CN

Transmission

↳ b/w transmitter & reciever.

(2) modes → Guided → coaxial, optical
→ Unguided → air, vaccum

- Direct link : → no intermediate device
- Point to Point : → only 2 device.
- Multi Point : → more than 2 device.

(i) Simplex : one dirn eg. TV

(ii) Half duplex : either dirn (but) only one way at a time.
eg. Police radio / walkie-Talkie

(iii) Full duplex : both dirn at same time.
eg. Telephone.

Ryx

Analog signal → varies in smooth way over time

Digital signal → maintain const. level & changes to another const. level

Periodic signal → pattern repeated over time

Aperiodic signal → pattern not repeated over time.

sine wave : Peak Amplitude → max. strength (A)
frequency (f) → cycles per second ($1/T$)
phase (ϕ) → relative posi. in time.

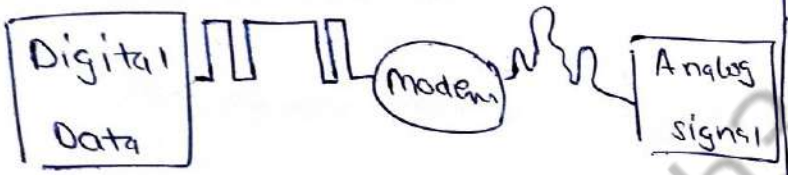
Audio Signal : f : 20Hz - 20kHz
↳ easily converted into electromagnetic signals.

Analog Signals

(1) Represent data with continuously varying electromagnetic wave

(2)

(3)



(4) Denoted by sine wave

(5) Human voice in air, analog electronic devices.

(6) Not flexible

(7) Stored in wave signals

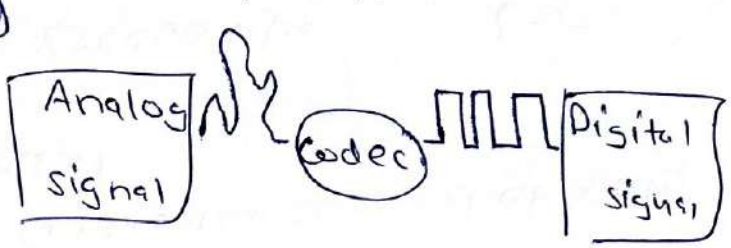
(8) Low cost & portable

(9) Can have Errors

Digital Signals

(1) Represent data with sequence of voltage pulses.

(2)



(3)

(4) Denoted by square waves

(5) Computers, CD DVD's

(6) Is flexible.

(7) Stored in binary bit

(8) High cost & not portable

(9) No Errors.

Transmission media:

① Attenuation:

② Distortion: Signal form is changed

③ Noise: Unwanted signal produces noise.

Ryx

Nyquist theorem:

For a noiseless channel

$$C = 2B \log_2 L$$

where C = Capacity in bits/second
B = Bandwidth in hertz

let say, A bandwidth of 3000 Hz is transmitting a ~~sig~~ signal with 2 signal levels. Max bit rate = ??

B = 3000 Hz
L = 2

$\therefore C = 2B \log_2 L$

$= 2(3000) \times \log_2 2$

$= 2(3000) =$ 6000 bps

Q.2 We send a 256 kbps over a noiseless channel of 20 kHz what/how many signals required.

C = 256 kbps = 256000 bps
B = 20 kHz = 20,000 Hz
L = (?)

$\therefore C = 2B \log_2 L$

$$256000 = 2(20,000) \times \log_2 L$$

$$\log_2 L = \frac{256000}{40,000}$$

$$\log_2 L = 6.4$$

$$L = 2^{6.4} = \boxed{84.44 \text{ Level}}$$

Shannon Theorem:

Shannon Thorm gives Capacity of system in presence of noise.

$$C = B \log_2 (1 + SNR)$$

; SNR = signal to Noise Ratio

When extreme noise → SNR = 0

i.e $C = B \log_2 (1+0)$

$\therefore C = B \log_2 (1)$

$\therefore C = B \times 0$

$\therefore C = 0$

The shannon capacity gives us the upper limit whereas the Nyquist formula tells us how many signal levels we need.

