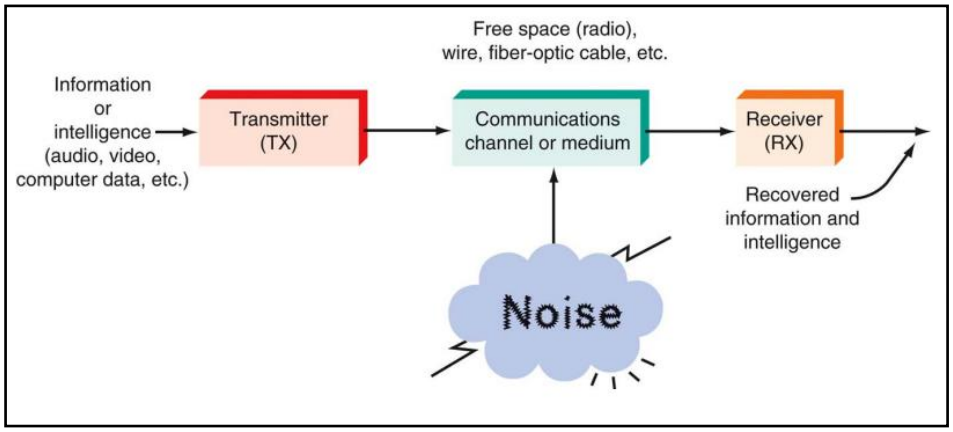
Communications

Elements of communication system

The purpose of a communication system is to transmit information bearing signals through a communication channel. Three basic blocks in any communication system are: 1) Transmitter 2) Communication medium or Channel and 3) Receiver.

The transmitter puts the information from the source onto the channel. The channel is the medium connecting the transmitter and the receiver and the transmitted information travels through this channel until it reaches the destination.



The figure depicts the elements of a communication system viz., transmitter, transmission channel and receiver. Each part plays a particular role in signal transmission, as explained below.

The transmitter processes the input signal to produce a suitable transmitted signal suited to the characteristics of the transmission channel. These signals propagate through medium two important things happen, 1. Signal strength is attenuated and 2. Noise is picking up by these signals. Noise is random, undesirable electronic energy that enters the communication system via the communicating medium and interferes with the transmitted message. The other end of communication is receiver which performs the following functions.

1. Interception of signal
2. Selection of desired signal by using tuned circuit and mixer.
3. Amplification of these selected signals.
4. Detection of useful information.
5. Amplification of extracted signal and convert into standard signal.

Types of Communication

Electronic communication system can be classified into three types as follows

1**.** According to facility like one way or two way communication

2. According to nature of signal

3. According to process of transmission

1. According to facility – Simplex and Duplex communication

Simplex communication – The one way communication is called as simplex communication. In this type the information is travelled only in one direction. E. g. T. V. and radio communication.

Duplex communication - The two way communication is called as duplex communication. In this type the information is travelled in both directions. Duplex communication is divided into two types

1. ***Half duplex* –** If only one end is transmitting the information at a time or both end transmits alternately is called as half duplex communication.

Example – Radio set in the hands of police or military persons, FAX machine.

2. ***Full duplex* –** If both the ends transmits or receives information at a time is called as full duplex communication. In this type the information is travelled in both directions.

Example – land line phone, cell phone, satellite communication

2. **According to nature of signal**

1. **Analog communication –** If the signal is continuously varying in voltage is known as analog signal and such signal is used for communication is called as analog communication.

Examples are Audio signal, sine wave, and decimal number system.

2. **Digital communication –** If the signal has only two values low or high is known as digital signal and such signal is used for communication is called as digital communication.

Examples are square wave, and binary number system.

3. According to process of transmission

1. **Base band communication –** When the communication system uses transmission of information directly into medium is called base band communication. Example is land line phone

2. **Modulated communication –** The original message signals usually contain frequencies in the low frequency or audio frequency range. Therefore, some form of frequency band shifting (converting to high frequency range) is necessary in order to make the signals suitable for transmission. This shifting in the range of frequencies is achieved by the process known as modulation. When the communication system transmits information through modulation process is called modulated communication.

Necessity of modulation

The message signals have a very low frequency due to which these signals cannot be transmitted over long distances. Hence such low-frequency message signals are modulated over the high-frequency carrier signal due to the following reasons:

1. Practical Length of Antenna:

For the effective transmission of a signal, the height ***h*** of the antenna should be comparable to the wavelength λ of the signal at least the height of the antenna ***h*** should be $\lambda / 4$ in length so that the antenna can sense the variations of the signal properly.

The low-frequency message signal has a very high value of λ which will require a very high antenna (practically not possible). Hence, we need to modulate the message signal over the high-frequency carrier signal so that we can have a practical value for the height ***h*** of the antenna.

2. Interference

If the signal is directly send then it would easily interfere with other signals. However by using high frequency carrier signal the mixing of signal can be prevented. Thus modulation ensures those signals received by receiver are entirely perfect.

3. **Poor reception –**

Power radiated by an antenna $\propto (l / \lambda)^2$ where ***l*** is the length of the antenna and λ is the wavelength of the signal which is to be transferred through the antenna. This relation clearly shows that when signals having a low frequency and high wavelength are transmitted directly the power radiated by the antenna is very low and the signal will vanish after traveling some distance. Hence, to transmit such signals over long distances, we superimpose these low-frequency signals over the carrier signal having a high frequency and short wavelength so that the power radiated by the antenna of the same length will be very large.

