BHADRAK ENGINEERING SCHOOL & TECHNOLOGY (BEST),
ASURALI, BHADRAK

Mobile Computing

(Th- 05)

(As per the 2020-21 syllabus prepared by the SCTE&VT, Bhubaneswar, Odisha)

Fifth Semester

Computer Science & Engg.

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MOBILE COMPUTING

CHAPTER-WISE DISTRIBUTION OF PERIODS & MARKS

Chapter No.	Topics	Periods as per syllabus	Expected marks
1	Introduction to Wireless networks & Mobile Computing	**06**	**10**
2	Introduction to Mobile Development Framework	**06**	**10**
3	Wireless Transmission	**06**	**20**
4	Medium Access Control	**06**	**10**
5	Wireless LANs	**06**	**10**
6	Ubiquitous Wireless Communication	**06**	**10**
7	Mobile IP	**06**	**10**
8	Mobile Computing	**06**	**10**
9	Wireless Telecomm Networks	**06**	**10**
10	Messaging Services	**06**	**10**
Total		**60**	**110**

CHAPTER-01

Introduction to Wireless networks & Mobile Computing

Articles to be covered

1.1Networks

1.2 Wireless Networks

1.3 Mobile Computing

1.4 Mobile Computing Characteristics

1.5 Application of Mobile Computing

1.1 Networks

A computer network is a group of computers linked to each other that enables a computer to communicate with another computer and share their resources.

Types of networks

Basically, three types of networks

1. Local area network
2. Metropolitan Area Network
3. Wide area network

1. Local area network

It is used for a short distance communication such as in a building or a group of buildings or a campus.

2. Metropolitan Area Network

A Metropolitan Area Network is a network with size between LAN and WAN. It normally covers the area inside the town and city.

3. Wide area network

Wide area network provides long distance transmission of data, audio ,video ,Informations in a large Geographic area that comprises a country, a continent or even the whole world.

A network can be wired or wireless.

1.2 Wireless Networks

- Wireless Local area network is a type of local area network that uses high frequency radio waves rather than wires to communicate between nodes.
- The use of wireless Technology is quickly becoming the most popular way to connect to a network.
- Wi-Fi is one of the many available Technologies that offer for the convenience of mobile computing.

Need of wireless networks

➢ Mobile communication is needed.

➢ communication systems must be deployed quickly.

➢ communication facilities must be installed at low initial cost. ➢ the same information must be broadcast to many locations.

How wireless networks work

- Moving data through a wireless network involves three separate elements. 1. Radio signal
  2. Data format
  3. The network structure

1. Radio signal- The radio signal operates at the physical layer.

2. Data format- The data--format controls several of the higher layers.

3. The network structure - The network structure includes the wireless network interface adaptors and best stations that send and receive the radio signals.

Types of network

- **WLANs- wireless Local area network**

  WLANs allowed users in a local area such as an University Campus or library to form a network or gain access to the internet.

- **WPANs- Wireless personal area network**

  The two current Technologies for wireless personal area networks are infrared (IR) and Bluetooth(IEEE 802.15). IR requires a direct line of sight and the range is less.

- **WMANs - Wireless Metropolitan Area Network**

  This technology allows the connection of multiple networks in a Metropolitan Area such as different buildings in a city.

Wireless LAN architecture

The basic architecture of wireless LAN consists of the following elements**.**

1. Stations

All components that can connect into a wireless medium in a network are referred to as stations. All stations are equipped with wireless network interface cards. All into one of the two categories Access points and clients.

- **Access points-** Access points are base stations for the wireless network .The transmit and receive radio frequencies for wireless enabled devices to communicate with.

- **Clients-** Wireless clients can be mobile devices such as laptops personal digital assistants fixed devices such as desktops and workstations that are equipped with a wireless network interface.

2. Basic service set

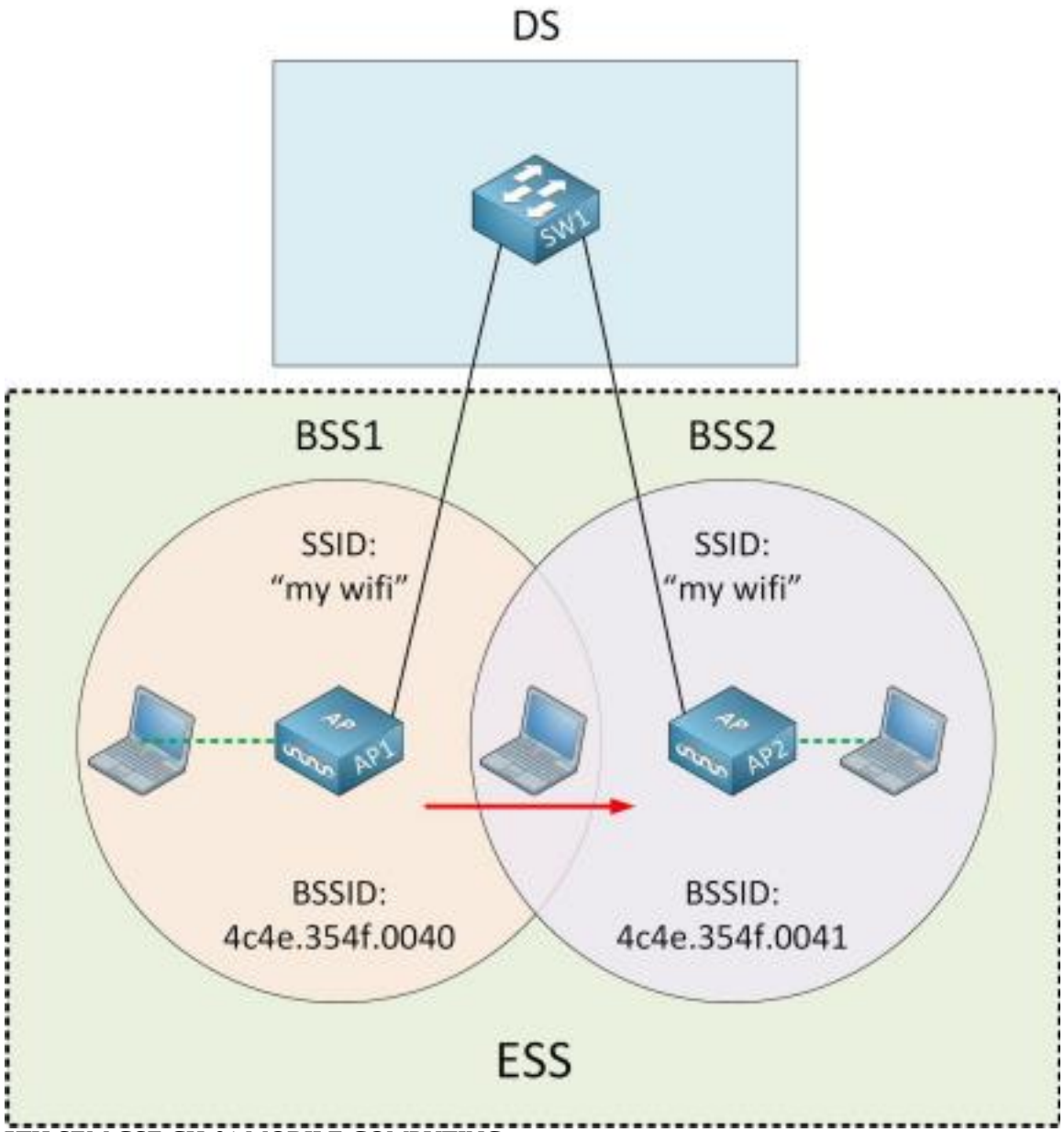
The best service set is a set of all stations that can communicate with each other. There are two types of BSS: independent BSS and infrastructure BSS. every BSS has an identification called BSS ID which is the MAC address of the access point servicing The BSS.

- **An independent BSS** is an Ad-Hoc network that contains no access points which means that cannot connect to any other basic service set.

- **An infrastructure BSS** can communicate with other stations not in the same basic service set by communicating through access points.

3. Extended service set

An ESS is a set of one or more interconnected BSS and integrated local area networks that appear as a single BSS to the logical link control layer at any station associated with one of those BSS. they must have a common network name or SSID . They can work on the same channel or work on different channels to boost aggregate throughput.



1.3 Mobile Computing

- Mobile Computing is a technology that allows transmission of data, voice and video via a computer or any other wireless enabled device without having to be connected to a fixed physical link.
- Mobile computing is a term used to describe Technologies that enable people to access network services at any place, anytime and anywhere .

1.4 Mobile Computing 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.

1.5 Application of Mobile Computing

- **Vehicles**
- **Medical**
- **Sales**
- **Emergencies**

Short Questions with Answers

1. Define Network.

A computer network is a group of computers linked to each other that enables a computer to communicate with another computer and share their resources.

2. What is Wireless Networks?

Wireless Local area network is a type of local area network that uses high frequency radio waves rather than wires to communicate between nodes.

● The use of wireless Technology is quickly becoming the most popular way to connect to a network.

● Wi-Fi is one of the many available Technologies that offer the convenience of mobile computing.

3. Define Access points

Access points are base stations for the wireless network .The transmit and receive radio frequencies for wireless enabled devices to communicate with.

4. Define Client.

Wireless clients can be mobile devices such as laptops, personal digital assistants, fixed devices such as desktops and workstations that are equipped with a wireless network interface.

5. What is mobile computing ? [W-2020]

Mobile Computing is a technology that allows transmission of data, voice and video via a computer or any other wireless enabled device without having to be connected to a fixed physical link.

Long Questions

Q1.Explain wireless LAN architecture

Q2. What is mobile computing ? Explain different mobile computing characteristics.

CHAPTER-2
Introduction to Mobile Development Framework

Articles to be covered

2.1 C/S architecture

2.2 n-tier architecture

2.3 n-tier architecture and www

2.4 Peer-to Peer architecture

2.5 Mobile agent architecture

2.1 C/S architecture (Client-Server Architecture)

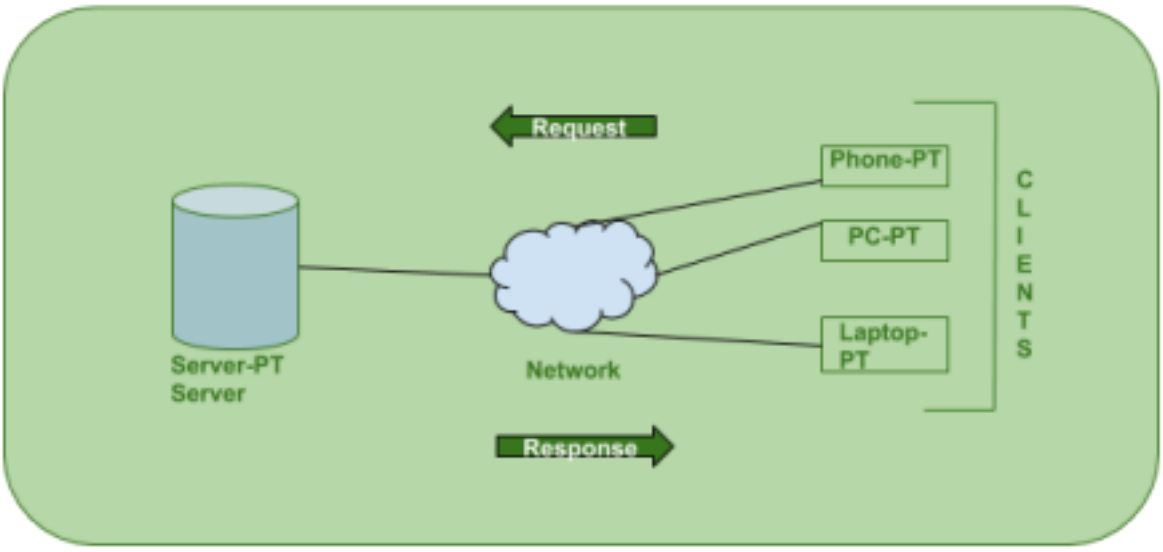
The Client-server model is a distributed application structure that partitions tasks or workload between the providers of a resource or service, called servers, and service requesters called clients. In the client-server architecture, when the client computer sends a request for data to the server through the internet, the server accepts the requested process and delivers the data packets requested back to the client. Clients do not share any of their resources. Examples of Client-Server Model are Email, World Wide Web, etc.

How the Client-Server Architecture works ?

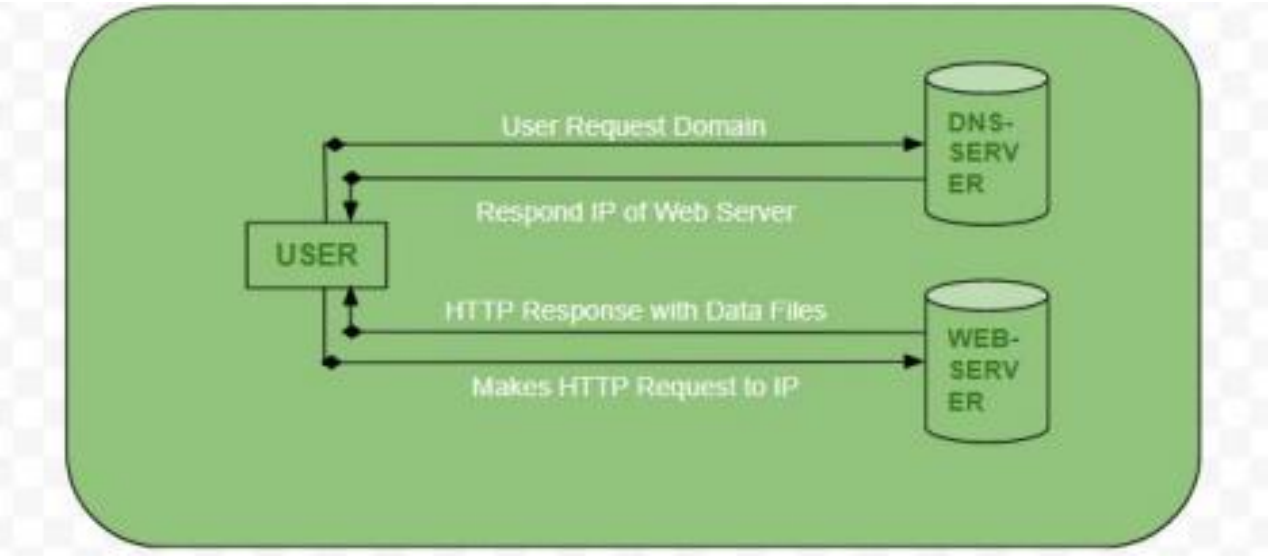
In this article we are going to take a dive into the Client-Server model and have a look at how the Internet works via web browsers. This article will help us in having a solid foundation of the WEB and help in working with WEB technologies with ease.

- **Client:** When we talk about the word Client, it mean to talk of a person or an organization using a particular service. Similarly in the digital world a Client is a computer (Host) i.e. capable of receiving information or using a particular service from the service providers (Servers).
- **Servers:** Similarly, when we talk about the word Servers, It means a person or medium that serves something. Similarly in this digital world a Server is a remote computer which provides information (data) or access to particular services.

So, it's basically the Client requesting something and the Server serving it as long as it's present in the database.



- User enters the URL(Uniform Resource Locator) of the website or file. The Browser then requests the DNS(DOMAIN NAME SYSTEM) Server.
- DNS Server lookup for the address of the WEB Server.
- DNS Server responds with the IP address of the WEB Server.
- Browser sends over an HTTP/HTTPS request to WEB Server's IP (provided by DNS server).
- Server sends over the necessary files of the website.
- Browser then renders the files and the website is displayed. This rendering is done with the help of DOM (Document Object Model) interpreter, CSS interpreter and JS Engine collectively known as the JIT or (Just in Time)compilers.



Common examples of client / server communication is:

- Desktop application to database server communication
- Browser to web server communication.
- Mobile to server communication.
- FTP client to FTP server communication.

Advantages of Client-Server model:

- Centralized system with all data in a single place.
- Cost efficient requires less maintenance cost and Data recovery is possible. ● The capacity of the Client and Servers can be changed separately.

Disadvantages of Client-Server model:

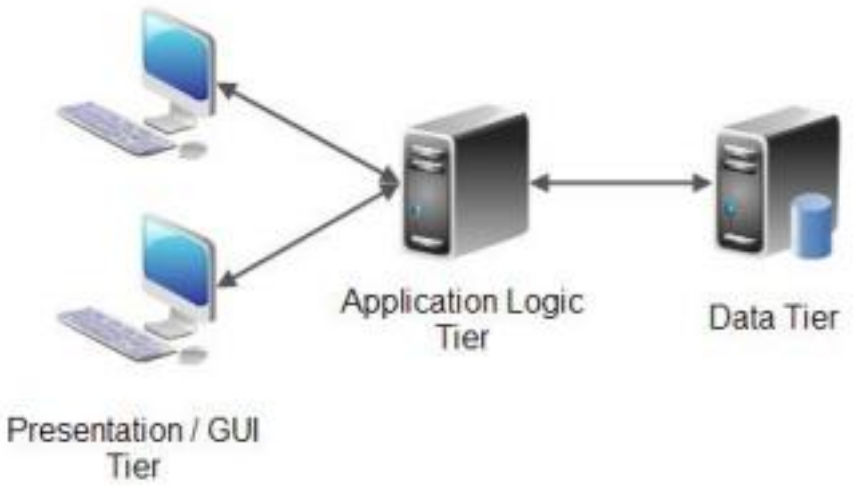
- Clients are prone to viruses, Trojans and worms if present in the Server or uploaded into the Server.
- Servers are prone to Denial of Service (DOS) attacks.
- Data packets may be spoofed or modified during transmission.
- Phishing or capturing login credentials or other useful information of the user are common and MITM(Man in the Middle) attacks are common.

2.2 n-tier architecture

N tier architecture means splitting up the system into N tiers, where N is a number from 1 to N .

A 1 tier architecture is the same as a single process architecture. A 2 tier architecture is the same as a client / server architecture etc.

A 3 tier architecture is a very common architecture. A 3 tier architecture is typically split into a presentation or GUI tier, an application logic tier, and a data tier. This diagram illustrates a 3 tier architecture:



2.3 n-tier architecture and www

N-tier architecture is also called multi-tier architecture because the software is engineered to have the processing, data management, and presentation functions physically and logically separated. That means that these different functions are hosted on several machines or clusters, ensuring that services are provided without resources being shared and, as such, these services are delivered at top capacity. The "N" in the name n-tier architecture refers to any number from 1.

Types of N-Tier Architectures

There are different types of N-Tier Architectures, like

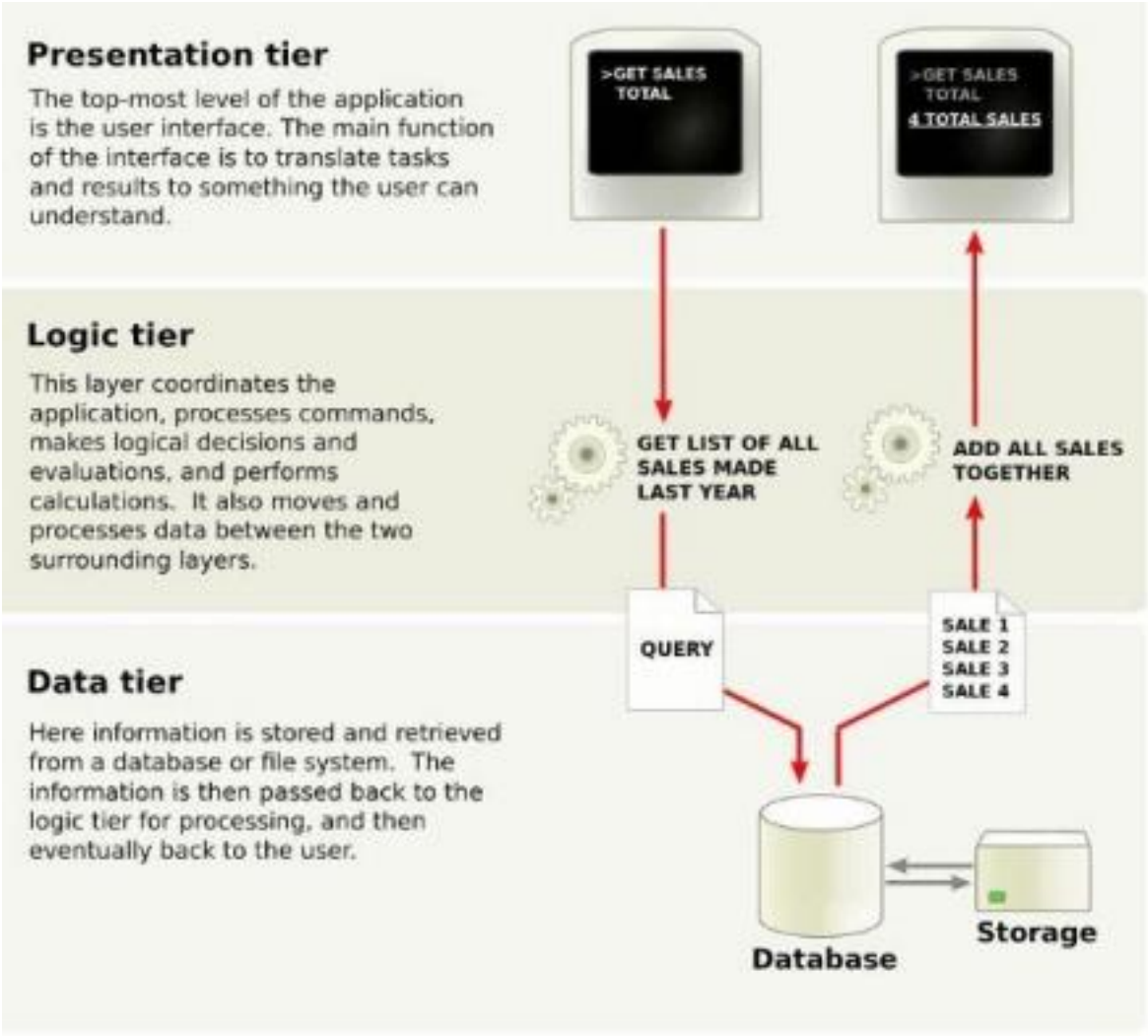
- 3-tier Architecture
- 2-Tier Architecture
- 1- Tier Architecture.

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

3-Tier Architecture

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

- Presentation tier
- Business Logic tier
- Database tier



(3 Tier Architecture Diagram)

Presentation tier

The presentation tier is the user interface. This is what the software user sees and interacts with. This is where they enter the needed information. This tier also acts as a go-between for the data tier and the user, passing on the user's different actions to the logic tier.

Business Logic tier -

This is the function of the business layer which accepts the data from the application layer and passes it to the data layer.

- Business logic acts as an interface between Client layer and Data Access Layer ● All business logic – like validation of data, calculations, data insertion/modification are written under the business logic layer.
- It makes communication faster and easier between the client and data layer ● Defines a proper workflow activity that is necessary to complete a task.

Database tier

- This is the data layer function, which receives the data from the business layer and performs the necessary operation into the database.
- The data tier is where all the data used in your application are stored. One can securely store data on this tier, do transactions, and even search through volumes and volumes of data in a matter of seconds.

2-Tier Architecture:

It is like Client-Server architecture, where communication takes place between client and server.

In this type of software architecture, the presentation layer or user interface layer runs on the client side while the dataset layer gets executed and stored on the server side.

There is no Business logic layer or immediate layer in between client and server.

Single Tier or 1-Tier Architecture: It is the simplest one as it is equivalent to running the application on the personal computer. All of the required components for an application to run are on a single application or server.

Presentation layer, Business logic layer, and data layer are all located on a single machine.

Hence, it is a part of a program which encrypts real-world business problems and determines how data can be updated, created, stored, or changed to get the complete task done.

WWW

1. The World Wide Web is based on several different technologies : Web browsers,

Hypertext Markup Language (HTML) and Hypertext Transfer Protocol (HTTP).

2. A Web browser is used to access web pages. Web browsers can be defined as programs which display text, data, pictures, animation and video on the Internet. Hyperlinked resources on the World Wide Web can be accessed using a software interface provided by Web browsers. Initially Web browsers were used only for surfing the Web but now they have become more universal. Web browsers can be used for several tasks including conducting searches, mailing, transferring files, and much more. Some of the commonly used browsers are Internet Explorer, Opera Mini, Google Chrome.

Features of WWW:

- HyperText Information System
- Cross-Platform
- Distributed
- Open Standards and Open Source
- Uses Web Browsers to provide a single interface for many services
- Dynamic, Interactive and Evolving.
- "Web 2.0"

Components of Web

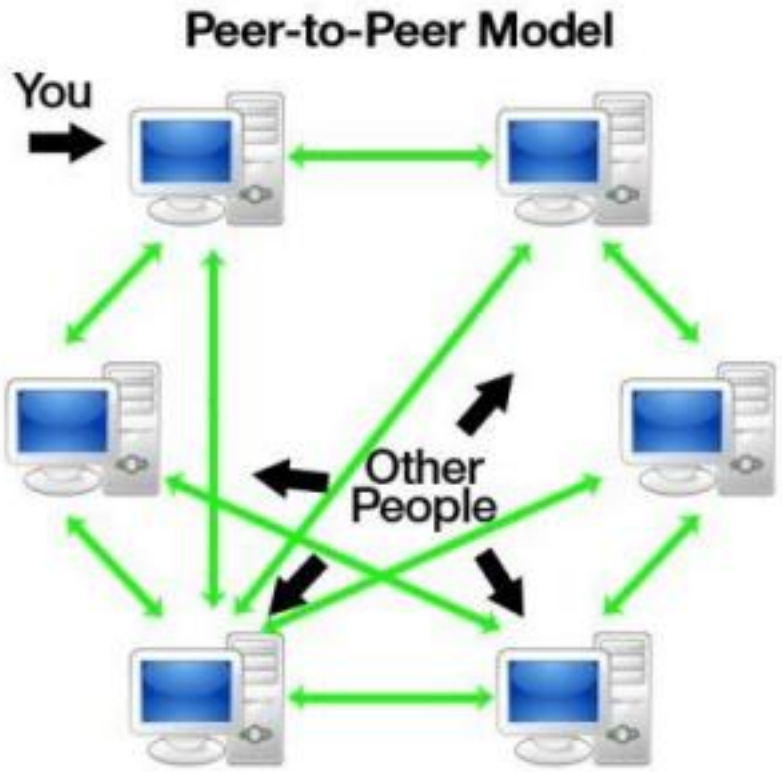
There are 3 components of web:

1. Uniform Resource Locator (URL): serves as a system for resources on the web. 2. HyperText Transfer Protocol (HTTP): specifies communication of browser and server.
3. Hyper Text Markup Language (HTML): defines structure, organisation and content of webpage.

2.4 Peer-to Peer architecture

- In the common client-server architecture, multiple clients will communicate with a central server.
- A peer-to-peer (P2P) architecture consists of a decentralized network of peers - nodes that are both clients and servers.
- P2P networks distribute the workload between peers, and all peers contribute and consume resources within the network without the need for a centralized server.
- However, not all peers are necessarily equal. Super peers may have more resources and can contribute more than they consume.
- Edge peers do not contribute any resources, they only consume from the network.
- In its purest form, P2P architecture is completely decentralized. ● However, in application, sometimes there is a central tracking server layered on top of the P2P network to help peers find each other and manage the network.

Here's a simple example of small P2P network.



Applications

- P2P works best if the workload is split into small chunks that can be reassembled later.
- This way, a large number of peers can work simultaneously on one task and each peer has less work to do.
- In the case of P2P file-sharing, a file can be broken down so that a peer can download many chunks of the file from different peers at the same time.

