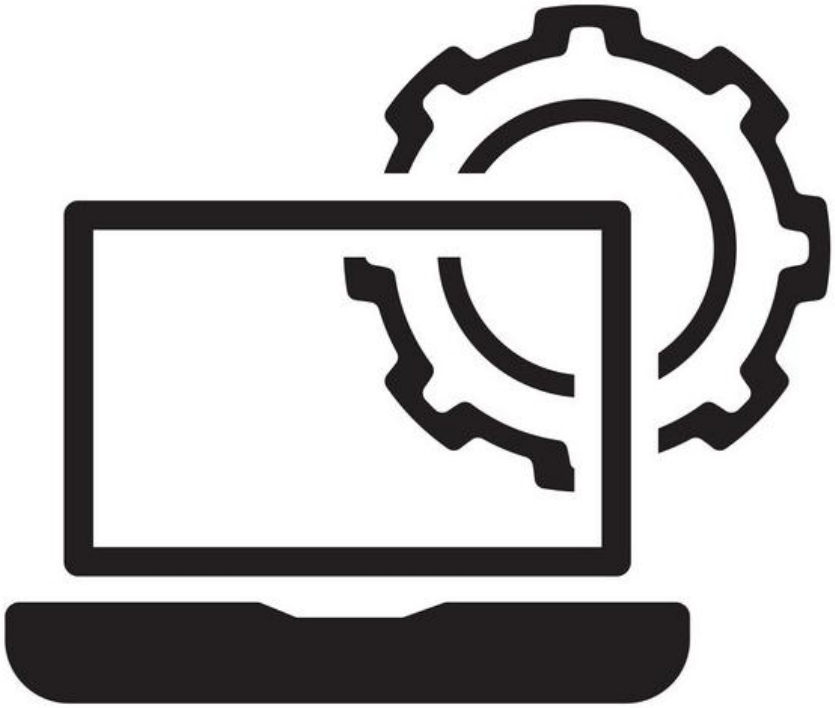
BALASORE SCHOOL OF ENGINEERING, BALASORE

STUDY MATERIAL



Branch:- Computer Science & Engineering
Subject:- Mobile Computing
Subject Code:- Th-5
Semester:- 5th
Prepared By:- Suvendu Nayak

Unit-1

(Introduction to Wireless networks & Mobile Computing)

Long Questions and Answers (10 Marks)

1) What is a network? Discuss about LAN, MAN, WAN and Wireless Networks.

A network consists of two or more computers that are linked in order to share resources (such as printers and CDs), exchange files, or allow electronic communications. The computers on a network may be linked through cables, telephone lines, radio waves, satellites, or infrared light beams.

The wire-based technology was used for connecting computers. This technology falls into three category such as:- LAN,MAN and WAN

A LAN (local area network) is a group of computers and network devices connected together, usually within the same building. By definition, the connections must be high speed and relatively inexpensive (e.g., token ring or Ethernet). Most Indiana University Bloomington departments are on LANs.

A LAN connection is a high-speed connection to a LAN. On the IUB campus, most connections are either Ethernet (10 Mbps) or Fast Ethernet (100 Mbps), and a few locations have Gigabit Ethernet (1000 Mbps) connections.

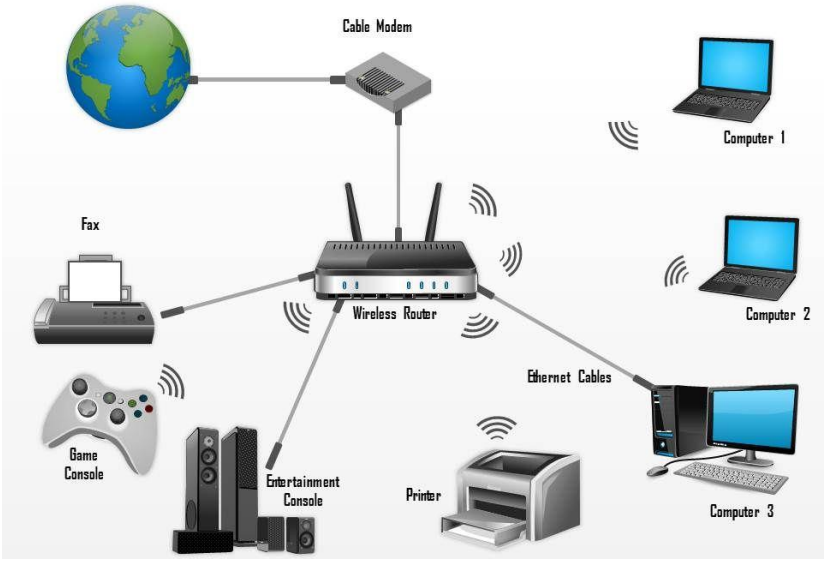
A MAN (metropolitan area network) is a larger network that usually spans several buildings in the same city or town. The IUB network is an example of a MAN.

A WAN (wide area network), in comparison to a MAN, is not restricted to a geographical location, although it might be confined within the bounds of a state or country. A WAN connects several LANs, and may be limited to an enterprise (a corporation or an organization) or accessible to the public. The technology is high speed and relatively expensive. The Internet is an example of a worldwide public WAN.

Wireless networks are computer networks that are not connected by cables of any kind. The use of a wireless network enables enterprises to avoid the costly process of introducing cables into buildings or as a connection between different equipment locations. The basis of wireless systems is radio waves, an implementation that takes place at the physical level of network structure.

Wireless networks use radio waves to connect devices such as laptops to the Internet, the business network and applications. When laptops are connected to Wi-Fi hot spots in public places, the connection is established to that business's wireless network.

Home Wireless Network Diagram



2) What is mobile computing? Explain all dimensions of mobile computing.

Mobile computing is a computing environment over physical mobility. The user of a mobile computing environment is able to access the data, information or other logical objects from any device in the network while on move. Mobile computing allows the user to perform the task from anywhere using a computing device in public(the web), corporate(business information) and personal information areas(medical records, address book etc.). To make the mobile computing environment effective, it is necessary that the communication bearer is spread over both wired and wireless media.

Dimensions of Mobile Computing

It is very necessary that the reader understands these dimensions of mobile computing and keeps them in mind throughout the process of design and implementation of the mobile application.

The dimensions of mobility are as follows :

(a) Location Awareness The definition of the mobile says the first dimesion of mobile computing is the location. As the mobile devices donot work in a particular location the location of the mobile devices may changes in every moment of time so the primary design issue is the location management in the development of mobile devices.

(b) Network Connectivity Quality of Service (QOS) The company focuses that our device is easily compatible for any type of network. The QOS is defined as "The collective effort of service performances, which determine the degree of satisfaction of a user of this service". The services can have qualitative and quantitative.

(c) Limited Device Capabilities: (Particularly Storage and CPU) The important issue is the storage related issues. The company's concern should be regarding the storage capacity of our device to improve the storage capacity of a mobile.

(d) Limited Power Supply: The mobile devices are totally based on battery power which provides less power supply.

(e) Support for wide variety of user interface: Mobile application can also be handled from the stationary devices like PC's. The keyboard, mouse and monitor have proved to be very efficient user interfaces for such type applications. The other interfaces include touchpad, mobile etc.

3) Explain mobile computing characteristics.

Mobile computing is a computing environment supports the following characteristics:-

1. Portability - The Ability to move a device within a learning environment or to different environments with ease.
2. Social Interactivity - The ability to share data and collaboration between users.
3. Context Sensitivity - The ability to gather and respond to real or simulated data unique to a current location, environment, or time.
4. Connectivity - The ability to be digitally connected for the purpose of communication of data in any environment.
5. Individual - The ability to use the technology to provide scaffolding on difficult activities and lesson customization for individual learners.
6. Small Size - Mobile devices are also known as handhelds, palmtops and smart phones due to their roughly phone-like dimensions. A typical mobile device will fit in the average adult's hand or pocket. Some mobile devices may fold or slide from a compact, portable mode to a slightly larger size, revealing built-in keyboards or larger screens. Mobile devices make use of touch screens and small keypads to receive input, maintaining their small size and independence from external interface devices. The standard form of a mobile device allows the user to operate it with one hand, holding the device in the palm or fingers while executing its functions with the thumb.

Netbooks and small tablet computers are sometimes mistaken for true mobile devices, based on their similarity in form and function, but if the device's size prohibits one-handed operation or hinders portability, then it cannot be considered a true mobile device.

7. Wireless Communication - Mobile devices are typically capable of communication with other similar devices, with stationary computers and systems, with networks and portable phones. Base mobile devices are capable of accessing the Internet through Bluetooth or Wi-Fi networks, and many models are equipped to access cell phone and wireless data networks as well. Email and texting are standard ways of communicating with mobile devices, although many are also capable of telephony, and some specialized mobile devices, such as RFID and barcode.

4) Explain applications of mobile computing.

1. Traffic:

During travelling in traffic if we require to know road situation, latest news and when if feel more stress in driving then can play music and other important broadcast data are received through digital audio broadcasting(DAB).If we forget the road then we can know our exact location with the help of global positioning system (GPS).In case if got accident then can to inform police and ambulance via an emergency call to service provider, which help to improve organization and save time & money.

2. Emergencies Situation:

To play vital role in medical sector can hire an ambulance with great quality wireless connection and help of this can carry significant information about injured persons. The useful step can prepare for particular accident and doctor can consulted for diagnosis. Only Wireless networks work of communication in nature disaster2 such as earthquakes, tsunami, flood and fire .In worst conditions only decentralized, wireless ad-hoc networks survive. Means that can handle Emergencies situation by mobile computing easily.

3. Use in Business:

As per business point of view CEO help of this computing system can represent the presentation at the front of their clients while can access hot news of market. Help of video conference could be discuss at the topic without hindrance any time. Other side if travelling salesman want to access company database as per requirement then can be retrieved data on his wireless device and maintain the consistency company's database. Cause of these every employee are updated up to date.

4. Credit Card Verification: Credit card verification using this computing most secure. In respect of Sale terminals(POS) when customer buy items in malls and other small shops when and pay bill in form of swap credit card for transactions then need to

establish network in between POS terminal and bank central computer then over protected cellular network verify the credential information of card fatly, if match it then proceed further otherwise denied get boost up speed of transaction process and relieve the burden at the POS network.

5. Replacement of Fixed Networks:

Wired network has been replaced in wireless network e.g. trade shows, remote sensors and historical buildings. in wired networks ,weather forecasting, earthquake detection and to get environmental data are impossible .This is possible only in adapting replacement of fixed networks in this computing.

6. Infotainment:

Wireless networks are capable to deliver latest information at any suitable regions and can download knowledge about concert at morning through wireless network that concert is conducting in any region as well as Another growing field of wireless network applications lies in entertainment and games to enable, e.g., ad-hoc gaming networks as soon as people meet to play together. So Infotainment by wireless computing is more easy.

Short Questions and Answers (5 marks & 2 marks)

1) What is mobile computing and the application?

Mobile computing is the process of computation on a mobile device. In such computing, a set of distributed computing systems or service provider servers participate, connect, and synchronize through mobile communication protocols.

Applications:

i) Mobile computing offers mobility with computer power.
ii) It provides decentralized computations on diversified devices, systems, and networks, which are mobile, synchronized, and interconnected via mobile communication standards and protocols.
iii) Mobile computing facilitates a large number of applications on a single device.

2) What are the obstacles in mobile communications?

- Interference
- Regulations and spectrum
- Low Bandwidth
- High delays, large delay variation
- Lower security, simpler to attack
- Shared Medium Adhoc-networks

3) Limitations of mobile computing?

- Resource constraints.
- Interface
- Bandwidth
- Dynamic changes in communication environment.
- Network issues.
- Interoperability issues.
- Security Constraints.

4) What is wireless networks and its types?

Computer networks that are not connected by cables are called wireless networks. They generally use radio waves for communication between the network nodes. They allow devices to be connected to the network while roaming around within the network coverage.

Types of Wireless Networks

Wireless LANs –

- Connects two or more network devices using wireless distribution techniques.
- Connects two or more wireless LANs spreading over a metropolitan area.
- Connects large areas comprising LANs, MANs and personal networks.

5) What is LAN?

Stands for "Local Area Network" and is pronounced "LAN." A LAN is a network of connected devices that exist within a specific location. LANs may be found in homes, offices, educational institution, or other areas.

A LAN may be wired, wireless, or a combination of the two. A standard wired LAN uses Ethernet to connect devices together. Wireless LANs are typically created using a Wi-Fi signal. If a router supports both Ethernet and Wi-Fi connections, it can be used to create a LAN with both wired and wireless devices.

