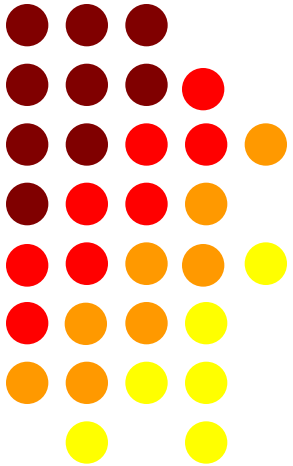
Lecture 35

Introduction of Communication system, different components of the system and their importance



Block Diagram of Communication System

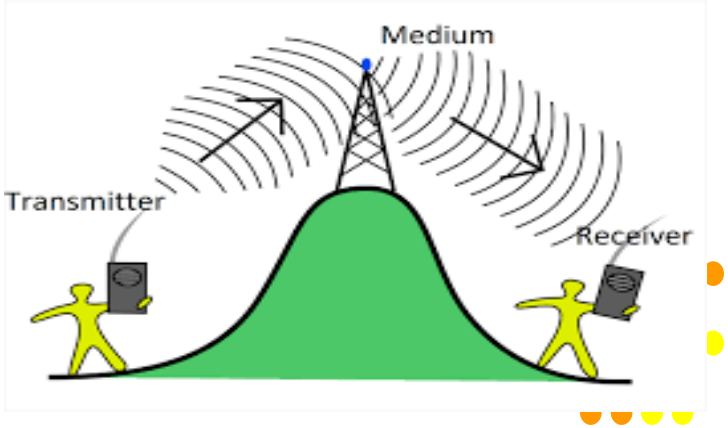
- Communication is the transfer of information from point A to point B using electricity or magnetism.

- Communication system can be divided into three parts:

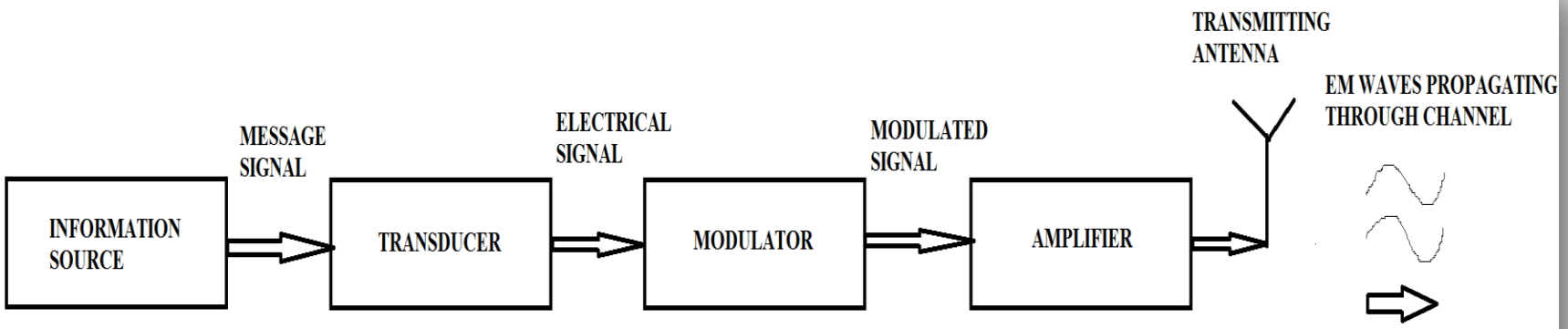
(i) Transmitter

(ii) Channel(Medium)

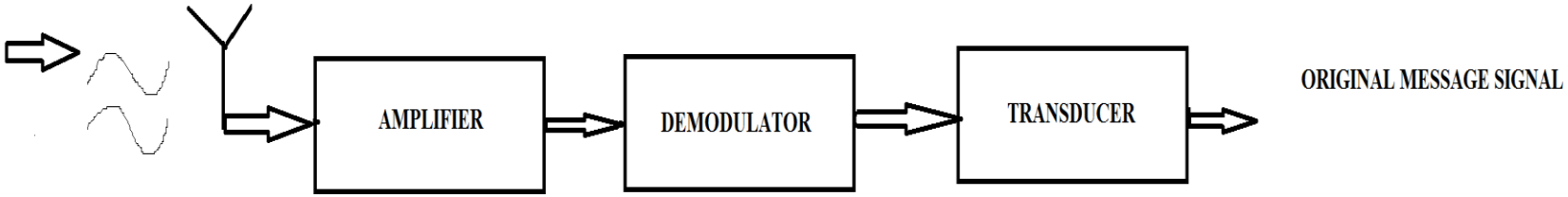
(iii) Receiver



BLOCK DIAGRAM OF COMMUNICATION SYSTEM



TRANSMITTER SECTION



RECEIVER SECTION

Transmitter Section

- The **transmitter section** consists of:

(i) **Information Source:** It is used to generate message signal which may be in the form of audio, video or data.

(ii) **Transducer:** It is a device which converts one form of energy into different form.

(iii) **Modulator:** Here message signal is superimposed on a high frequency carrier wave so that it can cover long distance.

(iv) **Amplifier:** This block is used to enhance the strength of the signal before transmission.

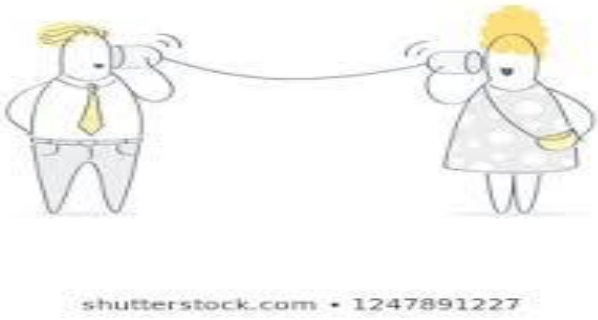
(v) **Transmitting Antenna:** It is used to convert electrical signal into electromagnetic waves which can travel in the atmosphere.

Channel Section

- The output of transmitter section travels through a path or medium to reach receiver. This path or medium is called channel.

- There are several types of channel such as:

(i) Wired Channel : medium is physical i.e. optical fibre, co-axial cable etc.



(ii) Wireless Channel : medium is air.

Receiver Section

The receiver section consists of:

(i) **Receiving Antenna:** It is used to convert desired electromagnetic waves in the atmosphere into the electrical signal.

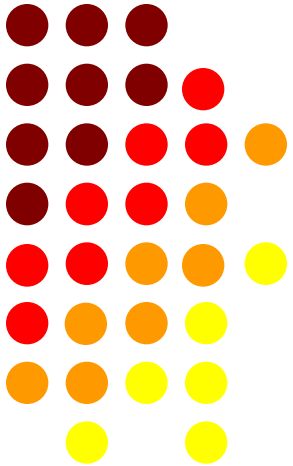
(ii) **Amplifier:** The signal at the receiver suffered various types of losses and become weak. So, an amplifier is used to increase its strength.

(iii) **Demodulator:** Here carrier wave is separated from the message signal.

(iv) **Transducer:** To convert electrical signal into original message signal.

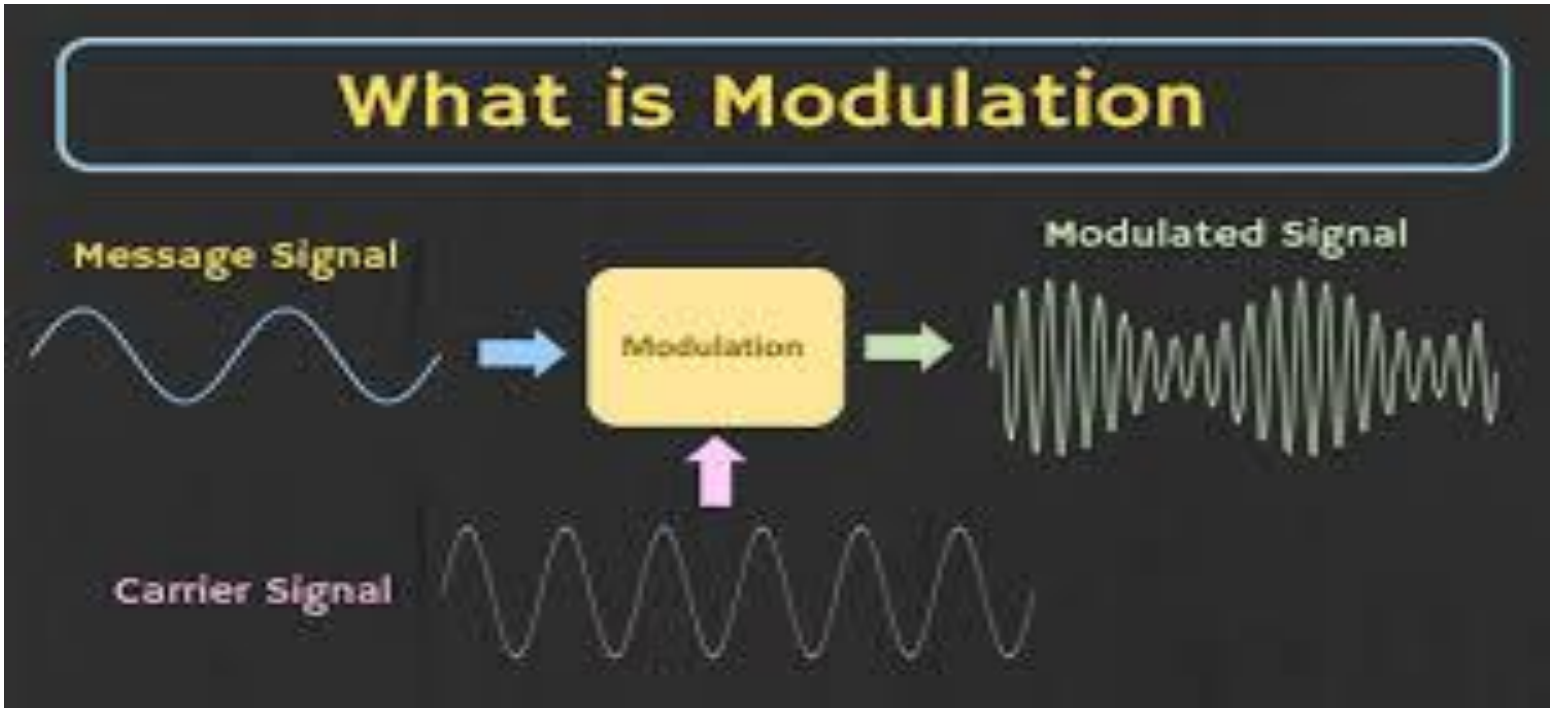
Lecture 36

Introduction of modulation and its need, Amplitude modulation: Expression, Power and current relation, modulation index



Modulation

- **It is a process in which low frequency message signal is superimposed on the high frequency carrier wave**. In this process one of the parameters of the carrier varies according to the message signal.



