Page NO.

1. 1 to 98 – Mid Term + Final Term
2.

MD IFTAKHAR KABIR SAKUR

25th BATCH

COMPUTER AND COMMUNICATION ENGINEERING

International Islamic University Chittagong

COURSE CODE: CCE-3607

COURSE TITLE: Cellular Mobile Communication

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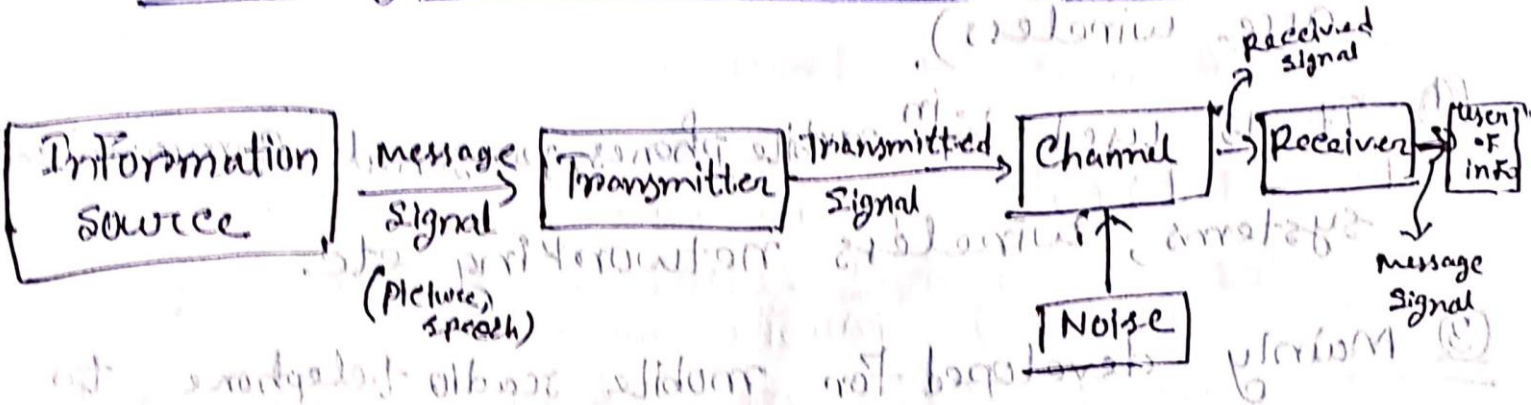
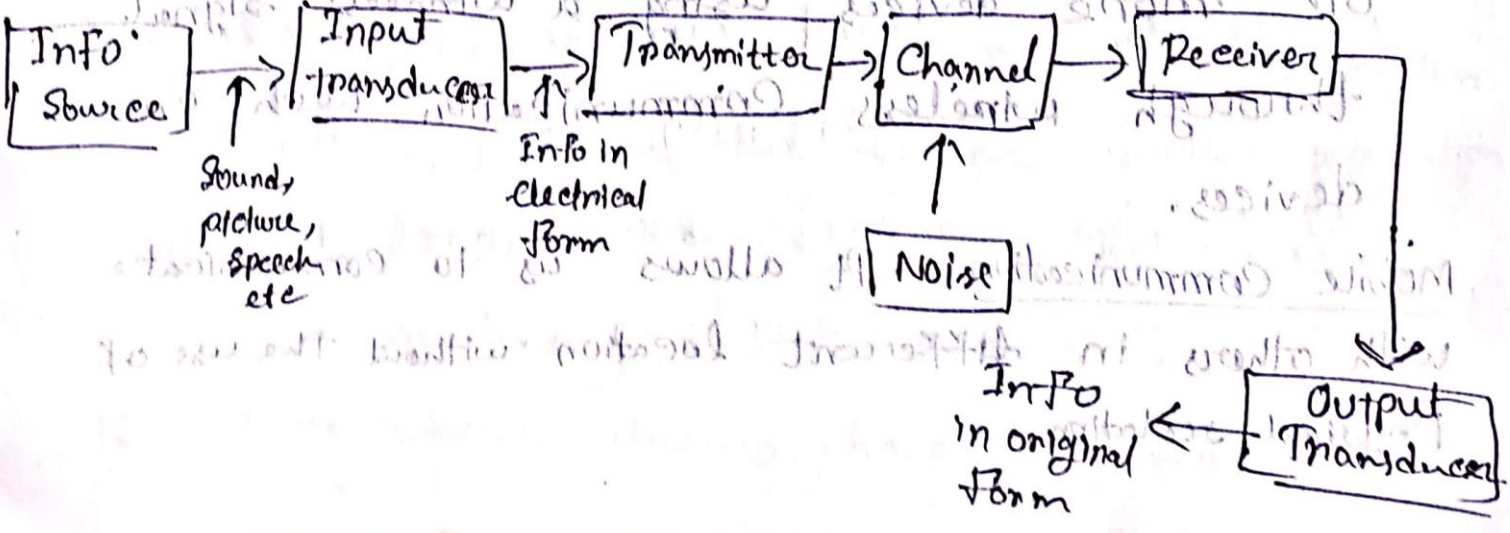
CCE 3607.
Cellular Mobile Communication

Block diagram of communication System:-



Elements of basic Communication System:-

- Information or input signal
- Input transducer
- Transmitter
- Communication channel or medium
- Noise
- Receiver
- Output transducer



Concept of cellular Network:-

① No any wired link. (Both sender & receiver are wireless).

② It is used in mobile phones, personal communication systems, wireless networking etc.

③ Mainly developed for mobile radio telephone to replace high power transmitter/receiver systems.

④ Uses lower power, shorter range & more transmitters for data transmission.

⑤ It don't need any electrical wires, cables or any other forms of electrical conductors.

⑥ It is a broad term that allows two or more devices using a wireless signal through wireless communication tech or devices.

Mobile Communication:- It allows us to communicate with others in different location without the use of physical relation.

A mobile phone: It is a full duplex two way radio telecommunication over a cellular network of base stations known as cell site.

It is the most use tech since 1980s.

Development of Cellular Communication:-

First proposed in 1940. Deployed in 1980 that the radio technology & systems were deployed to enable widespread availability.

In 2011 there were more wireless phone calls were made using wireless than wired phones.

Back in 2004 GSMA announced in Mobile world congress (February) that there were more than 1 billion GSM mobile subscribers.

Then by 2015 there were more than 7 billion subscriptions while the entire earth's population was just more than 7 billion. That means a person was having multiple subscription.

The place where wireless phone reached in 12

years; it took 100 years for wired telephone.

Cellular Telecommunications Generation:

1G
1G → 1979 → Mobile voice
2G → 1991 → Mobile voice
3G → 2001 → Mobile Broadband
4G → 2009 → Mobile Broadband
5G → 2020 (expected) → Ubiquitous, Connectivity

Features of cellular systems:-

→ Offer very high capacity in a limited spectrum
→ Reuse of different radio channel in different cells.
→ Enables a fixed number of channels to serve arbitarily large number of users by reusing that channel throughout the coverage area/region

→ A Communication always happens between mobile to base-station not between mobile to mobile.

→ Each cellular base station is allocated a group of radio channels within a small geographic area called a cell.

→ ~~Negi~~ Neighbouring groups are assigned different channel group.

→ By limiting the coverage area to within the boundary of the cell, the channel groups may be reused to cover different cells. (coverage area কমিয়ে boundary cell এর মধ্যে channel group গুলো use করে হবে পাশের cell cover এর জন্য)

→ Keep Interference levels within tolerable limits.

→ Frequency reuse or Frequency planning.

→ Organization of wireless cellular Network.

→ Cellular network is organized into multiple low power transmitters each 100 w or less.

Key Cellular Communications Concepts:-

Cellular Communication technology is based on the concept of using a large number of base stations each covering a small area or cell.

A cellular communications system has a number of different areas, each of which performs a different function. The main areas detailed below are the main ones that are normally referred to when discussing cellular communication systems. Each of these areas can often be split much further into different entities.

Cellular Communication:- (A mobile phone is a bidirectional radio (sends and receive signals) form of communication that enables the use of mobile phone. There is a limited number of frequencies in a cell. Cell is the thing which is known as coverage area. Cellular communication is based on geographic devision coverage area into cells and within cells. A large number of subscribers use

this limited frequency.

Mobile Handset or user equipment, UE :-

The equipment or mobile that a person or user sees in communications systems. It connects to the network and enables the user to access voice and data services. User can use this system on the laptop or PC using wireless equipment or installed system. The biggest use of it is in IOT. In IOT user can control equipment from a distance & can do the things they are cherishing.

Radio Access Network, RAN :-

It's periphery of the cellular communications system. It provides the link to the user equipment from cellular network. It comprises a number of elements and broadly includes the base station and base station controller. With cellular communications technology advancing, the terms used and

exactly what they contain is changing, but basic function remains as same

Core Network:

Hub of the cellular communication system. Manages overall system, storing user data, manages access control, links to the external world and provides a host of other functions.

Features of wireless Communication:-

→ Transmitted distance can be anywhere between a few meters.
(Television's remote control)
and thousands of kilometers (radio communication)

→ Can be used for cellular Telephony, wireless home networking, wireless access to the internet and so on.

→ Also used in GPS units, garage door openers, wireless computer mice, keyboard & headsets, radio receivers, satellite Television, etc.

Wireless - advantages :-

① Cost effectiveness :- Don't need wires. In wireless As a result cost is reduced. Any company providing wireless service don't need much money to spend. So, the service is cheap.

② Flexibility :- Can be accessed from any place in anytime. Don't need to be in the Telephone booth, office or any specific place to receive & send messages.

③ Convenience :-

Wireless communications services can also be seen in Internet tech. such as wi-fi. With no network cables hampering movement, we can now connect with almost anyone, anywhere, anytime.

④ Speed :- Speed is more than wired system. A wireless control of a machine can easily stop its working if something goes wrong, whereas direct operation can't act so fast.

⑤ Accessibility :- Can cover remote areas where ground lines can't be properly laid.

Example :- In rural region, online education is now possible.

⑥ Constant Connectivity :-

A wireless mobile can ensure you a constant connectivity though you move from place to place or while you travel.

Chapter - 02

Generation of Cellular Mobile Communication

G stands for Generation.

1G → 2.4 Kbps (1981)

2G → 64 Kbps and is based on GSM (1991)

3G → 144 Kbps - 2Mbps (1998)

4G → 100 Mbps - 1 Gbps is based on LTE Technology

5G → (2008)

History:-

Wireless journey started in 1979 from 1G.

2G technology was the major jump in the technology cause it went from Analog to Digital.

Cellular Network Evaluation:-

1G → 0 Data Transfer (1981)
→ (No on board storage)

2G → upto 40 Kbps (1991)
→ (No on board storage)

3G → upto 21.6 Mbps (1998)
[256 MB memory
16 GB Storage]

4G → upto 1Gbps (2008)
- 6GB Memory
- 256 GB Storage

5G → upto 20Gbps (2018)
- 8 GB Memory
- 512 GB Storage

1G (First Generation)

First generation of cell phone technology.
In the late 70s first commercial cellular network was introduced. was introduced by Telecom in 1987.
It was analog technology and the phones generally had poor battery life and voice quality was large without much security.
Sometimes experienced dropped calls.
Maximum speed was 14 Kbps.

1G Key Feature:-

→ First time calling way introduced
→ was analog ~~System~~ signals.
→ Used FDD ( ) scheme & allocated bandwidth of 25 Mhz.

→ Small coverage area.
→ NO roaming support between various operators
→ Low sound quality.
→ 24 Kbps speed.
→ Allows voice calls in one country.

Disadvantages :-

→ voice quality poor
→ poor battery life
→ Size of phone was very large
→ No security.
→ Capacity was limited.

