WIRELESS COMMUNICATION

- Introduction
- Advantages & Disadvantages
- Electromagnetic Waves
- Electromagnetic Spectrum
- Paging system
- Cordless telephone system
- Cellular telephone system

INTRODUCTION OF WIRELESS COMMUNICATION

- It is transfer of information over a distance without using electrical conductor or wireless.
- This may be one way communication as in broadcasting system eg Radio, TV and two way communication.
- The term wireless defined communication in which EM waves carry a signal over the entire communication path.**Wireless Communication can be via:**
  1) Radio frequency communication
  2) Microwave communication

ADVANTAGES & DISADVANTAGES OF WIRELESS COMMUNICATION

- **ADVANTAGES:**

ANYWHERE, ANYTIME WORK

Working professionals through wireless communication can access the internet and mobile anywhere, anytime without any problem of wires and cables.

ENHANCED PRODUCTIVITY

Wired internet or dial up connectivity increases the cost, whereas using wireless internet not only reduces the cost but also it is possible to complete an assignment or work at anytime.This ultimately improves productivity.

- **REMOTE AREA CONNECTIVITY**

  Wireless communication makes possible for the doctors, engineers and other professionals working in remote areas to keep in touch with each other.

- **WORLDWIDE CONNECTIVITY**

  Wireless communication is the best technology to connect billions of people worldwide.

- **MULTIPLE USAGE AND LOW INTERFERENCE**

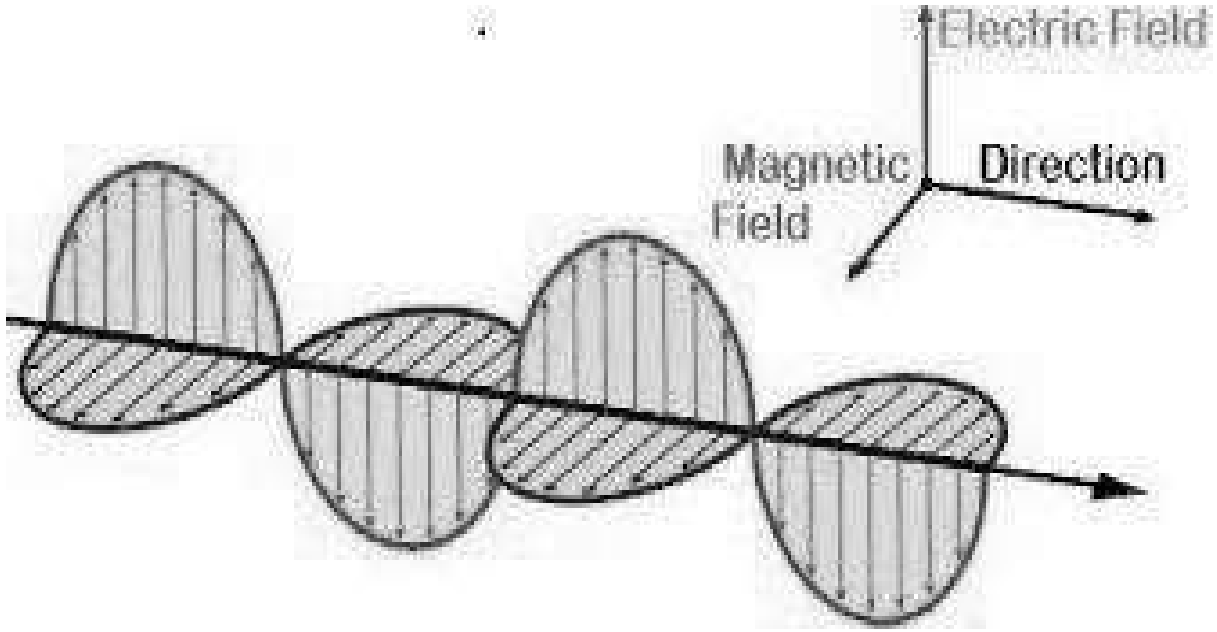
  Cell handsets can continuously change frequencies as per the requirements. Multiple usages and low interference rates are achieved through the use of low power transmitters.

DISADVANTAGES

- Wireless signals can be easily hacked and hence it will hamper privacy. To avoid this, security algorithms and modulations techniques are employed in wireless networks.
- The earlier wireless network were slower. Now a days wireless LANS with advance standards such as IEEE 802.11 AC and are available which provides same performance as traditional Ethernet based LANS.
- Wireless networks require careful radio frequency planning at the beginning of the installation.

ELECTROMAGNETIC WAVES

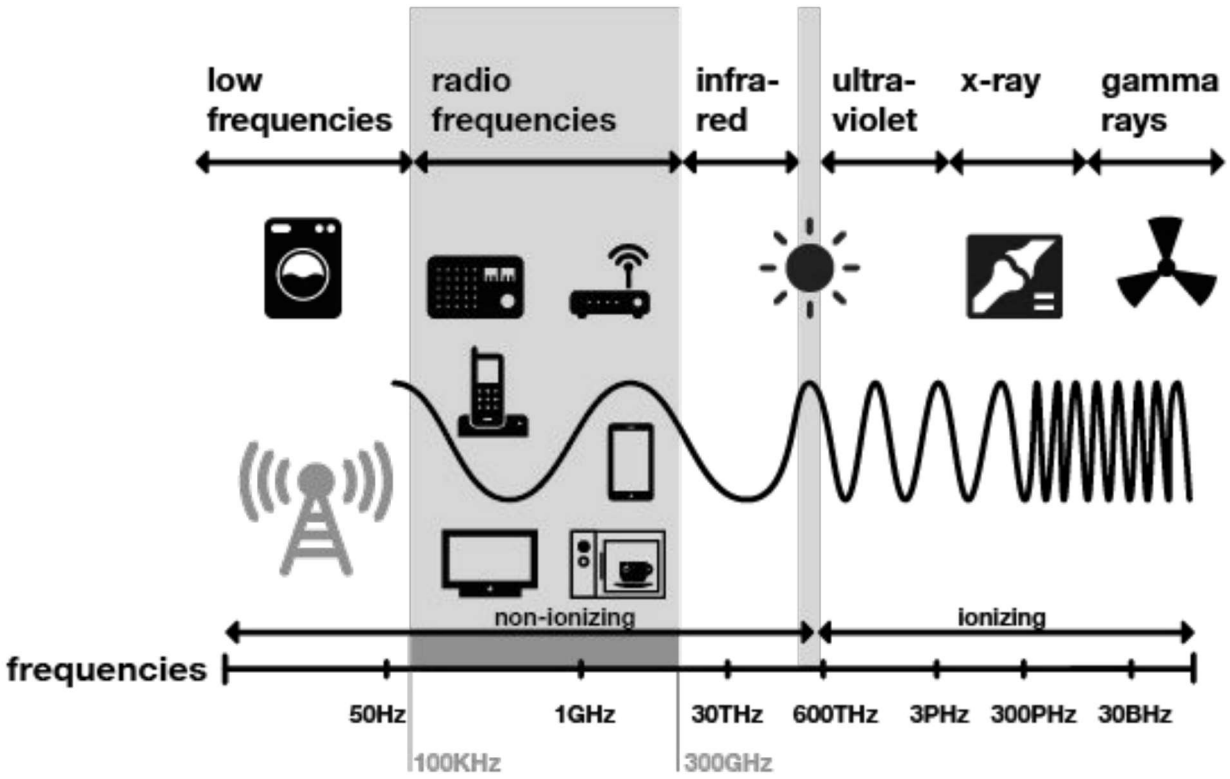
EM waves are the waves which have both electric and magnetic field vector mutually perpendicular to each other and also perpendicular to the direction of propagation of waves.



ELECTROMAGNETIC SPECTRUM

The electromagnetic frequency spectrum is divided into subsections or bands (depending on their wavelengths)and each band is having a different name and boundary. The portion used for wireless communication sits within that space and ranges from about 20 KHz to 300 GHz.

Band	Frequency Range	Wavelength Range	Applications
Extremely Low Frequency (ELF)	<3 kHz	>100 km	Waves in these frequencies suit long range communications, making their way with relative ease through the lower atmosphere, underground and various obstacles, but they need hefty-sized antennas, and their popular use for radio/TV, wireless internet, cell phones and more means a lot of them want to use the same part of the spectrum, leading to spectrum scarcity for that portion.
Very Low Frequency (VLF)	3 to 30 kHz	10 to 100 km	
Low Frequency (LF)	30 to 300 kHz	1 m to 10 km	
Medium Frequency (MF)	300 kHz to 3 MHz	100 m to 1 km	
High Frequency (HF)	3 to 30 MHz	10 to 100 m	
Very High Frequency (VHF)	30 to 300 MHz	1 to 10 m	Impediments such as vegetation and buildings do affect higher frequency waves, but it's still possible for them to carry signals in most instances. Services in the GHz range have arrived as the insatiable demand for radio communication systems continues (see footnote 3. Atmospheric attenuation, which plays a growing role once waves reach the 10 GHz frequency, hampers electromagnetic wave propagation.
Ultra High Frequency (UHF)	300 MHz to 3 GHz	10 cm to 1 m	
Super High Frequency (SHF)	3 to 30 GHz	1 m to 1 cm	
Extremely High Frequency (EHF)	30 to 300 GHz	1 mm to 1cm	


low frequencies
radio frequencies
infra-red
ultra-violet
x-ray
gamma rays
non-ionizing
ionizing
frequencies
50Hz
100KHz
1GHz
300GHz
30THz
600THz
3PHz
300PHz
30BHz

PAGING /MESSAGING SYSTEM

Paging system is a one-way personal wireless alerting and messaging system .

Pagers were developed in the 1950s and 1960s and became widely used by the 1980s. In the 21st century, the widespread availability of cellphones and smartphones has greatly diminished the pager industry.

A pager is a dedicated RF or radio frequency device that allow the pager user to receiver messages broadcast on a specific frequency over a special network of radio base stations.

Pager is also sometime called page. It is simple personal telecommunication device for the transmission of short messages.

A one way numeric pager can only receive a message consisting of a few digits, typically a phone number dialed by the subscriber.

The alphanumeric pagers are have ability to send and receive email, numeric pages and messages pages.

Pagers are used in the emergency or disaster times.

Two types of paging system:

- SIMPLE PAGING SYSTEM
- WIDE AREA PAGING SYSTEM

PAGING /MESSAGING SYSTEM

Paging systems are communication systems that send brief messgaes to subsciber. Message may be either a numeric, alpha numeric or voice message.

A message is sent to a paging subscriber via the paging system access number with a telephone keypad or modem. The issued message is called a page.

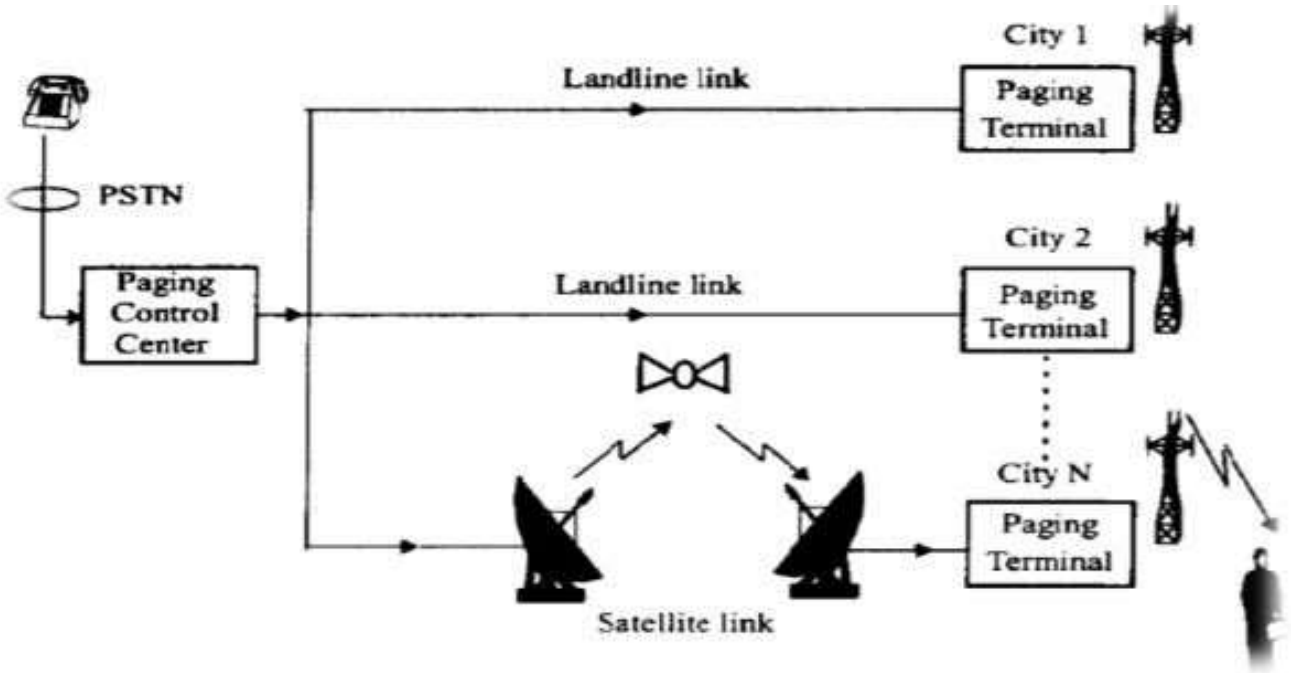
The paging system then transmits the page throughout the service area using base stations which broadcast the page on a radio carrier.

Paging system vary widely in their complexity and coverage area while simple paging systems may cover a limited range of 2 to 5 km or may even be confined to with in individual buildings, wide area paging systems can provide world wide coverage.

Though paging receivers are simple and inexpensive, the transmission system required is quite sophisticated.

Wide area paging systems consists of a network of telephone lines, many base station trasnmitters and large radio towers that simultaneously broadcast a page from each base station.(this is called simulcasting)

Large trasnmitter power and low data rate are necessary for maximum coverage from each base station


City 1
Landline link
Paging Terminal
PSTN
City 2
Paging Control Center
Landline link
Paging Terminal
City N
Paging Terminal
Satellite link

CORDLESS TELEPHONE SYSTEM

Cordless telephone systems are full duplex communication systems that use radio to connect a portable handset to a dedicated base station, which is then connected to a dedicated telephone line with a specific telephone number on the public switched telephone network (PSTN).

A cordless phone first appeared around 1980 . The earliest cordless phones operated at a frequency of 27MHz .

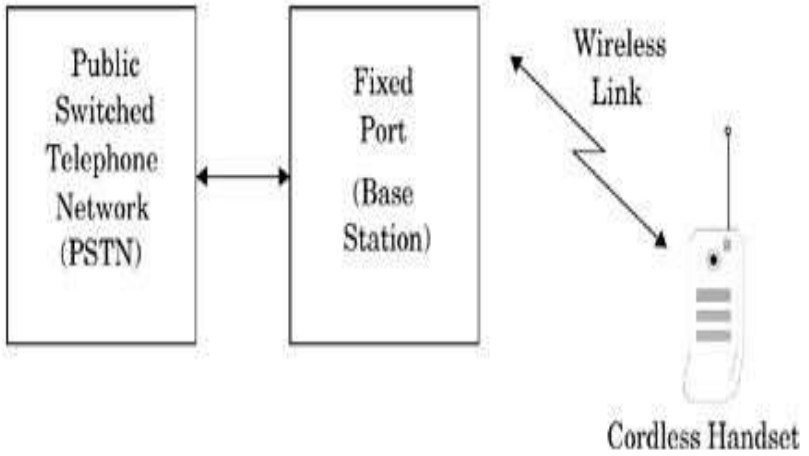
They had the following problems :

- LIMITED RANGE
- POOR SOUND QUALITY
- POOR SECURITY

A cordless phone is a model of telephone which replaces the coiled wire between the handset and base unit with wireless radio technology .

The land-line connection from the phone company is still fed into the base unit

, but the powered handset transmits and receive radio signal in place of traditional electronic pulses.