Ryx

we have a channel with 1MHz bandwidth. SNR is 63. what is appropriate bit rate & signal level.

$SNR = 63$ $\quad B = 1MHz = 10^6 Hz$

$C = ?$

$$C = B \log_2 (1 + SNR)$$

$$\therefore C = 10^6 \log_2 (1+63)$$

$$\therefore C = 10^6 \log_2 (64)$$

$$\therefore \boxed{C = 6Mbps}$$

Final no. of signals two

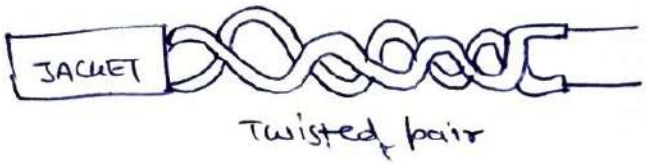
$$C = 2B \log_2 L$$

$$6 = 2 \times 1 \log_2 L$$

$$\frac{6}{2} = \log_2 L$$

$$3 = \log_2 L \quad \therefore L = 2^3 = \boxed{8}$$

Twisted pair:



→ frequency: 0 – 3.5 kHz

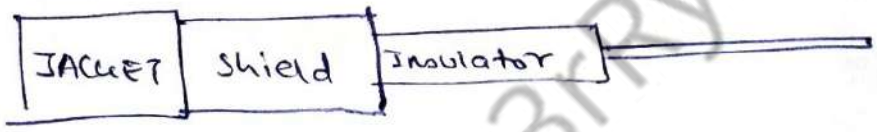
→ lightweight cable

→ easy to mount

A: cheap & easy to install
high speed

D: only used in short distances

Coaxial:



→ frequently used in media.

→ higher frequency.

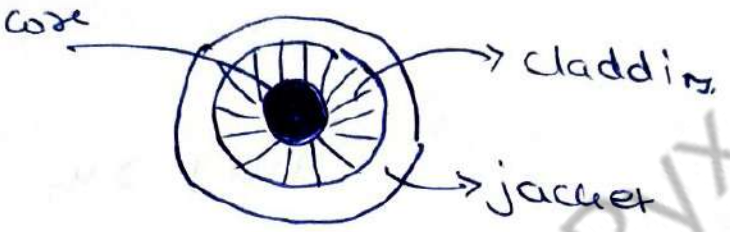
→ copper is inner conductor of coaxial cable & a coaxial mesh is the outer conductor.

→ middle core is responsible of transmitting the data while copper mesh prevents the EMI

Enrollment No :

Page No :

Fibre optic:

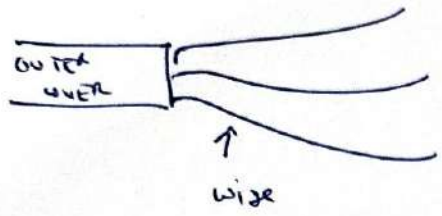


→ Consist of plastic coated fibre that transmits the data through light tubes.

→ provides faster data than wires

→ plastic layer avoids heat, cold, EMI of optical fibres.

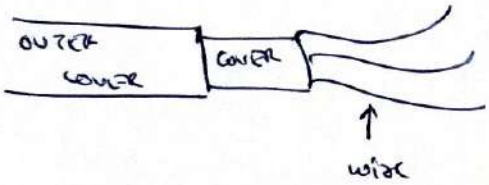
Unshielded Twisted Pair (UTP)



- ordinary wire of telephone
- cheapest
- easy to install

Disad. → suffers from external interference

Shielded Twisted Pair (STP)

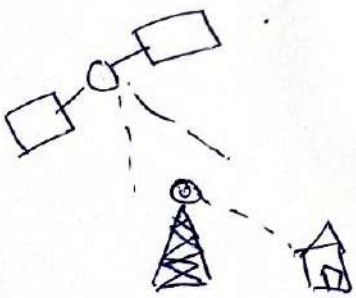


- metal braid
- expensive
- hard to handle.