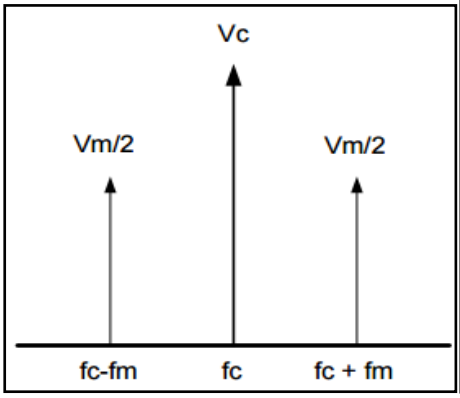
Modulation

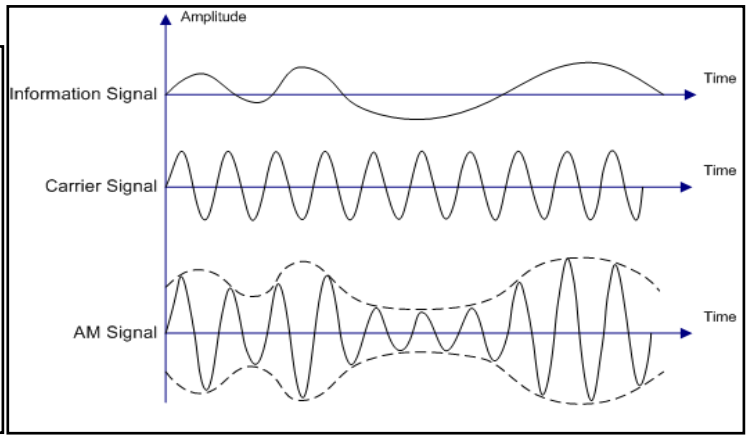
The process in which either of characteristics of high frequency carrier wave is varied in accordance with instantaneous amplitude of modulating signal, keeping other characteristics constant is known as modulation.

Amplitude Modulation (AM)

As the name suggests, in AM, the information signal varies the amplitude of the carrier sine wave. *The instantaneous value of the carrier amplitude changes in accordance with the amplitude variations of the modulating signal by keeping other parameters constant.* The carrier frequency remains constant during the modulation process, but its amplitude

varies in accordance with the modulating signal. An increase or a decrease in the amplitude of the modulating signal causes a corresponding increase or decrease in both the positive and the negative peaks of the carrier amplitude.





Using trigonometric functions, we can express the sine wave carrier and modulating wave with the simple expression

$$E_c = V_c \sin \omega_c t$$

$$E_m = V_m \sin \omega_m t$$

Amplitude of carrier signal will made proportional to the amplitude of modulating signal $V_m\ 2\pi\omega_m\ t$. The resultant amplitude of AM signal is given as,

$$A = E_c + E_m$$

$$A = V_c + V_m \sin \omega_m t$$

$$A = V_c \left[1 + \frac{V_m}{V_c} \sin \omega_m t \right]$$

$$A = V_c [1 + m \sin \omega_m t]$$

Where, $m = \frac{V_m}{V_c} = modulation\ index$

The resultant amplitude modulation is,

$$E_{AM} = A \sin \omega_c t$$

$$E_{AM} = V_c [1 + m \sin \omega_m t] \sin \omega_c t$$

$$E_{AM} = V_c \sin \omega_c t + m V_c \sin \omega_m t \sin \omega_c t$$

$$\sin A . \sin B = \frac{1}{2} [\cos(A - B) - \cos(A + B)]$$

$$E_{AM} = V_c \sin \omega_c t + \frac{m V_c}{2} \cos(\omega_c t - \omega_m t) - \frac{m V_c}{2} \cos(\omega_c t + \omega_m t)$$

The resultant signal possesses three frequencies

1) Original carrier frequency = ω_c 2) Upper side band $(\omega_c + \omega_m)$ 3) Lower side band $(\omega_c - \omega_m)$

That is AM signal consist of bandwidth. It is double of highest modulating frequency.

$$Band\ width = 2\ f_m$$

Modulation index tells about the quality of transmitted signal and usually expressed in percentage.

$$\%\ modulation\ index = \%\ m = \frac{peak\ amplitude\ of\ modulating\ signal}{peak\ amplitude\ of\ carrier\ signal}\ x\ 100$$

$$\%\ modulation\ index = \%\ m = \frac{V_m}{V_c}\ x\ 100$$

Significance of modulation index

If m < 1, means the resultant signal is undistorted but strength is very weak.

If m = 1, we get maximum strength of audio signal.

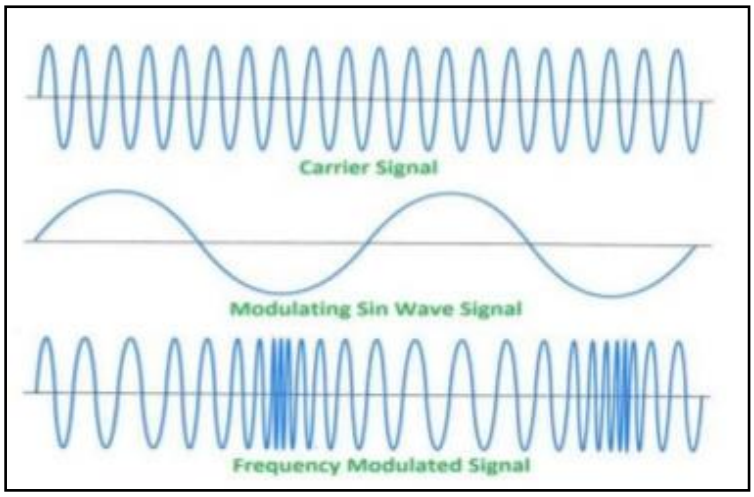
If m > 1, the resultant signal produces distortion.