2G Generation

2G Networks are digital. It implemented the concept of CDMA & GSM. ( )
provided SMS & MMS.
2G was commercially launched in GSM standard in Finland in 1991.
The features of 2G we still use today
(SMS, Intermall roaming, conference calls, call hold billing based on services charges based on

long distance calls & real time billing)

The max speed :- with GPRS (General packet Radio Service) is 50 Kbps or 1 MBPs.

Before moving to 3G the lesser know 2.5G & 2.75G was also introduced.

Key Features:-

→ From Analog to Digital
→ SMS & MMS
→ Supported Digital Cellular, Mobile data, PCS, WLAN
→ Moderate mobile data service
→ High Data rate & large area coverage
→ Speed : 64 Kbps.

Disadvantage:-

→ Couldn't handle video
→ Requires strong digital signals.

3G (Third Generation)

Introduced commercially in 2001. Web browsing, email, vide downloading, picture sharing and other smartphone technology were introduced in the third generation.

The goal was facilitate greater voice & data capacity, support a wider range of applications, and increase data transmission at a lower cost.

→ Utilises a new tech. UMTS (Universal Mobile Telecommunication System)

→ It combines 2G Net. & some other features with it to make a faster data rate.

→ IMT-2000 (International Mobile Telecommunications-2000) a union which standard the service of mobile phone. It standard the speed of 3G 200 kbps.

→ The UN's IMT-2000 standard requires stationary speeds of ~~2Mbps~~ 2 Mbps and Mobile speeds of 384 kbps. for a true 3G.

The theoretical max speed for HSPA+ is 21.6 Mbps.

Features:

→ Emailing
→ Packet switching rather than circuit switching like 2G
→ TV streaming, Mobile TV.
→ 3D Gaming
→ Faster communication
→ Web faster speed and more security
→ Connection used was UMTS, WCDMA.

Disadvantages:

→ Costly
→ Requirement of high bandwidth
→ Expensive for phones
→ Size of cell phones was very large

4G (Fourth Generation)

→ Came after 3G. Having more speed.

→ Provides:- High speed, High quality, High capacity to users while improving security & lower cost of voice and data services, multimedia and internet over IP.

→ Key tech:- (i) MIMO (Multiple input & Multiple output)
(ii) OFDM (Orthogonal Frequency Division Multiplexing)
(iii) WIMAX (has now fizzled out)
(iv) LTE (has seen widespread deployment.
↓
Long Term Evolution

LTE:- A series upgrades to existing UMTS tech. And will be rolled out existing 1800 Hz Frequency band.

→ While a 4G device moves the max speed is 100 Mbps. Or 1 Gbps. while walking or low speed moving.

→ 4G is not the same like 4G LTE.

→ To Download a new game or stream a TV show in HD, (without Buffering)

→ Newer generations devices are backward compatible.

4G Key Feature:

→ Was appeared 2010
→ Based on LTE, Mainly for Internet
→ IP based protocols.
→ VO-LTE for both voice and internet
→ Video Calling, real time language translation and video voicemail
→ HD quality streaming
→ Speed: 100 mbps
→ MAGIC → M → Mobile Multimedia
A → Anytime Anywhere
G → Global mobility support
I → Integrated wireless solution
C → Customized personal service

Disadvantage:

→ Uses more battery
→ Difficult to implement
→ Expensive equipment are required.

5G - Fifth Generation

- Still under development
- Faster Data rates
- better battery consumption, device-device communication
- Aimed to have 35.46 Gbps
- Massive MIMO, Milimeter wave Mobile communications
- Small cells, Li-Fi

Key Features:-

- Device to Device
- IoT (Internet OF Things)
- Faster Transmission Rate
- Connectivity will be more Fast & secure
- Data Latency will be reduced to a great level
- 30 times faster than 4G.

Lecture 3

How does a Mobile phone works.

→ Voice is picked by phone's mic. The mic turns the voice into a digital signal with the help of MEMS sensor and IC.

An antenna inside the phone is transmitting analog signal as 0s & 1s. using low & HIGH Frequency respectively.

→ But there a problem occur. Electromagnetic waves are not that capable of travelling long distances. they lose their strength due to the presence of physical objects, electrical equipment and some environmental factors

→ Even if there is no issues like that the wave can't carry on forever due to the earth's curved structure.

So, we use cell Tower to get rid from this.

Concept of cellular Technology:-

The geographical area is devided into hexagonal cells. Hexagonal shapes are perfect over square or triangular cell shapes in cellular architecture because it don't get overlapped with other cell.

And each cell has its own tower. (BTS).

And, the tower is connected through a wires or optical fiber cables. which are connected with National & International level connection.

How electromagnetic signals are reached to other?

=) Electromagnetic wave from phone picked by BTS of our cell → converting into HIGH Frequency ligh pulses → Light pulses carried to the Base Transceiver Box → voice signal routed toward destination Tower (via optical Fiber under ground/sea)

→ Receiving the pulses the destination tower radiates outwards in EMW → Receiver Phones receive the signal → Goes under reverse process → Receiver hear the voice

How Tower identifies which tower the EMW signal should be transferred :-

To get the Tower location cell Tower gets help from something called Mobile switching Tower. MSC is the central control for a group of cell Towers and database.

Mobile Switching Center : Home MSC and Foreign MSC :-

→ In the SIM Card, all the informations such as service plans, the current location, and your activity status.

→ The home MSC stores :

(1) Service plans
(2) The current location
(3) Activity status.

If going outside of the range than it would be then the new MSC will be known as Foreign MSC.

Foreign MSC <u>communicate</u> Home MSC

(1) The phone is registered temporarily

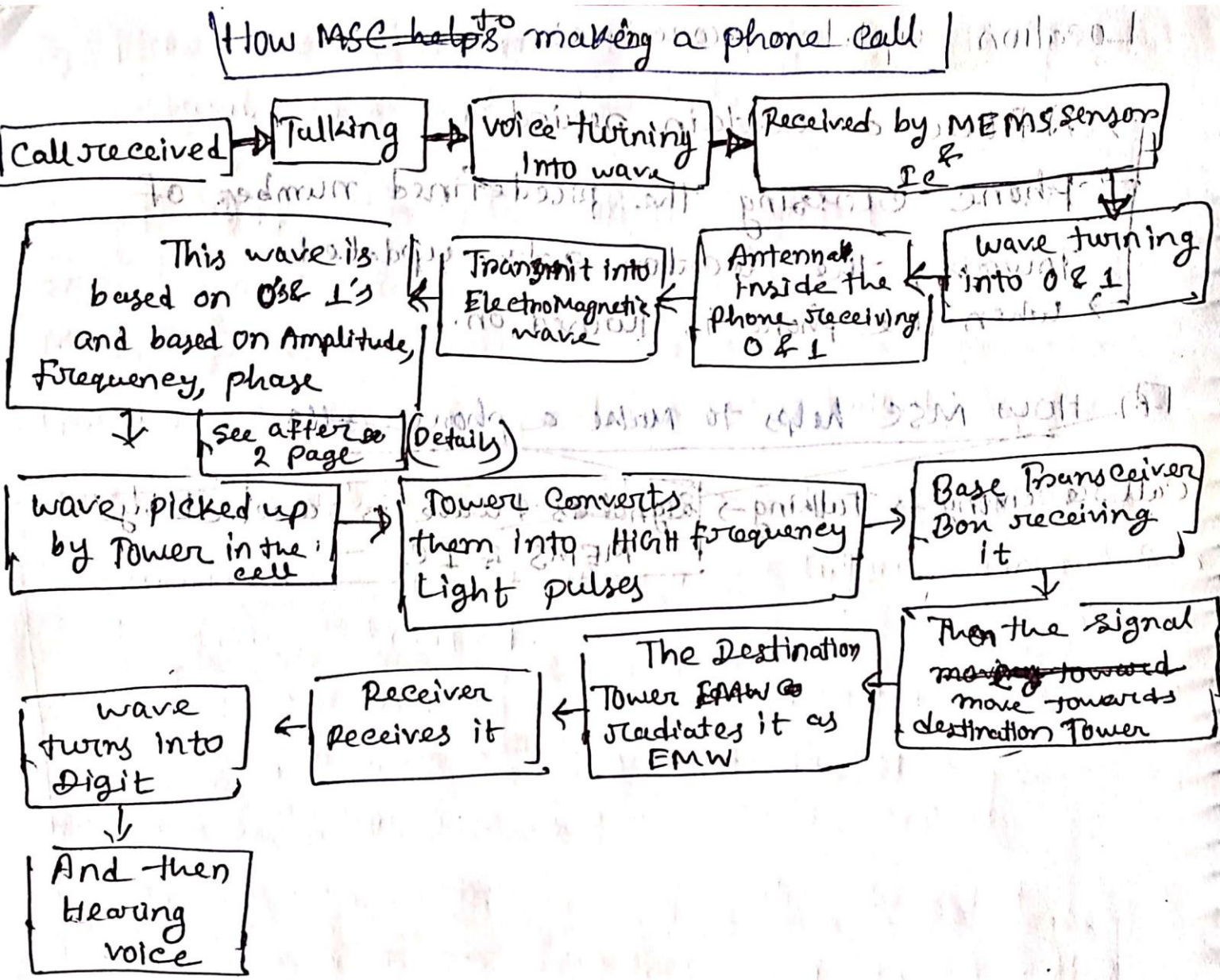
Location update procedure:-

→ After a certain period
→ Phone crossing the predefined number of towers, the location gets updated
→ When the phone is turned on.