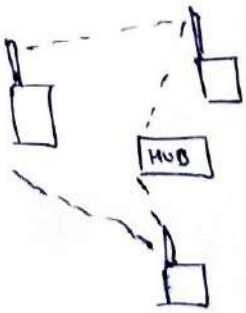
Unguided Media :

(1) Microwave.

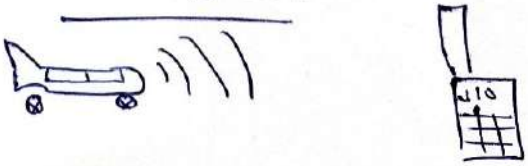
(2) Satellite:



(3) Radio waves:



(4) Infrared:



VLAN : (Virtual LAN)

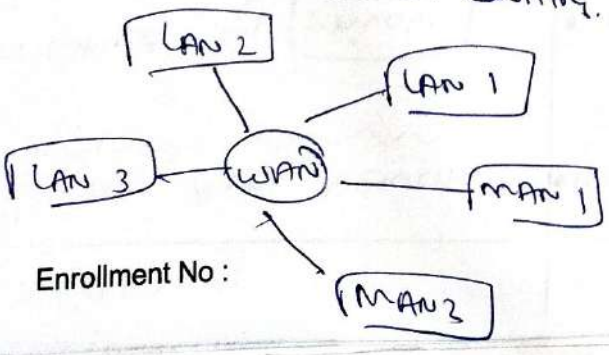
- logical network
- group of host with common set of requirements that communicates regardless of their physical location.
- same as LAN but allows end station for grouping together even if they are not located on same network.
- VLAN can change or add workstation
- mangge load allocation and band allocation.

MAN : (Metropolitan Area Network)

- MAN covers larger area than LAN but smaller than WAN.
- Transmission is moderate.
- interconnection of several local area network (LAN)

WAN: (Wide Area Network)

- Speed lower than LAN
- different LAN and MAN are connected together.
- located in state or country.



LAN : (Local Area Network)

Wired LAN: hardware grouping with physical inter-connection.

Wireless LAN: Communication w/o use of cables or wires but with infrared, radio & microwave

LAN	MAN	WAN
• Local Area Network	• Metropolitan Area Network	• Wide Area Network
• owned by private organization	• owned by private or public	• owned by private or public
• speed is very high	• speed is average	• speed is lower than LAN.
• Network delay is short	• Network delay is moderate	• Network delay is longer
• maintenance is easy & less costly than WAN	• maintenance is complex & costly than LAN	• maintenance is very complex & very costly than LAN & MAN

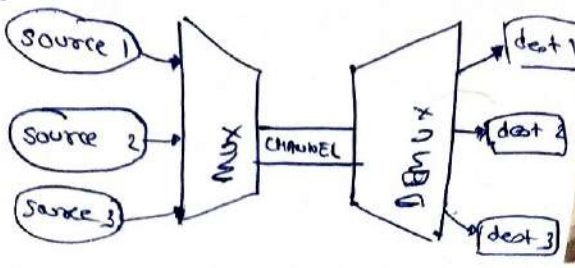
Multiplexing → Multiple signals at one time

→ Combines multiple signal → one signal

→ MUXing

→ Coaxial cable or optical fiber

eg.