Advantages and Disadvantages of Amplitude Modulation

Advantages	Disadvantages
Amplitude Modulation is easier to implement.	When it comes to power usage it is not efficient.
Demodulation can be done using few components and a circuit.	It requires a very high bandwidth that is equivalent to that of the highest audio frequency.
The receiver used for AM is very cheap.	Noise interference is highly noticeable.

Frequency Modulation

As the name suggests, in FM, the information signal varies the frequency of the carrier sine wave. *The instantaneous value of the carrier frequency changes in accordance with the amplitude variations of the modulating signal by keeping other parameters constant*. The carrier amplitude remains constant during the modulation process, but its frequency varies in accordance with the modulating signal. An increase or a decrease in the amplitude of the modulating signal causes a corresponding increase or decrease in frequency of carrier.

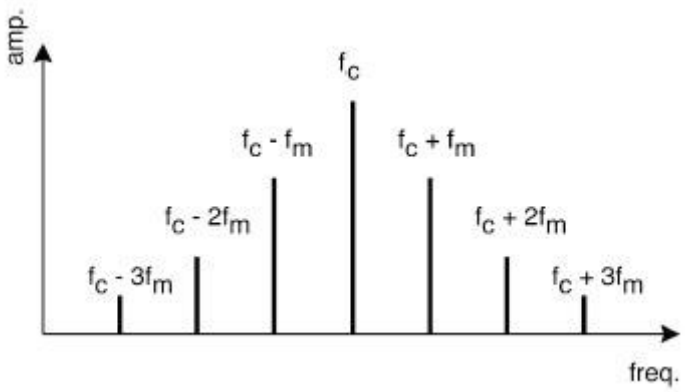


Frequency Deviation – The unmodulated carrier in FM is known as resting frequency or centre frequency. When amplitude of modulating signal varies carrier changes its frequency above or below the centre frequency from some minimum value to maximum value. $F_{max.}$ to $F_{min.}$ known as carrier swing.

$$F_{max} = F_c + \Delta F \quad and\ F_{min} = F_c - \Delta F$$

Modulation index –

$$\%\, m = \frac{maximum\ frequency\ deviation}{maximum\ modulating\ signal}\ x\ 100 = \frac{\Delta F}{f_{max}} x\ 100$$



Advantages of Frequency Modulation over Amplitude Modulation:

- The amplitude of an FM wave remains constant over time. This allows the encoders and decoders the freedom to remove the noise from the received signal. FM systems are noise immune systems. Since the AM signal transferred information using the amplitude, the envelope of the waveform cannot be altered.
- In AM systems, the power consumption for signal transmission is higher when compared to FM systems. FM is usually more power-efficient than AM systems.

- The baseband signal can be easily retrieved from the FM signals. In AM systems, the only method of reducing noise in the transmission is the increase in the transmitted power of the signal. This increases the cost of operation of the AM system.
- In an AM system, there is no guard band in between two adjacent channels. This seriously increases the occurrence of interference of AM radio station unless one signal is strong enough to overpower the other. Whereas in the case of FM signal, the adjacent FM channels are separated by guard bands which results in very little interference between adjacent FM channels.

Disadvantages of Frequency Modulation over Amplitude Modulation:

- The equipment cost of an FM channel is more since the equipment is much more complex and involves complicated circuitry. As a result FM systems are costlier than AM systems.
- FM systems work using line of sight propagation whereas AM systems use sky wave propagation. Consequently, the receiving area of an FM system is much smaller than that of an AM system.
- In an FM system, there is an infinite number of sidebands resulting in a theoretical bandwidth of an FM signal being infinite. In an AM system, the bandwidth is only twice the modulation frequency. This is another reason why FM systems are costlier than AM systems.

Super heterodyne Receiver

The super heterodyne receiver operates by taking the signal on the incoming frequency, mixing it with a variable frequency locally generated signal to convert it down to a frequency where it can pass through a high performance fixed frequency filter before being demodulated to extract the required modulation or signal.

The receiver circuit can be divided into following stages:

Antenna – It intercept radio signal (electromagnetic waves) transmitted by various radio stations and convert into electrical waves.

R. F. Stage – It is tuned RF amplifier having LC tuned circuit. It selects the desired station frequency and amplifies weak received signal.

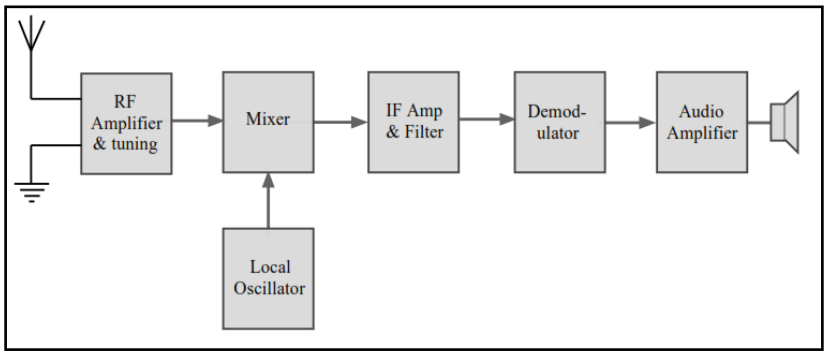
Mixer Stage - The amplified tuned frequency is converted into medium fixed frequency called as intermediate frequency (IF) by mixing it with appropriate local oscillator frequency. This action is called heterodyne action.