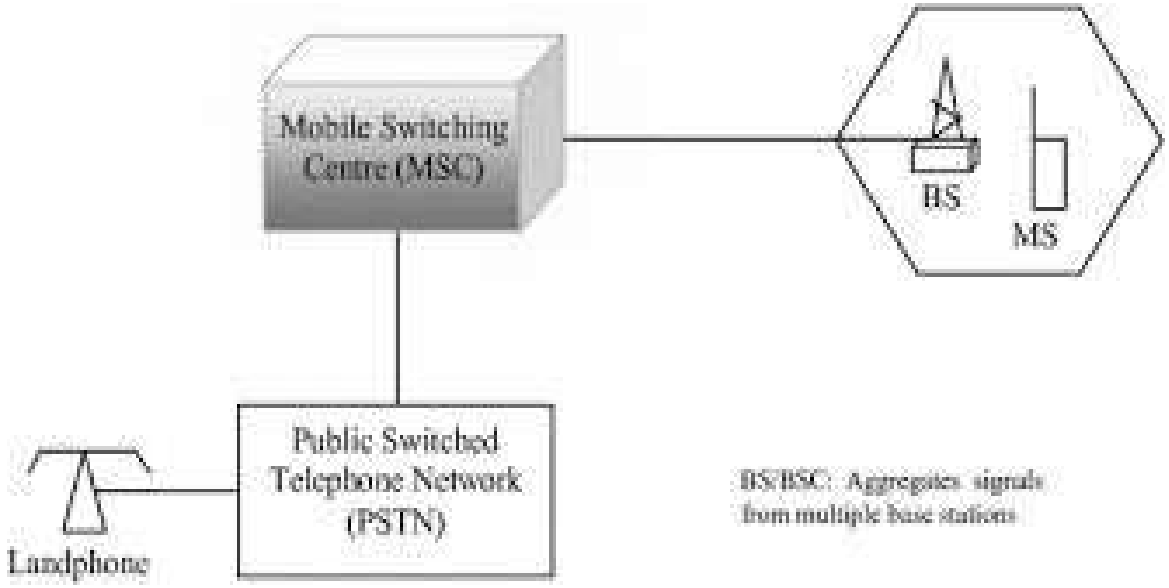


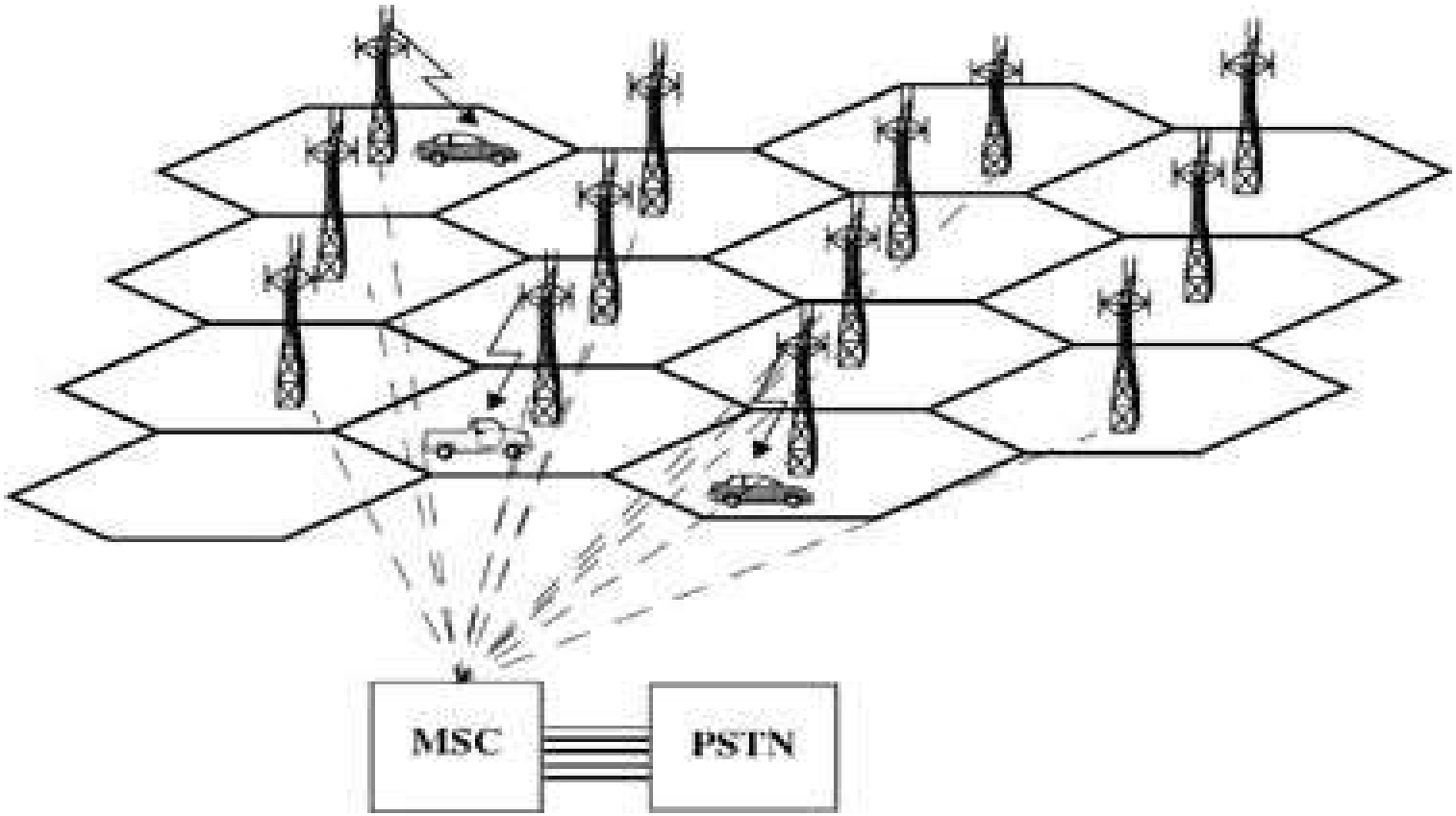
Cellular telephone system

Cellular telephony provides communication between two devices .One or both may be mobile .

Cell phone is a low powered , lightweight radio transceiver (combination transmitter – receiver) that provides voice telephone and other services to mobile users.

Unlike conventional wire based cordless phones, cellular telephone are completely portable and do not require proximity to a jack to access the wire based networks operated by local telephone companies .

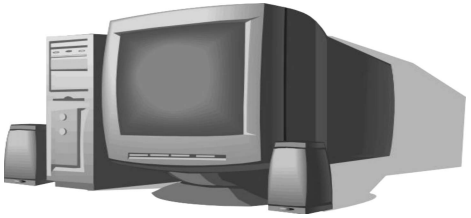



MSC
PSTN

COMPARISON

S.NO	PAGING SYSTEM	CORDLESS TELEPHONE SYSTEM	CELLULAR TELEPHONE SYSTEM
1.	It is a simple telecommunication device for the transmission of short message.	It uses fixed base station so that they may be plugged into the telephone line with a specific telephone number on the PSTN.	It uses a wireless connection to the PSTN.
2.	Pager system provides high coverage range.	Cordless telephone system provide the user ltd range.	Cellular telephone system provides high coverage range of use.
3.	Infrastructure required is high.	Infrastructure required is low.	Infrastructure required is high.
4.	Hardware cost is required low.	Hardware cost is low.	Hardware cost is moderate.
5.	Frequency less than 1 GHZ.	Frequency less than 1 GHZ.	Frequency less than 2GHZ.

DIFFERENT GENERATIONS OF CELLULAR TELEPHONE SYSTEM



SUMMARY

- Introduction
- First Generation
- Second Generation
- Third Generation
- Fourth Generation
- Comparison Between 1G, 2G, 3G and 4G Generation

INTRODUCTION(HISTORY OF WIRELESS)

- In 1897, Guglielmo Marconi first demonstrated radio's ability to provide continuous contact.
- The first radio telephone service was introduced in the US at the end of the 1940s.
- In the 1960s, a new system was launched by Bell system and this system was called "*Improved Mobile Telephone service".*
- The first analog cellular systems were based on IMTS and these were developed in late 1960s and early 1970s. These systems were named "**Cellular".**

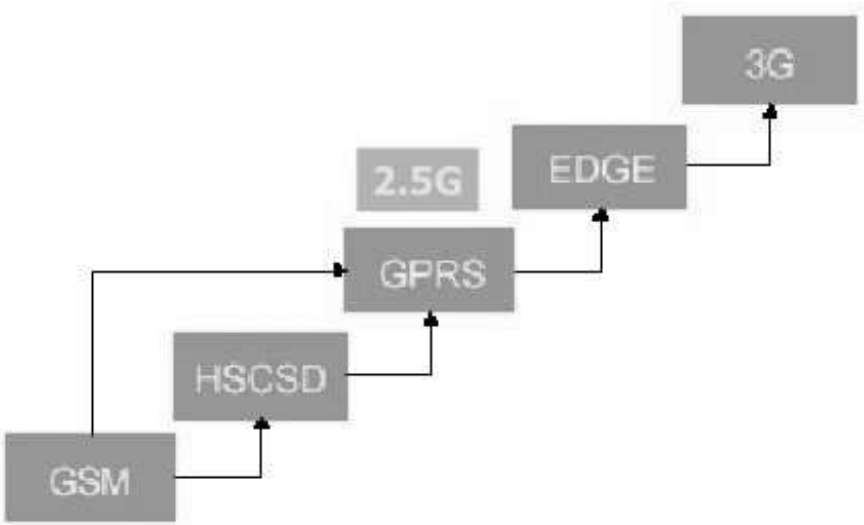
FIRST GENERATION (1G)

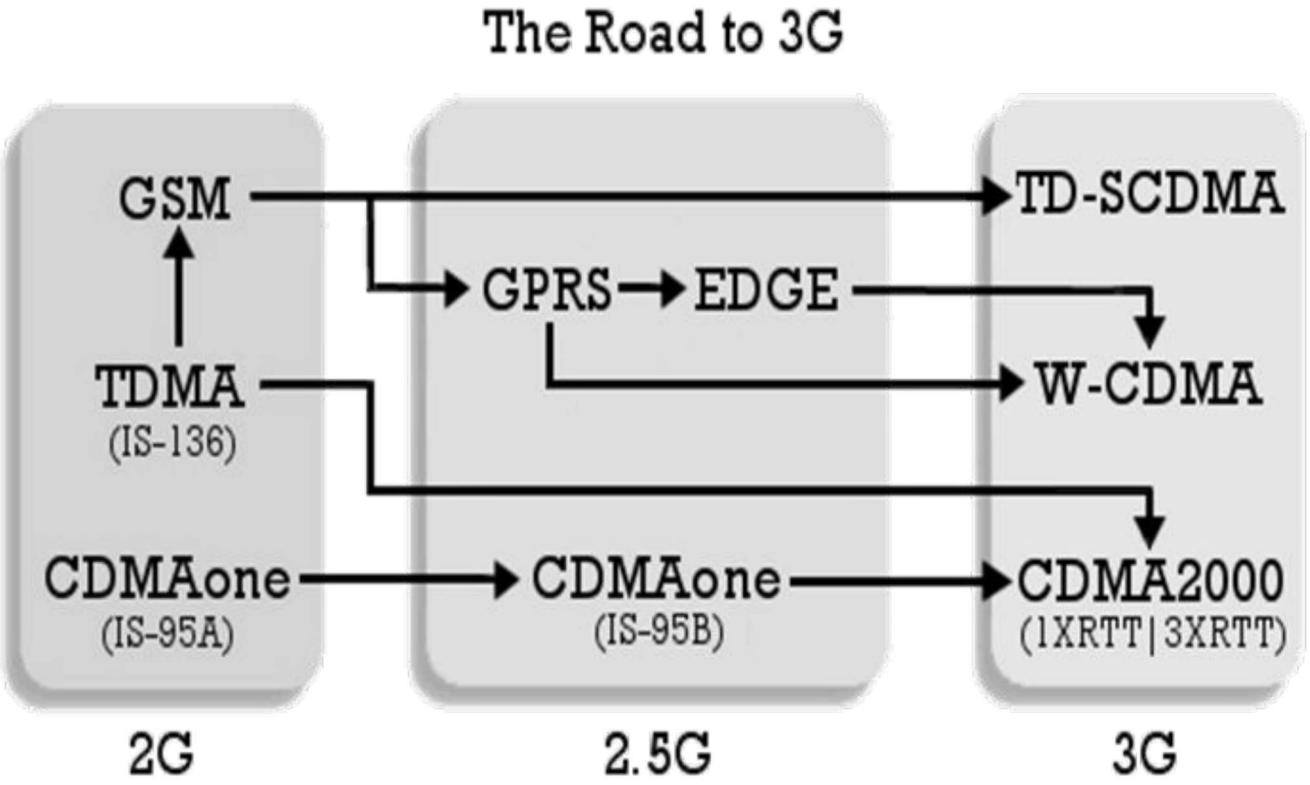
- It is written as 1G. It is the digitization of the control link b/w the mobile and cells.
- The first generation cellular system in the world was introduced by NTT (Nippon Telephone & Telegraph) in 1979 in Japan and data rate is 0.3kbps & developed by NMT (Nardic Mobile Telephone).
- **AMPS:-** Advanced Mobile Telephone services in US in 1982 & data rate is 10kbps.
- **ETACS**:- European Total Access Communication System & data rate in 8kbps

SECOND GENERATION (2G)

- Second Generation cellular system were developed at the end of the 1980. In this both control link & voice signal were digitized.
- This system provides better quality, higher capacity at lower cost to consumer.
- 2G Digital Cellular systems are GSM (Global System For Mobile Communication) based on TDMA (Time Division Multiple Access) in Europe.
- The Modulation Technique is used GMSK (Gaussian Minimum Shift Keying).

GSM to 3G (1/3)




The Road to 3G
GSM
TDMA
(IS-136)
CDMAone
(IS-95A)
GPRS
EDGE
CDMAone
(IS-95B)
TD-SCDMA
W-CDMA
CDMA2000
(1XRTT|3XRTT)
2G
2.5G
3G

THIRD GENERATION (3G)

- 3G system provides fast communication services.
- It includes Voice, Fax & Internet any time & any where.
- It includes Multimedia Entertainment & Location based services.
- 3G wireless data network uses both circuit & packet switching

Main 3G Cellular System:-

- **CDMA 2000**
- **TD-S CDMA**
- **W-CDMA (WIDE BAND CDMA)**
- **UMTS**: Universal Mobile Telecommunication
- **EV-DO**: Evolution Data Optimize
- **EV-DV**: Evolution Data & Voice

FOURTH GENERATION (4G)

- Fourth Generation system are called 4G systems.
- 4G mobile device must be able to provide data speeds of up to 100Mbps.
- It is also called as WIMAX (World Wide Inter Operability For Microwave Access).
- 4G offer any service at anytime & any where.

INTRODUCTION

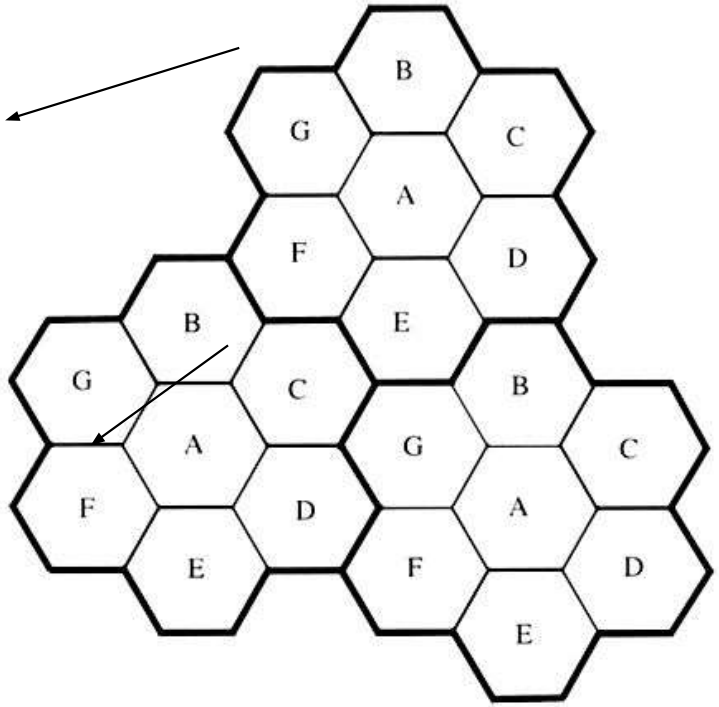
- **Cellular concept is a system level idea which calls for replacing a single , high power transmitter with low power small transmitters with each providing coverage to only a small portion of service area**
- **Each base station is allocated a portion of total no of channels available to entire system**
- **Nearby base station are assigned different groups of channels so that all the available channels are assigned to a relatively small no. of neighbouring base stations**
- **Nearby BS are assigned different groups of channel so that interference bt. BS is minimized**

NEED OF CELLULAR CONCEPT

- Early mobile radio system was to achieve a large coverage areas by using high powered transmitter with an antenna mounted on a tall tower
- In this case it is impossible to reuse those same frequencies throughout the system
- Since any attempts to achieve frequency reuse would result in interference

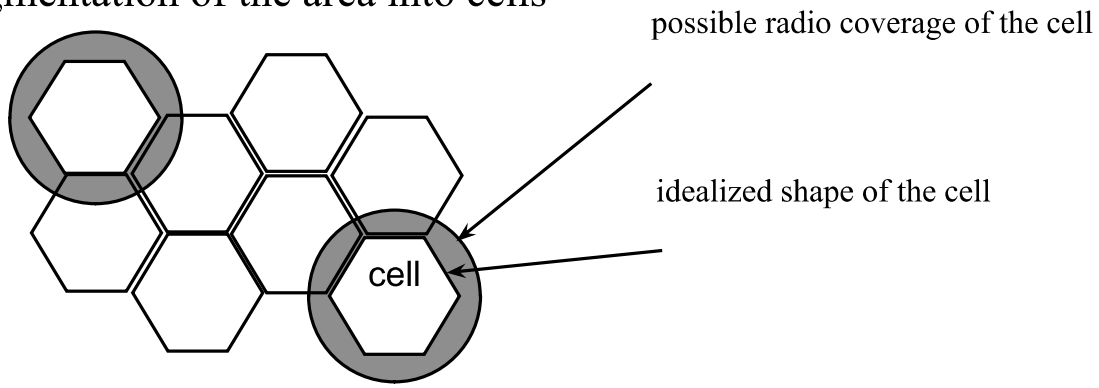
THE CELLULAR CONCEPT

- footprint of a cell - actual radio coverage
- seven groups of channel from A to G
- omni-directional antenna v.s. directional antenna



CELLULAR CONCEPT

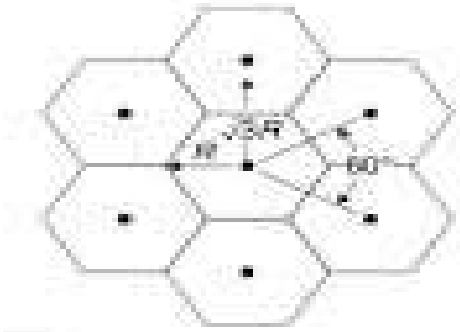
segmentation of the area into cells



- use of several carrier frequencies
- not the same frequency in adjoining cells
- cell sizes vary from some 100 m up to 35 km depending on user density, geography, transceiver power etc.
- hexagonal shape of cells is idealized (cells overlap, shapes depend on geography)
- if a mobile user changes cells
  - handover of the connection to the neighbor cell

HEXAGONAL GEOMETRY

- **Hexagonal shapes are preferred than square or circle in cellular architecture because it covers an entire area without overlapping. ... It is because it requires fewer cells to represent a hexagon than triangle or square. Other advantages of hexagonal cellular system: The frequency reuse become possible using this shape.**



CELLULAR CLUSTER

- ***A cluster is group of cells in which no frequency is reused within a cluster. Frequencies used in one cell cluster can be reused in another cluster of cells. ... A cell is basic geographical area covered by cellular transmitters for communication in cellular system.***

