

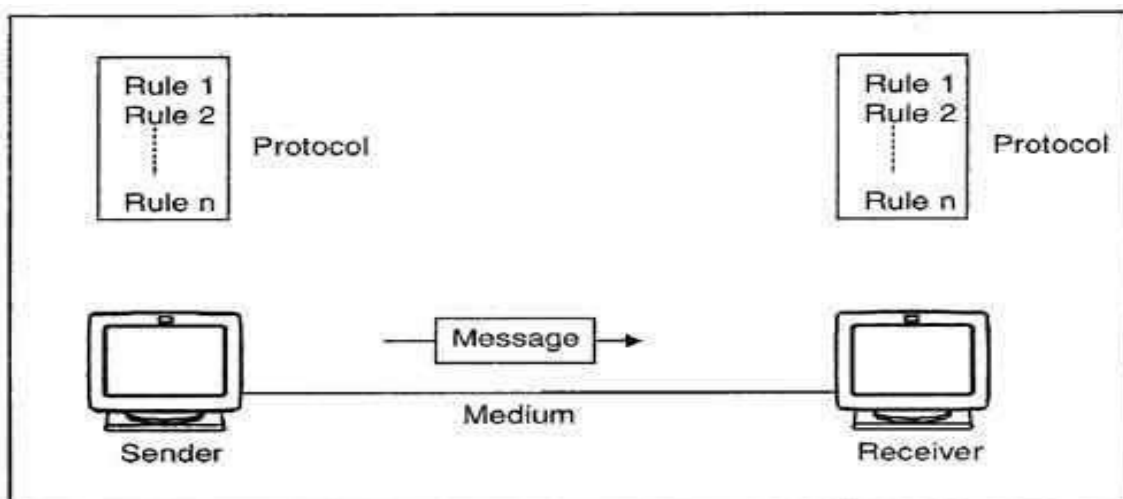
[UNIT -1]

Fundamental OF DATA COMMUNICATION & COMPUTER NETWORK

• Data Communication:

Data communication refers to the exchange of data between a source and a receiver via form of transmission media such as a wire cable is known as data communication.

+ Components of data communication system:

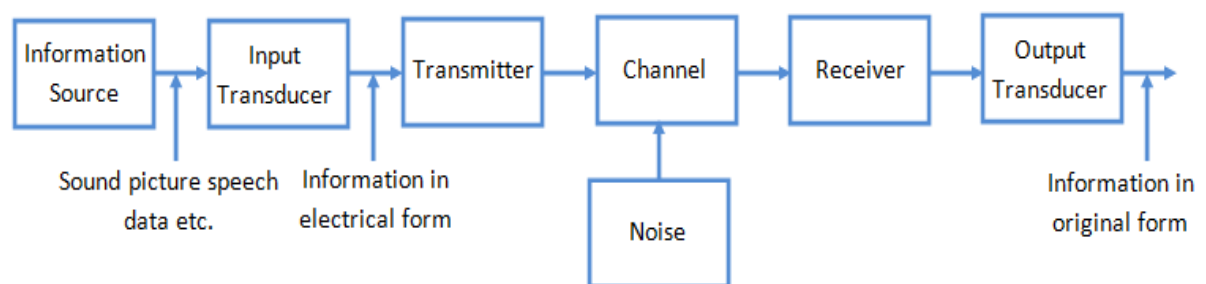


1. **Message:** It is the information or data to be communicated. It can consist of text, numbers, pictures, sound or video or any combination of these.
2. **Sender:** It is the device/[computer](#) that generates and sends that message. telephone ,computer are the examples of senders.
 - Sender is a device that generate host, video, camera, telephone etc. which send the message over the medium.
3. **Receiver:** It is the device or [computer](#) that receives the message. The location of receiver computer is generally different from the sender computer. The distance between sender and receiver depends upon the types of network used in between. telephone ,computer are the examples of receivers.

4. **Medium:** It is the channel or physical path through which the message is carried from sender to the receiver. The medium can be wired like twisted pair wire, coaxial cable, fibres-optic cable or wireless like laser, radio waves, and microwaves.