Need of Modulation

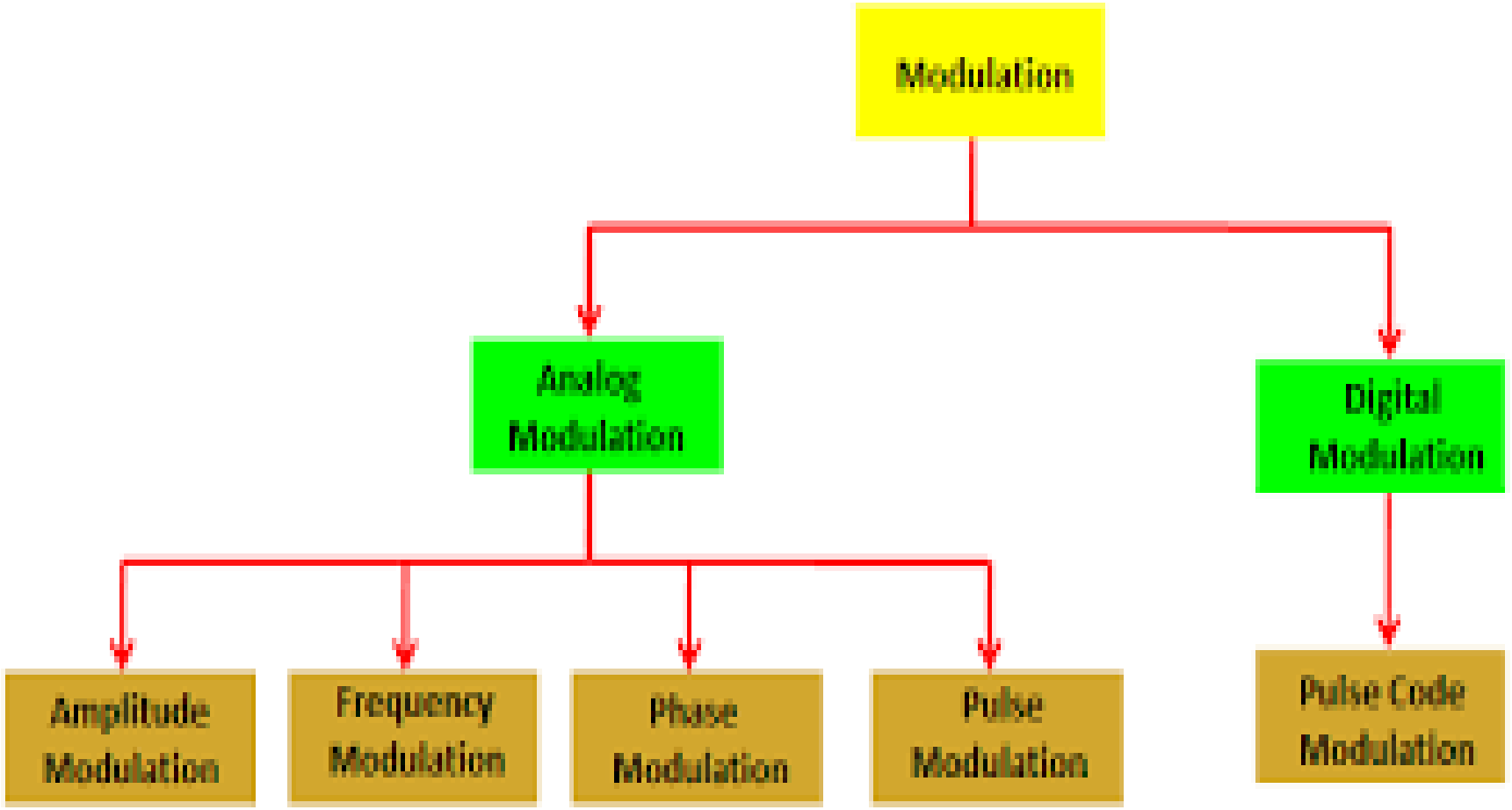
- There are several factors due to which modulation is needed in communication:-

(i) **Interference or Mixing Problem:** As message signals are generally low frequency signals there is large probability of mixing with other signals of the same frequency range already present in the atmosphere. So, low frequency message signals are sent through high frequency carrier wave (modulation) to avoid such problems.

(ii) **Height of Antenna:** Practical height of transmitting or receiving antenna = $\lambda/4$, where λ is the wavelength of the signal being used. If we use low frequency message signal without modulation the height of antenna is of the order of kilometres. Therefore to reduce the height of antenna modulation is needed.

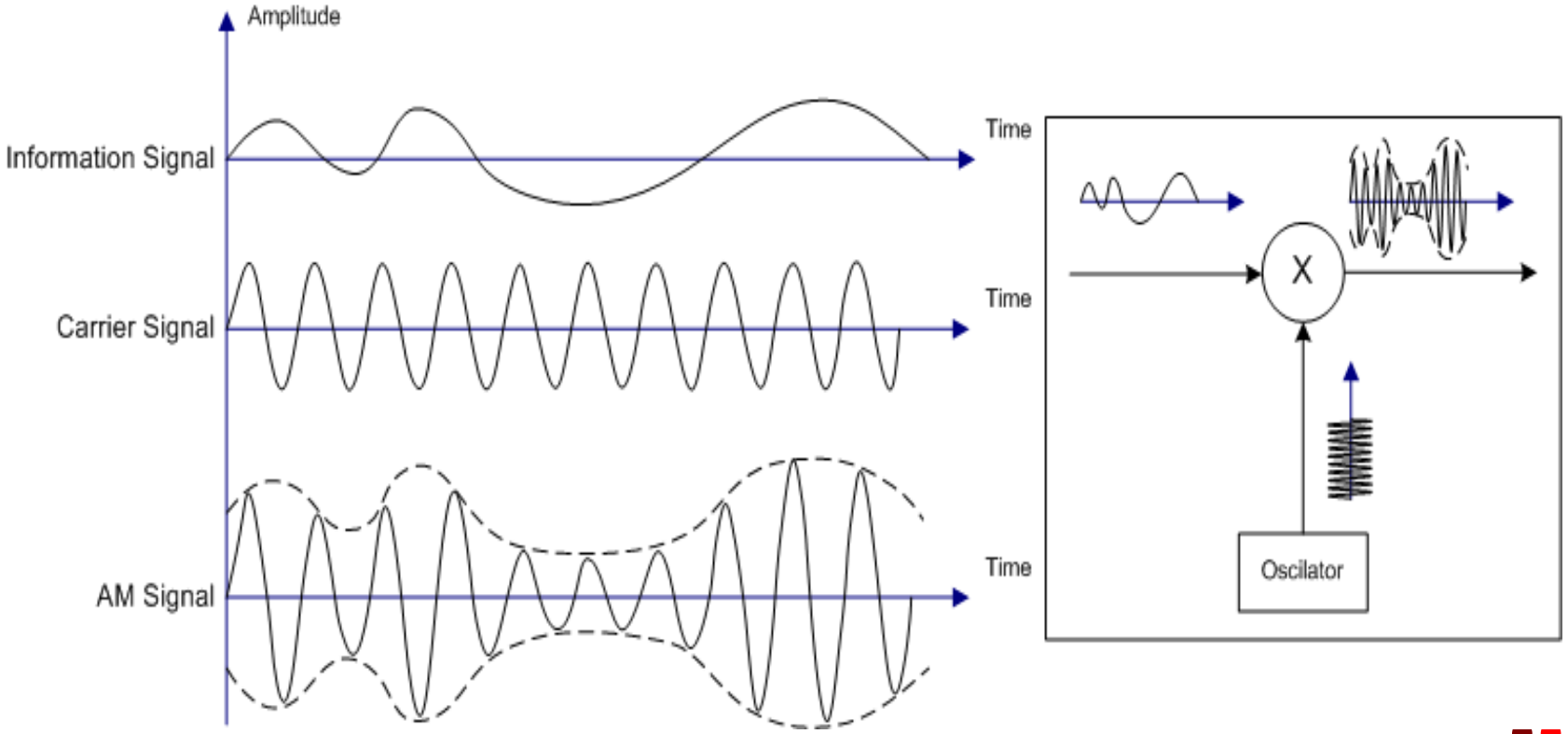
(iii) **Power Dissipation:** When an electromagnetic wave is travelling through atmosphere it suffers from various losses which are inversely proportional to the frequency of the signal. Thus low frequency signals are more prone to atmospheric losses and therefore modulation is used to reduce these losses.

Classification of Modulation



Amplitude Modulation (AM)

- In amplitude modulation the amplitude of the carrier signal is modulated according to the instantaneous amplitude of the message signal.