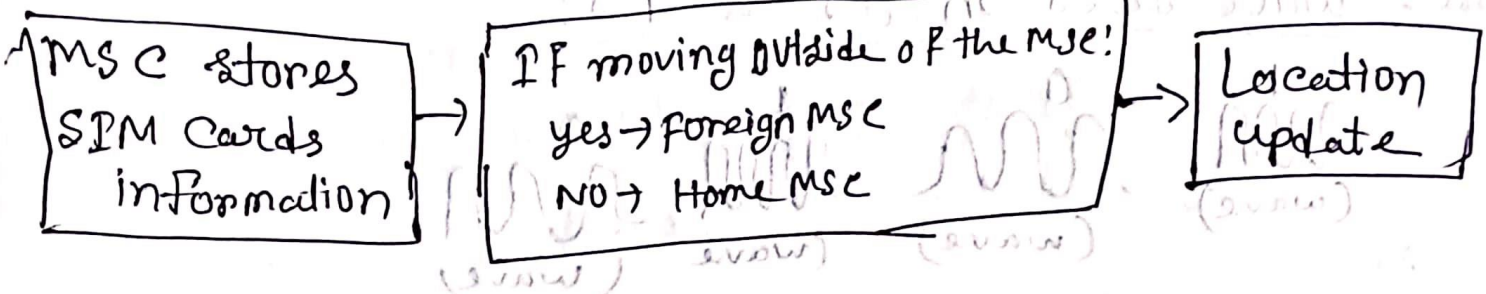
How MSC helps to Make a phone call:-

Call receiving → Talking → Signals & wave is received by MEMS & IC

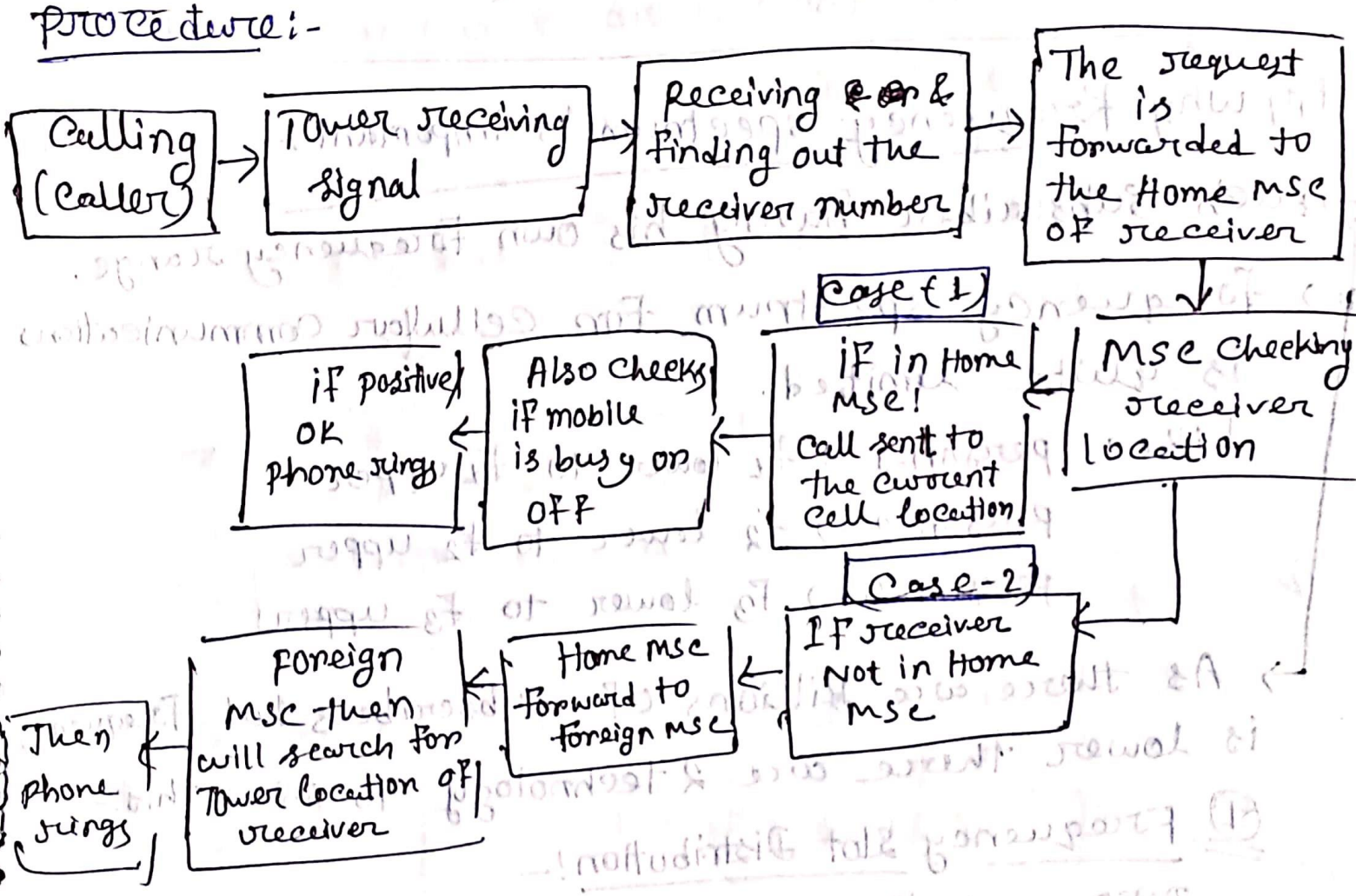
How MSC helps to making a phone call



How MSC Helps make a phone Call

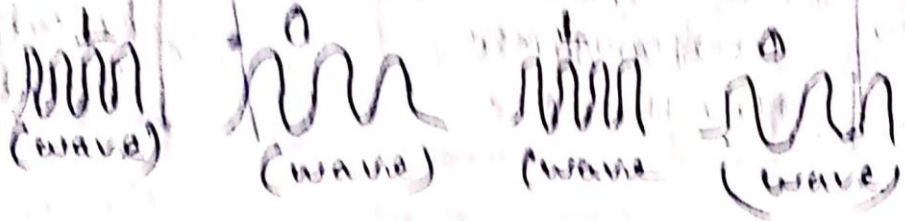


Procedure:-



* Details:-

Note:- wave based on gas & air:



(1) Why frequency spectrum is important:-

→ Each subscriber having his own frequency range.

→ Frequency spectrum for cellular communications is quite limited.

Like: person-1 → f_1 lower to f_1 upper
person-2 → f_2 lower to f_2 upper
person-3 → f_3 lower to f_3 upper

→ As there are billions of subscribers but frequency is lower there are 2 technology to solve this:-

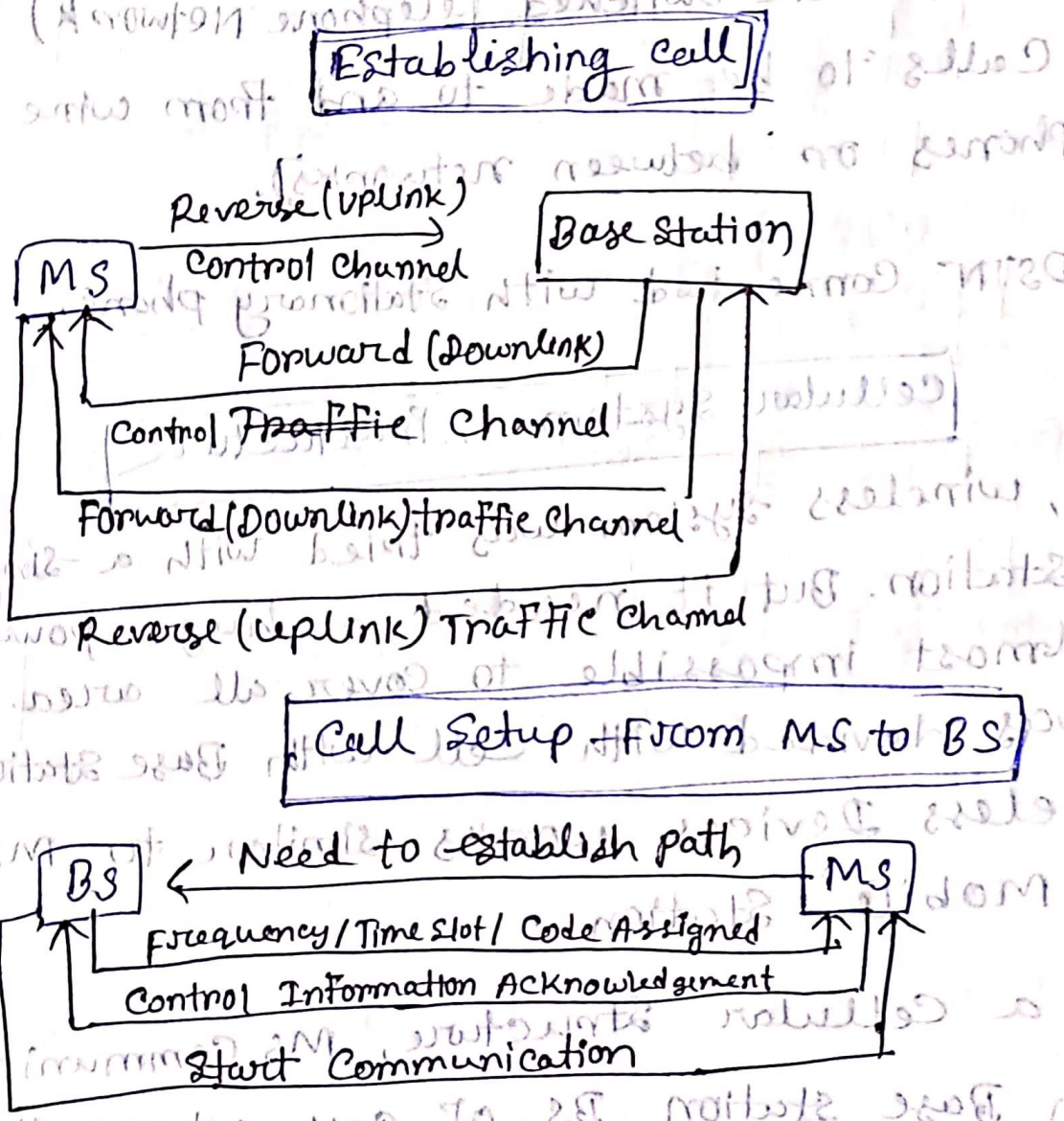
(1) Frequency slot Distribution:-
Different frequency slots are carefully allocated to different cell towers.

(2) Multiple Access Technique:-
Frequency distributed ~~by~~ ~~area~~ amongst all the active users. in the cell area.

* For frequency slot distribution the neighbouring cell towers are not allocating the same

frequency slot. This is done so that there is remains difference between two cell's Frequency. when moving to different cell there is a different ~~cell~~ Frequency will be allocated so that no call drops happen.

And this is known as Handoff or Handover.



Concept of Cellular Telephone System

~~Base Station Connected with Mobile Station~~

⇒ Mobile Station Connected with Base Station

⇒ Base Station Connected with Mobile Switching center

⇒ MSC is Connected with PSTN

[PSTN (Public Switched Telephone Network) helps Calls to be made to and from wire based phones or between networks].

⇒ PSTN Connected with Stationary phone..

Cellular System Infrastructure

⇒ Firstly, wireless system was tried with a single Base Station. But it needed a huge power & almost impossible to cover all area. Then it was devided with cell with Base Station.

⇒ Wireless Devices works similar to MS or Mobile Station.

⇒ In a Cellular Structure, MS Communicate with Base Station BS. OF cell where it it located.

BS is like a gateway to the rest of the world.

There might be several Base Station (BS) which are controlled by BSC (Base Station Controller) which are connected with MSC (Mobile Switching Center).