5. **Protocol:** It is a set of rules and regulations that govern the communication between the devices. Both sender and receiver follow same protocols to communicate with each other.

Block diagram of data communication:



The block diagram of a communication system will have five blocks, including the information source, transmitter, channel, receiver and destination blocks.

1. Information source :-

- The objective of any communication system is to convey information from one point to the other. The information comes from the information source, which originates it
- Information is a very generic word signifying at the abstract level anything intended for communication, which may include some thoughts, news, feeling, visual scene, and so on.
- The information source converts this information into physical quantity.
- The physical manifestation of the information is termed as message signal

2. Transmitter :-

- The objective of the transmitter block is to collect the incoming message signal and modify it in a suitable fashion (if needed), such that, it can be transmitted via the chosen channel to the receiving point.
- Channel is a physical medium which connects the transmitter block with the receiver block.

- The functionality of the transmitter block is mainly decided by the type or nature of the channel chosen for communication.

3.Channel :-

- Channel is the physical medium which connects the transmitter with that of the receiver.
- The physical medium includes copper wire, coaxial cable, fibre optic cable, wave guide and free space or atmosphere.
- The choice of a particular channel depends on the feasibility and also the purpose of the communication system.

4.Receiver:-

- The receiver block receives the incoming modified version of the message signal from the channel and processes it to recreate the original (nonelectrical) form of the message signal.
- There are a great variety of receivers in communication systems, depending on the processing required to recreate the original message signal and also final presentation of the message to the destination.

5.Destination:-

- The destination is the final block in the communication system which receives the message signal and processes it to comprehend the information present in it.
- Usually, humans will be the destination block.

✚ Characteristics of Data Communication System:

1. Delivery:

The primary task of a data communication system is to deliver or transfer data from sender to receiver. The system must deliver data to the exact destination. No other receiver should receive the data. This characteristics includes the security of the system, that is, the protection of data.

2. Accuracy:

The data communication system must deliver data to the receiver without being altered or damaged. The receiver should receive the exact same data which was sent by the sender. The protocol might require to alter the sent data to protect and optimize the process.

3. Timeliness:

The system must maintain timeliness. It must deliver data in a timely manner. Delayed delivery can make the data useless to the receiver. Data must be delivered as they are produced, in the order they are produced and without any significant delay.

Protocols:

Definition:

A protocol is a set of rules and regulations that govern data communications. It defines what is communicated, how it is communicated, and when it is communicated. Rules are defined for each step and process during communication between two or more computers

Key elements of protocol

The main elements of protocols are :

a. Syntax

It refers to the structure or format of the data, that is the order in which they are presented.

b. Semantics

It refers to the meaning of each section of bits.

c. Timing

Timing refers to two characteristics: When data should be sent and how fast they can be sent.

Need of Protocols:

In networking, a protocol is **a set of rules for formatting and processing data**. Network protocols are like a common language for computers. The computers within a network may use vastly different software and hardware; however, the use of protocols enables them to communicate with each other regardless.

Examples of Protocols:

1. TCP/IP (Transmission Control Protocol/Internet Protocol),
2. HTTPS (Secure Hyper Text Transmission Protocol),
3. SMTP (Simple Mail Transfer Protocol), and
4. DNS (Domain Name System)

Standards:

Standards are the set of rules for data communication that are needed for exchange of information among devices. It is important to follow Standards which are created by various Standard Organization like IEEE , ISO , ANSI etc.

Types of Standards:

Standards are of two types:

- De Facto Standard.
- De Jure Standard.

1) De Facto Standard : The meaning of the word " *De Facto* " is " By Fact " or "By Convention".

These are the standards that have not been approved by any Organization.

For example: Apple and Google are two companies which established their own rules on their products which are different. Also they use some same standard rules for manufacturing for their products.

2) De Jure Standard : The meaning of the word " *De Jure* " is "By Law" or "By Regulations" .

Thus , these are the standards that have been approved by officially recognized body like ANSI , ISO , IEEE etc. These are the standards which are important to follow if it is required or needed.

For example : All the data communication standard protocols like SMTP , TCP , IP , UDP etc. are important to follow the same when we needed them.