Some uses of P2P architecture:

- File sharing
- Instant messaging
- Voice Communication
- Collaboration
- High Performance Computing

Some examples of P2P architecture:

● Napster - it was shut down in 2001 since they used a centralized tracking server ● BitTorrent - popular P2P file-sharing protocol, usually associated with piracy ● Skype - it used to use proprietary hybrid P2P protocol, now uses client-server model after Microsoft's acquisition

- Bitcoin - P2P cryptocurrency without a central monetary authority

Advantages

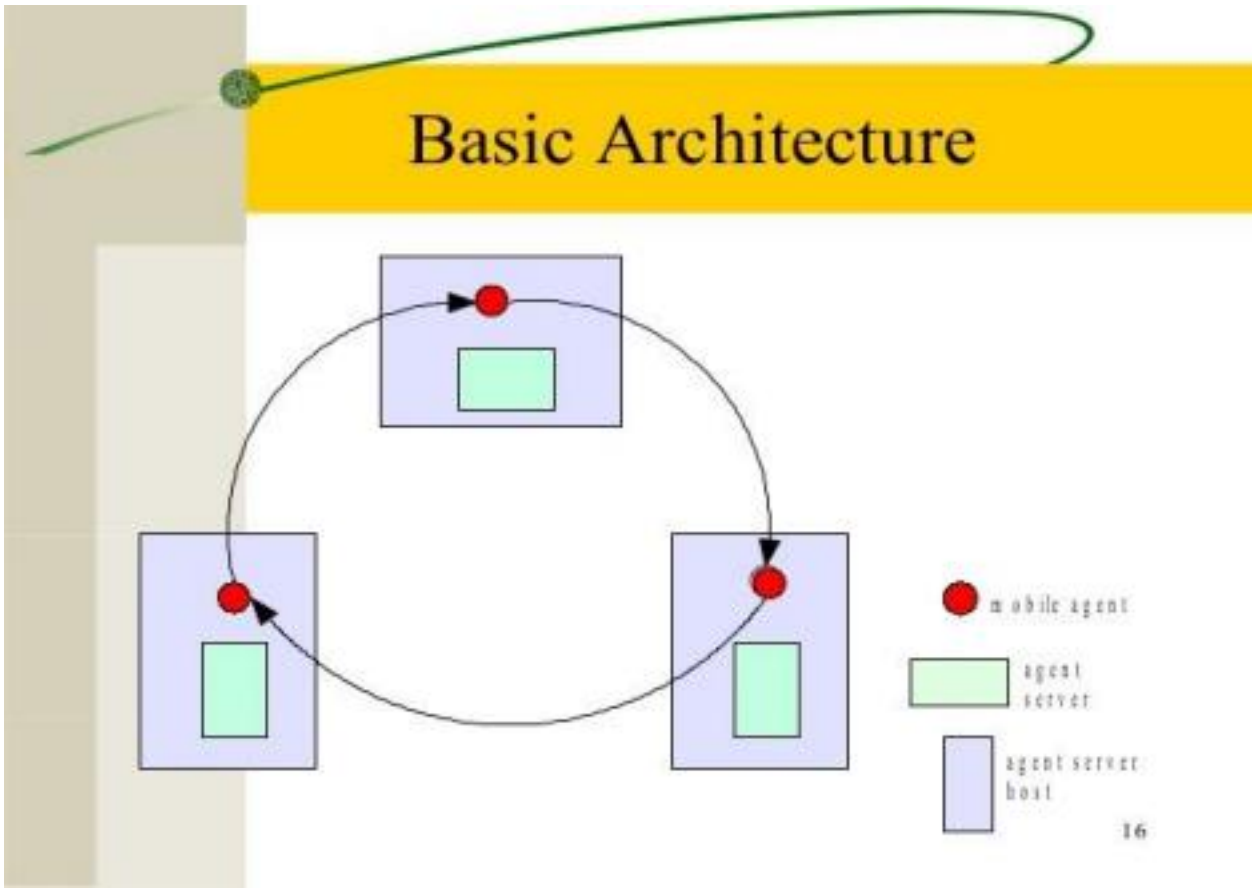
- There is no central server to maintain and to pay for (disregarding tracking servers), so this type of networks can be more economical.
- If a large group of peers join the network at once, the network can handle the increased load easily.

Disadvantages

- P2P networks introduce many security concerns. If one peer is infected with a virus and uploads a chuck of the file that contains the virus, it can quickly spread to other peers.

2.5 Mobile agent architecture

- A mobile Agent is an independent software program, which launches on behalf of a network user. there are also called as transportable agents.
- A mobile agent is a program that once it is launched by a user can travel from node to node autonomously and can continue to function even if the user is disconnected from the network.
- Mobile agents can be broadly classified into two types. 1. **Agents with predefined path**- have Static migration path 2. **Agents with undefined path**- have dynamic migration path
  depending on the present network condition the mobile agent loses its path.
- It is a program that can migrate.
- Agents decide when and where to move next.
- It has three steps to move
  1. Save state
  2. Transport
  3. resume
- An agent is an object hence it contains agent ID and it contains state data and methods.
- Code-program in a suitable language to define the behavior.
- States- set the internal variable, resume activities after moving to another host.
- Attributes- information describing the agent, its origin, owner, movement history and authentication keys.



Advantages : Mobile **Agents**

- Autonomous-Self Driven in nature.
- They possess Less delays in the 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.

SHORT QUESTIONS WITH ANSWER

Q1. Define Client- Server Architecture.

- The Client-server model is a distributed application structure that partitions tasks or workload between the providers of a resource or service, called servers, and service requesters called clients.
- In the client-server architecture, when the client computer sends a request for data to the server through the internet, the server accepts the requested process and delivers the data packets requested back to the client.

Q2. **Differentiate Client & Server.**

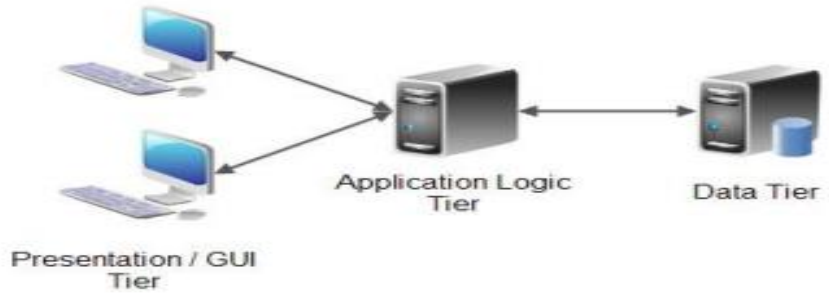
- **Client:** When we talk about the word Client, it mean to talk of a person or an organization using a particular service. Similarly in the digital world a Client is a computer (Host) i.e. capable of receiving information or using a particular service from the service providers (Servers).
- **Servers:** Similarly, when we talk about the word Servers, It means a person or medium that serves something. Similarly in this digital world a Server is a remote computer which provides information (data) or access to particular services.

Q3. State the advantages of Client- server model. [W-2020]

- Centralized system with all data in a single place.
- Cost efficient requires less maintenance cost and Data recovery is possible.
- The capacity of the Client and Servers can be changed separately.

Q4. Define 3-tier architecture.

A 3 tier architecture is a very common architecture. A 3 tier architecture is typically split into a presentation or GUI tier, an application logic tier, and a data tier.



Q5. What is WWW ?

1. The World Wide Web is based on several different technologies : Web browsers, Hypertext Markup Language (HTML) and Hypertext Transfer Protocol (HTTP).

2. A Web browser is used to access web pages. Web browsers can be defined as programs which display text, data, pictures, animation and video on the Internet.

Q6. Define a mobile agent .

A mobile agent is a program that once it is launched by a user can travel from node to node autonomously and can continue to function even if the user is disconnected from the network.

Long Questions

Q1. Explain Client-server Architecture.
Q2. Describe n -tier Architecture. [W-2020]
Q3. Explain peer to peer architecture.
Q4. Describe Mobile agent Architecture.
Q5. Explain WWW.[w-2020]

CHAPTER-3
Wireless Transmission

Articles to be covered

3.1 Introduction

3.2 Signals

3.3 Period, Frequency and Bandwidth.

3.4 Antennas

3.5 Signal Propagation

3.6 Multiplexing

3.7 Modulation

3.8 Spread Spectrum

3.9 Cellular System

3.1 Introduction

- Wireless Communication is the fastest growing and most vibrant technological area in the communication field.
- Wireless Communication is a method of transmitting information from one point to another, without using any connection like wires, cables or any physical medium.
- Generally, in a communication system, information is transmitted from transmitter to receiver that are placed over a limited distance.
- With the help of Wireless Communication, the transmitter and receiver can be placed anywhere between a few meters (like a T.V. Remote Control) to a few thousand kilometres (Satellite Communication).
- We live in a World of communication and Wireless Communication, in particular, is a key part of our lives.
- Some of the commonly used Wireless Communication Systems in our day – to – day life are mobile Phones, GPS Receivers, Remote Controls, Bluetooth Audio and Wi-Fi etc.
- Wireless Communication doesn't require any physical medium but propagates the signal through space.
- Here the transmission and reception of signals is accomplished through Antennas.
- Antennas are electrical devices that transform the electrical signals to radio signals in the form of Electromagnetic (EM) Waves and vice versa. These Electromagnetic Waves propagate through space. Hence, both transmitter and receiver consists of an antenna.

3.2 Signals

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

It is the key component behind virtually all:

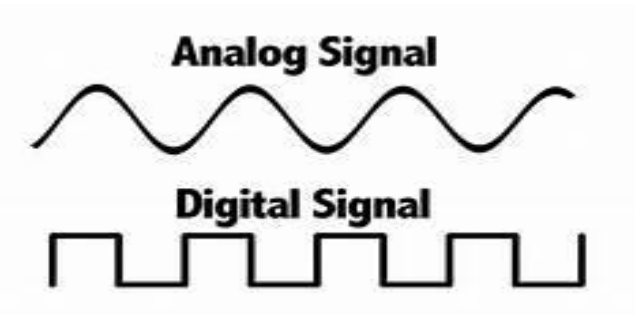
1. Communication
2. Computing
3. Networking
4. Electronic devices

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

Besides communication devices that broadcast a signal externally to the host system, signals are also used to communicate and send instructions by:

- Processors
- Memory
- Storage
- Numerous other components

A signal can be either analog or digital.



Analog signal is a continuous signal in which one time-varying quantity represents another time-based variable. These kind of signals works with physical values and natural phenomena such as earthquake, frequency, volcano, speed of wind, weight, lighting, etc.

A digital signal is a signal that is used to represent data as a sequence of separate values at any point in time. It can only take on one of a fixed number of values. This type of signal represents a real number within a constant range of values.

Difference Between Analog And Digital Signal	
Analog Signals	**Digital Signals**
Continuous signals	Discrete signals
Represented by sine waves	Represented by square waves
Human voice, natural sound, analog electronic devices are few examples	Computers, optical drives, and other electronic devices
Continuous range of values	Discontinuous values
Records sound waves as they are	Converts into a binary waveform.
Only be used in analog devices.	Suited for digital electronics like computers, mobiles and more.

3.3 Period, Frequency and Bandwidth.

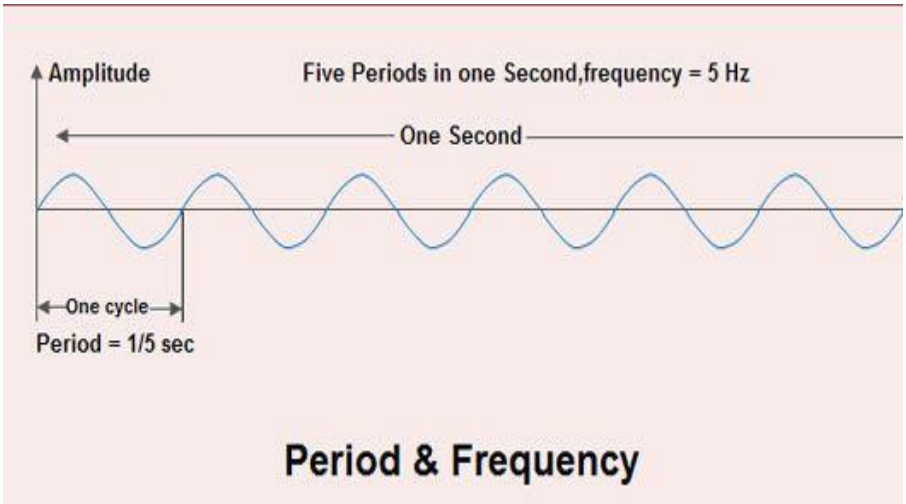
Period:

- A period is defined as the amount of time (expressed in seconds) required to complete one full cycle.

- T=1/f
- Unit of period is second.

Frequency:

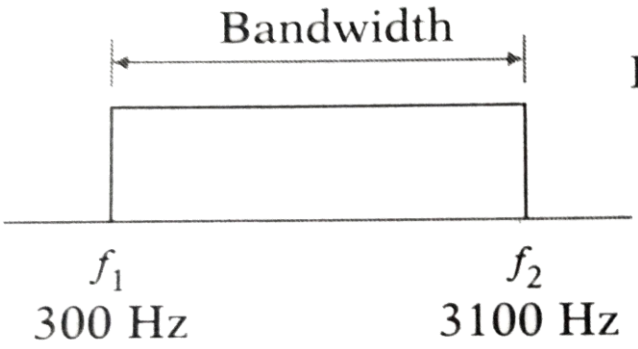
- The frequency of a signal is the number of complete cycles that can occur per second. Frequency is denoted with a lower-case f. It is defined in terms of the period, as follows:
- f = 1 /T
- Frequency has units of *hertz* or cycle per second.



Bandwidth:

- The bandwidth of a signal is defined as the difference between the highest and lowest frequency of a signal generated.
- Bandwidth (B.W) of the signal is equal to the difference between the highest frequency (fH) and the lowest frequency (fL).

  B.W= fH-fL
- It is measured in terms of Hertz(Hz) i.e. the unit of frequency.



$$\text{Bandwidth} = f_2 - f_1$$
$$= 3100 - 300$$
$$= 2800 \text{ Hz}$$

3.4 Antennas

- An antenna is a transducer that converts radio frequency (RF) fields into alternating current or vice versa.
- There are both receiving and transmission antennas for sending or receiving radio transmissions. Antennas play an important role in the operation of all radio equipment.

- They are used in wireless local area networks, mobile telephony and satellite communication.

Working of Antenna

- Antennas have an arrangement of metallic conductors with an electrical connection to receivers or transmitters.
- Current is forced through these conductors by radio transmitters to create alternating magnetic fields.
- These fields induce voltage at the antenna terminals, which are connected to the receiver input.
- In the far field, the oscillating magnetic field is coupled with a similar oscillating electric field, which defines electromagnetic waves capable of propagating the signal for long distances.

- Radio waves are electromagnetic waves that carry signals through air at the speed of light without any transmission loss.
- Antennas can be omni-directional, directional or arbitrary.

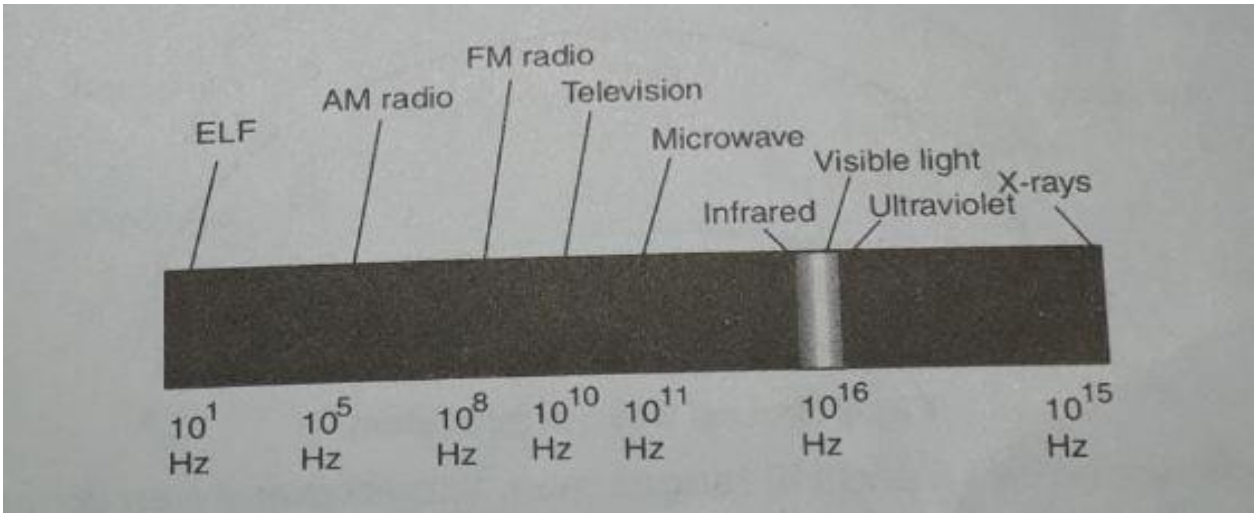
But they are broadly divided into 2 types

1. Omni-directional :- radiates equally in all directions.
2. Directional :- radiates more in one direction than in other.

A truely omnidirectional antenna transmits its powers in all directions whereas a directional antenna concentrates most of its power in one direction.

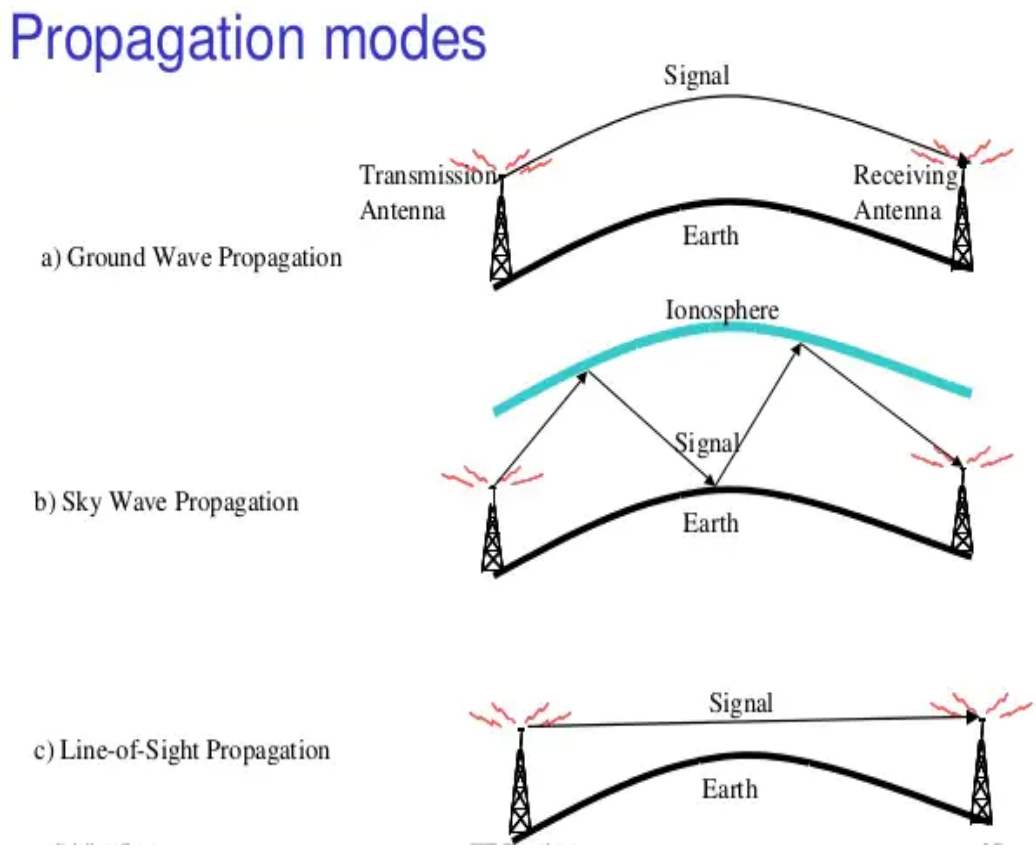
3.5 Signal Propagation

- The electromagnetic spectrum classifies electromagnetic energy according to frequency. As shown in figure below, the electromagnetic spectrum ranges from energy waves having extremely low frequency to energy waves having much higher frequency, such as X-rays.



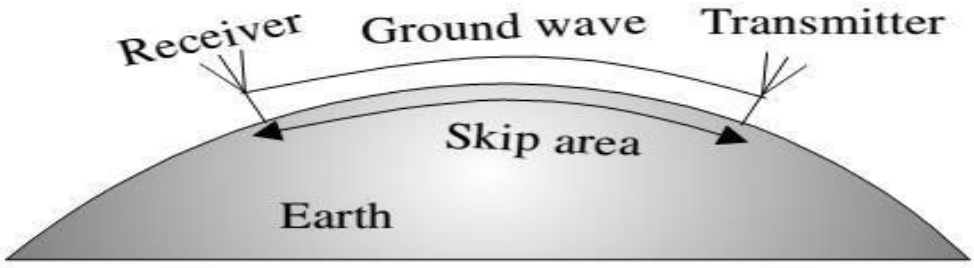
(Electromagnetic Spectrum)

- Signal Propagation is nothing but traveling of signals through some medium in case of both wired and wireless networks.
- Transmission media is of two types - guided and unguided. In case of guided media, it is through various types of cables like twisted pair, coaxial etc.
- In case of unguided media, signals travel through air.
- There is **ground propagation, sky propagation and line-of-sight propagation**.



Ground Propagation

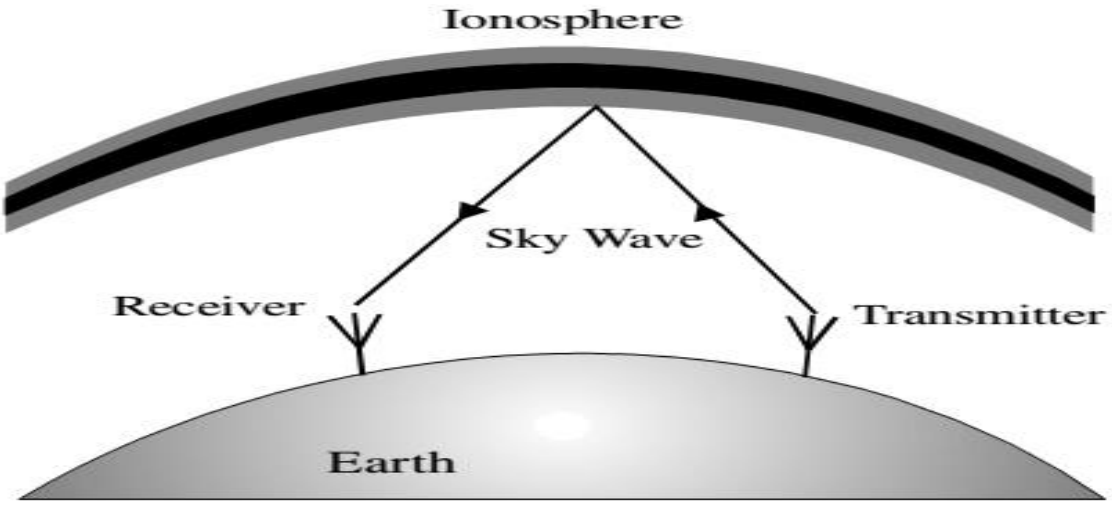
- Ground waves travel between two limits, the earth and the ionosphere, which acts like a duct. Since the channel curves with the earth, the ground wave will follow. Therefore, very long-range propagation is possible using ground waves.



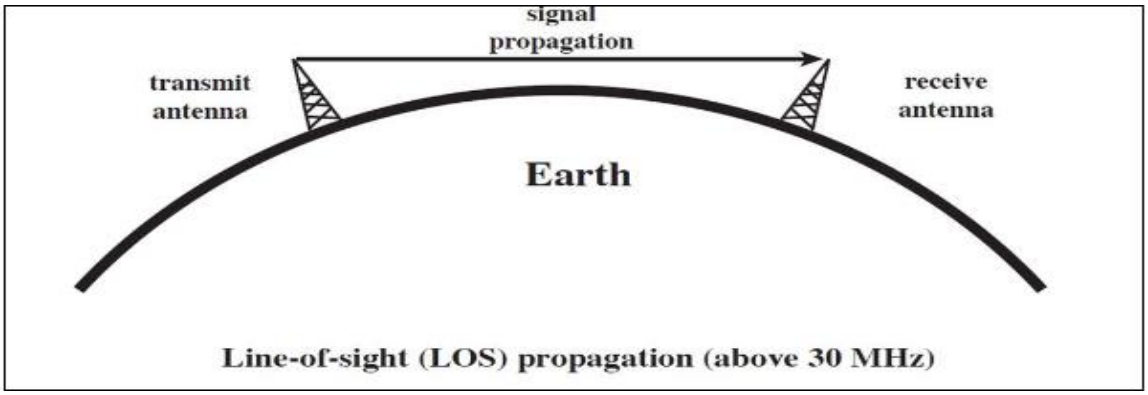
- Radio waves in the LF and MF ranges may also propagate as ground waves, but suffer significant losses, or are attenuated, particularly at higher frequencies. But as the ground wave mode fades out, a new mode develops: the sky wave.

Sky propagation

- Sky waves are reflections from the ionosphere. While the wave is in the ionosphere, it is strongly bent, or refracted, ultimately back to the ground. From a long distance away, this appears as a reflection. Long ranges are possible in this mode also, up to hundreds of miles.
- Sky waves in this frequency band are usually only possible at night, when the concentration of ions is not too great since the ionosphere also tends to attenuate the signal. However, at night. There are just enough ions to reflect the wave but not reduce its power too much.



Line-of-sight propagation



- Line-of-sight propagation is a characteristic of electromagnetic radiation or acoustic wave propagation which means waves travel in a direct path from the source to the receiver.
- Electromagnetic transmission includes light emissions traveling in a straight line.

- FM radio, microwave and satellite transmission are examples of line-of-sight communication.

Wireless transmission can be divided into three parts -

1. Radio waves
2. Microwaves
3. Infrared waves.

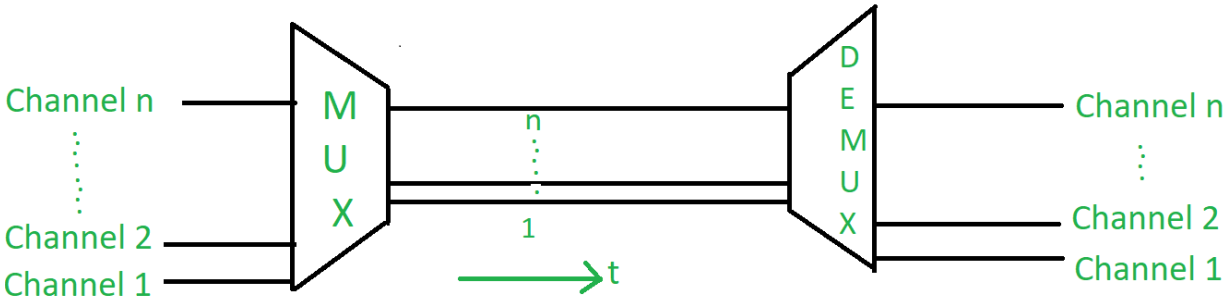
1. Radio waves- Electromagnetic waves ranging in frequencies between 3 KHz and 1 GHz are normally called radio waves. Electromagnetic waves ranging in frequencies between 1 KHz and 300 GHz are normally called microwaves. Radio waves are used for multicast communications, such as radio and television systems. Radio waves in the Very Low Frequency (VLF) band propagate in a ground, or surface wave.

2. Microwaves- Micro. waves are used for unicast communication such as cellular telephones, satellite networks and wireless LANS. with frequencies between 300 MHz (1 m) and 300 GHz (1 mm).