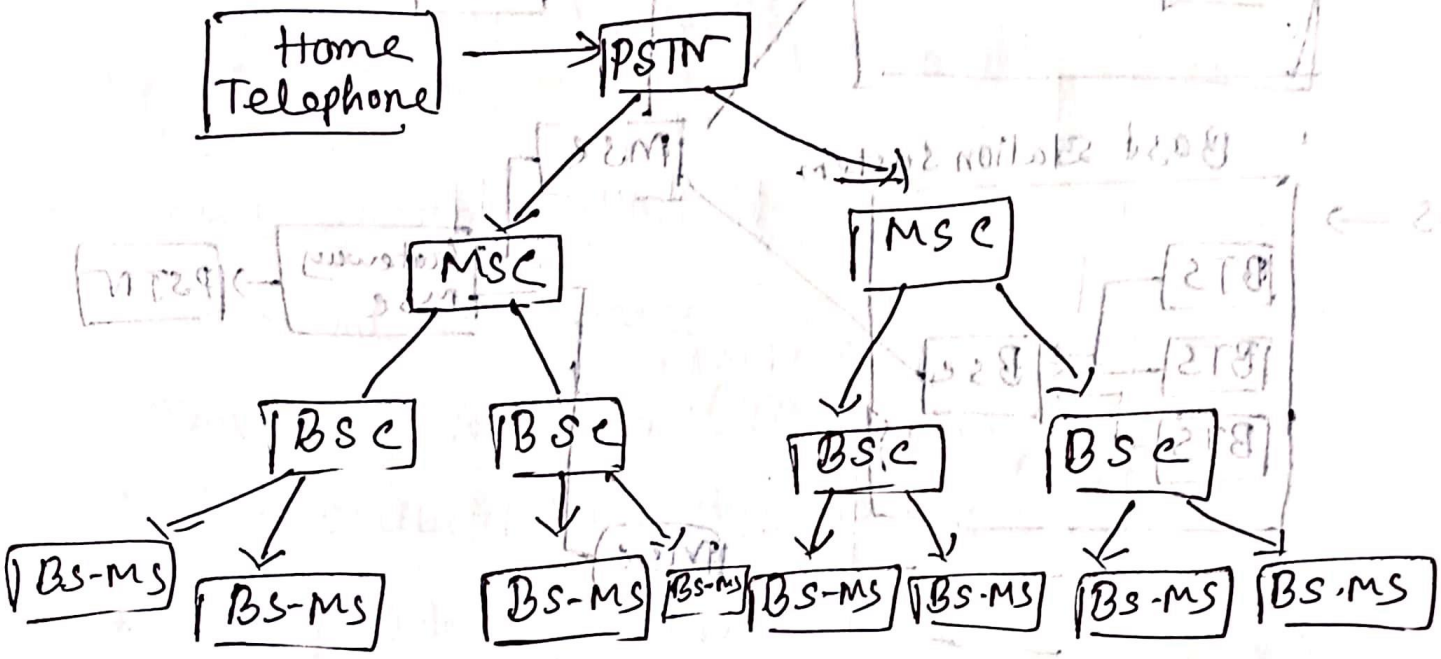
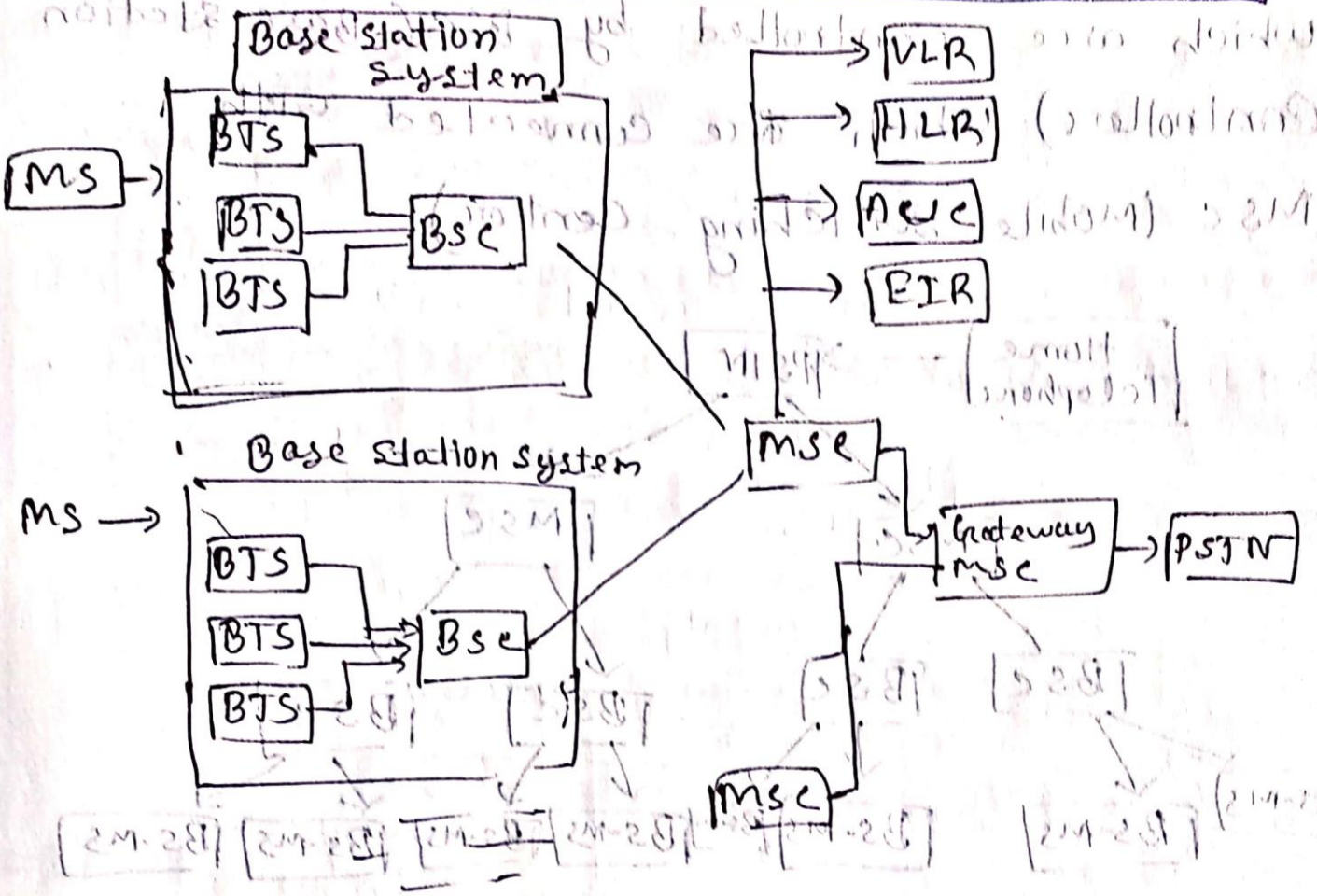


Fig:- Cellular System Infrastructure

Basic cellular Network Structure



VLR = Visitor Location Register

HLR → Home Location Register

AUC → Authentic center

EIR → Equipment Identity Register

PSTN → Public Switching Telephone Network.

Mobile Station (MS):-

Combination of user's all equipment (Mobile phone, SIM card..) & essential software for GSM network connectivity.

In GSM, MS consists of four main components :-

→ Mobile Termination (MT)
→ Terminal Equipment (TE)
→ Terminal Adapter (TA)
→ Subscriber Identity Module (SIM)

Subscriber Identity Module (SIM):-

Store data of cellular telephone subscriber. In here user identity, location, phone number, network Authorization data, Contact lists, personal security keys and otent message, Authentication & encryption etc.

Base Station (BS):-

Transmits & receives user data. It is connected to an antenna.

→ Fixed point of communication
→ Company specific.. One single site may have

multiple BS from multiple companies.

→ Different types:
  → Macrocells
  → Picocells

Base Transceiver Station (BTS):

Encryption used for data transmission between MS & BS.

→ Can encrypt & Decrypt.
→ Can Filter spectrum
→ Have antenna
→ Transceivers.
→ Duplexers
→ Amplifiers

Base Station Controller (BSC):

→ Controls BTS.
→ Allocates radio resources for mobile call.

Registration process:

→ Need for Authentication. All information of users are in needed.
→ The wireless system needs to know that if the user in home or foreign MSC
→ This helps incoming call with a route.

→ And desirable support for outgoing call.

→ And it is done by exchanging signal known as "Beacon Signal". between BS & MS.

→ This Beacon signal determines and test nearby MSs which is broadcasted periodically by BS.

→ MS listen to the beacon signals. If it hears from a new BS then it adds to the Beacon kernel table.

→ MS use this to locate nearest BS & use it with the outside world through the BS as a gateway.

→ This Beacon signal carries:-
- → Network identifier
- → TimeStamp
- → Gateway Address
- → Identification (ID)
- → Other parameters of the BS.

Steps are used by the MS's outside their own subscription area!

→ MS নতুন Beacon signal খুঁজে। পায়লে Active Beacon kernel Table এ রাখে। যদি device টা নতুন BS এর সাথে Connected হতে হয় তবে Handoff process follow করে।

→ MS কাছাকাছি থাকা BS কে খুঁজে বের করে

→ The visiting BS performs user level processing and determine who the user is. And the user's registered Home Site (MSC) for billing purposes, and what kind of permission the user has.

→ Home site BS ↑ HLR থেকে signal পাঠিয়ে currently যে BS আমাকে serve করছে তাকে। এবং এটা VLR এ জমা থাকবে। (HLR- BVLR pairs)

→ the BS approve - disapproves user access

Cell -> Lecture-4

Cell in wireless Communication:-

→ A geographical region that provides transmission facility.

→ Can be used in cellular Tech., Sattelite transmissions, Wireless Local Area Networks, packet radio, paging tech..

Cell work:-

→ Having different size. Can be a few dozen meters, thousands of km. in diameter. Depending on the tech. is used, Terrain Topography, The power of the transmission station.

→ Wireless Tech. are constantly evolving. So the cell sizes are approximate

→ Sattelite-based systems are getting popularity. In rural area cellular phone tech. typically use cells with radius 10 to 50 km. In urban area 1 to 10 km.

→ Can be 100 m in highly densed area.

Cell Radius measured by Tech.

WLAN → 10 to 100 meters

~~PAN~~

PCD (personal Communication Devices) → 0.1 to 1 km

Cellular Telephone → 0.1 to 50 km

Satellite-based → 1000 km or more

Pico-cellular Nets → 4-200 meter

Micro-cellular net → 200-2000 meter

Macro-cellular Net → 1-30 km

Decreasing cell size :-

→ User capacity बढ़ाना

→ per call a Handover बढ़ाना

→ Subscriber locate करने complex बढ़ाना

→ Lower power consumption.

→ Gives longer talk time

→ Safer operation.

Shape OF cells:-

Square:- Has neighbors at distance d and four at distance Root 2d

→ ভালো হবে যদি সকল Antenna সমদূরত্ব বজায় রাখে

→ নতুন Antenna. বুঁঝতে সহজ।

Hexagon:-

Highly recommended for easy & calculations. It

→ সম দূরত্বে Antenna provide করে

→ Center ও vertex হতে সম দূরত্ব

→ In between polygon or triangle Hexagon has the most area from center.

→ So, Fewer region or cells are enough to cover.

→ Can have BS in center or edge-excited cells.

→ NO overlapping, NO Gaps.

Hexagon for radio coverage:-

Cover the maximum area.

Cell in Hexagonal Shape:-

The process of selecting & allocating the frequency sub-bands for all of the cellular BS within a system. Is called Frequency reuse. It improve the spectral efficiency & Sound quality.

Frequency Reuse:-

Allocation & reuse of the channel happens in a region. Each cellular base station is allocated a group of radio channels or frequency sub-bands to be used within a small geographic area known as a cell.

The process of selecting and allocating the frequency sub-bands for all of the cellular base station within a system is called frequency reuse or frequency planning.

Secret / Silent Features:-

→ Good signal quality.

→ protection against interference

→ ~~Reusing the tolerance capacity~~

→ A frequency can be reused depends on the tolerance capacity.

→ Total Bandwidth (route of frequency) is de-divided into different sub-bands that are used by cells..

→ Communications within cell on given frequency.

→ Same frequency for multiple conversations.

→ 10 to 50 frequencies per cell.

Ex-2

In Advanced Mobile phone Services (AMPS), when

$K = 395$ & $N = 7$

$\therefore$ Average $395/7 = 56$ Hz (cell Frequency)

Formulae

S = Total Number of duplex channels available to use

K = Channel allocated to each cell ($k < s$) or (replicated)

N = Total number of cells or cluster size

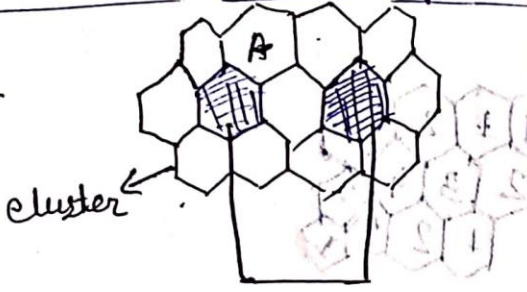
$S = K * N$

→ Frequency reuse Factor = $1/N$

→ Number of cell, $N = I^2 + I*j + j^2$ (cluster Number)

→ If cluster is replicated or repeated,

Then capacity, $C = MKN = MS$.



Note:- যে কোন কিছু cell একই set Frequency ব্যবহার করে থাকে। যদি এই cell গুলো পাশাপাশি বা কাছাকাছি থাকে তবে এদের মধ্যে overlap হতে পারে। তাই তাদের মধ্যে একটা minimum gap থাকতে হয়। The Distance is denoted by, D.

DQR*(3*

→ $D = R\sqrt{3N}$ | R = Radius of the cell
N = The reuse pattern.

Reuse factor,

$Q = \frac{D}{R} = \sqrt{3N}$

Math;-

Cell cluster size, $k = 7$

Frequency reuse factor $= 1/7$

$T = 490$ Total channel

∴ Channel/cell $= 490/7 = 70$

Clusters are replicated =, $M = 3$ times

∴ Total number of channels, $= 3 \times 490$

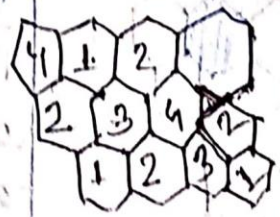
$= 1470$

Cluster size

$i=2, j=0$ $k = i^2 + i*j + j^2$

$= 4$

M = 3 times repeat



(এই math টা draw করার জন্য একটা অন্যরকম কায়দা দেওয়া হবে, example টা cell set করে নিজেদের আসতে হবে না)

Co-channels

Under coverage area @ same set frequency use must of co-channel.

