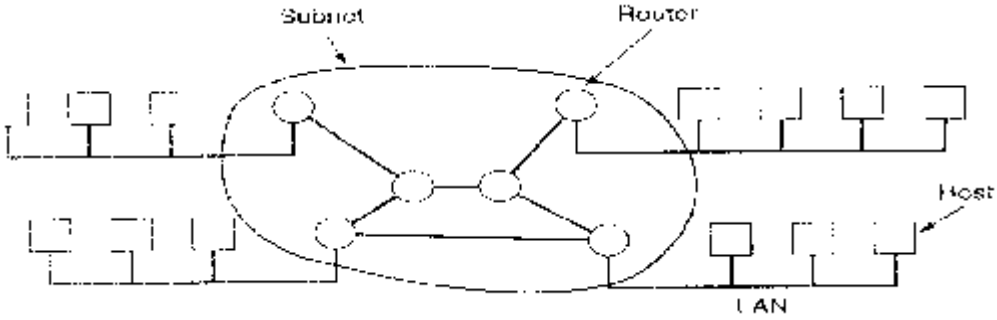
The transmission line (also called circuits, channels, or trunks) is used to carry the information between the hosts.

II. Switching Elements:

The switching elements are specialized computers used to connect two or more transmission lines. When data arrive on an incoming line, the

switching element must choose an outgoing line to forward them on. Generally, these nodes are known as packet switching nodes, intermediate systems, and data switching exchanges (router).

- Each host is generally connected to a LAN on which a router is present, although is some cases a host can be connected directly to a router. The collection of communication lines and routers form the subnet.



- In most WANs the network contains numerous cables or telephone lines, each one connecting a pair of routers. If two routers want to share some information then both the routers must be connected directly or indirectly. When a packet is sent from one router to another via one or more intermediate routers, the packet is received at each intermediate router in it's entirely, stored there until the required output line is free and then forwarded. A subnet using this principle is called a point-to-point, store-and-forward, or packet-switched subnet.
- Nearly all wide area networks have store-and-forward subnets. When the packets are small and all the same size, they are often called cells.
- Different types of topologies are used for point-to-point subnet. For example, star, bus, ring, tree, complete, intersecting ring, irregular.
- A second possibility for a WAN is a satellite or ground radio system. Each router has an antenna through which it can send and receive. The wired network transmits signals through some kind of cables. These cables can be copper wire or fiber optic. In wireless network radio signals are used to send the data to and from computers.

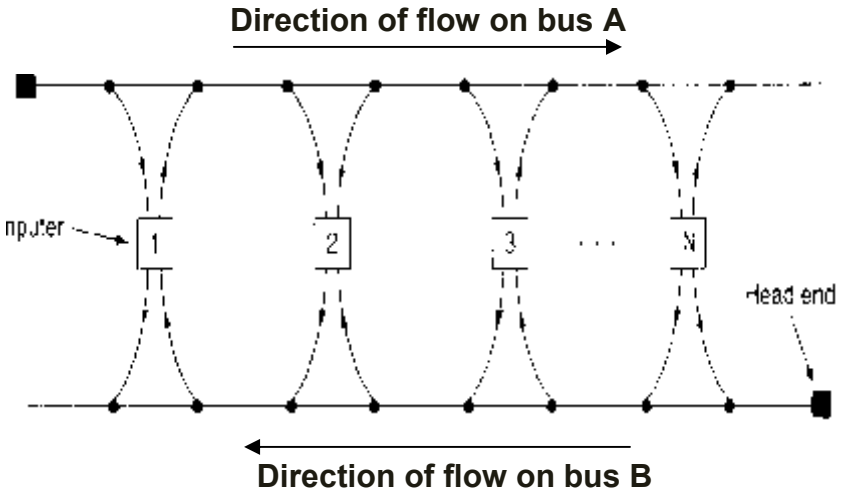
➢ **Categories of Networks:**

Into which category a network falls is determined by its size, its ownership, the distance it covers, and its physical architecture.