3. Infrared waves- Infrared waves, or infrared light, are part of the electromagnetic spectrum. A remote control uses light waves just beyond the visible spectrum of light—infrared light waves—to change channels on your TV.

3.6 MULTIPLEXING

Multiplexing provides a mechanism to share the use of a common cha by two or more devices. Multiplexing is a technique for sending more than information signal at a time over a single communication path (e.g. media circuit or channel). Multiplexing is sometimes loosely referred to as many into one.



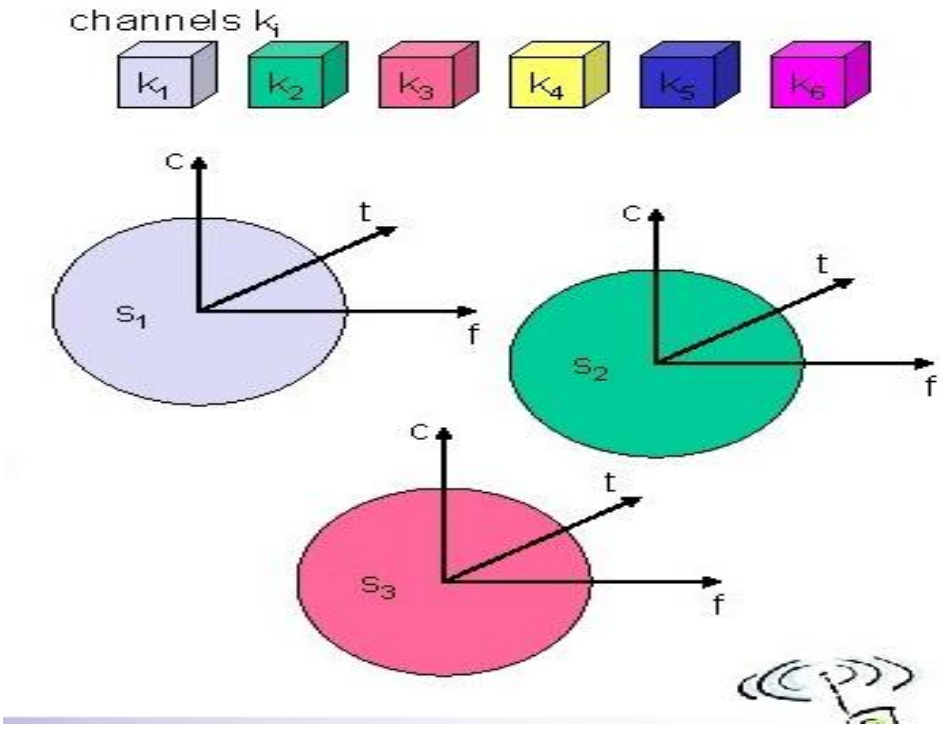
(Multiplexing)

Mobile Cellular Systems use various techniques to allow multiple users to access the same radio spectrum at the same time. Multiplexing can be achieved in a number of ways. The various techniques used in the systems are as follows.

1. Space Division Multiplexing (SDM)
2. Frequency Division Multiplexing (FDM)
3. Time Division Multiplexing (TDM)
4. Code Division Multiplexing (CDM)

Space Division Multiplexing (SDM)

- SDM means division of available space so that multiple sources can access the medium at the same time.
- Channels are assigned on the basis of "Space" (but operate on the same frequency).
- The assignment makes sure that the transmission does not interfere with each channel (with a guard band in between).
- Overlap, recovery of each of the possible at the receiving end.
- In order to prevent overlap of the signals to simplify filtering, each of the modulated signals is separated by a guard band, which consists of an unused portion of the available frequency spectrum.
- Each user is assigned a given frequency band for all time.

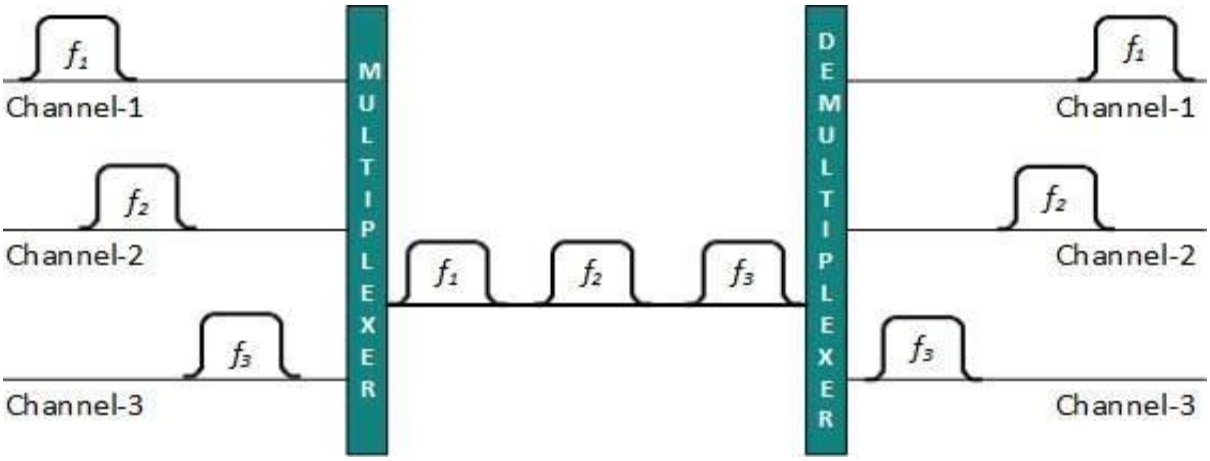


(Space Division Multiplexing)

From the above fig. it is clear that each user, here each Mobile Station is using the same frequency band for a piece of time.

Frequency Division Multiplexing (FDM)

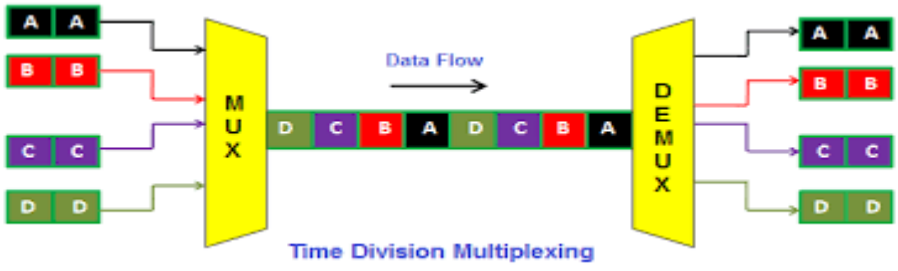
- FDM is a method in which each signal is allocated a frequency slot within the overall transmission bandwidth, in other words the total available frequency bandwidth on the transmission line is divided into frequency channels and each information signal occupies one of these channels.
- The signal will have exclusive use of this frequency slot all the time (i.e. each subscriber occupies his/her own slot)
- At the end of the long-distance cable, the individual signals are separated out by a circuit called a demultiplexer, and routed to the proper end users.



- For example, old telephone networks used FDM to carry several voice channels on a single physical circuit.

Time Division Multiplexing (TDM)

- TDM is a type of multiplexing where two or more channels of information are transmitted over the same link by allocating a different time interval ("slot or "slice") for the transmission of each channel i.e. the channels take turns to use the link.
- Some kind of periodic synchronizing signal or identifier(Address of the signal) is required so that the receiver can tell which channel goes to which receiver.
- TDM becomes inefficient when traffic is less or there is no traffic because the time slot is still allocated even when the channel has no data to transmit.



- For example, modern telephone systems use digital transmission ,in which TDM is used instead of FDM.

Code Division Multiplexing (CDM)

- CDM is a technique in which each channel transmits its bits as a coded channel-specific sequence of pulses.
- It allows signals from a series of independent sources to be transmitted at the same time over the same frequency band.
- This is achieved by using codes to spread each signal over a large, common frequency band.
- At the receiving end, the appropriate code is then used again to recover the particular signal intended for a particular user.
- All channels, each with a different code, can be transmitted on the same fiber and asynchronously demultiplexed. The key principle of CDM is spread spectrum.

3.7 Modulation

- Modulation is required to effective wireless transmission by increasing the compatibility of the transmitted signal and the medium of transmission.
- Signals consist of two components - the information signal and the carrier signal.
- The transmission of any signal over some communication medium usually involves modulation of a carrier.
- Prior to their transmission, the information signal and the carrier signal are combined and the process of combining these two signals is called modulation.
- A device that performs modulation is known as a modulator and a device that performs the inverse operation of modulation is known as a demodulator.
- A device that can do both operations is a modem (a combination of the two terms).

- A modem accepts a serial data stream and converts it into an analog format that matches the transmission medium.

- The high frequency wave, which carries the information through a medium is called the carrier.
- The information is superimposed onto the carrier wave by modulation.

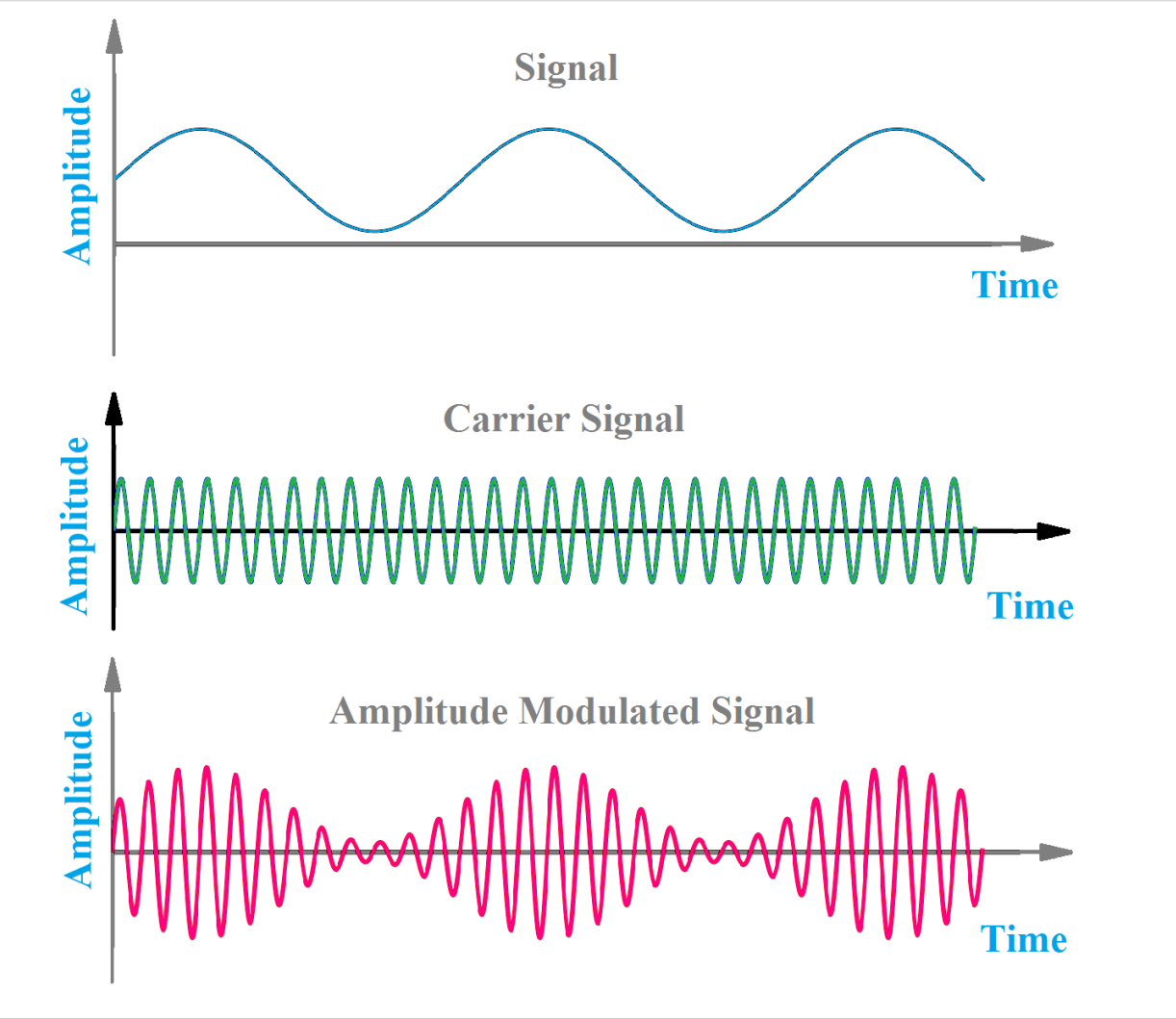
Modulation is of two types:
• Analog Modulation
• Digital Modulation

Analog Modulation- If the modulating signal's amplitude varies continuously with time, it is said to be an analog signal and the modulation is referred to as analog.

Digital Modulation- In the case where the modulating signal may vary its amplitude only between a finite number of values and the change may occur only at discrete moments in time, the modulating signal is said to be a digital signal and the modulation is referred to as digital.

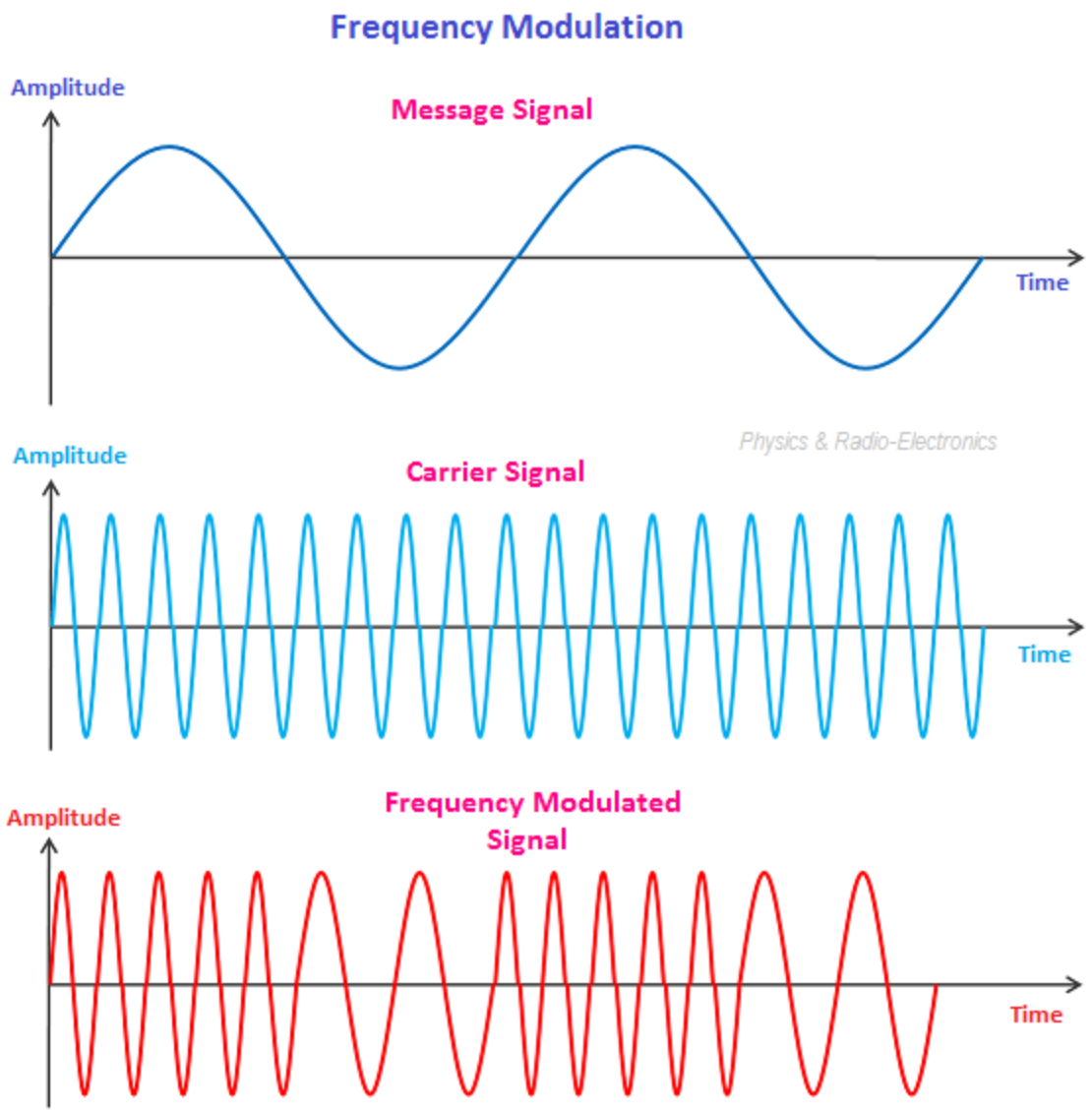
Analog Modulation
Modulation of an analog signal or analog to analog conversion is the representation of analog information by an analog signal. Analog modulation is of the following types:
• **Amplitude Modulation (AM)**
• **Frequency Modulation (FM)**
• **Phase Modulation (PM)**

Amplitude Modulation
- The encoding of a carrier wave by variation of its amplitude in accordance with an input signal is known as Amplitude Modulation.
- It is the process or result of the process where the amplitude of a carrier wave is changed in accordance with a modulating wave.
- AM is the oldest method of broadcasting radio programs. This form of modulation is not a very efficient way to send information; the power required is relatively large because the carrier, which contains no information, is sent along with the information.



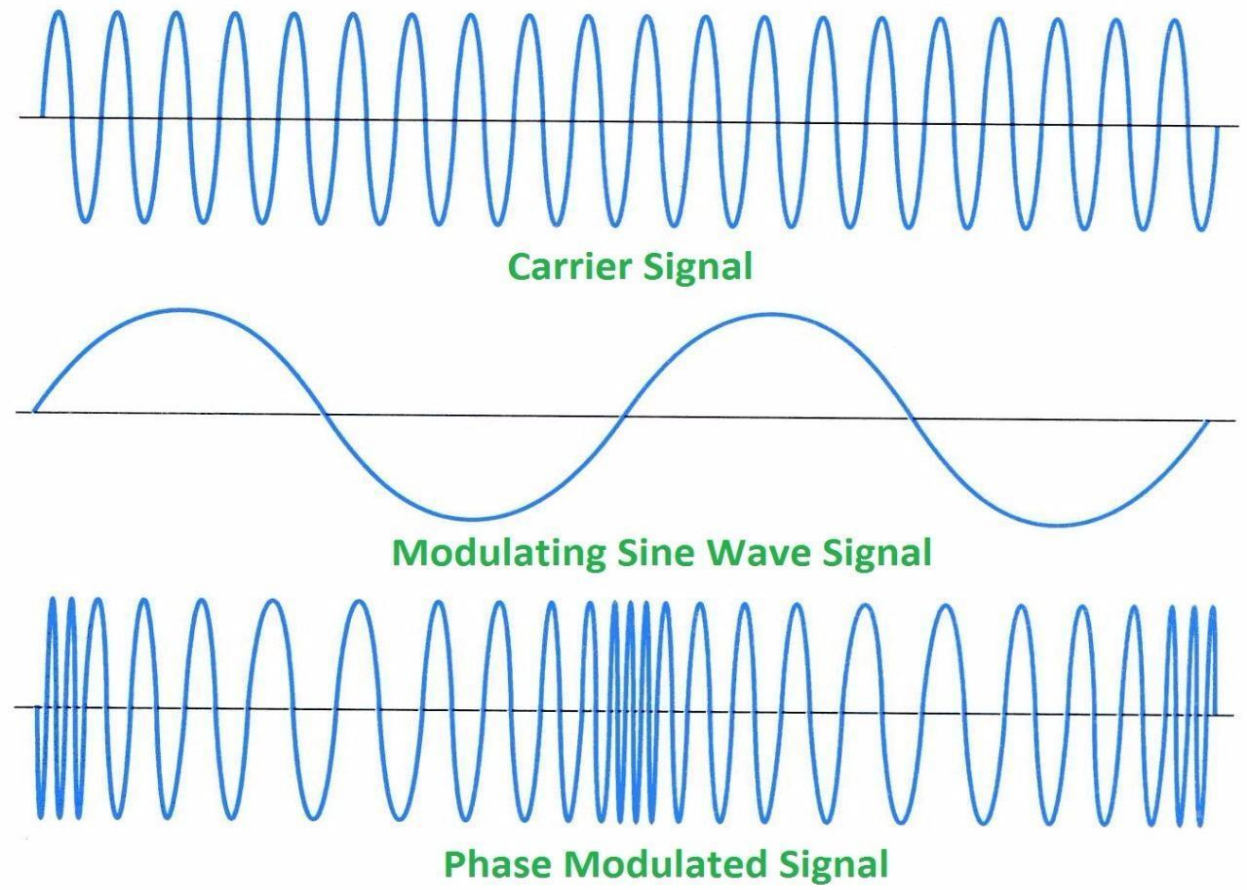
Frequency Modulation (FM)

- It is the process of encoding of a carrier wave by variation of its frequency in accordance with an input signal.
- This means that in frequency modulation (FM), unlike AM, the amplitude of the carrier is kept constant, but its frequency is altered in accordance with variations in the audio signal being sent.
- The FM band has become the choice of music listeners because of its low-noise, wide-bandwidth qualities; it is also used for the audio portion of a television broadcast.



Phase Modulation

- Phase modulation (PM) is a form of modulation that represents information as variations in the instantaneous phase of a carrier wave.
- It is a method of impressing data onto an alternating-current (AC) waveform by varying the instantaneous phase of the wave.
- This scheme can be used with analog or digital data.
- For example, the signal has 0° phase or 180° phase.



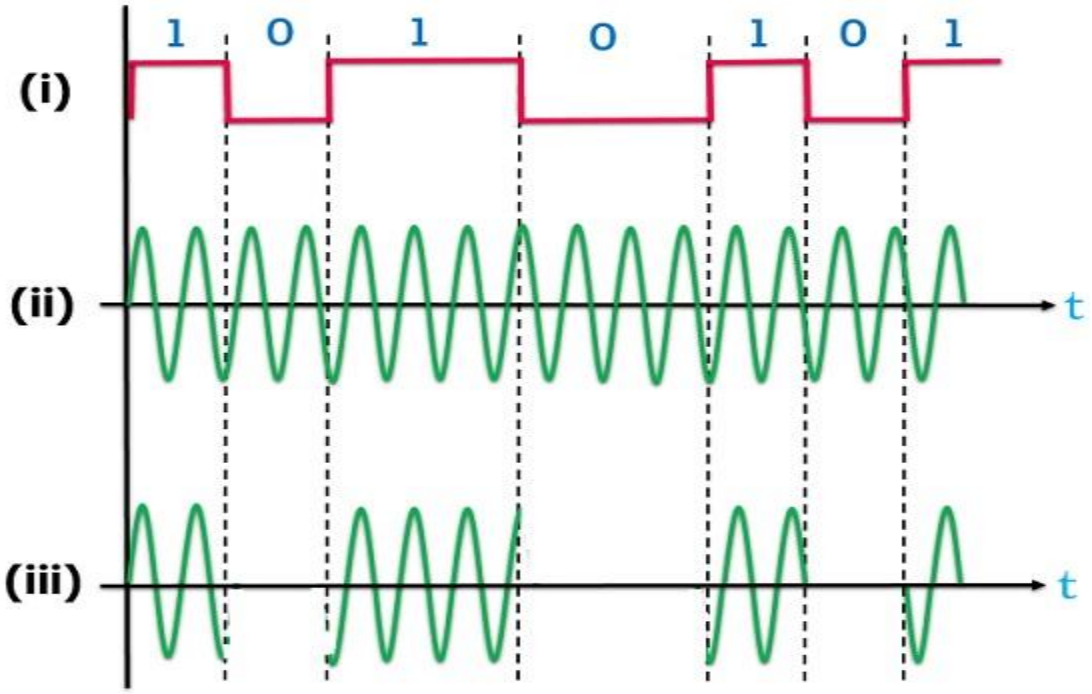
Digital modulation

- In digital modulation, an analog carrier signal is modulated by a digital bit stream of either equal length signals or varying length signals. This can be described as a form of analog-to-digital conversion.
- Digital modulation is of the following types:
  - Amplitude Shift Keying (ASK)
  - Frequency Shift Keying (FSK)
  - Phase Shift Keying (PSK)

Amplitude Shift Keying

- ASK is the most simple digital modulation scheme.
- Two binary values 0 and 1, are represented by two different amplitudes.
- It is a form of modulation that represents digital data as variations in the amplitude of a carrier wave.

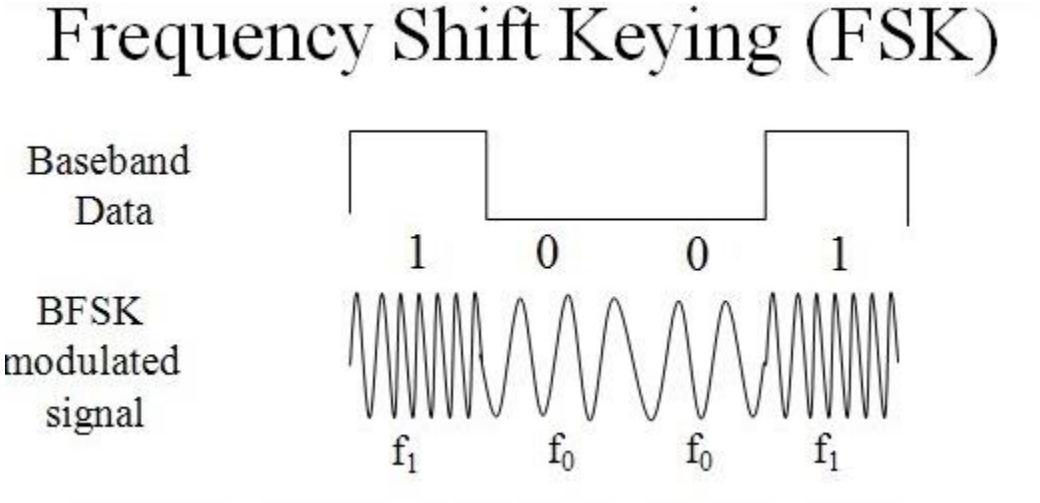
- Here, the strength of the carrier signal is varied to represent binary 1 or 0 . Both frequency and phase remains constant while amplitude changes. ASK transmission is highly susceptible to noise interference.
- The ASK technique is commonly used to transmit digital data over optical fiber. For LED transmitters, binary 1 is represented by a short pulse of light and binary O by the absence of light.



(i) = Digital bit sequence
(ii) = Carrier wave
(iii) = ASK modulated wave

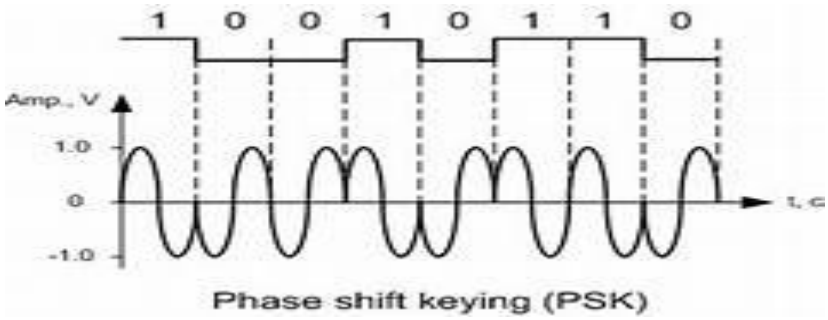
Frequency Shift Keying

- In this method the frequency of the carrier is changed to two different agencies depending on the logic state of the input bit stream.
- The typical waveform of an FSK is shown below. Notice that logic high causes the re frequency to increase to a maximum and a logic low causes the centre equency to decrease to a minimum.