Co-channel Interference:-

Co-channel cell to interference

This one can't be ended by increasing the carrier power of a transmitter cause it will increase the interfering in neighbouring co-channels cells.

⇒ Size of each cell is the same, BSs transmit same power:

$$Q = D/R = \sqrt{3N}$$

When Q is increased interference is reduced

Nearest co-channel:-

$$D = R\sqrt{3K}$$

$$d/r = \sqrt{3K}$$

Problem-1)

Bandwidth = 33 MHz

25 kHz Simplex

Compute the number of channels available per cell

(a) Four cell reuse

(b) Seven cell reuse

(c) 12 cell reuse

Ans:-

N

Bandwidth

Maximum capacity of a wired or wireless communications link to transmit data.

→ Can represent Kb, GB, MB, B

→ Narrow Bandwidth will fail in result of data
Wide " pass excessive noise.

→ Lower Bandwidth Lower data connection.
Speedy " Speedy data connection.

→ Cost of network goes up when bandwidth increases.

→ Streaming → 25 Mbps (4K ultra HD)
→ 5 Mbps (1080 HD video)
→ 3 Mbps (720p ")
→ 1.5 Mbps (Broadband)
→ 0.5 Mbps (Live streaming)
→ 150 Kbps (Screen Sharing)
→ 80 Kbps (VOIP calling)

HandoFF / Handover:

The phone calls remains available even though the user is moving from one cell to another.

The MSC automatically transfers the call to a new channel belonging to the new BS.

It is known as HandoFF / Handover.

Triggering HandoFF:

→ During interference of calls using the same frequency for communication.

→ When travelling HandoFF triggers.

→ If maximum capacity of cell reaches,

→ If a traveller stops the jurisdiction is transferred to a microcell to relieve the load on the large cell.

MSC must:

→ New cell finding /

→ Determining the new cell

→ perform 'Hand off

b. $\Delta = P_r\,handoff - P_r\,minimum$

(a) Improper Handoff Situation

Improper Handover where Handover didn't happen. Signal Drops.

Handoff Timing :-

$\Delta = P_A - P_B$ (If large too many Handoffs)

Hard Handoff :-

"Break before make". Can't connect to the other due to Inter-Frequency problem. NO problem for BS & MS. Call gets dropped for this.

Soft Handoff :-

NO gap between cell. Radio Links are added and removed to the MS. Make before break policy. Allows parallel connection between multiple series. More costly.

MAHO (Mobile Assisted Handoff)

Mobile Itself select BS & gets connected by doing Analysis. The analysis are sent to BS which then ~~sen~~ connect to the best available channels.

Lecture -6

Cell Capacity

Efficiency = Traffic Nonblocked / Capacity

= Earlangs × Portions of used Channel / Number of Channels.

Call Drops

→ Directly affect QoS.

→ Worrisome

→ Directly question to the service

Expected Causes:-

→ Lack of Towers

→ Increase amount of subscribers

→ Lack of Spectrum

Network Model:

Shape হবে Hexagonal আকার কেন? Real life এ এর ভিত্তি?

Signal Strength:-

BTS এর যত দূরে Signal এর তত কমবে।

Company & Call Drops:-

→ If billing happens in minute company is Happy.

→ If in second they are sad as it becomes a concern for them.

Govt:-

→ Can increase band from 900 to 1800 Hz

→ Better management of spectrum

→ Erecting tower on govt. building will help people.

→ Should be listed which company is having the most.

Improving Coverage & Capacity in cellular System

→ Cell Splitting, sectoring and coverage Zone s can be used.

Cell Splitting:- Divide the cell, to make it smaller These are called as microcells.

Cell sectoring:-

Replacing omnidirectional antenna with a number of directional antennas. Common in macro

cellular system.

A number of sectored antennas are mounted on a tower & other antennas are install to cover the full 360°.

Advantages of cell splitting:-

→ Improves S/N Ratio
→ Reduces interference which increases Capacity
→ Reduces Cluster size.
→ Capacity expands.

Disadvantage:-

→ Needs to be careful
→ Assignment becomes difficult
→ More Frequent (Handoff)

Antenna:

Types:- (DOPAO)

→ Directional
→ Omnidirectional
→ Phased arrays
→ Adaptive
→ Optimal.

Characteristic:- (efgaradi)

→ efficiency
→ gain
→ radiation patter
→ directivity

Omnidirectional:-

→ used to transmit/receive in any direction
→ Dipole antennas.  360°

Directional:-

used in a specific direction. 

Sector:- Broadcast 60/90°/120°

panel:- point to point

Sheet-02

Lecture-1

Propagation Model for Mobile communication:-

Basic Network planning process:-

(i) proper planning

(ii) Interference estimations

(iii) Frequency assignments

(iv) Cell parameters.

Note:-

(Radio propagation Model (RPM) = Radio wave propagation Model (RWPM) = Radio Frequency propagation Model (RFPM)).

In general, in city area there is no direct connection between transmitter & receiver but high buildings this causes the diffraction Loss.

There are Two types of Model

(1) Large-scale propagation Model

(2) Small-scale or fading Model.

Sheet-02

Lecture-1

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There are Two types of Model

(1) Large-scale propagation Model

(2) Small-scale or Fading Model.

Path Loss:-

Loss or attenuation a propagating electromagnetic signal (or wave) encounters along its path from transmitter to the receiver.

The result of path loss is, the received signal's ~~transmitted~~ power level is below than the transmitted one.

The received power level's factors:-

(1) Transmission power
(2) Antenna gains
(3) Frequency of operation
(4) Distance between the transmitter & receiver.

$$\text{Path Loss, } PL = 20\log_{10}\left(\frac{4\pi d}{\lambda}\right) \text{ dB}$$

Reasons of path loss:-

(1) Free Space Loss
(2) Refraction
(3) diffraction
(4) Reflection,
(5) Absorption.
(7) Terrain Contours
(8) Environment (urban/rural)
(9) Propagation medium
(10) Distance
(11) Height of Antennas.

① $PL(dB) = 20 \log_{10}\left(\frac{4\pi d}{\lambda}\right)$ d = Distance between Transmitter & receiver.

λ = wavelength

② Received Power level depends on path Loss

$$P_r = P_t G_t G_r \left(\frac{\lambda}{4\pi d}\right)^2$$

P_r = Power of received signal

P_t = Power " Transmitted "

G_t = Grain " " "

G_r = " " Received "

③ $\frac{P_t}{P_r} = \frac{1}{G_t G_r \left(\frac{\lambda}{4\pi d}\right)^2}$

Large scale path Loss

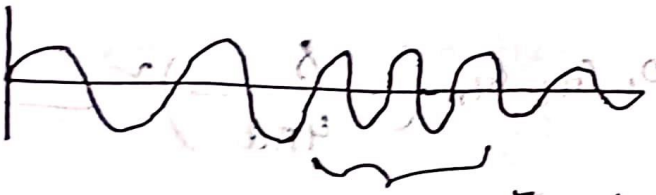
Large Distance move करने पर signal का gradually decrease होने लगता है इसे Large scale path Loss कहते हैं।

→ Local average received power is (5λ to 40λ) (1m - 10m)

→ useful for estimating the coverage area of transmitter.

Small Scale path Loss

ছোট movement এর কারণে যে Fluctuation হয় সেটাই Small Scale path Loss।



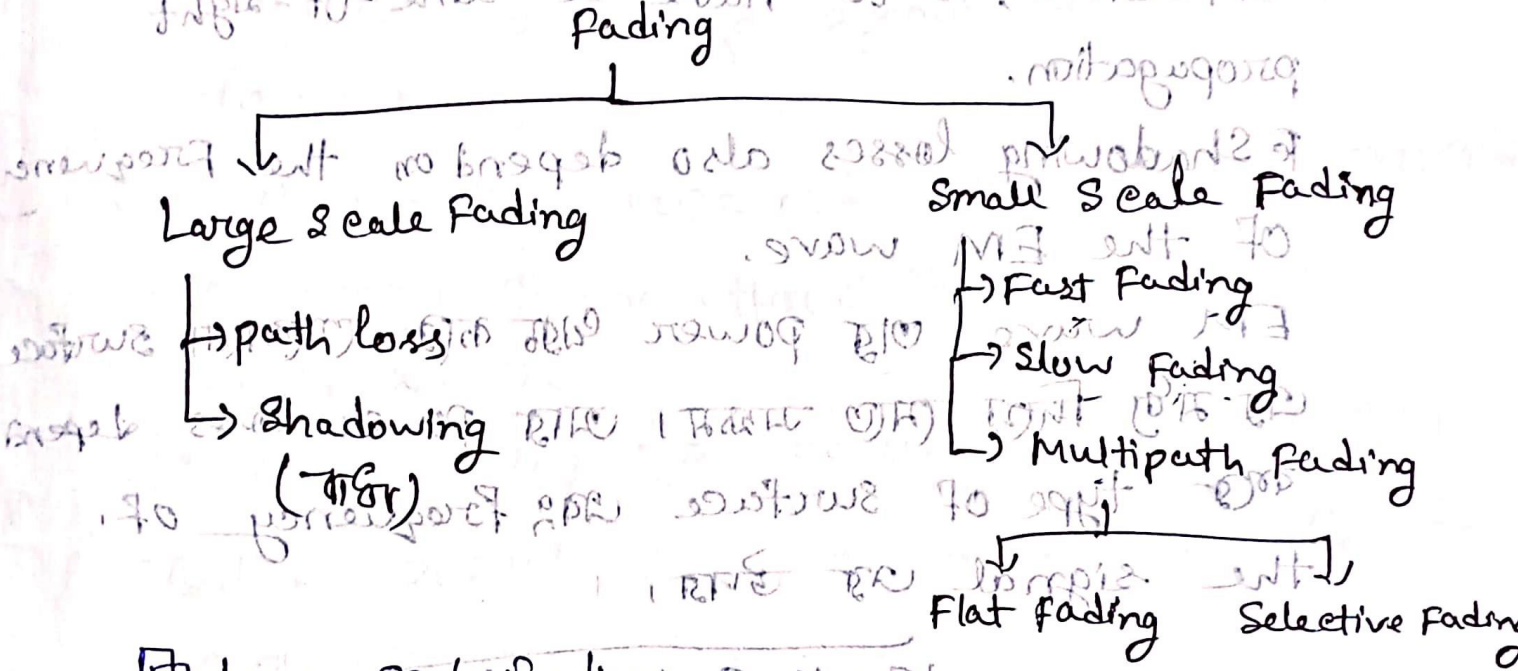
Fading

Fading means (Signal ফেডে যাওয়া)
অর্থাৎ Signal তার স্বাভাবিক মান হতে সরে যায় এবং হঠাৎ ~~কমে~~ বেড়ে যায় বা কমে যায়।

Fast Fading :-

Rapid fluctuations in the amplitude, phase or multipath Delays of received signal due to the multiple versions of the same transmitted signal arriving at the receiver at slightly different times. The multipath propagation of the transmitted signal, which causes fast fading is because of the three propagation mechanism-

- Reflection (reflected back to the origin)
- Diffraction (Bend the waves around small obstacles)
- Scattering (Moving particles ছোট আকার বাধা পায়)



Large Scale Fading:

Attenuation of signal power due to obstacles between the transmitter & receiver. Covers a large distance (in km)

Path Loss: When a signal is transmitted to a large area, wireless signals spread as they propagate through the medium and as the distance increases the energy per unit area starts decreasing.

It can be minimized by increasing the capture area.

Shadowing:- Refers to the loss in signal power due to the obstructions in the path of propagation. One that is the most effective, is to have a line-of-sight propagation.

Shadowing losses also depend on the Frequency of the EM wave.