Mathematical Analysis

- Let message signal is given as: $m(t) = \text{Am}\cos(2\pi f_m t)$
- Let the carrier signal is: $c(t) = A_c cos(2\pi f_c t)$
- Then expression of AM signal can be given as:

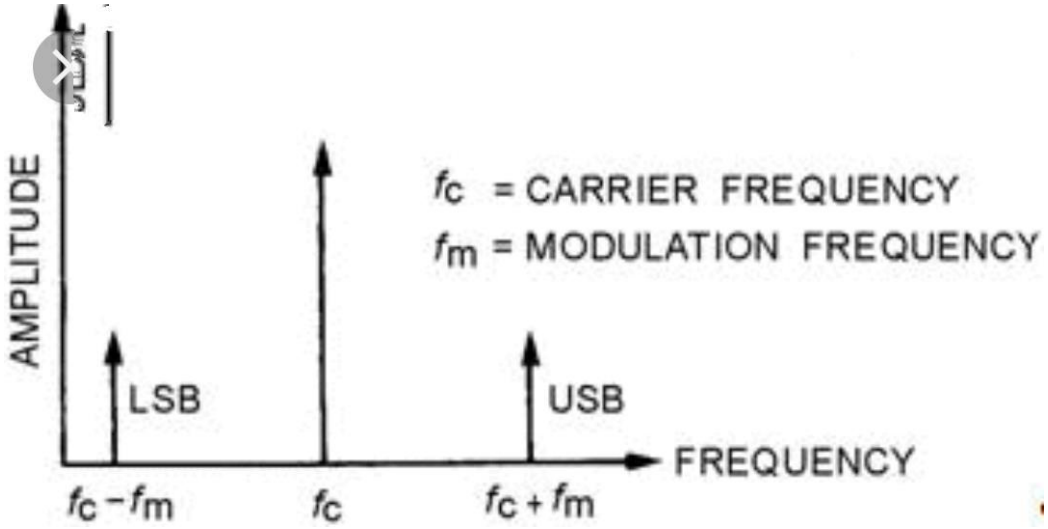
$$\boldsymbol{S_{AM}(t) = [Ac + m(t)]\, cos(2\pi f_c t)}$$

- It can further be written as,

$$\boldsymbol{S_{AM}(t) = A_c cos\ (2\pi f_c t) + \frac{A_c m}{2}\cos(f_c - f_m)\, t + \frac{A_c m}{2}\cos(f_c + f_m)\, t}$$

Frequency Spectrum of AM

- Frequency spectrum of any signal is the graphical representation of maximum amplitude with respect to frequency.



Parameters of AM

- **Bandwidth of an AM signal =** $2f_m$
- **Modulation Index (Percentage of Modulation):** In AM, It is the % in amplitude variation. Modulation index can be given as ratio of maximum amplitude of message to maximum amplitude of carrier.

$$m = \frac{A_m}{A_c}$$

(i) Its range is between **0 and 1**.

(ii) For m>1 (i.e. $\mathbf{A_m > Ac}$), This condition is known as **over modulation**.

- **Transmission Efficiency of AM:** Efficiency of any system is ratio of desired output to total input

$$\eta = \frac{Useful\ Power(Power\ of\ side\ band)}{Total\ Power(Carrier\ power + USB\ Power + LSB\ Power)}$$

POWER

- Power of any ac voltage can be obtained from the rms value of the ac voltage. If we assume that the resistance of channel as R, then power content of message

$$P_{side\ band} = \frac{(m.Ac\ \ /2\sqrt{2})^2}{R} + \frac{(m.Ac\ \ /2\sqrt{2})^2}{R}$$

- Power content of AM signal is,

$$P_{AM} = \frac{(A_c/\sqrt{2})^2}{R} + \frac{(m.Ac\ \ /2\sqrt{2})^2}{R} + \frac{(m.Ac\ \ /2\sqrt{2})^2}{R}$$

- Then,

Or,

$$\eta = \frac{m^2}{2 + (V_m/V_c)^2} = \frac{m^2}{2 + m^2}$$

So,

maximum efficiency (m=1) for AM transmission is 1/3 or 33.33%.

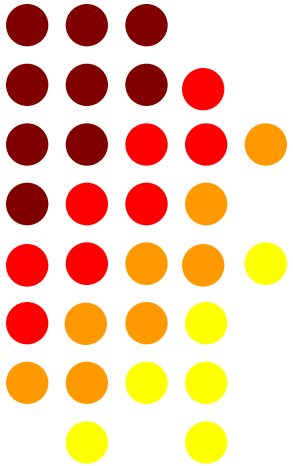
Current calculations:

$$\frac{P_t}{P_c} = \frac{I_t^2 R}{I_c^2 R} = \left(\frac{I_t}{I_c}\right)^2 = 1 + \frac{m^2}{2}$$

$$\frac{I_t}{I_c} = \sqrt{1 + \frac{m^2}{2}} \quad \text{or} \quad I_t = I_c \sqrt{1 + \frac{m^2}{2}}$$

Lecture 37

Numerical based on AM Modulator and Demodulator technique of AM



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.
The receiver used for AM is very cheap.	Noise interference is highly noticeable.

Q.1 . A modulating signal $m(t)=10\cos(2\pi\times10^3t)$ is amplitude modulated with a carrier signal $c(t)=50\cos(2\pi\times10^5t)$. Find the modulation index, the carrier power, and the power required for transmitting AM wave.

- Given, the equation of modulating signal as
- m(t)=10cos(2π×10^3t)
- We know the standard equation of modulating signal as
- m(t)=Am.cos(2πfmt)
- By comparing the above two equations, we will get
- Amplitude of modulating signal as Am=10volts
- and Frequency of modulating signal as
- $fm=10^3Hz=1KHz$

- Given, the equation of carrier signal is
- $c(t)=50\cos(2\pi\times10^5t)$
- The standard equation of carrier signal is
- $c(t)=Ac.\cos(2\pi fct)$
- By comparing these two equations, we will get
- Amplitude of carrier signal as Ac=50volts
- and Frequency of carrier signal as $fc=10^5Hz=100KHz$
- We know the formula for modulation index as
- $\mu=Am/\ Ac$
- Substitute, Am and Ac values in the above formula.

$$\mu = \frac{10}{50} = 0.2$$

- The formula for Carrier power,

$$P_c = \frac{{A_c}^2}{2R}$$

- Assume R=1Ω

$$P_c = \frac{(50)^2}{2\,(1)} = 1250W$$

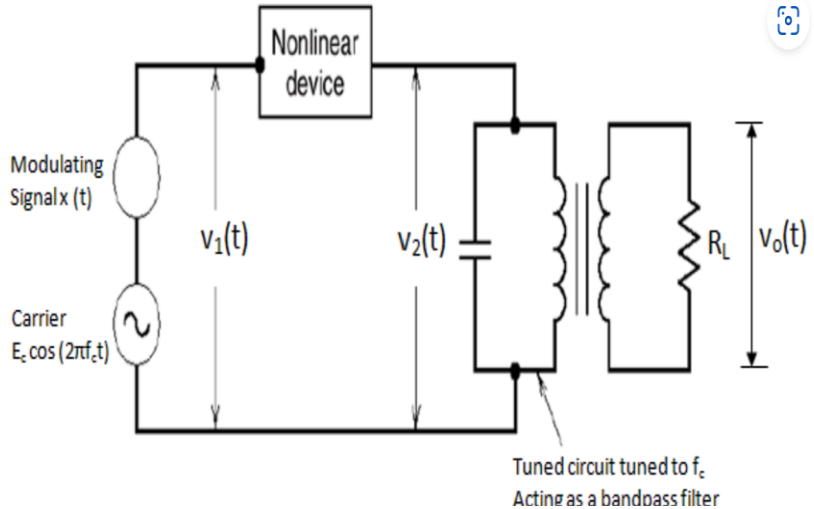
- Therefore, the **Carrier power**, Pc is **1250 watts**.
- We know the formula for **power** required for **transmitting AM** wave is

$$\Rightarrow P_t = P_c\left(1 + \frac{\mu^2}{2}\right)$$

- Substitute Pc and μ values in the above formula.

$$P_t = 1250\left(1 + \frac{(0.2)^2}{2}\right) = 1275W$$

Square law AM modulator



It consists of the following :

1. A non-linear device
2. A bandpass filter
3. A carrier source and modulating signal

The modulating signal and carrier are connected in series with each other and their sum V1(t) is applied at the input of the non-linear device, such as diode, transistor etc.

Thus,

$$v_1(t) = x(t) + E_c \cos(2\pi f_c t)$$

.....(1)

The input output relation for non-linear device is as under :

$$v_2(t) = av_1(t) + bv_1^2(t)$$

.....(2)

where a and b are constants.

Now, substituting the expression (1) in (2), we get

$$v_2(t) = a[x(t)+E_c\cos(2\pi f_c t)] + +b[x(t) + E_c\cos(2\pi f_c t)]^2$$

Or,

$$v_2(t) = ax(t)+aE_c\cos(2\pi f_c t) + +b[x^2(t) + 2x(t)\cos(2\pi f_c t) + E_c^2\cos^2(2\pi f_c t)]$$

Or,

$$v_2(t) = \underbrace{ax(t)}_{(1)}+\underbrace{aE_c\cos(2\pi f_c t)}_{(2)} + +\underbrace{bx^2(t)}_{(3)} + \underbrace{2bx(t)\cos(2\pi f_c t)}_{(4)} + \underbrace{bE_c^2\cos^2(2\pi f_c t)}_{(5)}$$

The five terms in the expression for V2(t) are as under :

Term 1: ax(t) : Modulating Signal

Term 2 : a Ec cos (2π fct) : Carrier Signal

Term 3 : b x2 (t) : Squared modulating Signal

Term 4 : 2 b x(t) cos (2π fct) : AM wave with only sidebands

Term 5 : b Ec2 cos2 (2π fct) : Squared Carrier

Out of these five terms, terms 2 and 4 are useful whereas the remaining terms are not useful .

Let us club terms 2, 4 and 1, 3, 5 as follows to get ,

$$v_2(t) = \underbrace{ax(t) + bx^2(t) + bE_c{}^2\cos^2(2\pi f_c t)}_{\text{Unuseful Terms}} + \underbrace{aE_c\cos(2\pi f_c t) + 2bx(t)E_c\cos(2\pi f_c t)}_{\text{Useful Terms}}$$

The LC tuned circuit acts as a bandpass filter . Its frequency responce is shown in fig 2 which shows that the circuit is tuned to frequency fc and its bandwidth is equal to 2fm . This bandpass filter eliminates the unuseful terms from the equation of v2(t) .

