

UNIT I :- Introduction to Computer Networks

- ☐ **Definition & Applications of Computer Network**
- ☐ **Basic Concepts Signals, Types – Analog and Digital Signals**
- ☐ **Network topologies- star, bus, mesh, ring**
- ☐ **Data Transmission Media**
- ☐ **Network Types LAN, MAN, WAN**
- ☐ **Connection Oriented & Connectionless services**

What is Network ?

- 1) A network as an interconnected collection of autonomous computers.
- 2) Two computers are said to be interconnected if they are capable of exchanging information.
- 3) Central to this definition is the fact that the computers are autonomous. This means that no computer on the network can start, stop, or control another.

Advantages :

- (i) **RESOURCE SHARING.** The aim is to make all programs, data and peripherals available to anyone on the network irrespective of the physical location of the resources and the user.
- (ii) **RELIABILITY.** A file can have copies on two or three different machines, so if one of them is unavailable (hardware crash), the other copies could be used. For military, banking, air reservation and many other applications it is of great importance.
- (iii) **COST FACTOR.** Personal computers have better price/performance ratio than micro computers. So it is better to have PC's, one per user, with data stored on one shared file server machine.

(iv) **COMMUNICATION MEDIUM.** Using a network, it is possible for managers, working far apart, to prepare financial report of the company. The changes at one end can be immediately noticed at another and hence it speeds up co-operation among them.

Applications & Uses of Networks In the short time they have been around, data communication networks have become an indispensable part of business, industry, and entertainment. Some of the network applications in different fields are the following:

- **Marketing and sales.** Computer networks are used extensively in both marketing and sales organizations. Marketing professionals use them to collect, exchange, and analyze data relating to customer needs and product development cycles. Sales applications include teleshopping, which uses order entry computers or telephones connected to an order-processing network, and on-line reservation services for hotels, airlines, and so on.
- **Financial services.** Today's financial services are totally dependent on computer networks. Applications include credit history searches, foreign exchange and investment services, and electronic funds transfer (EFT), which allows a user, to transfer money without going into a bank (an automated teller machine is a kind of electronic funds transfer; automatic paycheck deposit is another).
- **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.
- **Electronic messaging:** Probably the most widely used network application is electronic mail (e-mail).
- **Directory services:** Directory services allow lists of files to be stored in a central location to speed worldwide search operations.

- **Information services:** Network information services include bulletin boards and data banks. A World Wide Web site offering the technical specifications for a new product is an information service.

- **Electronic data interchange (EDI):** EDI allows business information (including documents such as purchase orders and invoices) to be transferred without using paper.

- **Teleconferencing:** Teleconferencing allows conferences to occur without the participants being in the same place. Applications include simple text conferencing (where participants communicate through their keyboards and computer monitors), voice conferencing (where participants at a number of locations communicate simultaneously over the phone) and video conferencing (where participants can see as well as talk to one another).

- **Cellular telephone:** In the past two parties wishing to use the services of the telephone company had to be linked by a fixed physical connection. Today's cellular networks make it possible to maintain wireless phone connections even while travelling over large distances.

- **Cable television:** Future services provided by cable television networks may include video on request, as well as the same information, financial, and communications services currently provided by the telephone companies and computer networks.

Network Topology

Network Topologies Def: The pattern of interconnection of nodes(devices or computer) in a network is called the TOPOLOGY.

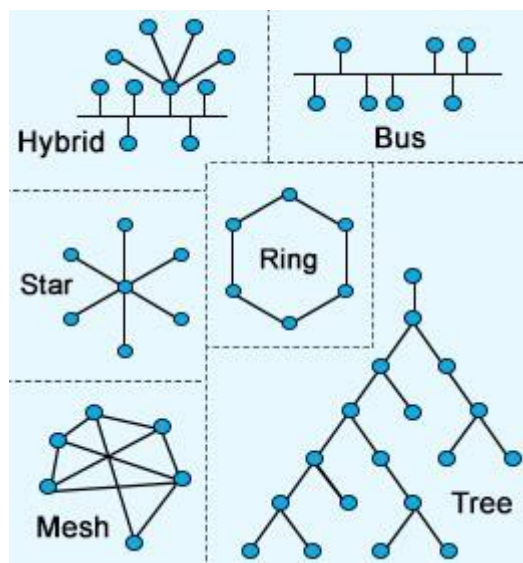
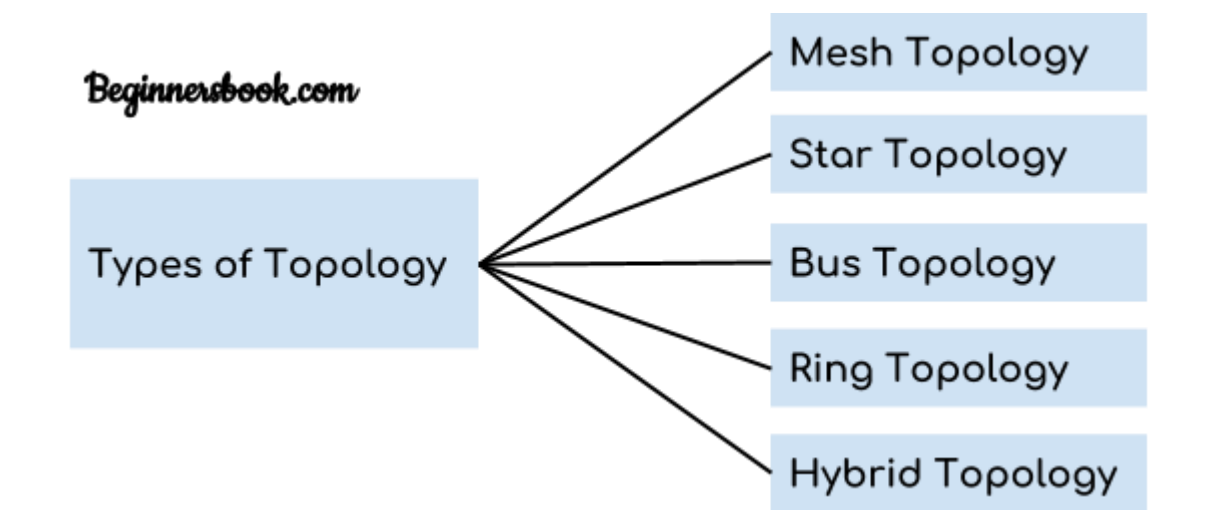
The selection of a topology for a network cannot be done in isolation as it affects the choice of media and the access method used. There are a number of factors to consider in making this choice, the most important of which are set out below:

1. **Cost:** For a network to be cost effective, one would try to minimize installation cost. This may be achieved by using well understood media and also, to a lesser extent, by minimizing the distances involved. .

2. Flexibility: Because the arrangement of furniture, internal walls etc. in offices is often subject to change, the topology should allow for easy reconfiguration of the network. This involves moving existing nodes and adding new ones.

3. Reliability: Failure in a network can take two forms. Firstly, an individual node can malfunction. This is not nearly as serious as the second type default where the network itself fails to operate. The topology chosen for the network can help by allowing the location of the fault to be detected and to provide some means of isolating it.

Types of Network Topology



I)Star Topology

i) **The Star Topology :** This topology consists of a central node to which all other nodes are connected by a single path. It is the topology used in most existing information networks involving data processing or voice communications.

Example of this is IBM 370 installations. In this case multiple 3270 terminals are connected to either a host system or a terminal controller.

Fig 1.1 Star Topology

Advantages of the Star Topology

1. Ease of service: The star topology has a number of concentration points (where connections are joined). These provide easy access for service or reconfiguration of the network.

2. One device per connection: Connection points in any network are inherently prone to failure in the star topology, failure of a single connection typically involves disconnecting one node from an otherwise fully functional network.

3. Centralized control/problem diagnosis: The fact that the 'central node is connected directly to every other node in the network means that faults are easily detected and isolated. It is a simple matter to disconnect failing nodes from the system.

4. Simple access protocols: Any given connection in a star network involves only the central node. In this situation, contention for who has control of the medium for the transmission purposes is easily solved. Thus in a star network, access protocols are very simple.

Disadvantages of the Star Topology.

1. Long cable length: Because each node is directly connected to the center, the star topology necessitates a large quantity of cable as the cost of cable is often small, congestion in cable ducts and maintenance and installation problems can increase cost considerably.