Unit-2

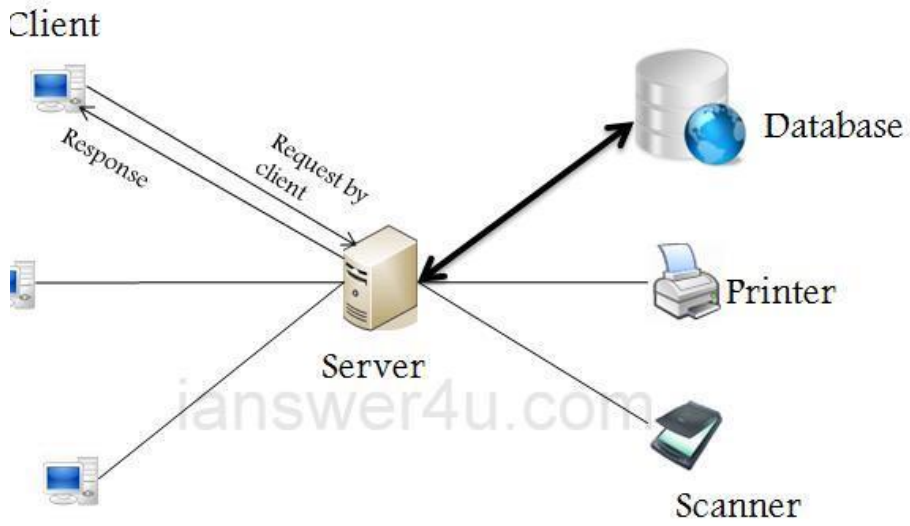
(Introduction to mobile development framework)

Long Questions and Answers (10 Marks)

1) Explain client-server architecture and n-tire architecture.

Client/server architecture is a computing model in which multiple components work in strictly defined roles to communicate. The server hosts, delivers and manages most of the resources and services to be consumed by the client. This type of shared resources architecture has one or more client computers connected to a central server over a network or internet connection.

Client/server architecture is also known as a networking computing model or client/server network because all the requests and services are delivered over a network. It's considered a form of distributed computing system because the components are doing their work independently of one another.



An **N-Tier** Application program is one that is distributed among three or more separate computers in a distributed network.

The most common form of n-tier is the 3-tier Application, and it is classified into three categories.

- User interface programming in the user's computer
- Business logic in a more centralized computer, and
- Required data in a computer that manages a database.

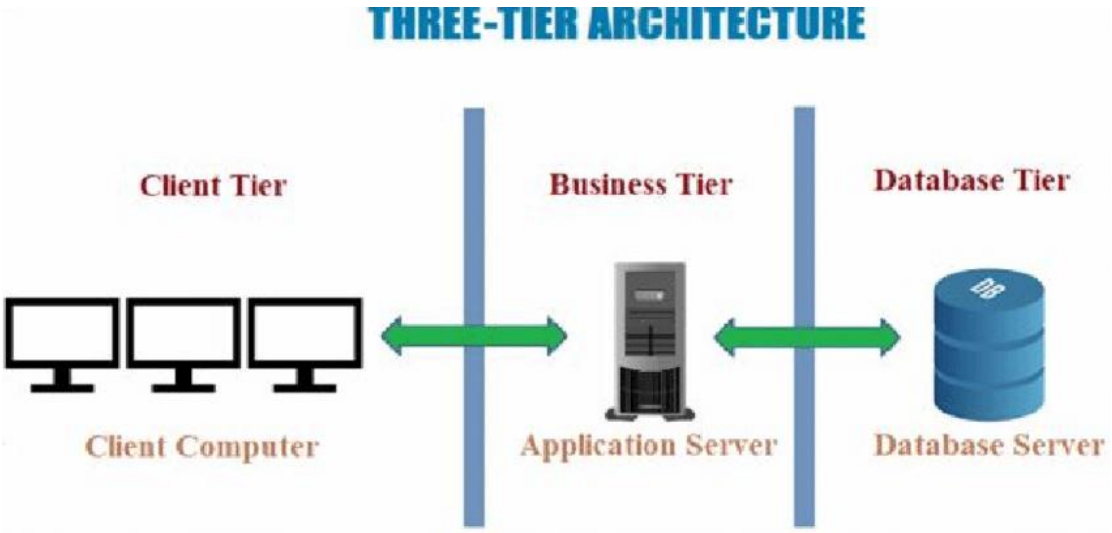
This architecture model provides Software Developers to create Reusable application/systems with maximum flexibility.

In N-tier, "N" refers to a number of tiers or layers are being used like – 2-tier, 3-tier or 4-tier, etc. It is also called “Multi-Tier Architecture”.

The n-tier architecture is an industry-proven software architecture model. It is suitable to support enterprise level client-server applications by providing solutions to scalability, security, fault tolerance, reusability, and maintainability. It helps developers to create flexible and reusable applications.

There are different types of N-Tier Architectures, like **3-tier Architecture, 2-Tier Architecture and 1- Tier Architecture.**

First, we will see 3-tier Architecture, which is very important.



3-Tier Architecture

By looking at the above diagram, you can easily identify that **3-tier architecture** has three different layers.

- Presentation layer
- Business Logic layer
- Database layer

2) Differentiate between peer-to-peer architecture and client-server architecture.

Sl no	CLIENT-SERVER	PEER-TO-PEER
1	In Client-Server Network, Clients and server are differentiated, Specific server and clients are present.	In Peer-to-Peer Network, Clients and server are not differentiated.
2	Client-Server Network focuses on information sharing.	While Peer-to-Peer Network focuses on connectivity.
3	In Client-Server Network, Centralized server is used to store the data.	While in Peer-to-Peer Network, Each peer has its own data.
4	In Client-Server Network, Server respond the services which is request by Client.	While in Peer-to-Peer Network, Each and every node can do both request and respond for the services.
5	Client-Server Network are costlier than Peer-to-Peer Network.	While Peer-to-Peer Network are less costlier than Client-Server Network.
6	Client-Server Network are more stable than Peer-to-Peer Network.	While Peer-to-Peer Network are less stable if number of peer is increase.
7	Client-Server Network is used for both small and large networks.	While Peer-to-Peer Network is generally suited for small
8	The client-server are expensive to implement.	Peer-to-peer are less expensive to implement.
9	When several clients request for the services simultaneously, a server can get bottlenecked.	As the services are provided by several servers distributed in the peer-to-peer system, a server in not bottlenecked.
10	The data is stored in a centralized server.	Each peer has its own data.

3) Explain mobile agent architecture and applications.

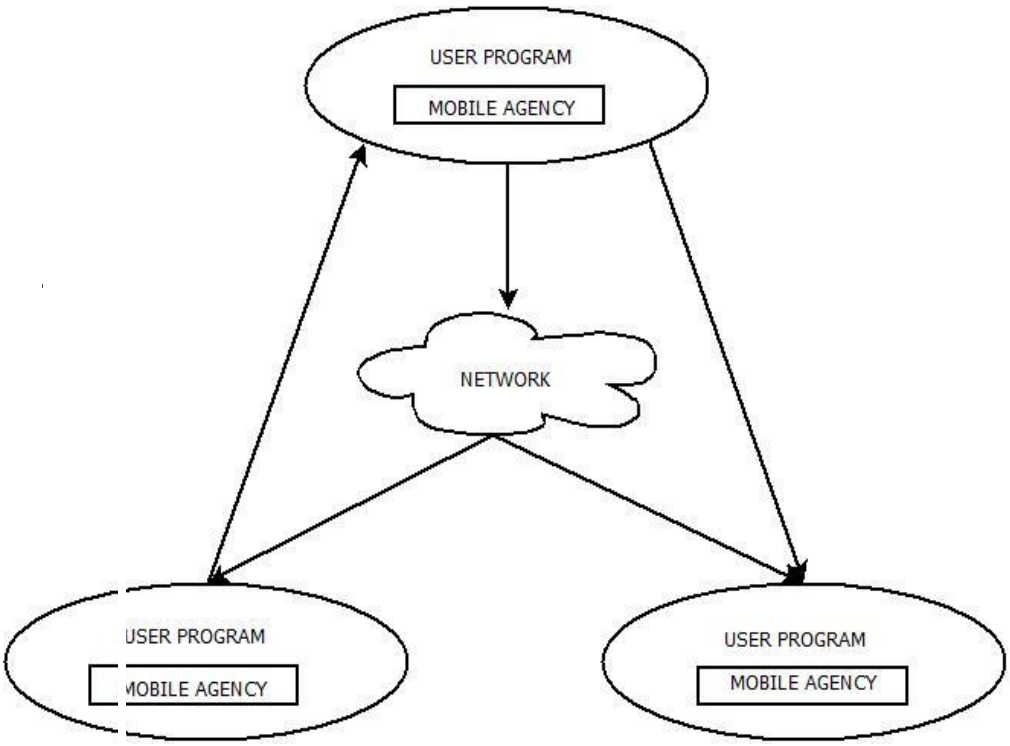
Mobile Agents are the pieces of codes that are used to store data and are independent in nature i.e. they are self-driven and does not require corresponding node for communication as they are capable of functioning even if user gets disconnected from the network.
They are also called as transportable agents.
They can be broadly classified into two types:

- Agents with pre-defined path.
- Agents with undefined path i.e. Roamer.

Life Cycle of a mobile agent:-

The life-cycle of these agents ensures that they are :

- Able to adapt the environment i.e. either home or foreign environment.
- Able to switch among the positions of one node to other.
- Focused towards the final output.
- Autonomous.



Advantages : Mobile Agents

- Autonomous-Self Driven in nature.
- They possess Less delays in network.
- They are Maintainable/Maintenance Friendly.
- They are Fault tolerant.
- They possess less load on the network.

Disadvantages : Mobile Agents

- Less secured : Security is the major loop while this concept.

Applications : Mobile Agents

- Mobile Computing.
- Parallel Computing.
- Distributed Computing.
- e-Commerce.

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3) What is WWW?

The World Wide Web (WWW) is combination of all resources and users on the Internet that are using the Hypertext Transfer Protocol (HTTP).

A broader definition comes from the World Wide Web Consortium (W3C):
"The World Wide Web is the universe of network-accessible information, an embodiment of human knowledge."

The Web, as it's commonly known, is often confused with the internet. Although the two are intricately connected, they are different things. The internet is, as its name implies, a network -- a vast, global network that incorporates a multitude of lesser networks. As such, the internet consists of supporting infrastructure and other technologies. In contrast, the Web is a communications model that, through HTTP, enables the exchange of information over the internet.

4) What is peer-to-peer architecture?

The peer to peer computing architecture contains nodes that are equal participants in data sharing. All the tasks are equally divided between all the nodes. The nodes interact with each other as required as share resources.

Characteristics of Peer to Peer architecture:-

The different characteristics of peer to peer networks are as follows −

- Peer to peer networks are usually formed by groups of a dozen or less computers. These computers all store their data using individual security but also share data with all the other nodes.
- The nodes in peer to peer networks both use resources and provide resources. So, if the nodes increase, then the resource sharing capacity of the peer to peer network increases. This is different than client server networks where the server gets overwhelmed if the nodes increase.
- Since nodes in peer to peer networks act as both clients and servers, it is difficult to provide adequate security for the nodes. This can lead to denial of service attacks.
- Most modern operating systems such as Windows and Mac OS contain software to implement peer to peer networks.

5) Define advantages and disadvantages of peer-to-peer architecture?

Advantages of Peer to Peer architecture

Some advantages of peer to peer architecture are as follows −

- Each computer in the peer to peer network manages itself. So, the network is quite easy to set up and maintain.
- In the client server network, the server handles all the requests of the clients. This provision is not required in peer to peer computing and the cost of the server is saved.
- It is easy to scale the peer to peer network and add more nodes. This only increases the data sharing capacity of the system.
- None of the nodes in the peer to peer network are dependent on the others for their functioning.

Disadvantages of Peer to Peer architecture

Some disadvantages of peer to peer computing are as follows −

- It is difficult to back up the data as it is stored in different computer systems and there is no central server.
- It is difficult to provide overall security in the peer to peer network as each system is independent and contains its own data.

Unit-3

(Wireless Transmission)

Long Questions and Answers (10 Marks)

1) What is a signal? Explain about analog and digital signal with diagram.