FREQUENCY REUSE

- Each cellular base station is allocated a group of radio channels within a small geographic area called a *cell*.
- Neighboring cells are assigned different channel groups.
- By limiting the coverage area to within the boundary of the cell, the channel groups may be reused to cover different cells.
- Keep interference levels within tolerable limits.
- Frequency reuse or frequency planning

"The design process of selecting and allocating channel groups for all of the cellular base station within a system is FREQUENCY REUSE/PLANNING"

- Consider a cellular system which has a total of S duplex channels.
- Each cell is allocated a group of k channels, $k < S$.
- The S channels are divided among N cells.
- The total number of available radio channels

$$S = kN$$

- The N cells which use the complete set of channels is called cluster.
- The cluster can be repeated M times within the system. The total number of channels, C, is used as a measure of capacity

$$C = MkN = MS$$

- The capacity is directly proportional to the number of replication M.
- The cluster size, N, is typically equal to 4, 7, or 12.
- Small N is desirable to maximize capacity.
- The frequency reuse factor is given by

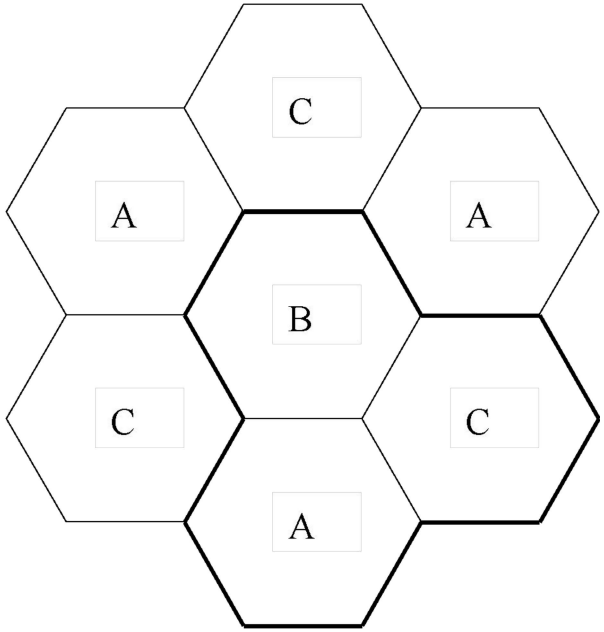
$$1/N$$

- Hexagonal geometry has
  - exactly six equidistance neighbors
  - the lines joining the centers of any cell and each of its neighbors are separated by multiples of 60 degrees.
- Only certain cluster sizes and cell layout are possible.
- The number of cells per cluster, N, can only have values which satisfy

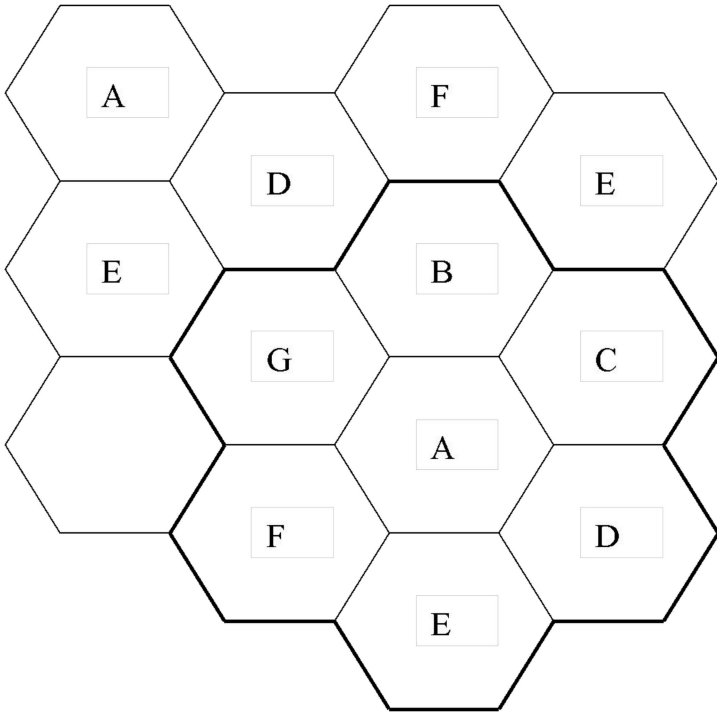
$$N = i^2 + ij + j^2$$

- Co-channel neighbors of a particular cell, ex, i=3 and j=2.

CLUSTER SIZES AND CELL LAYOUT



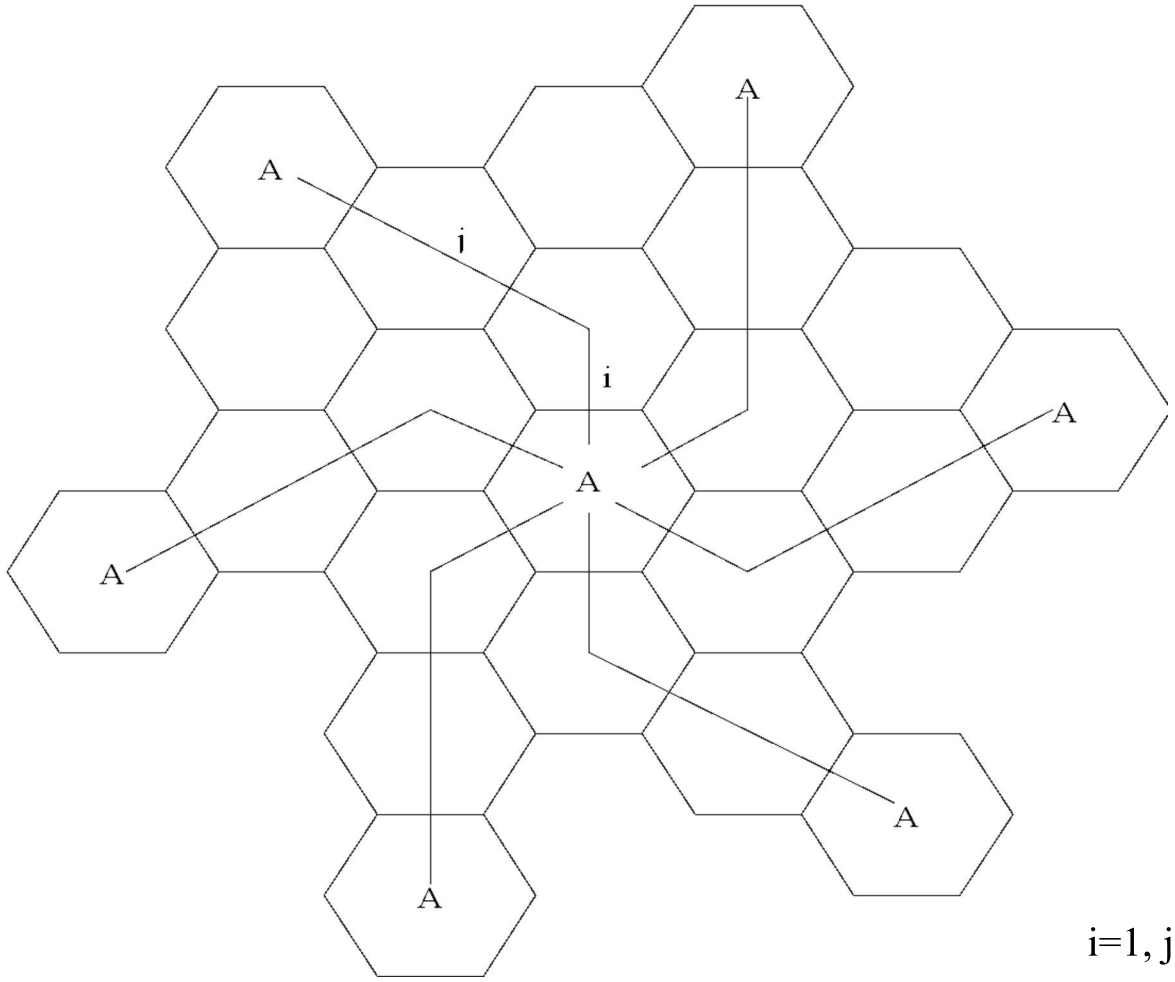
Eg for i=1,j=1



Eg for i=2,j=1

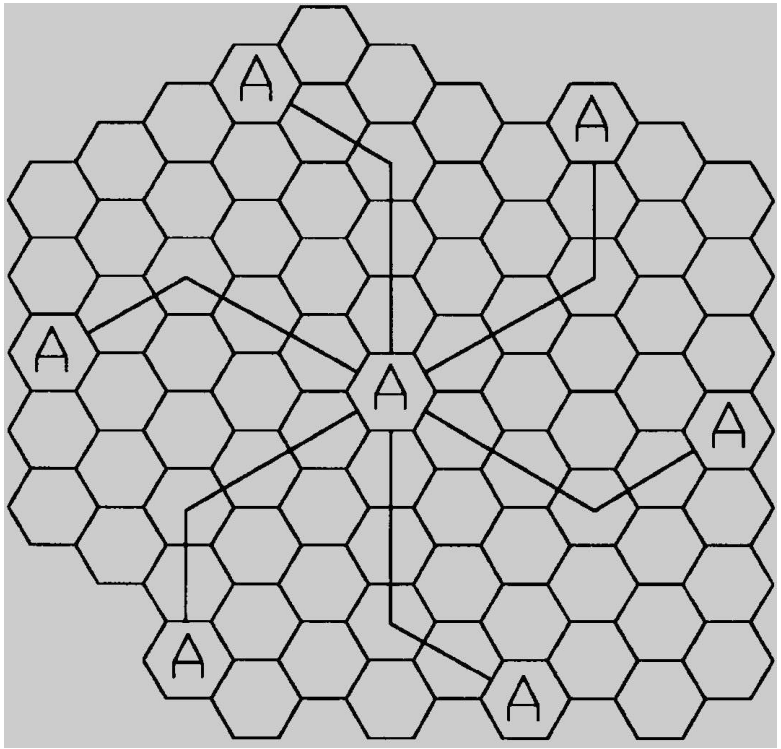
The factor N is called the cluster size and is given N=i2+ij+j2

CLUSTER SIZES AND CELL LAYOUT



i=1, j=2 , N=1+2+4=7

CELL REUSE
EXAMPLE (N=19)



To find the nearest co-channel neighbor of a particular cell

1. Move ‘i’ cells along any chain of hexagons
2. Then turn 60 degrees counter-clockwise and
3. Move ‘j’ cells.

Method of locating co-channel cells in a cellular system. In this example, $N = 19$ (i.e., $I = 3$, $j = 2$).

Frequency Reuse Distance. When the same channel is to be **reused** in two cells, the two cells are called cochannel cells. The **distance** D is the separation of the two cochannel cells. The smaller the D, the greater the spectrum efficiency would be.

CAPACITY EXPANSION IN CELLULAR SYSTEM

Techniques to provide more channels per coverage area is by

- Cell splitting
- Cell sectoring
- Coverage zone approches

CELL SPLITTING

- cell splitting increases the capacity of cellular system since it increases the number of times the channel are reused
- Cell splitting - defining new cells which have smaller radius than orginal cells by installing these smaller cells called MICROCELLS between existing cells
- Capacity increases due to additional number of channels per unit area

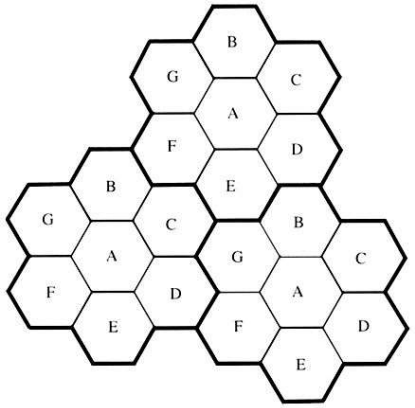
"Cell splitting is process of subdividing a congested cell into smaller cells each with its own base station(with corresponding reduction in antenna height and tx power)"

CELL SPLITTING

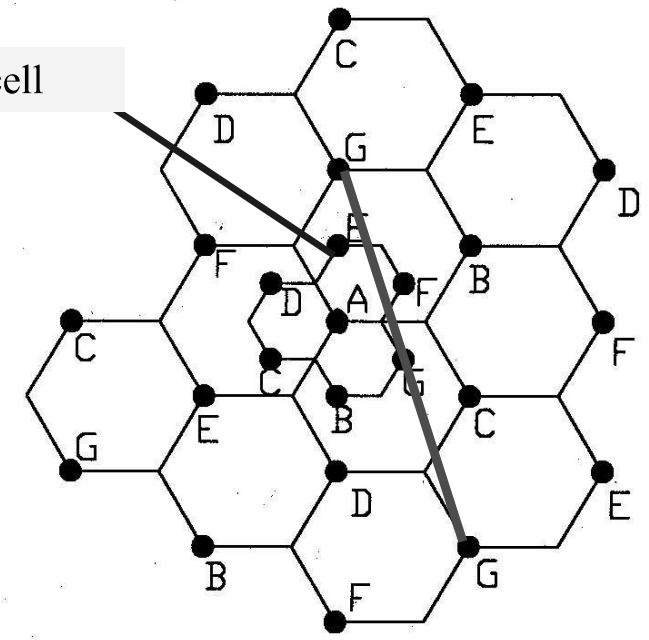
Split congested cell into smaller cells.

- Preserve frequency reuse plan.
- Reduce transmission power.

Reduce *R* to *R/2*



microcell



- Transmission power reduction from P_{t1} to P_{t2}
- Examining the receiving power at the new and old cell boundary

$$P_r[\text{at old cell boundary}] \propto P_{t1} R^{-n}$$
$$P_r[\text{at new cell boundary}] \propto P_{t2} (R/2)^{-n}$$

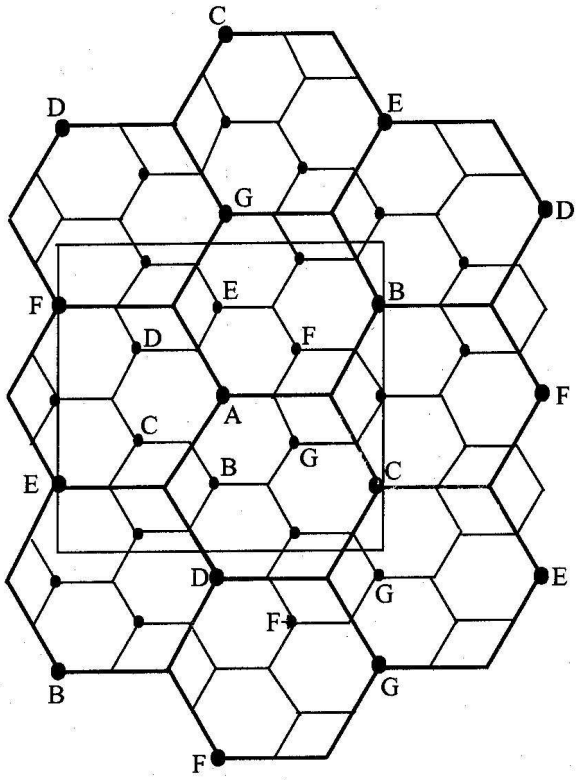
- If we take $n = 4$ (path loss) and set the received power equal to each other

$$P_{t2} = \frac{P_{t1}}{16}$$

- The transmit power must be reduced by 12 dB in order to fill in the original coverage area.
- Problem:

  if only part of the cells are splited
  - Different cell sizes will exist simultaneously
- Handoff issues - high speed and low speed traffic can be simultaneously accommodated

CELL SPLITTING

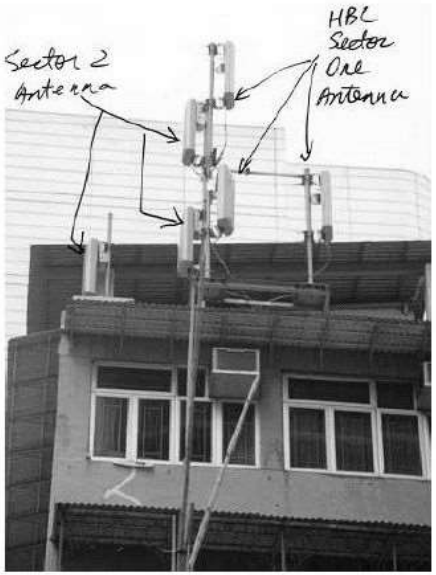


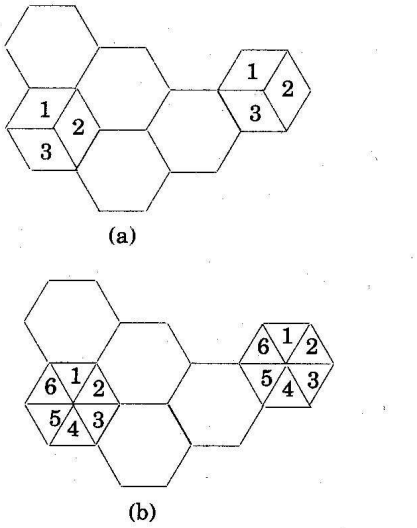
- Splitting cells in each CELL
  - Antenna downtiliting