IF Stage – The output of mixer is amplified by two or more stages of I. F. amplifiers to get better selectivity, sensitivity and fidelity.

Detector Stage – The output of I. F. amplifier is modulated signal. It is demodulated by this circuit and detect audio signal. This stage is also known as demodulator stage.

A. F. amplifier stage – The detected audio signals are amplified by using push pull power amplifier and connected to the loud speaker.

Loud speaker – It converts audio electric signal into sound signal.



Satellite Communication

Satellite communication is the method of transporting information from one place to another using a communication satellite in orbit around the Earth.

A communication satellite is an orbiting artificial earth satellite that receives a communications signal from a transmitting ground station, amplifies and possibly processes it, then transmits it back to the earth for reception by one or more receiving ground stations.

Today's communications satellites offer extensive capabilities in applications involving data, voice, and video, with services provided to fixed, broadcast, mobile, personal communications, and private networks users

The communication satellites are similar to the space mirrors that help us in bouncing the signals such as radio, internet data, and television from one side of the earth to another. There are three stages that are involved which explain the working of satellite communications. These are:

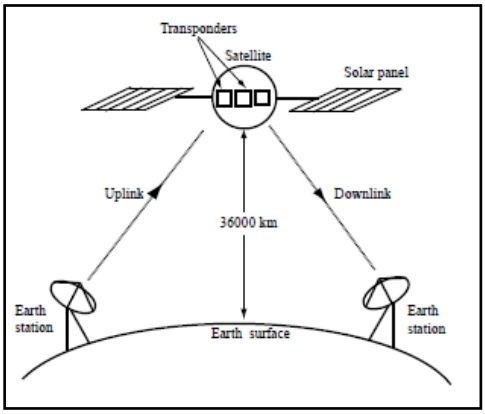
- Uplink
- Transponders
- Downlink

Let's consider an example of signals from a television. In the first stage, the signal from the television broadcast on the other side of the earth is first beamed up to the satellite from the ground station on the earth. This process is known as uplink.

The second stage involves transponders such as radio receivers, amplifiers, and transmitters. These transponders are used for boosting the incoming signal and to change

their frequency so that the outgoing signals are not altered. Depending on the incoming signal sources, the transponders vary.

The final stage involves a downlink in which the data is sent to the other end of the receiver on the earth. It is important to understand that usually there is one uplink and multiple downlinks.



Geostationary or geosynchronous earth orbit (GEO)

GEO satellites are synchronous with respect to earth. Looking from a fixed point from Earth, these satellites appear to be stationary. These satellites are placed in the space in such a way that only three satellites are sufficient to provide connection throughout the surface of the Earth (that is; their footprint is covering almost 1/3rd of the Earth). The orbit of these satellites is circular. There are three conditions which lead to geostationary satellites. Lifetime expectancy of these satellites is 15 years.

1) The satellite should be placed 35,786 kms (approximated to 36,000 kms) above the surface of the earth.

2) These satellites must travel in the rotational speed of earth, and in the direction of motion of earth, that is eastward.

3) The inclination of satellite with respect to earth must be 0^0.

Applications of Satellite Communication

1) **Weather Forecasting:** Certain satellites are specifically designed to monitor the climatic conditions of earth. They continuously monitor the assigned areas of earth and predict the weather conditions of that region. This is done by taking images of earth from the satellite. These satellites are exceptionally useful in predicting disasters like hurricanes, and monitor the changes in the Earth's vegetation, sea state, ocean color, and ice fields.

2) Radio and TV Broadcast: These dedicated satellites are responsible for making 100s of channels across the globe available for everyone. They are also responsible for broadcasting

live matches, news, world-wide radio services. These satellites require a 30-40 cm sized dish to make these channels available globally.

3) Military Satellites: These satellites are often used for gathering intelligence, as a communications satellite used for military purposes, or as a military weapon.

4) Navigation Satellites: The system allows for precise localization world-wide, and with some additional techniques, the precision is in the range of some meters. Ships and aircraft rely on GPS as an addition to traditional navigation systems.

5) Global Telephone: One of the first applications of satellites for communication was the establishment of international telephone backbones.

6) Connecting Remote Areas: Due to their geographical location many places all over the world do not have direct wired connection to the telephone network or the internet (e.g., researchers on Antarctica) or because of the current state of the infrastructure of a country.

7) Global Mobile Communication: The basic purpose of satellites for mobile communication is to extend the area of coverage.

RADAR (RAdio Detection and Ranging)

RADAR is an acronym for Radio Detection and Ranging. It is an electronic system used to detect, locate or measure the velocity of targets. *It collects information about distant objects or targets by sending electromagnetic waves to them and thereafter analyzing reflected waves or the echo signals from the objects.* Radar can detect static or mobile objects in various conditions such as darkness, rain, fog and snow. The frequencies used by radar lies in the upper UHF and microwave range.