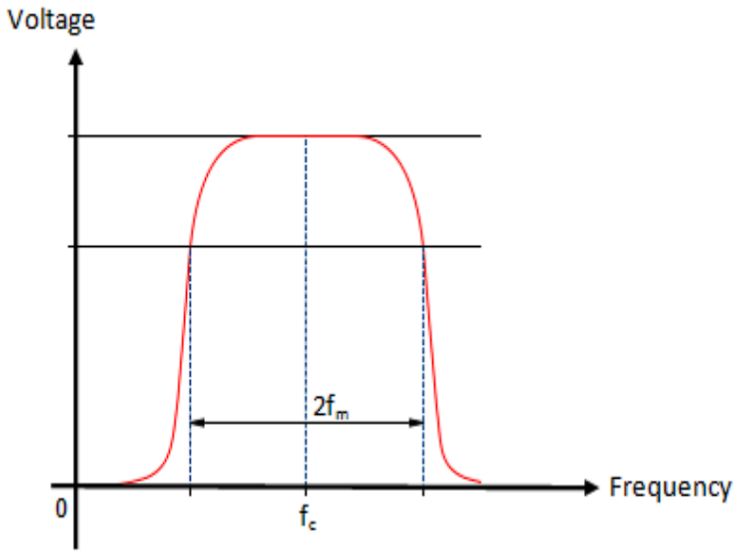


Fig 2

Hence the output voltage vo(t) contains only the useful terms .

$$V_o(t) = aE_c \cos(2\pi f_c t) + 2bx(t)E_c \cos(2\pi f_c t)$$

Envelope Detector

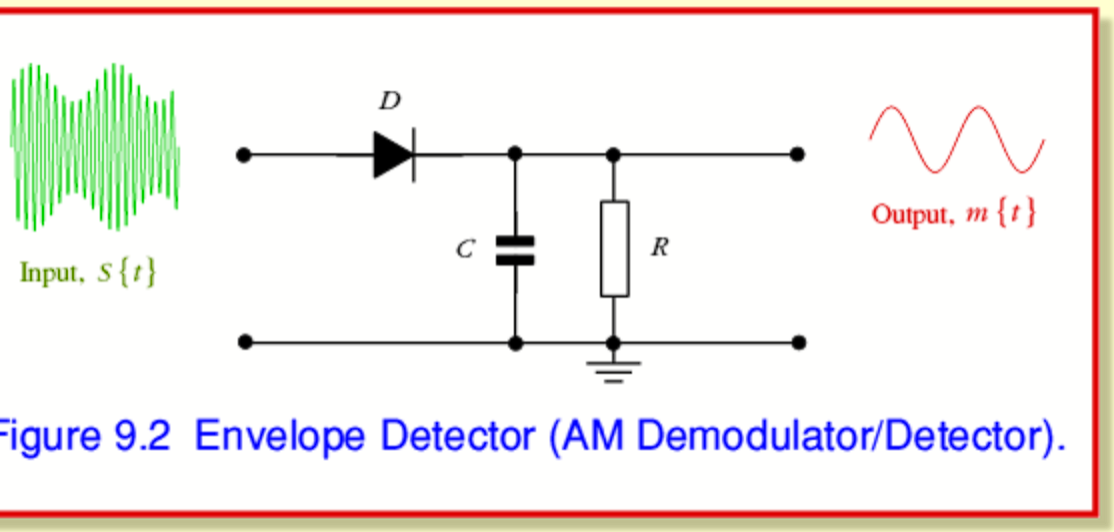


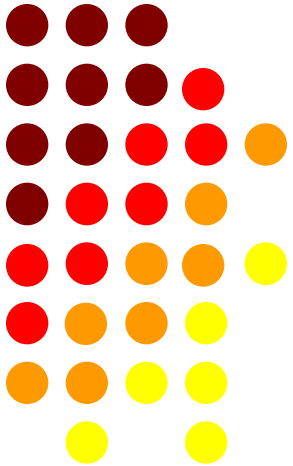
Figure 9.2 Envelope Detector (AM Demodulator/Detector).

English: A simple envelope detector circuit, used to demodulate amplitude modulated (AM) radio signals in AM radio receivers. It consists of a semiconductor diode *(D)* with a bypass capacitor. The diode allows current to pass in only one direction, rectifying the AC radio signal to a pulsing DC current, whose peak value is proportional to the modulation. The capacitor *C* charges up to the peak value of the pulses, following the envelope of the modulation. It serves as a low pass filter, smoothing the pulsing current, removing the pulses of radio frequency carrier, leaving the audio frequency modulation.

Lecture 38

MIET GROUP OF INSTITUTIONS

Wireless and cellular communication



DATA & INFORMATION

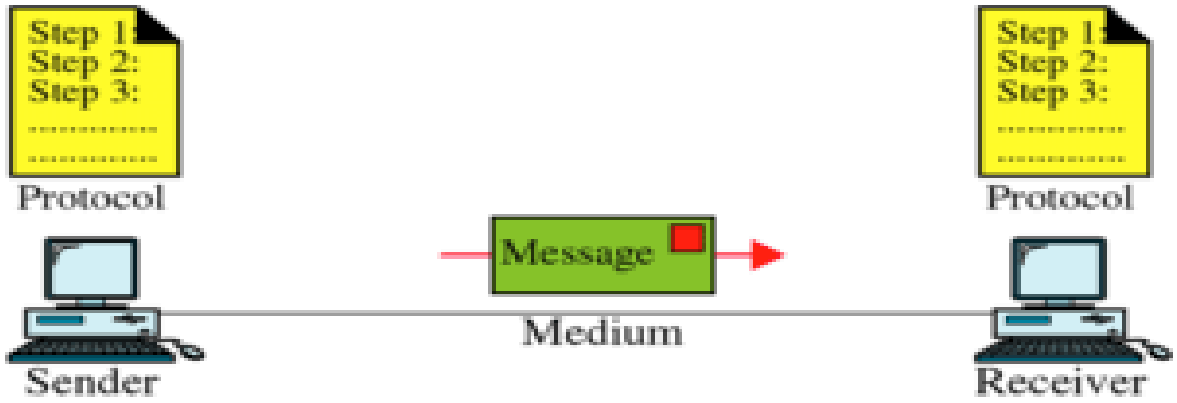
1.Data refers to the raw facts that are collected.

2. While information refers to processed data that enables us to take decisions.

3. Ex. When result of a particular test is declared it contains data of all students, when you find the marks you have scored you have the information that lets you know whether you have passed or failed.

DATA COMMUNICATION

1. Data Communication is a process of exchanging data or information.



2. In case of computer networks this exchange is done between two devices over a transmission medium. This process involves a data communication system which is made up of hardware and software:-

(i) The hardware part involves the sender and receiver devices and the intermediate devices through which the data passes.

(ii) The software part involves set of rules which specify what is to be communicated, how it is to be communicated and when. It is also called as a Protocol.

DATA PACKET

1. A packet is a basic unit of communication over a digital network.

2. A packet is also called a datagram, a segment, a block, a cell or a frame, depending on the protocol used for the transmission of data.

3. When data has to be transmitted, it is broken down into similar structures of data before transmission, called packets, which are reassembled to the original data chunk once they reach their destination.

4. The structure of a packet depends on the type of packet it is and on the protocol.

CHARACTERISTICS OF DATA COMMUNICATION

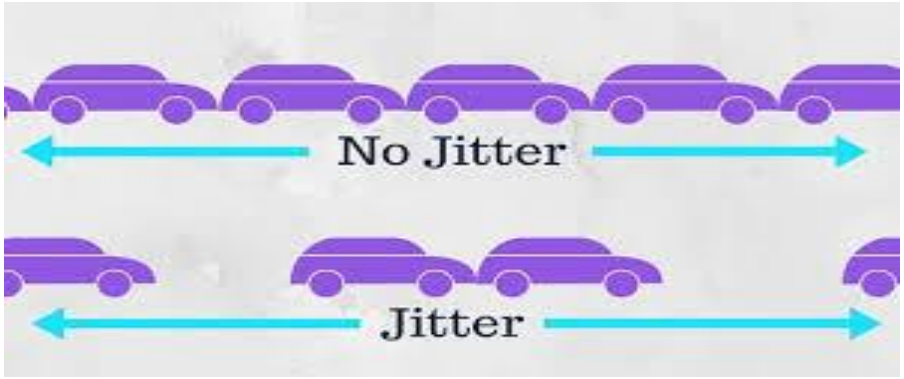
The effectiveness of any data communications system depends upon the following four fundamental characteristics:

1. **Delivery:** The data should be delivered to the correct destination and correct user.

1. **Accuracy:** The communication system should deliver the data accurately, without introducing any errors.

3. Timeliness: Audio and Video data has to be delivered in a timely manner without any delay.

4. Jitter: It is the variation in the packet arrival time. Uneven Jitter may affect the timeliness of data being transmitted.



COMPONENTS OF DATA COMMUNICATION

- A Data Communication system has five components as shown in the diagram below:

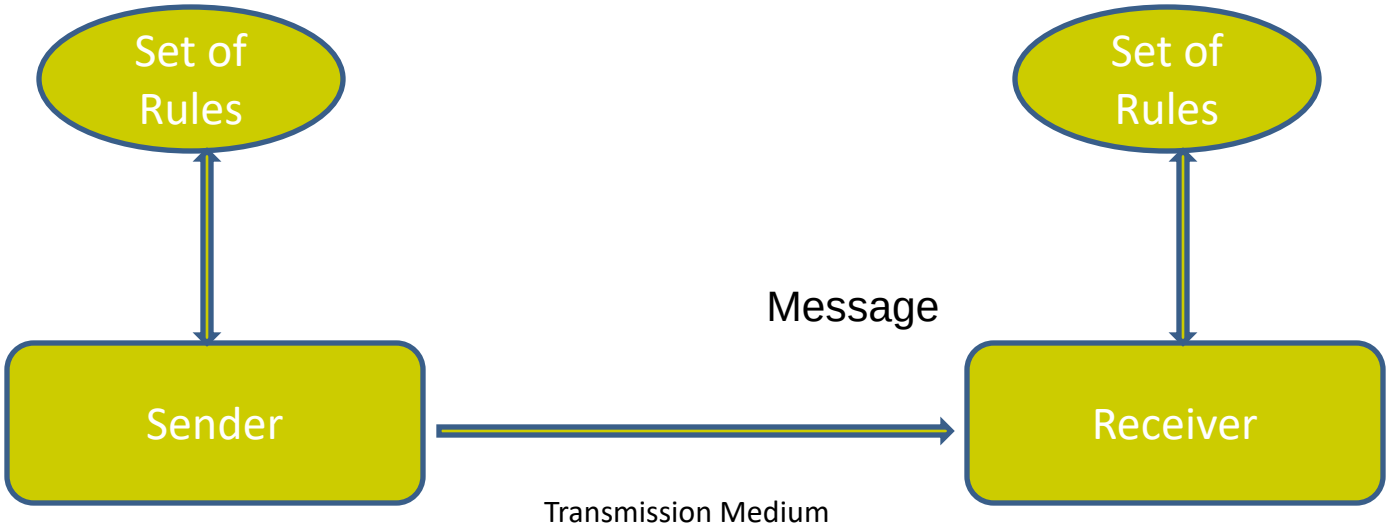


Fig. Components of a Data Communication System

1. **Message:-** Is the information to be communicated by the sender to the receiver.