Illustration of cell splitting within a 3 km by 3 km square

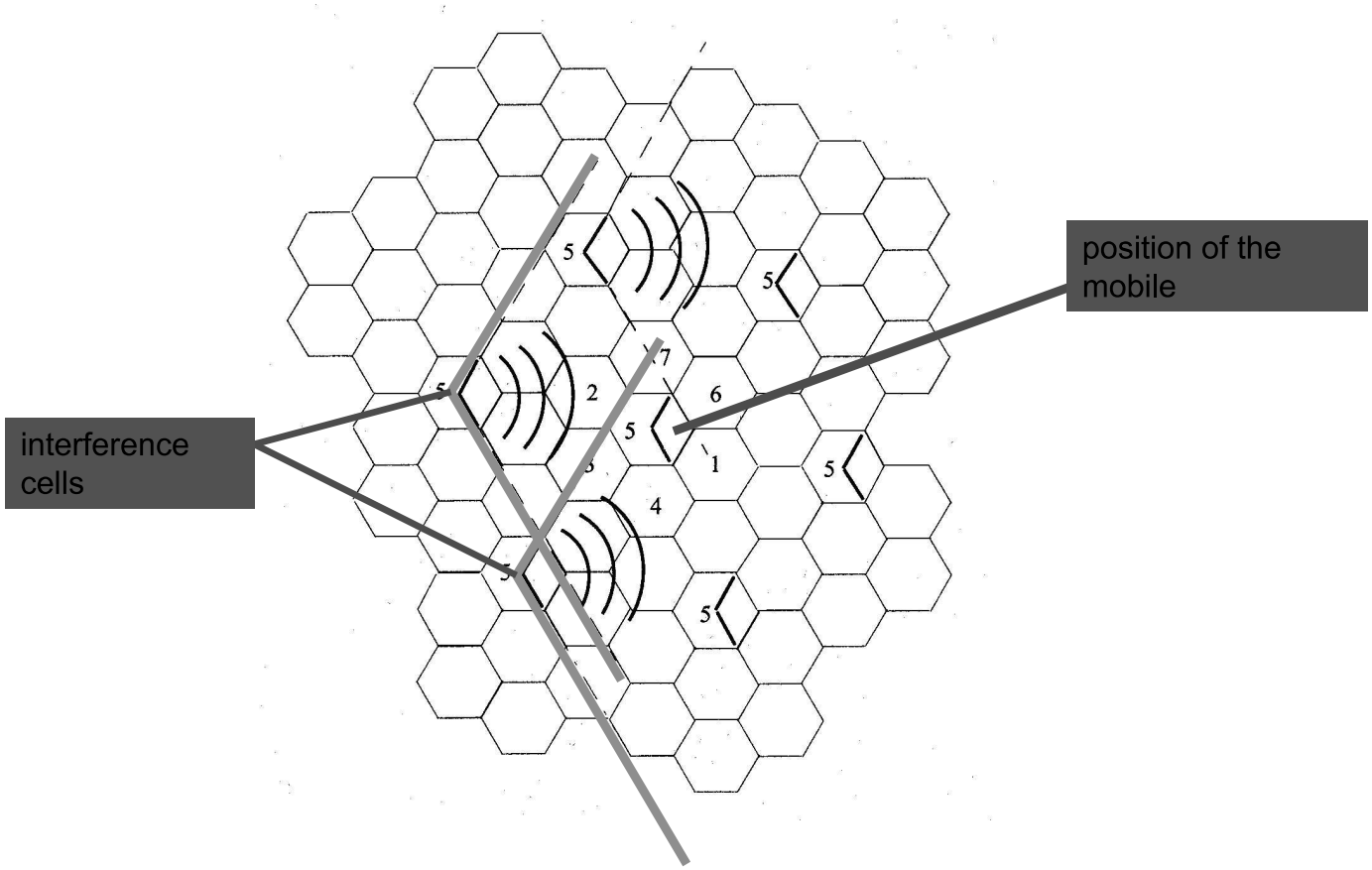
Sectoring

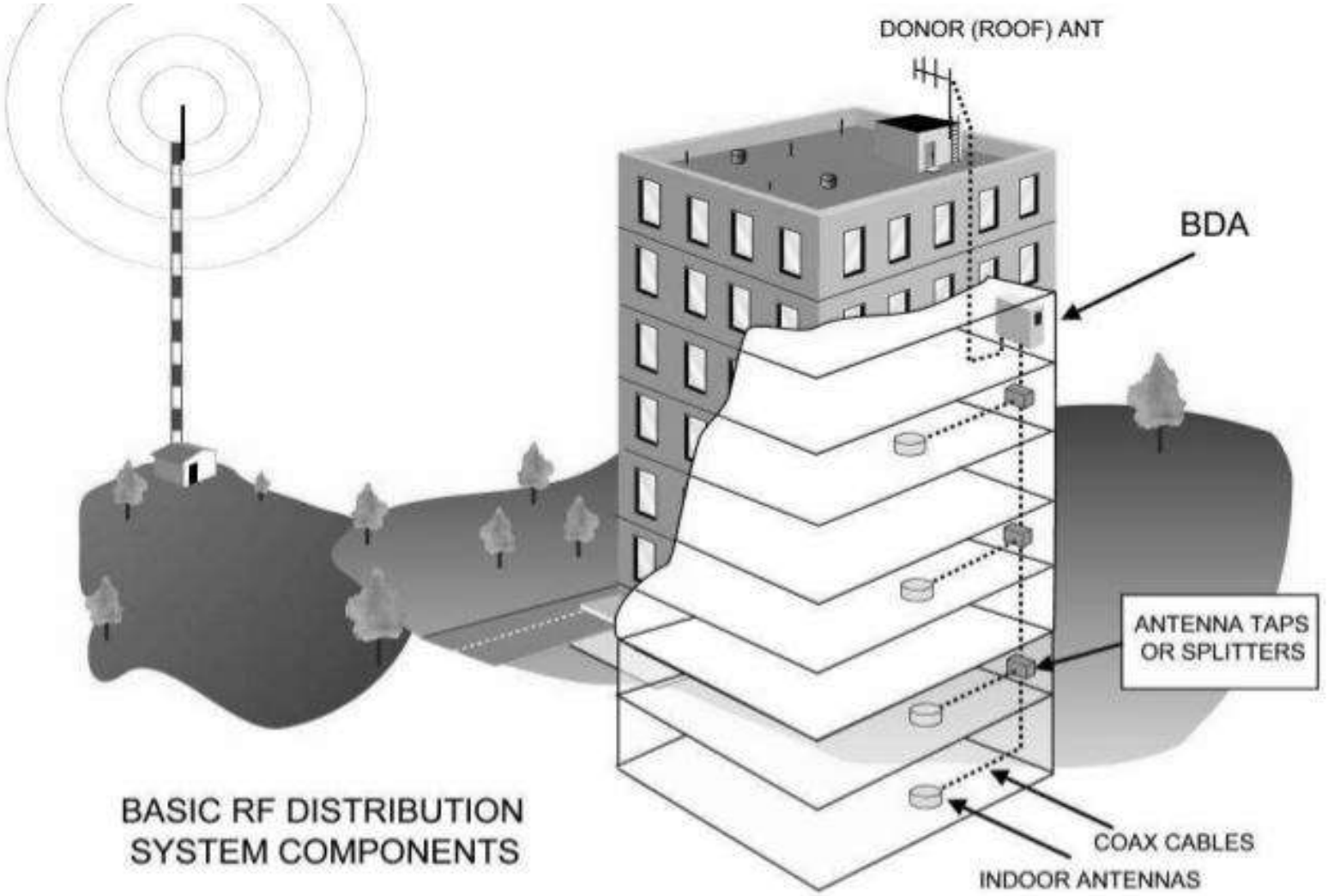
- Decrease the *co-channel interference* and keep the cell radius *R* unchanged
  - Replacing single omni-directional antenna by several directional antennas
  - Radiating within a specified sect-



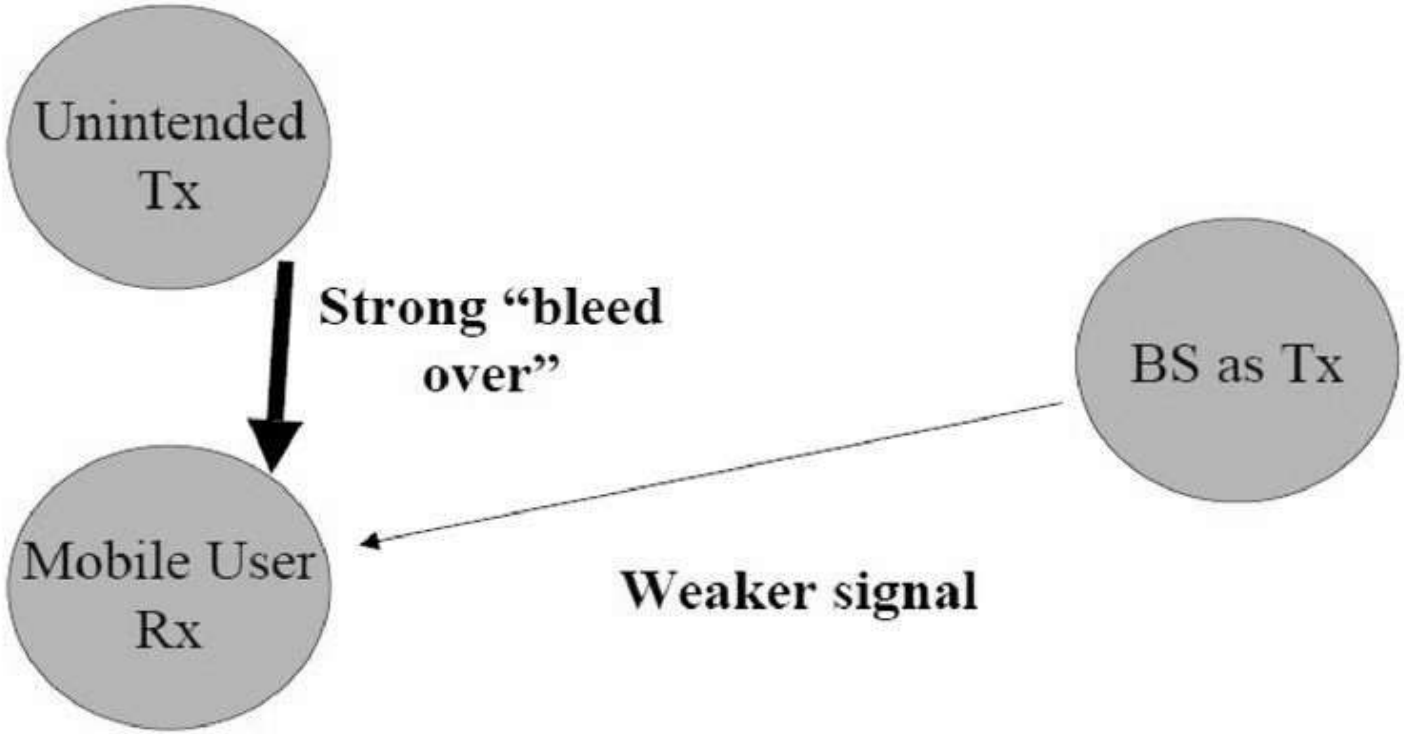


- Interference Reduction



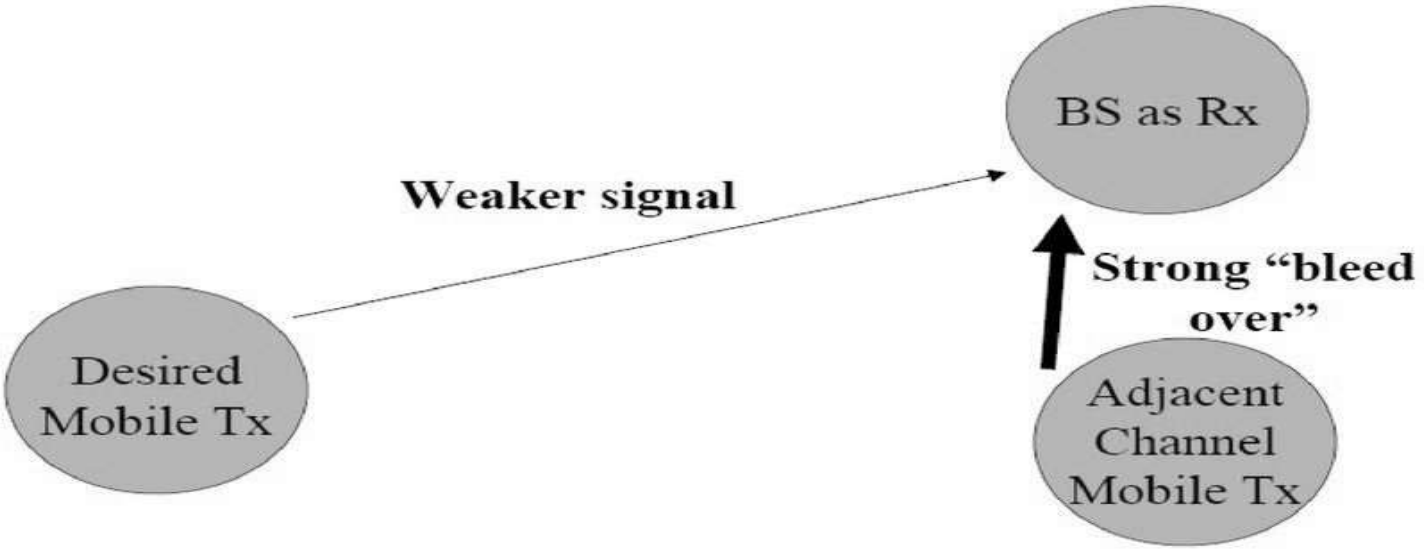


BASIC RF DISTRIBUTION
SYSTEM COMPONENTS



- *The Mobile receiver is captured by the unintended, unknown transmitter, instead of the desired base station*

Near-Far Effect: Case 2



- *The Base Station faces difficulty in recognizing the actual mobile user, when the adjacent channel bleed over is too high.*

Minimization of ACI

(1) Careful Filtering ---- min. leakage or sharp transition

(2) Better Channel Assignment Strategy

- Channels in a cell need not be adjacent: For channels within a cell, Keep frequency separation as large as possible.
- Sequentially assigning cells the successive frequency channels.
- Also, secondary level of interference can be reduced by not assigning adjacent channels to neighboring cells.
- For tolerable ACI, we either need to increase the frequency separation or reduce the passband BW.

Improving Capacity in Cellular Systems

- Cost of a cellular network is proportional to the number of Base Stations. The income is proportional to the number of users.
- Ways to increase capacity:
  - New spectrum –expensive. PCS bands were sold for $20B.
  - Architectural approaches: cell splitting, cell sectoring, reuse partitioning, microcell zones.
  - Dynamic allocation of channels according to load in the cell (non-uniform distribution of channels).
  - Improve access technologies. 3.7 Improving Capacity in Cellular Systems

Cell Splitting

- Cell Splitting is the process of subdividing the congested cell into smaller cells (microcells),Each with its own base station and a corresponding reduction in antenna height and transmitter power.

- Cell Splitting increases the capacity since it increases the number of times the channels are reused.

An Example

- The area covered by a circle with radius R is four times the area covered by the circle with radius R/2
- The number of cells is increased four times
- The number of clusters the number of channels and the capacity in the coverage area are increased
- Cell Splitting does not change the co-channel re-use ratio Q =D/R

Transmit Power

- New cells are smaller, so the transmit power of the new cells must be reduced
- How to determine the transmit power?
- The transmit power of the new cells can be found by examining the received power at the new and old cell boundaries and setting them equal

- Pr(at the old cell boundary) is proportional to

$$P_{t1} * R^{-n}$$

- Pr(at the new cell boundary) is proportional to

$$P_{t2} * (R/2)^{-n}$$

Transmit Power

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- Pr(at the new cell boundary) is proportional to

$$P_{t2} * (R/2)^{-n}$$

Transmit Power

- Take n=4, we get

$$P_{t2} = P_{t1}/16$$

- We find that the transmit power must be reduced by 16 times or 12 dB in order to use the microcells to cover the original area. While maintaining the same S/I.

TYPES OF CELL

MACRO CELL = The maximum coverage area cells are known as macro cell. These cells have a radius between 1mills to 15 mills. Cell site having an radio frequency coverage area of diameter greater than 2000feet is called Macro cell.

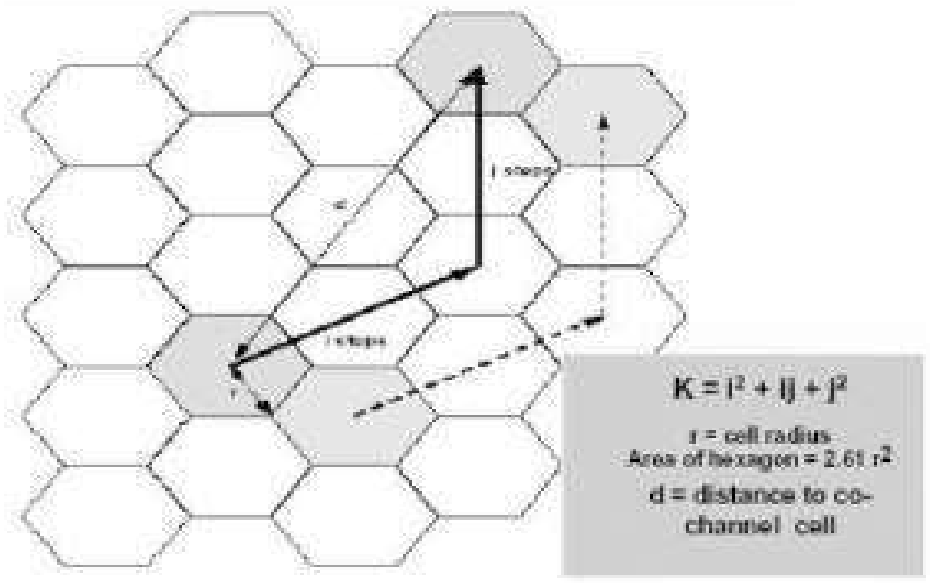
MICRO CELL = These cells are used in highly populated area such as in large cities and big building. A cell site Having a radio frequency coverage area of diameter greater than 400 feet but less than than 2000 feet.

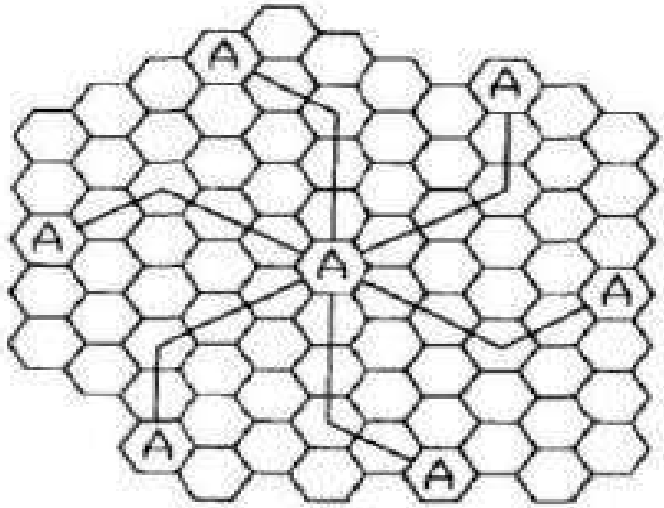
PICO CELL = Pico cell are used in areas with high level of interference . These are very small cells with cell sites Having a radio frequency coverage area of diameter less than 400 feet.