2. Difficult to expand: The addition of a new node to a star network involves a connection all the way to the central node.

3. Central node dependency: If the central node in a star network fails, the entire network is rendered inoperable. This introduces heavy reliability and redundancy constraints on this node. The star topology has found extensive application in areas where intelligence in the network is concentrated at the central node.

Examples of Star Topology Asynchronous Transmission Mode (ATM) Asynchronous Transfer Mode (ATM) is an International Telecommunication Union - Telecommunication Standardization Sector (ITU- T) standard for cell relay wherein information for multiple service types, such as voice, video, or data, is conveyed in small, fixed-size cells. ATM networks are connection oriented.

ii) The Bus or Linear Topology :

i) This consists of a single length of the transmission medium (normally coaxial cable) onto which the various nodes are attached.

ii) The topology is used in traditional data communication network where the host at one end of the bus communicates with several terminals attached along its length.

iii) The transmission from any station travels the length of the bus, in both directions, and can be received by another stations.

iv) The bus has terminators at either end which absorb the signal, removing it from the bus.

Data is transmitted in small blocks, known as packets. Each packet has some data bits, plus a header containing its destination address. A station wanting to transmit some data sends it in packets along the bus. The destination device, on identifying the address on the packets, copies the data onto its disk.

Advantages of the Linear /Bus Topology

1. Short cable length and simple wiring layout: Because there is a single common data path connecting all nodes, the linear topology allows a very short cable length to be used. This decreases the installation cost, and also leads to a simple, easy to maintain wiring layout.

2. Resilient Architecture: The LINEAR architecture has an inherent simplicity that makes it very reliable from a hardware point of view. There is a single cable through which all the data propagates and to which all nodes are connected.

3. Easy to extend: Additional nodes can be connected to an existing bus network at any point along its length. More extensive additions can be achieved by adding extra segments connected by a type of signal amplifier known as repeater.

Disadvantages of the Bus (Linear) Topology

1. Fault diagnosis is difficult: Although simplicity of the bus topology means that there is very little to go wrong, fault detection is not a simple matter. Control of the network is not centralized 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: In the star topology, a defective node can easily be isolated from the network by removing its connection at the center. If a node is faulty on the bus, it must be rectified at the point where the node is connected to the network.

3. Repeater configuration: When BUS type network has its backbone extended using repeaters, reconfiguration may be necessary.

4. Nodes must be intelligent: Each node on the network is directly connected to the central bus. This means that some way of deciding who can use the network at any given time must be performed in each node.

Examples of Bus Topology Ethernet: Ethernet is the least expensive high-speed LAN alternative. It transmits and receives data at a speed of 10 million bits per second. Data is transferred between wiring closets using either a heavy coaxial cable (thick net) or fiber optic cable. Thick net coaxial is still used for medium-long distances where medium levels of reliability are needed.

iii) The Ring or Circular Topology :

i) In this case, each node is connected to two and only two neighbouring nodes. Data is accepted from one of the neighbouring nodes and is transmitted onwards to another.

Thus data travels in one direction only, from node to node around the ring. After passing through each node, it returns to the sending node, which removes it.

It is important to note that data 'passed through' rather than 'travels past' each node. This means that the signal may be amplified before being 'repeated' on the out ward channel.

Advantages of the Ring Topology

1. Short cable length. : The amount of cabling involved in a ring topology is comparable to that of a bus and is small relative to that of a star. This means that less connections will be needed, which will in turn increase network reliability.

2. No wiring closet space required. Since there is only one cable connecting each node to its immediate neighbours, it is not necessary to allocate space in the building for wiring closets.

3. Suitable for optical fibers. Using optical fibers offers the possibility of very high speed transmission. Because traffic on a ring travels in one direction, it is easy to use optical fibers as a medium of transmission.

Disadvantages of the Ring Topology

1. Node failure causes network failure. The transmission of data on a ring goes through every connected node on the ring before returning to the sender. If one node fails to pass data through itself, the entire network has failed and. no traffic can. flow until the defective node has been removed from the ring.

2. Difficult to diagnose faults. The fact that failure of one node will affect all others has serious implications for fault diagnosis. It may be necessary to examine a series of adjacent nodes to determine the faulty one. This operation may also require diagnostic facilities to be built into each node.

3. Network reconfiguration is difficult. It is not possible to shut down a small section of the ring while keeping the majority of it working normally.

Examples of Token Ring Topology IBM Token Ring: A local area network access mechanism and topology in which all stations actively attached to the bus listen for a broadcast token or supervisory frame.

iv)**Mesh Topology** : A mesh topology is a network setup where each computer and network device is interconnected with one another. This topology setup allows for most transmissions to be distributed even if one of the connections goes down. It is a topology commonly used for wireless networks. Below is a visual example of a simple computer setup on a network using a mesh topology.

Advantages of a mesh topology

- Manages high amounts of traffic, because multiple devices can transmit data simultaneously.
- A failure of one device does not cause a break in the network or transmission of data.
- Adding additional devices does not disrupt data transmission between other devices.

Disadvantages of a mesh topology

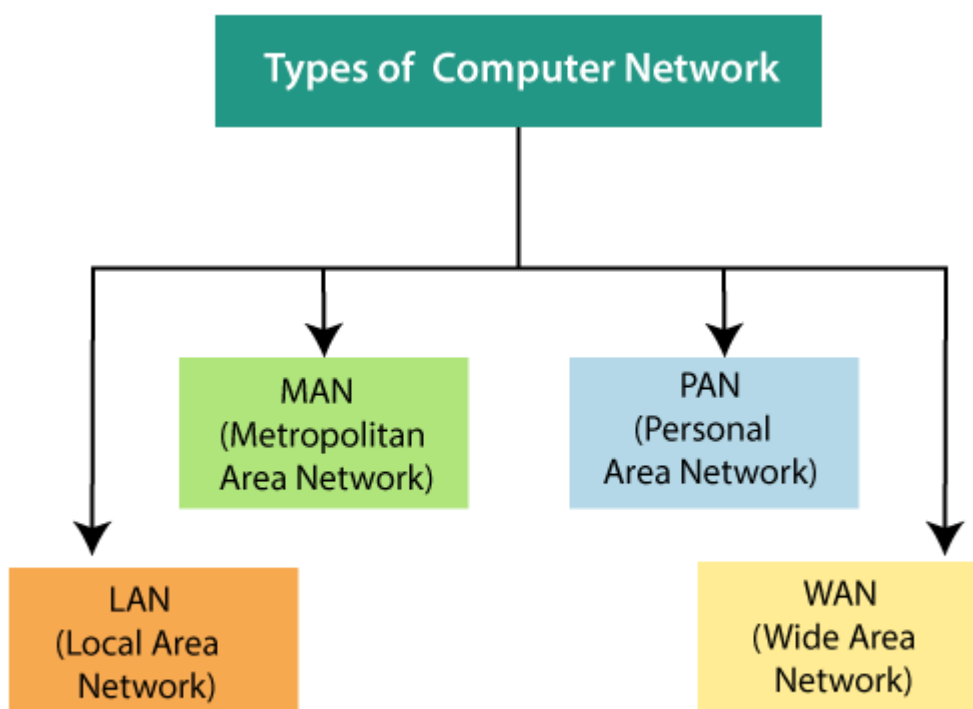
- The cost to implement is higher than other network topologies, making it a less desirable option.
- Building and maintaining the topology is difficult and time consuming.
- The chance of redundant connections is high, which adds to the high costs and potential for reduced efficiency.

v)**Tree Topology** Tree topology can be derived from the star topology. Tree has a hierarchy of various bubs, like you have branches in a tree; hence the name. Figure 1.6 in this case

every node is connected to some hub. However, only a few nodes are connected directly to the central hub.