EM wave এর power খুব কম কোনো surface এর মধ্য দিয়ে যেতে সক্ষম। আর power loss depend করে type of surface এবং Frequency of the signal এর উপর।

Small Scale Fading

Small Scale Fading বলতে কম distance এর মধ্যে rapid changes of the amplitude & phase of a radio signal.

Features of Slow Fading:

① Transmitter ও Receiver এর মধ্যে থাকা Object দ্বারা transmission absorb করে,

② The duration may last for multiple seconds or minutes.

(3) যখন receiver ও transmitter এর মাঝে wall থাকে radio wave কে wall ভেদ করে ভিতরে ঢুকতে ও receiver এ যেতে হয়। তাছাড়া এই কারণটি received signal এ random variation তৈরি করে।

(4) Slow fading received signal power এ পরিবর্তন হতে পারে। Transmitter ও Receiver এর দূরত্ব সমান থাকলেও

(5) Slow fading কে shadow fading ও বলা হয়। যেহেতু object direct transmission বাধা প্রদান করতে পারে।

Factors influencing small scale fading :-

* Multipath propagation :-

Reflecting objects and scattering in the channel এমনটি environment create করে যার ফলে signal এর energy in Amplitude, phase & time এ পরিবর্তন হয়। এবং এই signal যখন receiver Antenna তে আসে তখন তা real time ও space এ different হয়ে আসে।

আর Random phase & amplitude of

Components গুলোর signal এর fluctuation এর কারণে small scale fading হয়

→ Multipath propagation baseband portion এর সমস্যা বাড়ায় receiver এ signal পাওয়ার জন্য যা signal এ সমস্যার কারণ হয়ে দাড়ায়।

② Speed of Mobile:-

Mobile এর speed এর কারণে এর base station হতে দূরত্বের উপর নির্ভর করে Frequency Modulation এর উপর নির্ভর করে Doppler shift হয়।

positive Doppler Shift (যদি Mobile sped receiver এর দিকে হয়)

Negative Doppler Shift (যদি Mobile speed receiver হতে দূরে যায়।

③ Surrounding of Mobile:-

Radio channel এর object যদি motion এ থাকে।

যদি mobile হতে movement rate কমি হয় তবে Small scale fading হয়।

① Transmission Bandwidth of signal:-

যদি radio signal bandwidth > Multipath Channel Bw

হয় তখন received signal মোট যাবে, কিন্তু local area তে কোনো fade হবে না।

⇒ If transmitted Radio Signal BW < Multipath Channel BW হয় তবে received signal কোনো distorted হবে না কিন্তু এর signal strength খুব দ্রুত পরিবর্তন হয়।

⇒ Channel এর bandwidth Coherence BW দ্বারা quantified (ব্যাখ্যা) হয়। যা কিছু নির্দিষ্ট multipath channel এর মাঝে সম্পর্ক। আর Coherence BW maximum frequency difference দ্বারা measure করা হয়। যা Amplitude এর সাথে সম্পর্ক।

Small Scale Fading/ Rayleigh Fading :-

Also known as Rayleigh Fading. It affects almost all forms of communication.

Fast Fading :- Transmitter or receiver এর movement এর কারণে হয়।

Fast Fading এ High Doppler observe করা হয়।

Doppler BW Signal BW এর কোনো এর Channel variation, signal variation হতে কোনো হয়। Linear Distortion

Create করে Baseband Signal এর shape
এ এবং ISI (Inter Symbol Interfece)
তৈরি করে।

Multipath Fading:-

Transmit করার পর signal বিভিন্ন জায়গায়
reflect/refract হতে পারে। Ionosphere
এ reflect হতে পারে, Waterbody (River/sea)
তে বাধা বা reflect হতে পারে, পাহাড়
(mountain) এ reflect হতে পারে। এবং
এগুলোর এর বিভিন্ন path হতে receiver
এ signal আসতে পারে। আর এতে যে সমস্যা
~~Multip~~ signal fade হয়ে যায়, Both Amplitude
& the phase of the signal causing phase
distortions and ISI. এটাই Multipath Fading.
2 ~~types~~ ways:-

Flat Fading:- All Frequency component get affected
Amplitude fluctuate over a period of time

Selective Fading:- Selected Frequency Component is affected. এর মানে হচ্ছে selected
Frequencies এ increased error এবং attenuation

কারণ এটা আমাদের হচ্ছে। Using OFDM technique it can overcome.

Rayleigh Fading

Caused by multipath reception. Mobile antenna receives a large number of scatter and reflected waves. wave cancellation এর কারণে power receive করার ২য় moving antenna এর random variable যার Antenna এর location এর উপর depend করে।

Ideally suited to situations where large numbers of signal paths & reflections. যেখানে fixed place এ signal reflect, refract হয় (HF ionospheric communications where the uneven nature of the ionosphere means that overall signal can arrive having take many different paths.

→ Also appropriate for tropospheric propagation.

Rician Fading

Similar to that for Rayleigh fading. কেবল strong dominant component থাকে। যে strong component হচ্ছে line of sight wave (waves travels from sender to receiver without obstacles)

⇒ Dominant wave can be a phasor sum of two or more dominant signals. (The line of sight, plus a ground reflection).

⇒ Transmitted signal এর replica different attenuation এ arrive করে এবং different delays এ receiver এ arrive করে।

⇒ Dominant Componant সাধারণত mobile antenna দ্বারা reflected, refracted wave receive করে।

Lecture-2

① Path Loss Model develop করা হয় signal strength loss অথবা coverage particular location - এর জন্যে।

* $PL(dB) = PL(d_0) + 10\,n \log_{10}\left(\frac{d}{d_0}\right)$

ratio of the Transmitted to received power

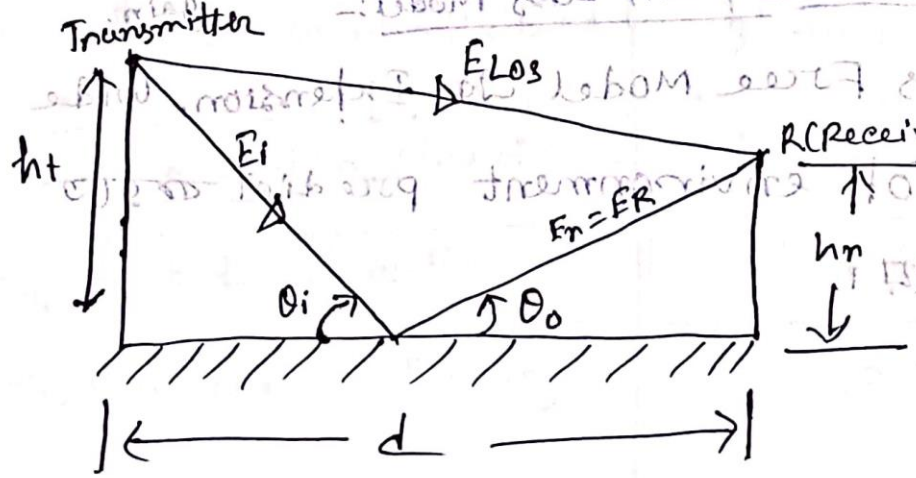
d = distance, d_0 = preference point at 1 Km

n = path loss exponent

Two Ray Ground Reflected Model

Mobile Radio channel এ Base station এবং mobile direct single path ~~sig~~ নিয়ে। কিন্তু এটা Free space propagation model inaccurate। তাই Two Ray Ground Reflection model ব্যবহার useful।

এটা কারণ, এই model use করে কয়েক km পর্যন্ত predict করা সম্ভব। এই model এ উঁচু Tower ব্যবহৃত হয় (50 m height এর বেশি)। Urban area Line-of-sight Microcell channel use হয়।



Model Description:-

Tx & Rx Antenna with ht & hr height. Signal দুইটি পথ দিয়ে Receiver এ যায়। একটা LOS, আরেকটি Reflected Component। সাধারণত, দুরত্ব signal টি reflected হয়ে Receiver এ যাচ্ছে এমনটি ধরে নেয়া হয়। There is no ET।

Received power,

$$P_r(d) = \frac{P_t G_t G_r h_t^2 h_r^2}{d^4 L}$$

P_t = Transmitted power Signal

h_t = Height of Transmitter

h_r = Height of receiver

d = Distance

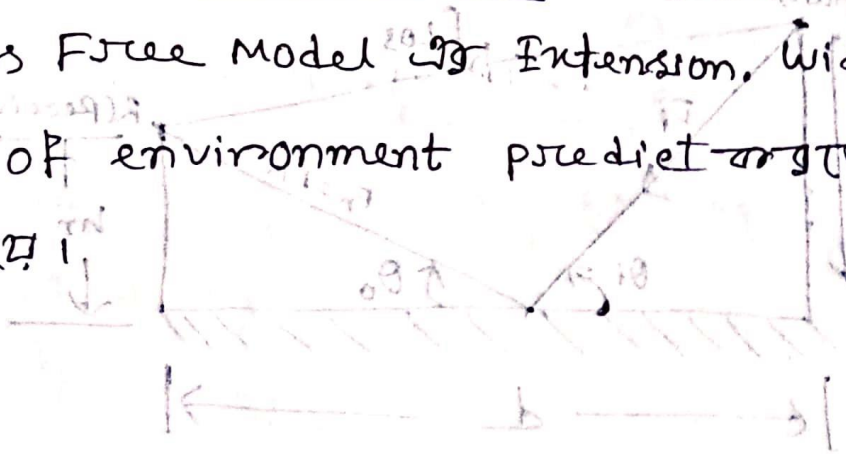
L = 1

G_t = Transmitter Antenna Gain

G_r = Receiver Antenna gain.

Long Distance path Loss Model:-

এটা Friss Free Model এর Extension. Wide range of environment predict করতে ব্যবহৃত হয়।



path loss at an arbitrary distance $d > d_0$

$$[P_L(d)]dB = [P_L(d_0)]dB + 10 n \log_{10}\left(\frac{d}{d_0}\right) + X$$

For $d \geq d_0 > d$

$P_L(d)$ = path loss at an arbitrary distance d meters.

n = path loss exponent depends on the environment

Path Loss Exponent (PLE)

PLE is considered to be known as a-priori.

Care must be taken to estimate PLE for the given environment before design. Theoretical value ... environment ... value ...

Environment	Path Loss Exponent (PLE) (n)
free space	2
Urban area cellular radio	2.7 to 3.5
Shadowed urban cellular radio	3 to 5
Inside a building (line-of-sight)	1.6 to 1.8
Obstructed in building	4 to 6
Obstructed in factory	2 to 3

Traffic Analysis

=> It is method for determining the cost effectiveness of various sizes & config of network.

→ এর মাধ্যমে এর users এর প্রয়োজন পাওয়া যায়। তবে exact time বের করা অসম্ভব হয়। কারণ service arrival সম্পর্কে জানা অসম্ভব।

First step:- Characterization of traffic arrivals and service times.

→ একটা network এর মূল্যায়ন (evaluation) করা মানে Normal / Average load এ তার traffic কতটুকু নিতে পারে এবং সর্বোচ্চ কতটুকু নিতে পারে, তার এটা দিয়েই বের করা হয়। the ability of telecommunication Network.

Generical Catagories

Two Catagories:-

① Loss systems

② Delay systems

* ~~overload~~ Appropriate Analysis Category for a particular system, overload traffic এর system treatment এর উপর depend করে।

Loss System:-

over traffic এর কারণে যে service rejected।

* Conventional circuit switching এর excess traffic block করা হয়। আর যদি user retry না করে।

* Lost calls are loss of revenue

Delay System:-

facilities available না থাকায় আরো পর্যন্ত hold থাকে।

* Store-and-forward message / packet switching delay system maintain করে।

⊛ packet-switching operation loss system এও পড়তে পারে।

⊛ circuit-switching-system delay তেও কাজ করে।

Exam:- Access to a digit receiver, An operator/call processor controlled by queuing process.

⊛ Basic measure:-

→ Loss system:- probability of rejection (Blocking probability).

→ Delay system:- measured in terms of service delays.