Frequency reuse

- **It is defined as the process in which the same set of frequency (channel) can be allocated more than one cell provided ,cell are separated by sufficient distance, which is known as frequency reuse.**
- **A collection of cell that uses the entire bandwidth is called cluster. The total number of channel available in a cluster is given by**
- **F = GN**
- **F = Number of full duplex cellular channel available in a cluster**
- **G =Number of channel in a cell**
- **N =Number of cell in a cluster**

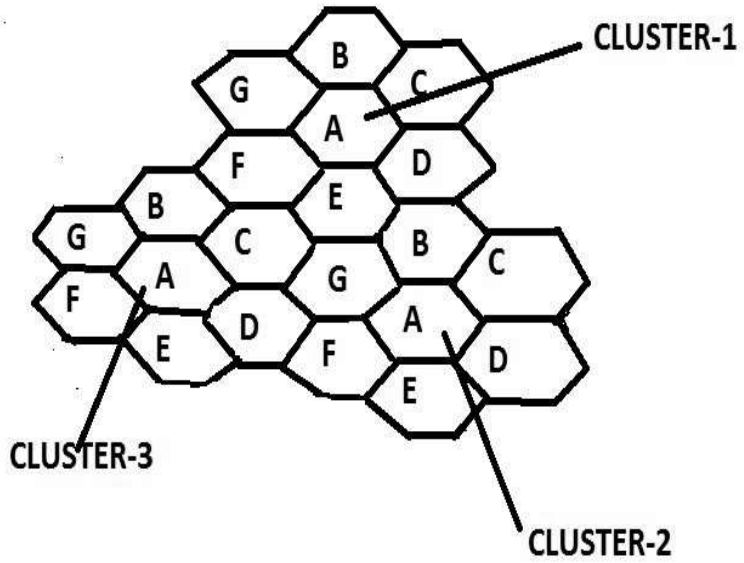
Cellular Concepts





In this case K=19
(*i=3, j=2*)

DIAGRAM OF FREQUENCY REUSE



CELL CAPACITY

The maximum number of subscriber in a system is called cellular capacity. Cellular capacity can also be defined as a product of number of a cluster in a given area and number of full duplex channel available in a cluster.

We get the cellular capacity of the system

C = MGH ; F=GN

C=MF

When the cluster size is reduced and cell sized held constant than more clusters are required to cover a given area therefore the frequency reuse factor FRF is inversely proportional to the number of cell in a cluster.

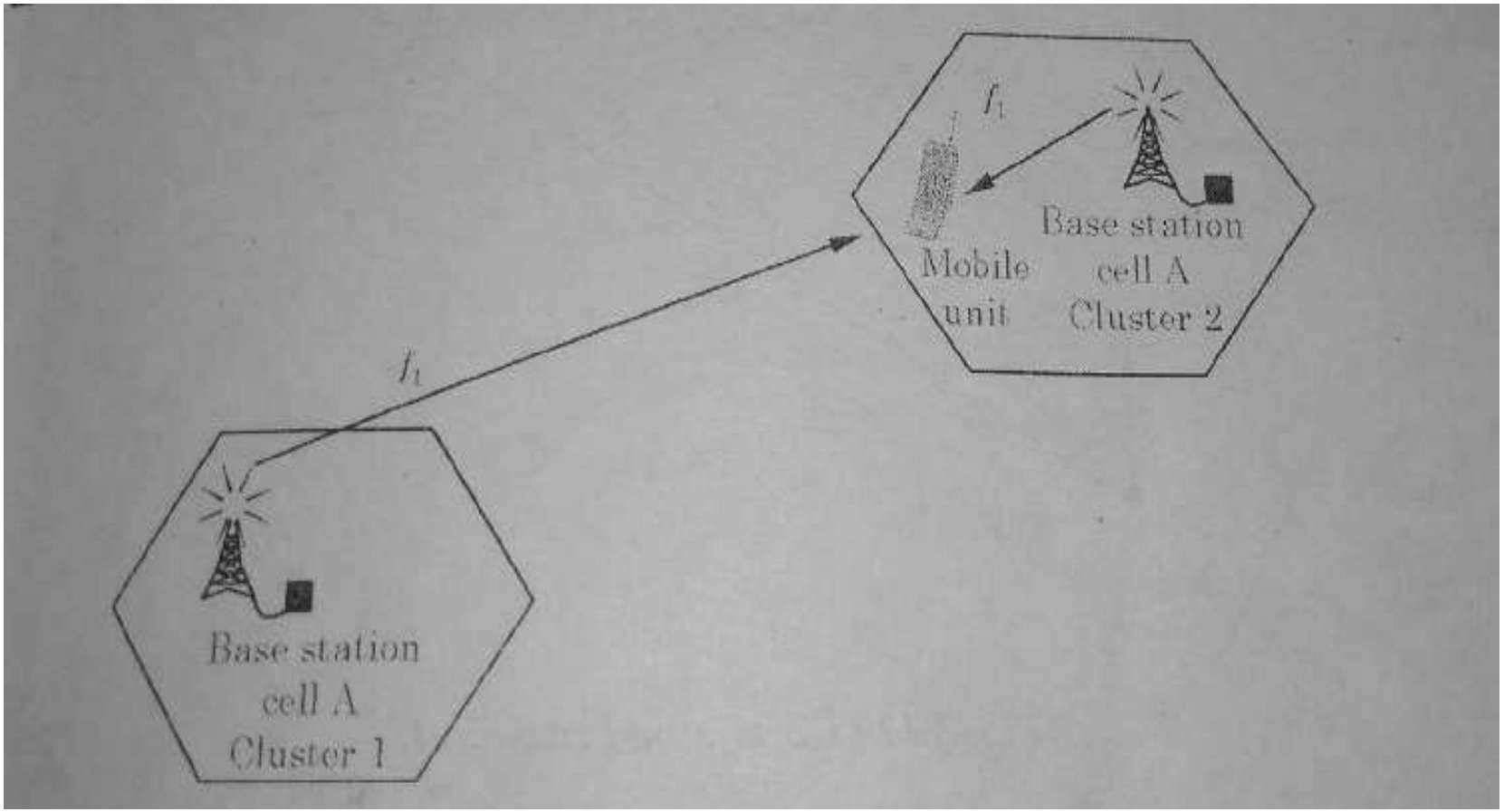
FRF proportional 1/N

Interference

Interference is defined as a form of external noise and as the name implies , it means to
"disturb or detract from".
There are two types of interference
1. Co-channel interference
2. Adjacent-channel interference
1. Co-channel interference :- two cells using same set of frequencies are called co- channel cells. The interference between co-channel cells is called as co-channel cells interference.
To reduce the co-channel interference it is must that two co-channel cells must be separated by a certain minimum distance.
Co-channel reuse ratio (Q):
Q = D/R
Where,
Q=Co channel reuse ratio.
D=distance to the center of the nearest co-channel cell
R=Cell radius

hannel interference

Co-channel interference



Interference

Adjacent-channel interference :- adjacent channel interference occurs when transmission from adjacent channel interfere with each other. It is due to imperfect filters in the receivers . The imperfection in the filters allow the nearby frequencies to enter the receiver .

Smaller frequency reuse factor:

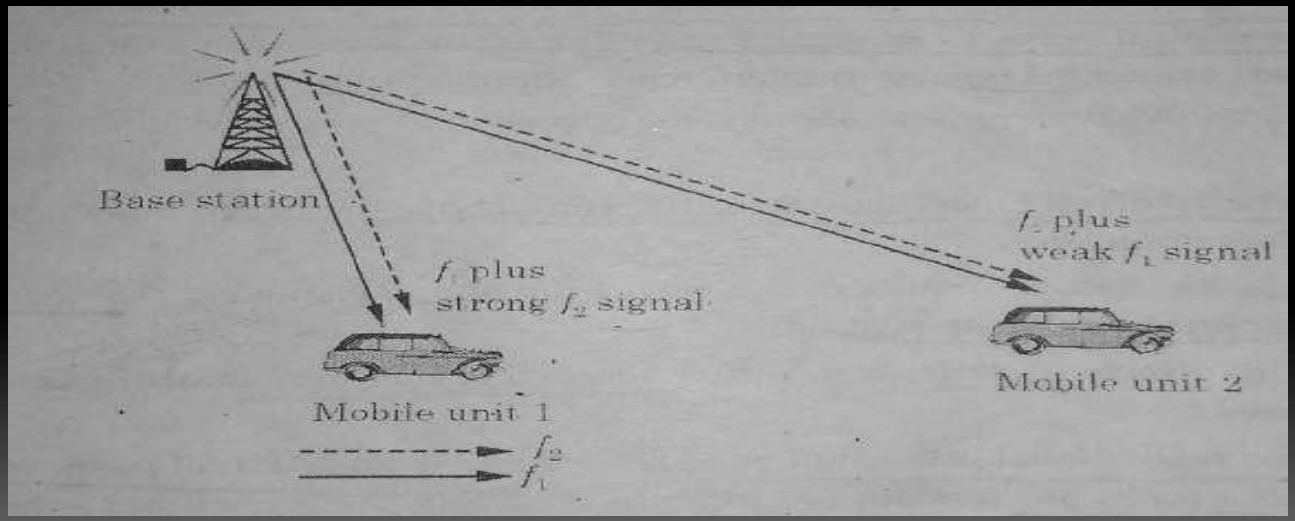
$$FRF=N/C$$

Where,

N=total number of full duplex channels in an area are less.

C=total number of full duplex channels in a cell are more.

Adjacent channel interference

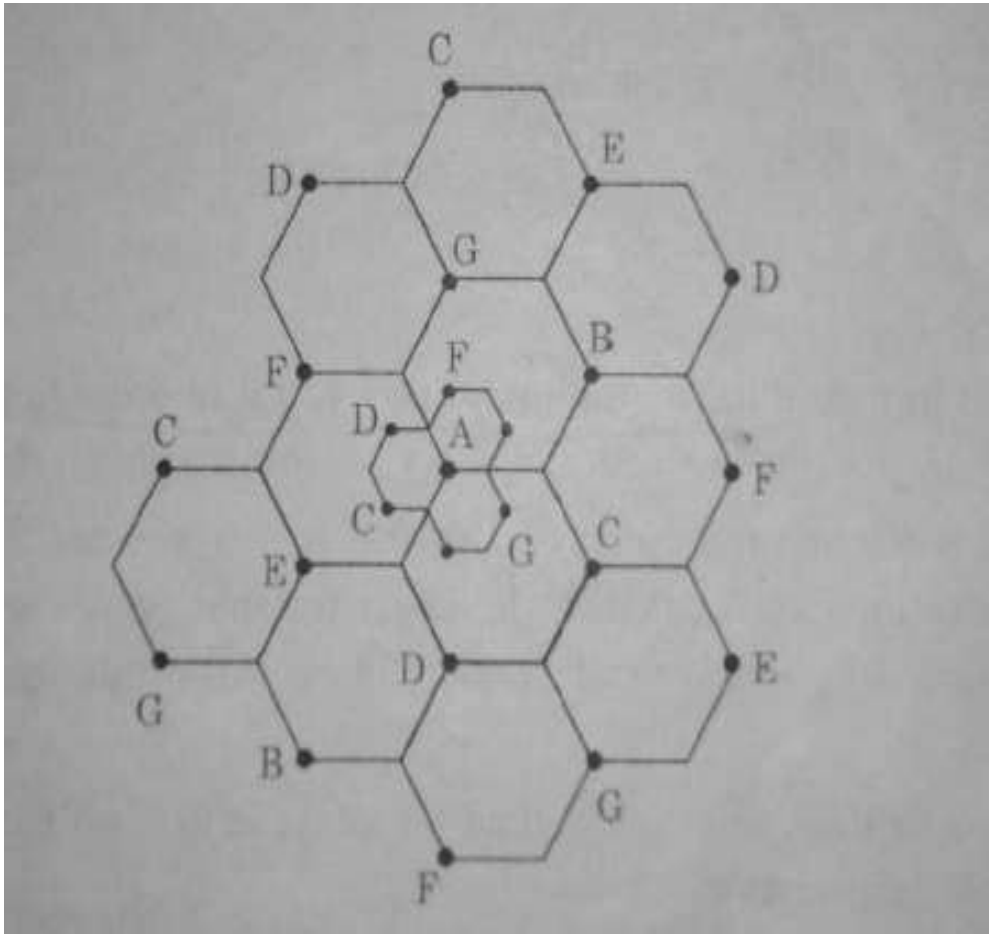


Improving coverage and capacity in cellular system

There are three following techniques are used:
cell splitting
sectoring
coverage zone

CELL SPLITTING :- it is the process of subdividing a congested cell into smaller cells. Each smaller cell has its own base station and an antenna of reduced height and power .cell splitting basically increase the capacity of cellular system because it increase the number of times that channels which are reused

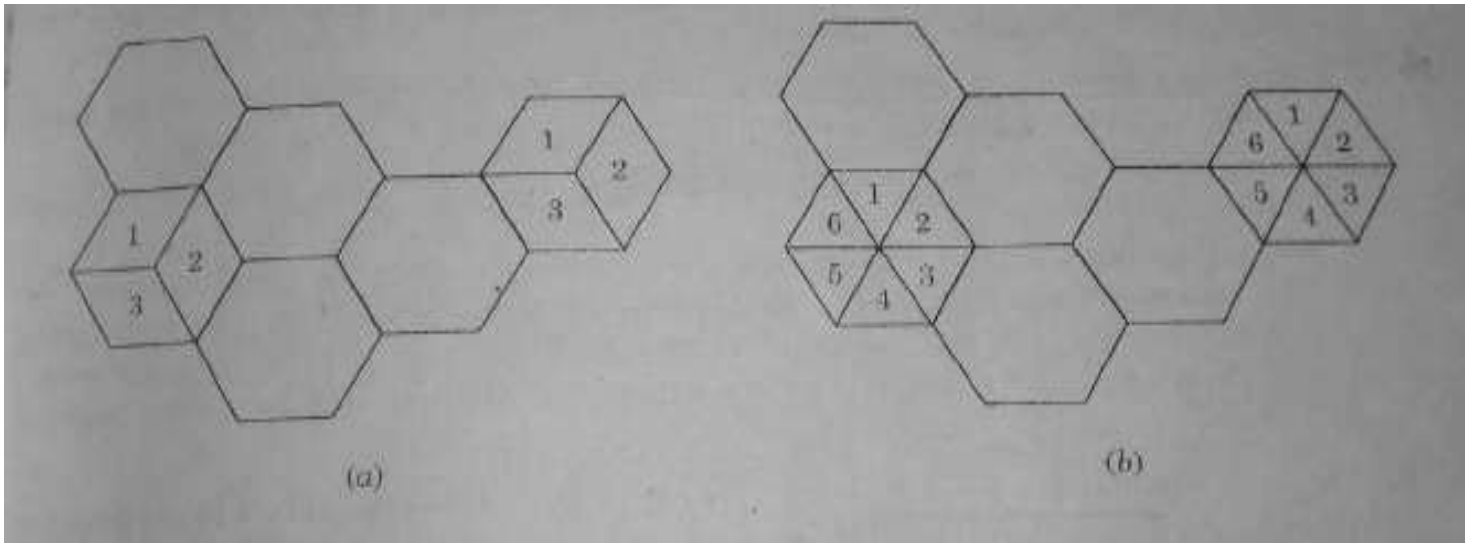
splitting



Sectoring:

n the sectoring technique, cell radius is not changed but D/R ratio is changed. Sectoring process increases SIR(signal to interference ratio) so that the cluster size may be reduced.

The technique of decreasing co-channel interference and improving system performance by using directional antenna is called sectoring.



Coverage zone / repeater for range extension

It is must for that areas of less coverage such as building, valleys or tunnels. To provide effective services in he cellular communication, radio re transmitters, known as repeaters are used. Repeaters are bidirectional in nature and are capable to send and receive signals from a base station.

Repeater do not increase the cellular capacity, it only serves to reradiate the base station signal to the specific location.

FULL FORMS

- **MS** Mobile station
- **BS** Base station
- **MSC** Mobile switching Center
- **PSTN** Public switched telephone network
- **VLR** Visito location register
- **HLR** Home location register

FULL FORMS

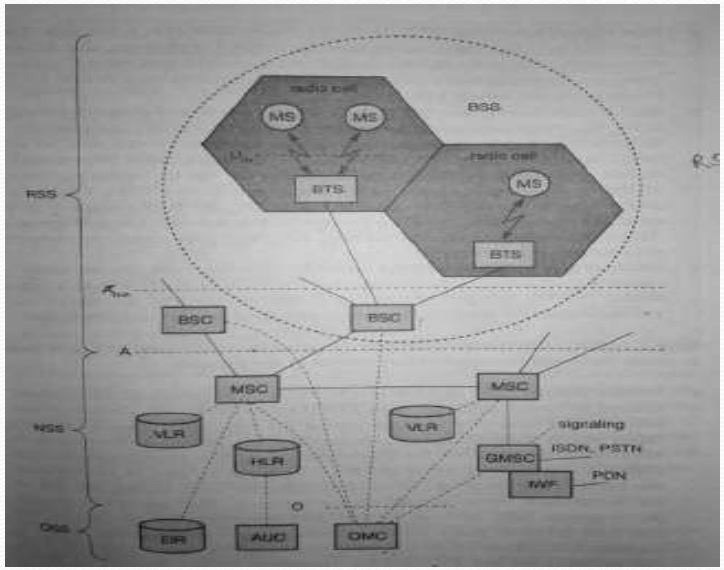
- MS Mobile station
- BS Base station
- MSC Mobile switching Center
- PSTN Public switched telephone network
- VLR Visitor location register
- HLR Home location register

MOBILE COMMUNICATION SYSTEM

GSM

- Earlier GSM was known as Groupe speciale module. It was first developed in Europe. Its name was changed and now it is known as Global system for mobile communication. It is typically second generation cellular system using digital modulation and offering improved efficiency and voice quality replacing the first generation system which was based on analog FM technology design to carry only voice services. It operates basically in the three freq. band.
- 1) 900 MHz (known as GSM 900)
- 2) 1.8 GHz (known as GSM 1800)
- 3) 1.9 GHz (known as GSM 1900)

ARCHITECTURE OF GSM



FULL FORMS

- RSS:- Radio Subsystem
- NSS:- Network & Switching Sub
- OSS:- Operation Subsystem
- MS:- Mobile Station
- SIM:- Subscribe identity module
- BSS:- Base Subsystem
- BTS:- Base Subsystem
- BSC:- Base station controller
- MSC:- Mobile switching center
- HLR:- Home location center
- VLR:- Vistor location register
- EIR :- Equipment identify register
- AUC :- Authentication center

RADIO SUBSYSTEM

- RSS:- It consist of the mobile station and the base subsystem (BSS). The connection b/w Radio subsystem (RSS) and Network switching subsystem (NSS) is through A interface.