1. The **Sender** is any device that is capable of sending the data (message).

1. **Receiver** The receiver is a device that the sender wants to communicate the data (message).

1. **Transmission Medium** It is the path by which the message travels from sender to receiver. It can be wired or wireless and many subtypes in both.

1. **Protocol** It is a set of rules used by the sender and receiver to communicate data. Like two persons trying to talk to each other in a different language without know the other language.

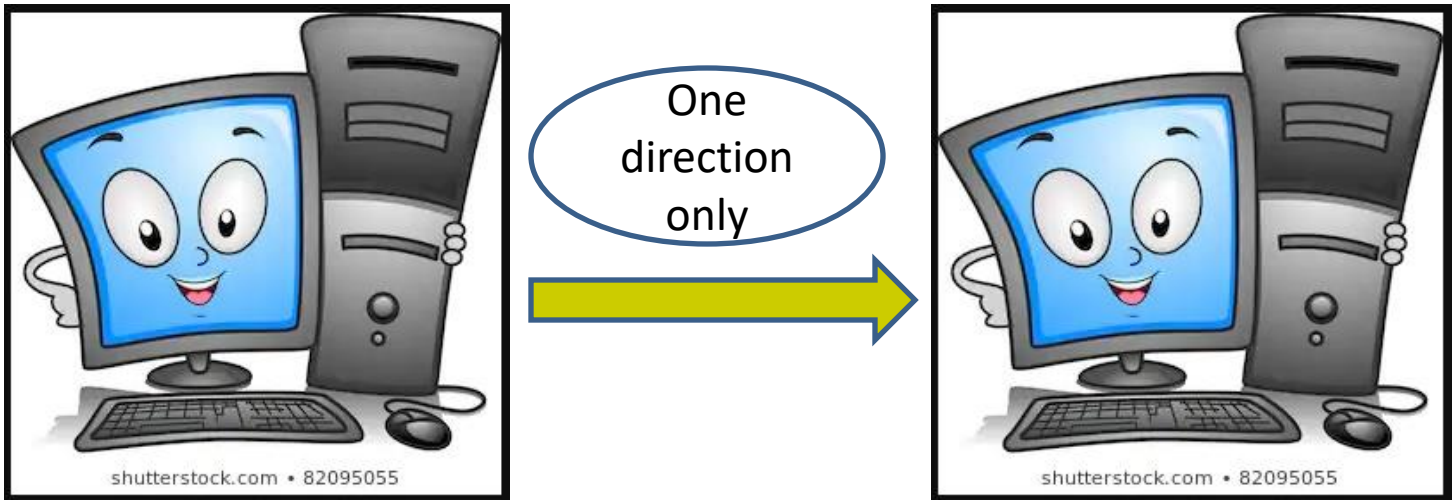
DATA FLOW

- Devices communicate with each other by sending and receiving data.

- The data can flow between the two devices in the following ways.

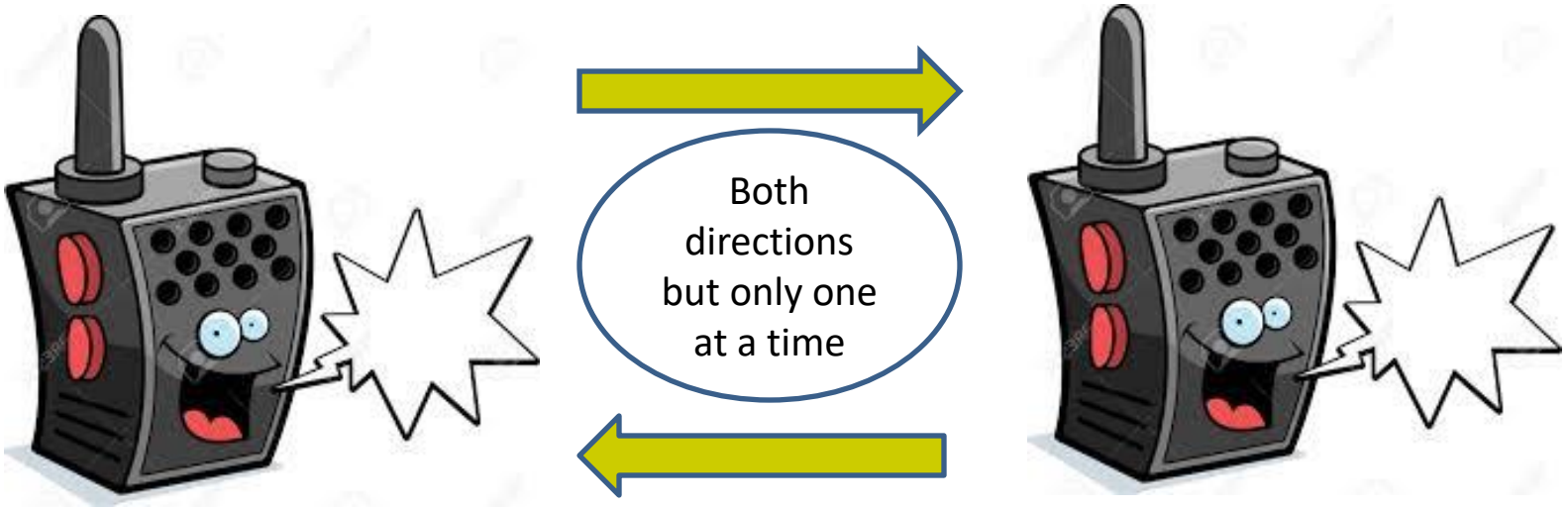
1. Simplex
2. Half Duplex
3. Full Duplex

SIMPLEX



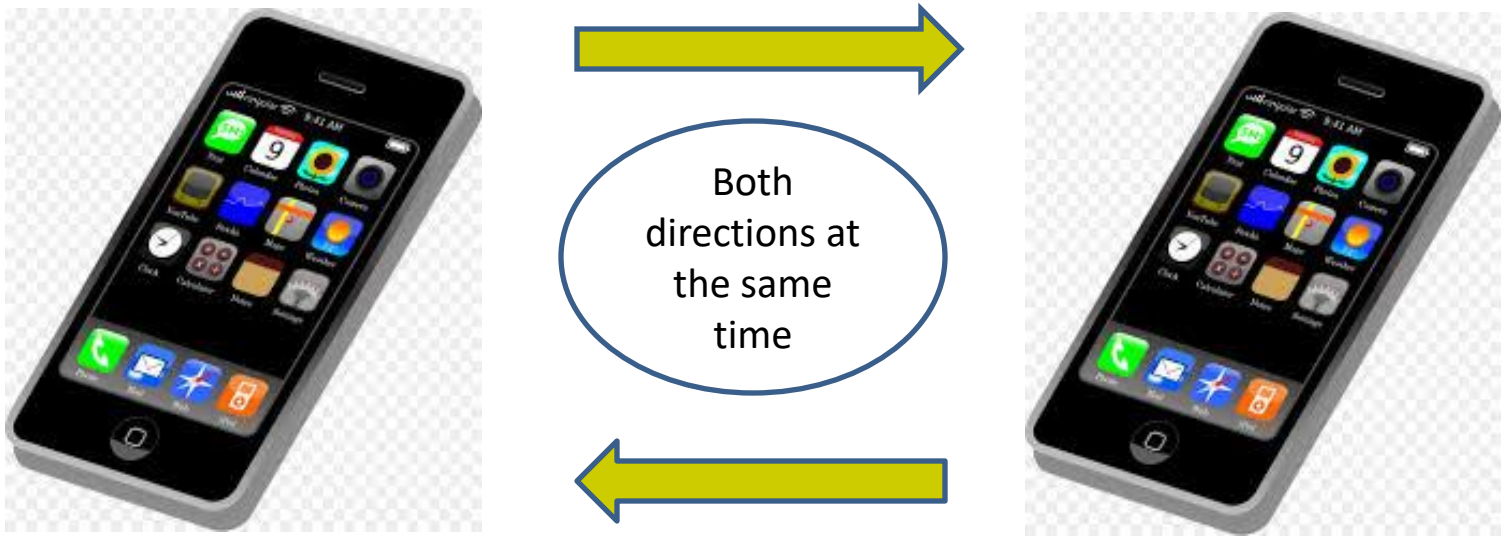
In Simplex, communication is unidirectional Only one of the devices sends the data and the other one only receives the data. Example: in the above diagram: a cpu send data while a monitor only receives data.

HALF DUPLEX



In half duplex both the stations can transmit as well as receive but not at the same time. When one device is sending other can only receive and vice-versa (as shown in figure above.) Example: A walkie-talkie.

FULL DUPLEX



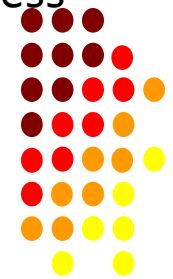
In Full duplex mode, both stations can transmit and receive at the same time. Example: mobile phones

Wireless Communication

- Wireless communication involves the transmission of information over a distance without the help of wires, cables or any other forms of electrical conductors.
- Wireless communication is a broad term that incorporates all procedures and forms of connecting and communicating between two or more devices using a wireless signal through wireless communication technologies and devices.