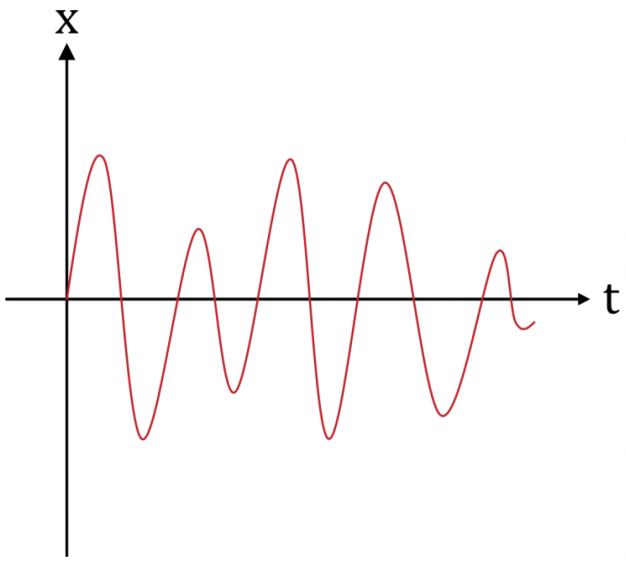
It is the physical representation of data. In electrical engineering, the fundamental quantity of representing some information is called a signal. It does not matter what the information is i-e: Analog or digital information. In mathematics, a signal is a function that conveys some information. In fact any quantity measurable through time over space or any higher dimension can be taken as a signal. A signal could be of any dimension and could be of any form.

Signal is of two types such as 1) Analog Signal 2) Digital Signal

Analog Signal

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.

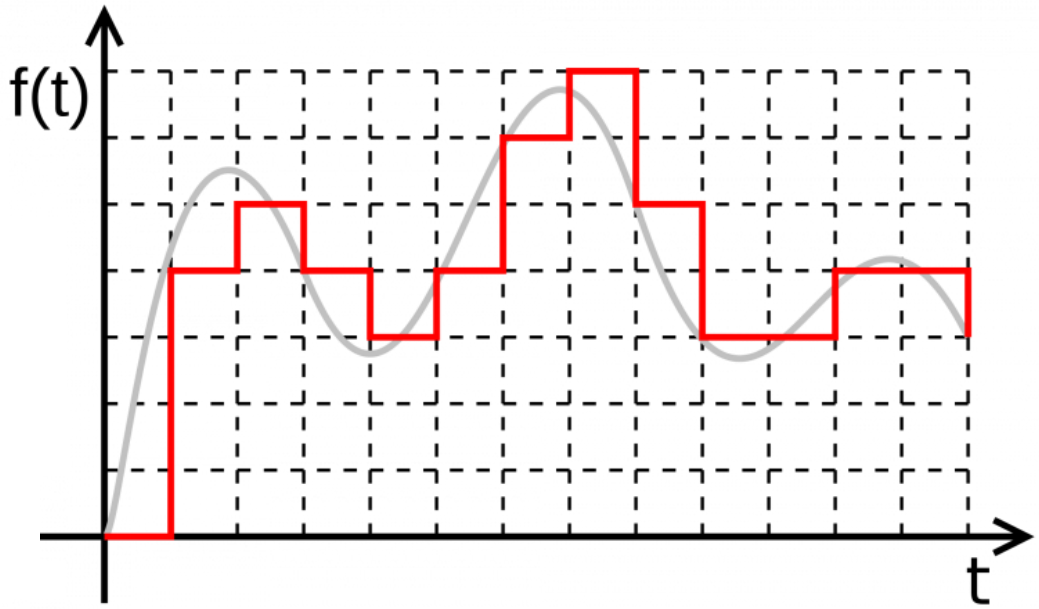
Amplitude streaks the highest height of the signal, frequency streaks the rate at which an analog signal is varying, and phase streaks the signal position with respect to time nothing. An analog signal is not resistant toward the noise, therefore; it faces distortion as well as reduces the transmission quality. The analog signal value range cannot be fixed.



(analog signal)

Digital Signal

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 in nothing but the required time for transmitting an only bit, whereas the bit rate is bit interval frequency.



(Digital Signal)

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.

2) Define amplitude, frequency and period with diagram.

Period:-

A **period** can be said to be the time taken to do something. If an event occurs repeatedly then the event is said to be periodic.

The time taken by the periodic event to repeat itself is known as the period. The time taken by the particle to complete one vibration cycle is the time period for that particle.

Frequency:-

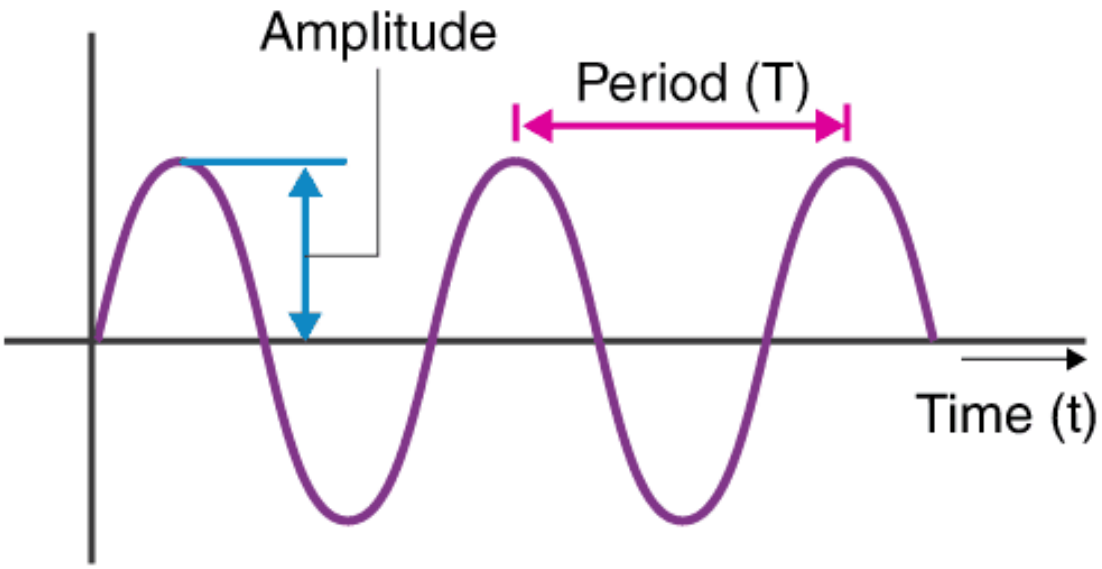
The number of cycle is completed in one second is called **frequency**. The number of oscillations per second is known as the frequency of oscillation.

Its unit is hertz and is denoted by Hz.

The frequency of a wave in general means how frequently the particles of a medium vibrate when a wave moves through the medium.

So frequency is inversely proposal to period and vice-versa so:-

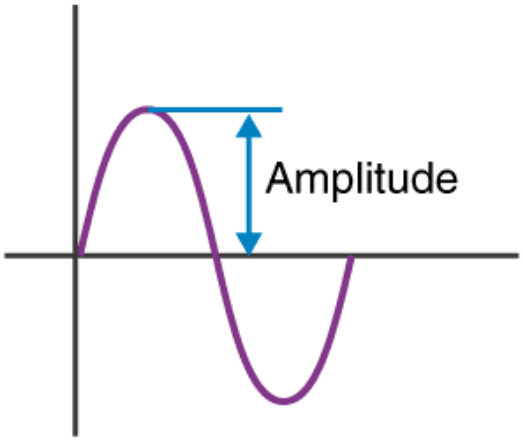
Period = 1/Frequency and Frequency = 1/Period



Frequency = 3Hz.

Amplitude:-

The amplitude of a wave is the measure of the height of the wave. The amplitude of a sound wave can be defined as the loudness or the amount of maximum displacement of vibrating particles of the medium from their mean position when the sound is produced. It is the distance between crest or trough and the mean position of the wave.



The amplitude is measured in voltage; the peak amplitude is the maximum voltage.

3) What is an antenna? Explain types of antennas

An antenna is a device to transmit and/or receive electromagnetic waves. Electromagnetic waves are often referred to as radio waves. Most antennas are resonant devices, which operate efficiently over a relatively narrow frequency band.

An antenna must be tuned (matched) to the same frequency band as the radio system to which it is connected, otherwise reception and/or transmission will be impaired.

It is two types such as:-

Directional Antenna:-

Directional antennas send and receive signals in one direction only, usually in a tightly focused, very narrow beam. The signal pattern from a directional antenna has a cigar shape, and looks the same from the top as from the sides. This shape is referred to as a lobe. Directional antennas usually have small side lobes, which are typically ignored because they don't do much for a signal. However, you should be aware that they exist in case you find a small signal off to the side of a directional antenna.

Directional antennas come in a variety of shapes, sizes and designs that fluctuate widely according to their intended purpose. Common directional antenna designs include panel antennas, parabolic or “dish” antennas, sector antennas, grid antennas, and the Yagi antenna. All of these have different applications that are highly dependant on the particular setup.

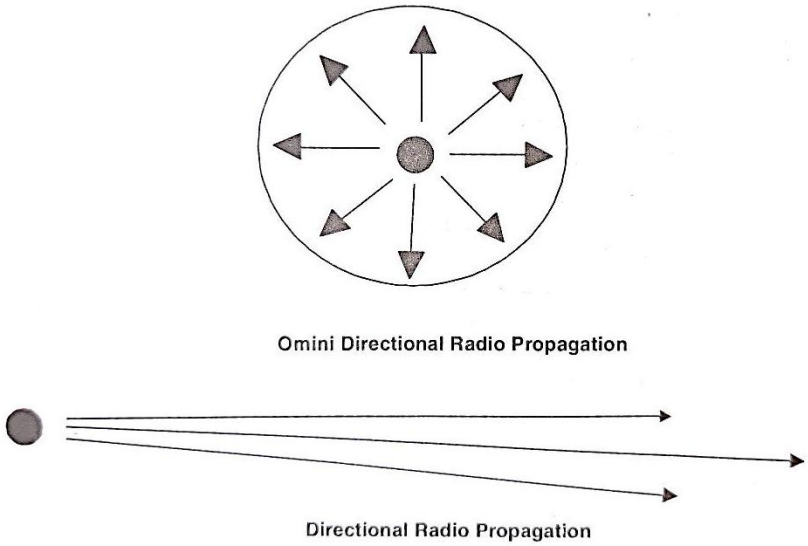


Fig. 4 Two types of Antennae

Omni Directional Antenna:-

An omnidirectional antenna is a class of antenna which radiates equal radio power in all directions perpendicular to an axis (azimuthal directions), with power varying with angle to the axis (elevation angle), declining to zero on the axis.

When graphed in three dimensions (see graph) this radiation pattern is often described as doughnut-shaped. Note that this is different from an isotropic antenna, which radiates equal power in all directions, having a spherical radiation pattern. Omnidirectional antennas oriented vertically are widely used for no directional antennas on the surface of the Earth because they radiate equally in all horizontal directions, while the power radiated drops off with elevation angle so little radio energy is aimed into the sky or down toward the earth and wasted.

Omnidirectional antennas are widely used for radio broadcasting antennas, and in mobile devices that use radio such as cell phones, FM radios, walkie-talkies, wireless computer networks, cordless phones, GPS, as well as for base stations that communicate with mobile radios, such as police and taxi dispatchers and aircraft communications.

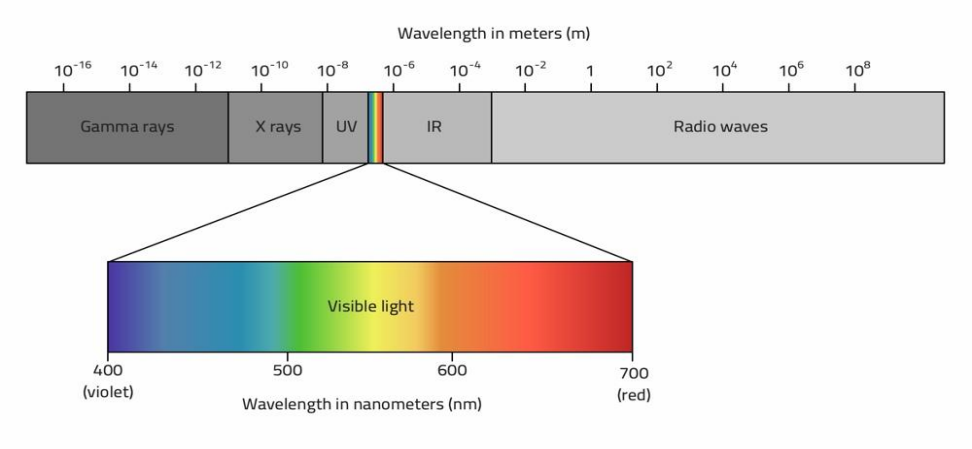
4) What is signal propagation? Explain LOS propagation with diagram.