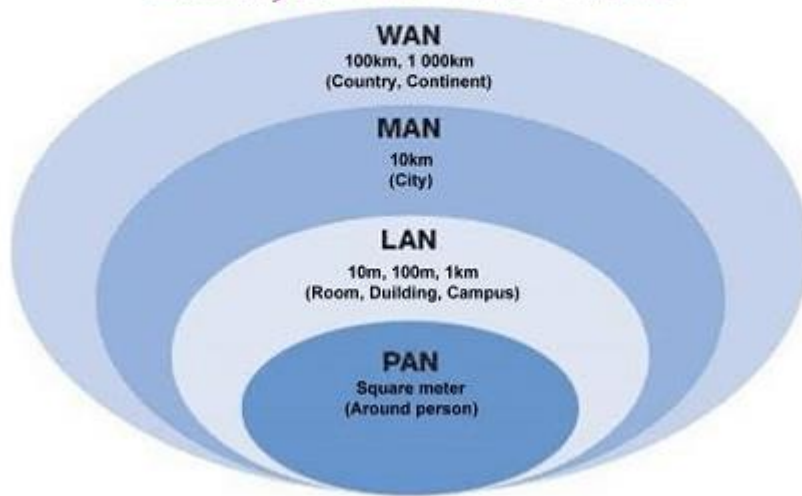
The central hub contains a repeater, which looks at the incoming bits and regenerates them afresh as the full blown signals for 0 or 1 as required. This allows the digital signals to traverse over longer distances. Therefore, the central hub is also called active hubs. The tree topology also contains many secondary hubs, which may be active hubs or passive hubs. The merits and demerits of tree topology are almost similar to those of the star topology.

vi) Hybrid Topology Hybrid topology is one that uses two or more of the topologies mentioned above together, Figure 1.7 depicts this. In this case, the bus, star and ring topologies are used to create this hybrid topology. There are multiple ways in which this can be created. In practice, many networks are quite complex but they can be reduced to some form of hybrid topology.



Network - Types of Computer Network

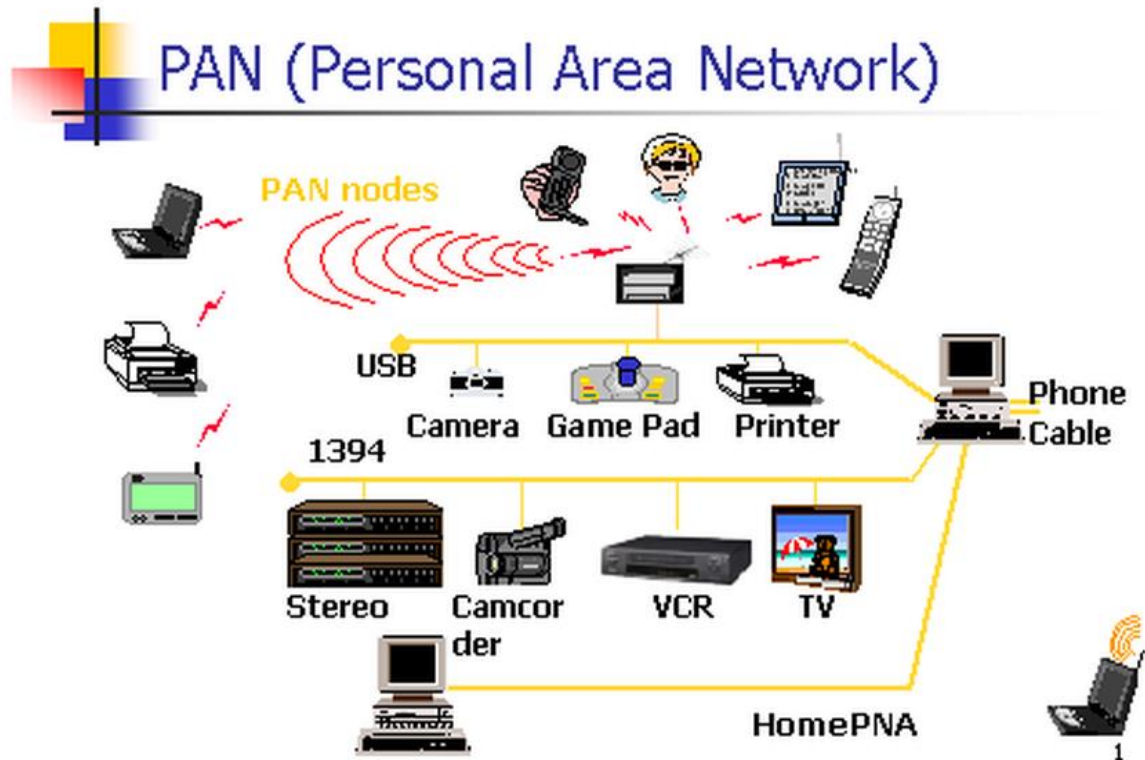
LAN, MAN and WAN



What is PAN (Personal Area Network)?

PAN is a computer network formed around a person. It generally consists of a computer, mobile, or personal digital assistant. PAN can be used for establishing communication among

these personal devices for connecting to a digital network and the internet.



Characteristics of PAN

It is mostly personal devices network equipped within a limited area.

Allows you to handle the interconnection of IT devices at the surrounding of a single user.

PAN includes mobile devices, tablet, and laptop.

It can be wirelessly connected to the internet called WPAN.

Appliances use for PAN: cordless mice, keyboards, and Bluetooth systems.

Advantages of PAN

- 1) PAN networks are relatively secure and safe
- 2) It offers only short-range solution up to ten meters
- 3) Strictly restricted to a small area

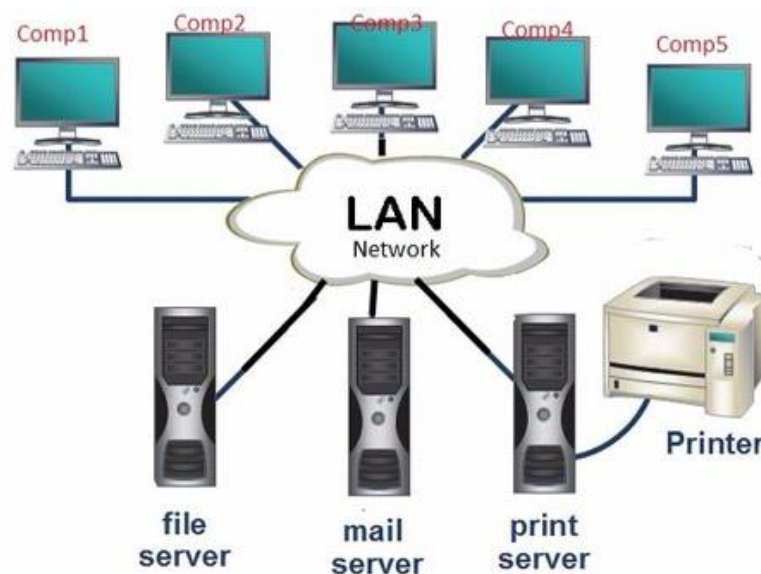
Disadvantages of PAN

- 1) It may establish a bad connection to other networks at the same radio bands.

2) Distance limits.

What is LAN?

A Local Area Network (LAN) is a group of computer and peripheral devices which are connected in a limited area such as school, laboratory, home, and office building. It is a widely useful network for sharing resources like files, printers, games, and other application. The simplest type of LAN network is to connect computers and a printer in someone's home or office. In general, LAN will be used as one type of transmission medium. It is a network which consists of less than 5000 interconnected devices across several buildings.



Characteristics of LAN

Here are important characteristics of a LAN network:

- 1) It is a private network, so an outside regulatory body never controls it.
- 2) LAN operates at a relatively higher speed compared to other WAN systems.
- 3) There are various kinds of media access control methods like token ring and ethernet.

Advantages of LAN

- 1) Computer resources like hard-disks, DVD-ROM, and printers can share local area networks. This significantly reduces the cost of hardware purchases.

- 2) One can use the same software over the network instead of purchasing the licensed software for each client in the network.
- 3) Data of all network users can be stored on a single hard disk of the server computer.
- 4) One can easily transfer data and messages over networked computers.
- 5) It will be easy to manage data at only one place, which makes data more secure.
- 6) Local Area Network offers the facility to share a single internet connection among all the LAN users.