Features of Wireless Communication

- The evolution of wireless technology has brought many advancements with its effective features.
- The transmitted distance can be anywhere between a few meters (for example, a television's remote control) and thousands of kilometers (for example, radio communication).
- Wireless communication can be used for cellular telephony, wireless access to the internet, wireless home networking, and so on.



•Other examples of applications of radio wireless technology include GPS units, garage door openers, wireless computer mice, keyboards and headsets, headphones, radio receivers, satellite television, broadcast television and cordless telephones.

Types of Wireless Communication Technologies

In recent days, wireless communication technology has become an integral part of several types of communication devices as it allows users to communicate even from remote areas. The devices used for wireless communication are cordless telephones, mobiles, GPS units, ZigBee technology, wireless computer parts, and satellite television, etc. Wireless communication technology is categorized into different types depending on the distance of communication, the range of data, and the type of devices used. The following are the different types of wireless communication technologies.

Cellular communication

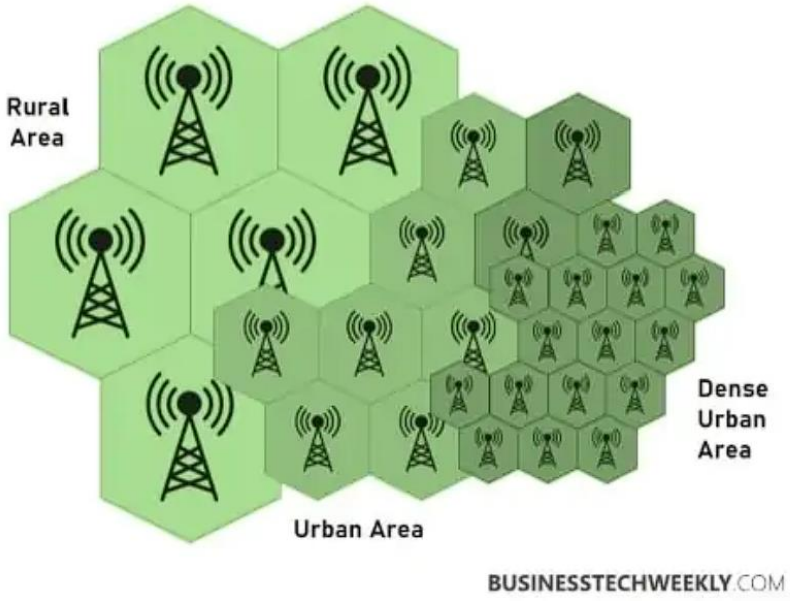
CELLULAR COMMUNICATIONS

In a cellular network, a land area to be supplied with radio service is divided into cells.

The pattern depends on the terrain and reception characteristics.

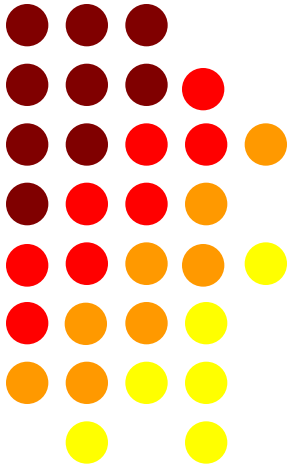
Each of these cells is assigned with multiple frequencies which corresponding radio base stations.

The group of frequencies can be reused in other cells, provided that the same frequencies are not reused in adjacent neighboring cells as that would cause co-channel interference.



Lecture 39

Introduction of mobile communication and its different generations



EVOLUTION OF MOBILE COMMUNICATION

- Over recent years, the evolution of mobile wireless communication in the world has become more important after arrival of 5G technology.

- This evolution journey consists of several generations start with 1G followed by 2G, 2.5G,3G, 4G, and under research future generations 5G is still going on.

FIRST GENERATION (1G)

- It uses analog radio signal which has frequency 150 MHz, only voice transmission call is done.
- This generation is unreliable.
- It speeds up to 2.4Kbps.

SECOND GENERATION (2G)

- The next generation of mobile networks, 2G uses **GSM technology** (Global System for Mobile Communication).
- Some of its significant features included send text messages (SMS), picture messages.
- It used digital signal for transmission rather than analog.
- Data speed up to 64Kbps.

2.5G

- **GPRS(General Packet Radio Service)** is extension of existing 2G network to have the capacity of launching packet based services while enhancing the data rates supported by these networks.

- It provides services such as Wireless Application Protocol (WAP) access, Multimedia Messaging Service (**MMS**) and for internet communication services such as e-mail and World Wide Wireless Web (**WWW**) access.

3G

- 3G is the third generation of mobile phone standards and technology,
- 3G uses **CDMA technique** for data transmission.
- 3G transmits data up to 2 Mbps.

3G has the following **enhancements** over **2.5G** and previous networks:

- Enhanced audio and video streaming.
- Several Times higher data speed.
- Video-conferencing support.
- Web and WAP browsing at higher speed

4G

- This generation provide wider bandwidth, high security and high speed internet access. This generation based on Long Term Evolution (LTE).

- The 4G is offering improved multimedia, video gushing, worldwide access, and around the world transportability through a wide range of gadgets.

- 4G transmits data up to 100 Mbps.

- 4G also features reduced latency, which if you're a mobile gamer is essential. With reduced latency, you'll see a much quicker response to your commands. So it provides amazing real time experience for gamers playing a fighting game like PUBG.

DISADVANTAGES OF 4G

- 4G introduces a potential inconvenience for those who travel internationally.
- In order to make and receive 4G voice calls, the subscriber handset must have a matching frequency (and in some cases require unlocking).
- It requires software update regularly.

5G

- 5G networks are cellular networks, in which the service area is divided into small geographical areas called *cells*.
- The main advantage of the new networks is that they will have greater bandwidth, giving higher download speeds.
- 5G transmits data up to 10 gigabits per second (Gbit/s).
- 4G cellphones are not able to use the new networks, which require 5G enabled wireless devices.

5G networks operate on up to three frequency bands — low, medium, and high.

(i) **Low-band 5G** uses a similar frequency range to 4G cellphones giving download speeds a little higher than 4G.

(ii) **Mid-band 5G** uses frequency ranges from 2.5-3.7 GHz, with each cell tower providing service up to several miles in radius.

(iii) **High-band 5G** uses frequencies of 25–39 GHz, near the bottom of the millimeter wave band, although higher frequencies may be used in the future. Due to their higher cost, plans are to deploy these cells only in dense urban environments and areas where crowds of people congregate such as sports stadiums and convention centers.

APPLICATIONS OF 5G

The three main application areas for the enhanced capabilities of 5G are:-

- Enhanced Mobile Broadband (eMBB)
- Ultra Reliable Low Latency Communications (URLLC)
- Massive Machine Type Communications (mMTC).

- **Enhanced Mobile Broadband (eMBB)** used for mobile broadband services, with faster connections and more capacity. This will benefit areas of higher traffic such as stadiums, cities, and concert venues.

- **Ultra-Reliable Low-Latency Communications (URLLC)** refer to using the network for mission critical applications that require uninterrupted and robust data exchange.

- **Massive Machine-Type Communications (mMTC)** would be used to connect to a large number of devices.

Technologies / Features	*1G*	*2G/2.5G*	*3G*	*4G*	*5G*
Evolution	1970	1980	1990	2000	2010
Deployment	1984	1999	2002	2010	2015
Data Rate	2 kbps	14.4-64 kbps	2 Mbps	200 Mbps to 1 Gbps for low mobility	10 Gbps to 100 Gbps
Famous Standards	AMPS	2G: GSM,C]DMA 2.5G: GPRS, EDGE, 1xRTT	WCDMA, CDMA-2000	LTA, WiMAX	Not yet defined
Technology behind	Analog cellular technology	Digital cellular technology	Broad bandwidth CDMA, IP technology	Undefined IP and seamless combination of broadband. LAN/WAN/PAN/ WLAN	Undefined IP and seamless combination of broadband. LAN/WAN/ PAN/WLAN
Service	Voice	2G: Digital Voice, SMS 2.5G: Voice+Data	Integrated high quality audio, video and data	Dynamic information access, wearable devices	Dynamic information access, wearable devices with AI capabilities
Multiplexing	FDMA	TDMA,CDMA	CDMA	CDMA	CDMA
Type of Switching	Circuit	2G: Circuit 2.5G: Circuit and packet	Packet	Packet	Packet
Handoff	Horizontal	Horizontal	Horizontal	Horizontal and Vertical	Horizontal and Vertical
Core Network	PSTN	PSTN	Packet network	Internet	Internet

GSM

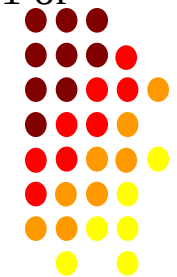
- A GSM network comprises of many functional units. These functions and interfaces are explained in this chapter. The GSM network can be broadly divided into –
- The Mobile Station (MS)
- The Base Station Subsystem (BSS)
- The Network Switching Subsystem (NSS)
- The Operation Support Subsystem (OSS)

GSM - The Mobile Station

- The MS consists of the physical equipment, such as the radio transceiver, display and digital signal processors, and the SIM card. It provides the air interface to the user in GSM networks. As such, other services are also provided, which include −
- Voice teleservices
- Data bearer services

GSM - The Base Station Subsystem (BSS)

- The BSS is composed of two parts −
- The Base Transceiver Station (BTS)
- The Base Station Controller (BSC)
- The BTS and the BSC communicate across the specified Abis interface, enabling operations between components that are made by different suppliers. The radio components of a BSS may consist of four to seven or nine cells. A BSS may have one or more base stations. The BSS uses the Abis interface between the BTS and the BSC. A separate high-speed line (T1 or E1) is then connected from the BSS to the Mobile MSC.



GSM - The Network Switching Subsystem (NSS)

- The Network switching system (NSS), the main part of which is the Mobile Switching Center (MSC), performs the switching of calls between the mobile and other fixed or mobile network users, as well as the management of mobile services such as authentication.

The switching system includes the following functional elements –

- Home Location Register (HLR)

The HLR is a database used for storage and management of subscriptions. The HLR is considered the most important database, as it stores permanent data about subscribers, including a subscriber's service profile, location information, and activity status. When an individual buys a subscription in the form of SIM, then all the information about this subscription is registered in the HLR of that operator.