What is bit Rate:

The number of bit intervals per second is known as the bit rate. The time it takes to transport one single bit is referred to as the bit interval. In layman's terms, bit rate refers to the number of bits transferred every second, which is commonly stated in bits per second (bps). For example, ***Kilobits per second*** (Kbps), ***Megabits per second*** (Mbps), ***Gigabits per second*** (Gbps), etc.

What is Baud Rate:

The number of times a signal can change on a transmission line per second is referred to as the baud rate. Typically, just two signal states are used on the transmission line, with the baud rate equal to the number of bits per second that can be transferred.

It can be illustrated with an example. For example, the **1500** baud rate indicates that the channel state can change up to **1500** times per second. The term "**changing state**" refers to a channel's ability to change state from **0** to **1** or **1** to **0** up to **1500** times per second (in the given case).

Difference Between Bit Rate and Baud Rate

Basis For Comparison	Bit Rate	Baud Rate
Basic	The number of bits per second is known as the bit rate.	The number of signal units per second is known as the baud rate.
Meaning	Bit rate determines the number of bits travelled per second.	Baud Rate determines the number of times a signal's status changes.
Formula	Bit rate= baud rate x the count of bits per signal unit.	Baud rate= bit rate/ the number of bits per signal unit.
Term Usually Used	The focus is on computer efficiency.	On the other hand, data transmission over the channel is more concerned.
Bandwidth Determination	Bit Rate cannot determine the bandwidth.	It can determine the amount of bandwidth necessary to send the signal.

● **Mode of data communication**

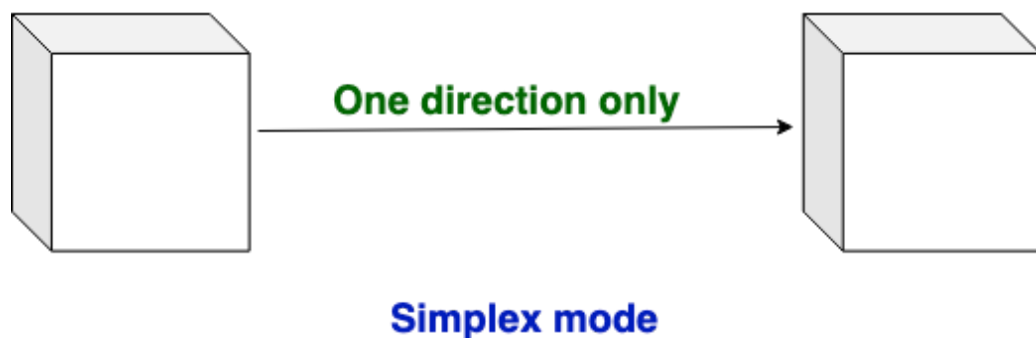
The Transmission mode is divided into three categories:

- Simplex mode
- Half-duplex mode
- Full-duplex mode

Simplex mode:

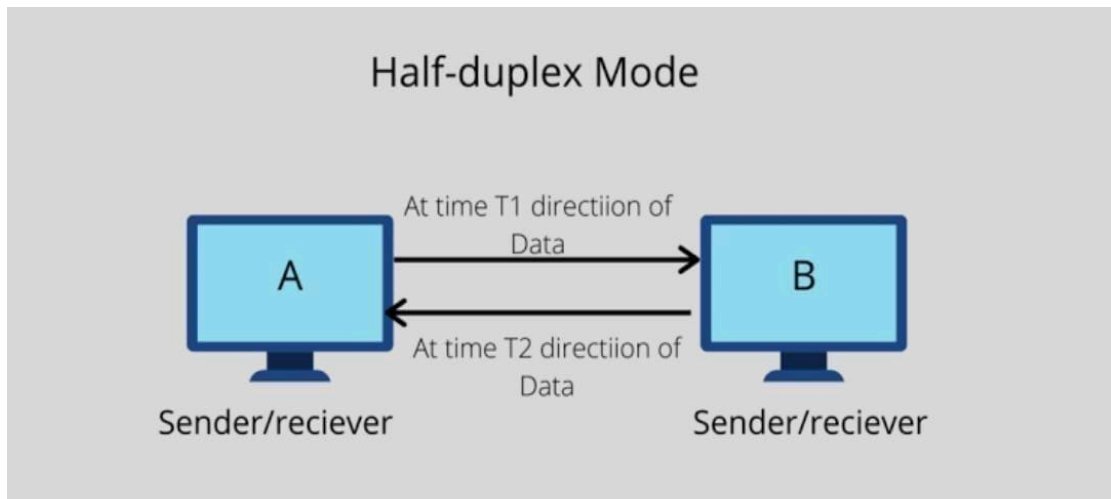
- In Simplex mode, the communication is unidirectional, i.e., the data flow in one direction.
- A device can only send the data but cannot receive it or it can receive the data but cannot send the data.