Radio propagation is the way radio waves travel or propagate when they are transmitted from one point to another and affected by the medium in which they travel and in particular the way they propagate around the Earth in various parts of the atmosphere.

In Radio communication systems, we use wireless electromagnetic waves as the channel. The antennas of different specifications can be used for these purposes. The mode of propagation of electromagnetic waves in the atmosphere and in free space may be divided into the following three categories:

- The line of sight (LOS) propagation
- Ground wave propagation
- Skywave propagation

In ELF (Extremely low frequency) and VLF (Very low frequency) frequency bands, the Earth, and the ionosphere act as a wave-guide for electromagnetic wave propagation. In these frequency ranges, communication signals practically propagate around the world. The channel bandwidths are small. Therefore, the information is transmitted through these channels has slow speed and confined to digital transmission.



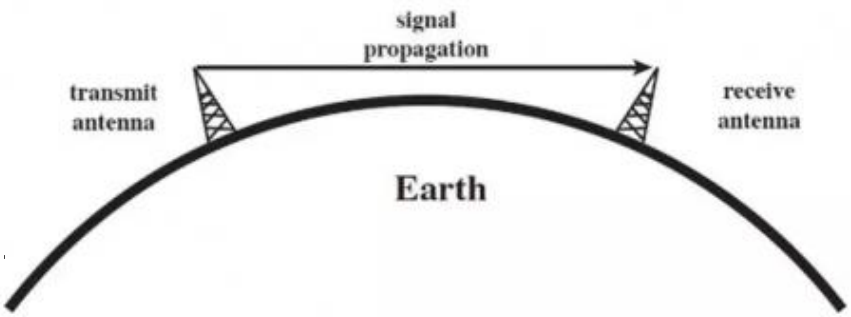
Factors affecting signal propagations:-

There are many factors that affect the way in which radio signals or radio waves propagate. These are determined by the medium through which the radio waves travel and the various objects that may appear in the path. The properties of the path by which the radio signals will propagate governs the level and quality of the received signal.

Reflection, refraction and diffraction may occur. The resultant radio signal may also be a combination of several signals that have travelled by different paths. These may add together or subtract from one another, and in addition to this the signals travelling via different paths may be delayed causing distorting of the resultant signal. It is therefore very important to know the likely radio propagation characteristics that are likely to prevail.

The line of Sight (LOS) Propagation

Among the modes of propagation, this line-of-sight propagation is the one, which we would have commonly noticed. In the line-of-sight communication, as the name implies, the wave travels a minimum distance of sight. Which means it travels to the distance up to which a naked eye can see. Then we need to employ an amplifier cum transmitter here to amplify the signal and transmit again.



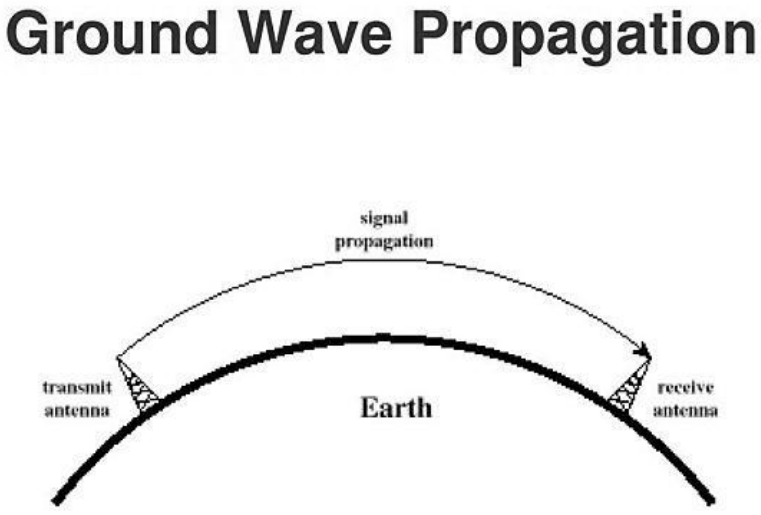
Line-of-sight (LOS) propagation (above 30 MHz)

The line-of-sight propagation will not be smooth if there occurs any obstacle in its transmission path. As the signal can travel only to lesser distances in this mode, this transmission is used for infrared or microwave transmissions.

5) Explain ground propagation and sky propagation technique.

Ground Wave Propagation

Ground wave propagation of the wave follows the contour of the earth. Such a wave is called a direct wave. The wave sometimes bends due to the Earth's magnetic field and gets reflected the receiver. Such a wave can be termed as a reflected wave. The following figure depicts ground wave propagation.



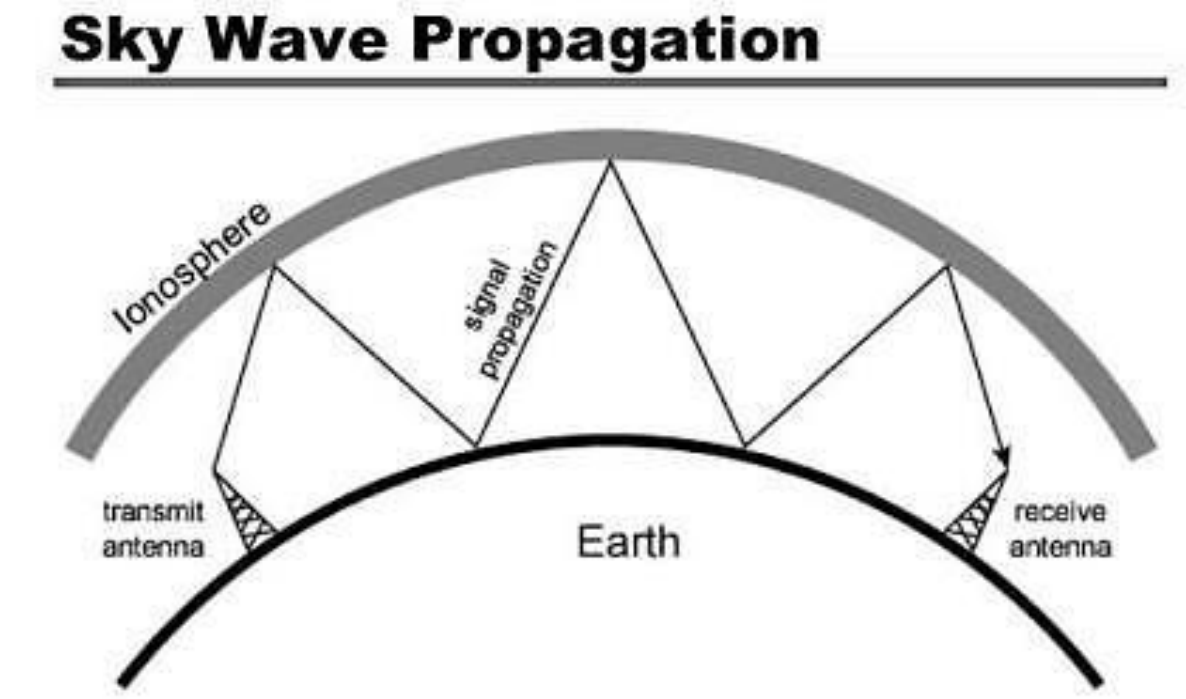
The wave then propagates through the Earth's atmosphere is known as a ground wave. The direct wave and reflected wave together contribute the signal at the receiver station. When the wave finally reaches the receiver, the lags are cancelled out. In addition, the signal is filtered to avoid distortion and amplified for clear output.

Sky Wave Propagation

Sky wave propagation is preferred when the wave has to travel a longer distance. Here the wave is projected onto the sky and it is again reflected back to the earth.

The sky wave propagation is well depicted in the above picture. Here the waves are shown to be transmitted from one place and where it is received by many receivers. Hence, it is an example of broadcasting.

The waves, which are transmitted from the transmitter antenna, are reflected from the ionosphere. It consists of several layers of charged particles ranging in altitude from 30-250 miles above the surface of the earth.



(b) Sky-wave propagation (2 to 30 MHz)

Such travel of the wave from the transmitter to the ionosphere and from there to the receiver on Earth is known as Sky Wave Propagation. The ionosphere is the ionized layer around the Earth's atmosphere, which is suitable for sky wave propagation.

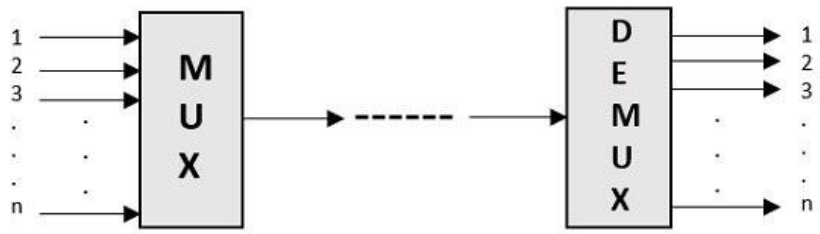
6) What is multiplexing technique? Explain FDM with proper diagram.

Multiplexing is the process of combining multiple signals into one signal, over a shared medium. If the analog signals are multiplexed, then it is called as analog multiplexing. Similarly, if the digital signals are multiplexed, then it is called as digital multiplexing.

Multiplexing was first developed in telephony. A number of signals were combined to send through a single cable. The process of multiplexing divides a communication channel into several number of logical channels, allotting each one for a different message signal or a data stream to be transferred. The device that does multiplexing can be called as Multiplexer or MUX.

The reverse process, i.e., extracting the number of channels from one, which is done at the receiver is called as de-multiplexing. The device that does de-multiplexing can be called as de-multiplexer or DEMUX.

The following figures illustrates the concept of MUX and DEMUX. Their primary use is in the field of communications.



Multiplexing and Demultiplexing

Frequency division multiplexing (FDM) is a technique of multiplexing which means combining more than one signal over a shared medium. In FDM, signals of different frequencies are combined for concurrent transmission.

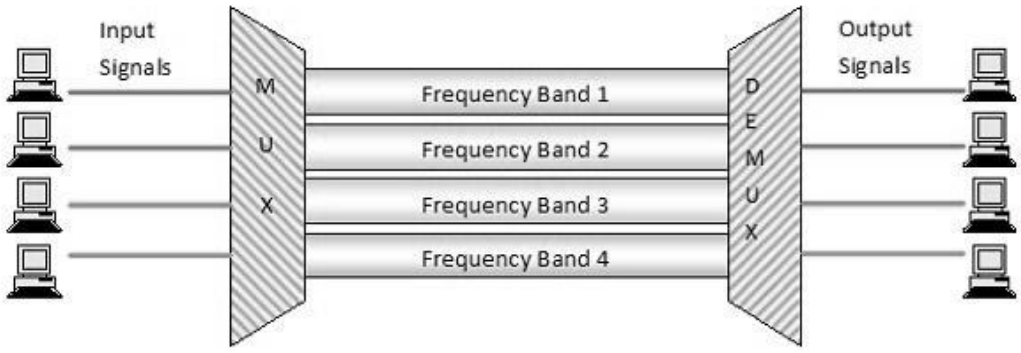
Concept and Process

In FDM, the total bandwidth is divided to a set of frequency bands that do not overlap. Each of these bands is a carrier of a different signal that is generated and modulated by one of the sending devices. The frequency bands are separated from one another by strips of unused frequencies called the guard bands, to prevent overlapping of signals.

The modulated signals are combined together using a multiplexer (MUX) in the sending end. The combined signal is transmitted over the communication channel, thus allowing multiple independent data streams to be transmitted simultaneously. At the receiving end, the individual signals are extracted from the combined signal by the process of de-multiplexing (DEMUX).

Example

The following diagram conceptually represents multiplexing using FDM. It has 4 frequency bands, each of which can carry signal from 1 sender to 1 receiver. Each of the 4 senders is allocated a frequency band. The four frequency bands are multiplexed and sent via the communication channel. At the receiving end, a de-multiplexer regenerates the original four signals as outputs.



Here, if the frequency bands are of 150 KHz bandwidth separated by 10KHz guard bands, then the capacity of the communication channel should be at least 630 KHz (channels : 150 × 4 + guard bands : 10 × 3).

Uses and Applications

- It allows sharing of a single transmission medium like a copper cable or a fiber optic cable, among multiple independent signals generated by multiple users.
- FDM has been popularly used to multiplex calls in telephone networks. It can also be used in cellular networks, wireless networks and for satellite communications.