- **Mobile Services Switching Center (MSC)**

The central component of the Network Subsystem is the MSC. The MSC performs the switching of calls between the mobile and other fixed or mobile network users, as well as the management of mobile services such as registration, authentication, location updating, handovers, and call routing to a roaming subscriber. It also performs such functions as toll ticketing, network interfacing, common channel signaling, and others. Every MSC is identified by a unique ID.

- **Visitor Location Register (VLR)**

The VLR is a database that contains temporary information about subscribers that is needed by the MSC in order to service visiting subscribers. The VLR is always integrated with the MSC. When a mobile station roams into a new MSC area, the VLR connected to that MSC will request data about the mobile station from the HLR. Later, if the mobile station makes a call, the VLR will have the information needed for call setup without having to interrogate the HLR each time.

- **Authentication Center (AUC)**

The Authentication Center is a protected database that stores a copy of the secret key stored in each subscriber's SIM card, which is used for authentication and ciphering of the radio channel. The AUC protects network operators from different types of fraud found in today's cellular world.

- **Equipment Identity Register (EIR)**

The Equipment Identity Register (EIR) is a database that contains a list of all valid mobile equipment on the network, where its International Mobile Equipment Identity (IMEI) identifies each MS. An IMEI is marked as invalid if it has been reported stolen or is not type approved.

GSM - The Operation Support Subsystem (OSS)

The operations and maintenance center (OMC) is connected to all equipment in the switching system and to the BSC. The implementation of OMC is called the operation and support system (OSS).

Here are some of the OMC functions−

- Administration and commercial operation (subscription, end terminals, charging, and statistics).
- Security Management.
- Network configuration, Operation, and Performance Management.
- Maintenance Tasks.

GPRS

- General Packet Radio Service (GPRS) is a packet oriented mobile data standard on the 2G and 3G cellular communication network.
- GPRS offers following services such as:-

(i) SMS messaging.

(ii) "Always on" internet access

(iii) Multimedia messaging service (MMS)

(iv) Internet applications for smart devices through wireless application protocol (WAP)

(v) Point-to-point (P2P) service: inter-networking with the Internet (IP)

(vi) Point-to-multipoint (P2M) service: point-to-multipoint multicast and point-to-multipoint group calls

(vii) If SMS over GPRS is used, an SMS transmission speed of about 30 SMS messages per minute may be achieved. This is much faster than using the ordinary SMS over GSM, whose SMS transmission speed is about 6 to 10 SMS messages per minute.

BENEFITS OF GPRS

- **Higher Data Rate -** GPRS benefits the users in many ways, one of which is higher data rates in turn of shorter access times.

- **Easy Billing -** GPRS packet transmission offers a more user-friendly billing than that offered by 2G services. In 2G, billing is based on the duration of the connection. This is unsuitable for applications with busty traffic. The user must pay for the entire airtime, even for idle periods when no packets are sent (e.g., when the user reads a Web page).

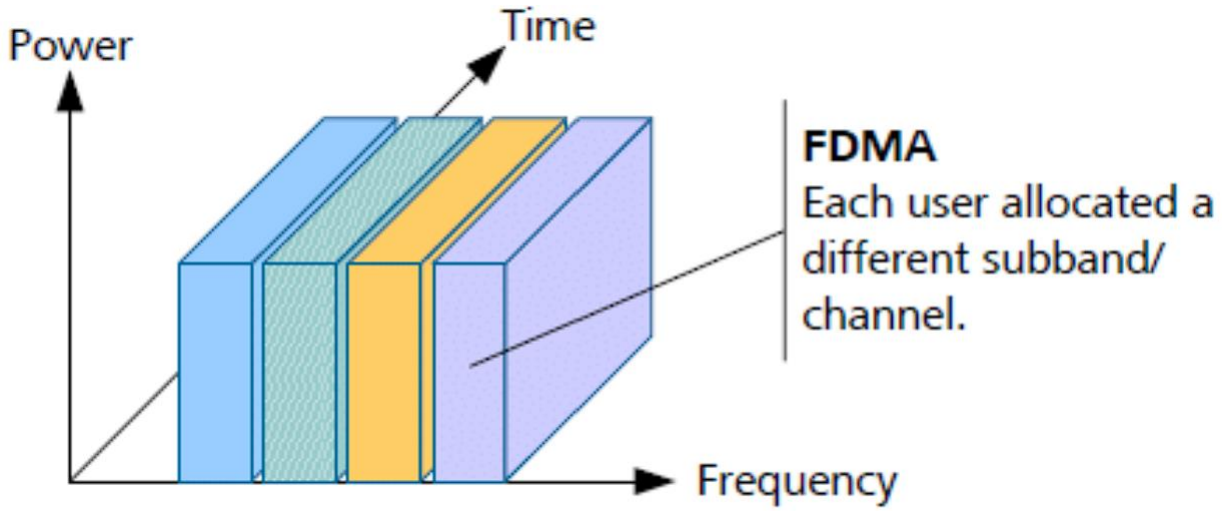
(TDM)Time Division Multiplexing

- In this multiplexing we split the data exchange time into multiple small slots and transmit/receive different data onto different slot. The time frame is divided into slots. This technique is used to transmit a signal over a single communication channel, with allotting one slot for each message.

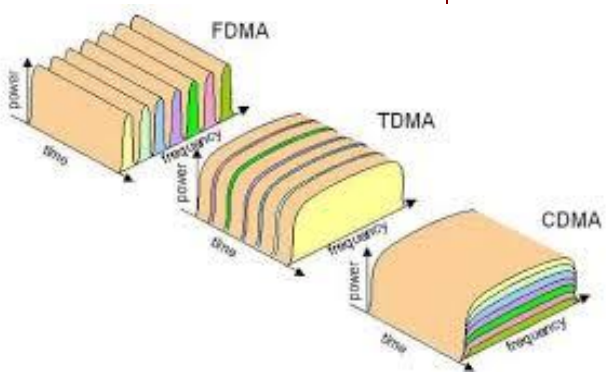
- For example: TDM can be used in the settings of telephone switchboards to control the calls.

Frequency Division Multiple Access (FDMA)

(FDMA) : FDMA is a type of channelization protocol. In this bandwidth is divided into various frequency bands. Each station is allocated with band to send data and that band is reserved for particular station for all the time allocated with band to send data and that band is reserved for particular station for all the time.



CDMA



- **Code division multiplexing** (CDM) is a networking technique in which multiple data signals are combined for simultaneous transmission over a common frequency band.

- When CDM is used to allow multiple users to share a single communications channel, the technology is called **code division multiple access** (CDMA).

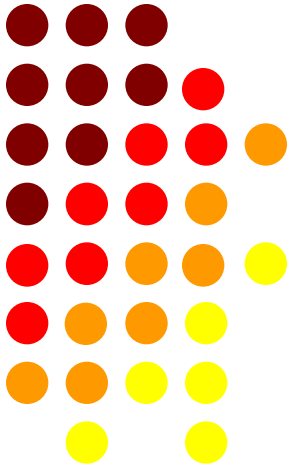
- Code Division Multiple Access system is very different from time and frequency multiplexing. In this system, a user has access to the whole bandwidth for the entire duration.

Comparison between GSM and CDMA

SNO	GSM	CDMA
1.	It is an abbreviation for Global System for Mobile Communication.	It is an abbreviation for Code Division Multiple Access.
2	For data and voice transmission, it employs the TDMA and FDMA mechanisms.	It transmits data and calls via CDMA technology.
3	When compared to CDMA, the transmission rate is sluggish.	When compared to GSM, the transmission rate is faster.
4	GSM makes use of the EDGE data transfer technology.	It makes use of the EVDO data transfer technology.
5	It is SIM-specific, thus communication requires a SIM card.	CDMA is handset-specific and does not require the use of a SIM card for communication.
6	It is less susceptible to radiation emission during transmission.	It is highly susceptible to radiation emission during transmission.
7	GSM provides less secure communication than CDMA.	It provides more secure connection than GSM.

Lecture 40

GROUP OF INSTITUTIONS



Introduction of Radar Communication and its basic principles and Satellite communication

RADAR COMMUNICATION

- **Radar** is a detection system that uses radio waves to determine the range, angle, or velocity of objects.
- It can be used to detect aircraft, ships, spacecraft, guided missiles, motor vehicles, weather formations, and terrain.
- Radio waves are electromagnetic waves of frequency between 10 hertz (Hz) and 30000 megahertz (MHz).

- **Elements of Radar Communication system**:-

(i) Transmitter:- For transmitting signal.