➢ **Metropolitan Area Networks:**

- A metropolitan area network, or MAN (plural: MANs, not MEN) is basically a bigger version of a LAN and normally uses similar technology. It might cover a group of nearby corporate offices or a city and might be either private or public. A MAN can support both data and voice, and might even be related to the local cable television network. A MAN just has one or two cables and does not contain switching elements, which shunt packets over one of several potential output lines. Not having to switch simplifies the design.

- **The main reason for even distinguishing MANs as a special category is that a standard has been adopted for them, and this standard is now being implemented. It is called DQDB (Distributed Queue Dual Bus) or for people who prefer numbers to letters, 802.6 (the number of the IEEE standard that defines it). DQDB consists of two unidirectional buses (cables) to which all the computers are connected, as shown in Fig. Each bus has a head-end, a device that initiates transmission activity. Traffic that is destined for a computer to the right of the sender uses the upper bus. Traffic to the left uses the lower one.**



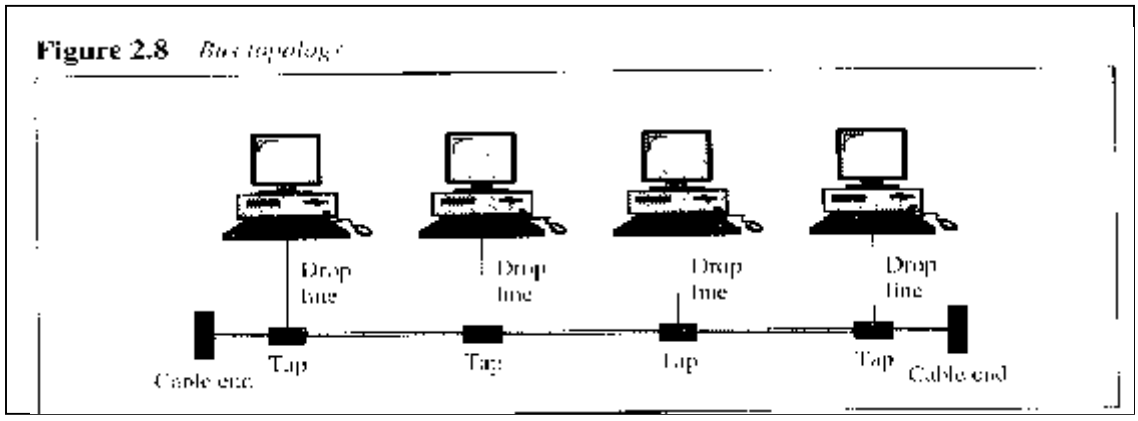
[Architecture of the DQDB metropolitan area network]

A key aspect of a MAN is that there is a broadcast medium (for 802.6, two cables) to which all the computers are attached. This greatly simplifies the design compared to other kinds of networks.

- **<u>Network Topologies</u>:**

❖ Bus Topologies:

- **This is the most popular topology used in the Ethernet LAN.**
- **Here a single main cable connects each node 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 link to the main cable.**
- **Each node is connected to two others, except the machines at either end of the cable, which are each connected only to one other node.**
- **Messages are broadcast along the whole bus.**
- **In order to receive a transmission, the workstations must be able to recognise their own address.**
- **As a signal travels along the main cable, some of its energy is transformed into heat. Therefore, it becomes weaker and weaker the father it has to travel.**
- **For this reason there is a limit on the number of taps a bus can support and on the distance between those taps.**
- **Common Cable: Twisted Pair, Coxial, Fiber Optic.**
- **Common Protocol: Ethernet.**