- This transmission mode is not very popular as mainly communications require the two-way exchange of data. The simplex mode is used in the business field as in sales that do not require any corresponding reply.
- The radio station is a simplex channel as it transmits the signal to the listeners but never allows them to transmit back.
- Keyboard and Monitor are the examples of the simplex mode as a keyboard can only accept the data from the user and monitor can only be used to display the data on the screen.
- The main advantage of the simplex mode is that the full capacity of the communication channel can be utilized during transmission.



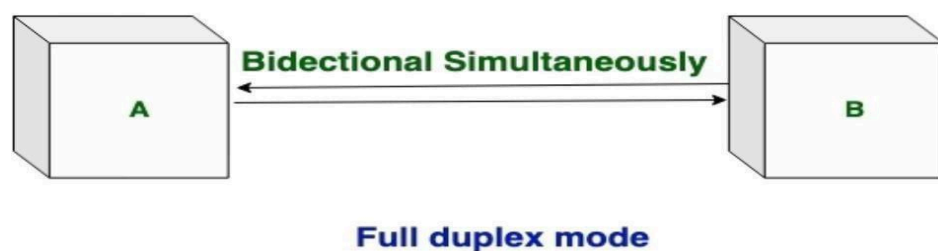
Half Duplex:

- In a Half-duplex channel, direction can be reversed, i.e., the station can transmit and receive the data as well.
- Messages flow in both the directions, but not at the same time.
- The entire bandwidth of the communication channel is utilized in one direction at a time.
- In half-duplex mode, it is possible to perform the error detection, and if any error occurs, then the receiver requests the sender to retransmit the data.
- A **Walkie-talkie** is an example of the Half-duplex mode. In Walkie-talkie, one party speaks, and another party listens. After a pause, the other speaks and first party listens. Speaking simultaneously will create the distorted sound which cannot be understood.



Full Duplex:

- In Full duplex mode, the communication is bi-directional, i.e., the data flow in both the directions.
- Both the stations can send and receive the message simultaneously.
- Full-duplex mode has two simplex channels. One channel has traffic moving in one direction, and another channel has traffic flowing in the opposite direction.
- The Full-duplex mode is the fastest mode of communication between devices.
- The most common example of the full-duplex mode is a telephone network. When two people are communicating with each other by a telephone line, both can talk and listen at the same time.



- **Difference between Simplex, Half Duplex and full duplex**

Parameters	Simplex	Half Duplex	Full Duplex
The direction of communication	<u>Simplex mode</u> is a uni-directional communication.	<u>Half Duplex</u> mode is a two-way directional communication but one at a time.	<u>Full Duplex mode</u> is a two-way directional communication simultaneously.
Sender and Receiver	In simplex mode, Sender can send the data but that sender can't receive the data.	In Half Duplex mode, Sender can send the data and also can receive the data but one at a time.	In Full Duplex mode, Sender can send the data and also can receive the data simultaneously.
Channel usage	Usage of one channel for the transmission of data.	Usage of one channel for the transmission of data.	Usage of two channels for the transmission of data.
Performance	The simplex mode provides less performance than half duplex and full duplex.	The Half Duplex mode provides less performance than full duplex.	Full Duplex provides better performance than simplex and half duplex mode.
Bandwidth Utilization	Simplex utilizes the maximum of a single bandwidth.	The Half-Duplex involves lesser utilization of single bandwidth at the time of transmission.	The Full-Duplex doubles the utilization of transmission bandwidth.
Suitable for	It is suitable for those transmissions when there is requirement of full bandwidth for delivering data.	It is suitable for those transmissions when there is requirement of sending data in both directions, but not at the same time.	It is suitable for those transmissions when there is requirement of sending and receiving data simultaneously in both directions.
Examples	Example of simplex mode are: Keyboard and monitor.	Example of half duplex mode is: Walkie-Talkies.	Example of full duplex mode is: Telephone.