7) Explain TDM and CDM multiplexing techniques

Multiplexing is the process of combining multiple signals into one signal, over a shared medium. It is three types i:e FDM,TDM and CDM.

Time division multiplexing (TDM) is a technique of multiplexing, where the users are allowed the total available bandwidth on time sharing basis. Here the time domain is divided into several recurrent slots of fixed length, and each signal is allotted a time slot on a round-robin basis.

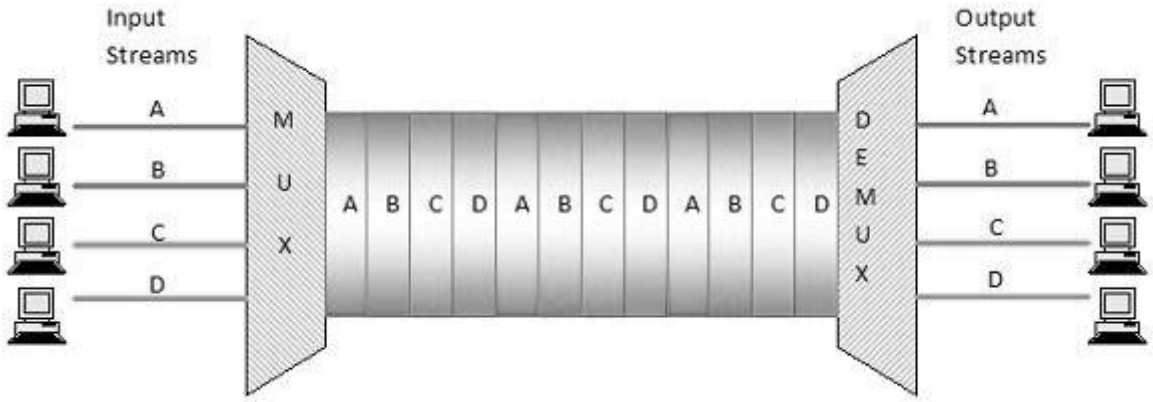
Concept and Process

In TDM, the data flow of each input stream is divided into units. One unit may be 1 bit, 1 byte, or a block of few bytes. Each input unit is allotted an input time slot. One input unit corresponds to one output unit and is allotted an output time slot. During transmission, one unit of each of the input streams is allotted one-time slot,

periodically, in a sequence, on a rotational basis. This system is popularly called round-robin system.

Example

Consider a system having four input streams, A, B, C and D. Each of the data streams is divided into units which are allocated time slots in the round – robin manner. Hence, the time slot 1 is allotted to A, slot 2 is allotted to B, slot 3 is allotted to C, slot 4 is allotted to D, slot 5 is allocated to A again, and this goes on till the data in all the streams are transmitted.



Uses and Applications

It is widely used in telephone and cellular networks.

Code division multiplexing (CDM) is a multiplexing technique that uses spread spectrum communication. In spread spectrum communications, a narrowband signal is spread over a larger band of frequency or across multiple channels via division. It does not constrict bandwidth's digital signals or frequencies. It is less susceptible to interference, thus providing better data communication capability and a more secure private line.

Code Division Multiple Access

When CDM is used to allow multiple signals from multiple users to share a common communication channel, the technology is called Code Division Multiple Access (CDMA). Each group of users is given a shared code and individual conversations are encoded in a digital sequence. Data is available on the shared channel, but only those users associated with a particular code can access the data.

Concept

Each communicating station is assigned a unique code. The codes stations have the following properties –

- If code of one station is multiplied by code of another station, it yields 0.
- If code of one station is multiplied by itself, it yields a positive number equal to the number of stations.

The communication technique can be explained by the following example –

Consider that there are four stations w, x, y and z that have been assigned the codes cw , cx, cy and cz and need to transmit data dw , dx, dy and dz respectively. Each station multiplies its code with its data and the sum of all the terms is transmitted in the communication channel.

Thus, the data in the communication channel is dw . cw+ dx . cx+ dy . cy+ dz . cz

Suppose that at the receiving end, station z wants to receive data sent by station y. In order to retrieve the data, it will multiply the received data by the code of station y which is dy.

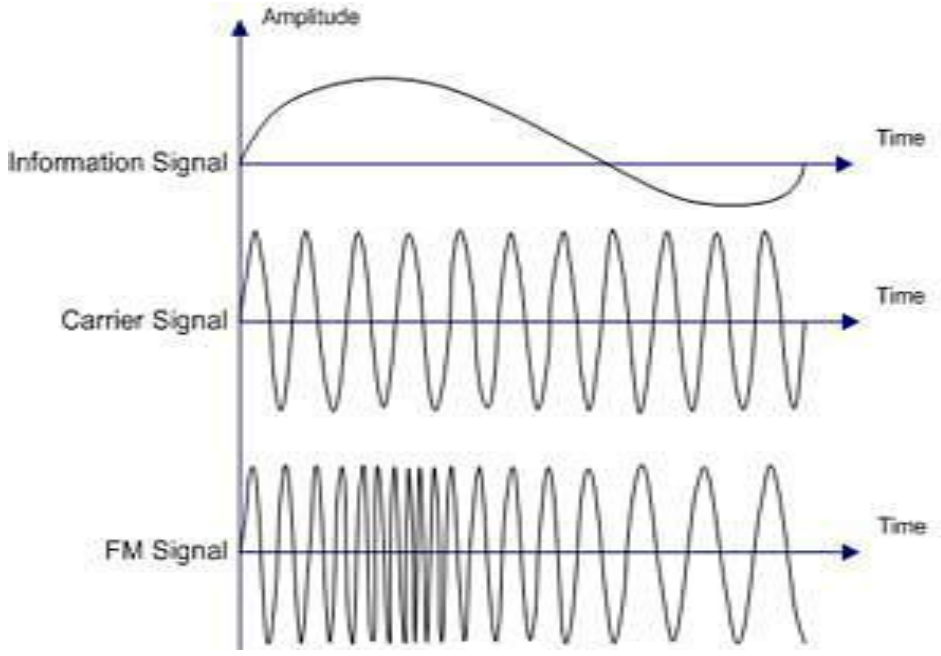
8) Explain about AM, PM and FM modulation technique.

Modulation is the process of converting data into electrical signals optimized for transmission. Modulation techniques are roughly divided into four types: Frequency Modulation, Amplitude modulation, Phase modulation.

Frequency Modulation

In amplitude modulation, the amplitude of the carrier varies. But in Frequency Modulation (FM), the frequency of the carrier signal varies in accordance with the instantaneous amplitude of the modulating signal.

The amplitude and the phase of the carrier signal remains constant whereas the frequency of the carrier changes. This can be better understood by observing the following figures.



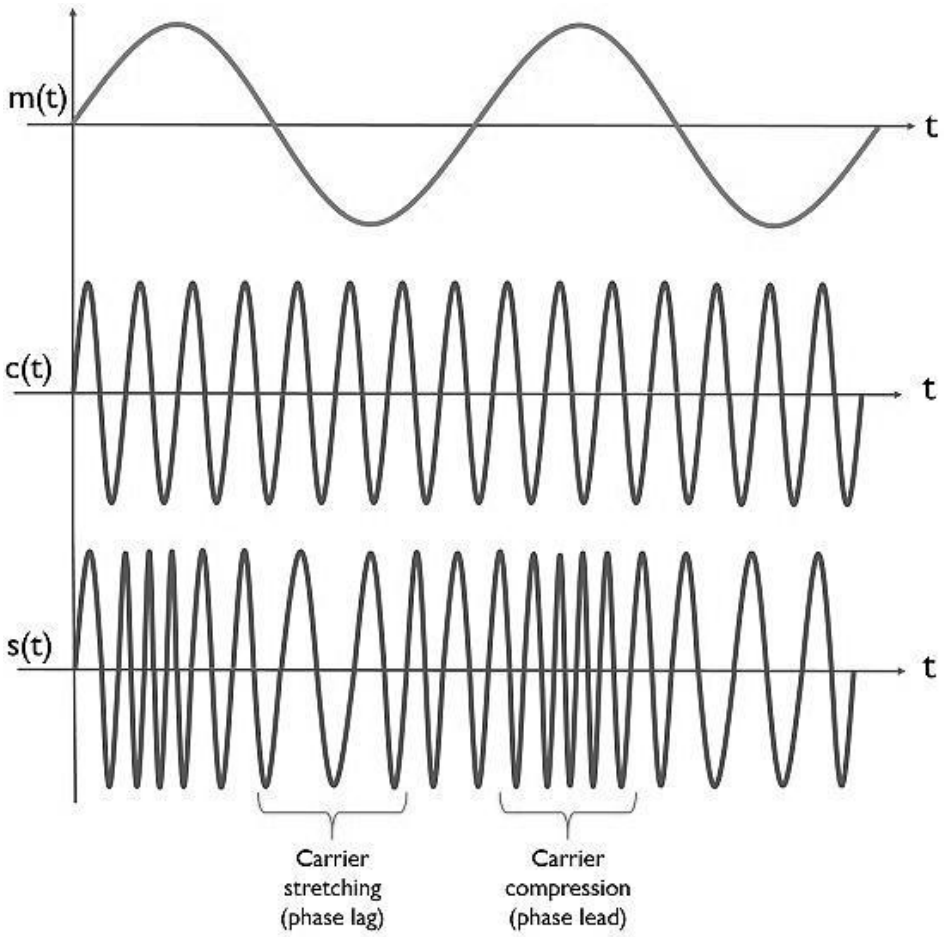
The frequency of the modulated wave remains constant as the carrier wave frequency when the message signal is at zero. The frequency increases when the message signal reaches its maximum amplitude.

Which means, with the increase in amplitude of the modulating or message signal, the carrier frequency increases. Likewise, with the decrease in the amplitude of the modulating signal, the frequency also decreases.

Phase Modulation

In frequency modulation, the frequency of the carrier varies. But in Phase Modulation (PM), the phase of the carrier signal varies in accordance with the instantaneous amplitude of the modulating signal.

The amplitude and the frequency of the carrier signal remains constant whereas the phase of the carrier changes. This can be better understood by observing the following figures.



Waveform for Phase Modulation

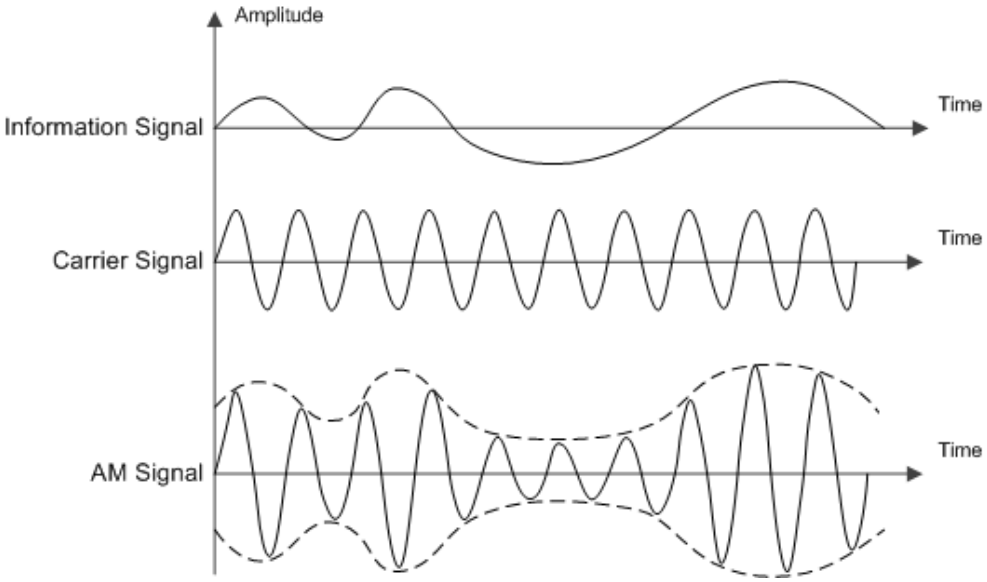
Electronics Coach

The phase of the modulated wave has got infinite points where the phase shift in a wave can take place. The instantaneous amplitude of the modulating signal, changes the phase of the carrier. When the amplitude is positive, the phase changes in one direction and if the amplitude is negative, the phase changes in the opposite direction.

Amplitude Modulation

A continuous-wave goes on continuously without any intervals and it is the baseband message signal, which contains the information. This wave has to be modulated.

According to the standard definition, "The amplitude of the carrier signal varies in accordance with the instantaneous amplitude of the modulating signal." Which means, the amplitude of the carrier signal containing no information varies as per the amplitude of the signal containing information, at each instant. This can be well explained by the following figures.