Traffic characterization

The domain of traffic flow analysis, Blocking probability → Congestion Theory
Delay Analysis → Queuing Theory.

⊛ circuit-switched Network এ যেসব কোন information important কোন hold

করে। সকল info এর Flow important নয়।

* Message-switching & packet-switching network এর জন্য Actual Flow important যেহেতু Systems traffic on the transmission links Activity of the sources এর উপর নির্ভরশীল।

* Call arrivals & holding two underlying random process:-

=> যেকোনো call arrival user এর উপর নির্ভর করে। এবং এই call অন্যান্য users হতে independent থাকতে হবে। যদিও এই call arrival কখন কখন অমুক নয়। Holding times ও randomly distribute করা হয়।

Traffic intensity:-

Average activity during a period time. It is obtained by dividing the traffic volume by the length of time during which it is measured.

☐ Calling rate :- (λ)

per time ला किती call आलेत.

$$\lambda = \frac{n}{T}$$

n = Average Number of calls

T = During a period of T seconds

☐ Holding Time / Service Time :-

$$\mu = \frac{1}{h}$$

Average holding time calls per hour

⊛ for voice traffic average holding time per calls in hours or 100 s or 3os. seconds per call or minutes per call.

⊛ Data Traffic average transmission per message in seconds.

☐ Average occupancy / Traffic intensity :-

$$A = \frac{n}{T} h = \lambda h = \lambda/\mu$$

Average occupancy is the ratio of average arrival rate to the average

service rate.

* many short calls can produce same traffic as few long ones.

Earlang:-

A server is said to have 1 earlang if it is occupied for the entire period of observation (60 minutes).

Traffic intensity কে কত measure করা।

(1) Earlang

(2) CCS (century call seconds)

*International unit is Earlang.

* 1 earlang = 36 CCS

Traffic statistics

Busy Hour:- যেকোন ২ ঘন্টা যেখান 60 minute এ traffic high থাকে। অর্থাৎ call attempts বেশি থাকে। এটা পরিবর্তন হয়।

Time consistent Busy Hour:- যেকোন দিনের নির্দিষ্ট 1 ঘন্টার traffic averages

বিভিন্ন ধরনের।

Busy Hour Call Attempts (BHCA):-

Number of call attempts in busy hour.

EWSD & CP-113C can support 6M Call attempts in busy hour.

It may not go 70-80% of its designed value.

Busy Hour Calling Rate (BHCR):-

$$BHCR = \frac{BHCA \times CCR}{N}$$

$$= \frac{\text{Average Busy Hour Call}}{\text{Total Number of Subscriber}}$$

Call Completion Rate (CCR)

কোন given Network এ

Number of calls completed এবং

Number of call attempt এর ratio

$$CCR = \frac{\text{Number of calls completed}}{\text{Number of calls attempt}} \times 100$$

Answer to Seizure Ratio (ASR)

$$ASR = \frac{\text{Number of Answered calls}}{\text{Number of seized calls}} \times 100$$

Call Setup Success Rate :-

→ নির্দিষ্ট সময়ে মোট কতগুলো call attempt এর মধ্যে কয়টি call সফল হয়েছে।

Call Failure Rate (CFR) :-

$$CFR = \frac{\text{Number of calls failed}}{\text{Number of seized calls}} \times 100$$

Call Drop Rate (CDR)

→ Abnormal disconnect calls.

→ Dropped call is significantly less than 0.01%.

Trunk efficiency :-

Efficiency of circuit trunk to handle the traffic.

0.8 Erlang / ckt as per PTCL.

Grade of Service (GOS):-

GOS যত ছোট Service তত ভালো।

In a service on system যদি সমান server এবং user থাকে তবে GOS equal to zero.

Call Failure এর কারণ :-

- Customer behavior
- Wrong Number
- NO answer
- Busy subscriber
- Long Delay
- Due to system

Math

During a busy hour 1400 calls offered, 14 lost, Average call 3 minutes. T=60

(a) Traffic offered:-

T = 60 minutes

n = 1400

h = 3

$$A = \frac{n \times h}{T} = \frac{1400 \times 3}{60} = 70E$$

(b) Traffic carried:-

n = 1400 - 14 = 1386

T = 60

h = 3

$$\therefore A_0 = \frac{1386 \times 3}{60} = 69.3E$$

(c) $$GoS = \frac{A - A_0}{T} = \frac{70 - 69.3}{60} = 0.01$$

(d) Period of congestion:-

$$GoS \times T(s) = 0.01 \times 3600 = 36s.$$

* Call congestion = Number of call repeated / Number of call offered

Types of Traffic :-

① Originating Traffic :-

Traffic generated by subscriber connected to the exchange.

② Originating outgoing Traffic :-

Local exchange, total calls during one hour 1800. Avg holding time 3m. Traffic intensity?

$\Rightarrow n = 1800$

$T = 60$

$h = 3 = 3 \times 60 = 180$

Traffic intensity, $A = \frac{n \cdot h}{T}$

$= \frac{1800 \times 3}{60}$

In busy hour Company makes 120 outgoing calls of 2 mins average duration. And receives 200 incoming calls of 3 minutes average duration. Find (i) outgoing traffic (ii) incoming traffic. (iii) Total traffic.

Ans: (i) $T = 60$

$h = 2$

$n = 120$

Outgoing, $A_o = \frac{n \cdot h}{T}$

$= \frac{120 \times 2}{60}$

$= 4E$

(ii) Incoming $A_i = \frac{200 \times 3}{60}$ $\quad n = 200$, $h = 3$

$= 10E$

(iii) Total, $A_o + A_i = (4 + 10)E$

$= 14E$

An exchange serves 2000 subscribers. If average BHCA = 1000 & CCR = 60%

∴ BHCR = ?

Ans:

N = 2000

BHCA = 1000

CCR = 60%

$$\therefore BHCR = \frac{BHCA \times CCR}{N}$$

$$= \frac{1000 \times 60}{2000}$$

$$= 3$$

10 servers, 30 minute occupied, 2 hours observation. Calculate traffic carried by the group.

$$\Rightarrow \text{Traffic carried per source} = \frac{30 \text{ min}}{120 \text{ min}}$$

$$= 0.25E$$

∴ Traffic Carried by the group = 10 × 0.25E

$$= 2.5E$$

Q) 20 servers, 10E traffic, 3 mins,
Single server call = ?
& as a group = ? one hour period

=>
Number of servers = 20
Traffic intensity (A) = 10E
Avg call duration = 3mins

∴ Traffic per server = $\frac{10}{20}$ = 0.5E

Number of call from one server

= $\frac{\text{Server busy time}}{\text{Call duration}}$

= $\frac{30}{3}$ = 10 calls

∴ Total call by group = 10 × 20
= 200 calls

VVIm

A group 1200 subscribers, generate 600 calls during the busy hour. Avg holding time 2.2 minutes. Traffic, CCS, CM = ?

2) ~~Traffic~~ $n = ~~1200~~ 600$

$T = 60$

$h = 2.2$

$\therefore$ Traffic intensity $= \frac{n \cdot h}{T} = \frac{600 \times 2.2}{60}$

$= 22 E$

$\therefore CCS = \frac{n \cdot h \cdot T}{100}$

$= \frac{600 \times 2.2 \times 60}{100}$

$= .792 CCS$

$\therefore CM = CCS \times 100$

$= 792 \times 100$

$= 79200 CS$

$= \frac{79200}{60} CM = 1320 CM$

VVIM Q] Group of 20 Trunk carries 10 erlangs & the avg. call duration is 3 mins.

(a) Average number of calls in progress

(b) Total number of outgoing originating per hour.

Ans:-

Number of trunks = 20

Traffic intensity = 10E

h = 3m.

(a)

Traffic intensity per trunk = $\frac{10}{20}$ = 0.5 E/trunk

Avg. number of calls/trunk for 1E (60min) = 20

∴ For 0.5 erlang, average no. of calls in prog = 10

(b) Traffic intensity, $A = \frac{n \cdot h}{T} = 10E$

$= \frac{\quad}{\quad}$

∴ Total no. of calls originating per hour,

$$n = \frac{10 \times 60}{3}$$

$$= 200 \text{ calls}$$

Part-B

1. GSM Archi

[Global System for Mobile Communication]

(GSM)

First implemented using radio system in 1970

Different GSM :- GSM900, EGSM1800, GSM1900.

GSM uses technique :- TDMA / FDMA (Frequency Division Multiple Access)

↳ (Time Division Multiple Access)

GSM900 :- uplink : 890 to 915 MHz Frequency band

downlink :- 935 to 960 MHz Frequency Band

Bandwidth :- 200 kHz

Uses for transmitting & receiving data & voice signal over a network.

=> 900MHz (used by the original GSM system)

=> 1800 MHz (used to add support for increasing customers).

=> 1900 MHz (used in US)

Features of GSM:

=> supports international roaming.

=> clear voice clarity

=> Ability to support multiple handeld devices.

=> Spectral/ Frequency efficiency.

Phase-1 of GSM):

=> voice telephony

=> International roaming

=> Basic fax/Data services (upto 9.6 kbit/s)

=> Call forwarding

=> Call barring

=> SMS

Phase-2 :-

2 are
- → Advice of charge
- → Additional data communications capability.

5 are
- → Call waiting
- → Call hold
- → Calling line identification
- → Conference calling
- → Closed user groups.

Phase 2+ :-

(MPAI)

- → Muliple service profile
- → Private numbering plan
- → Access to centrex services.
- → Interworking with GSM 1800, GSM 1900, DECT standard

GSM Frequency Band:-

GSM 900:-

=) It was an original frequency band

=) Worldwide GSM use this.

=) Some countries use extented version of GSM 900.

=) Extended version of GSM, E-GSM.
Primary version of GSM, P-GSM.

GSM 1800:-

1990 সালে শুরু হয়। Subscriber বেশি হলে সেক্ষেত্রে এরা use করতে পারে।

GSM 1900:-

→ person to person communication

→ North America could not use GSM-900 due to prior allocation ~~by~~ but GSM-1900 filled this gap.

→ It support ANSI signalling

frequency related specifications:

CDMA & GSM:-

→ Both converts data from mobile phone into radio waves.

→ GSM uses SIM cards to connect a mobile phone.

→ CDMA does not need any SIM card it uses ESN.

(i) Technology:-

GSM:- use wedge spectrum technology. known as carrier. Carrier is split into various time slot TDMA.

That's why until one outgoing call is finished, no other user can access the slot. uses FDMA to provide multiuser access.

CDMA:- Spread spectrum tech is used. OP

2] SIM Cards:-

→ GSM use it

→ CDMA do not use it.

3] Flexibility:-

→ GSM is flexible cause SIM card is used

→ If a phone stops working, need to buy a new one.

4] Spectrum Freq:-

→ GSM → 850 to 1900 MHz

CDMA → 850 to 1900 MHz

5] Radiation Exposure:-

→ GSM phones:- 28 times more radiation exposure

→ CDMA:- Does not radiate much

6] Global reach:-

GSM

CDMA:- 80% of 210 countries use this

CDMA:- US, Canada, Japan use this most.