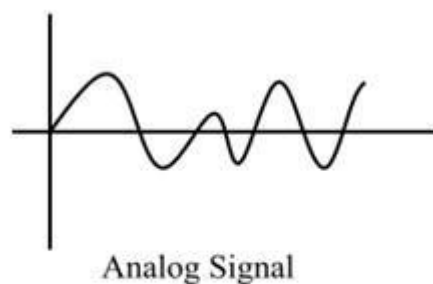
- **Signals:**

A Signal is an electromagnetic wave that is used to communicate system-to-system by sending data from one network to another network is basically known as “Signal”.

Types of Signals:

Analog Signals:

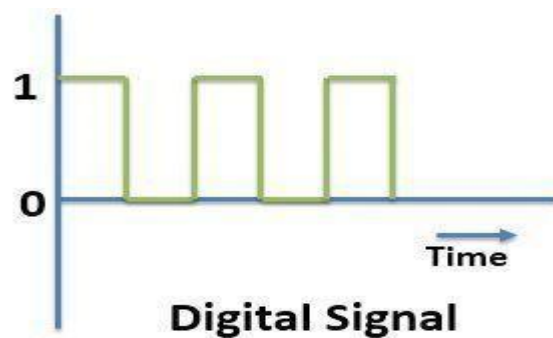
- Analog signal is the signal which varies continuously with time.
- It is represented by sine wave
- Analog signals are more accurate than digital signals.
- Analog signals take time to be stored. It has infinite memory.
- There is a continuous representation of signals in Analog signals.
- Analog signals produce too much noise.
- Examples of Analog signals are Human voice, Thermometer, Analog phones etc.



Digital Signals:

- Digital signals are easy to analyze.
- A signal that is discrete function of time, i.e. which is not a continuous signal, is known as a **digital signal**.

- The digital signals are represented in the binary form and consist of different values of voltage at discrete instants of time.
- Digital signals can be easily stored.
- Basically, a digital signal represents the data and information as a sequence of separate values at any given time. The digital signal can only take on one of a finite number of values.
- Digital signals do not produce noise.
- Examples of digital signals are Computers, Digital Phones, Digital pens, etc



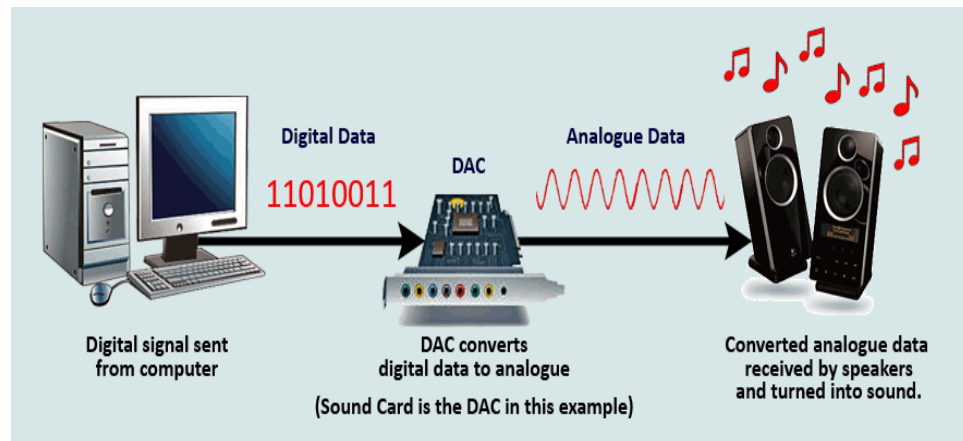
• Difference between Analog and Digital signal

	Analog System	Digital System
Signal	Analog signal represents physical measurements.	Digital signals are discrete and generated by digital modulation.
Waves	Sine Waves	Square Waves
Representation	Continuous range of values to represent information	Uses discrete values to represent information
Technology	Records waveforms as they are.	Samples analog waveforms into a limited set of numbers and then records them.