Phase Shift Keying

- With this method the phase of the carrier changes between different phases determined by the logic states of the input bit stream.
- Any digital modulation scheme uses a finite number of distinct signals to represent digital data.
- In the case of PSK, a finite number of phases are used. Each of these phases is assigned a unique pattern of binary bits. Usually, each phase encodes an equal number of bits. Each pattern of bits forms the symbol that is represented by the particular phase.



Phase shift keying (PSK)

3.8 Spread Spectrum

- In telecommunication, a band - sometimes called a frequency band - is a specific range of frequencies in the Radio Frequency (RF) spectrum, which is divided among ranges from Very

Low Frequencies (VLF) to Extremely High Frequencies (EHF). Each band has a defined upper and lower frequency limit.

- Because two radio transmitters sharing the same frequency band cause interference, band usage is regulated. International use of the radio spectrum is regulated by the International Telecommunication Union (ITU).
- Domestic use of the radio spectrum is regulated by national agencies such as the Federal Communications Commission (FCC) in the U.S. Regulatory organizations assign each transmission source a band of operation, a transmitter radiation pattern, and a maximum transmitter power.

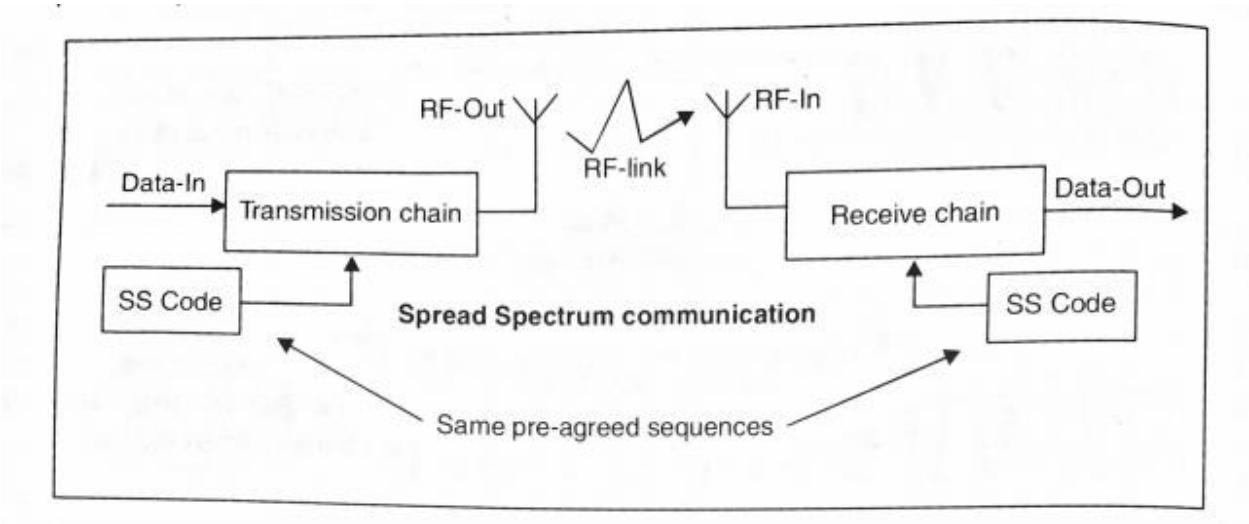
Designation		Frequency	Users
ELF	extremely low frequency	3Hz to 30Hz	-
SLF	superlow frequency	30Hz to 300Hz	-
ULF	ultralow frequency	300Hz to 3000Hz	-
VLF	very low frequency	3kHz to 30kHz	Time signals and standard frequencies
LF	low frequency	30kHz to 300kHz	Fixed, maritime mobile and navigational systems and radio broadcasting

MF	medium frequency	300kHz to 3000kHz	Land, maritime mobile and radio broadcasting
HF	high frequency	3MHz to 30MHz	Fixed, mobile, aeronautical and marine mobile, amateur radio, and radio broadcasting
VHF	very high frequency	30MHz to 300MHz	Fixed, mobile, aeronautical and marine mobile, amateur radio, television and radio broadcasting, and radio navigation
UHF	ultrahigh frequency	300MHz to 3000MHz	Fixed, mobile, aeronautical and marine mobile, amateur radio, television, radio navigation and location, meteorological, and space communication
SHF	superhigh frequency	3GHz to 30GHz	Fixed, mobile, radio navigation and location, and space and satellite communication
HF	extremely high frequency	30GHz to 300GHz	Amateur radio, atellite, and earth and space exploration

Electromagnetic spectrum with largest wavelengths from 10cm to 300000m and more are called Radio Waves. The radio spectrum is further divided into bands that are useful for specific applications. It is shown as under:

- In conventional transmission system, the information is modulated along with the carrier signal and then transmitted through a medium. When transmitted, all the power of the signal is transmitted which is around a particular frequency. This generally has a narrow band.
- Spread spectrum is an RF communications system in which the baseband signal bandwidth is intentionally spread over a larger bandwidth by injecting a frequency signal. As a direct consequence, energy used in transmitting energy is spread over a wider bandwidth, and appears as noise.
- The ratio between the spread baseband and the original signal is called processing gain. Typical SS processing gains run from 10dB to 60dB.
- To apply an SS technique, simply inject the corresponding Spread Spectrum (SS) code somewhere in the transmitting chain before the antenna.

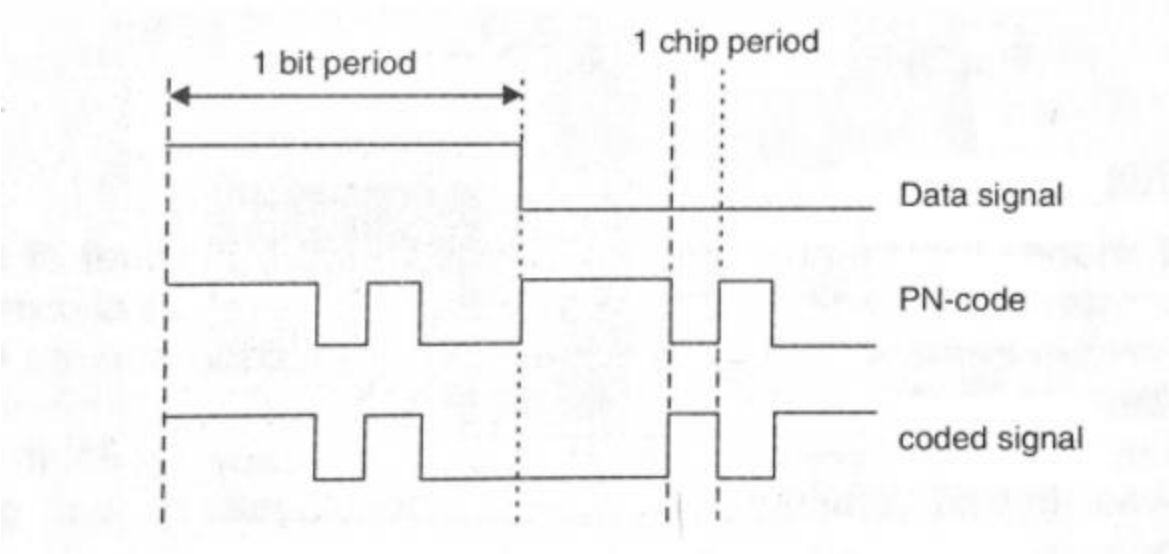
- The effect is to diffuse the information in larger bandwidth. Conversely, you can remove the SS code (despreading operation) at a point in the receive chain before data retrieval.
- The effect on despreading operation is to reconstitute the information in its original bandwidth Obviously, the same code must be known in advance at both ends of the transmission channel. (In some circumstances, it should be known only by the two parties.)



Various Spread Spectrum methods are as follows:
• Direct Sequence Spread Spectrum (DSSS)
• Frequency Hopping Spread Spectrum (FHSS)

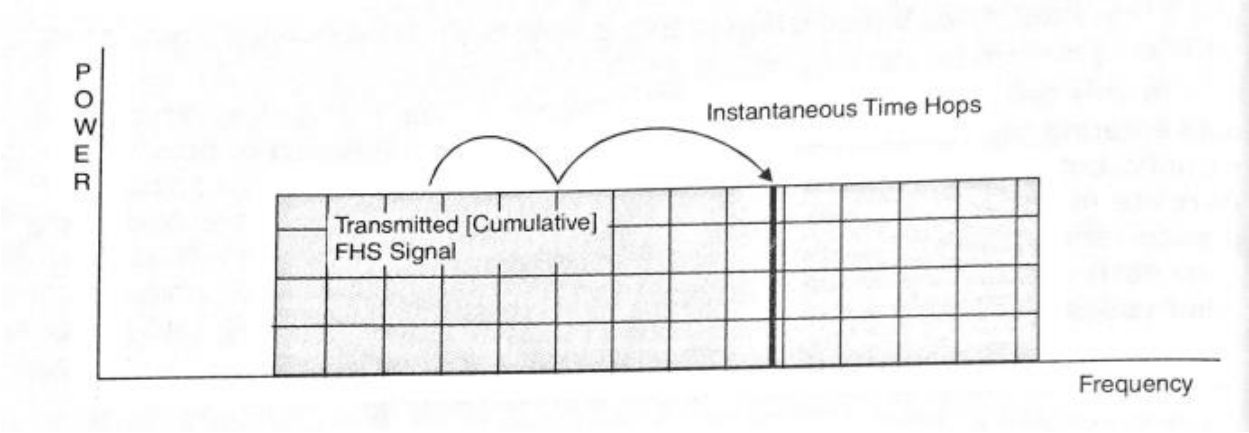
Direct Sequence Spread Spectrum (DSSS)

- DSSS is generally used to transmit digital information. Here, the digital information channel is mixed with a pseudo random code whose bandwidth is much greater than that of the signal itself.
- This method uses a wide frequency band together with Code Division Multiple Access (CDMA). Signals from different units are transmitted at a given frequency range.
- The power levels of these signals are very low (just above background noise).
- A code is transmitted with each signal so that the receiver can identify the appropriate signal transmitted by the sender unit.
- The frequency at which such signals are transmitted is called the ISM (Industrial, Scientific and Medical) band. This frequency band is reserved for ISM devices. The ISM band has three frequency ranges: 902-928, 2400-2483.5 and 5725-5850 MHz.



Frequency Hopping Spread Spectrum (FHSS)

- FHSS is a form of spreading in which the frequency of a carrier is altered many times within a fixed time period in accordance with a pseudo-random list of channels.
- The signal jumps from one frequency to another within a given frequency range.
- The transmitter device "listens" to a channel, if it detects an idle time (i.e. no signal is transmitted), it transmits the data using the full channel bandwidth. If the channel is full, it "hops" to another channel and repeats the process. The transmitter and the receiver "jump" in the same manner.
- Total available bandwidth is split into many channels of smaller bandwidth and guard spaces. Transmitter and receiver stay on one of these channels for a certain time and then hop to another channel.
- It implements FDM and TDM. Pattern of channel usage is hopping sequences



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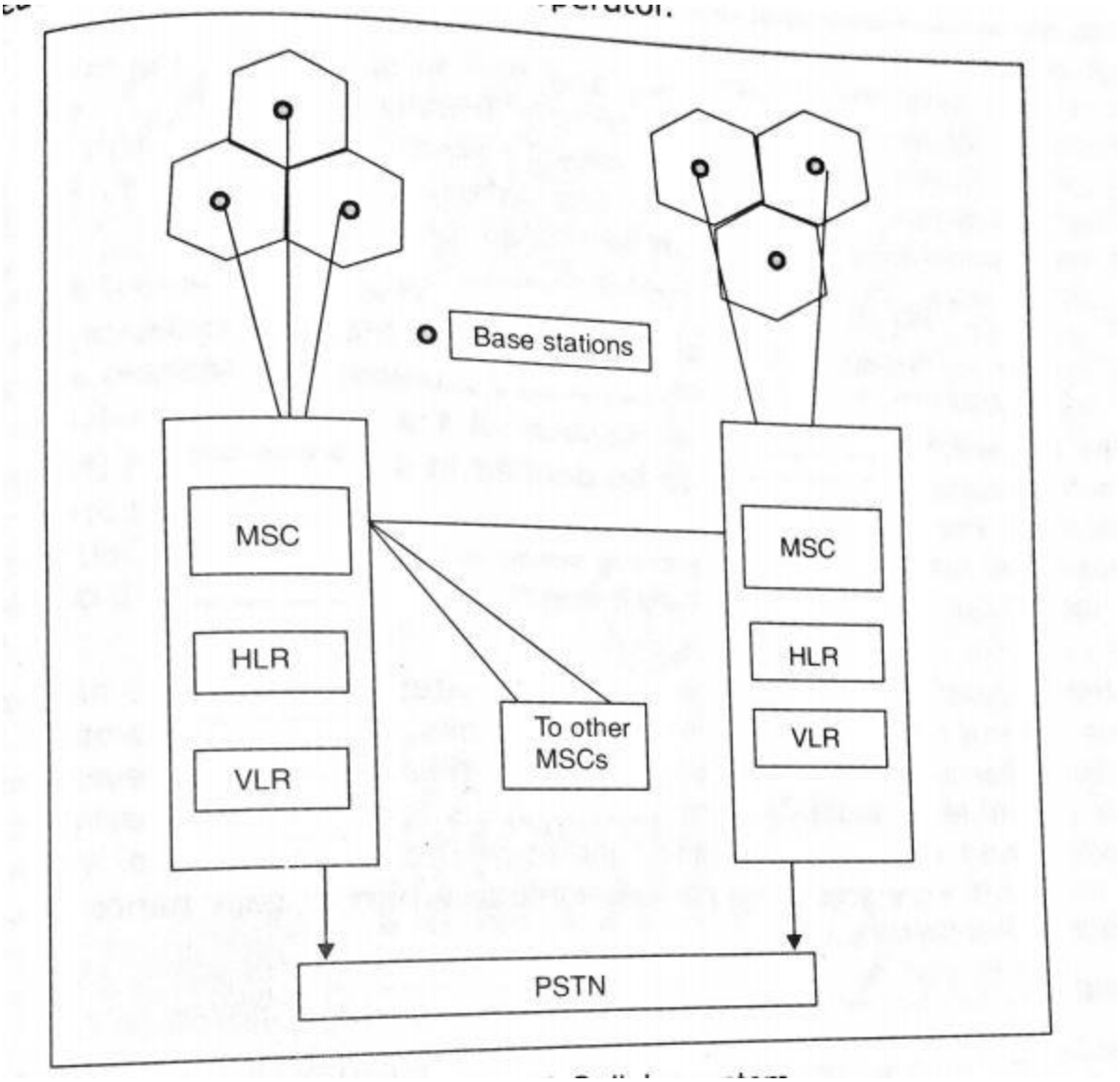
3.9 CELLULAR SYSTEM

- A cellular mobile communication system uses a large number of low power wireless transmitters to create cells-the service area of a wireless communications system.
- Increase in demand and the poor quality of existing service providers to research ways to improve the quality of service and to support more users in their systems. Because the frequency available for mobile cellular use was limited, efficient use of required frequency was needed for mobile cellular coverage.
- In order to work properly, a cellular system must verify the following two main conditions:

    1. The power level of a transmitter within a single cell must be limited in order to reduce the interference with the transmitters of neighboring cells.
    2. Neighboring cells cannot share the same channels. In order to reduce the interference, the frequencies must reuse only a certain pattern.
- A cellular network is a radio network made up of a number of radio cells (or just cells) each served by a fixed transmitter, known as a cell site or base station. These cells are used to cover different areas in order to provide radio coverage over a wider area than the area of one cell.

Cellular networks offer a number of advantages:

- Increased capacity
- Reduced power usage
- Better coverage



(Cellular Systems)

Provisioning for each region is planned according to an engineering plan that includes **cells, clusters, frequency reuse, and handovers.**

Cells

- A cell is the basic geographic unit of a cellular system. Cells are base stations Sitting over small geographic areas that are represented as hexagons.
- Size varies depending on the landscape. Because of constraints imposed or terrain and man-made structures.

Different types of cells are used:

1. **Macro cells**
2. **Micro cells**
3. **Selective cells**
4. **Umbrella cells**

1. Macro cells -They are large cells for remote and sparsely populated areas.

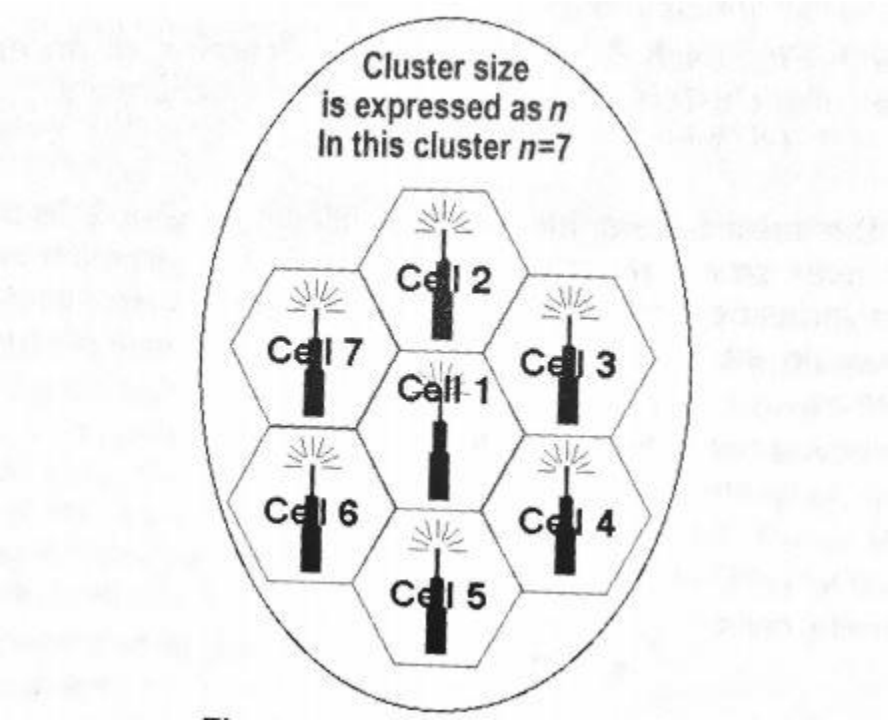
2. Micro cells -They are used for densely populated areas. By splitting the existing areas into smaller cells, the available channels are increased as well as the capacity of cells.

3. Selective cells- The cells should be defined in such a way that they prove their existence.

4. Umbrella cells- Crossing of small cells creates an important number of handovers among different small neighboring cells. To solve the problem, the idea of umbrella cells was introduced. An umbrella cell covers several micro cells.

Clusters

A cluster is a group of cells. No channels are reused within a cluster. It is a 7 cell-cluster.



Frequency Reuse

The concept of frequency reuses based on assigning to each cell a group of radio channels used within a small geographic area.

Cell Splitting

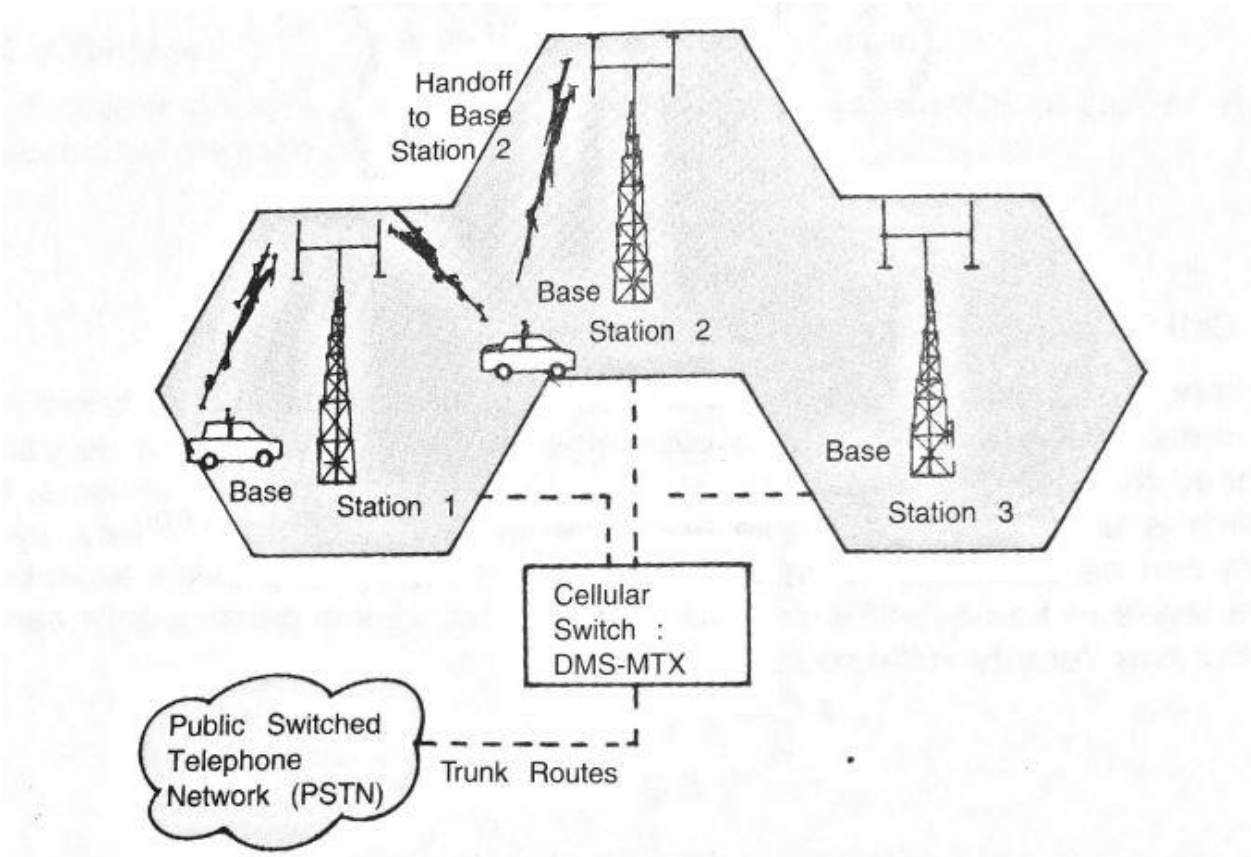
As a service area becomes full of users, a cell splitting approach is used to split a single area into smaller ones.

Handoff

- The final obstacle in the development of the cellular network involved the problem

created when a mobile subscriber traveled from one cell to another during a call.

- As adjacent areas do not use the same radio channels, a call must either be dropped or transferred from one radio channel to another when a user crosses the line between adjacent cells.
- Because dropping the call is unacceptable. The process of handoff was created. Handoff occurs when the mobile telephone network automatically transfers a call from radio channel to radio channel as mobile crosses adjacent cells.



Cellular Radio

- Each base station provides a radio coverage to a geographical area known as a cell.
- Base stations are connected to one another by central switching centers, which track calls and transfer them as the caller moves from one cell to the next.
- If a person with a mobile phone starts to move out of one cell and into another, the controlling network hands over communication to the adjacent base station.

Possible Short Questions with answer

Q1. Define term wireless? [W-2020]

- Wireless Communication is a method of transmitting information from one point to another, without using any connection like wires, cables or any physical medium.
- Ex- Air, Free space

Q2. What is communication?[w-2020]

- Wireless Communication is a method of transmitting information from one point to another, without using any connection like wires, cables or any physical medium.
- Generally, in a communication system, information is transmitted from transmitter to receiver that are placed over a limited distance.

Q3. Define signal and its types. [w-2020]

- A signal is an electrical or electromagnetic current that is used for carrying data from one device or network to another.
- Two types – Analog and digital signals

Long Questions

Q1. Explain the difference between wired and wireless networks.[w-2020]

Q2. Explain in detail about the signal propagation. Define each of the components and relation between them.[w-2020]

Q3. What do you mean by modulation? Discuss types of modulation.[w-2020]

Q4. Discuss about each of the multiplexing technique. Illustrate with diagrammatic representation.[w-2020]

CHAPTER-04
Medium Access Control

Articles to be covered

4.1 Introduction

4.2 Hidden/ Exposed Terminals

4.3 The basic Access Method

4.4 Near / Far Terminals

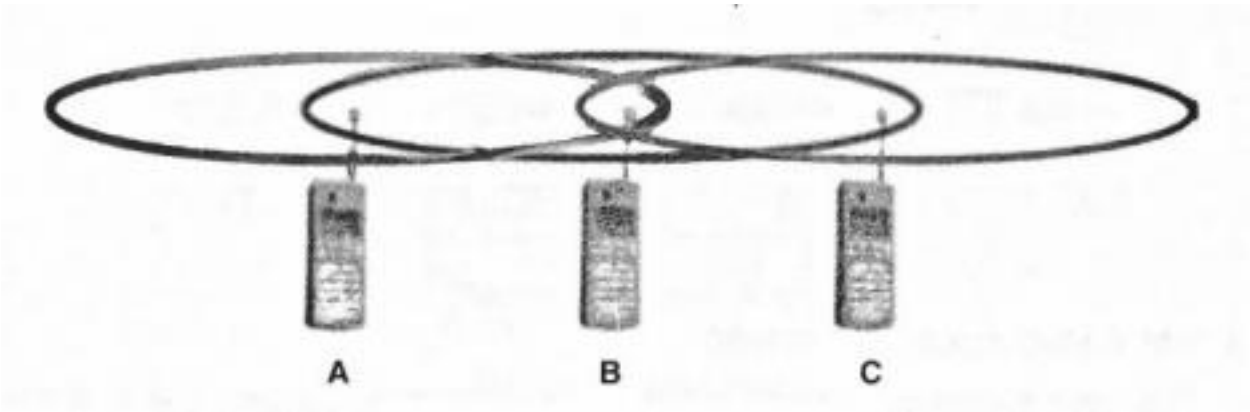
4.5 SDMA, FDMA,TDMA, CDMA

4.1 Introduction

- When a no. of signal sources attempt to access a wireless medium simultaneously, networks encounter the problem of receiving signals from each radio carrier distinctly.
- This is because the signals (electromagnetic signals) tend to interfere with each other when they are transmitted simultaneously through the medium. Also networks encounter the problems of signals from hidden and exposed terminals as well as near and far terminals.
- To overcome these problems, communication system receivers extract distinct signals from various terminals in presence of signals divided into different cells, time slots, frequencies and codes (SDMA, TDMA, FDMA and CDMA signals).
- CDMA is a big step forward for medium access control during access to the transmission medium by multiple wireless systems at a given instant and frequency band.

4.2 Hidden/ Exposed Terminals

- This problem does not occur on a wired LAN. Consider the scenario with three mobile phones.



● The transmission range of C reaches B, but not A. Finally the transmission range of B reaches A and C. A cannot detect C and C can not detect A.

● A starts sending to B, C does not receive this transmission. C also wants to send some data to B and senses the medium.

● Thus C starts sending causing a collision at B. But A can not detect this collision and continues with its transmission, A is hidden for C And vice versa.