Amplitude modulation or AM as it is often called, is a form of modulation used for radio transmissions for broadcasting and two way radio communication applications.

Although one of the earliest used forms of modulation it is still used today, mainly for long, medium and short wave broadcasting and for some aeronautical point to point communications.

One of the key reasons for the use of amplitude modulation was its ease of use. The system simply required the carrier amplitude to be modulated, but more usefully the detector required in the receiver could be a simple diode based circuit. This meant that AM radios did not need complicated demodulators and costs were reduced - a key requirement for widespread use of radio technology, especially in the early days of radio when ICs were not available.

9) Explain ASK, PSK and FSK .

Digital Modulation provides more information capacity, high data security, quicker system availability with great quality communication. Hence, digital modulation techniques have a greater demand, for their capacity to convey larger amounts of data than analog ones.

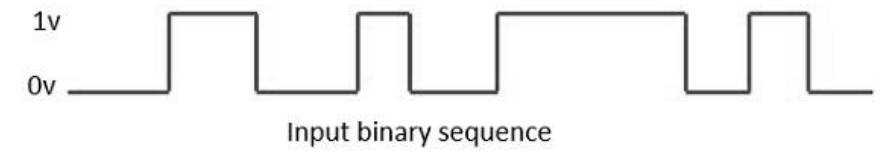
There are many types of digital modulation techniques and we can even use a combination of these techniques as well. In this chapter, we will be discussing the most prominent digital modulation techniques.

Amplitude Shift Keying(ASK)

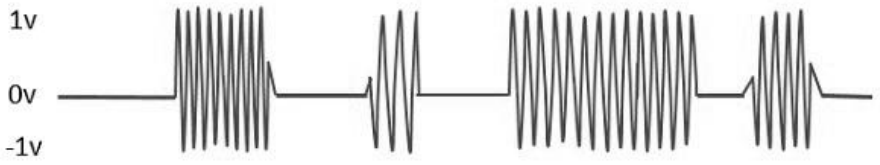
The amplitude of the resultant output depends upon the input data whether it should be a zero level or a variation of positive and negative, depending upon the carrier frequency.

Amplitude Shift Keying (ASK) is a type of Amplitude Modulation which represents the binary data in the form of variations in the amplitude of a signal.

Following is the diagram for ASK modulated waveform along with its input.



Input binary sequence



ASK Modulated output wave

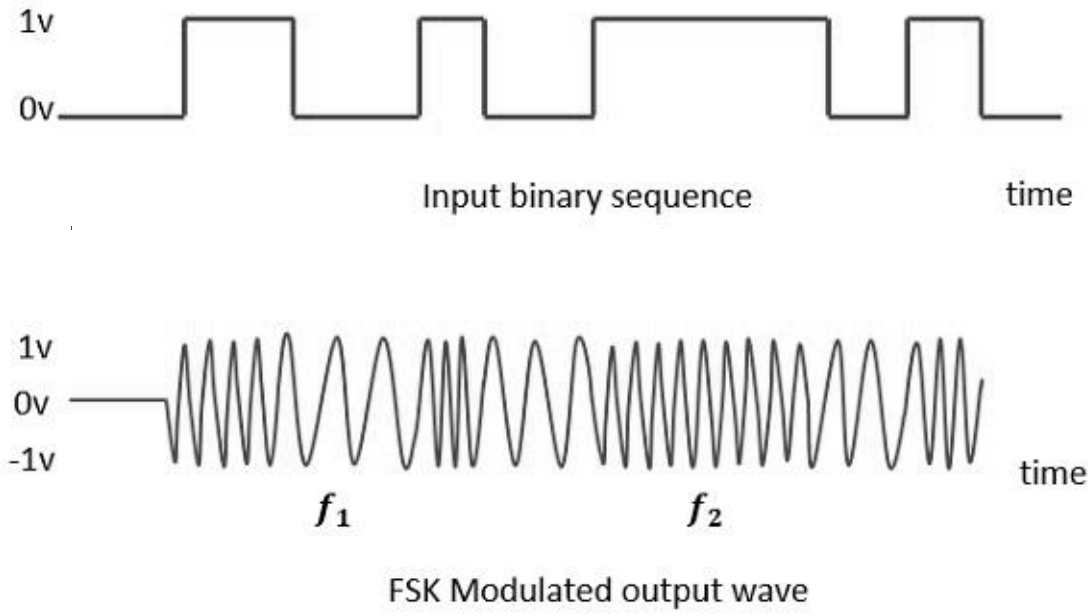
Any modulated signal has a high frequency carrier. The binary signal when ASK is modulated, gives a zero value for LOW input and gives the carrier output for HIGH input.

Frequency Shift Keying(FSK)

The frequency of the output signal will be either high or low, depending upon the input data applied.

Frequency Shift Keying (FSK) is the digital modulation technique in which the frequency of the carrier signal varies according to the discrete digital changes. FSK is a scheme of frequency modulation.

Following is the diagram for FSK modulated waveform along with its input.



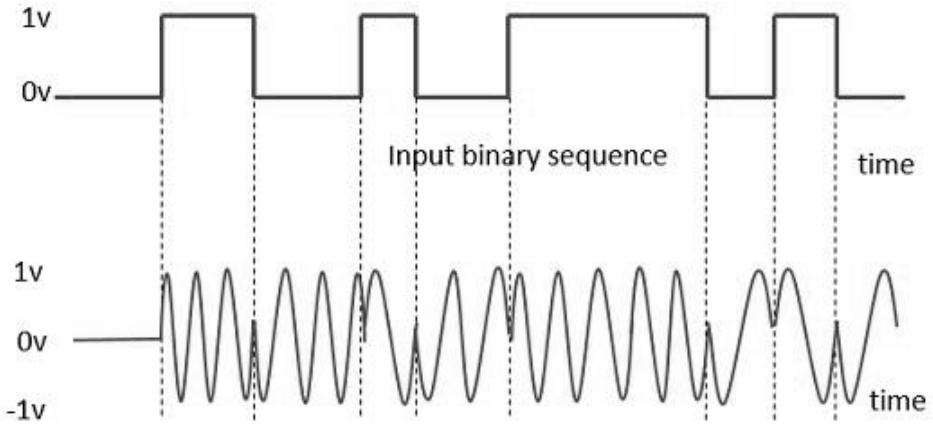
FSK Modulated output wave

The output of a FSK modulated wave is high in frequency for a binary HIGH input and is low in frequency for a binary LOW input. The binary 1s and 0s are called Mark and Space frequencies.

Phase Shift Keying(PSK)

The phase of the output signal gets shifted depending upon the input. These are mainly of two types, namely BPSK and QPSK, according to the number of phase shifts. The other one is DPSK which changes the phase according to the previous value.

Phase Shift Keying (PSK) is the digital modulation technique in which the phase of the carrier signal is changed by varying the sine and cosine inputs at a particular time. PSK technique is widely used for wireless LANs, bio-metric, contactless operations, along with RFID and Bluetooth communications.



BPSK Modulated output wave

10) What is cellular system? Define cell size and cell cluster.

Cellular system is an underlying technology for mobile phones, personal communication systems, wireless networking etc. The technology is developed for mobile radio telephone to replace high power transmitter/receiver systems. Cellular networks use lower power, shorter range and more transmitters for data transmission.

Features of Cellular Systems

Wireless Cellular Systems solves the problem of spectral congestion and increases user capacity. The features of cellular systems are as follows −

- Offer very high capacity in a limited spectrum.
- Reuse of radio channel in different cells.
- Enable a fixed number of channels to serve an arbitrarily large number of users by reusing the channel throughout the coverage region.
- Communication is always between mobile and base station (not directly between mobiles).
- Each cellular base station is allocated a group of radio channels within a small geographic area called a cell.
- Neighboring cells are assigned different channel groups.
- By limiting the coverage area to within the boundary of the cell, the channel groups may be reused to cover different cells.
- Keep interference levels within tolerable limits.
- Frequency reuse or frequency planning.
- Organization of Wireless Cellular Network.

Cell size

Even though the number of cells in a cluster in a cellular system can help govern the number of users that can be accommodated, by making all the cells smaller it is possible to increase the overall capacity of the cellular system. However a greater number of transmitter receiver or base stations are required if cells are made smaller and this increases the cost to the operator. Accordingly in areas where there are more users, small low power base stations are installed.

The different types of cells are given different names according to their size and function:

1. **Macro cells:**
   Macro cells are large cells that are usually used for remote or sparsely populated areas. These may be 10 km or possibly more in diameter.
2. **Micro cells:**
   Micro cells are those that are normally found in densely populated areas which may have a diameter of around 1 km.

3. **Pico cells:**

   Pico cells are generally used for covering very small areas such as particular areas of buildings, or possibly tunnels where coverage from a larger cell in the cellular system is not possible. Obviously for the small cells, the power levels used by the base stations are much lower and the antennas are not position to cover wide areas. In this way the coverage is minimised and the interference to adjacent cells is reduced.

4. **Selective cells**:

   Sometimes cells termed selective cells may be used where full 360 degree coverage is not required. They may be used to fill in a hole in the coverage in the cellular system, or to address a problem such as the entrance to a tunnel etc.

5. **Umbrella cells:**

   Another type of cells known as an umbrella cell is sometimes used in instances such as those where a heavily used road crosses an area where there are microcells. Under normal circumstances this would result in a large number of handovers as people driving along the road would quickly cross the microcells. An umbrella cell would take in the coverage of the microcells (but use different channels to those allocated to the microcells). However it would enable those people moving along the road to be handled by the umbrella cell and experience fewer handovers than if they had to pass from one microcell to the next.

Cell clusters

When devising the infrastructure technology of a cellular system, the interference between adjacent channels is reduced by allocating different frequency bands or channels to adjacent cells so that their coverage can overlap slightly without causing interference. In this way cells can be grouped together in what is termed a cluster.

Often these clusters contain seven cells, but other configurations are also possible. Seven is a convenient number, but there are a number of conflicting requirements that need to be balanced when choosing the number of cells in a cluster for a cellular system:

- Limiting interference levels
- Number of channels that can be allocated to each cell site

It is necessary to limit the interference between cells having the same frequency. The topology of the cell configuration has a large impact on this. The larger the number of cells in the cluster, the greater the distance between cells sharing the same frequencies.

In the ideal world it might be good to choose a large number of cells to be in each cluster. Unfortunately there are only a limited number of channels available. This means that the larger the number of cells in a cluster, the smaller the number available to each cell, and this reduces the capacity.

This means that there is a balance that needs to be made between the number of cells in a cluster, and the interference levels, and the capacity that is required.

11) What is spread spectrum? Define range of spread spectrum.

Spread spectrum is a form of wireless communications in which the frequency of the transmitted signal is deliberately varied. These results in a much greater bandwidth than the signal would have if its frequency were not varied.

A conventional wireless signal has a frequency, usually specified in megahertz (MHz) or gigahertz gigahertz), that does not change with time (except for small, rapid fluctuations that occur as a result of modulation).