The basic principle of radar can be explained with the help of the block diagram as shown in figure. It consists of a transmitter and a receiver, each connected to a directional antenna. The transmitter generates high power modulated signal and transmits through the antenna. The duplexer allows the use of a single antenna for transmission and reception and also separates transmitter and receiver from each other. During transmission, the duplexer disconnects the receiver and connects the transmitter to the antenna. The antenna radiates electromagnetic waves and these waves strike on a distant target which can reflect (echo) some of energy back to the same antenna. After transmission, the duplexer connects the antenna with the receiver and disconnects the transmitter. Then echo signals from the target are received by the receiver and processed to extract the required information. By noting the time taken for the signal to reach the target and echo signal to return back, the distance of the target can be calculated. The direction of the received echo signal gives an idea about the angular position of the target. It is also possible to detect the height, speed and direction of a

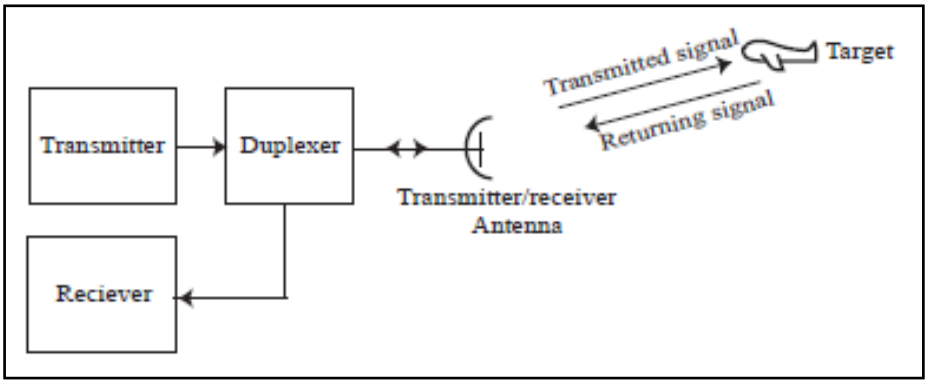
moving target. The display systems of radar provide the range information such as azimuth, altitude and distance of the target. Commonly used displays are Plan position Indicator (PPI) and Amplitude Scope.

Radar equation

A basic radar range equation is given below.

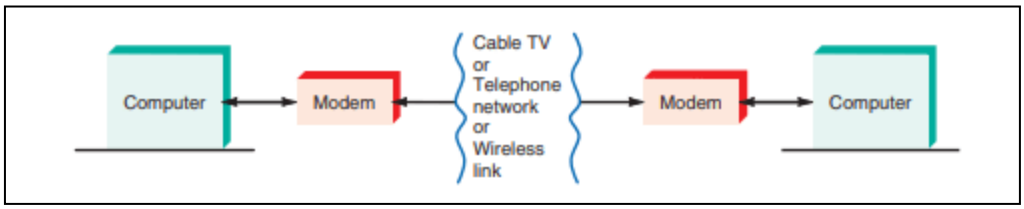
$$R = \frac{C\,T}{2}$$

Where, R = Range. C = Velocity of electromagnetic waves. T = Time elapsed between transmission and reception of signal.



MODEM (modulation – demodulation) technique

MODEM is a technique of using a telephone line for digital communication. If we want to use computer for long or short distance communication, the MODEM is the technique used to interconnect computers by using common media telephone line.



Using telephone line for direct transmission of the digital data, the main problem involved while using telephone line directly are –

Telephone line produces electrical disturbances

Capacity to transmit only audio signal having frequency range (300 Hz to 3KHz)

Analog circuit is not compatible for digital data transmission

Small band width

To overcome these difficulties a new technique is employed. MODEM it stands for Modulation – Demodulation technique. In this technique digital information is to be transmitted over long distance using telephone line by converting digital data into analog signal before transmission on telephone line using modulator. Modulation technique used

may be FSK type. At the receiving end, this analog modulated information is converted into original digital data by means of demodulator. MODEM is necessary at both ends.

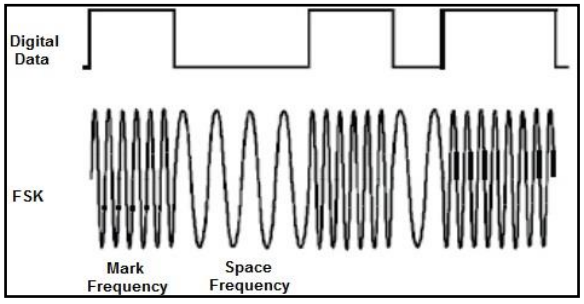
Applications of MODEM

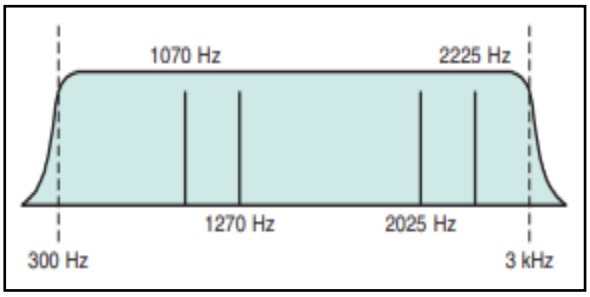
1. FAX communication
2. E mail Communication
3. Chat communication
4. Internet browsing

FSK Modulation (Frequency Shift Keying) technique –

FSK is a technique of sending digital data in the form of analog signal. FSK uses two analog signals. Bit 0 (known as space) = 1070 Hz and Bit 1 (known as mark) = 1270 Hz. These two frequencies lie in the voice signal range with sufficient frequency difference between 0 and 1. When MODEM converts digital data into analog modulated signal it transmit sequentially in the form of frequency shifted signal for bit o and bit 1.

The MODEM the another end uses frequencies 2025 Hz for bit 0 and 2225 Hz for bit 1 so that no interference is produced by each other. At both ends analog signal is converted into original digital signal using FSK demodulator.