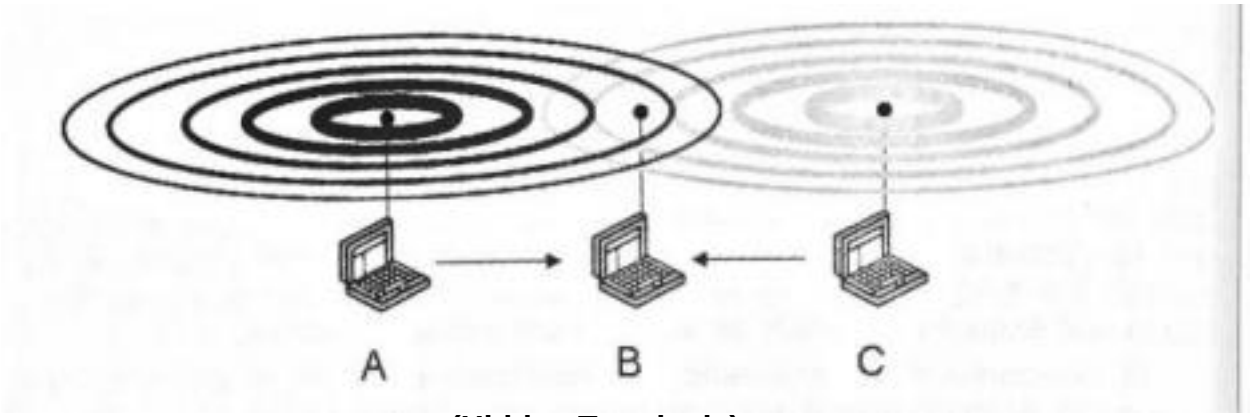
● While hidden terminals cause collision, the next effect is unnecessary delay. ● Now, B sends something to A and C wants to send data to some other mobile phone outside the range of A, B and C.

● C senses carrier and detects that carrier is busy. Hence, C postpones its transmission But as A is outside the interference range of C, waiting is not necessary.

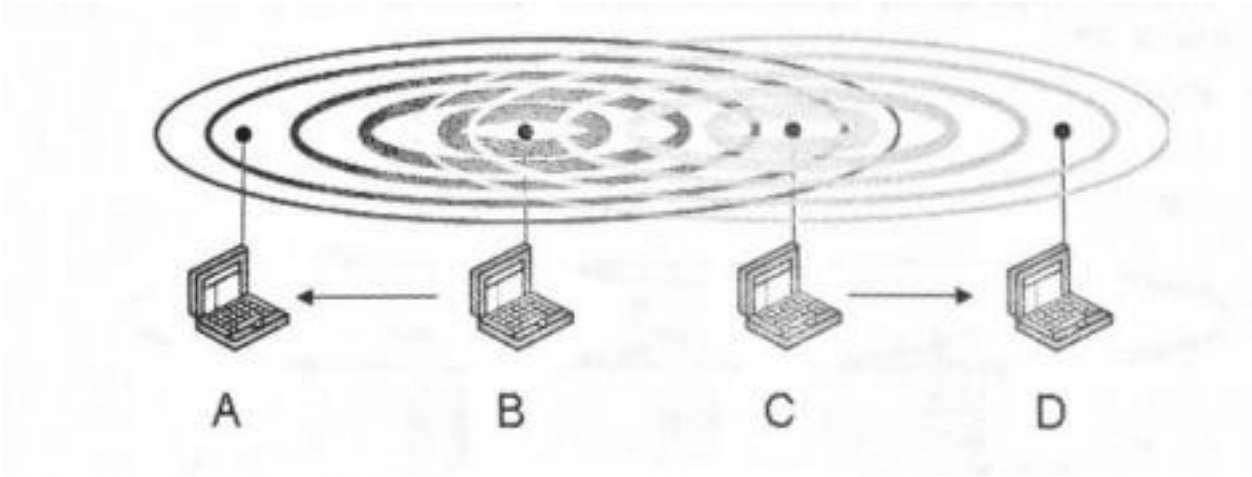
● Causing a collision at B does not matter because the collision is too weak to propagate to A. In this situation, C is exposed to B.

Carrier Sense Multiple Access with Collision Detection

CSMA/CD.. Hidden Terminal Problem:



(Hidden Terminals)



(Exposed Terminals)

4.3 The basic Access Method

● The basic access mechanism is Carrier Sense Multiple Access, CSMA. ● It has two types Carrier Sense Multiple Access with Collision Avoidance, CSMA/CA and Carrier Sense Multiple Access with Collision Detection, CSMA/CD.

● CSMA protocol works as follows: A station, which wants to transmit the data, senses the medium, if the medium is busy then the station will pause its transmission for some time, if the medium is sensed free then the station is allowed to transmit.

CSMA/CD protocol works as follows:

● A sender senses the medium to see if it is free. If the medium is busy, the sender waits until it is free.

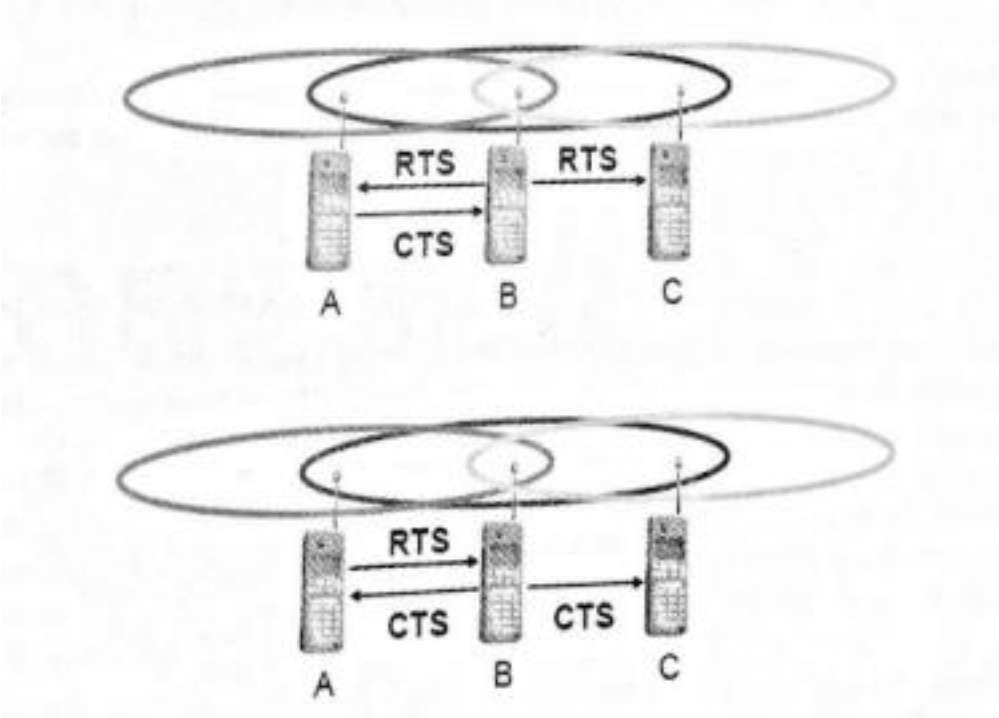
● If the medium is free, the sender starts transmitting data and continues to listen to the medium. If the sender detects a collision while sending, it stops at once.

CSMA/CA protocol works as follows:

● It uses two short signaling packets for collision avoidance .They are *Request To Send (RTS*) and *Clear To Send (CTS)*.

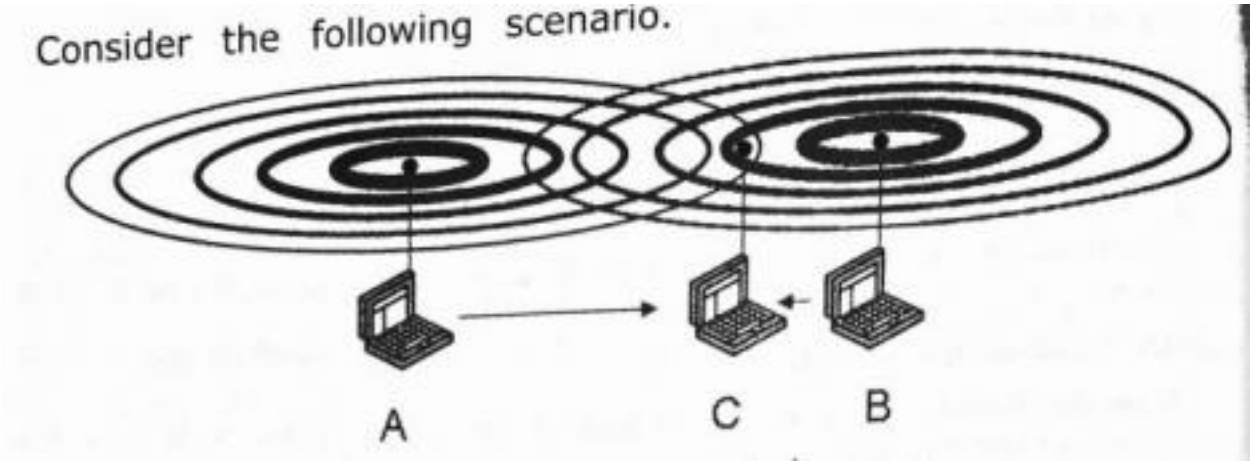
● The sender requests the right to send from a receiver with a short RTS packet before it sends a data packet.

● The receiver grants the right to send as soon as it is ready to receive. Signaling packets contain sender address, receiver address and packet length (the length of the future transmission). It avoids the problem of Hidden and Exposed Terminals.



(CSMA/CA WORKING)

4.4 Near / Far Terminals

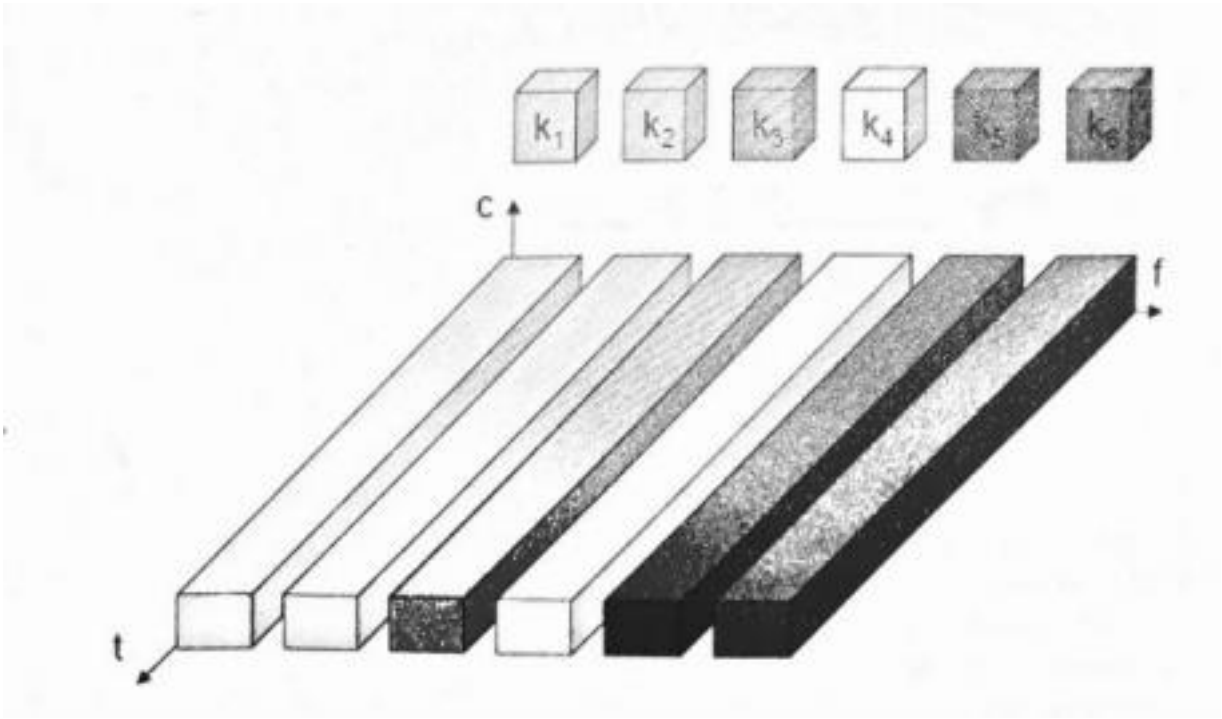


- Near/Far Terminals Here A and B both are sending signals with the same transmission power.
- As the signal strength decreases proportionally to the square of the distance, B's signal drowns out A's signal. As a result C can not receive A's transmission.

4.5 Frequency Division Multiple Access (FDMA)

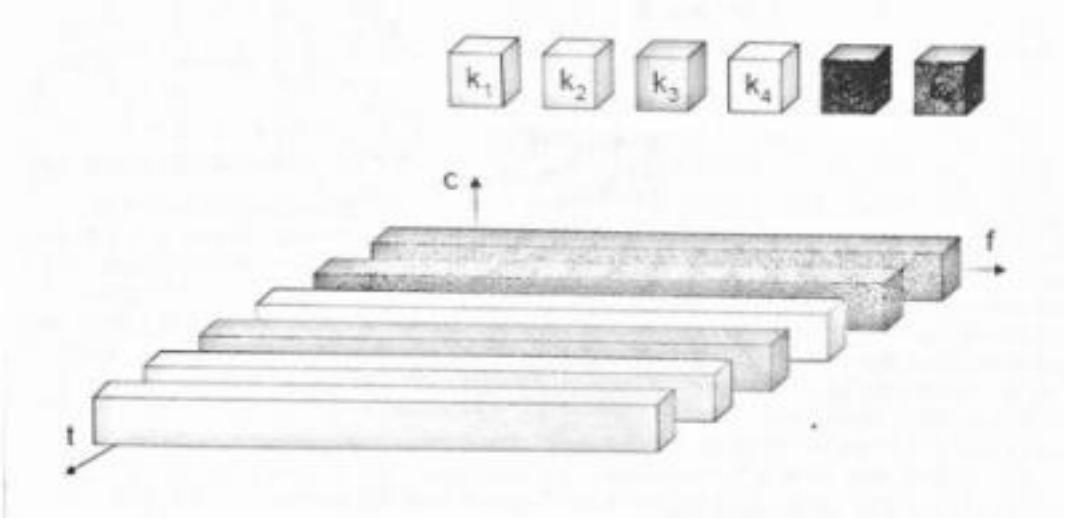
- It is one of the most common multiplexing techniques. The available frequency band is divided into channels of equal bandwidth so that each communication is carried on a different frequency.
- This multiplexing technique Is used in all the 1st generation analog mobile networks like Advanced Mobile Phone System (AMPS) in the USA and Total Access Communication System (TACS) in the UK.

- Each user is allocated two channels, one for uplink and another for downlink communication. No other user is allocated the same channel at the same time.



TIME DIVISION MULTIPLE ACCESS (TDMA)

- It is a more expensive technique compared to FDMA as it needs proper synchronisation between sender and receiver.
- TDMA is access method for shared (usually radio) networks. It allows several users to share the same channel by dividing the signal into different time slots i.e. each channel it up into time segments, and a transmitter is given exclusive use of one or channels only during a particular time period.
- TDMA is used in digital 2G cellular systems such as Global System for Mobile Communications (GSM), personal Digital Cellular (PDC) etc.
- It is also used extensively in satellite systems.



Code Division Multiple Access (CDMA)

● CDMA is a broadband system and hence functionally different from FDMA and TDMA. ● It uses spread spectrum technique where each subscriber uses the whole system Bandwidth.

● To separate the signals, each subscriber is assigned an orthogonal code called chip. ● They are difficult to detect and jam. CDMA has been used in many Communications and navigation systems, including the Global Positioning System (GPS) and in the satellite system for transportation.

Space Division Multiple Access (SDMA)

● This is a technique where different parts of space are used for multiplexing. ● It is a technique in which a transmitter transmits the modulated signal and accesses a slot of space and another transmitter uses another slot of space such that both the signals can propagate in two separate spaces in the medium without affecting each other.

- It is used in radio transmission and is more useful in satellite communication to optimize the use of radio spectrum by using directional properties of antennas.
- In SDMA, antennas are highly directional, allowing duplicate frequencies to be used at the same time for multiple surface zones on earth. Precise antenna alignment is also required.

Possible Short Questions with Answers

Q1. What is CSMA?

CSMA protocol works as follows: A station, which wants to transmit the data, senses the medium, if the medium is busy then the station will pause its transmission for some time, if the medium is sensed free then the station is allowed to transmit.

2.HOW CSMA/CD protocol works?

- A sender senses the medium to see if it is free. If the medium is busy, the sender waits until it is free.
- If the medium is free, the sender starts transmitting data and continues to listen to the medium. If the sender detects a collision while sending, it stops at once.

3. Define SDMA.

- This is a technique where different parts of space are used for multiplexing.
- It is a technique in which a transmitter transmits the modulated signal and accesses a slot of space and another transmitter uses another slot of space such that both the signals can propagate in two separate spaces in the medium without affecting each other.

4. What is TDMA?

- TDMA is an access method for shared (usually radio) networks.
- It allows several users to share the same channel by dividing the signal into different time slots i.e. each channel it up into time segments, and a transmitter is given exclusive use of one or channels only during a particular time period.

5. Define CDMA.

- It uses spread spectrum technique where each subscriber uses the whole system Bandwidth.
- To separate the signals, each subscriber is assigned an orthogonal code called chip.

6. Define hidden Terminal[w-2020]

- The transmission range of C reaches B, but not A. Finally the transmission range of B reaches A and C. A cannot detect C and C can not detect A.
- A starts sending to B, C does not receive this transmission. C also wants to

send some data to B and senses the medium.

- Thus C starts sending causing a collision at B. But A can not detect this collision and continues with its transmission, A is hidden for C And vice versa.

LONG QUESTIONS

Q1. Explain hidden & exposed terminals.
Q2. Describe how CSMA/CD and CSMA/CA works?
Q3. Explain different multiple access techniques.

CHAPTER-05
WIRELESS LANs

Articles to be covered
5.1 Wireless LAN and communication
5.2 Infrared
5.3 Radio Frequency
5.4 IR Advantages and Disadvantages
5.5 RF Advantages and Disadvantages
5.6 Wireless Network Architecture Logical
5.7 Types of WLAN
5.8 IEEE 802.11
5.9 MAC layer
5.10 Security
5.11 Synchronization
5.12 Power Management
5.13 Roaming
5.14 Bluetooth Overview

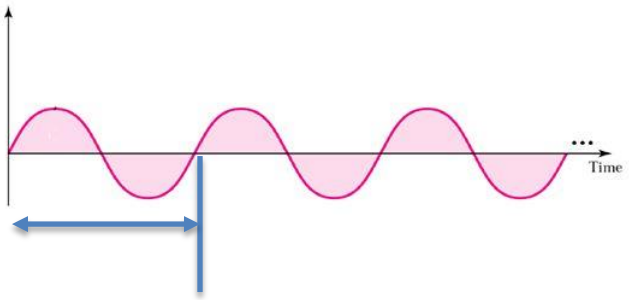
5.1 Wireless LAN and communication

- Wireless communication allows information exchange between two devices without the use of wires or cables.
- A wireless LAN or WLAN is a wireless local area network that uses radio waves as its carrier to give a network connection to all users in the surrounding area. Areas may range from a single room to an entire campus.
- The backbone network usually uses cables, with one or more wireless access points connecting the wireless users to the wired network.
- It allows users to move around in a confined area while they are still connected to the network. By using a small radio transmitter and a building full of special sensors, your desktop can be anywhere you are, not just at your workstation.
- At the press of a button, the computer closest to you in any room becomes your computer for as long as you need it. In addition to computers, the system can work with other devices, including phones and digital cameras.

  WLANS transmit information by three main ways. They are microwave, spread spectrum and infrared.
- A typical electromagnetic wave is shown in below fig, where vertical axis represents the amplitude or strength of the wave, and horizontal axis represents time. In relation to electromagnetic energy, frequency is:

1. The number of cycles a wave completes (or the number of times a wave repeats itself) in one second Expressed as Hertz (Hz), which equals once cycle per second .
2. Commonly indicated by prefixes such as KHZ, MHZ, GHZ
3. Directly related to the amount of information that can be transmitted on the wave.

Amplitude



One full Cycle

(A simple Signal)

The term wavelength is used almost interchangeably with frequency relation to electromagnetic energy, wavelength is:
Shortest distance at which the wave pattern fully repeats itself
• Expressed as meters
• Commonly indicated by prefixes such as km, mm, nm
• Inversely proportional to frequency.

- Other terms used in wireless communication include transmitter, receiver, and transceiver.
- In any type of wireless technology, information must be sent (or transmitted) by one device and captured (or received) by another device.
- The transmitter takes its input - a voice or stream of data bits for example, creates an energy wave that contains the information, and sends the wave using an appropriate output device.
- As an example, a radio transmitter outputs its energy waves using an antenna, while an infrared transmitter uses an infrared light- emitting diode (LED) or laser diode. The electromagnetic energy waves are captured by the receiver, which then processes the waves to get and output the information in its original form.
- Any Wireless device having the mechanism to both transmit and receive energy signal is referred to as a transceiver.

5.2 Infrared

- Infrared (IR) is electromagnetic radiation with wavelengths longer than visible light but shorter than radio waves, Infrared radiation is the region of the electromagnetic spectrum between microwaves and visible light.
- In infrared communication, an LED transmits the infrared signal as bursts of non-visible light .
- At the receiving end, a photodiode or photoreceptor detects and captures the light pulses, which are then processed to retrieve the information they contain. ● Some common applications of infrared technology are listed below: ➢ Computers - Mouse, Keyboards, Floppy disk drives, Printers
    - ➢ Headphones .
    - ➢ Home security systems .
    - ➢ Telephones .
    - ➢ TVS, VCRS, CD players, stereos
    - ➢ Toys etc.

5.3 Radio Frequency

- Radio Frequency (RF) refers to that portion of the electromagnetic spectrum in which electromagnetic waves can be generated by alternating current, which is fed to an antenna.
- When you listen to a radio station and the announcer says, "You are listening to 91.5 FM WRKX The Rock!," what the announcer means is that you are listening to a radio station broadcasting an FM radio signal at a frequency of 91.5 megahertz, with Federal Communications Commission (FCC) assigned call letters of WRKX Megahertz means "millions of cycles per second," so "91.5 megahertz means that the transmitter at the radio station is oscillating at a frequency of 91,500,000 cycles per second.
- Your FM (Frequency Modulated) radio can tune in to that specific frequency and give you clear reception of that station.
- All FM radio stations transmit in a band of frequencies between 88 megahertz and 108 megahertz. This band of the radio spectrum is used for no other purpose but FM radio broadcasts.
- In the same way, AM radio is confined to a band from 535 kilohertz to 1,700 Kilohertz (kilo meaning "thousands," so 535,000 to 1,700,000 cycles per second). ● Therefore, an AM (Amplitude Modulated) radio station that says, "This is AM 680 "!" means that the radio station is broadcasting an AM radio signal at 680 kilohertz and its FCC-assigned call letters are WPTF.

5.4 IR Advantages and Disadvantages

• Low power requirements: therefore ideal for laptops, telephones, per sonal digital assistants

• Low circuitry costs
• Simple circuitry: no special or proprietary hardware is required, can be incorporated into the integrated circuit of a product
• Portable
• Few international regulatory constraints: IrDA (Infrared Data Association,)functional devices will ideally be usable by international travelers, no matter where they may be.
• High noise immunity: not as likely to have interference from signals from other devices.

IR Disadvantages

• Line of sight is required i.e. transmitters and receivers must be almost directly aligned to communicate
• Blocked by common materials: people, walls, plants, etc. can block transmission
• Short range: performance drops off with longer distances
• Light, weather sensitive: direct sunlight, rain, fog, dust, pollution can affect transmission
• Speed: data rate transmission is lower than typical wired transmission.

5.5 RF Advantages and Disadvantages

RF ADVANTAGES

• Line of sight is not required.
• Not blocked by common materials: can penetrate most solids and pass through walls. • Longer range.
• Not light sensitive.
• Not as sensitive to weather/environmental conditions.

RF Disadvantages

• Interference: communication devices using similar frequencies - wireless phones, scanners, wrist radios and personal locators can interfere with transmission. • Lack of security: easier to "eavesdrop" on transmissions since signals are spread out in space rather than confined to a wire.
• Higher cost than infrared.
• Federal Communications Commission(FCC) licenses required for some products. • Lower speed: data rate transmission is lower than wired and infrared transmission.

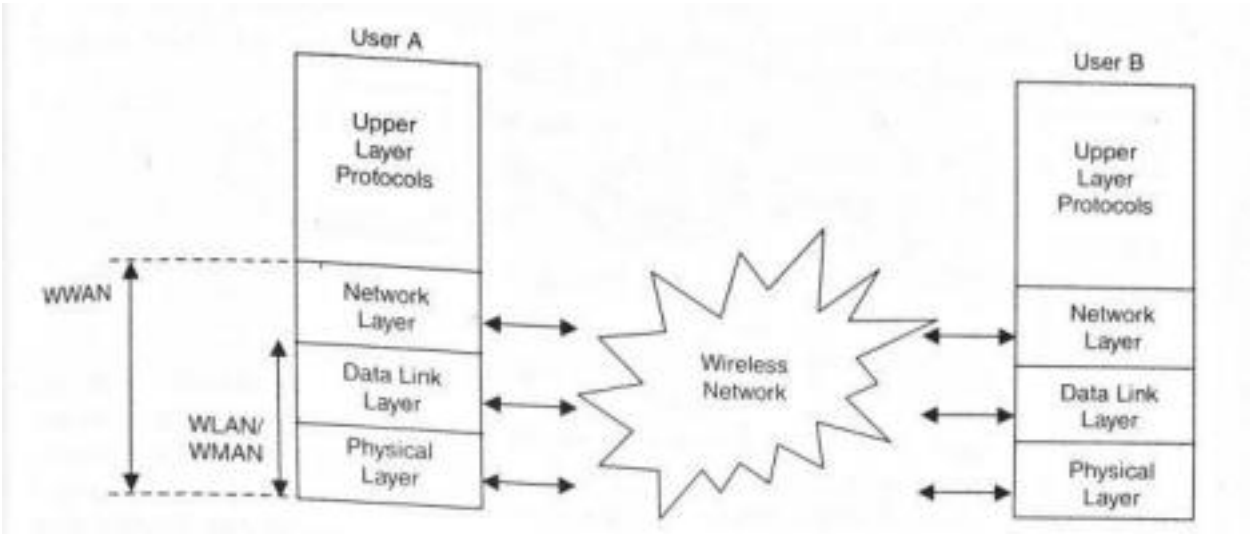
5.6 Wireless Network Architecture Logical

Network performs many functions to transfer information from source to destination. They are as follows:

• The medium provides the path for data to flow.
• Medium access techniques provide the sharing of a common medium. • Synchronization and error control mechanisms ensure transfers of data properly. • Routing mechanisms move the data from the originating source to destination properly.

Logical Architecture of Wireless Network

- Logical architecture defines the network's protocol rules by which two entities communicate. The most popular standard logical architecture is 7 layers open System Interconnection (OSI) model.
- Wireless Network doesn't concern all 7 layers. They function only with physical and data link layers which provide the above-mentioned functions.



(Logical Architecture of Wireless Network)

5.7 Types of WLAN

There are two types of WLANs. They are as follows:

- Ad-hoc Mode
- Infrastructure Mode

Ad-hoc Mode

- The ad-hoc mode includes WLAN cells interacting without connecting to wired networks i.e. without connection to an access point.
- No access point is needed and the devices might connect to the internet through wired or other wireless techniques.
- There is no fixed infrastructure and information is forwarded in peer-to-peer (P2P) mode. ● There is no administration, no setup, and no cost.
- Each node can directly communicate with another node. Nodes can only communicate if they reach each other physically (if they are within each other's radio range) or if other nodes can forward the message.