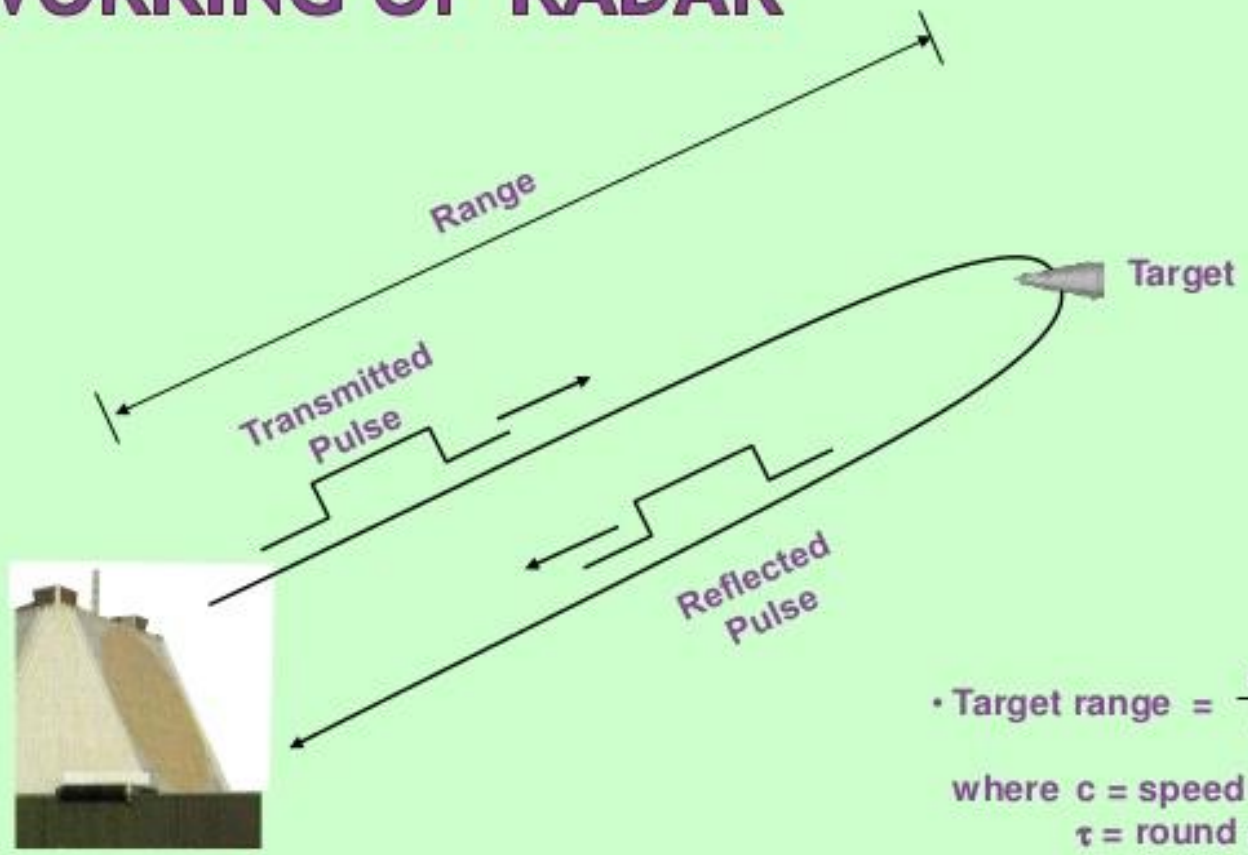
(ii) Antenna:- used to transmit or receive signal

(iii) Receiver :- used to receive signal

(iv) Power supply:- used to provide power.

- Radio waves (pulsed or continuous) from the transmitter reflect off the object and return to the receiver, giving information about the object's location and speed.

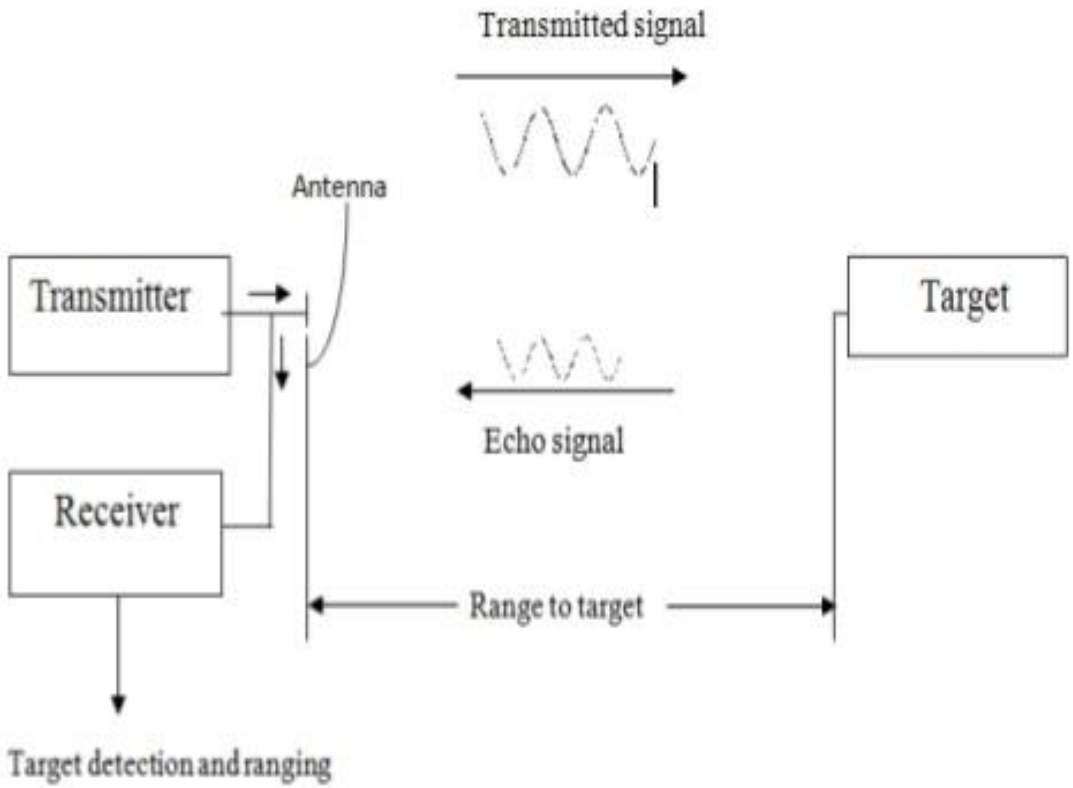
WORKING OF RADAR



- Target range = $\frac{c\tau}{2}$

where c = speed of light
τ = round trip time

Principle of Working



WORKING

- A radar system has a transmitter that emits radio waves known as *radar signals* in predetermined directions.
- When these signals contact an object they are usually reflected in many directions.
- Radar signals are reflected by materials of considerable electrical conductivity—such as most metals, seawater, and wet ground.
- The radar signals that are reflected back towards the radar receiver are the desirable ones that make radar detection work.
- If the object is *moving* either toward or away from the transmitter, there will be a slight change in the frequency of the radio waves due to the Doppler effect.

DOPPLER EFFECT

- that the Doppler effect is the change in frequency that occurs when a source and a target are in relative motion.
- The Doppler affect can be used in a CW radar in order to determine velocity.

ADVANTAGES OF RADAR

- Penetration Capability
- Uses electromagnetic wave so it require no medium
- Less susceptible to weather conditions
- Flexible – can be used in number of ways
- Beam spread can incorporate many targets
- Reliable

DISADVANTAGES

- Several target tend at a given bearings tend to cause confusion.
- Very costly circuit.
- If there are several targets then Radar system cannot tell the distance between them.
- It cannot identify the color of the object.

SATELLITE COMMUNICATION

- A **Satellite** is a smaller object that revolves around a larger object in space. For example, moon is a natural satellite of earth.
- **Communication** refers to the exchange (sharing) of information between two or more entities, through any medium or channel.
- Communication takes place between any two earth stations through a satellite, then it is called as **satellite communication**.
- In this communication, electromagnetic waves are used as carrier signals. These signals carry the information such as voice, audio, video or any other data between ground and space and vice-versa.

NEED OF SATELLITE COMMUNICATION

The following two kinds of propagation are used earlier for communication up to some distance.

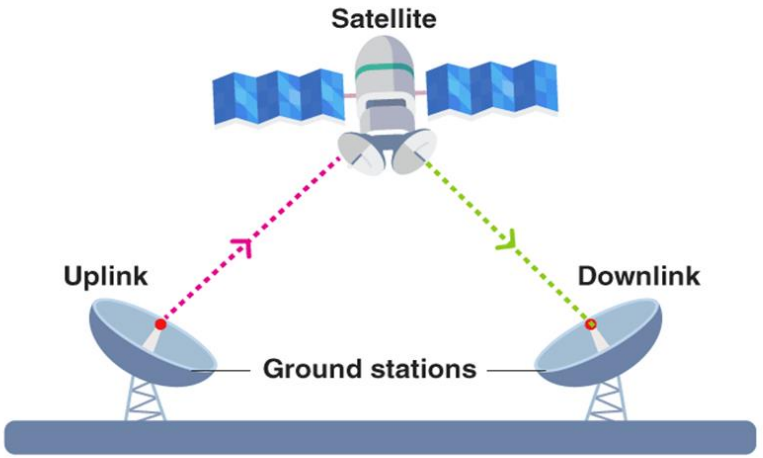
- **Ground wave propagation** − Ground wave propagation is suitable for frequencies up to 30MHz.

- **Sky wave propagation** − The suitable bandwidth for this type of communication is broadly between 30–40 MHz.

- The maximum station distance is limited to 1500KM only in both ground wave propagation and sky wave propagation. Satellite communication overcomes this limitation. In this method, satellites provide **communication for long distances**, which is well beyond the line of sight.

HOW A SATELLITE WORKS

- A **satellite** is a body that moves around another body in a particular path. A communication satellite is nothing but a repeater station in space. It is helpful in telecommunications, radio and television along with internet applications.
- A **repeater** is a circuit, which increases the strength of the received signal and then transmits
- The frequency with which, the signal is sent into the space is called as **Uplink frequency**.
- Similarly, the frequency with which, the signal is sent by the satellite is called as **Downlink frequency**.



ELEMENTS OF SATELLITE COMMUNICATION

Basic Elements shown in the figure are:

- User
- Satellite
- Earth Station(Ground Station)

(i) The user generates a signal which is transmitted to a satellite at the earth station.

(ii) The satellite consists of a large number of repeaters in the space that perform the reception of high frequency carrier from all the earth station.

(iii) Repeaters retransmits these carriers back to the Earth Station in the down link frequency spectrum.

(iv) In order to avoid the interference downlinks frequency spectrum should be different from uplink frequency spectrum.

ADVANTAGES

Following are the **advantages** of using satellite communication:

- Area of coverage is more than that of terrestrial systems.
- Each and every corner of the earth can be covered.
- More bandwidth and broadcasting possibilities.

DISADVANTAGES

Following are the **disadvantages** of using satellite communication −

- Launching of satellites into orbits is a costly process.
- Difficult to provide repairing activities if any problem occurs in a satellite system.
- Free space loss is more.

APPLICATIONS OF SATELLITE COMMUNICATION

Satellite communication plays a vital role in our daily life. Following are the applications of satellite communication −

- Radio broadcasting and voice communications
- TV broadcasting such as Direct To Home (DTH)
- Internet applications such as providing Internet connection for data transfer, GPS applications, Internet surfing, etc.
- Military applications and navigations
- Weather condition monitoring & Forecasting