Ranges of radio frequency as follows:-

Band name	Abbreviation	ITU band number	Frequency and Wavelength	Example Uses
Extremely low frequency	ELF	1	3–30 Hz 100,000–10,000 km	Communication with submarines
Super low frequency	SLF	2	30–300 Hz 10,000–1,000 km	Communication with submarines
Ultra low frequency	ULF	3	300–3,000 Hz 1,000–100 km	Submarine communication, communication within mines
Very low frequency	VLF	4	3–30 kHz 100–10 km	Navigation, time signals, submarine communication, wireless heart rate monitors, geophysics
Low frequency	LF	5	30–300 kHz 10–1 km	Navigation, time signals, AM long wave broadcasting

				(Europe and parts of Asia), RFID, amateur radio
Medium frequency	MF	6	300–3,000 kHz 1,000–100 m	AM (medium-wave) broadcasts, amateur radio, avalanche beacons
High frequency	HF	7	3–30 MHz 100–10 m	Shortwave broadcasts, citizens band radio, amateur radio and over-the-horizon aviation communications, RFID, over-the-horizon radar, automatic link establishment (ALE) / near-vertical incidence sky wave (NVIS) radio communications, marine and mobile radio telephony
Very high frequency	VHF	8	30–300 MHz 10–1 m	FM, television broadcasts, line-of-sight ground-to-aircraft and aircraft-to-aircraft communications, land mobile and maritime mobile communications, amateur radio, weather radio
Ultra high frequency	UHF	9	300–3,000 MHz 1–0.1 m	Television broadcasts, microwave oven, microwave devices/communications, radio astronomy, mobile phones, wireless LAN, Bluetooth, ZigBee, GPS and two-way radios such as land mobile, FRS and GMRS radios, amateur radio, satellite radio, Remote control Systems, ADSB

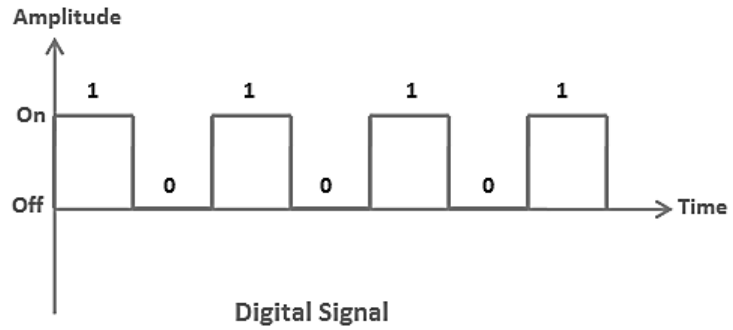
Super high frequency	SHF	10	3–30 GHz 100–10 mm	Radio astronomy, microwave devices/communications, wireless LAN, DSRC, most modern radars, communications satellites, cable and satellite television broadcasting, DBS, amateur radio, satellite radio
Extremely high frequency	EHF	11	30–300 GHz 10–1 mm	Radio astronomy, high-frequency microwave radio relay, microwave remote sensing, amateur radio, directed-energy weapon, millimeter wave scanner, wireless LAN (802.11ad)
Terahertz or Tremendously high frequency	THz or THF	12	300–3,000 GHz 1–0.1 mm	Experimental medical imaging to replace X-rays, ultrafast molecular dynamics, condensed-matter physics, terahertz time-domain spectroscopy, terahertz computing/communications, remote sensing

Short Questions and Answers (5 marks & 2 marks)

1) What digital signal?

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.

Data in the form of zeros (0) and ones (1) bit.



Digital Signal

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 in nothing but the required time for transmitting an only bit, whereas the bit rate is bit interval frequency.

2) What is multiplexing?

Multiplexing is the process of combining multiple signals into one signal, over a shared medium. If the analog signals are multiplexed, then it is called as analog multiplexing. Similarly, if the digital signals are multiplexed, then it is called as digital multiplexing.

Multiplexing was first developed in telephony. A number of signals were combined to send through a single cable. The process of multiplexing divides a communication channel into several number of logical channels, allotting each one for a different message signal or a data stream to be transferred. The device that does multiplexing can be called as Multiplexer or MUX.

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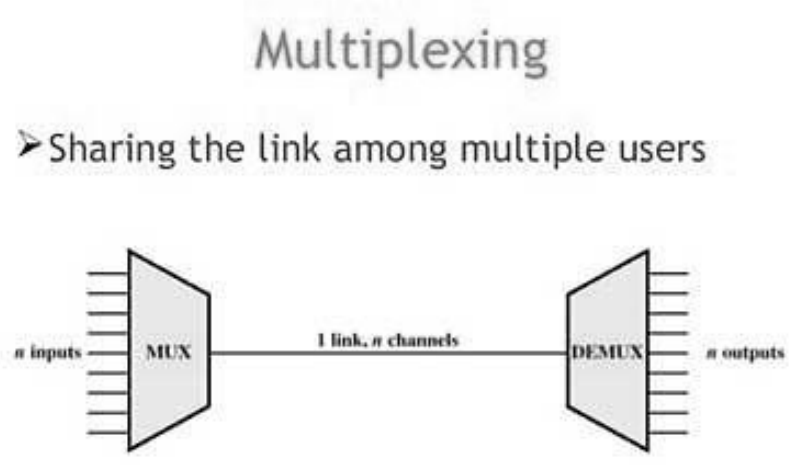

3) What is cellular system?

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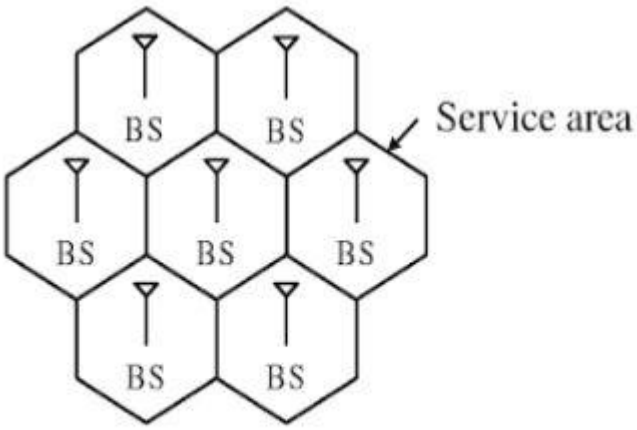
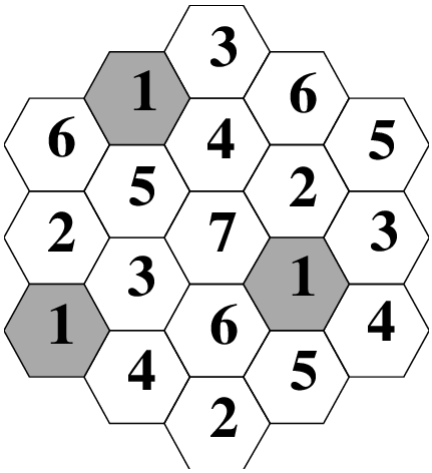


Fig: Cellular system: small zone

4) What is frequency reuse and its features?

Frequency Reuse is the scheme in which allocation and reuse of channels throughout a coverage region is done. Each cellular base station is allocated a group of radio channels or Frequency sub-bands to be used within a small geographic area known as a cell.



The shape of the cell is Hexagonal. The process of selecting and allocating the frequency sub-bands for all of the cellular base station within a system is called **Frequency reuse** or **Frequency Planning**.

Features of using Frequency Reuse:

- Frequency reuse improves the spectral efficiency and signal Quality (QoS).
- Frequency reuse classical scheme proposed for GSM systems offers a protection against interference.
- The number of times a frequency can be reused is depend on the tolerance capacity of the radio channel from the nearby transmitter that is using the same frequencies.
- In Frequency Reuse scheme, total bandwidth is divided into different sub-bands that are used by cells.
- Frequency reuse scheme allow WiMax system operators to reuse the same frequencies at different cell sites.

5) What is cell size?

The cell size accordingly in areas where there are more users, small low power base stations are installed.

The different types of cells are given different names according to their size and function:

1. **Macro cells:**
   Macro cells are large cells that are usually used for remote or sparsely populated areas. These may be 10 km or possibly more in diameter.
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Unit-4

(Medium Access Control)

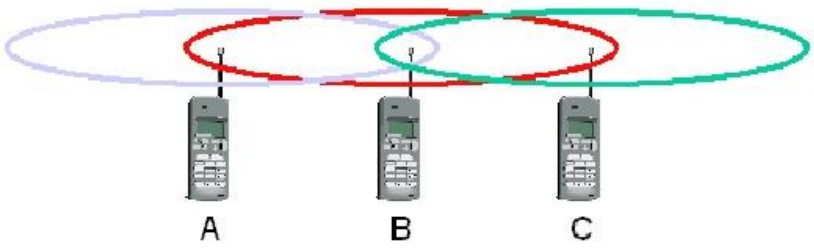
Long Questions and Answers (10 Marks)

1) What is hidden/exposed terminal?

A wireless network with lack of centralized control entity, sharing of wireless bandwidth among network access nodes i.e. medium access control (MAC) nodes must be organized in decentralized manner. The hidden terminal problem occurs when a terminal is visible from a wireless access point (APs), but not from other nodes communicating with that AP. This situation leads the difficulties in medium access control sublayer over wireless networking.

Consider A,B and C are three terminals, In a formal way hidden terminals are nodes in a wireless network that are out of range of other node or a collection of nodes. Consider a wireless networking, each node at the far edge of the access point's range, which is known as A, can see the access point, but it is unlikely that the same node can see a node on the opposite end of the access point's range, C. These nodes are known as hidden. The problem is when nodes A and C start to send packets simultaneously to the access point B. Because the nodes A and C are out of range of each other and so cannot detect a collision while transmitting, Carrier sense multiple access with collision detection (CSMA/CD) does not work, and collisions occur, which then corrupt the data received by the access point.

Consider the scenario of wireless networking with three wireless devices (e.g. mobile phones) as shown below.



The transmission range of access point A reaches at B, but not at access point C, similarly transmission range of access point C reaches B, but not at A. These nodes are known as hidden terminals.

The problem occurs when nodes A and C start to send data packets simultaneously to the access point B. Because the access points A and C are out of range of each other and resultant they cannot detect a collision while transmitting, Carrier sense multiple access with collision detection (CSMA/CD) does not work, and collisions occur, which then corrupt the data received by the access point B due to the hidden terminal problem.

The hidden and exposed terminal analogy is described as follows:

- Terminal A sends data to B, terminal C cannot hear A
- Terminal C wants to send data to B, terminal C senses a "free" medium (CS fails) and starts transmitting
- Collision at B occurs, A cannot detect this collision (CD fails) and continues with its transmission to B
- Terminal A is "hidden" from C and vice versa.
- Terminal B is exposed to terminal C and vice versa.

2) Differentiate between CSMA/CA and CSMA/CD.

CSMA/CD:
CSMA/CD stands for Carrier Sense Multiple Access / Collision Detection is a network protocol for carrier transmission. It is operated in the medium access control layer. It senses of the shared channel is busy for broadcasting and interrupts the broadcast until the channel is free. In CSMA/CD collision is detected by broadcast sensing from the other stations. Upon collision detection in CSMA/CD, the transmission is stopped and a jam signal is sent by the stations and then the station waits for a random time context before retransmission.

CSMA/CA:
CSMA/CA stands for Carrier Sense Multiple Access / Collision Avoidance is a network protocol for carrier transmission. Like CSMA/CD it is also operated in the medium access control layer. Unlike CSMA/CD(that is effective after a collision) CSMA / CA is effective before a collision.

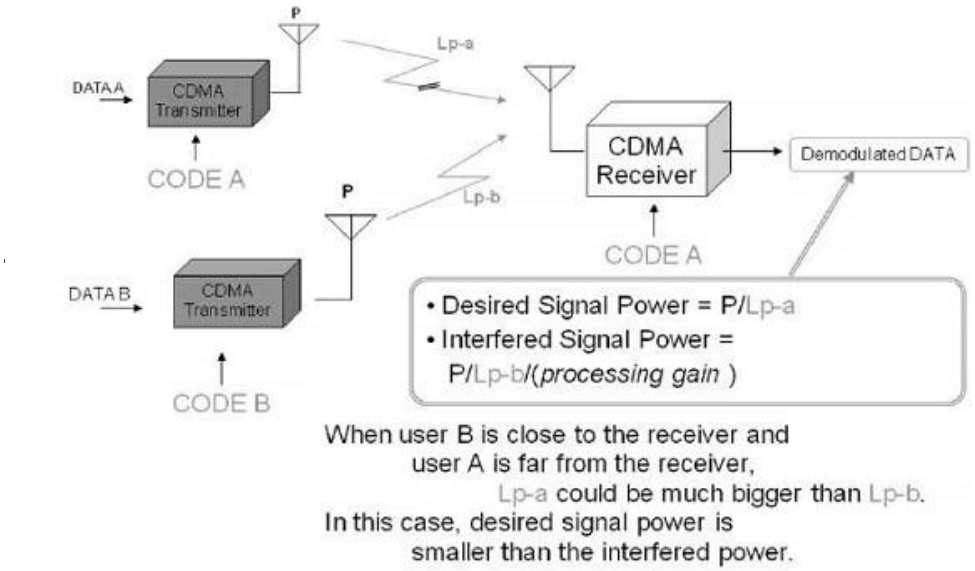
Let's see the difference between CSMA/CA and CSMA/CD:-

S.NO	CSMA/CD	CSMA/CA
1.	CSMA / CD is effective after a collision.	Whereas CSMA / CA is effective before a collision.
2.	CSMA / CD is used in wired networks.	Whereas CSMA / CA is commonly used in wireless networks.
3.	It only reduces the recovery time.	Whereas CSMA/ CA minimizes the possibility of collision.
4.	CSMA / CD resends the data frame whenever a conflict occurs.	Whereas CSMA / CA will first transmit the intent to send for data transmission.
5.	CSMA / CD is used in 802.3 standard.	While CSMA / CA is used in 802.11 standard.
6.	It is more efficient than simple CSMA(Carrier Sense Multiple Access).	While it is similar to simple CSMA(Carrier Sense Multiple Access).