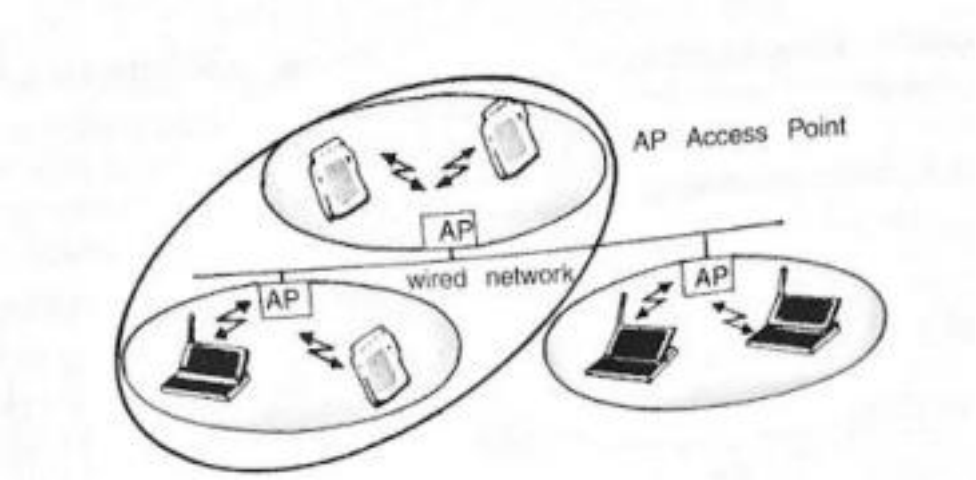
Ad-hoc Network

- This network structure may operate in a stand-alone fashion. Each node is equipped with a wireless

transmitter and receiver with appropriate antenna.

Infrastructure Mode

- The infrastructure mode includes one or several interconnected WLAN cells which are connected to a fixed net through an access point.
- Wireless access points can be compared with an Ethernet hub or switch and is used to allow computers or other devices with wireless cards to participate in a network.
- All communication occurs through access points.



(Infrastructure Network)

- Communication typically takes place only between the wireless nodes and the access point and not directly between the wireless nodes.

● Access point acts as a bridge. Access points with a fixed network can connect several wireless networks to form a larger network beyond the actual radio coverage. ● Cellular phone and satellite-based cellular phone are typically infrastructure-based networks

5.8 IEEE 802.11

● The IEEE adopted the first standard for WLANS. As the standards number indicates, this standard belongs to the group of 802.X LAN standards.

● This means that the standard specifies the physical and medium access layer adapted to the special requirements of wireless LANs, but offers the same interface as the Others to higher layers to maintain interoperability.

● The primary goal of the standard was the specification of a simple and robust WLAN which

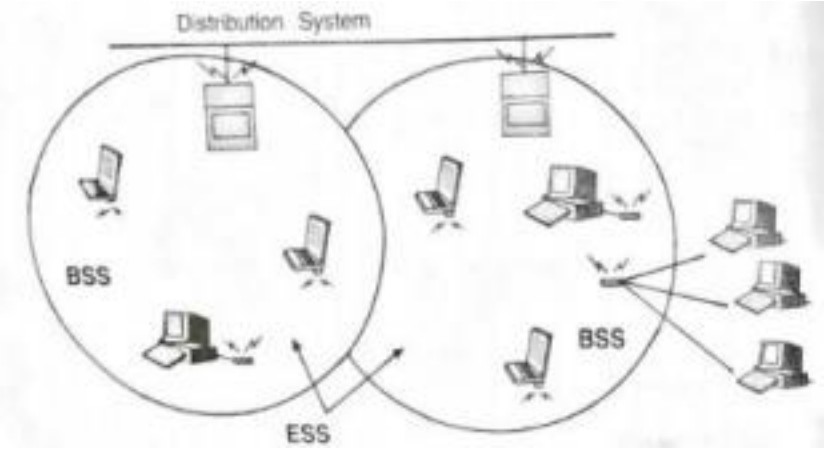
offers time bound and asynchronous services.

● The IEEE 802 committee was formed to set up standards for the LAN domain. There are many standards within this family with almost all letters from a to x.

● These specifications define an over-the-air interface between a wi ent and a base station (or access point), or between two or more wireless clients.

● More popularly, 802.11 is known as Wi-Fi.

IEEE 802.11 Architecture



- The IEEE 802.11 standard permits devices to establish either peer-to. (P2P) networks or networks based on fixed access points (AP) with which means nodes can communicate.
- Hence, the standard defines two basic net topologies: the infrastructure network and the ad hoc network.
- A WLAN environment has wireless client stations that use radio modems to communicate to an AP.
- The client stations are generally equipped with a wireless network interface card (NIC) that consists of the radio transceiver and the logic to interact with the client machine and software.
- An AP comprises essentially a radio transceiver on one side and a bridge to the wired backbone on the other Access Points are connected through some kind of backbone called Distribution System (DS).
- All communications between the client stations and between clients and the wired network go through the AP.
- Various components are explained below.
    - ➢ BSS: It is a set of stations that communicate with one another .
    - ➢ IBSS: When all of the stations in The BSS are mobile stations and there is no connection to a wired network The BSS is called independent BSS. ➢ Infrastructure BSS: When BSS includes an access point (AP) the BSS is called infrastructure BSS.
    - ➢ ESS :ESS is a set of infrastructure BSS.
    - ➢ DS : The access points perform communication via an abstract medium called a distribution system. DS is the mechanism by which one AP communicate with another

to exchange frames for stations in their BSSs , forward frame and exchange frames with wired networks.

5.9 MAC layer

- When the transmission medium is shared, there should be a method to control access to the medium at any moment of time.
- To prevent the collision on the network, there should be a method for medium access control.
- This method defines the procedure a computer follows when it needs to send frames.
- The Medium Access Control (MAC) is a sub layer of Data Link Layer. This layer defines who can use the network medium when multiple computers are trying to access it simultaneously.
- Most decisions for accessing the wireless medium are made in the MAC layer. It establishes a reliable point-to-point connection between different devices over a wireless medium. For eg. token passing or CSMA/CD for Ethernet.
- MAC Layer functionality is reliable data delivery, fairly control access to the shared wireless medium and protect the data that it delivers.
- The 802.11 family uses a MAC layer known as CS (Carrier Sense Multiple Access/Collision Avoidance). Classic Ethernet uses CSMA/CD - collision detection).

In CSMA/CA a wireless node that wants to transmit performs the following sequence:

1. Listen on the desired channel.
2. If the channel is idle (no active transmitters) it sends a packet.
3. If the channel is busy (an active transmitter) node waits until transmission stops then a further contention period.
4. If the channel is still idle at the end of the contention period then the node transmits its packet otherwise it repeats the process defined in 3 above until it gets a free channel.

To improve efficiency additional features are employed:

1. Positive Acknowledgement (ACK)
2. MAC level retransmission
3. Fragmentation

At the end of every packet the receiver, if it has successfully received the packet, will return an ACK packet (if not received or received with errors the receiver will NOT respond i.e. there is no ACK i.e. NACK).

5.10 Security

- In the wireless world, every bit is in air so security is the major issue. ● IEEE 802.11 provides two mechanisms to select a key for use when encrypting or decrypting a frame.
- The first mechanism is a set of default keys. Default keys are intended to be shared by all stations in a BSS or an ESS. The benefit of using a default key is that, once the station obtains

the default keys, a station can communicate securely with all of the other a BSS or ESS.

- The second mechanism establishes a key mapping relationship with another station. Key mapping allows a station to create a key that is used with only one other station.

The three basic security services defined by IEEE for the WLAN environment are as follows:

- .Authentication:- This provides access control to the network by denying access to client stations that can not authenticate properly. This service addresses the question, “Are only authorized persons allowed to gain access to my network?"

- Confidentiality:- Confidentiality, or privacy, was a second goal of WEP. It was developed to provide "privacy achieved by a wired network." The intent was to prevent information compromise from casual eavesdropping (passive attack).

- Integrity:- This ensures that messages are not modified in transit between the wireless clients and the access point in an active attack.

5.11 Synchronization

- Synchronization is the process of the stations in a BSS getting in step with each other, so that reliable communication is possible. ● Mobile nodes need to maintain synchronization.
- The MAC provides the synchronization method to allow support of physical (PHY) layers.
- It is achieved by all the stations updating their clocks according to the access point's clock.
- The receiving station checks the value of their clocks at the moment the signal is received and corrects it to keep synchronized with the clock of the access point. This prevents clock drifting.

5.12 Power Management

In the case of wireless LANs (mobile application), battery power is to be saved. Power saving enables stations to go into sleep mode without losing information. The access point maintains an updated record of all the stations in power saving mode.

5.13 Roaming

- It is the process of moving from one cell to another cell without losing connection. A client can switch between access points while physically moving or because of load balancing between access points.
- Clients are not restricted to being stationary. Usually this is completely transparent to the user; they are not aware that a different access point is being used from area to area.

- Access points are required to have overlapping wireless areas to achieve this. A user can move from Area 1 to Area 2 transparently.
- The Wireless networking hardware automatically swaps to the Access Point with the best signal.
- Not all access points are capable of being configured to support roaming.

5.14 Bluetooth Overview

- It is an emerging technology and the global initiative taken by Ericsson, IBM, Intel, Nokia and Toshiba to set a standard for cable-free connectivity between mobile PCs, handheld computers and other peripherals.
- **Bluetooth** is a wireless technology standard used for exchanging data between fixed and mobile devices over short distances using UHF radio waves in the industrial, scientific and medical radio bands, from 2.402 GHz to 2.480 GHz, and building personal area networks (PANs).
- This Bluetooth technology achieves its goal by embedding small, inexpensive, short-range radio transceivers either into the devices that are available today, directly or through an adapter such as a PC Card.
- Two Bluetooth devices can talk to each other when they come within a range of 10 meters to each other.
- Due to their dependence on a radio link, Bluetooth devices do not require a line-of sight connection in order to communicate. Therefore, a laptop could print information on a printer in the adjoining room, or the microwave in the kitchen could send a message to the mobile phone in the living room indicating that the meal is ready.

Possible Short Questions with Answer

1. What is Communication?[W-2020]

- Mobile communication is the use of technology that allows us to communicate with others in different locations without the use of physical connection.
- It makes our life easier, saves time and effort.

2. Define the term wireless.[W-2020]

- Wireless is a term used to define telecommunication and data communication without wires.
- Wireless refers to transfer of data through electromagnetic waves.

3. What are the basic services provided by MAC layer?[W-2020]

- Access control
- Data encryption
- Frame integrity
- Flow Control
- Multiplexing
- Data encapsulation etc.

Long Questions

Q1. Explain the difference between Wired and wireless networking.[W-2020]

CHAPTER-06
UBIQUITOUS WIRELESS COMMUNICATIONS

Articles to be covered

6.1 Introduction

- In addition to taking the hardware with you, Researchers are designing a ubiquitous networking system that allows your program applications to follow you wherever you go.
- By using a small radio transmitter and a building full of special sensors, your desktop can be anywhere you are, not just at your workstation.
- At the press of a button, the computer closest to you in any room becomes your computer for as long as you need it.
- The idea of "anywhere, anytime, by anything and anyone networking" is at the core of a new emerging networking is referred to as a "ubiquitous networking".
- The concept of networking originated from the concept of ubiquitous computing, which was aimed to "make many computers available throughout the physical environment while making them effectively invisible to the user".

6.2 Scenario of Mobile Communication

- The mobile industry has witnessed explosive growth in number of subscriber particularly over the past few years.
- However, while usage measured in terms of the number of wireless minutes is increasing, the price per minute for these services is falling.
- This means that Average Revenue Per User (APRU) is shrinking.
- Running a profitable business with stagnant or even declining ARPU is one of the fundamental Challenges mobile carriers are facing today. The industry is addressing this challenge in two ways:

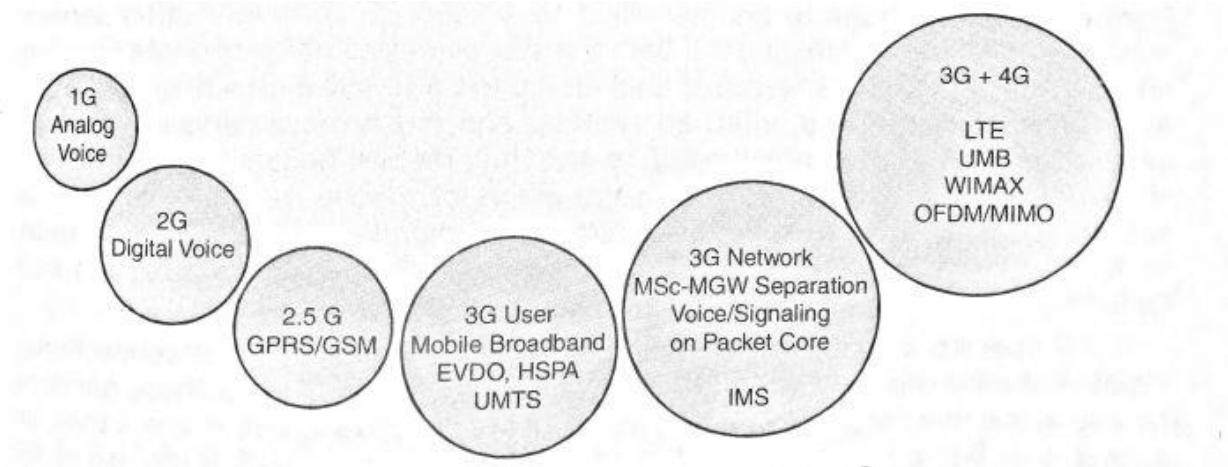
- ➢ . By adding new services or new user experiences for which mobile subscribers are willing to pay.
- ➢ By reducing operating expenses (OPEX). At the top of the list is the wireline infrastructure that mobile operators have to maintain regardless of whether they own or lease lines.

There are two primary ecosystems in the wireless industry.

1. Global System for Mobile Communications (GSM)
2. Code Division Multiple Access (CDMA)

6.3 Mobile Communication Generations 1G to 3G

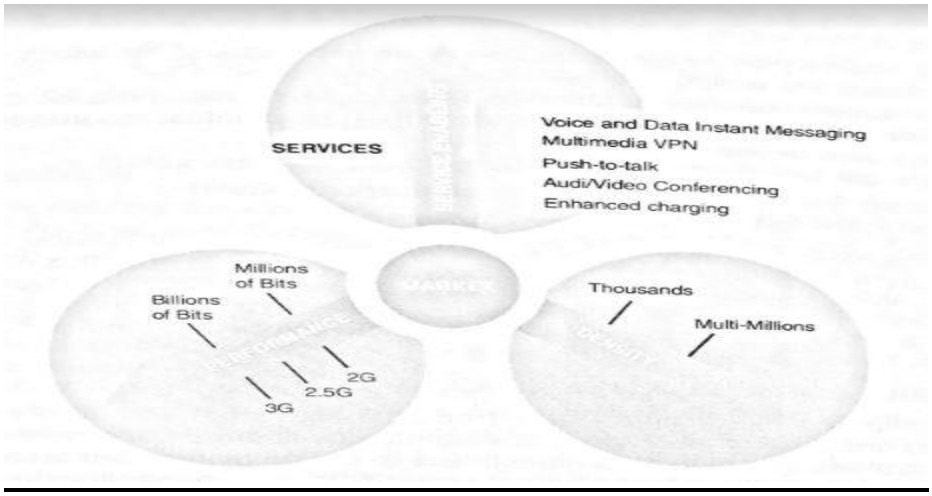
- Standards bodies such as 3GPP (for GSM networks) and 3GPP2 (for CDMA networks) are actively involved in driving the development of a next-generation wireless system.
- The high level objective is to create high-speed broadband and IP-based mobile systems featuring network-to network interconnection, feature/ service transparency, global roaming, and seamless services independent of location.



(Cellular Network evolution: 1G to 4G)

- 3G (third-generation) mobile systems are defined by International telecommunications Union (ITU) specification IMT-2000 (International Mobile Telecommunications-2000) a radio and network access specification.
- 3G is the successor of 2G-the existing and hugely deployed digital mobile system.
- 2G is the successor of 1G-the original analogue mobile system.
- GSM is the most predominant choice for 2G deployments. Though voice remains the primary method of mobile communication, a new generation of wireless technologies now offering higher speed data and multimedia capabilities.

6.4 3rd Generation Mobile Communication Network



- A Cellular Communication service initiates with 1G services delivery of Voice from one mobile phone to another. Next to 1G the 2G communication service enhances the service including the Data transfer such as sms, multimedia messages
- The 3G Network enables a bunch of services which ranges from Audio/video conferencing, internet, chatting and much more services.
- 3G pushed the growth of the Mobile Market in direction to increase service, revenue, no. of users as well QoS.

Characteristics:

- Data speed was 144 Kbps to 2 Mbps.
- High speed web browsing.
- Supports video conferencing & multimedia e-mails etc.
- Fast & easy transfer of audio & video files.
- 3D gaming.

6.5 Universal Mobile telecommunication System (UMTS)

- ❏ The Universal Mobile Telecommunication System (UMTS) is a third generation (3G) mobile communications system that provides a range of broadband services in the world of wireless and mobile communications.
- ❏ The UMTS delivers low-cost mobile communications at data rates of up to 2 Mbps. It preserves the global roaming capability of second-generation GSM/GPRS networks and provides new enhanced capabilities.
- ❏ The UMTS is designed to deliver pictures, graphics, video communications, and other multimedia information, as well as voice and data, to mobile wireless subscribers.

These needs should be fulfilled with the following objectives:

- ❏ High transmission rates encompassing circuit-switched and packet-switched connections;
  - ❏ High spectral efficiency and overall cost improvement;
  - ❏ Definition of common radio interfaces for multiple environments.

- ❑ Portability of services in various environments (indoor, outdoor, suburban, urban, rural, pedestrian, vehicular, satellite, etc.). This service port ability is also known as the Virtual Home Environment concept.

The UMTS takes a phased approach toward an all-IP network by extending second generation (2G) GSM/GPRS networks and using Wide-band Code Division Multiple Access (CDMA) technology. Handover capability between the UMTS and GSM is supported. The GPRS is the convergence point between the 2G technologies and the packet-switched domain of the 3G UMTS.

Possible Short Questions & Answers

1. What are the obstacles in mobile communication? [W-2020]

- Voice security
- Cellular safety
- Electromagnetic radiation
- Non-internal compatibility etc.

2. What is ubiquitous wireless networking?

- In addition to taking the hardware with you, Researchers are designing a ubiquitous networking system that allows your program applications to follow you wherever you go.
- By using a small radio transmitter and a building full of special sensors, your desktop can be anywhere you are, not just at your workstation.

3. State characteristics of 3G wireless communication?

Data speed was 144 Kbps to 2 Mbps.
High speed web browsing.
Supports video conferencing & multimedia e-mails etc.
Fast & easy transfer of audio & video files.
3D gaming.

4. Define UMTS.

- The Universal Mobile Telecommunication System (UMTS) is a third generation (3G) mobile communications system that provides a range of broadband services in the world of wireless and mobile communications.
- The UMTS is designed to deliver pictures, graphics, video communications, and other multimedia information, as well as voice and data, to mobile wireless subscribers.

LONG QUESTIONS

Q1. What is the aim of ubiquitous computing? Describe the generations of mobile communication from 1G to 5G.[W-2020]
Q2. State the difference between Circuit switching and packet switching. [W-2020]
Q3. Define Mobile Communication Generations from 1G to 3G.
Q4. Explain 3G mobile communication.
Q5. Describe UMTS.

CHAPTER-07
MOBILE IP

Articles to be covered

7.1 OVERVIEW
7.2 Working with mobile IP
7.3 Mobile IP Entities
7.4 Mobility Agents
7.5 Components of Mobile IP
7.6 MOBILE IPV6 FEATURES
7.7 Mobile IPv6 Address Types
7.8 Mobile IPv6 Address Scope
7.9 Mobile IP Operation

7.1 OVERVIEW

- Mobile IP is part of both IPv4 and IPv6 standards.
- Mobile IP allows a host device to be identified by a single IP address even though the device may move its physical point of attachment from one network to another.
- A data connection between two end-points through TCP/IP network requires a source IP address, source TCP port and a target IP address with a target TCP port.
- TCP port number is application specific and remains constant.
- IP address is network specific and varies from network to network. IP addresses are assigned to a host from a set of addresses assigned to a network.
- This structure works well as long as the client is static and is using a desktop computer. Now consider that the user is mobile and he is using his laptop. As the user moves, the point of attachment will change from one network to another resulting in the change of IP address. This change will terminate the connection.
- The technology to maintain mobility during a live connection is called Mobile IP.
- Mobile IP is most often found in wireless WAN environments where users need to carry their mobile devices across multiple LANS with different IP addresses.
- IP addresses consist of a varying length network part and a host part. The network part defines IP address' topological location in the Internet and IP packets are routed with that information to the right destination.

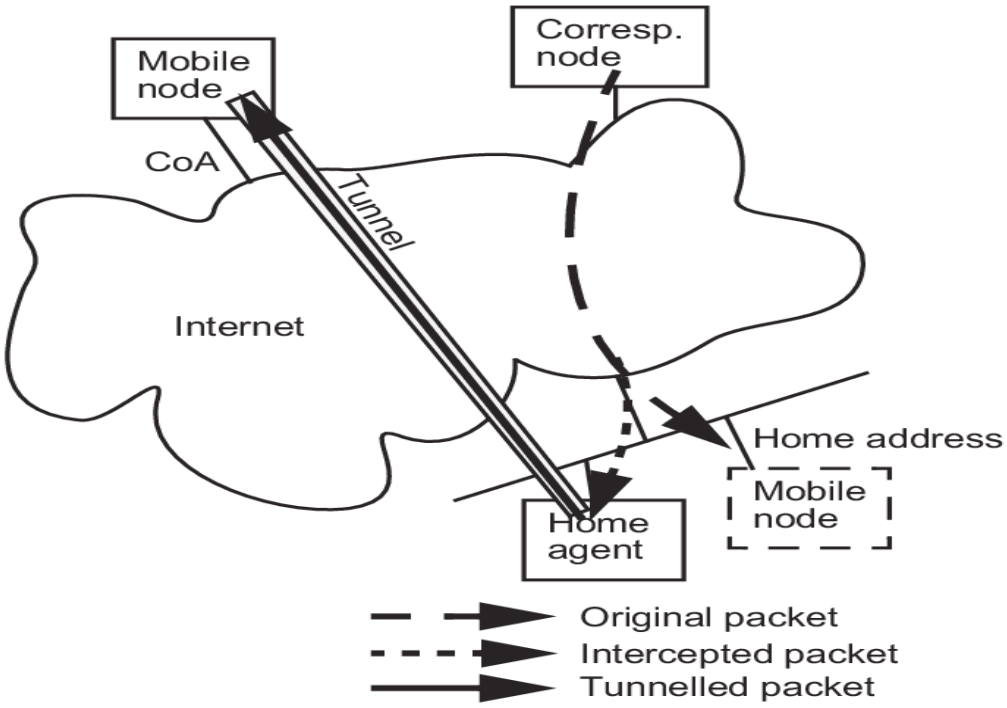
7.2 Working with mobile IP

- Mobile IP is a communication protocol (created by extending Internet Protocol, IP) that allows the users to move from one network to another with the same IP address. It ensures that the communication will continue without user’s sessions or connections being dropped.
- Port addresses are application specific and generally constant. However, the IP address changes from network to network.
- To fix this problem, mobile IP allows the mobile node to use two IP addresses. These IP addresses are home address and care-of-address.
- The home address is static and known to everybody as the identity of the host. The care-of-address changes every time a new attachment is made. This is the mobile node's location specific address.
- When the mobile node is roaming and is attached to a foreign network, the home agent receives all the packets for the mobile node and arranges to forward them
  to the mobile node's current point of attachment. The node that is responsible for forwarding and

managing the transparency is called home agent.

- Whenever the mobile node moves, it registers its new care-of-address with its home agent. The home agent forwards that the packet to the foreign network using the care-of-address becomes the destination IP address. This new header encapsulates the original packet, causing the mobile node' home address to have no impact on the encapsulated packet's routing. This phenomenon is called Tunnelling.

Basic mobile IP arrangement is as follows-:



(Mobile IP arrangement)

7.3 Mobile IP Entities

- **Mobile Node (MN):**

  It is the hand-held communication device that the user carries e.g. Cell phone.

- **Home Network:**

  It is a network to which the mobile node originally belongs to as per its assigned IP address (home address).

- **Home Agent (HA):**

  It is a router in home network to which the mobile node was originally connected

- **Home Address:**

  It is the permanent IP address assigned to the mobile node (within its home network).

- **Foreign Network:**

  It is the current network to which the mobile node is visiting (away from its home network).

- **Foreign Agent (FA):**

  It is a router in foreign network to which a mobile node is currently connected. The packets

from the home agent are sent to the foreign agent which delivers it to the mobile node.

● **Correspondent Node (CN):**

It is a device on the internet communicating to the mobile node. ● **Care of Address (COA):**

It is the temporary address used by a mobile node while it is moving away from its home network.

7.4 Mobility Agents

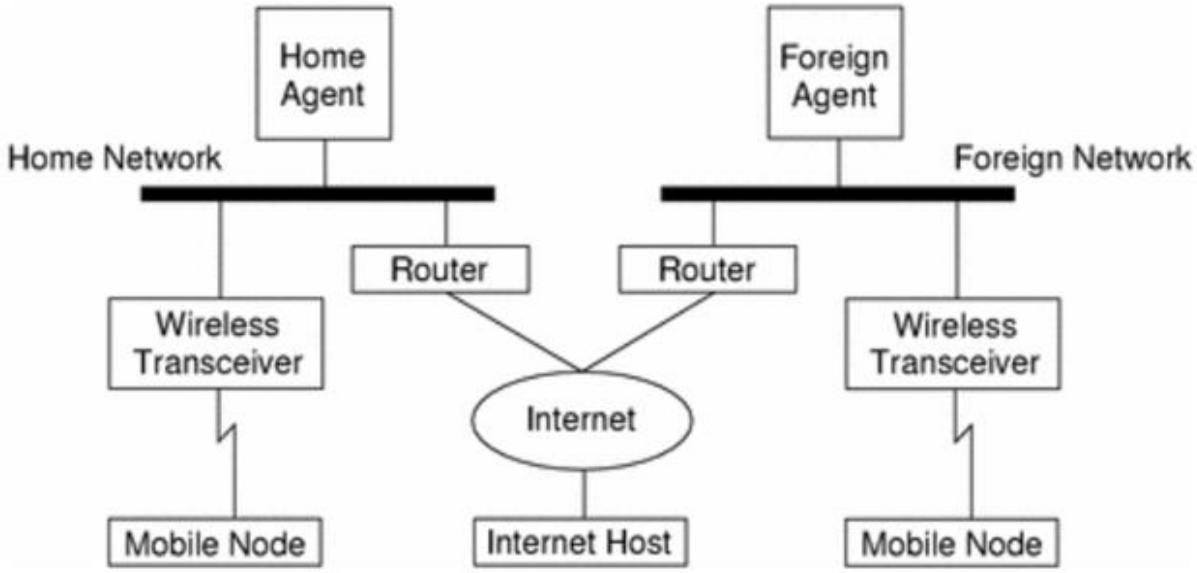
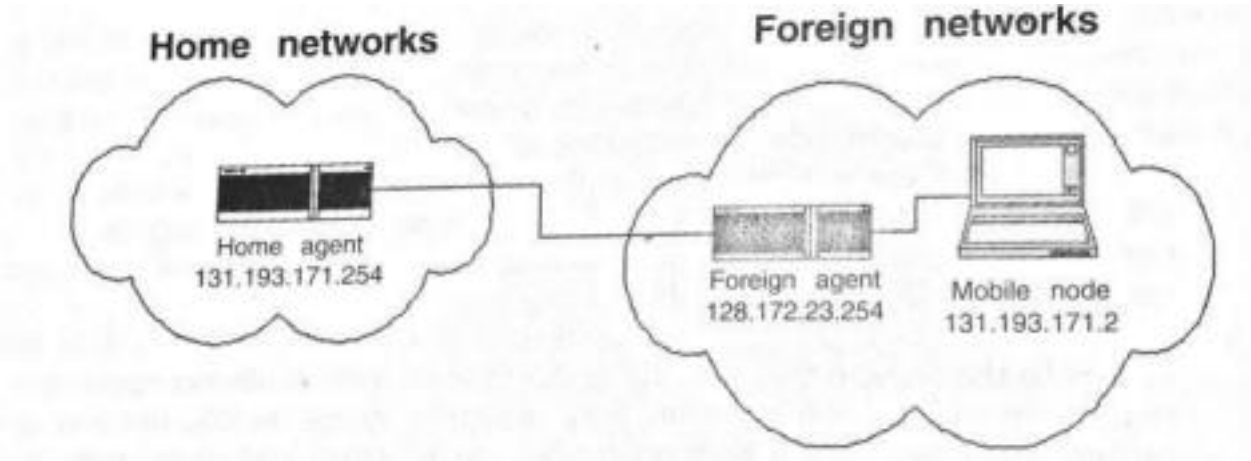


Fig: Mobile IP topology

Home Agent

Home agents maintain mobility binding in their mobility binding table. Home-address Care-of-address Lifetime (sec) 131.193.171.2 128.172.23.254 200



Foreign Agents

Foreign agents maintain visitor tables, which contain all mobile nodes currently visiting them.