Network in communication

A network is a communication system with two or more stations that can communicate with one another. When it is desired to have each computer communicate with two or more additional computers,

Each computer or user in a network is referred to as a node. The interconnection between the nodes is referred to as the communication link. In most computer networks, each node is a personal computer, but in some cases a peripheral device such as a laser printer or an embedded controller built into another piece of equipment can be a node. There are three basic types of electronic networks in common use: wide-area networks (WANs), metropolitan-area networks (MANs), local-area networks (LANs),

Local Area Networks:

A local area network (LAN) is a computer network that interconnects computers within a limited area such as a residence, school, laboratory, university campus or office building. LAN contains 10 to 1000 PCs interconnected with common control and storage. LANs, are privately owned networks within a single building or campus of up to a few kilometres in size.

The LAN will be made up from a variety of network components and may include a router, server, switches, computers, peripherals like printers, wireless access points and the like. LAN can provide common software program accessible to each and every node, common hardware like printer, hard disc etc. communication among nodes and common database.

LANs are distinguished from other kinds of networks by three characteristics:

(1) Their size,

(2) Their transmission technology, and

(3) Their topology.

Metropolitan Area Network (MAN):

This network is smaller than WAN and bigger than LAN. A metropolitan area network, or MAN, covers a city. The best known example of a MAN is the cable television network available in many cities. The communication link is through cable and one way.

Wide Area Network (WAN)

A wide area network, or WAN, spans a large geographical area, often a country or continent. It contain s a collection of machines intended for running user (i.e., application) programs. These machines are called as hosts. The hosts are connected by a communication subnet. The hosts are owned by the customers (e.g., people's personal computers), whereas the communication subnet is typically owned and operated by a telephone company or Internet service provider. In WAN; link may be established by using cable, microwave or may be satellite link or it can be combination of two or more. The railway / aero plane reservation system are examples of WAN.

In *Data Communications*, data generally are defined as information that is stored in digital form. Data communications is the process of transferring digital information between two or more points. Data communications can be summarized as the transmission, reception,

and processing of digital information. For data communications to occur, the communicating devices must be part of a communication system made up of a combination of hardware (physical equipment) and software (programs). The effectiveness of a data communications system depends on four fundamental characteristics: delivery, accuracy, timeliness, and jitter

Network Topology

Network system containing many nodes is physically interconnected in certain configuration to provide efficient communication. These configurations of interconnecting nodes in the network are known as network topology. The following points must be considered while selecting network topology.

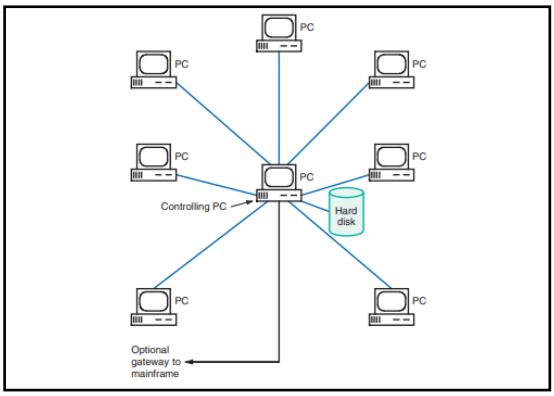
1. Cost of physical interconnection
2. Reliability and possibility of failure
3. Network controlling strategy

There are three important topologies commonly used as, star network topology, ring network topology and bus network topology.

Star Topology:

In a star topology, each device has a dedicated point to point link only to a central controller, usually called a hub. The devices are not directly linked to one another. A star topology does not allow direct traffic between devices. The controller acts as an exchange: If one device wants to send data to another, it sends the data to the controller, which then relays the data to the other connected device. A star topology is less expensive. In a star, each device needs only one link and one I/O port to connect it to any number of others. This factor also makes it easy to install and reconfigure. Far less cabling needs to be housed, and additions, moves, and deletions involve only one connection: between that device and the hub.

One big disadvantage of a star topology is the dependency of the whole topology on one single point, the hub. If the hub goes down, the whole system is dead. Each node must be linked to a central hub. For this reason, often more cabling is required in a star than in some other topologies (such as ring or bus).

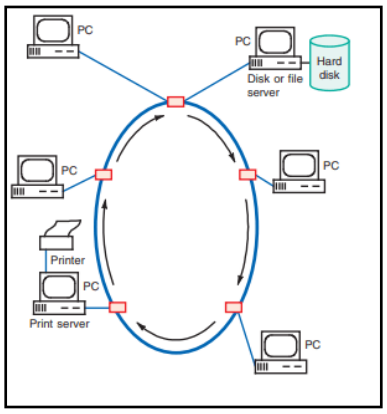


Ring Topology

A ring is relatively easy to install and reconfigure. Each device is linked to only its immediate neighbors (either physically or logically). To add or delete a device requires changing only two connections. The only constraints are media and traffic considerations (maximum ring length and number of devices). In addition, fault isolation is simplified. Generally in a ring, a signal is circulating at all times. If one device does not receive a signal within a specified period, it can issue an alarm. The alarm alerts the network operator to the problem and its location.

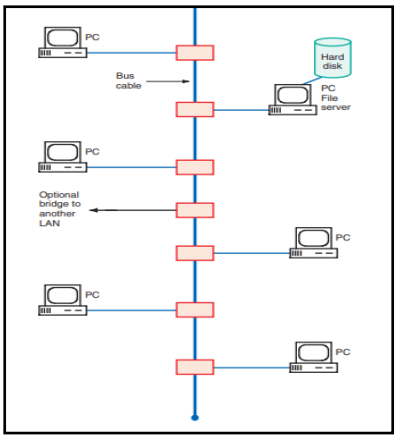
However, unidirectional traffic can be a disadvantage. In a simple ring, a break in the ring

(such as a disabled station) can disable the entire network.