3) What is near/far problem in CDMA Service.

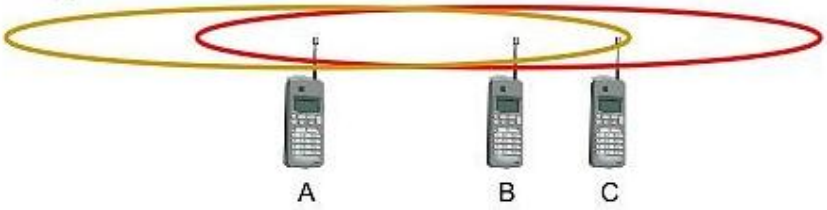
The near–far problem is the effect of a strong signal from a near signal source in making it hard for a receiver to hear a weaker signal from a further source due to adjacent-channel interference, co-channel interference, distortion, capture effect, dynamic range limitation, or the like. Such a situation is common in wireless communication systems, in particular CDMA.

In some signal jamming techniques, the near–far problem is exploited to disrupt ("jam") communications.



As shown in the illustration, user A is far away from the receiver and user B is close to the receiver, there will be big difference between desired signal power and interfered signal power. Desired signal power will be much higher than the interfered signal power and hence SN ratio of user A will be smaller and communication quality of user A will be severely degraded.

- Signal strength decreases proportional to the square of the distance
- So, B's signal drowns out A's signal making C unable to receive A's transmission
- If C is an arbiter for sending rights, B drown out A's signal on the physical layer making C unable to hear out A.

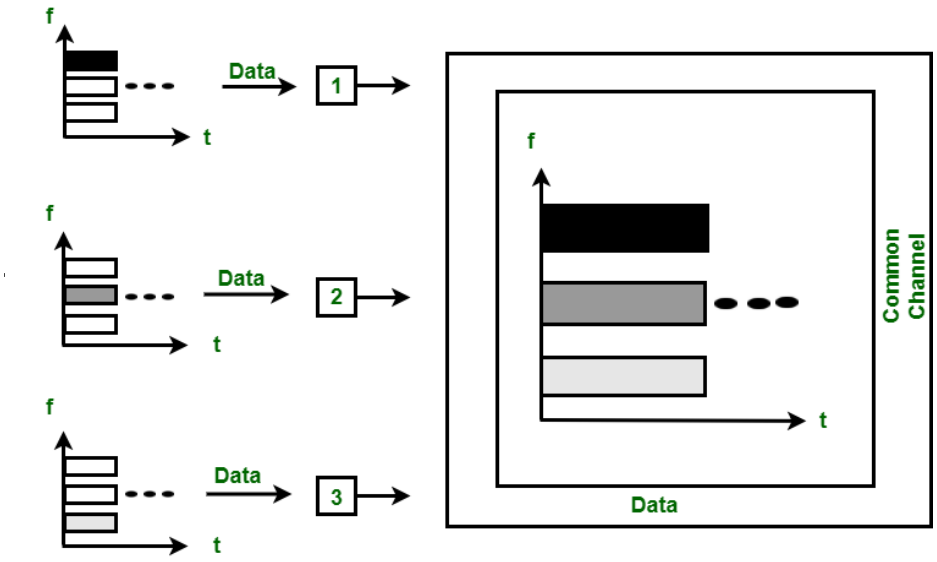


- The near/far effect is a severe problem of wireless networks using CDM.
- All signals should arrive at the receiver with more or less the same strength for which Precise power control is to be implemented.

4) Differentiate between FDMA and TDMA service.

Frequency Division Multiple Access (FDMA) :

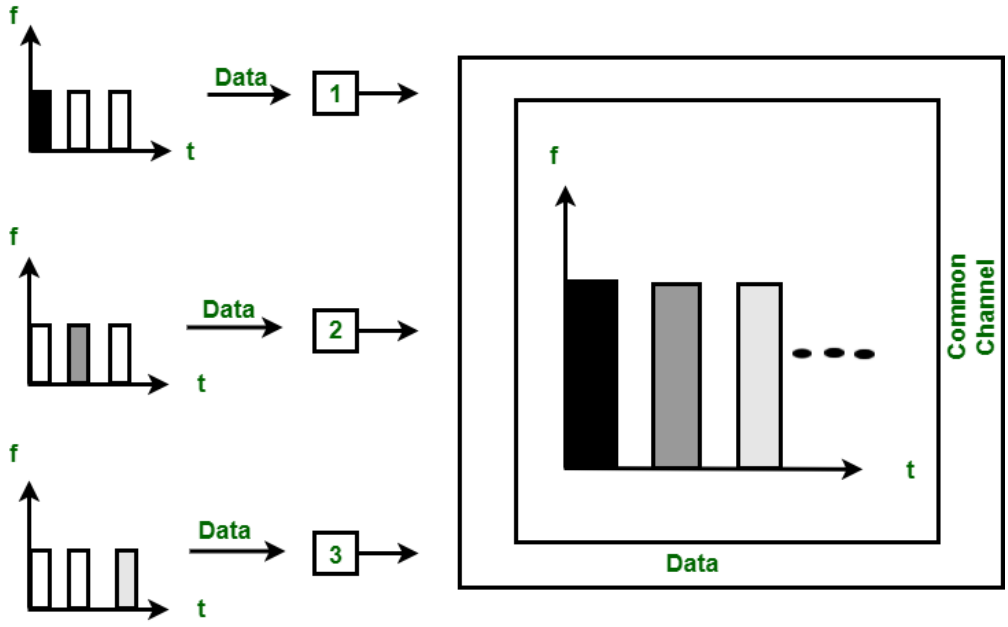
FDMA is the channelization protocol in which bandwidth is divided into various frequency bands. Each station is allocated with band to send data and that band is reserved for particular station for all the time which is as follows:



The frequency bands of different stations are separated by small band of unused frequency and that unused frequency bands are called as guard bands that prevent interference of stations. It is like access method in data link layer in which data link layer at each station tells its physical layer to make band pass signal from data passed to it. The signal is created in allocated band and there is no physical multiplexer at physical layer.

Time Division Multiple Access (TDMA) :

TDMA is channelization protocol in which bandwidth of channel is divided into various stations on time basis. There is time slot given to each station, station can transmit data during that time slot only which is as follows:



Each station must aware of its beginning of time slot and location of the time slot. TDMA requires synchronization between different stations. It is type of access method in data link layer. At each station data link layer tells station to use allocated time slot.

Difference between FDMA and TDMA :

SL. NO.	FDMA	TDMA
1.	FDMA stands for Frequency Division Multiple Access.	TDMA stands for Time Division Multiple Access.
2.	Overall bandwidth is shared among number of stations.	Time sharing of satellite transponder takes place.
3.	Guard bands between adjacent channels is necessary.	Guard time between adjacent slots is necessary.
4.	Synchronization is not required.	Synchronization is necessary.
5.	Power efficiency is less.	Power efficiency is high.
6.	It requires stability of high carrier efficiency.	It does not require stability of high carrier efficiency.
7.	It is basically used in GSM and PDC.	It is basically used in advanced mobile phone systems.

5) What is CDMA technique? Explain SDMA technique.

Code Division Multiple Access (CDMA) is a sort of multiplexing that facilitates various signals to occupy a single transmission channel. It optimizes the use of available bandwidth. The technology is commonly used in ultra-high-frequency (UHF) cellular telephone systems, bands ranging between the 800-MHz and 1.9-GHz.

CDMA Overview

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. The basic principle is that different CDMA codes are used to distinguish among the different users.

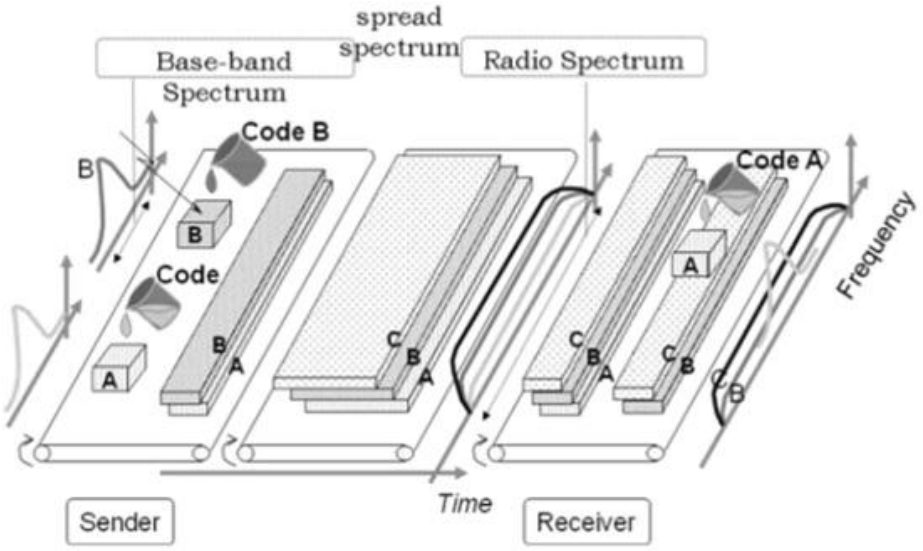
Techniques generally used are direct sequence spread spectrum modulation (DS-CDMA), frequency hopping or mixed CDMA detection (JDCDMA). Here, a signal is generated which extends over a wide bandwidth. A code called spreading code is used to perform this action. Using a group of codes, which are orthogonal to each other, it is possible to select a signal with a given code in the presence of many other signals with different orthogonal codes.

CDMA Work

CDMA allows up to 61 concurrent users in a 1.2288 MHz channel by processing each voice packet with two PN codes. There are 64 Walsh codes available to differentiate between calls and theoretical limits. Operational limits and quality issues will reduce the maximum number of calls somewhat lower than this value.

In fact, many different "signals" baseband with different spreading codes can be modulated on the same carrier to allow many different users to be supported. Using different orthogonal codes, interference between the signals is minimal. Conversely, when signals are received from several mobile stations, the base station is capable of isolating each as they have different orthogonal spreading codes.

The following figure shows the technicality of the CDMA system. During the propagation, we mixed the signals of all users, but by that you use the same code as the code that was used at the time of sending the receiving side. You can take out only the signal of each user.



Space Division Multiple Access (SDMA)

Space division multiple access or spatial division multiple access is a technique which is MIMO (multiple-input multiple-output) architecture and used mostly in wireless and satellite communication. It has the following features.

- All users can communicate at the same time using the same channel.
- SDMA is completely free from interference.
- A single satellite can communicate with more satellites receivers of the same frequency.
- The directional spot-beam antennas are used and hence the base station in SDMA, can track a moving user.
- Controls the radiated energy for each user in space.

Short Questions and Answers (5 marks & 2 marks)

1) What is media access control?

In wireless networks, multiple terminals need to communicate at the same time and a medium access control (MAC) protocol allows several terminals to transmit over the wireless channel and to share its capacity.

MAC protocols multiplex several data streams of different terminals to share the same channel and deal with issues such as addressing, how a terminal obtains a channel when it needs one, and so forth.

The design of MAC protocols closely relates to the condition of the physical channels. Initially MAC protocols were designed for wired communications where multiple computers need to transmit data packets at the same time in a local area network (LAN).

With wired networks, the physical medium can be copper or fiber optics, which are in general very reliable with abundant bandwidth. Packet loss in wired networks is mainly due to collisions and the MAC designs are relatively simple.

2) Discuss advantages and disadvantages of CDMA?

Advantages of CDMA

CDMA has a soft capacity. The greater the number of codes, the more the number of users. It has the following advantages −

- CDMA requires a tight power control, as it suffers from near-far effect. In other words, a user near the base station transmitting with the same power will drown the signal latter. All signals must have more or less equal power at the receiver
- Rake receivers can be used to improve signal reception. Delayed versions of time (a chip or later) of the signal (multipath signals) can be collected and used to make decisions at the bit level.
- Flexible transfer may be used. Mobile base stations can switch without changing operator. Two base stations receive mobile signal and the mobile receives signals from the two base stations.
- Transmission Burst − reduces interference.

Disadvantages of CDMA

The disadvantages of using CDMA are as follows −

- The code length must be carefully selected. A large code length can induce delay or may cause interference.
- Time synchronization is required.
- Gradual transfer increases the use of radio resources and may reduce capacity.
- As the sum of the power received and transmitted from a base station needs constant tight power control. This can result in several handovers.