- **Advantages:**

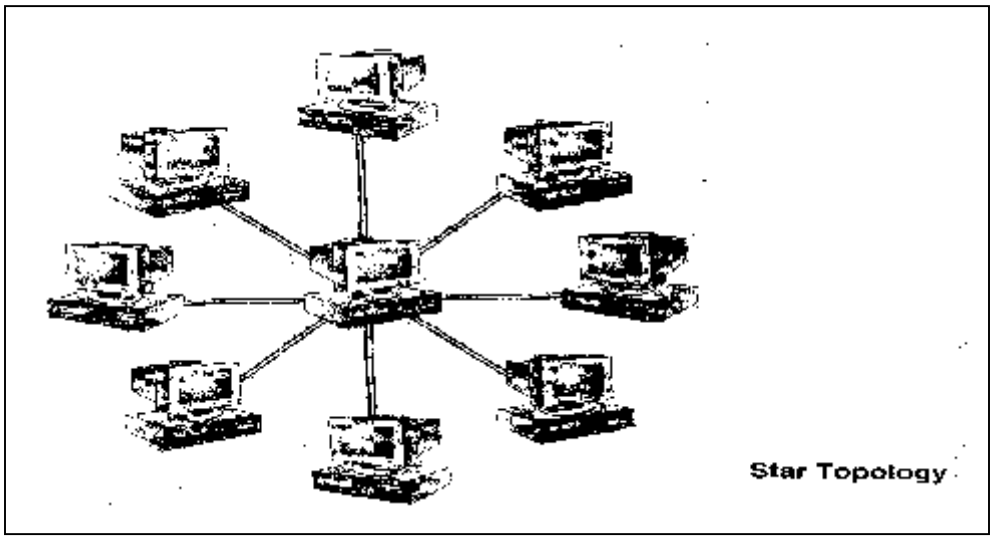
1. **Short cable length and easy installation: Single main cable connects each node, so it allows a very short cable length to be used. This decrease the installation cost, and also leads to a simple, easy to maintain and install.**
2. **Reliability: The failure of a computer does not affect the communication among other computers in the network.**
3. **Easy to extend: Addition of new computers to the network is easy.**

- **Disadvantages:**

1. **Fault diagnosis is difficult: In most LANs based on a bus, control of the network is not centralised in any particular node. This means that detection of a fault may have to be performed from many points in the network.**
2. **Fault isolation is difficult: If a node is faulty on a bus, it must be rectified at the point where the node is connected to the network and simply be removed. But if the communication line fails, the entire system breaks down. (A fault or break in the bus cable stops all transmission.)**
3. **Reconfiguration is difficult: When a bus network has its main cable extended using repeaters, reconfiguration may be necessary.**
4. **Nodes must be intelligent: All computers in the network must have good communication and decision-making capability.**

❖ Star Topologies:

- **In this topology each node is connected to a single, centrally located file server, using its own dedicated segment cable; i.e. point-to-point link.**
- **That is, the computers in the network are not linked directly to each other and can communicate only via the host (server) computer.**
- **The routing function is performed by the host computer, which centrally controls communication between any two other computers by establishing a logical path between them.**
- **Common Cable: Twisted Pair, Fiber Optic.**
- **Common Protocol: Ethernet.**



- **Advantages:**

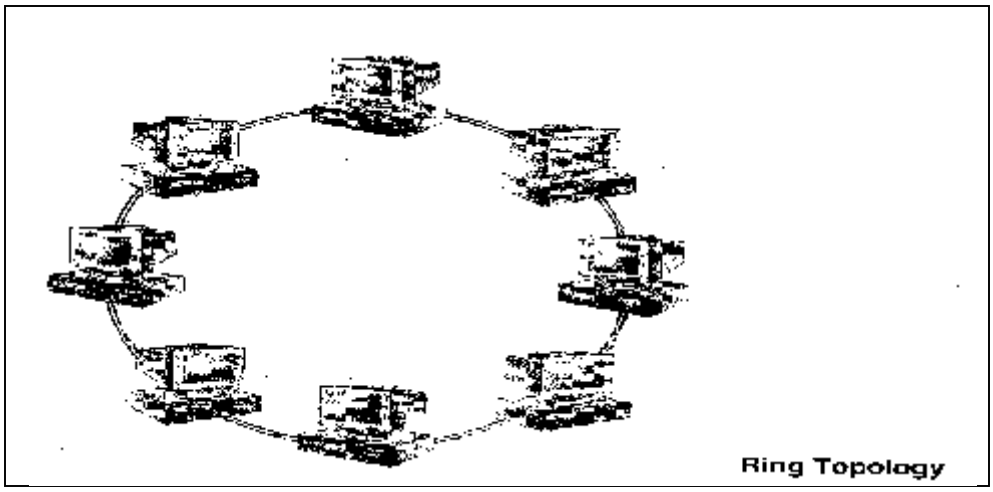
1. **Minimum data traffic along the cables (node to server only), for optimum performance.**
2. **Transmission delays between two nodes do not increase by adding new nodes to the network, because any two nodes may be connected via two links only.**
3. **The fact that the central node is connected directly to every other node in the network means that faults are easily detected and isolated.**
4. **If any of the local computers fails, the remaining portion of the network is unaffected.**