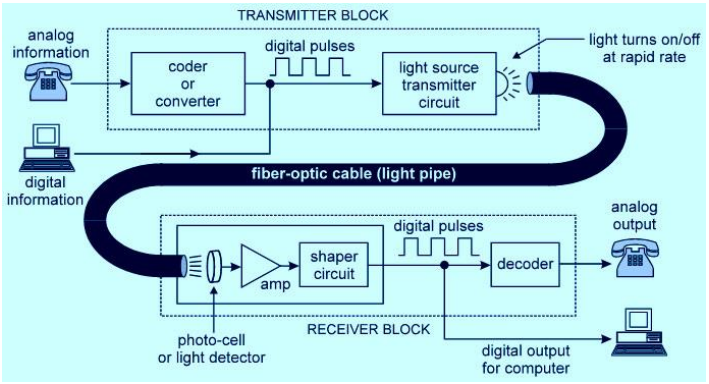
Bus topology

This topology is more reliable and efficient than star and ring topology also known as multi point or multi drop technology. A bus topology is a topology in which all the nodes are connected to a single cable it bidirectional communication. The cable to which the nodes connect is called a "backbone". If the backbone is broken, the entire segment fails. The main advantages are it is faster than other methods, direct communication between two stations without any control, can be extended, failure of any node does not affect other node communication.



Fiber optic communication

Fiber optics deals with study of propagation of light through transparent dielectric waveguides. The fiber optics is used for transmission of data from point to point location. The carrier frequencies used in conventional systems had the limitations in handling the volume and rate of the data transmission and external noise interference results in poor quality communication. The fiber optic cable has greater the carrier frequency larger the available bandwidth and information carrying capacity.



The **Optical fiber communication process** transmits a signal in the form of light which is first converted into the light from electrical signals and transmitted, and then vice versa happens on the receiving side.

This process can be explained using a diagram as shown below:

Transmitter side:

On the transmitter side, first if the data is analog, it is sent to a coder or converter circuit which converts the analog signal into digital pulses of 0,1,0,1…(depending on how the data is) and passed through a **light source transmitter circuit**. And if the input is digital then it is directly sent through the light source transmitter circuit which converts the signal in the form of light waves.

Optical Fiber Cable:

The light waves received from the transmitter circuit to the fiber optic cable is now transmitted from the source location to the destination and received at the receiver block.

Receiver Side:

Now on the receiver side the **photocell**, also known as the light detector, receives the light waves from the optical fiber cable, amplifies it using the amplifier and converts it into the proper digital signal. Now if the output source is digital then the signal is not changed further and if the output source needs analog signal then the digital pulses are then converted back to an analog signal using the decoder circuit.

The whole process of transmitting an electrical signal from one point to the other by converting it into the light and using Fiber optic cable as transmission source is known **as Optical Fiber Communication**.

Advantages -

- ✓ **Large Transmission capacity:** A single silica fiber can carry hundreds of thousands of telephone channels, utilizing only a small part of the theoretical capacity.
- ✓ **Small Losses:** Approximately 0.2 dB/km signal is lost for modern single mode silica fibers so that many tens of kilometers can be bridged without amplifying the signals.
- ✓ **Easy Amplification:** A large number of channels can be re-amplified in a single fiber amplifier if required for very large transmission distances.
- ✓ **Low Cost:** Due to the huge transmission rate achievable, the cost per transported bit can be extremely low.
- ✓ **Light Weight:** Compared with electrical cables, fiber-optic cables are very lightweight.
- ✓ **No Interference:** Fiber-optic cables are immune to problems that arise with electrical cables, such as ground loops or electromagnetic interference (EMI).
- ✓ **Transmission security –** Optical encryption and no presence of the electromagnetic signal make the data secure over optical fiber.

Applications –

Telephone Signals transmission.

Internet Communication.

Cable Television Signal transmission.

FAX communication

Fax (short for facsimile), sometimes called tele-copying or telefax (the latter short for telefacsimile), is the telephonic transmission of scanned printed material (both text and images), normally to a telephone number connected to a printer or other output device. The

original document is scanned with a fax machine (or a tele-copier), which processes the contents (text or images) as a single fixed graphic image, converting it into a bitmap, and then transmitting it through the telephone system in the form of audio frequency tones. The receiving fax machine interprets the tones and reconstructs the image, printing a paper copy.

Fax machines, because of their low cost and their reliability, speed, and simplicity of operation, revolutionized business and personal correspondence.

The main parts of FAX machine are:

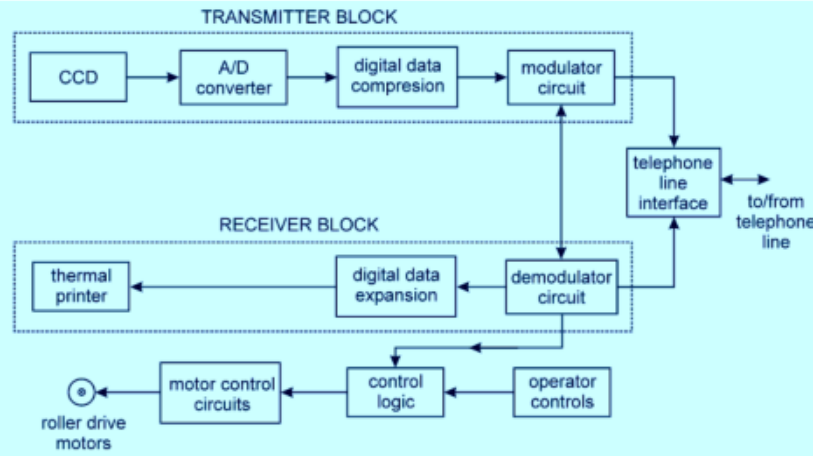
1. Optical scanner,
2. Photo sensor,
3. Modem and
4. Printer