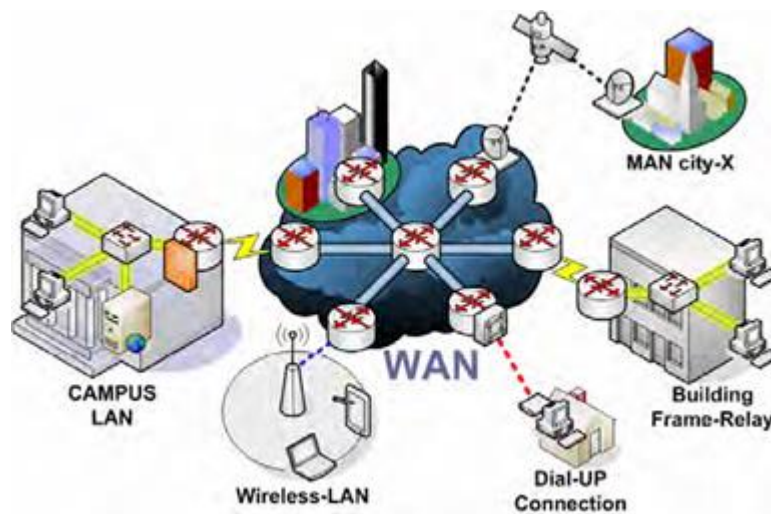
Disadvantages of LAN

- 1) LAN will indeed save cost because of shared computer resources, but the initial cost of installing Local Area Networks is quite high.
- 2) The LAN admin can check personal data files of every LAN user, so it does not offer good privacy.
- 3) Unauthorized users can access critical data of an organization in case LAN admin is not able to secure centralized data repository.
- 4) Local Area Network requires a constant LAN administration as there are issues related to software setup and hardware failures

What is WAN?

WAN (Wide Area Network) is another important computer network that which is spread across a large geographical area. WAN network system could be a connection of a LAN which connects with other LAN's using telephone lines and radio waves. It is mostly limited

to an enterprise or an organization.



Characteristics of WAN:

- 1)The software files will be shared among all the users; therefore, all can access to the latest files.
- 2)Any organization can form its global integrated network using WAN.

Advantages of WAN

- 1)WAN helps you to cover a larger geographical area. Therefore business offices situated at longer distances can easily communicate.
- 2)Contains devices like mobile phones, laptop, tablet, computers, gaming consoles, etc.
- 3)WLAN connections work using radio transmitters and receivers built into client devices.

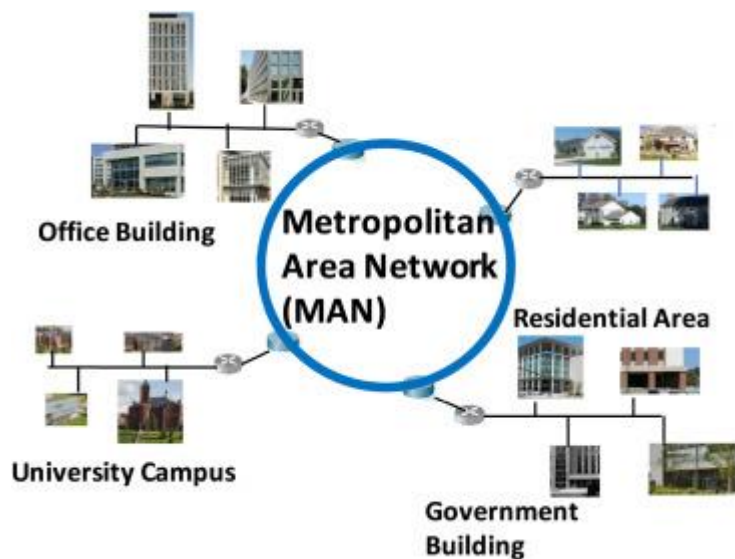
Disadvantage of WAN

- 1)The initial setup cost of investment is very high.
- 2)It is difficult to maintain the WAN network. You need skilled technicians and network administrators.
- 3)There are more errors and issues because of the wide coverage and the use of different technologies.
- 4)It requires more time to resolve issues because of the involvement of multiple wired and wireless technologies.

5) Offers lower security compared to other types of networks.

What Is MAN?

A Metropolitan Area Network or MAN is consisting of a computer network across an entire city, college campus, or a small region. This type of network is large than a LAN, which is mostly limited to a single building or site. Depending upon the type of configuration, this type of network allows you to cover an area from several miles to tens of miles.



Characteristics of MAN

- 1) It mostly covers towns and cities in a maximum 50 km range
- 2) Mostly used medium is optical fibers, cables
- 3) Data rates adequate for distributed computing applications.

Advantages of MAN

- 1) It offers fast communication using high-speed carriers, like fiber optic cables.
- 2) It provides excellent support for an extensive size network and greater access to WANs.
- 3) The dual bus in MAN network provides support to transmit data in both directions concurrently.

Disadvantages of MAN

- 1) One needs more cable to establish MAN connection from one place to another.

2) In MAN network it is tough to make the system secure from hackers

Other Types of Networks

Apart from above mentioned here, are some other important types of networks:

- WLAN (Wireless Local Area Network)
- Storage Area Network
- System Area Network
- Home Area Network
- POLAN- Passive Optical LAN
- Enterprise private network
- Campus Area Network
- Virtual Area Network

Let's see all of them in detail:

1) WLAN

WLAN (Wireless Local Area Network) helps you to link single or multiple devices using wireless communication within a limited area like home, school, or office building. It gives users an ability to move around within a local coverage area which may be connected to the network. Today most modern day's WLAN systems are based on IEEE 802.11 standards.

2) Storage-Area Network (SAN)

A Storage Area Network is a type of network which allows consolidated, block-level data storage. It is mainly used to make storage devices, like disk arrays, optical jukeboxes, and tape libraries.

3) System-Area Network

System Area Network is used for a local network. It offers high-speed connection in server-to-server and processor-to-processor applications. The computers connected on a SAN network operate as a single system at quite high speed.

4) Passive Optical Local Area Network

POLAN is a networking technology which helps you to integrate into structured cabling. It allows you to resolve the issues of supporting Ethernet protocols and network apps.

POLAN allows you to use optical splitter which helps you to separate an optical signal from a single-mode optical fiber. It converts this single signal into multiple signals.

5) Home Area Network (HAN):

A Home Area Network is always built using two or more interconnected computers to form a local area network (LAN) within the home. For example, in the United States, about 15 million homes have more than one computer.

This type of network helps computer owners to interconnect with multiple computers. This network allows sharing files, programs, printers, and other peripherals.

6) Enterprise Private Network :

Enterprise private network (EPN) networks are build and owned by businesses that want to securely connect numerous locations in order to share various computer resources.

7) Campus Area Network (CAN):

A Campus Area Network is made up of an interconnection of LANs within a specific geographical area. For example, a university campus can be linked with a variety of campus buildings to connect all the academic departments.

8) Virtual Private Network:

A VPN is a private network which uses a public network to connect remote sites or users together. The VPN network uses "virtual" connections routed through the internet from the

enterprise's private network or a third-party VPN service to the remote site.

What is Transmission media?

1. Transmission media is a communication channel that carries the information from the sender to the receiver. Data is transmitted through the electromagnetic signals.
2. The main functionality of the transmission media is to carry the information in the form of bits through LAN(Local Area Network).
3. It is a physical path between transmitter and receiver in data communication.
4. In a copper-based network, the bits in the form of electrical signals.
5. In a fibre based network, the bits in the form of light pulses.
6. In OSI(Open System Interconnection) phase, transmission media supports the Layer 1. Therefore, it is considered to be as a Layer 1 component.
7. The electrical signals can be sent through the copper wire, fibre optics, atmosphere, water, and vacuum.
8. The characteristics and quality of data transmission are determined by the characteristics of medium and signal.

Transmission media is of two types are wired media and wireless media. In wired media, medium characteristics are more important whereas, in wireless media, signal characteristics are more important.

Different transmission media have different properties such as bandwidth, delay, cost and ease of installation and maintenance.

The transmission media is available in the lowest layer of the OSI reference model, i.e., Physical layer.

Some factors need to be considered for designing the transmission media:

1. Bandwidth: All the factors are remaining constant, the greater the bandwidth of a medium, the higher the data transmission rate of a signal.