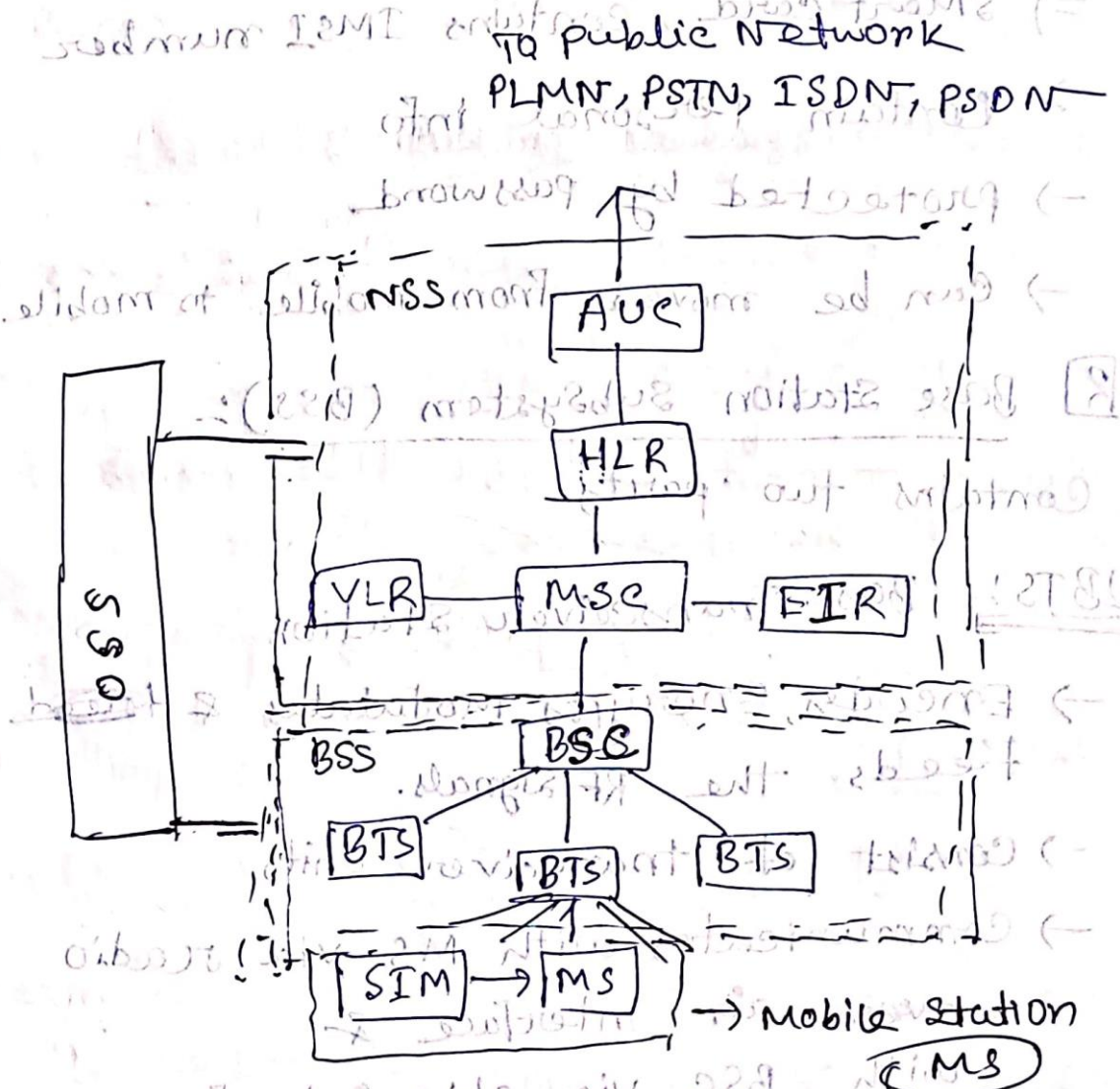
Security! –

→ CDMA provides more security.

Data Transfer Rate:-

CDMA higher than GSM

GSM Network Architecture:



1] Mobile Station (MS):-

(i) Mobile Equipment:- (मोबाइल डिवाइस)

→ portable, Hand held device

→ Identified IMEI number.

→ used for voice & data transmission.

→ 160 character SMS can be sent

(ii) Subscriber Identity Module (SIM):-

=) Smart card, contains IMSI number

→ Contain personal info

→ protected by password

→ Can be moved from mobile to mobile

2] Base Station SubSystem (BSS):-

Contains two parts

(i) BTS:- Base Transceiver Station

→ Encodes, Encrypts, Modulates & ~~Feeds~~ Feeds the RF signals.

→ Consist of tranceiver units

→ Communicates with MS via radio air interface &

with BSC via abis interface.

(ii) BSC (Base Station Controller):-

→ Assigns frequency & time slots for all Mobile Stations in its area.

→ Handles call set up, transcoding & adaptation functionality handover for each MS & radio power control.

→ Communicates with MSC & BTS.

[3] Network Switching Subsystem (NSS):-

(i) Mobile Switching Centere (MSC):-

→ communicates between GSM & other networks.

→ Manages call set up function, routing & basic switching.

→ Mobility Management
  - → Registration
  - → Location updating
  - → Inter BSS & MSC all handoff

→ Billing info

(ii) Home Location Register (HLR):-

permanent Database of large service area. about mobile subscriber. Contains, IMSI, IMSISDN, prepaid/postpaid, roaming restrictions etc.

c) Visitor Location Register (VLR):-

Temporary Database. when new MS enters its area by HLR Database. Controls mobile roaming in its area.

d) Authentication Centre (AUC):-

provides security & protection against intruders.

e) Equipment Identity Register (EIR):-

→ Database that use IMEI number

→ Three Subclasses are used

→ White List:- List of IMEI numbers enter in the network.

→ Black List:- IMEI numbers that can't enter into network cause they are stolen.

→ Grey List:- For a moment IMEI number that can't enter the network.

→ version of software too old or in repair

⊞ OSS (Operation SubSystem):-

→ Management to charging & billing

→ To maintain all hardware & network operations.

⊞ PSTN: public Switched Telephone Network

→ An Analog system, but now entirely digital

→ uses signal system 7, SS7 as signal protocol

→ SS7 is a set up & terminate a telephone call.

⊞ ISDN:- Digital Network which is to transmit voice, image, video & text over the existing circuit.

GSM Handover:-

(i) Intra BTS Handover:-

When need to change the frequency or slot because of interference

(ii) Inter BTS intra BSC Handover:-

Happens when mobile phones travels & leaves one BTS & join another BTS of the same BSC.

(iii) Inter BSC handover:-

Mobile moves out of cells which is controlled by one BSC. So move to another BSC. It is controlled by MSC.

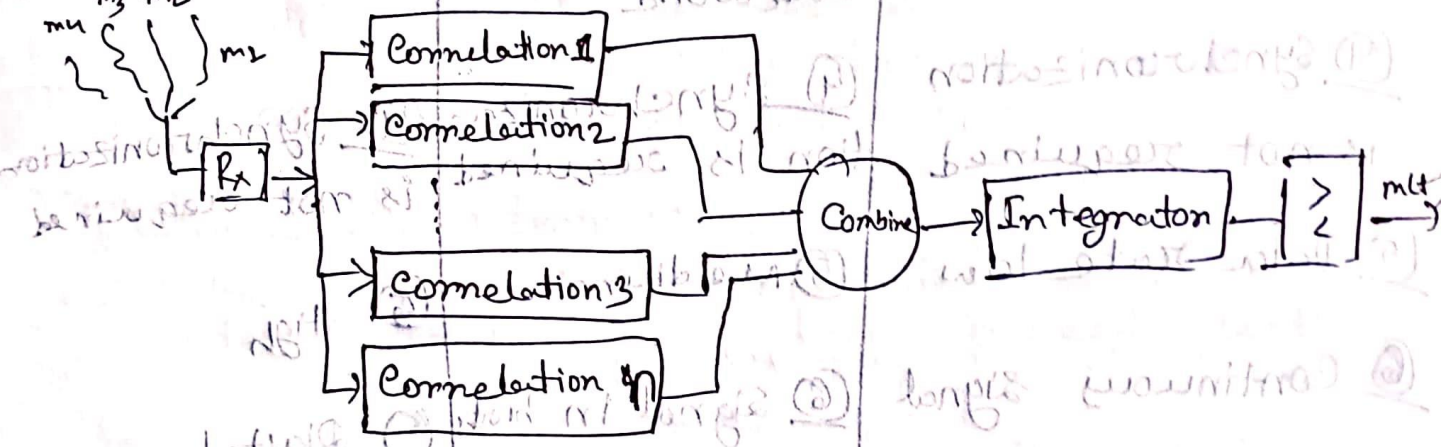
(iv) Inter-MSC Handover:-

Changing between networks. Two MSC control the handover.

Rake Receiver

Radio Receiver, which receives multiple signal & combine them together.

When radio signal travels it goes from various obstacles. So it gets faded. So need a combiner to combine all signals together to form the real signal.

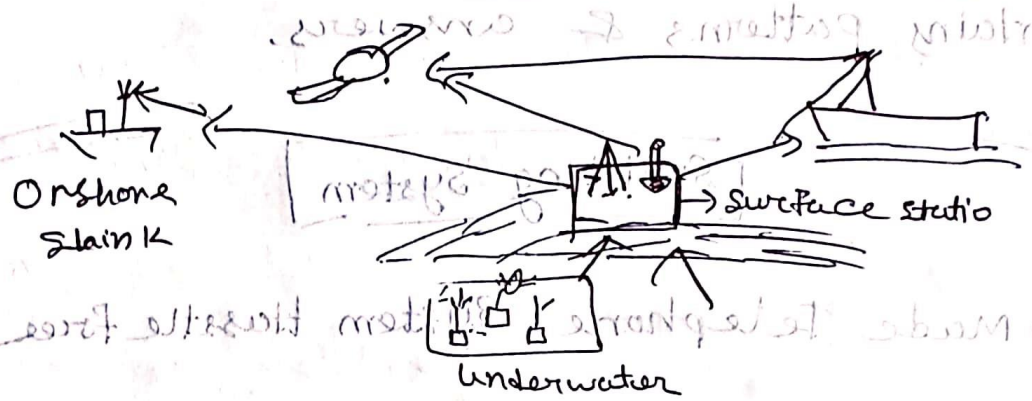


FDMA	TDMA	CDMA
① Frequency Division Multiple Access	① Time Division Multiple Access	① Codes Division Multiple Access
② Sharing of BW with different station happens.	② Sharing of Satellite transponder takes place	② Sharing of both BW & time among different stations takes place
③ No need of Codeword	③ No need of Codeword	③ Codeword needed
④ Synchronization is not required	④ Synchronization is required	④ Synchronization is not required
⑤ Data rate low	⑤ Medium	⑤ High
⑥ Continuous signal	⑥ Signal in burst	⑥ Digital
⑦ Little Flexible	⑦ Moderate Flexible	⑦ Highly Flexible

Underwater Communication

Sending & receiving signal from underwater. Can be done in two ways :-

(1) Centralized & (2) Decentralized Architecture.



Elements of IOT Structure :-

(1) Connectivity → centralized gateway

(2) Identity → It is cloud based. So need identity & register.

(3) Capture :- Requires Data for solutions of anything

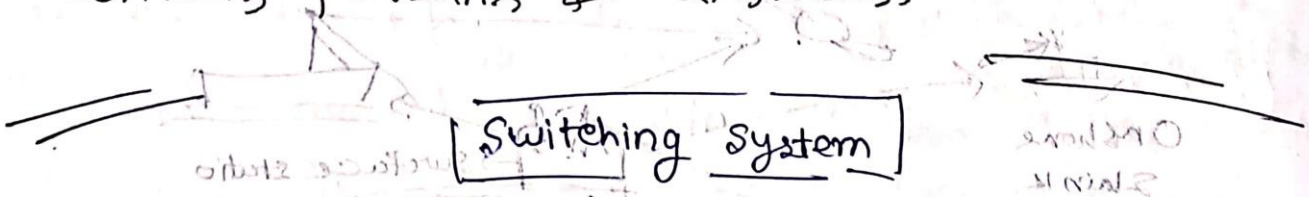
(4) Ingestion :- Meaningful data needed. So, IOT platform that is capable of Consuming millions of data, to retrieve valuable insights is required.

Storage :- Need Storage.

Transformation & Analytics :- Dates are filters

Presentation :- Information & Analytics

Contains patterns & answers.



→ Made Telephone System Hasstle Free

Elements of switching System :-

(1) Switching Network :- Heart of switching System. Responsible for connecting calling & called parties. Can be implemented using a variety of tech.

(ii) Control System :- Manages Switching Network.