- **Disadvantages:**

1. **A single machine must coordinate all the data communication; this topology requires an extremely powerful (and expensive) file server.**
2. **Long cable length: Because each node is directly connected to the centre, the star topology requires a large quantity of cable.**
3. **Difficult to expand: The addition of a new node to a star network involves a connection all the way to the central node.**
4. **Central node dependency: The system crucially depends on the central node. If the host computer fails, the entire network fails.**

❖ Ring Topologies:

- **This layout is similar to the linear bus, except that the nodes are connected in a circle using cable segments and has no master computer for controlling other computers.**
- **In this layout, each node is physically connected only to two others and receives data from one of its two adjacent nodes.**
- **Each node passes the information along to the next, until it arrives at the intended destination.**
- **This type of topology can be found in *peer-to-peer* networks.**



- **Advantages:**

1. **Easy installation and reconfiguration: A ring network is easy to install and reconfigure. Each device is linked only to its immediate neighbours. To add or delete a device requires moving only two connections.**
2. **The ring network works well where there is no central-site computer system.**
3. **It is more reliable than a star network because communication is not dependent on a single host computer. If a link between any two computers breaks down, or if one of the computers breaks down, alternate routing is possible.**

- **Disadvantages:**

1. **In a ring network, communication delay is directly proportional to the number of nodes in the network. Hence, addition of new nodes in the network increases the communication delay.**
2. **Unidirectional traffic: In a simple ring, a break in the ring can disable the entire network.**
3. **The ring network requires more complicated control software than star network.**

❖ Mesh Topologies:

- **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.**
- **A fully connected mesh network therefore has $n(n - 1)/2$ physical channels to link n devices.**
- **Therefore, every device on the network must have $n - 1$ input/output (I/O) ports.**
- **In mesh network, each node is directly connected to all nodes on the network.**
- **This type of network involves the concept of routes.**
- **In this type of network, each node may send message to destination through multiple paths.**
- **It means that each node of mesh network has several possible paths to send (or to receive) message, but in Bus, Star, Ring and Tree topologies each node has only one path.**

- **Advantages:**

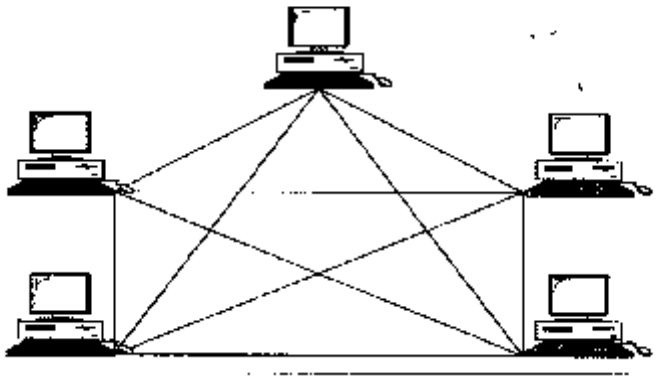
1. **It has multiple links, so if one route is blocked then other routes can be used for data communication.**

2. **Each connection can have its own data load, so the traffic problem is eliminated.**
3. **It ensures the data privacy or security, because every message travels along a dedicated link.**
4. **Troubleshooting of this topology is easy as compared to other networks.**
5. **Its performance is not affected with heavy load of data transmission.**

- **Disadvantages:**

1. **It becomes very expensive because a large number of cabling and 110 ports are required.**
2. **It is difficult to install.**

Figure 2.5 *Fully connected mesh topology (for five devices)*



❖ Hybrid Topology:

- **Hybrid network is the combination of different topologies such as star, Ring, Mesh, Bus etc.**
- **For example, if a department uses a Bus network, second department uses the ring network, third department uses the Mesh network and fourth department uses the star network.**
- **All the networks of different types (of four departments) can be connected together through a central hub (in the form of star network) as shown in the figure below.**

Figure 2.10 *Hybrid topology*