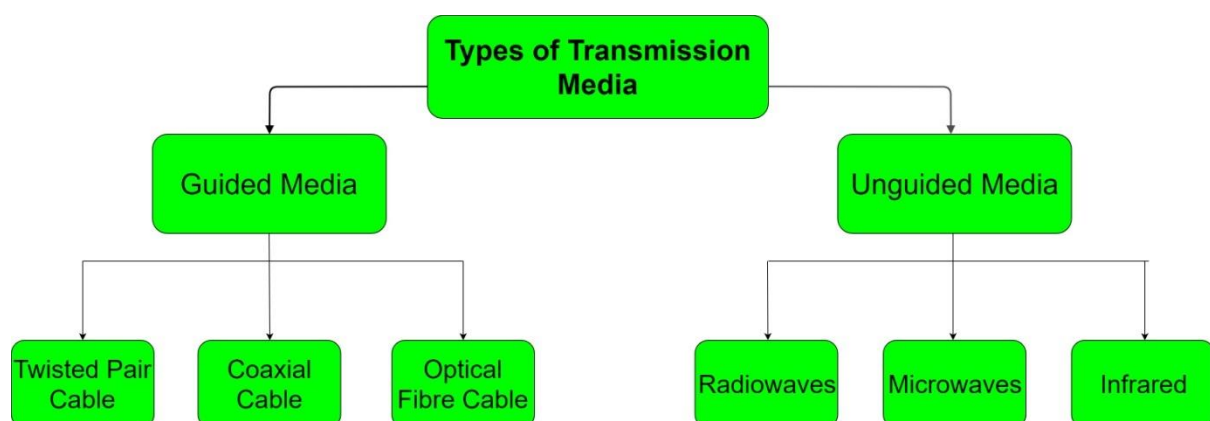
2. **Transmission impairment:** When the received signal is not identical to the transmitted one due to the transmission impairment. The quality of the signals will get destroyed due to transmission impairment.
3. **Interference:** An interference is defined as the process of disrupting a signal when it travels over a communication medium on the addition of some unwanted signal.

Causes Of Transmission Impairment:

Transmission media

1. **Attenuation:** Attenuation means the loss of energy, i.e., the strength of the signal decreases with increasing the distance which causes the loss of energy.
2. **Distortion:** Distortion occurs when there is a change in the shape of the signal. This type of distortion is examined from different signals having different frequencies. Each frequency component has its own propagation speed, so they reach at a different time which leads to the delay distortion.
3. **Noise:** When data is travelled over a transmission medium, some unwanted signal is added to it which creates the noise.

Classification Of Transmission Media:



1. Guided Media:

It is also referred to as Wired or Bounded transmission media. Signals being transmitted are directed and confined in a narrow pathway by using physical links.

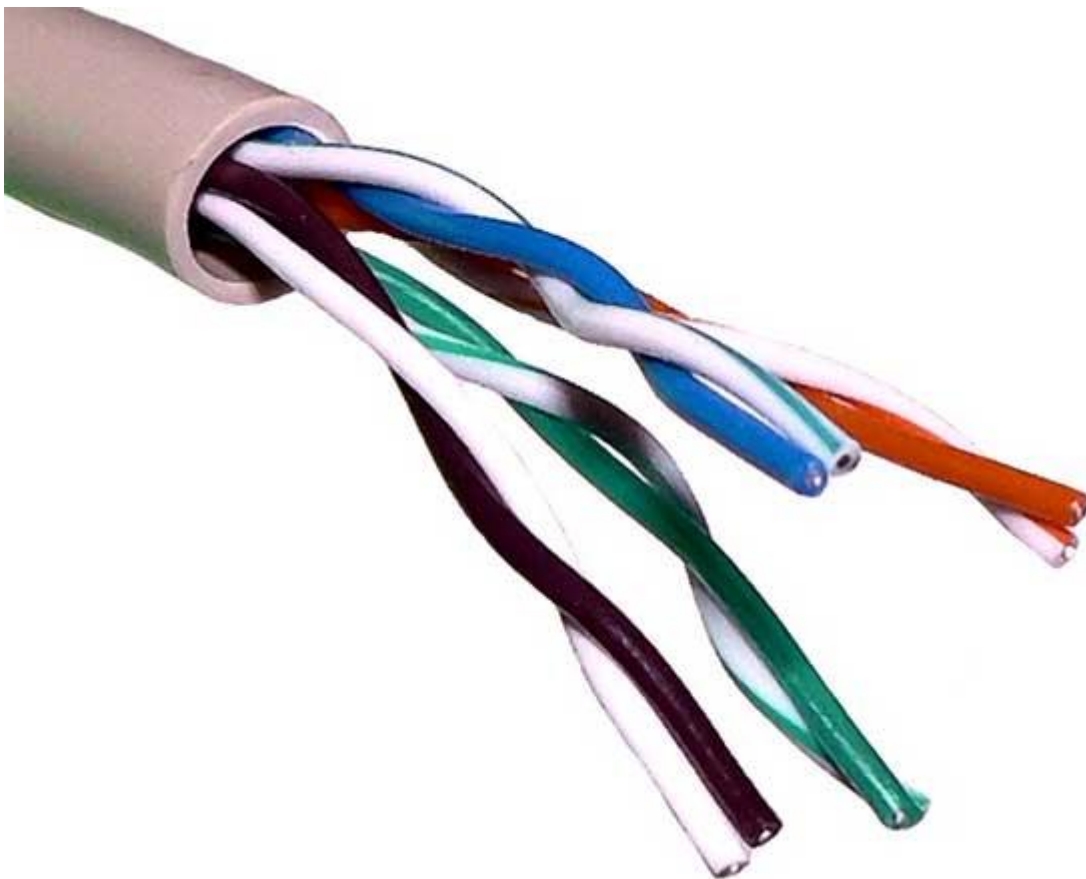
Features:

- High Speed
- Secure
- Used for comparatively shorter distances

There are 3 major types of Guided Media:

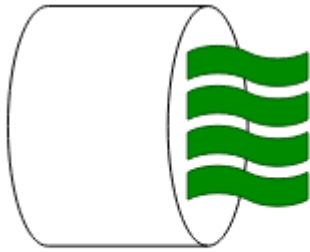
(i) Twisted Pair Cable –

It consists of 2 separately insulated conductor wires wound about each other. Generally, several such pairs are bundled together in a protective sheath. They are the most widely used Transmission Media. Twisted Pair is of two types:



Unshielded Twisted Pair (UTP):

This type of cable has the ability to block interference and does not depend on a physical shield for this purpose. It is used for telephonic applications.



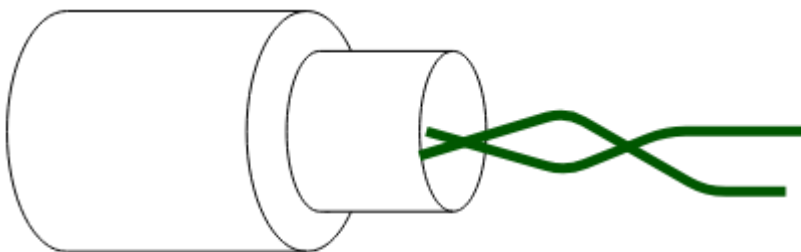
Unshielded Twisted Pair

Advantages:

- Least expensive
- Easy to install
- High speed capacity
- Susceptible to external interference
- Lower capacity and performance in comparison to STP
- Short distance transmission due to attenuation

Shielded Twisted Pair (STP):

This type of cable consists of a special jacket to block external interference. It is used in fast-data-rate Ethernet and in voice and data channels of telephone lines.



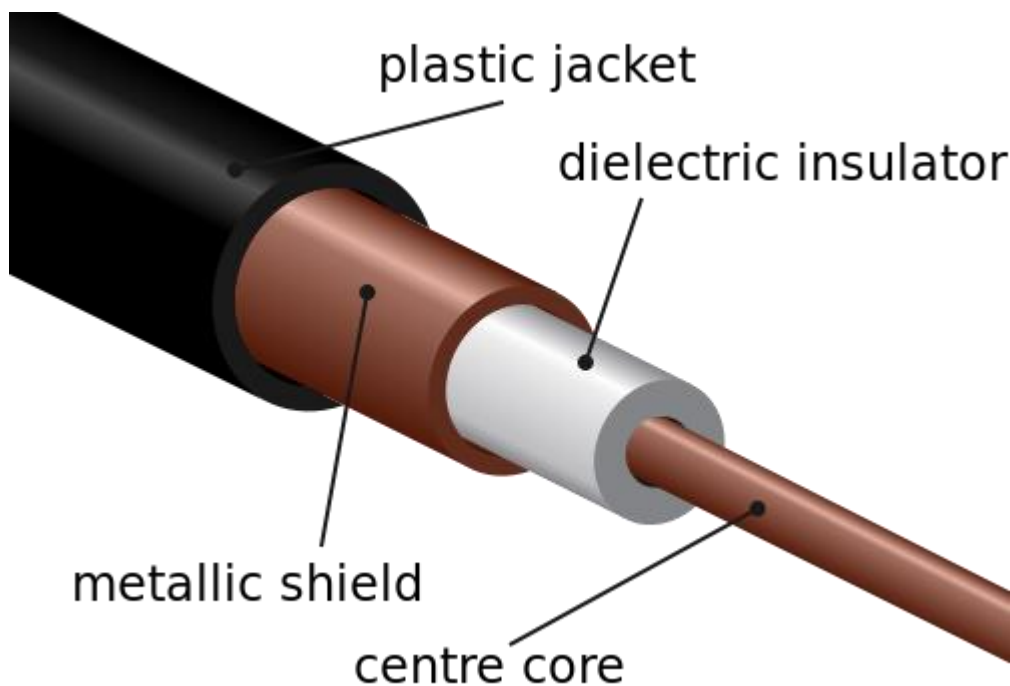
Shielded Twisted Pair

Advantages:

- Better performance at a higher data rate in comparison to UTP
- Eliminates crosstalk
- Comparatively faster
- Comparatively difficult to install and manufacture
- More expensive
- Bulky

(ii) **Coaxial Cable –**

It has an outer plastic covering containing 2 parallel conductors each having a separate insulated protection cover. Coaxial cable transmits information in two modes: Baseband mode(dedicated cable bandwidth) and Broadband mode(cable bandwidth is split into separate ranges). Cable TVs and analog television networks widely use Coaxial cables.



Advantages:

- High Bandwidth
- Better noise Immunity
- Easy to install and expand

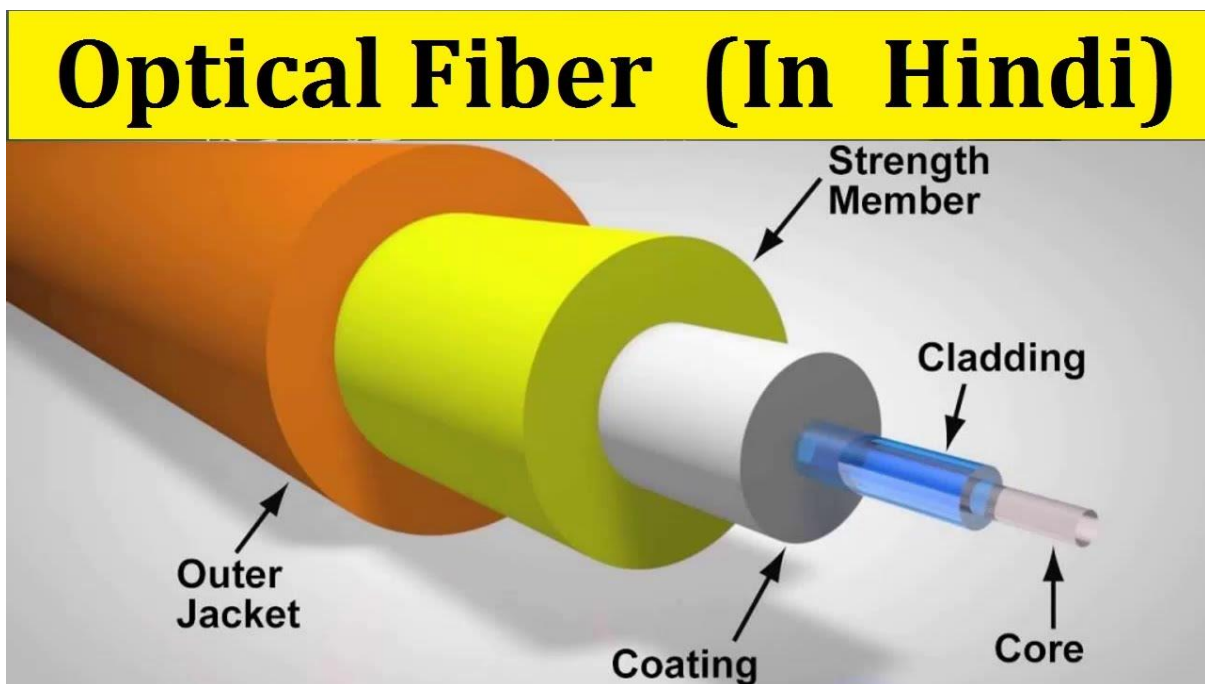
- Inexpensive

Disadvantages:

- Single cable failure can disrupt the entire network

(iii) Optical Fibre Cable –

It uses the concept of reflection of light through a core made up of glass or plastic. The core is surrounded by a less dense glass or plastic covering called the cladding. It is used for transmission of large volumes of data. The cable can be unidirectional or bidirectional. The WDM (Wavelength Division Multiplexer) supports two modes, namely unidirectional and bidirectional mode.



Advantages:

- Increased capacity and bandwidth
- Light weight
- Less signal attenuation
- Immunity to electromagnetic interference

- Resistance to corrosive materials

Disadvantages:

- Difficult to install and maintain
- High cost
- Fragile

2. Unguided Media:

It is also referred to as Wireless or Unbounded transmission media. No physical medium is required for the transmission of electromagnetic signals.

Features:

- Signal is broadcasted through air
- Less Secure
- Used for larger distances

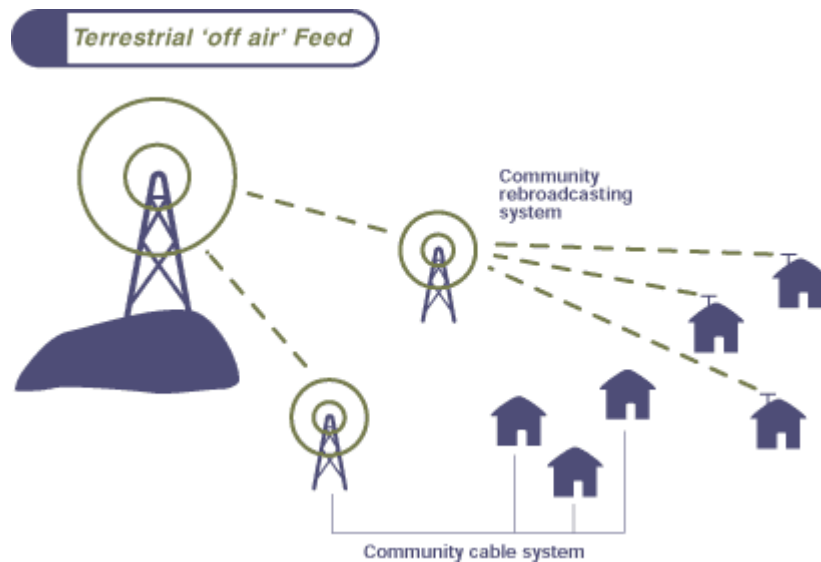
There are 3 major types of Unguided Media:

(i) Radiowaves –

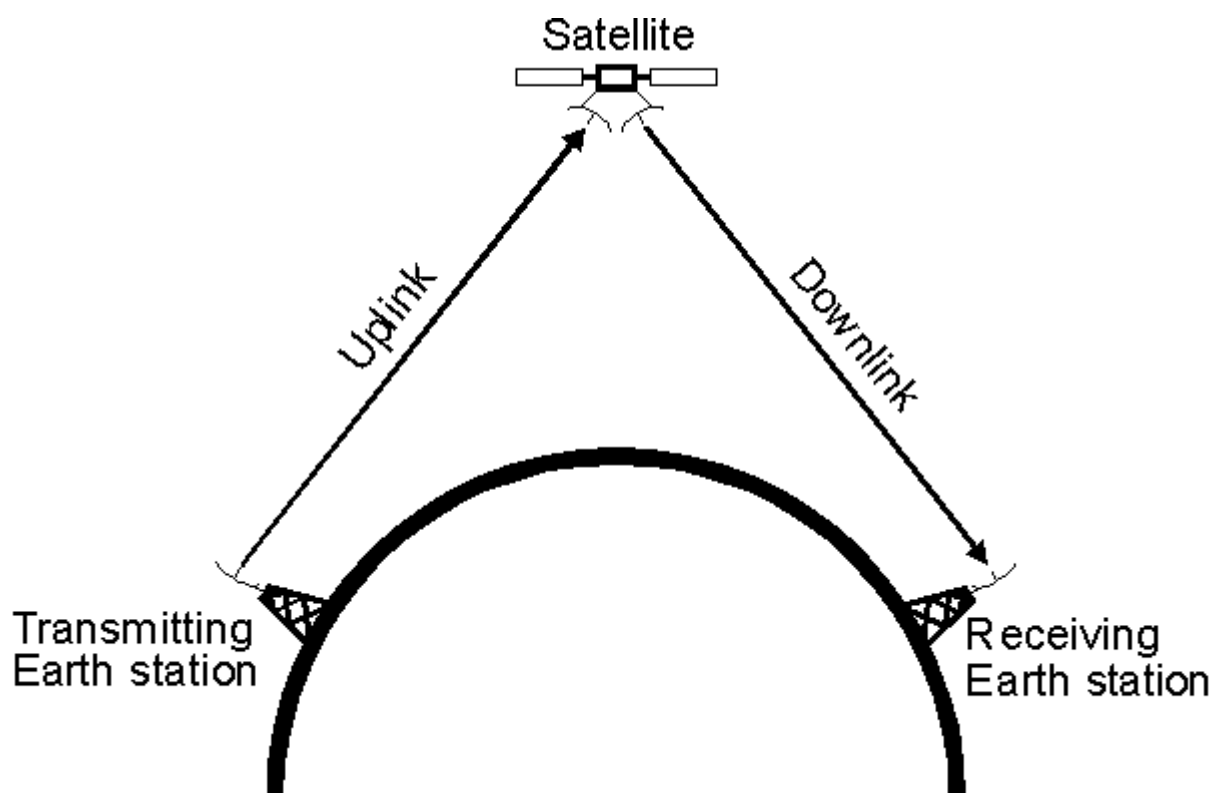
These are easy to generate and can penetrate through buildings. The sending and receiving antennas need not be aligned. Frequency Range: 3KHz – 1GHz. AM and FM radios and cordless phones use Radiowaves for transmission.

Further Categorized as

(i) Terrestrial and



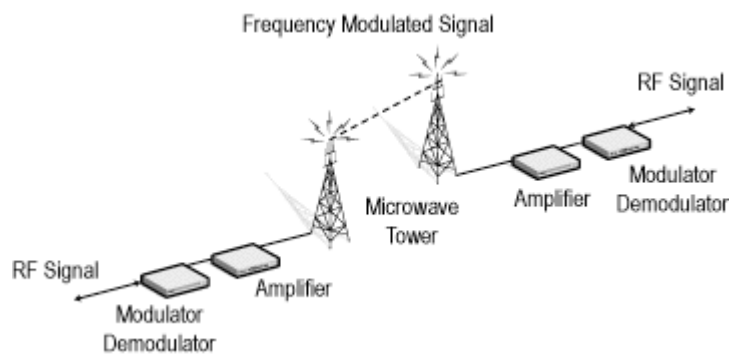
(ii) Satellite.



(ii) Microwaves –

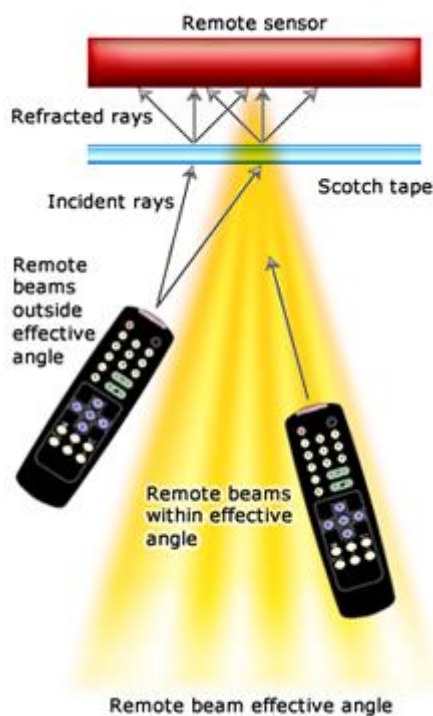
It is a line of sight transmission i.e. the sending and receiving antennas need to be properly aligned with each other. The distance covered by the signal is directly proportional to the

height of the antenna. Frequency Range:1GHz – 300GHz. These are majorly used for mobile phone communication and television distribution.



(iii) Infrared –

Infrared waves are used for very short distance communication. They cannot penetrate through obstacles. This prevents interference between systems. Frequency Range:300GHz – 400THz.



What is Signal?

A signal is an electrical or electromagnetic current that is used for carrying data from one device or network to another.

It is the key component behind virtually all:

- Communication
 - Computing
 - Networking
 - Electronic devices
- o a signal is created when a command or data is sent to a device.
 - o It has implementation in electrical and electronic components as well, but it mainly refers to analog and digital communication technologies and devices.
 - o Each signal carries data in some form.
 - o The data is fed into the signal using analog or digital modulation techniques, depending upon the source and destination device and/or medium.

A signal can be either analog or digital.

What is Analog and Digital Signal?

Analog and digital signals are different types which are mainly used to carry the data from one apparatus to another. Analog signals are continuous wave signals that change with time period whereas digital is a discrete signal in nature. The main difference between analog and digital signals is, analog signals are represented with the sine waves whereas digital signals are represented with square waves. Let us discuss some dissimilarity of analog & digital signals. The best example of an analog and digital is electronics because it deals with analog as well as digital signals, input & outputs. In some way, an electronics project mainly interacts by the real analog world whereas digital signals with computers, microprocessors, and logic units. These two kinds of signals are similar to different electronic languages. As some of the other languages can only recognize as well as speak one of the two. This article discusses an overview of both analog as well as digital signals, and comparison between them.

An analog signal is one type of continuous time-varying signals, and these are classified into composite and simple signals. A simple type of analog signal is nothing but a sine wave, and that can't be decomposed, whereas a composite type analog signal can be decomposed into numerous sine waves. An analog signal can be defined by using amplitude, time period otherwise frequency, & phase. Amplitude streaks the highest height of the signal, frequency streaks the rate at which an analog signal is varying, and phase streaks the signal position with respect to time nothing. An analog signal is not resistant toward the noise, therefore; it faces distortion as well as reduces the transmission quality. The analog signal value range cannot be fixed.

Similar to analog, digital signals carry the data although it is a bit different. These signals are discrete or not continuous. A digital signal carries the data in the form of binary because it signifies in the bits. These signals can be decomposed into sine waves which are termed as harmonics. Every digital signal has amplitude, frequency, & phase like the analog signal. This signal can be defined by bit interval as well as bit rate. Here, bit interval is nothing but the required time for transmitting an only bit, whereas the bit rate is bit interval frequency.

Digital signals are more resistant toward the noise; therefore, it barely faces some distortion. These waves are simple in transmitting as well as more dependable while contrasted to analog waves. Digital signals include a limited variety of values which lies among 0-to-1.