BASE SUBSYSTEM

- BSS:-It compose of two parts BTS and BSC (Base station controller). A GSM n/w comprises many BSS each controller by a BSC.

BASE TRANSCEIVER SYSTEM

- BTS:- It comprises all radio equipment that is antennas, signalling equipment specific to the radio interface in order to contact the MS, transmitter,receiver & amplifiers necessary for radio transmission.

Base Station Controller

- BSC:- Several BTS with in a single BSS are controlled by a signal BSC. The interface used b/w several BTS & BSC is Abis .

MOBILE STATION

- MS:It is carried by the subscriber . It comprises of all user equipment and software needed for comm. within GSM n/w. It consist of SIM (Subscriber identity module.

NETWORK & SWITCHING SUBSYSTEM

- NSS:- It is the wireless n/w with standard public n/w, perform handover b/w different BSS & support charging ,accounting & roaming of user b/w different providers in different countries.

MOBILE SWITCHING CENTER

- MSC:- MSC'S are high performance digital ISDN switches. They set up connection to the other MSC'S and to the BSC'S through the A interface and forms the fixed backbone n/w of the GSM n/w.

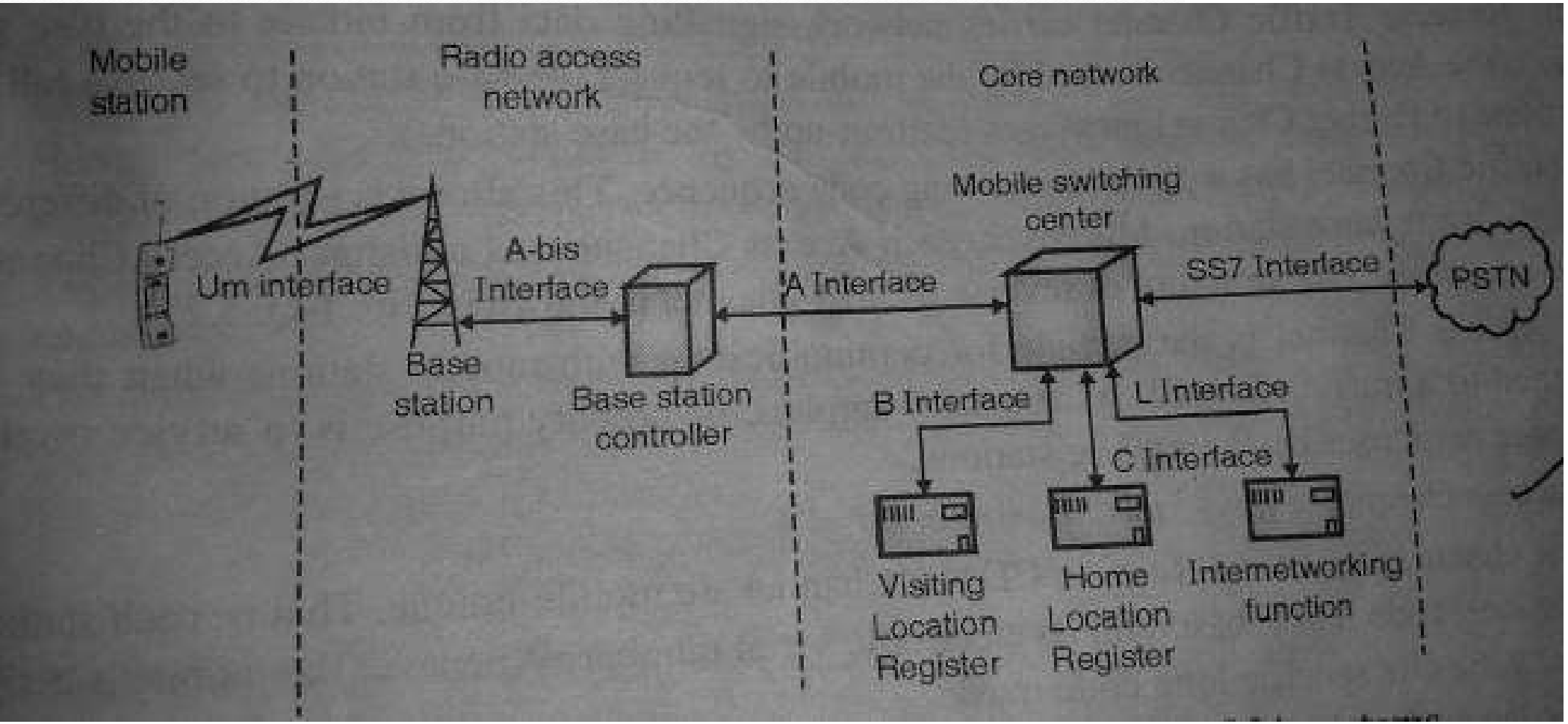
FUNTIONS OF MSC

- Call control :- This identifies the subscriber, establish the calls and clear the connection after the conversation is over.
- Charging:- This convert the charging information about a call that is the no. of a caller and the called subscriber.
- Signaling:- This applies to interfacing with the BSS and the PSTN.
- Subscriber data handling:-This is the permanent data storage in the HLA & temporary storage of relevant data in the VLR.

CDMA

- CDMA stand for code division multiple access . In 1984 qual communication purpose totally digital mobile telephone with the primary goal to increase the capacity.
- This system was made available in the US and the based on CDMA technique.
- The US telecommunication industry association named it IS-95 that is (interim standard 95) that is basically CDMA - one and is also known as TIA-EIA-95.
- In this technique, user uses unique code to differentiate to one another and any number of user can transmit at any time using the same frequency and time slot.

ARCHITECTURE OF CDMA



ADVANTAGE OF CDMA

- It increase capacity and performance of the cellular system.

DISADVANTAGES OF CDMA

- There should be a proper synchronization between the transmitter and receiver unit.

PARAMETERS	GSM	CDMA
Modulation	Gaussian minimum shift keying	QPSK
Multiple Access Technique	TDMA	CDMA
Stands For	Global System for Mobile Communication	IS -95 or one CDMA
Bandwidth	200kHz	1.25 MHz
Data Transmission Rate	270.873KB/s	9.6KB/s or 14.4KB/s
FrameDuration	4.615ms	20ms
Power	Maximum mobile handset power is 1000 mw	Power is 600mw

BLUETOOTH

- Bluetooth is a wireless technology and it is use for creating personal network operating in the 2.4 GHz band.
- Bluetooth wireless technology (BWT) is based on IEEE.802.15 standard.
- BWT enabled device use a technique called frequency hopping to minimize eaves dropping and interference from other network.
- It can work within a range of 10m.
- In bluetooth network are usually from temporary and the network are formed with portable devices such as cellular phones, handset or handhold and laptop.

CLASSES OF BLUETOOTH

- Class 1 (100meter)
- Class 2 (50 Meter)
- Class 3 (10 Meter)

Bluetooth is designed for short range (100m, 10m and 1 m).It is designe nsumption.

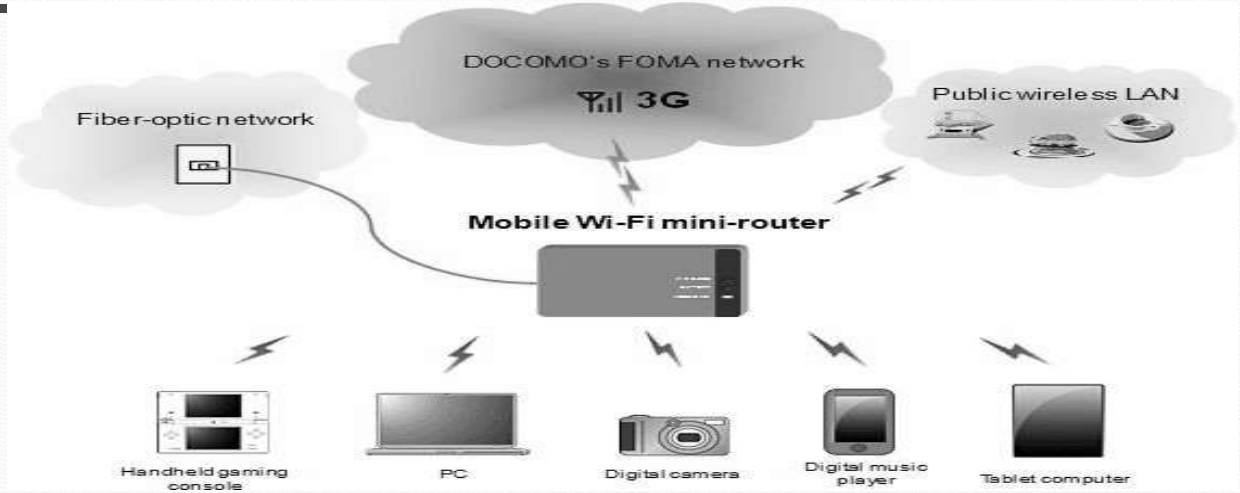
SYMBOL OF BLUETOOTH

The term Wi-Fi suggests Wireless Fidelity, resembling the long established audio-equipment classification term high fidelity

WIRELESS FIDELITY (Wi-Fi)

- It basically includes device to device connectivity such as Wi-Fi peer to peer AKA Wi-Fi direct.
- It support a range of technologies that support PAN, LAN and even WAN connections.
- The technical term "IEEE 802.11" has been used interchange with Wi-Fi, Wi-Fi is used over 700 million peoples and these are over 750 thousand places with Wi-Fi connectivity around the world.

DIAGRAM OF Wi-Fi



OPERATING MODES OF Wi-Fi

There are two operating modes specifies in the IEEE 802.11 standards:-

- Ad-hoc mode:- In ad-hoc mode, wireless station comm. Directly with one another using the ad-hoc operating mode. Such a network follows a peer to peer model. There is no connections to other Wi-Fi network or to any wired LAN's.
- Infrastructure mode:- The infrastructure operation mode requires that the BSS contains one wireless access point (AP).

BENEFITS OF WI-FI

- Wireless Ethernet
- Extended access
- Lost reduction
- Mobility
- Flexibility

USES OF WI-FI

- Internet access
- City wide Wi-Fi
- Campus wide Wi-Fi
- Direct computer to computer comm.

DIFFERENCE BETWEEN BLUETOOTH AND WIRELESS FIDELITY

BLUETOOTH

- HOP freq. is 1600HOP/sec.
- Data transfer rate is 1mb/sec.
- It uses low transmission power.
- Transmission range is 10m.
- It uses quassion freq. shift keying modulation scheme.

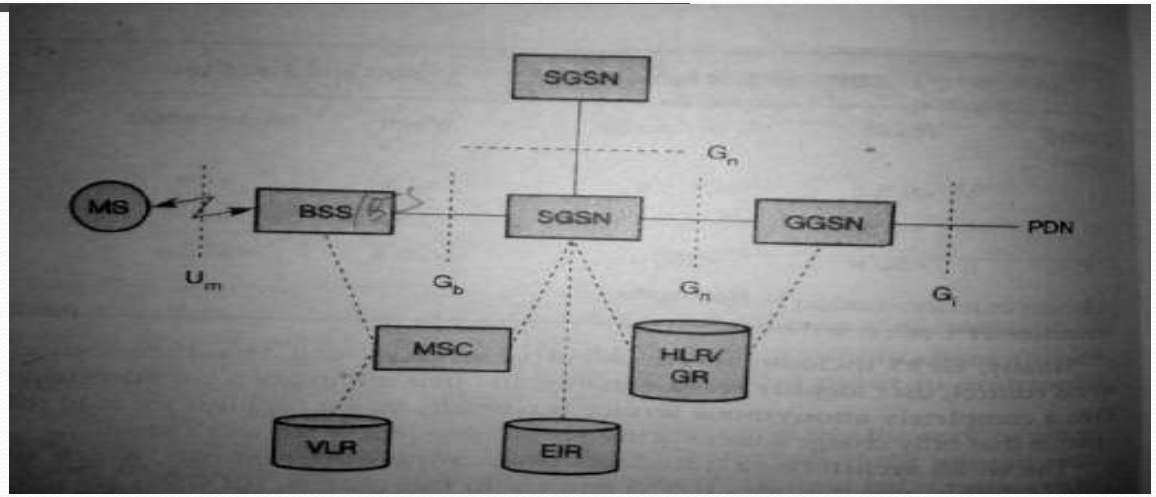
Wi-Fi

- HOP freq. is 2.5HOP/sec.
- Data transfer rate is 1101kb/sec.
- It uses more transmission power than bluetooth.
- Transmission range is 15- 50m indoor and 300m outdoor.
- It uses complimentary code keying modulation scheme.

GENERAL PACKET RADIO SERVICE (GPRS)

- It is based on time division multiple access technique (TDMA).
- It maximizes the capacities of GSM network for longer messages and high data rates.
- This service supports sending packet to packet and packet to multipacket, messages and is known as broadcast and multicast data transmission.
- GPRS minimizes the wastage of bandwidth because it will not permanently allocate separate freq. channel on the radio interface.
- It is useful in those cases where the users download much more data then it uploads on the internet to get back of e- mail, faxes are some of such cases.

DIAGRAM OF GPRS

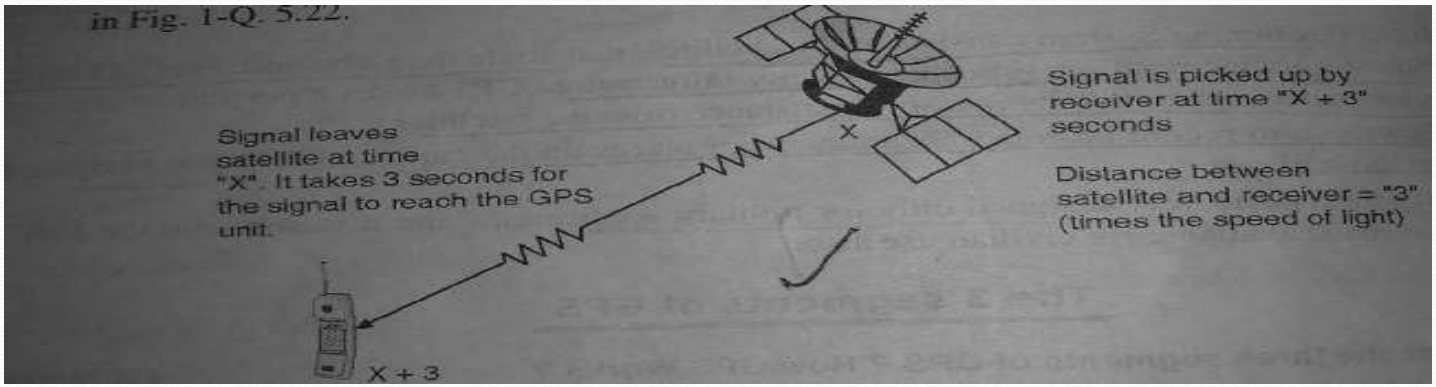


GLOBAL POSITIONING SYSTEM (GPS)

- It is the mostaccurate. and useful radio navigation system..That is for determining force or movements.
- It consist of 24 Satellite that circles the globe once every 12 hour to provide world wide position, time and velocity information.
- It possible to precisely identifying location on the earth by measuring distance from the satellite. It allows us to record or create location from places of the earth.
- It uses for military applications.
- It is basically consist of three segment:-

1. Space
2. Controller
3. User

DIAGRAM OF GPS



ADVANTAGES OF GPS

- It is extremely easy to navigate from one place to another as it tells us the direction for each turn.
- It works in all weather.
- It is economical.

DISADVANTAGES OF GPS

- If we are using a GPS on a battery operating device there may be a battery failure.
- Some times GPS signals are not very accurate due to opstricals. Like buildings, trees.

5.3 UMTS

- The word UMTS means **"Universal Mobile Telecommunication System"**. This system was introduced in late 1996 under *European Telecommunication Standards Institute* (ETSI). UMITS is also known as **3GW-CDMA.**
- Several Competing wideband CDMA (W-CDMA) have merged into a *single* W-CDMA standard and the **resulting W-CDMA** is called UMTS.
- UMTS was submitted by ETSI to ITU's IMT-2000 body in 1998 for consideration as word standard. At that time, UMTS was called as **UMTS Terrestrial Radio Access** (UTRA).
- UTRA has the following features :
  - (*i*) **Mode of Operation :** DS_CDMA at rates of N × 0.960 Mcps with N = 4, 8, 16
  - (*ii*) **Duplexing Method :** FDD and TDD Modes
  - (*iii*) **Key Features:**
    - Wideband DS_CDMA system.
    - Backward compatibility with GSM/DCS–1900.
    - It has upto 2.048 Mbps on Downlink in FDD Mode.
    - Minimum forward Channel bandwidth of 5GHZ.

- It supports a common set of chip rates, 10 ms frame structure, with 16-slots per frame.
- Dedicated pilot bits assist in downlink beam forming.