	Analog System	Digital System
Data transmissions	Affected by noise during transmission and write/read cycle.	Noise-immune during transmission and write/read cycle.
Response to Noise	More likely to get affected	Less likely to get affected
Flexibility	Hardware is not flexible.	Hardware is flexible.
Bandwidth	Less bandwidth.	More bandwidth to carry out the same information
Memory	Stored data in the form of wave signal	Stored data in the form of binary bit
Power	Consumes large power	Consumes negligible power
Uses	Best suited for audio and video transmission.	Best suited for Computing and digital electronics.
Cost	Cost is low	Cost is high
Example	Human voice in air, analog electronic devices.	Computers, CDs, DVDs,

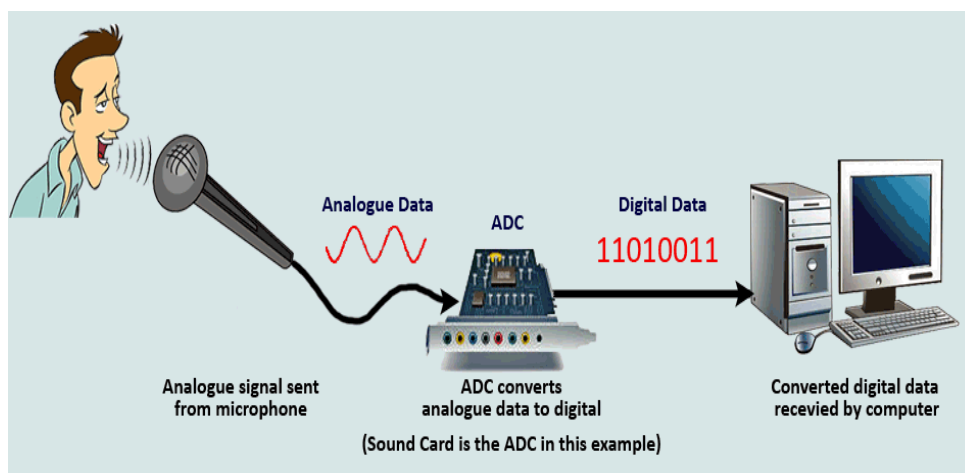
● Digital to Analog Conversion

- In the Process of D to A conversion the digital data at the input is converted in to an Analog signal.
- These signal are transmitted over the transmission medium
- The most familiar application of D to A conversion is for transmitting digital data through the public telephone network.
- The D to A conversion is done by the modem to convert the digital data from the computer into the Analog signal that are sent on telephone line for the internet



● Analog to Digital Conversion

- The Process of converting the Analog data to digital signal is known as digitisation.
- This process is essential in all the digital communication system such as pulse code modulation or Delta modulation
- In order to carry out this transformation, one has to follow a sequence of operation such as sampling, quantization and encoding.
- The A to D Conversion is done by Encoder.



✚ Computer Network

A computer network is a set of devices connected through links. A node can be computer, printer, or any other device capable of sending or receiving the data. The links connecting the nodes are known as communication channels.

A group of computer which are connected to each other for the purpose of sharing resources is called computer network.

OR

A computer network is defined as a system that connect two or more computing device for transmitting and sharing information.

Features of Computer network

A list Of Computer network features is given below.

- Communication speed
- File sharing
- Back up and Roll back is easy
- Software and Hardware sharing
- Security
- Scalability
- Reliability

Need of Computer

In today's technology-oriented world, sharing has become an integral part of businesses and other activities. This sharing can be achieved by networking. A computer network is linking two or more computers in order to share files or resources.

Here, we will see why we need computer networks in more detail below –

➤ To share computer files:

Networks enable users to share files with others. For example, in a company, one file is to be shared by multiple branches. When we locate this file on the network system, all the branches can use this file.

➤ To share computer equipment:

Laser printers and large hard-disk drives can be expensive. Networks enable users to share such equipment by networking microcomputers or workstations together.