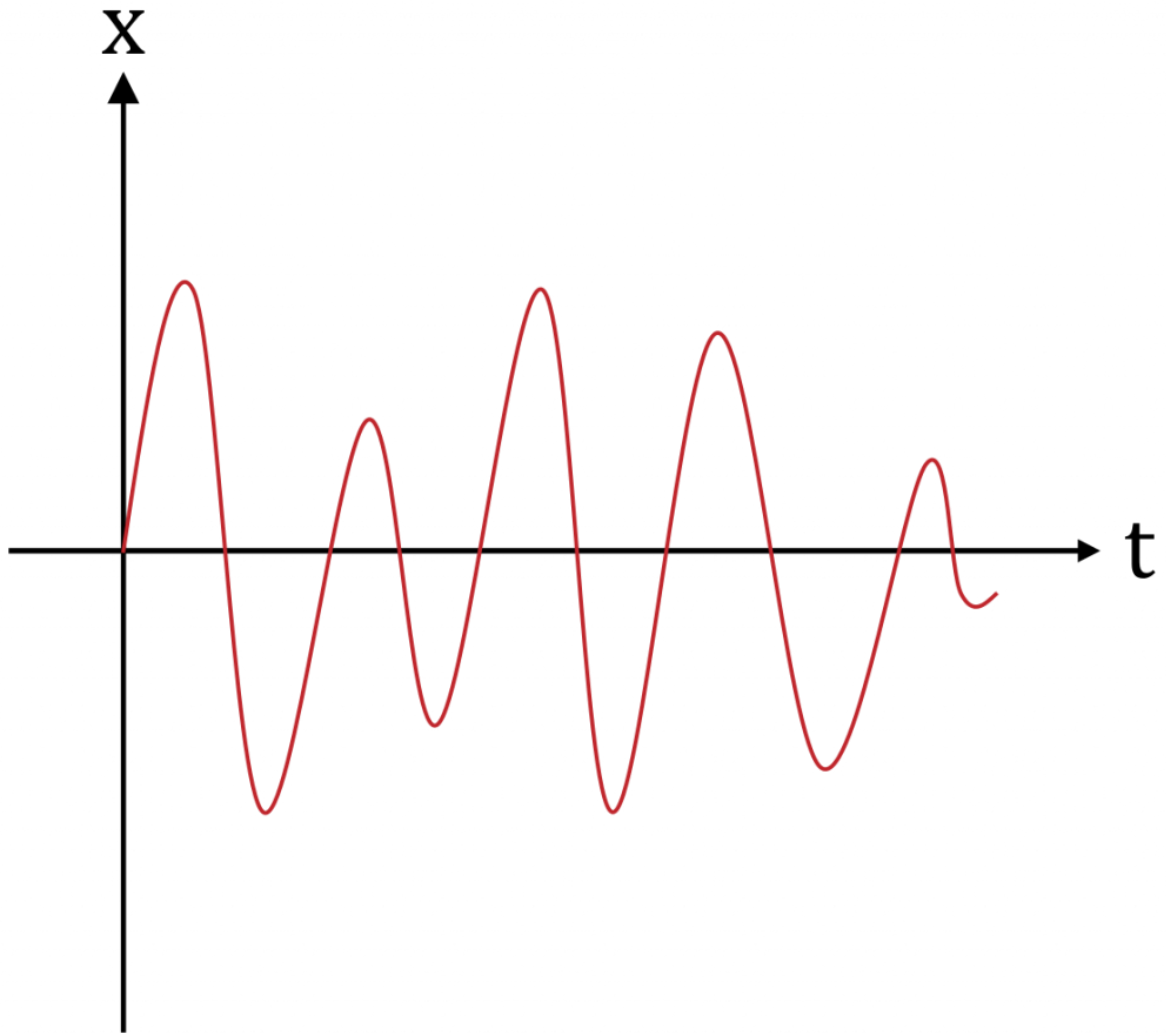


Fig. Analog Signal

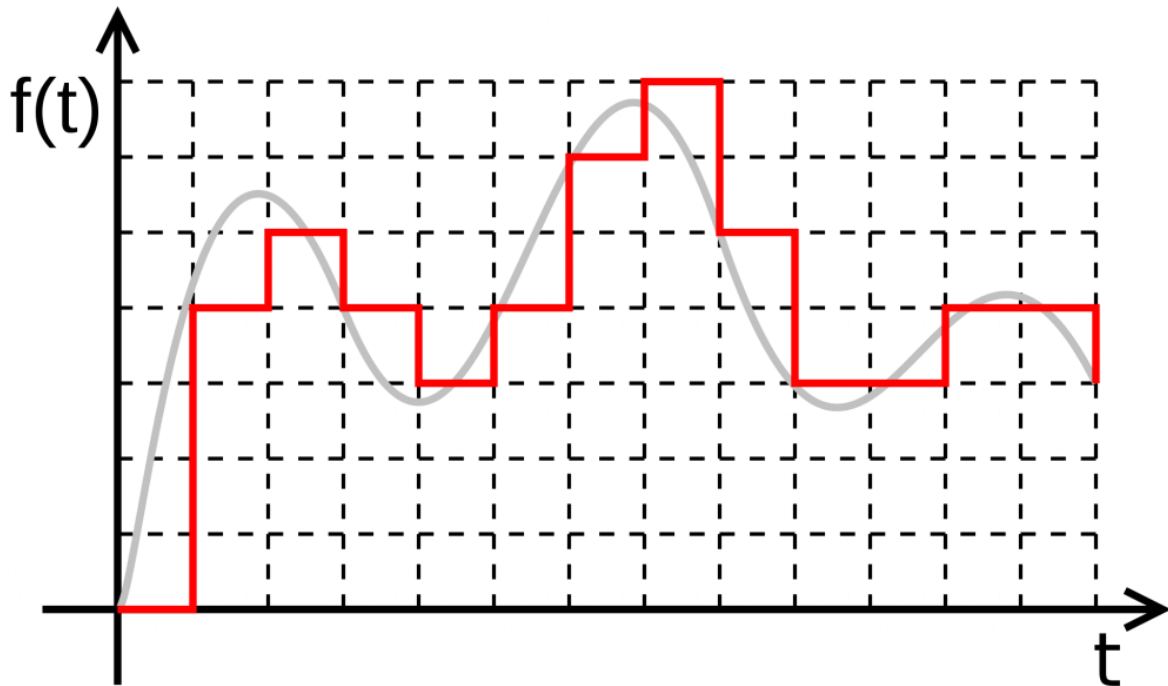


Fig Digital Signal

Characteristics of Analog and Digital Signals

The analog and Digital signal characteristics mainly include adaptability, continuity, representation, data type, signal type, medium of transmission, type of values, security, bandwidth, hardware, data storage, portability, data transmission, impedance, power consumption, recording data, use, rate of data transmission, examples and applications.

Adaptability : Analog signals are less adjustable for a range of use, whereas digital signals are more adjustable for a range of use.

Continuity : Analog signals use a continuous variety of amplitude values whereas digital signal takes a limited set of distinct values at consistently spaced spots in the time.

Type of Data : Analog signals are continuous in nature, whereas digital signals are discrete.

Type of Waves : Analog signal wave type is sinusoidal, whereas a digital signal is a square wave.

Medium of Transmission : Analog signal medium of transmission is wire or wireless, whereas a digital signal is a wire.

Type of Values : Analog signal value type if positive as well as negative, whereas a digital signal is positive.

Security : The security of an analog signal is not encrypted, whereas a digital signal is encrypted.

Bandwidth : The analog signal bandwidth is low, whereas the digital signal is high.

Hardware : Analog signal hardware is not elastic, whereas digital is elastic in execution

Data Storage : The data storage of an analog signal is in the wave signal form, whereas digital signal stores the data in the binary bit form.

Portability : Analog signals are portable similar to the thermometer and low cost, whereas digital signals are portable similar to computers and expensive.

Data transmission : In analog, the signal can be deterioration due to noise throughout transmission, whereas digital signal can be noise resistant throughout transmission devoid of any deterioration.

Impedance : The impedance of the analog signal is low, whereas the digital signal is high.

Power Consumption : Analog devices use more power, whereas digital devices use less power.

Data Transmission Rate : The data transmission rate in the analog signal is slow, whereas in the digital signal it is faster.

Examples : The best examples of the analog signal are video, human voice in the air, radio transmission waves or TV transmission waves.

Applications

Analog signals can be utilized in analog devices exclusively, thermometer, whereas digital signals are appropriate for digital electronic devices like computers, PDA, cell phones.

Key Differences between Analog and Digital Signals

The key difference between analog and digital signals in tabular form is shown below.

Analog Signal	Digital Signal
An analog signal signifies a continuous signal that keeps changes with a time period.	A digital signal signifies a discrete signal that carries binary data and has discrete values.
Analog signals are continuous sine waves	Digital signal is square waves.
Analog signals describe the behavior of the wave with respect to amplitude, time period, & phase of the signal.	Digital signals describe the behavior of the signal with respect to the rate of a bit as well as bit interval.
Analog signal range will not be set.	Digital signal is limited as well as ranges from 0 to 1.
Analog signal is further horizontal toward distortion during the response to noise	A digital signal has resistance in response toward the noise, therefore, it does not often face distortion.
An analog signal broadcasts the information in the signal form.	A digital signal broadcasts the information in the form of binary that is bits.
The example of an analog signal is the human voice	The example of a digital signal is the data transmission in a computer.

Advantages of Digital Signal Over Analog Signal

There are several advantages using digital signal over an analog signal.

- Digital signals are more secure, and they do not get damaged by noise.
- These signals use low bandwidth
- They allow the signals transmitted over a lengthy distance.

- Digital signal has a higher rate transmission
- By using these signals, we can translate the messages, audio, video into device language.
- Digital signals enable the transmission of multidirectional concurrently.