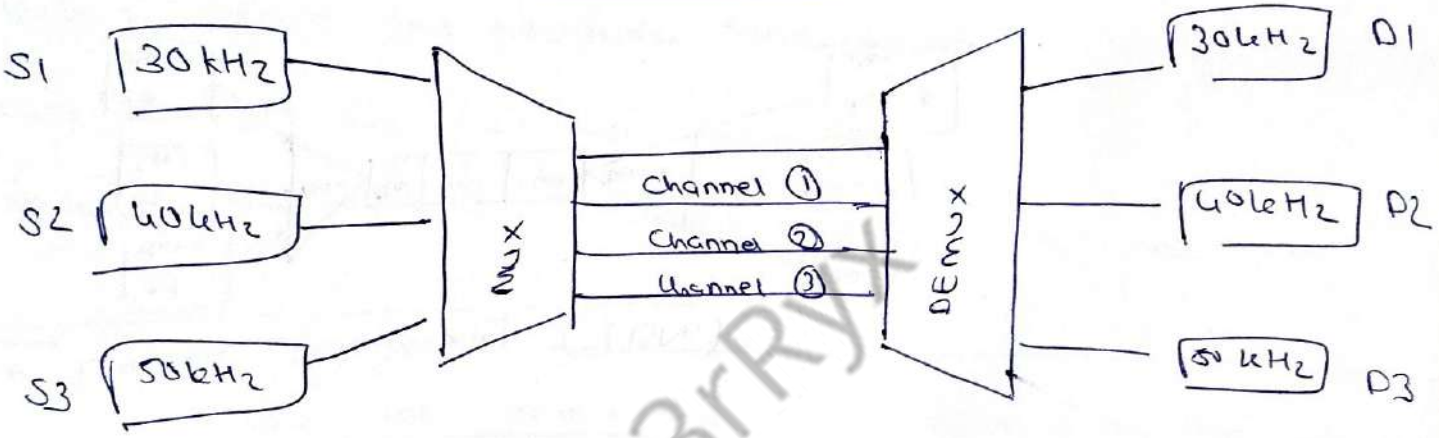


Annexure No :

Faequency divisian multiplexing (FDM):

Signals of different frequencies → Multiplexer → Multiplexed signals are separated by using demultiplexer

Multiplexer ⇓ Send signals over communication channel

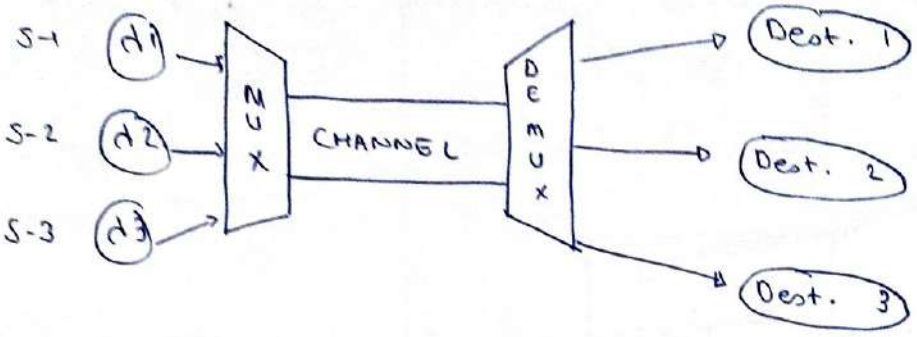


A: Multiple signals at same time.
Demodulation 2 ez
no need of synchronization

D: needs a large bandwidth communication channel

Application: FM or AM
Telephone
TV broadcasting

Wavelength Division multiplexing (WDM):

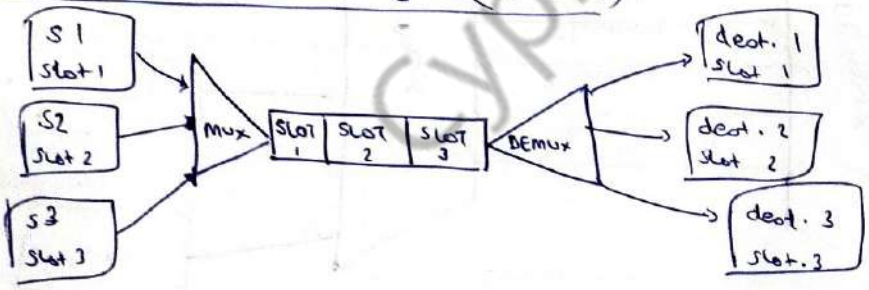


WDM is same as FDM but instead different wavelength are multiplexed into same channel than different frequencie..

A.