➤ To enable unlike computer equipment to communicate:

A company with computers of multiple uses using several operating systems, including MS-DOS, UNIX, WINDOWS 95, and Apple DOS, cannot share files from one computer to another unless arranged using a Networking operating system including Network 4.1 or Windows NT 4.0.

➤ To improve communication speed and accuracy

Sending messages through networks is virtually instantaneous, and there is also less chance of a message being lost.

➤ To reduce the cost of data transfer

The cost of transfers of files using computers associated with networks is less expensive than other traditional means like telegrams.

➤ Verify Data Transfer

Fluctuations of costs in foreign exchange and shares can be broadcasted promptly using the channel of computer communications. The transmission can be increased and checked at any occurrence of time.

➤ E-commerce

E-commerce stand for electronic commerce. Computer network provide access to the internet. We can sell products and services online through the internet.

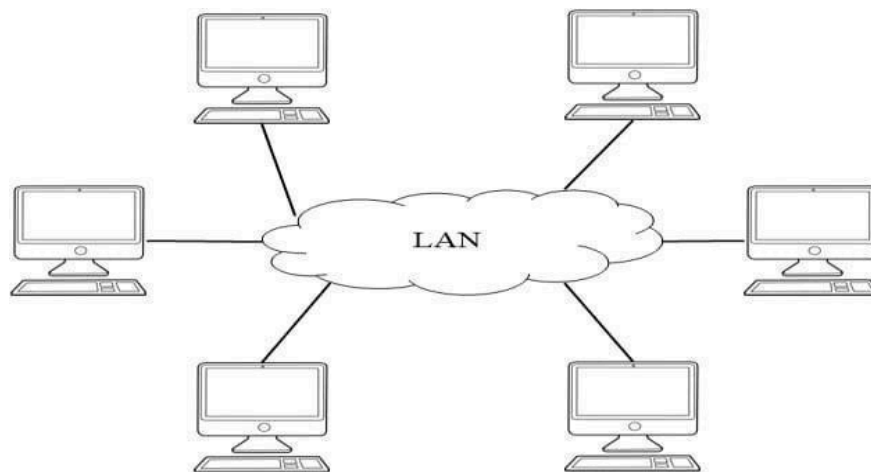
o Entertainment

Millions of people use computer network or internet for entertainment. Computer network, especially the internet offer various source of entertainment. These are many websites available on the internet that provide entertainment related content.

Types of Computer Network

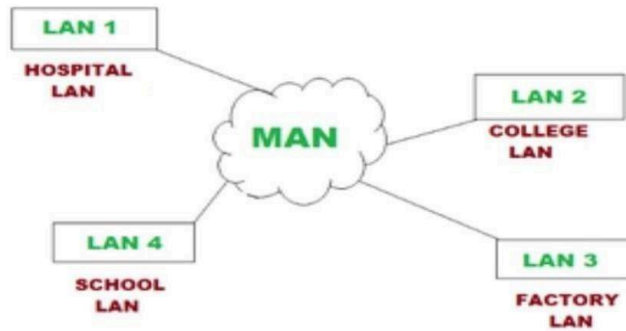
1) **Local area network (LAN):**

- LAN is defined as a computer network that links the local areas like schools, universities, organizations, etc.
- The full form of the LAN is Local Area Network
- LAN is a wired network, i.e., all the computers and printers are connected through wires
- The internet speed of LAN is very high, i.e., 10m to 1000m. ○ The maintenance cost of LAN is easy.
- The bandwidth of LAN is high
- Examples:
College, School, University, Hospital



2) Metropolitan area network (MAN):

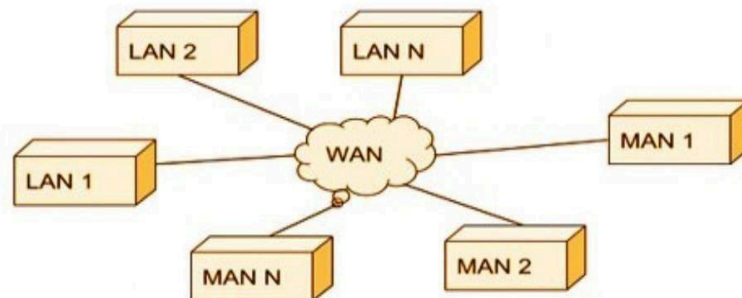
- MAN is defined as a computer network that links the metropolitan areas.
- The full form of MAN is Metropolitan Area Network
- The connections in MAN are connected through modem or cables/wires
- The ownership of MAN might be public or private
- The speed of MAN is moderate, i.e., 5km - 50 km
- The maintenance cost of MAN is difficult.
- The bandwidth of MAN is less
- Examples: City, Building