Home-address	Home agent address	Media address	Lifetime (sec)
131.193.171.2	131.193.171.254	00-00-E2-30-59-18	200

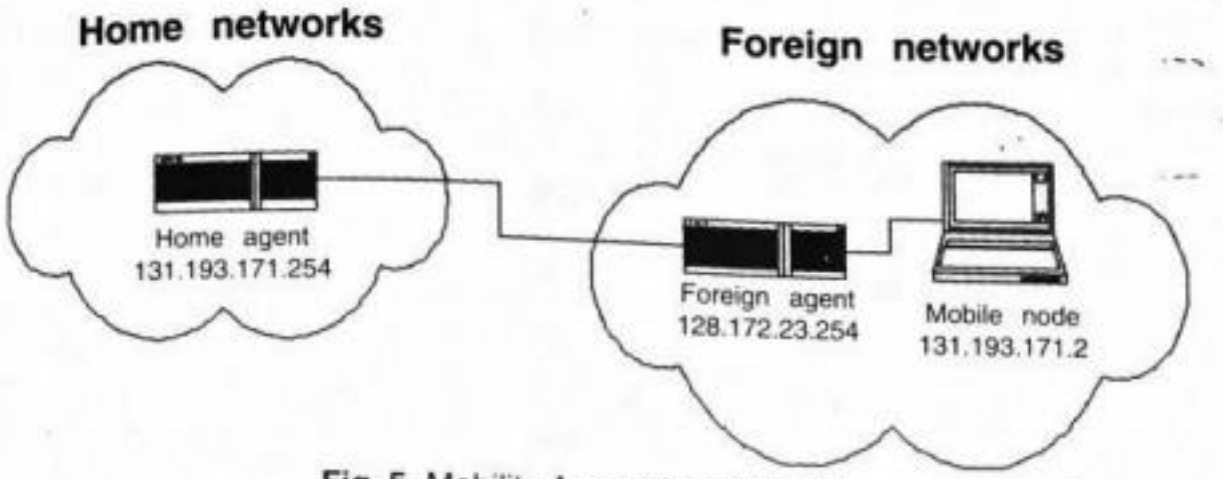


Fig. 5 Mobility Agents in a network

7.5 Components of Mobile IP

Three main components of Mobile IP:

• Discovering the care-of address: mobile node uses discovery procedure to identify prospective home and foreign agents

• Registering the care-of address: mobile node uses an authenticated registration procedure to inform home agent of its care-of address

• Tunnelling the care-of address: used to forward IP datagrams from a home address to a care-of address

7.6 MOBILE IPV6 FEATURES

• Larger address space => Unique Global address for each device. (6.65 . 1023 addresses per m2 of earth surface)

• Scalable => Run over multiple media i.e. Wireless-LAN, Ethernet, 3G
• Auto configuration capabilities=> Network Plug-and-Play.
• Fixed header format => Fewer fields (8 as compared to 12 in IPv4)
• Router headers => MIP updates are in extension headers. No header length anymore.
• Security extensions => Internet level Security in IPV6 Header.
• Anycast addresses => Special type of address in IPv6.
• Encapsulation =>IP-layer authentication & encryption possible.
• Quality of service and flow labels => efficient routing for real-time applications.
• Elimination of "triangle routing" for mobile IP
• All nodes can handle bindings.
• Small overhead for distributing bindings. Fixed header format
• option extension headers not parsed by intermediate routers anymore.

7.7 Mobile IPv6 Address Types

Various addresses are described below:

- **Unicast:** It is a communication between a single host and a single receiver. A Unicast address defines a single interface. A packet sent to a unicast address is delivered to that specific computer.

- **Multicast:** It is communication between a single host and multiple receivers. These addresses are used to define a set of interfaces that typically belong to different nodes instead of just one. When a packet is sent to a multicast address, the protocol delivers the packet to all interfaces identified by that address.

- **Anycast:** It is a communication between a single sender and a list of addresses. These addresses are also assigned to more than one interface belonging to different nodes. However, a packet sent to an anycast address is delivered to just one of the member interfaces, typically the nearest according to the routing protocol's idea of distance.

7.8 Mobile IPv6 Address Scope

• Link-Local: Used on a single link. Packets with link-local source or destination addresses are not forwarded to other links. In other words, it can only be used between nodes of the same link. It cannot be routed.
• Site-Local: Used for a single site. Packets with site-local source or destination addresses are not forwarded to other sites. In other words, it can only be used between nodes of the same site. It cannot be routed outside the site.
• Global: A globally unique address. Packets with global addresses can be forwarded to any part of the global network.

7.9 Mobile IP Operation

- A MN listens for agent advertisement and then initiates registration. If the responding agent is the HA, then mobile IP is not necessary.
- After receiving the registration request from a MN, the HA acknowledges and registration is complete. Registration happens as often as MN changes networks.
- HA intercepts all packets destined for MN. This is simple unless the sending application is on or near the same network as the MN. There is a specific lifetime for service before a MN must register.
- There is also a de-registration process with HA if an MN return HA then encapsulates all packets

addressed to MN and forwards them to FA.

- FA de encapsulates all packets addressed to MN and forwards them via hardware addresses.

Possible short questions and answers

Q1. What are two different kinds of mobility? [W-2020]

Two types of mobility are:

1. User mobility
2. Device portability

Q2. State different address types in IPV6?

- Unicast
- Multicast
- Anycast

Long Questions

Q1. Explain mobile IP entities.

Q2. Explain how mobile IP works.

Q3. Explain how mobile IP works.

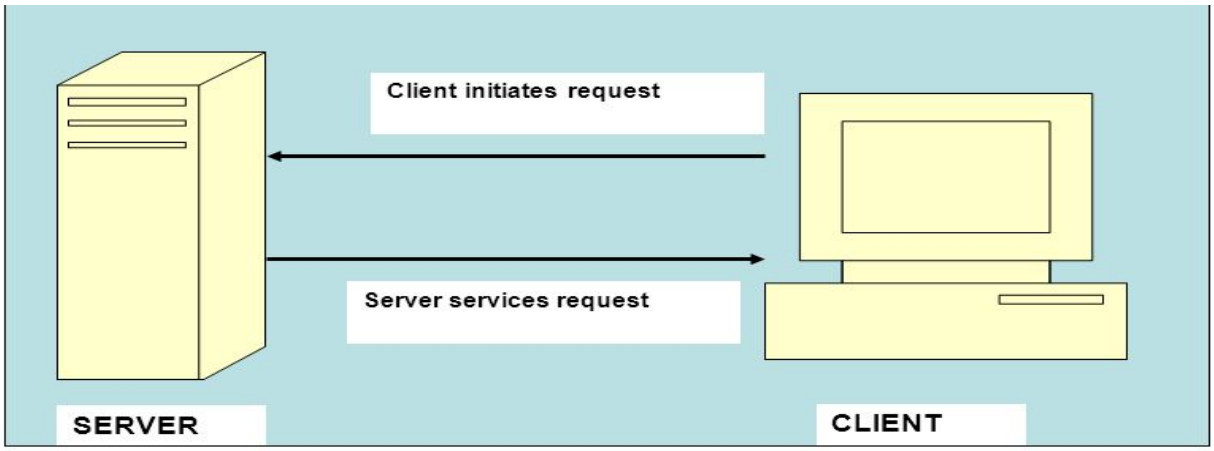
CHAPTER-8: MOBILE COMPUTING

Articles to be covered

8.1 WORLD WIDE WEB ARCHITECTURE FOR MOBILE COMPUTING
8.2 NEED OF WAP
8.3 BENEFITS OF WAP
8.4 EXAMPLES OF *WAP*
8.5 WAP- Architecture
8.6 WAP protocols
8.7 WIRELESS MARKUP LANGUAGE(WML)
8.8 WAP Push architecture
8.9 PUSH-PULL BASED DATA ACQUISITION
8.10 I-Mode
8.11 WAP 2.x

8.1 WORLD WIDE WEB ARCHITECTURE FOR MOBILE COMPUTING

The www architecture provides a very flexible and powerful programming model. Applications and content are presented in standard data formats, and are browsed by applications known as web browsers. The web browser is a networked application, i.e., it sends requests for named data objects to a network server and the network server responds with the data encoded using the standard formats.



(WWW Architecture)

The WWW standards specify many of the mechanisms necessary to build a general-purpose application environment, including:

- Standard naming model: All servers and content on the WWW are named with an Internet-standard Uniform Resource Locator (URL).

- Content typing: All content on the WWW is given a specific type thereby

allowing web browsers to correctly process the content based on its type.

- Standard content formats: All web browsers support a set of standard content formats. These include the Hyper Text Markup Language (HTML), Scripting languages (JavaScript), and a large number of other formats.

- Standard Protocols: Standard networking protocols allow any web browser to communicate with any web server. The most commonly used protocol on the WWW is the HyperText Transport Protocol (HTTP), operating on top of the TCP/IP protocol suite.

8.2 NEED OF WAP

- Having the performance and data transfer capacities of the common desktop computers in mind, the web designers constructed the Internet technology for devices as powerful as those computers.
- Hand-held wireless devices have less powerful CPU's or low battery life, less memory, restricted power consumption. smaller displays and different input devices.

- Similarly, wireless data networks have less bandwidth, more latency, less connection stability and less predictable availability than conventional wired networks.

8.3 BENEFITS OF WAP

• It is device independent.
• It is network independent.
• WAP utilizes standard Internet markup language technology, XML,
• Optimizing the content and air link protocols.

• The Wireless. Markup Language (WML) User Interface (UI) components map well onto existing mobile phone user interfaces.
• No re-education of the end-users.

8.4 EXAMPLES OF *WAP*

- Checking train table information
- Ticket purchase
- Flight check in
- Viewing traffic information
- Checking weather conditions
- Looking up stock values
- Looking up phone numbers
- Looking up addresses
- Looking up sport results.

8.5 WAP- Architecture

- The WAP programming model is the WWW programming model with a few Incements.
- Adopting the WWW programming model provides several benefits to the application developer community, including a familiar programming model,
  a proven architecture, and the ability to use existing tools (e.g., Web servers,
  ML tools, etc.).
- Optimizations and extensions have been made in order to match the characteristics of the wireless environment. Wherever possible, existing standards have been adopted or have been used as the starting point for the WAP technology.
- The most significant enhancements WAP has added to the programming model are Push and Telephony Support (WTA).
- The classical request-response mechanism is commonly referred to as pull to contrast it with the push mechanism.

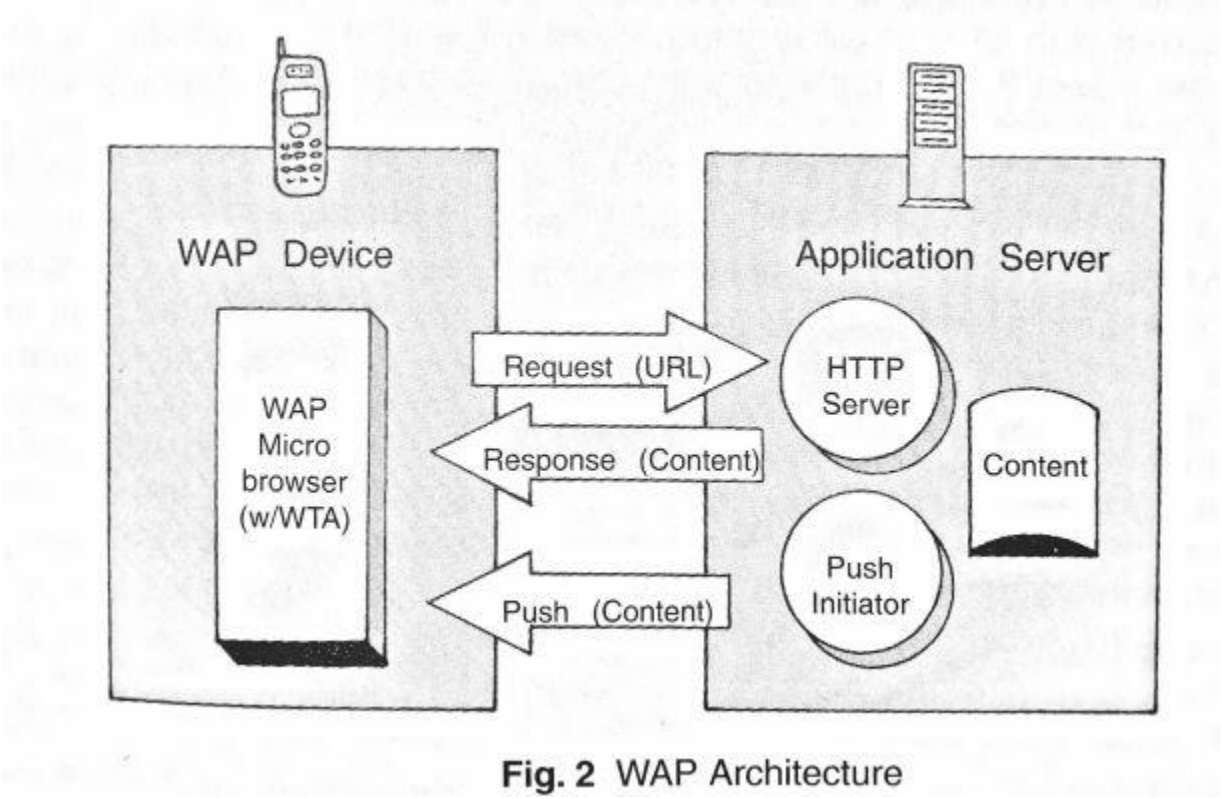
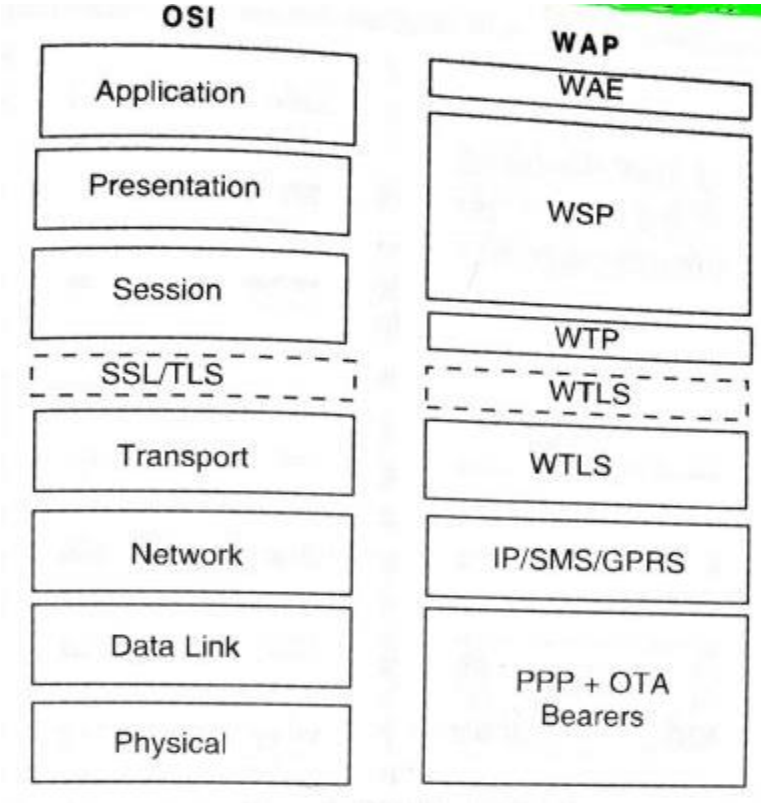


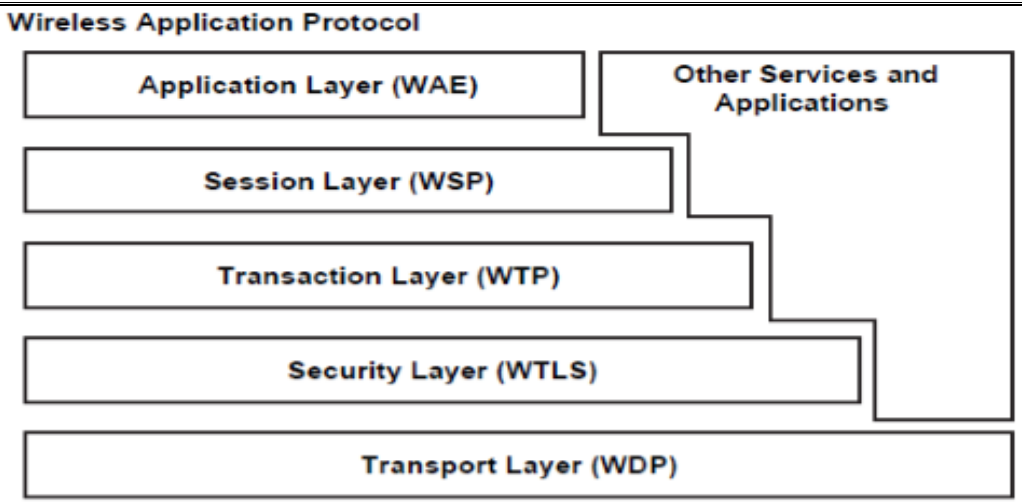
Fig. 2 WAP Architecture

8.6 WAP protocols

The mapping of the WAP protocol stack to the OSI model is shown below:



- WAP devices communicate with web servers through an intermediate WAP gateway. WTLS is only used between the device and the gateway, while SSL/TLS can be used between the gateway and the web server on the Internet.



Physical and Data Link Layer: In WAP, Point to Point Protocols (PPP) aro used over one or more Over-The-Air (OTA) bearer protocols.

Network Layer: IP is the network layer of choice. However, not all wireless networks are capable of transmitting IP. That is why SMS or some other non packet network protocol can be used.

Transport Laver: The protocol used in the transport layer is UDP. However, this may not be feasible over non-IP networks. That is why (there are also other reasons) that WAP defines an additional transport layer protocol, WDP, which can be used when UDP can not.

Session Layer: The functionality of the session layer is partially included in WTP. Other aspects of the functionality are implemented in WSP.

Presentation Layer: The functionality of the presentation layer is included in WSP.

Application Layer: Some aspects of the functionality of the application layer are included in WSP, the others are implemented in WAE.

8.7 WIRELESS MARKUP LANGUAGE(WML)

- ➢ The WAP suite is similar to the HTTP suite that consists of many components.

- ➢ The WAP suite includes a Wireless Markup Language (WML) that is used to create WAP pages and is very similar to HTML that is used to create web pages.
- ➢ WML is tag based document manipulation language. WML is based on XML and HTML. Every line is compiled to binary by WAP gateway.
- ➢ WML represents standardized markup language defined by WAP forum, an organization whose members promote wireless standards.
- ➢ This language is designed for operation with small wireless devices, usually having the following characteristics:

- A small screen size with low resolution.

- Limited data entry capabilities.
- Limited computation capabilities.

➢ WML implements a deck and card metaphor.
➢ A deck is a logical representation of a document. Decks are made up of multiple cards.
➢ Each WML card in a deck performs a specific task for a particular user interaction. WML decks can be stored in static files and fetched by CGI, JSP or ASP scripts.
➢ WML has wide varieties of features including:

• **Support for Text and Images:** WML provides the facility for writing text and making images to the user.

• **Support for User Input:** WML supports several elements for user input. In addition, WML supports client-side validation by allowing the author to invoke scripts to check the user input.

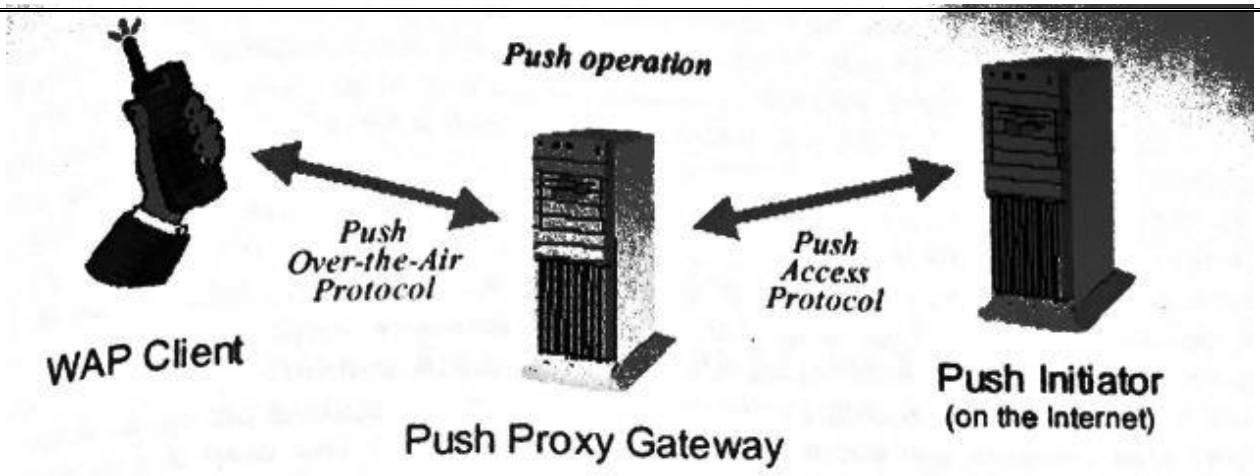
Task Invocation Controls: These controls initiate a navigation task such as traversing a link to another card.

International Support: The character set for the WML document is the Universal Character Set.

State and Context Management: Each WML input control can introduce variables.

8.8 WAP Push architecture

- The WAP Push framework allows information to be sent to a client device without user action.
- In a client/server model, a client requests for a service or information from a server. The server then responds to this request by providing information back to the client. This is referred to as Pull Technology.
- Here, the client pulls the information from the server.
- In addition to this tec provides other technology called Push Technology. It is also a server model, but there is no explicit request originated by the client.
- The server transmits its content before the client's request.
- In short, pull transactions are always initiated by clients while push transactions are always initiated by the server.
- Push technology is helpful to implement alerts and notifications. Push saves resources.
- The push content originated on a server in the Internet that needs to be delivered to a mobile phone.
- The Push Initiator (PI) contacts the Push Proxy Gateway (PPG) from the Internet side and delivers content to the destination client.
- The PPG then forwards the content to the mobile network to be delivered to the destination client over-the-air.
- The Internet side PPG protocol is called the Push Access Protocol. The WAP side protocol is called Over-The-Air.



8.9 PUSH-PULL BASED DATA ACQUISITION

Three types of browsing content can be pushed to a WAP microbrowser: 'Service indication (SI), Service Loading (SL), and Cache Operation (CO).

- Push SI provides the ability to push content to users to notify them about electronic mail messages awaiting retrieval, news headlines, commercial offers, and so on

.

- Push SL provides the ability to push some content to the WAP device without user explicit request. Upon receipt of the push SL, the push content is automatically fetched by the WAP device and is presented to the user.
- Push CO provides a means for invalidating objects stored in the WAP device's cache memory.

8.10 I-Mode

- i-Mode is the packet-based service for mobile phones offered by Japan's wireless technology.
- I-Mode eschews the Wireless Application Protocol (WAP) and uses a simplified version of HTML; Wireless Markup Language (WML). First introduced in 1999, i-Mode was the world's first smartphone for Web browsing.
- The i-Mode wireless data service offers color and video over many phones. Its mobile computing service enables users to do telephone banking, make airline reservations, conduct stock transactions, send and receive email, and have access to the Internet. As of early 2000, i-Mode had an estimated 5.6 million users.

8.11 WAP 2.x

WAP 2. **x** contains a new version of WML, commonly referred to as WML2; it is based on the eXtensible HyperText Markup Language (XHTML), signaling part of **WAP's** move toward using common Internet specifications such as HTTP and TCP/IP.

Possible Short Questions with answers

Q1. Define WAP 2.x.

- **WAP 2**. **x** contains a new version of WML, commonly referred to as WML2.
- It is based on the eXtensible HyperText Markup Language (XHTML), signaling part of **WAP's** move toward using common Internet specifications such as HTTP and TCP/IP.

Q2. What is **I-Mode ?**

- The i-Mode wireless data service offers color and video over many phones.
- Its mobile computing service enables users to do telephone banking, make airline reservations, conduct stock transactions, send and receive email, and have access to the Internet.

Long Questions

Q1. What is meant by WML? What are the capabilities of WML script?[W-2020]

Q2. What is the basic purpose of DHCP? Name the entities of DHCP.[W-2020]

Q3. Draw a neat diagram of WAP architecture and explain in detail.[W-2020]

CHAPTER: 9
Wireless Telecom Networks

Articles to be covered

9.1 GSM
9.2 GPRS
9.3 IS-95
9.4 CDMA-2000
9.5 W-CDMA
9.6 Wireless Sensor Networks

9.1 GSM

GSM stands for Global System for Mobile Communication. It is a digital cellular technology used for transmitting mobile voice and data services. Important facts about the GSM are given below −

- GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard.
- GSM is the most widely accepted standard in telecommunications and it is implemented globally.
- GSM is a circuit-switched system that divides each 200 kHz channel into eight 25 kHz time-slots. GSM operates on the mobile communication bands 900 MHz and 1800 MHz in most parts of the world.
- GSM makes use of narrowband Time Division Multiple Access (TDMA) technique for transmitting signals.
- GSM was developed using digital technology. It has an ability to carry 64 kbps to 120 Mbps of data rates.
- Presently GSM supports more than one billion mobile subscribers in more than 210 countries throughout the world.
- GSM provides basic to advanced voice and data services including roaming service. Roaming is the ability to use your GSM phone number in another GSM network.