- UMTS is also known as 3GW-CDMA and it is designed for *"always-on"* packet based wireless service. This feature enables computers, entertainment devices and telephones to share the same wireless network. This also helps to get connected with Internet, anytime, anywhere.
- 3G W-CDMA supports packet data rates up to 2.048 Mbps per user (if the user is stationary). This ultimately helps high quality data, multimedia, streaming audio, streaming video and broadcast-type service to consumers. Enhanced version of W-CDMA supports data rate in excess of 8 Mbps.
- 3G W-CDMA (UMTS) provides public and private networks features. It also provides *video conferencing and virtual home entertainment (VHE).*
- UMTS requires minimum spectrum allocation of 5MHz and this is an important distinction from the other G-standards.
- With 3G W-CDMA (UMTS) it is possible to achieve data rates as low as 8 kbps and as high as 2 Mbps. 3G W-CDMA (UMTS) uses variable/Selectable direct sequence spread spectrum chip rates and that can exceed 16-Megachips per second per user.
- It has been find out that UMTS will provide at least a six times increase in spectral efficiency over GSM, when it is compared on a system wide basis. 3G W-CDMA (UMTS) requires expensive new base station equipment and this will slow down the installation of UMTS throughout the world.
- 3G W-CDMA (UMTS) will require dual mode or tri-mode cell phones and that can automatically switch between the 2G TDMA, EDGE or W-CDMA service.
- It is likely that 3G W-CDMA will be fully installed, eliminating the need for backward compatibility with GSM/GPRS, IS-136, PDC and EDGE.

5.4 HIGH SPEED PAKCET ACCESS (HSPA)

HSPA is an amalgomation of two mobile protocol, that include HSUPA and HSDPA. HSUPA means High speed uplink packet access and HSDPA means High speed down link packet access. HSPA improves the performance of existing 3G mobile telecommunication networks using WCDMA protocols. HSPA offers data speed upto 21 Mbps in 3G and upto 42 Mbps in 4G.

HSPA network consists of user equipment (UAE), node B and Radio network controller (RNC). It offers 14.4/7.2 Mbps speed in downlink and 5.76 Mbps in uplink. It uses QPSK /16QAM modulation in Down link and QPSK in uplink.

.4.1 Advantages of HSPA

The main Advantages of HSPA are as follows–

1. It gives coherent coverage to users *i.e.* user can move indoor to outdoor with full data service.
2. It is easy to connect.
3. It offers lower production costs.
4. It gives better performance as compared to Wi Fi.
5. It offers lower latency rate.

.4.2 Disadvantages of HSPA

The drawbacks of HSPA are as follows–

1. HSPA complaint UE does not get total bandwidth when it is far way from base station.
2. Up gradation of system and user equipment both are expansive.
3. Quality of service in HSPA network depends on number of users. It means quality goes poorer with increase in number of users.

.5 LONG TERM EVOLUTION (LTE)

LTE or long term evolution is a 4G wireless communications standard. It was developed by GPP (3rd Generation partnership projects. It provides Ten times speed of 4G networks for obile devices like smart phones, tablets, wireless hotspots, note books etc.

.5.1 LTE Features

A number of features are there in LTE that enable the operation of the instant conditions of dio channel with a very high efficiency. It increases the system capacity significantly by timizing the required power.

The main characteristics of LTE are–

- Use of OFDMA in down link
- Use of Sc-FDMA in uplink
- Spectrum flexibility
- Use of multiple antennas
- Inter cell interference coordination
- Power control

Use of orthogonal frequency division multiplexing in down link allows multiple access by viding the channel into a set of orthogonal subscribers. These subscribers are distributed into oups as per need of each user.

Use of SC-FDMA in uplink is a more efficiency alternative in terms of power which reserves most of the disadvantages of OFDMA which uses low efficiency linear amplifiers.

Spectrum flexibility is one of the key features of LTE. LTE defines bandwidths of 1.4 MHz, 5 MHz, 10 MHz, 15 MHz and 20 MHz. It operates in both FDD and TDD. It allows optimal use of radio spectrum using DSA (Dynamic Spectrum assignment) technique.

The use of multiple antennas gives additional protection to radio channel fading and ability to shape the radiation patterns in transmission and reception. It also help in obtaining very high data rates when channels are in parallel. This is called Multiple input – Multiple Output (MIMD) technique.

LTE allows coordination between different base stations to identify the location of user of in the cell. The inter-cellular interference is reduced by using different frequency reuse scheme.

The power control in uplink improves system capacity and reduces power consumption.

5.5.2 Architecture of TLE

A standard LTE system architecture consists of an involved and system architecture evolution UMTS terrestrial radio access network. It is comprised of following–

- user equipments
- evolved node B base station
- evolved universal terrestrial radio

The radio access network is also known as E-UTRAN. Fig. 5.1 shows LTE architecture.

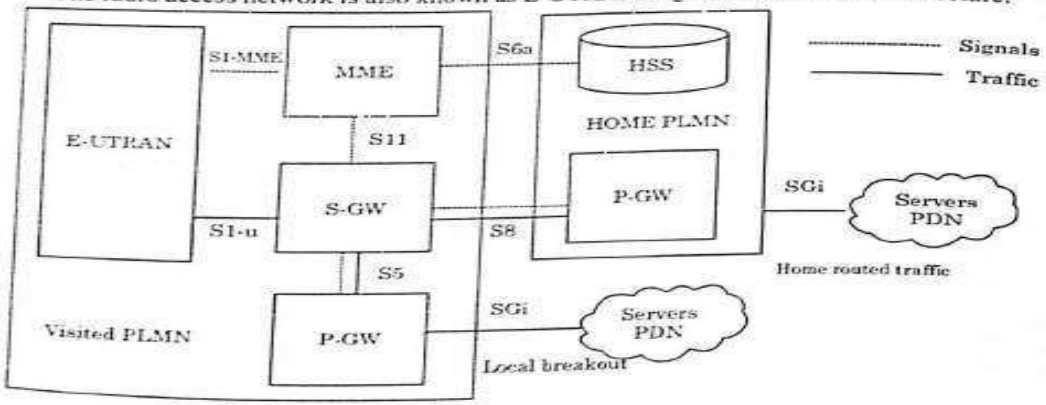


Fig. 5.1: LTE architecture

The system are architecture evolution (SAE) is made up of EPC or evolved packet core. It consists of follows–

- The mobility management Entity (MME)

- The serving gateway (SGW) and packet data network gateway (PGW)
- The home subscriber server (HSS)
- The evolved packet data gateway (ePDG)
- The access network discovery and selection function (ANDSF)

EPC is the core network of LTE. Its components provide authentication, quality of service, mobility management, routing upload and download of IP packets, IP address allocation etc. It has a flat IP architecture which allows handling of great amount of data traffic more efficiently and in lesser cost.

The mobility management entity (MME) handles the exchange of signals between user equipments (UEs) and EPC. It is done through NAS (Non access stratum) protocol hence also called NAS signalling. Functions of MME are Authentication, location update, mobility management, handover support and bearer establishment. MME also allocates gateway router to the internet if more of them are available. MME supports lawful interception of signalling.

The serving gateway acts like an anchor between neighbouring e node Bs routes. It routes all data packets of users and handles mobility between LTE and other CS networks. It performs replication of the user traffic in case of lawful interception.

The packet data network gateway ensures the connectivity of user equipments to external packet data networks. A user equipment can be connected to more than one P-GW (Packet Data Network Gateway) while accessing multiple PDNs. It handles user by user packet filtering, policy enforcement, charging support packet screening and lawful interruption.

The home subscriber server (HSS) is a central database. It contains user related and subscription related information. It performs mobility management, user authentication, access authorization and provides session establishment support.

e Node B is a part of E-UTRAN radio access network. It allows UEs to connect to LTE network. It communicates with UE, with EPC through various interfaces and with other e Node Bs. The main functions of e Node B are radio bearer control, admission control, dynamic resource allocation, mobility management, MME selection, enabling UE to be served, routing of user plane packets towards S-GW, packet compression and ciphering, method scheduling and transmission and establishment of route towards an MME.

E-UTRA is the air interface of an LTE network. It enables a latency decrease, allows high bandwidth capabilities and is optimized for packet data. It uses OFDMA in down link, Sc FDMA is uplink and MIMO technology.

E-UTRAN is the architecture of the evolved UMTS terrestrial radio access network. See fig. 5.2

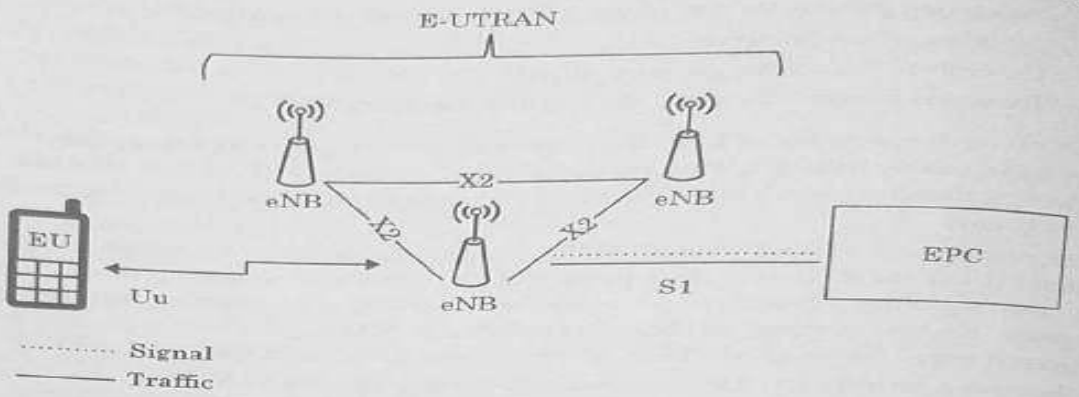


Fig. 5.2: UTRAN architecture

E-UTRAN handles the radio communication between the mobile and the evolved packet core/the evolved base stations. It can carry many types of traffic and allows connectivity between the user equipment and the core network.

EXERCISES

(A) VERY SHORT ANSWER QUESTIONS:

1. Define 3G.
2. What is 4G?
3. Define cell area.
4. What is UMTS?
5. Define HSPA.
6. Write full form of LTE.
7. Define E-UTRAN.
8. Define EPC.

(B) SHORT ANSWER QUESTIONS:

1. List properties of 3G.
2. What are the characteristics of 4G?
3. What is cellular network? What is its advantages?
4. Write short note on UMTS.
5. Write advantages of HSPA.
6. List LTE features.

(C) LONG ANSWER QUESTIONS:

1. Explain 3G and 4G wireless communication in brief.
2. What is LTE? Explain its features, advantages and disadvantages.
3. Explain LTE architecture with help of a diagram.
4. What is UMTS? What are its functions and features?

8. **ROM:** It is found in the Power Section of a Mobile Phone.
Work / Function: It loads current operating program in a Mobile Phone.
Faults: If ROM is faulty then there will software problem in the mobile phone and the set will get dead.

9. **RAM:** It is found in the Power Section of a Mobile Phone.
Work / Function: It sends and receives commands of the operating program in a mobile phone.
Faults: If RAM is faulty then there will be software problem in the mobile phone and it will get frequently get hanged and the set can even get dead.

10. **Flash IC:** It is found in the Power Section of a Mobile Phone. It is also called EEPROM IC, Memory IC, RAM IC and ROM IC.
Work / Function: Software and IMEI Number of the mobile phone is installed in the Flash IC.
Faults: If Flash IC is faulty then the mobile phone will not work properly and it can even get dead.

11. **Power IC:** It is found in the Power Section of a Mobile Phone. There are many small components mainly SMD capacitor around this IC. RTC is near the Power IC.
Work / Function: It takes power from the battery and supplies to all other parts of a mobile phone.
Faults: If Power IC is faulty then the set will get dead.

12. **Charging IC:** It is found in the Power Section near R22.
Work / Function: It takes current from the charger and charges the battery.
Faults: If Charging IC is faulty then there will be battery not charging problem and the set will not get charged. If the Charging IC is short then the set will get dead.

13. **RTC (Simple Silicon Crystal):** It is Real Time Clock and is found in the Power Section near Power IC. It is made up of either metal or non-metal. It is of long shape.
Work / Function: It helps to run the date and time in a mobile phone.
Faults: If RTC is faulty then there will be no date or time in the mobile phone and the set can even get dead.

14. **CPU:** It is Central Procession Unit of the Phone and is found in the Power Section. It is also called MAD IC, RAP IC and UPP. It is the largest IC on the PCB of a Mobile Phone and it looks different from all other ICs.
Work / Function: It controls all sections of a mobile phone.
Faults: If CPU is faulty then the mobile phone will get dead

6 TROUBLESHOOTING GSM MOBILE PHONE

6.1 ASSEMBLING GSM PHONE

A GSM phone can be assembled if you have following components.

- ❑ Printed circuit board (PCB) for phone
- ❑ A liquid display (LCD) panel
- ❑ A keyboard
- ❑ Microphone
- ❑ Speaker
- ❑ Battery
- ❑ Plastic body/Cover of phone
- ❑ Battery connector
- ❑ Sim card slots and Sim card connectors
- ❑ Vibrator and vibrator connector
- ❑ Charging tips
- ❑ Ringer component
- ❑ Camera

The circuit board is the heart of the system. It contains most of the inbuilt components like jacks for camera, speaker, microphone, keypads that connect the device directly through pins when placed at correct position. Follow these steps to assemble your phone, once all required components are gathered.

1. Place camera on its slot in plastic body.
2. Fix speaker and microphone at positions.
3. Fix vibrator on vibrator connector.
4. Place Sim card tip in its place in the body of phone.
5. Fix key board is slot above PCB.
6. Now place the Display panel on the PCB and fix it by pressing softly.
7. Check that each components are touching their tips on the PCB.
8. Fix the board in phone body using screws and tight them.
9. Close the upper cover softly by fixing the jacks in place.

10. Place Battery in the battery socket and fix it properly.
11. Close the back cover over battery.
12. Test by charging with battery charger.

6.2 HOW TO OPEN AND DISASSEMBLE A MOBILE CELL PHONE

6.2.1 Tools to Open and Disassemble Mobile Phone

Before proceeding to open and disassemble a mobile cell phone, make sure you have all the required tools for mobile phone repairing. The tools you will need are:

1. T4, T5 and T6 Precision Screwdriver. A screwdriver set or kit can be very useful. These screwdrivers must have magnetic tip to hold the screws so that you don't lose them.
2. Mobil Phone Opener
3. Tweezers
4. Antistatic Wrist Strap
5. Antistatic Hand Gloves
6. Antistatic or ESD-Safe Mat
7. ESD-Safe Apron
8. ESD-Safe Footwear

6.2.2 How to Open and Disassemble Android Smartphone

1. Remove the back cover carefully. Most people use their nails for this but you should always use a mobile phone opening tool. Modern smartphones have Fingerprint sensor and Antenna Connector attached to the back cover. So, be careful or you will damage these connectors.
2. Remove the Battery. Removable batteries are easy to remove. But if your Android Smartphone has a Non-Removable Battery then it is connected to the Board with a Connector. Remove this connector first. The non-removable batteries are glued at the bottom with a double-sided tape. Carefully remove this tape and the battery will easily come out.
3. Remove the SIM card and memory card.
4. You will find several small screws at the back. Using suitable precision screwdriver, unscrew and remove all the screws and keep them in a safe box. These screws must be kept very carefully so that they do not get lost.

5. Once all the screws are open, remove the front cover or the front Facia of the smartphone.
6. Now you have the internal Facia or skeleton of the mobile phone. It is attached to the mobile phone PCB with screws. Modern Android Smartphone and iPhone have 2 to 3 PCBs connected to each other using connectors. These PCBs are from different Sections of Mobile Phone – Network Section, Power Section and Audio Section. Unscrew and open all the screws.
7. Remove connectors for display and camera and pull the display and the camera out.

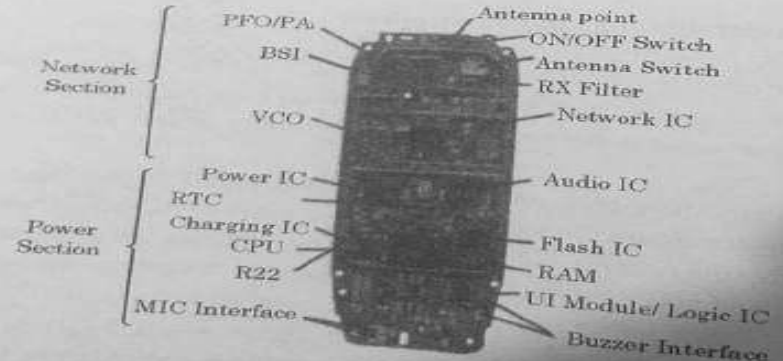
NOTE: *Modern smart phones have too many connectors that can break or get damaged very easily. So, be very careful when opening and disassembling them.*

6.3 MOBILE PHONE SECTIONS AND PARTS IN EVERY SECTION

Mobile Phone Sections : A Mobile Phone PCB is divided into 3 Main Sections –

(1) Network Section
(2) Power Section
(3) Audio Section (*in Android Smartphone and iPhone*).

This is applicable to all Mobile Phones and Smartphones of All Brands including – Samsung, Nokia, LG, Motorola, Sony Ericsson, Acer, Alcatel, Apple, Amoi, Asus, BenQ Siemens, Bird, Blackberry, Blu, Celkon, Dell, Gigabyte, Haier, HTC, Huawai, Micromax Panasonic, Philips, Sagem, Spice, Toshiba, ZTE Etc.



NOTES:

1. **UEM=** logic IC + Change IC + Audio IC + Power IC
2. **PFO=** Antenna Switch + PFO
3. **Flash IC =** RAM + Flash IC

Fig. 6.1 : Mobile Phone PCB Diagram

Now, these Broad Sections can again be divided in Several Small Sections for Easy of Understanding. Let us understand these All These Sections in Detail and Electronic Components and IC Parts Present in these Sections and Their Function.

1. **Keyboard or Keypad Section:** The keyboard section of any mobile cell phone is directly connected with the CPU. This means that rows and columns of keys are directly connected with the CPU. Protector IC or Interface IC or Varactor diode is connected in the row or column line for the protection of key section. In modern mobile cell phones which have qwerty keys, a separate control IC is connected with the CPU for extra protection to the keys.

Fig. 6.2

In Latest Android Smartphones and Apple iPhone, there is No Physical Keypad. The Keys are Displayed and Controlled by the Operating System (*OS*) and Apps. These Virtual Keys on the Display are Controlled by a Touch Screen Connected Separately to the PCB / Logic Board.