3) Wide Area Network (WAN):

- The full form of WAN is a Wide Area Network
- On the other hand, WAN is defined as the telecommunications network that covers a large geographical area.
- The network of WAN is connected through broadband services, 3G or 4G internet services, etc.
- The network of WAN is connected through broadband services, 3G or 4G internet services, etc.
- The ownership of WAN might be private or public
- The speed of WAN is 1000000Km.
- The maintenance cost of WAN is difficult
- The bandwidth of WAN is relatively low.
- Examples :Broadband and internet throughout the country or continent.

Wide Area Network (WAN)



Basis	LAN	MAN	WAN
Full-Form	LAN stands for local area network.	MAN stands for metropolitan area network.	WAN stands for wide area network.
Geographic Span	Operates in small areas such as the same building or campus.	Operates in large areas such as a city.	Operates in larger areas such as country or continent.
Ownership	LAN's ownership is private.	MAN's ownership can be private or public.	While WAN also might not be owned by one organization.
Transmission Speed	The transmission speed of a LAN is high.	While the transmission speed of a MAN is average.	Whereas the transmission speed of a WAN is low.
Propagation delay	The propagation delay is short in a LAN.	There is a moderate propagation delay in a MAN.	Whereas, there is a long propagation delay in a WAN.
Congestion	There is less congestion in LAN.	While there is more congestion in MAN.	Whereas there is more congestion than MAN in WAN.
Design & Maintenance	LAN's design and maintenance are easy.	While MAN's design and maintenance are difficult than LAN.	Whereas WAN's design and maintenance are also difficult than LAN as well MAN.

Advantages of Computer Network

- **Resource Sharing:** Resource Sharing is one of the important applications of Computer Networking. You can share a single software among Multiple users. We can also share Hardware Devices via this technique.
- **Communication:** Communication Medium means various ways through which we can communicate like Email Calls, broadcasts, etc.

- **Backup and recovery:** with the help of computer network, we can maintain a backup of our data and if ever the data is loss, then from that backup we can recover our data again.

Disadvantages of Computer Network

- **Expensive:** Execution of the network can be expensive in the case of an initial setup, as the wires and the cost of the cable are high and sometimes equipment is also costly.
- Computer network required server computers, computer hardware and software. Purchasing can be expensive.
- **Virus and Malware:** Computer Networking can lead to the spreading of viruses to another computer through the network.
- **Lack of Independence:** the computer network is not completely independent. Because it depend on the main server.
- **Loss of Information:** In case of a crash of the Computer Network, it can lead to the loss of information or not being able to access information for some time.
- **Lack of Robustness:** if the main central server of a computer network Faces issues like a breakdown. Then the whole system suffers.

Application of Computer Network

- **Resource Sharing:** Resource Sharing is one of the important applications of Computer Networking. You can share a single software among Multiple users. We can also share Hardware Devices via this technique.
- **Communication:** Communication Medium means various ways through which we can communicate like Email Calls, broadcasts, etc.
- **Home Applications:** Home Applications are an important application of Computer Networking. Examples are User-to-User Communication, Entertainment, E-Commerce, etc.
- **Business Applications:** Business Application is also an important application of Computer Networking. Almost all companies are doing business online with the help of Computer Networking.

- **Social Media:** Social Media is one of the recent and widely used applications of Computer Networking. It helps people in getting news, feed, current trending topics of all types, etc.
- **Online Education:** Computer Networking has revolutionized education by providing online learning platforms, distance education, and virtual classrooms.
- **E-commerce:** Computer Networking has facilitated the growth of e-commerce by allowing businesses to sell their products and services online and reach a global market.