- High security,
- Low cost,
- long distance communication,
- Great transmission capacity

Time Division Multiplexing (TDM):



All signals are not transmitted simultaneously, instead they are transmitted one after another.

First we send signal (1) then signal (2) then signal (3) then each user occupies an entire bandwidth for short period of time.

Annexure No :

Switching Techniques:

(1) Circuit switching :
- dedicated path for sender & reciever
- that path remains till connection is terminated

Advantage :
- fixed bandwidth
- communication channel is dedicated

Disadvantage: Expensive & inefficient.

(2) message switching: it uses nodes to transfer the entire message. message is transferred as a complete unit and routed through intermediate nodes.

Advantage:
- Traffic congestion is reduced
- message priority can be used to manage network.

Disadvantage :
- Long delay
- message switches must have sufficient storage.

(3) PACKET SWITCHING:
- message is split in small pieces and is sent in one go.
- packet travels across the network, taking the shortest path possible.
- one all packets are sent, acknowledgement is recieved.

A: Reliable, efficient, cost effective

D: requires low delay & high quality service ⟶ loss of critical information ⟶ highly complex

Ckt switching	Packet switching
(1) has dedicated path.	(1) donot have dedicated path.
(2) fixed bandwidth	(2) dynamic bandwidth
(3) delay is uniform.	(3) delay is not uniform.
(4) wastage of resource	(4) less wastage of resource.
(5) not a store and forward technique.	(5) is a store and forward technique.
(6) not efficient.	(6) efficient.
(7) connection oriented	(7) not connection oriented

Comparison

Circuit Switching	Datagram Packet Switching	Virtual Circuit Packet Switching
Dedicated transmission path	No dedicated path	No dedicated path
Continuous transmission of data	Transmission of packets	Transmission of packets
Fast enough for interactive	Fast enough for interactive	Fast enough for interactive
Messages are not stored	Packets may be stored until delivered	Packets stored until delivered
The path is established for entire conversation	Route established for each packet	Route established for entire conversation
Call setup delay; negligible transmission delay	Packet transmission delay	Call setup delay; packet transmission delay
Busy signal if called party busy	Sender may be notified if packet not delivered	Sender notified of connection denial
Overload may block call setup; no delay for established calls	Overload increases packet delay	Overload may block call setup; increases packet delay
Electromechanical or computerized switching nodes	Small switching nodes	Small switching nodes
User responsible for message loss protection	Network may be responsible for individual packets	Network may be responsible for packet sequences
Usually no speed or code conversion	Speed and code conversion	Speed and code conversion
Fixed bandwidth	Dynamic use of bandwidth	Dynamic use of bandwidth
No overhead bits after call setup	Overhead bits in each packet	Overhead bits in each packet

Image Source: google.com

RYX :→
Ryy

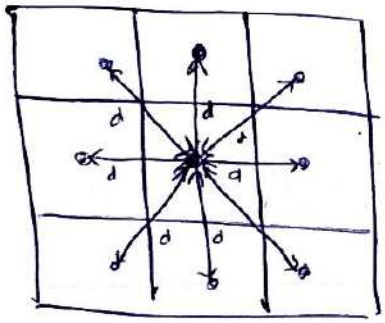
Principles of cellular networks:

Cellular Technology → supports users in location that are not easily served by wired networks.

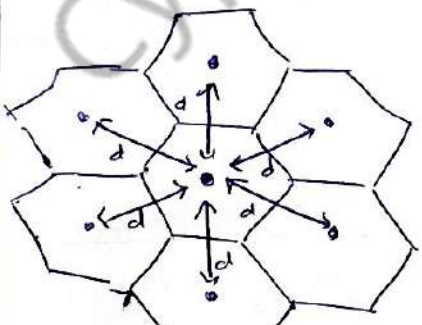
foundation of mobile wireless comms

→ underlying tech for → mobile, wifi, personal comms system.

→ for mobile radio to replace high power transmitter reciever low power.



square



Hexagon

→ equidistant antennas

→ distant beth centers of cell radius R is "R".

↳ not ideal geometry.