GSM ARCHITECTURE

A GSM network comprises 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
- The features' supplementary services

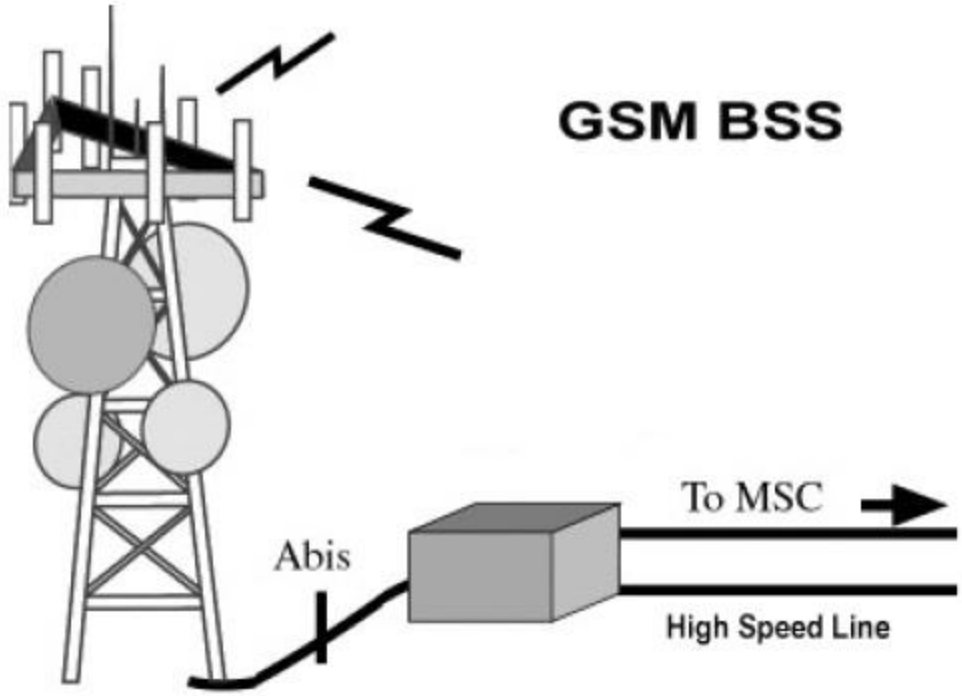
The MS also provides the receptor for SMS messages, enabling the user to toggle between the voice and data use. Moreover, the mobile facilitates access to voice messaging systems.

GSM - The Base Station Subsystem (BSS)

The BSS is composed of two parts −

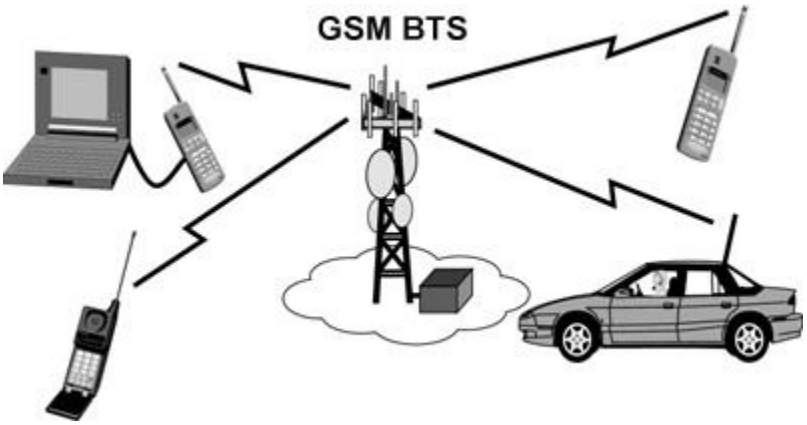
- The Base Transceiver Station (BTS)
- The Base Station Controller (BSC)

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.



The Base Transceiver Station (BTS)

The BTS houses the radio transceivers that define a cell and handles the radio link protocols with the MS. In a large urban area, a large number of BTSs may be deployed.



The BTS corresponds to the transceivers and antennas used in each cell of the network. A BTS is usually placed in the center of a cell. Its transmitting power defines the size of a cell. Each BTS has between 1 and 16 transceivers, depending on the density of users in the cell. Each BTS serves as a single cell. It also includes the following functions −

- Encoding, encrypting, multiplexing, modulating, and feeding the RF signals to the antenna

- Transcoding and rate adaptation
- Time and frequency synchronizing
- Voice through full- or half-rate services
- Decoding, decrypting, and equalizing received signals
- Random access detection
- Timing advances
- Uplink channel measurements

The Base Station Controller (BSC)

The BSC manages the radio resources for one or more BTSs. It handles radio channel setup, frequency hopping, and handovers. The BSC is the connection between the mobile and the MSC. The BSC also translates the 13 Kbps voice channel used over the radio link to the standard 64 Kbps channel used by the Public Switched Telephone Network (PSDN) or ISDN.

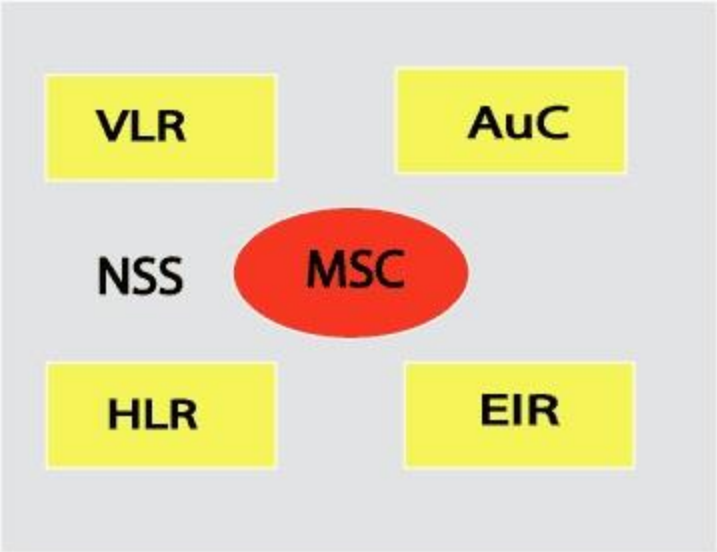
It assigns and releases frequencies and time slots for the MS. The BSC also handles intercell handover. It controls the power transmission of the BSS and MS in its area. The function of the BSC is to allocate the necessary time slots between the BTS and the MSC. It is a switching device that handles the radio resources.

The additional functions include−

- Control of frequency hopping
- Performing traffic concentration to reduce the number of lines from the MSC
- Providing an interface to the Operations and Maintenance Center for the BSS
- Reallocation of frequencies among BTSs
- Time and frequency synchronization
- Power management
- Time-delay measurements of received signals from the MS

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 a 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.

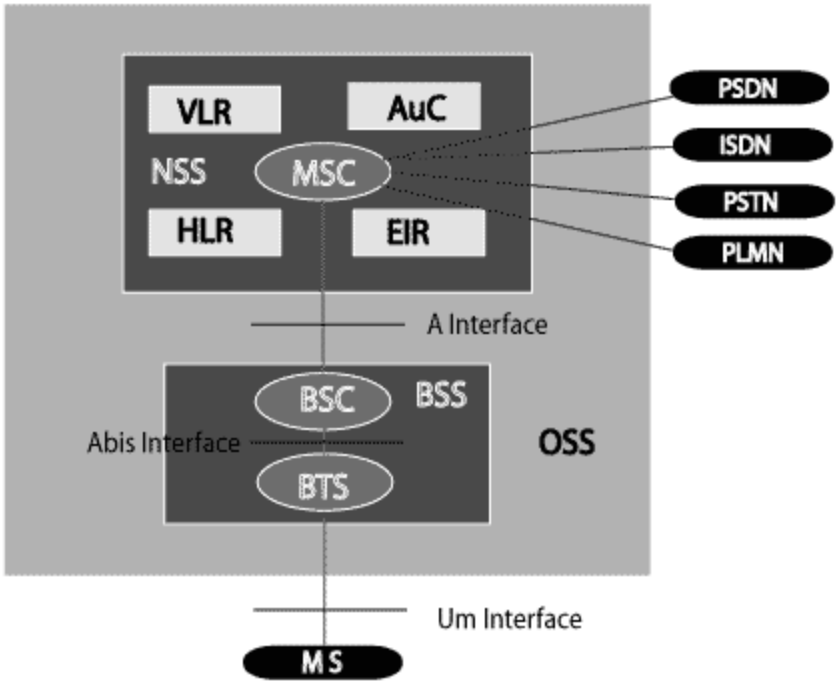
GSM - The Operation Support Subsystem (OSS)

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.

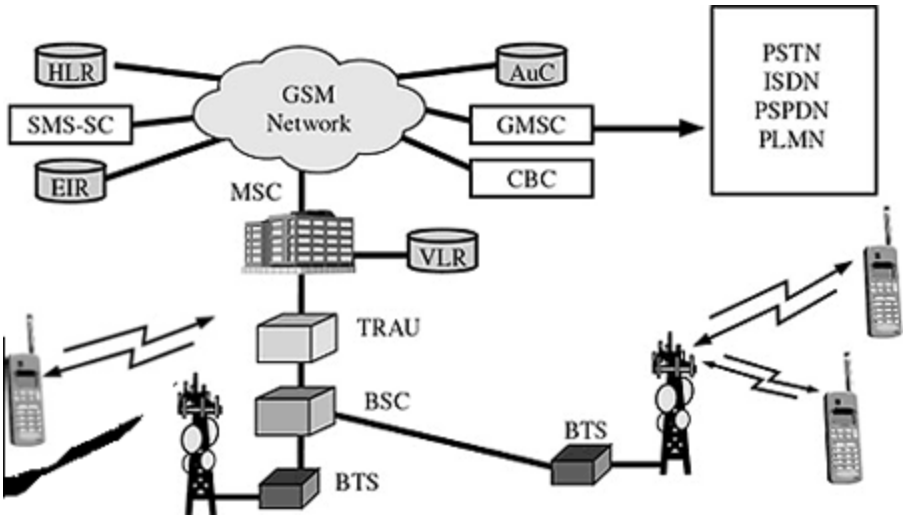
A simple pictorial view of the GSM architecture is given below −



The additional components of the GSM architecture comprise of databases and messaging systems functions −

- Home Location Register (HLR)
- Visitor Location Register (VLR)
- Equipment Identity Register (EIR)
- Authentication Center (AuC)
- SMS Serving Center (SMS SC)
- Gateway MSC (GMSC)
- Chargeback Center (CBC)
- Transcoder and Adaptation Unit (TRAU)

The following diagram shows the GSM network along with the added elements −



(GSM Architecture)

The MS and the BSS communicate across the Um interface. It is also known as the *air interface* or the *radio link*. The BSS communicates with the Network Service Switching (NSS) center across the *A* interface.

9.2 GPRS

- General Packet Radio System is also known as GPRS is a third-generation step toward internet access. GPRS is also known as GSM-IP that is a Global-System Mobile Communications Internet Protocol as it keeps the users of this system online, allows to make voice calls, and access internet on-the-go.
- Even Time-Division Multiple Access (TDMA) users benefit from this system as it provides packet radio access.
- GPRS also permits the network operators to execute an Internet Protocol (IP) based core architecture for integrated voice and data applications that will continue to be used and expanded for 3G services.

Key Features

Following three key features describe wireless packet data:

- The always online feature - Removes the dial-up process, making applications only one click away.
- An upgrade to existing systems - Operators do not have to replace their equipment; rather, GPRS is added on top of the existing infrastructure.
- An integral part of future 3G systems - GPRS is the packet data core network for 3G systems EDGE and WCDMA.

Goals of GPRS

GPRS is the first step toward an end-to-end wireless infrastructure and has the following goals:

- Open architecture
- Consistent IP services
- Same infrastructure for different air interfaces
- Integrated telephony and Internet infrastructure
- Leverage industry investment in IP
- Service innovation independent of infrastructure

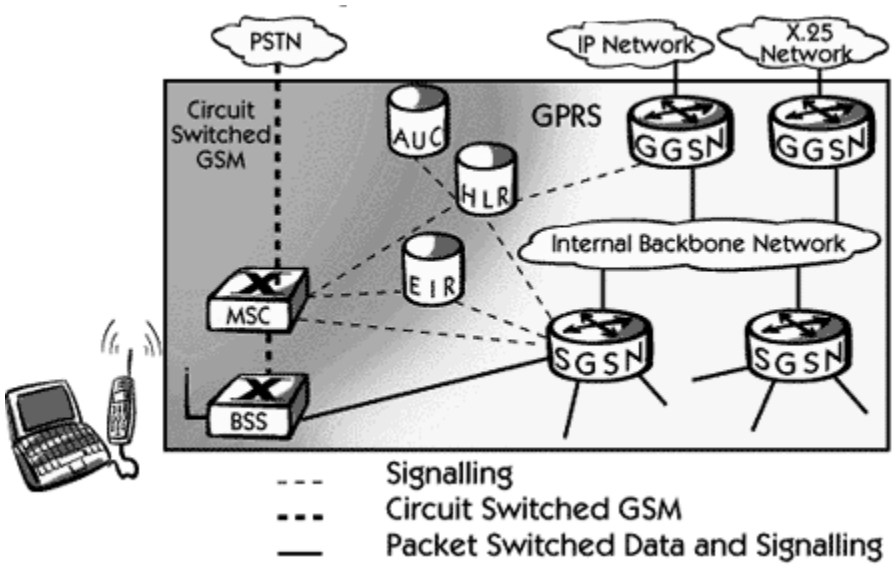
Benefits of GPRS

- Higher Data Rate
- Easy Billing

GPRS Architecture

GPRS architecture works on the same procedure like GSM network, but has additional entities that allow packet data transmission. This data network overlaps a second-generation GSM network providing packet data transport at the rates from 9.6 to 171 kbps. Along with the packet data transport the GSM network accommodates multiple users to share the same air interface resources concurrently.

Following is the GPRS Architecture diagram:



GPRS attempts to reuse the existing GSM network elements as much as possible, but to effectively build a packet-based mobile cellular network, some new network elements, interfaces, and protocols for handling packet traffic are required.

Therefore, GPRS requires modifications to numerous GSM network elements as summarized below:

GSM Network Element	Modification or Upgrade Required for GPRS.
Mobile Station (MS)	New Mobile Station is required to access GPRS services. These new terminals will be backward compatible with GSM for voice calls.
BTS	A software upgrade is required in the existing Base Transceiver Station(BTS).
BSC	The Base Station Controller (BSC) requires a software upgrade and the installation of new hardware called the packet control unit (PCU). The PCU directs the data traffic to the GPRS network and can be a separate hardware element associated with the BSC.
GPRS Support Nodes (GSNs)	The deployment of GPRS requires the installation of new core network elements called the serving GPRS support node (SGSN) and gateway GPRS support node (GGSN).
Databases (HLR, VLR, etc.)	All the databases involved in the network will require software upgrades to handle the new call models and functions introduced by GPRS.

GPRS Applications

• Chat
• Textual and visual information
• Still & moving images
• Web browsing
• Document sharing/Collaborate working
• Audio
• Email, File Transfer...

9.3 IS-95

- Interim Standard 95 (IS-95) is the first CDMA-based digital cellular stand.
- The brand name for IS-95 is cdma One. It is a 2G Mobile Telecommunication Standard that uses CDMA, a multiple access scheme for digital radio, to call voice, data and signaling data (such as a dialed telephone number) between mobile telephones and cell sites.
- CDMA is a digital radio system that transmits streams of bits competing systems used in 2G GSM, all radios can be active all the time, because network capacity does not directly limit the number of active radios.
- Each user is identified by a different spreading code.
- Transmissions are asynchronous on the uplink, but synchronous on the downlink. Power control is needed to mitigate near-far problems.

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9.4 CDMA-2000

CDMA2000 is the 3G version of IS-95. It builds on the inherent advantages of CDMA technologies and introduces other enhancements, such as orthogonal Frequency Division Multiplexing (OFDM and OFDMA), advanced control and signaling mechanisms, improved interference management techniques, end-to-end Quality of Service (QoS), and new antenna techniques such as Multiple Inputs Multiple Outputs (MIMO) and Space Division Multiple Access (SDMA) to increase data throughput rates and quality of service, while significantly improving network capacity and reducing delivery cost.

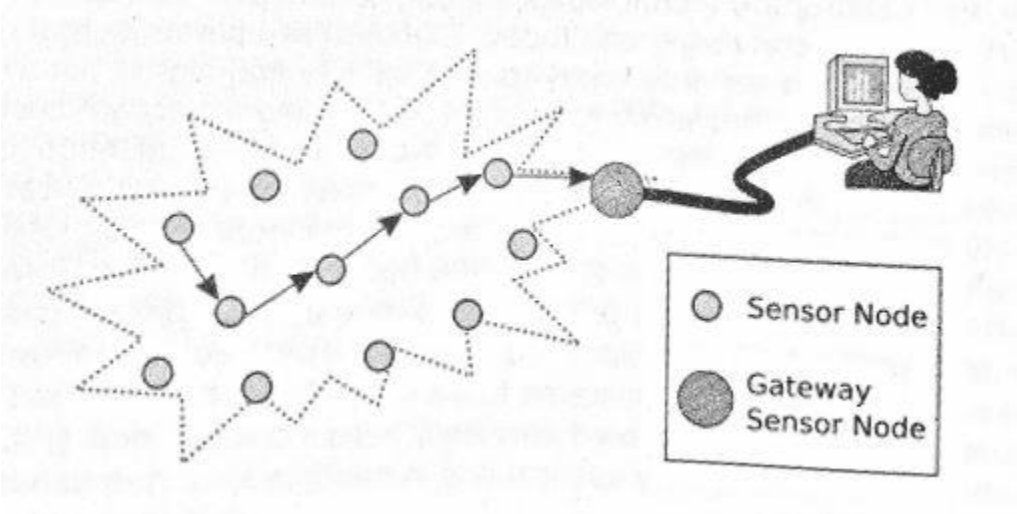
9.5 W-CDMA

- WCDMA is a wideband spread-spectrum 3G mobile telecommunication air interface that utilizes code division multiple access (or CDMA the general multiplexing scheme, not to be confused with CDMA the standard).
- It provides simultaneous support for a wide range of services with different characteristics on a common 5MHz carrier.
- The term WCDMA also refers to one of the International Telecommunications Union's IMT-2000 standards, a type of 3G cellular network.

- WCDMA is the technology behind the 3G UMTS standard and is closely allied with the 2G GSM standard. It provides new service capabilities, increased network capacity and reduced cost for voice and data services.

9.6 Wireless Sensor Networks

- A wireless sensor network is a wireless network consisting of spatially distributed devices using sensors to monitor physical or environmental conditions such as temperature, sound, vibration, pressure, motion or pollutants, at different locations.
- Wireless sensor networks are now used in many civilian application areas, including environment , healthcare applications, home automation,military applications such as battlefield surveillance and traffic control.
- In addition to one or more sensors, each node in a sensor network is typically equipped with a radio transceiver or other wireless communication devices, a small microcontroller, and an energy source, usually a battery.
- A sensor network normally constitutes a wireless ad-hoc network, meaning that each sensor supports a multi-hop routing algorithm (several nodes may forward data packets to the base station).



Possible Short Questions with answer

Q1. Define Wireless sensors network.

A wireless sensor network is a wireless network consisting of spatially distributed devices using sensors to monitor physical or environmental conditions such as temperature, sound, vibration, pressure, motion or pollutants, at different locations.

Long Questions

Q1. Explain in detail about the GSM architecture with diagrammatic representation.[W-2020]

Q2. Describe the mobile services provided by bGSM.[W-2020]

CHAPTER-10.
Messaging Services

Articles to covered

10.1 Short Message Services (SMS)
10.2 Multimedia Message Services (MMS)
10.3 Multimedia transmission over wireless

10.1 Short Message Services (SMS)

- SMS is the delivery of alphanumeric messages to mobile phones over wireless works.
- It is not a wireless communication technology. It is a value-added service which operates on long range wireless networks.
- SMS provides a Connectionless transfer of messages with low capacity and low time performance.
- It is the most important form of data communication.
- It can be sent from any mobile device to any destination as a message, an email or some other form of electronic message.
- The features which make SMS functionally different from other data communication technologies is that it can be delivered to the destination whether or not the voice service is in use and it is an asynchronous messaging service in its operation.
- In other words, an active mobile handset is able to receive or submit a short message at any time, independent of whether or not a voice or data call is in progress.
- SMS also guarantees delivery of the short message by the network. Temporary failures are identified, and the short message is stored in the network until the destination becomes available.
- It can be implemented on the network which is available. Because of its pervasive nature it is used as a text-based application layer transport protocol.
- SMS is a service for sending messages of up to 160 characters to mobile phones that use Global System for Mobile (GSM) communication. Typical uses of SMS include:

• Notifying a mobile phone owner of a voicemail message
• Notifying a salesperson of an inquiry and contact to call
• Notifying a doctor of a patient with an emergency problem
• Notifying a service person of the time and place of their next call
• Notifying a driver of the address of the next pickup

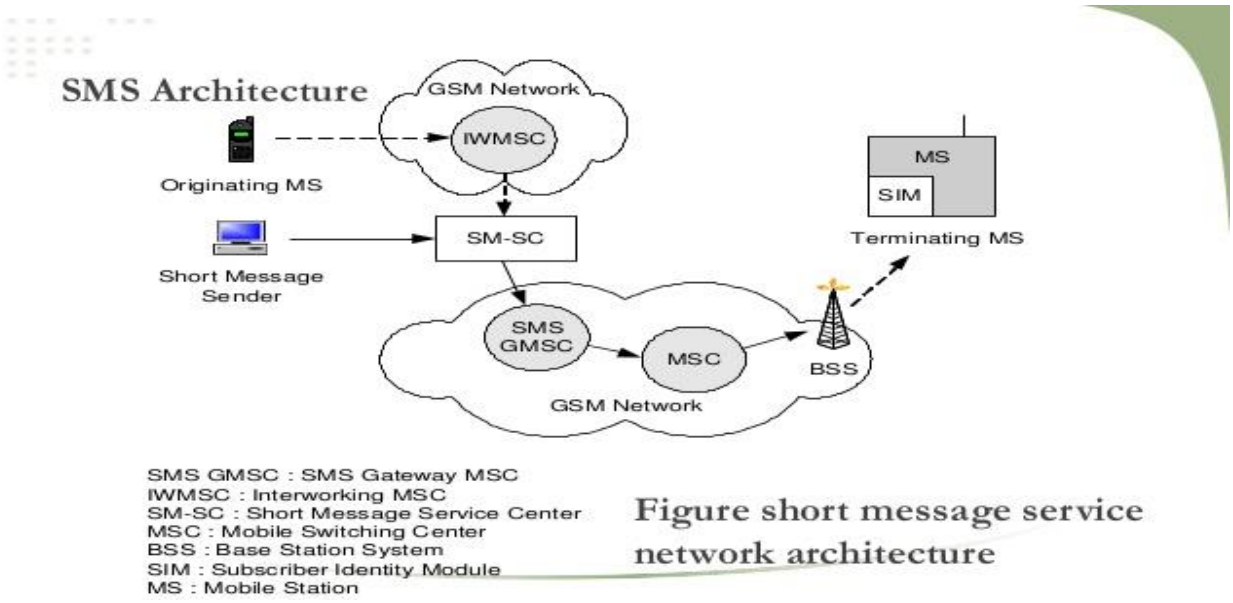


Figure short message service network architecture

10.2 Multimedia Message Services (MMS)

- Multimedia Messaging Service (MMS) is a communications technology developed by 3GPP (Third Generation Partnership Project) that was developed to enable the transmission of multimedia content via text message.
- An extension to the Short Message Service (SMS) protocol, MMS defines a way to send and receive, almost instantaneously, wireless messages that include images, audio, and video clips in addition to text.
- A common application of MMS messaging is picture messaging, which is the use of phone cameras to take photos for immediate delivery to a mobile recipient. Other possibilities include animations and graphic presentations of stock quotes, sports news and weather reports.

How MMS works

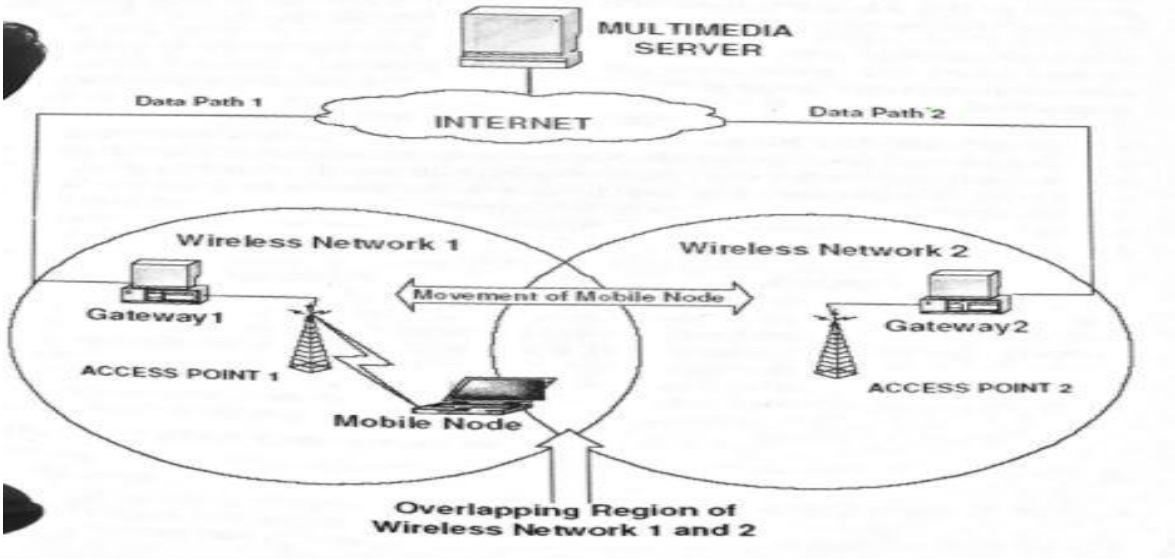
The process of sending and receiving a MMS message in a typical phone-to-phone MMS transaction works this way:

- The sending phone triggers a data connection that provides TCP/IP network connectivity, typically over GPRS (General Packet Radio Service).
- The sending phone performs an HTTP POST to a Multimedia Messaging Service Center (MMSC) of the MMS message encoding in the MMS Encapsulation Protocol as defined by the Open Mobile Alliance. The encoded MMS message includes all of the content of the MMS message, along with header information that includes a list of intended recipients for the message.
- The MMSC receives the submitted MMS message and validates the sender of the message.
- The MMSC stores the content of the MMS message, making it available as a URL link that’s dynamically generated.

- The MMSC generates an MMS notification message, which is sent via WAP Push over SMS to the recipient(s) of the message. This MMS notification message contains a URL pointer to the dynamically generated MMS content.
- The recipient receives the MMS notification message and then initiates a data connection that provides TCP/IP network connectivity (usually over GPRS).
- The recipient phone performs an HTTP (or Wireless Session Protocol) GET to retrieve the MMS message content URL from the MMSC.

10.3 Multimedia transmission over wireless

- With the increase in the number of wireless data networks, there is an increasing interest in carrying multimedia over wireless networks using portable devices such as laptops and personal digital assistants.
- Mobility gives rise to the need for handoff schemes between wireless access points. Here we are going to discuss the effectiveness of transport layer handoff schemes for multimedia transmission.
- Many applications that run on a mobile computer involve multimedia search is video conferencing, audio conferencing, watching Live movies, Sports etc.
- streaming multimedia over wireless networks is a challenging task. Extensive research has been carried out to ensure a smooth and uninterrupted multimedia to a mobile host (MH) over wireless media.
- The current research propel is to ensure an uninterrupted multimedia transmission when the MH moves between networks.
- Ensuring uninterrupted multimedia transmission during hand off is challenging because the MH is already receiving multimedia from the network to which it is connected; when it moves into another network, it needs to break the connection with the old network and establish a connection with the new network.



Possible Short Questions with answer

Q1. What is SMS?

- SMS is the delivery of alphanumeric messages to mobile phones over wireless works.
- SMS provides a Connectionless transfer of messages with low capacity and low time performance.
- It is the most important form of data communication.

Q2. What is MMS?

- Multimedia Messaging Service (MMS) is a communications technology developed by 3GPP (Third Generation Partnership Project) that was developed to enable the transmission of multimedia content via text message.
- An extension to the Short Message Service protocol, MMS defines a way to send and receive, almost instantaneously, wireless messages that include images, audio, and video clips in addition to text.

LONG QUESTIONS

Q1. What is MMS? Explain how MMS works?

Q2. Explain SMS architecture.