1. Optical Scanner: It scans the document to be transmitted in form of white and black spots. Light from a strong source is made incident on the document. The part of the document where there is ink, reflected a very small amount of light, while the part where there is no ink, reflects a large amount of light. Generally the document is kept stationary and the scanning is done by moving the source of light. Thus we get a light signal of the document.

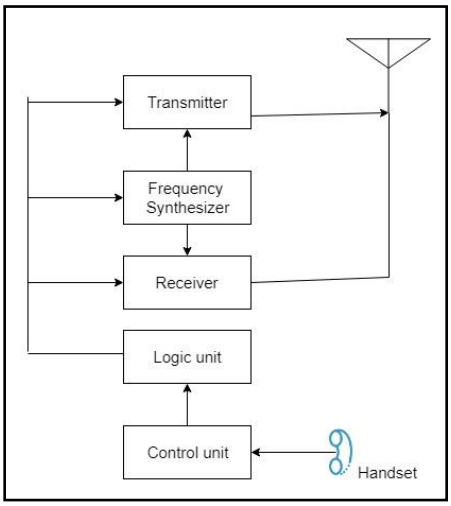
2. Photo sensor: It changes the light signal into the digital signal.

3. Modem: In the transmitter, the modem changes the digital signal into the analog signal, while in the receiver the modem changes the analog signal into digital signal again

4. Printer: It creates the photocopy of digital signal in the receiver. Thus is start with the sender dials the phone number of the Fax machine at the receiving end is set as the receiver. Then the document to be transmitted is fed into the Fax machine. The optical scanner scans the document and changes it to a light signal. The photo sensor then changes the light signal into the digital signal creating a high voltage pulse at more intensity of light and a low voltage pulse at less intensity of light. Then the modem inside the transmitting Fax machine converts the digital signal to the analog signal which are transmitted to the receiving Fax machine through the telescope line. At the receiving end, the modem in the Fax machine converts the analog signal back into the digital signal which is then printed by the printer in form of white and black spots to reproduce an exact copy of the original document.



Cellular Mobile communication system



Transmitter: It is low power FM unit operating in the frequency range of 825 to 845 MHz.. There are 666,30 KHz transmit channel. The carrier is furnished by a frequency synthesizer is a phase modulated by voice signal.

Receiver: The receiver is a dual conversion super heterodyne. the incoming signal frequency is down converted twice to frequency of 455 KHz or 10.7 MHz with the help of mixer and IF amplifier stages. The signal is then demodulated deemphasized and filtered and given to loud speaker.

Frequency synthesizer: The block generates all the signals used by transmitter and receivers. it uses standard PLL circuits and a mixer.

Logic Unit: This unit contains master control circuit for a cellular radio. It is made up of microprocessor with RAM and ROM and additional circuit used for interpreting signals from MSC and BS and generates control signal for the trannsmitter and receiver.

Control Unit: The control unit contains the handset with speaker and microphone. The control unit is operated by a separated microprocessor that drives the LCD display and other indicators.

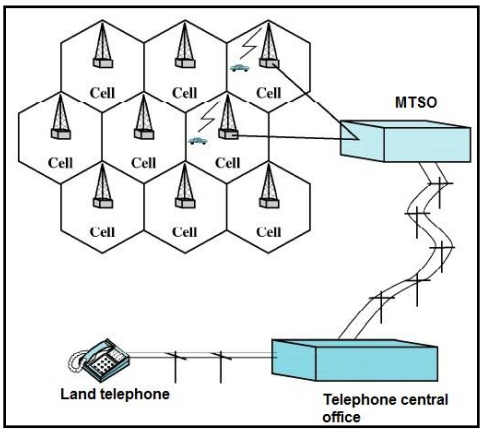
Features

1) Typical o/p power is 3 W if mobile unit is mounted on vehicle

2) o/p power is only 500Mw if it is a handheld unit

3) Transmitter is a low power FM unit operating in frequency range of 825 to 845 Mhz

4) It has 666 transmit channels which are spaced 30 Khz apart



Frequencies reuse technique in cellular mobile communication –

Frequency Reuse - Frequency reuse refers to the use of radio channels operating on the same frequency, to cover different areas, which are physically separate from each other.

In frequency reuse it is necessary to see that the co-channel interference is not objectionable.

Frequency reuse is an important concept because in this a single transmitter of higher power need not be used to cover the entire area. Instead many transmitter of small output power operating at the same frequency can be used.

This technique also reduces the minimum height of the transmitting antenna, because now each antenna has to cover a small area.

Frequency reuse is a very important concept of the cellular mobile radio system.

The users located in different geographical areas i.e. different cells can use the same frequency simultaneously.

The advantages of frequency reuse are that it drastically increases the spectrum efficiency but the disadvantage is that if the system is not designed properly then co-channel interference may take place.

We can use the concept of frequency reuse in either time domain or in the space domain. In the time domain the same frequency is used by different users in different time slots. This is called as time division multiplexing (TDM).