2. **Display Section:** The display section is directly connected with the CPU to receive following signals – LCD Data Signal, LCD Reset Signal, LCD WR Signal, LCD RD Signal, LCD FLM Signal, LCD HSYN Signal etc. These signals are given to the LCD Module through the CPU. 2.8V power supply or 1.8V power supply is given to the LCD for functioning. LCD signal interface filter are connected in many mobile cell phones for interfacing these signals of LCD Module.

3. **SIM Card Section:** The SIM Card Interface section is directly connected with the CPU in most mobile cell phones. If there is no power supply in a mobile phone then the SIM section is connected with the CPU through the Power IC. Mainly V-SIM (*3.0V*), SIM-RST (*2.85V*), SIM CLK, SIM-Data (*2.5V*), and SIM GND are made in the SIM Section. These four pins (*Beside SIM GND*) are directly connected with the SIM interface / control section and V-SIM volt are given to the SIM data pin from V-SIM pin through the 10-18 Kilo Ohms Resistance.

4. **Memory Card Section:** Now mostly Micro SD Card is connected in most mobile cell phones which is connected with micro card section through a 8 pin socket. Memory card section is made inside the CPU. Descriptions of these 8 pins are as follows:

1. MMC-Data-2
2. MMC Data
3. MMC CMD (*Command*)
4. VMMC / VSD (*Positive Supply Pin*)
5. MMC-CLK
6. GND
7. MMC-Dta0
8. MMC Data-1

2.8 Volt Power is supplied to Pin Number 4 from Power Supply for functioning of the MMC Card and connection the 50 tp 100 Kilo Ohms resistance in this power supply. This power supply is given to Pin Numbers – 1, 2, 3, 7, 8 of MMC Socket. One MMC detector switch or pin is made in MMC socket at which, if there is no MMC Card then 1.8 V power is continuously received and after the MMC is connected, it becomes zero.

5. **MIC Interface Section:** MIC interface section is directly connected with the CPU in most mobile phones. Working voltage (*MIC Bios*) (*1.8 to 2.8 V*) is supplied from the CPU or the Power Supply Section for functioning of the MIC and MIC Positive and Negative Volt are input through two SMD Capacitors.

6. **Ear Speaker Section:** In most modern mobile cell phones, in which there is a separate ear speaker, it is directly related to the CPU. It receives sound via signals directly from the CPU or from the audio section inbuilt within the CPU. In some mobile phones, these sound signals are received via SMD Coil / SMD Resistance. Some mobile phones have audio IC in the audio section. Some mobile phones have audio amplifier.

7. **Speaker / Ringer Section:** Ringer, Buzzer or Speaker in most mobile phones are connected with the audio amplifier IC to obtain loud sound. The amplifier IC amplifies the sound or audio signal received from the CPU of the audio section.

8. **Key Backlight Section:** LED Lights are connected according to the parallel circuit in the key backlight section. Anode ends of all the LEDs are connected to each other and all the cathode ends are connected to each other. 3 to 3.3 V is supplied for the functioning of these Key LED Lights. This power supply is given to the cathode ends of LEDs from the ground ends. Power supply to the anode ends of LED Lights is controlled bu using LED-Driver or PNR IC.

9. **LCD Backlight Section:** LCD Backlight in mobile cell phones is made according to the series circuit. A Boost Voltage Generator Section is built for the supply of high voltage (*10 to 18V*) for the functioning of the LCD LED. Boost coil, Boost Volt Driver IC, Rectifier Diode etc are present in this section.

10. **Vibrator Motor Section:** Positive power supply is given to this section directly from the positive end of the battery. Negative power supply is given through a NPN transistor or from the ground of any circuit.

11. **Network Section:** Antenna, External Antenna Socket, RX-Band Pass Filter, RF Crystal, FEM, PFO, TX-Band Pass Filter, RF IC, CPU are connected in the Network Section. Signal received at the antenna during the RX is given to the antenna switch or FEM through the antenna socket where the next processing is completed by selecting a frequency of proper band and is passed on to the RF IC through RX-Band Pass Filter. RF Signal out from the RF IC during TX is given to the FEM or PFO to amplify the signal. After the Band Selection Process the signal is passed through the antenna.

12. **Battery Charging Section:** Charger and system interface connector is made together in most modern mobile cell phones. Regulator section is made separately for the battery charging section. In some mobile phones, the battery charging section is made inside the Power IC.

13. **FM Radio Section:** FM Radio Driver IC, FM Antenna, Signal and Supply Components are made in the FM Radio Section.

14. **Bluetooth Section:** Bluetooth Antenna, Bluetooth RF Signal Filter, Bluetooth Driver IC, Supply and Signal Components are made in this section. The Bluetooth sections functions like the Network Section. RF-CLK signal is given to the Bluetooth driver IC during signal processing.

15. **Set Power ON:** Power IC, CPU (UCP), Flash IC, RF-CLK, Crystal, RF-IF, PWR Ket etc components are present this section. Battery positive supply is given to the power IC and connecting the battery (3.7V) from 2.87 to 3.0 Power ON Volts are received at one tip of the Power Key. Supply is given to the CPU, Flash IC, RF-CLK, Generator Section (RF Crystal, RF IC) by which the mobile phone gets switched ON.

16. **Hands-free / Earphone Section:** Mainly hands free jack, hands free MIC, speaker signal component and hands free audio amplifier are present in this section. Hands free symbol is displayed after connection the Hands free jack.

6.4 BIG PARTS OF A MOBILE CELL PHONE AND THEIR FUNCTION

1. **Antenna Switch:** It is found in the Network Section of a mobile phone and is made up of metal and non-metal. In GSM sets it is found in white color and in CDMA sets it is found in golden metal.
   Work / Function: It searches network and passes forward after tuning.
   Faults: If the Antenna Switch is faulty then there will be no network in the mobile phone.
2. **P.F.O:** It is found near the Antenna Switch in the Network Section of the PCB of Mobile Phone. It is also called P.A (*Power Amplifier*) and Band Pass Filter.
   Work / Function: It filters and amplifies network frequency and selects the home network.
   Faults: If the PFO is faulty then there will be no network in the mobile phone. If it gets short then the mobile phone will get dead.
3. **RF IC / Hagar / Network IC:** This electronic component found near the PFO in the Network Section of a Mobile Phone. It is also called RF signal processor.
   Work / Function: It works as transmitter and receiver of audio and radio waves according to the instruction from the CPU
   Faults: If the RF IC is faulty then there will be problem with network in the mobile phone. Sometime s the mobile phone can even get dead.
4. **26 MHz Crystal Oscillator:** It is found near the PFO in the Network Section of a Mobile Phone. It is also called Network Crystal. It is made up of metal.
   Work / Function: It creates frequency during outgoing calls.
   Faults: If this crystal is faulty then there will be no outgoing call and no network in the mobile phone.
5. **VCO:** It is found near the Network IC in the Network Section of a Mobile Phone.
   Work / Function: It sends time, date and voltage to the RF IC / Hager and the CPU. It also creates frequency after taking command from the CPU.
   Faults: If it is faulty then there will be no network in the mobile phone and it will display "*Call End*" or "*Call Failed*".
6. **RX Filter:** It is found in the Network Section of a Mobile Phone.
   Work / Function: It filters frequency during incoming calls.
   Faults: If it is faulty then there will network problem during incoming calls.
7. **TX Filter:** It is found in the Network Section of a Mobile Phone.
   Work / Function: It filters frequency during outgoing calls.
   Faults: If it is faulty then there will network problem during outgoing calls.

15. **Logic IC / UI IC:** It is found in any section of a mobile phone. It has 20 pins or legs. It is also called UI IC and Interface IC.

    Work / Function: It controls Ringer, Vibrator and LED of a mobile phone.

    Faults: If Logic IC / UI IC is faulty then Ringer, Vibrator and LED of mobile phone will not work properly.

16. **Audio IC:** It is found in Power Section of a mobile phone. It is also called Cobba IC and Melody IC.

    Work / Function: It controls Speaker and Microphone of a mobile phone.

    Faults: If Audio IC is faulty then Speaker and Microphone of a mobile phone will not work and the set can even get dead.

6.5 TESTING OF VARIOUS MOBILE PARTS

You will need following mobile phone repairing tools:

1. Multimeter
2. DC Power Supply

Ringer of a Mobile Phone: To check if the ringer of a mobile phone is faulty or damaged, keep the multimeter in buzzer mode and check the ringer. Value must be between 8 to 10 Ohms. If the value is between this range then the ringer is good and does not need replacement. If the value on multimeter is 4-5 or 12-14 then change the ringer.

Vibrator or Motor of a Mobile Phone: To check vibrator or motor of a mobile phone, keep the multimeter in Buzzer Mode and check the vibrator. Value must be 8 to 16 Ohms. If the value is between 8-16 Ohms then the vibrator is good. Otherwise change it.

Speaker or Earpiece of a Mobile Phone: Check the speaker / earpiece with a multimeter on Buzzer mode. Value must be in the range of 25 to 35 Ohms. If the value is in this range then the speaker / earpiece is OK and need not be changed. Otherwise, change the speaker / earpiece.

Microphone or Mic of a Mobile Phone: Keep the multimeter in buzzer mode and check the microphone. Value reading on the multimeter must be in the range of 600 to 1800 Ohms. There will also be a Beep or Buzz sound from the multimeter.

Keypad of a Mobile Phone: Keep the multimeter on Buzzer mode and check Rows and Columns or the Key Pad. If there is Beep or Buzz sound from the multimeter then Keypad is ok, otherwise it is faulty.

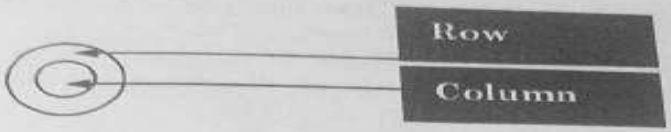


Fig. 6.3

Battery Connector: Keep multimeter on 20V DC and check. Value must be 1.5 to 3.5 V DC.

Battery: Check voltage with a multimeter. Keep multimeter on 20V DC and check. Value must be 3.7 V DC or above.

ON / OFF Switch: Check voltage with a multimeter. Keep multimeter on 20V DC and check. Value must be between 2.5 to 3.7 V DC.

NOTE: *Please note that only one side of the microphone will show value. If we check by reversing the Red and Black Probes / Test Leads of the multimeter and check the microphone then there will be no value.*

6.6 TESTING OF ELECTRONIC COMPONENTS

Coil: Check the SMD coil with a multimeter on Buzzer Mode. If it is good then it the multimeter will give a Beep or Buzz sound. If there is no sound then the coil is faulty. Replace it with a new one.

Resistor or Resistance: Check it with a multimeter on Buzzer Mode. If it is good then the multimeter will give a Beep or Buzz sound. If there is no sound then the SMD resistor is faulty. Replace it with a new one.

Capacitor: To check SMD Capacitor with a multimeter on Buzzer Mode. If it is good then the multimeter will NOT give any Beep or Buzz sound. If there is sound then the capacitor is faulty. Replace it with a new one.

Diode: Check it with a multimeter on Buzzer Mode. If it is good then the multimeter will NOT give any Beep or Buzz sound. If there is sound then the diode is faulty. Replace it with a new one.

LED: Keep the multimeter in Buzzer mode and check the LED. If the LED is good then they will glow otherwise not.

Coil and Boosting Coil: Check for continuity. If there is continuity then the coil or the Boost Coil is good otherwise it is faulty.

Network IC: Use a Analog DC Power Supply to check Network IC. Switch ON DC Power Supply and call any number from your mobile phone. The Needle of the DC Ampere will start moving. This shows that the Network IC is OK and not fault.

Power IC and CPU: Adjust voltage of the DC Power Supply to 4.2. Place the Red Probe / Test Lead of the DC Power Supply to the "+" of the Battery Connector of the mobile phone and the Black Probe / Test Lead to "–":

1. If DC Ampere is over 6 then Power IC or CPU is damaged. Check by replacing Power IC and the CPU one by one.
2. If there is no movement of the Ampere Needle of the Power Supply then the Battery connector, On / OFF Switch Track, RTC or Network Crystal is damaged. Give heat to these components using hot air blower. If the problem is not solved then check by replacing them one by one.
3. If the Ampere Needle fluctuates below 2 ten there could be problem with software or RTC (*Real Time Clock*).
4. If the Ampere needle stands at some fixed point then there is problem with the Flash IC.
5. If there is beep sound from the DC Power Supply then there is problem with "+" and "–" or the mobile handset is short.

NOTE: *When checking a faulty mobile phone with DC Power supply, connect the* ***Red*** *Probe to "+" and* ***Black*** *Probe to "–" of the Battery Connector of the Mobile Phone.*

6.7 METHODS OF TESTING FOR FAULT FINDING OF MOBILE COMPONENTS

There are 2 Main Mobile Phone Repairing Testing Methods

1. **Cold Testing Method:** When we check the value of Resistance Using a Multimeter at the time of mobile repairing and fault finding, it is called cold testing. There is no need to give any power supply to the faulty mobile phone from any equipment such as DC Power Supply or Battery during Cold Testing.

Diode Range and Beep Sound from the Multimeter is used to find fault in a mobile cell phone using the cold testing method of mobile phone repairing. In this testing method, the **RED Probe** of the multimeter is connected to the **Ground** of the Mobile Phone PCB and the **BLACK Probe** is touched at the **Testing Points** of the Mobile Phone.

During the fault finding and repairing process of each part, SMD Electronic Component or Mobile Phone Section, following correct values will be received:

1. **Ear Phone Connector Tip (+ , -):** .500 to .700

2. **Loud Speaker / Ringer Connector Tip (+,-)**: .300 to .600
3. **Battery Connector Tip (+)**: .400 to .500
4. **Battery Connector Tip (*Sense*)**: above .800
5. **Display Connector Supply Pins**: .250 to .400
6. **Display Connector Signal Pins**: .500 to .800
7. **Camera Connector Supply Pins**: .250 to .400
8. **Camera Connector Signal Pins**: .600 to .900
9. **Key Tip (Row and Column)**: .400 to .800
10. **Charger Connector Tip**: .600 to .700
11. **Vibrator Motor Connector**: .40 to .500
12. **Power ON / OFF Switch Point (+)**: .600 to .900
13. **MIC Connector Tip (Analog MIC) (+,-)**: .700 to .900
14. **Battery Charging Out Point (+,-)**: .300 to .400
15. **SIM Card Connector Pin 1 (VSim)**: .500 to .700
16. **SIM Card Connector Pin 2,3,6**: .400 to .800
17. **SIM Card Connector Pin 4 (GND)**: .00 (Beep)
18. **Micro SD Card Connector Pin 4**: .500 to .600
19. **Micro Card Connector Pin 6 (GND)**: .00 (Beep)
20. **Micro Card Connector Pin 1,2,3,5,7,8**: .600 to .800
21. **RTC**: .400 to .500
22. **Data RX and TX Pins**: .600 to .700

2. **Hot Testing Method:** This is the second method of fault finding and repairing any mobile cell phone. Hot testing method is used when the fault cannot be found or when the phone cannot be repaired using the Cold Testing Method.

In this Process, VOLTAGE of damaged part, component or section of a mobile phone is checked. The fault is found by giving Power Supply to the mobile phone with a Battery OR DC Power Supply.

In this method, DC V (*DC Volt*) range of the Multimeter is selected. The **BLACK Probe** of the multimeter is connected with the **Ground** of the Mobile Phone PCB and the **RED Probe** is touched at the **Testing Points**.

During Hot Testing method, Voltage of different part or sections should be as follows (*All Values in Volt*):

1. **Ear Phone Connector Tip (+ , -) during working**: .0 to 2.5
2. **Loud Speaker / Ringer Connector Tip (+,-) during working**: .0 to 2.5

3. **Battery Connector Tip (+)**: 3.7
4. **Display Connector Supply Pins**: 1.8 to 2.9
5. **Display Connector Signal Pins During Working**: .0 to 1.8
6. **Camera Connector Supply Pins**: 1.8 to 2.9
7. **Camera Connector Signal Pins During Working**: .0 to 1.8
8. **Key Tip (Row and Column) One Side**: 1.8 to 2.8
9. **Charger Connector Tip**: 5 to 6
10. **Vibrator Motor Connector Tip During Working**: 1.9 to 3.6
11. **Power ON / OFF Switch Point (+)**: 3 to 3.6
12. **MIC Connector Tip (Analog MIC) (+,-)**: 1.8 to 3.0
13. **Battery Charging Out Point (+,-)**: 3.7 to 4.2
14. **SIM Card Connector Pin 1 (VSim) When SIM Connected**: 1.8 to 3.0
15. **SIM Card Connector Pin 2,3,6 During Working**: 0 to 2.8
16. **Micro SD Card Connector Pin**: 2.8
17. **Micro Card Connector Pin 1,2,3,5,7,8**: 0 to 2.8
18. **Data RX and TX Pins**: 1.8 to 2.8

(***All Values in Volt***)

EXERCISES

(A) VERY SHORT ANSWER TYPE QUESTIONS

1. The ... is heart of the mobile phone system.
2. Name a tool to open mobile phone.
3. Name various sections of mobile phone.
4. How many pins are there in memory card section?
5. What happens if antenna switch in a cell phone is faulty?
6. What is the function of P.F.O.?
7. What is the function of Flash IC?
8. Where does VCO found?
9. What happens if RAM of a mobile is faulty?
10. What is the effect of faulty ROM on a mobile phone?

(B) SHORT ANSWER TYPE QUESTIONS

1. Write the need of components for assembling a mobile phone.
2. Write steps for assembly a mobile phone.
3. What tools are required to disassemble a mobile phone?
4. Write steps to disassemble mobile phone.
5. Write steps for testing a mobile phone.
6. Discuss methods of fault finding in cell phones.
7. Explain Hot testing method of mobile testing.

(C) LONG ANSWER TYPE QUESTIONS

1. Explain assembling of GSM mobile phone in brief.
2. How will you disassemble a GSM phone? Explain.
3. Explain various sections of mobile phone.
4. Explain testing of electronic components in a mobile phone.
5. Discuss Cold testing and Hot testing in brief.