↳ all adjacent antennas equidistant.

↳ each cell has (4) neighbour at distance "d"

Frequency Reuse:

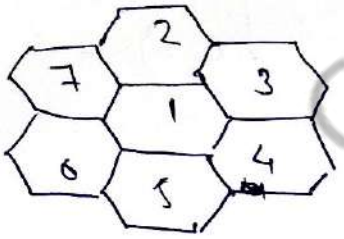
↳ concept of using the same radio frequencies within a given area, separated by (considerable distance)

Benifits:

(i) use same frequency for multible convos.

(ii) allows reuse of frequencies in nearby cells.

(iii) (limits) power escaping.



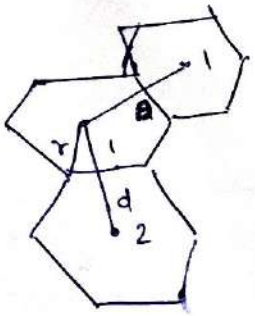
(N) cells all using same no. of frequencies.

Frequency (f) = $f = K/N$

let K = here 395 KHz

$= \frac{395}{7} = 57$ kHz.

(K) = total no. of frequencies used in systems.



r = radius of cell

d = distance betn adjacent cells

D = Min. distance betn 2 same frequencies.

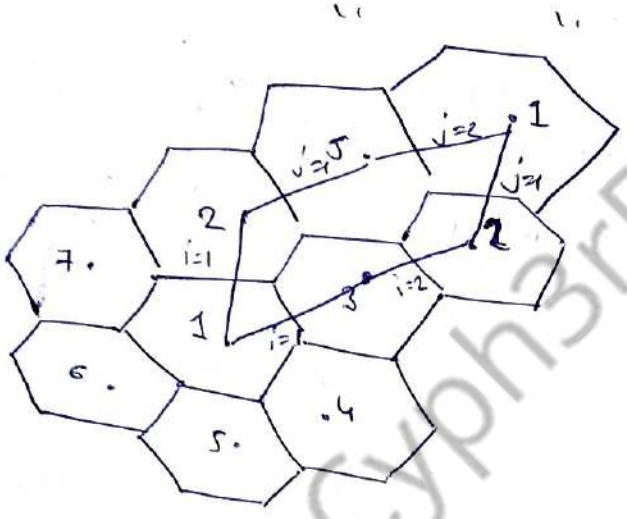
Cluster size:

$$N = I^2 + J^2 + (I \times J)$$

N = no. of cell with repeated frequency

I = no of steps required to move in one dirn in order to reach cells with same frequency

J = ''



in other dirn

I = 1
J = 2

or I = 2
J = 1

∴ let I = 1 & J = 2

$N = I^2 + J^2 + (I \times J)$

$= (1)^2 + (2)^2 + (1 \times 2)$

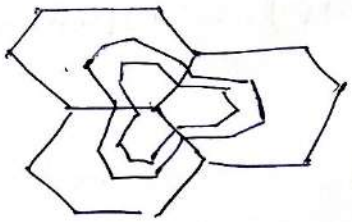
$= (5) + (2) = \boxed{7}$

To maintain the capacity / demand we need to increase the no. of channels.

By. (1) cell splitting
(2) cell sectoring
(3) Coverage zone approaches.

→ ways.

1) Cell splitting



↳ subdividing a congested cell into the smaller cells

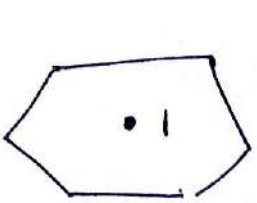
↳ increases the capacity because additional channels per unit area is included.

Eg.

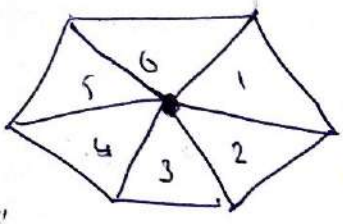
Towers for mobiles are divided into regions

→ reduced power levels from original cell.

Cell sectoring:



Before



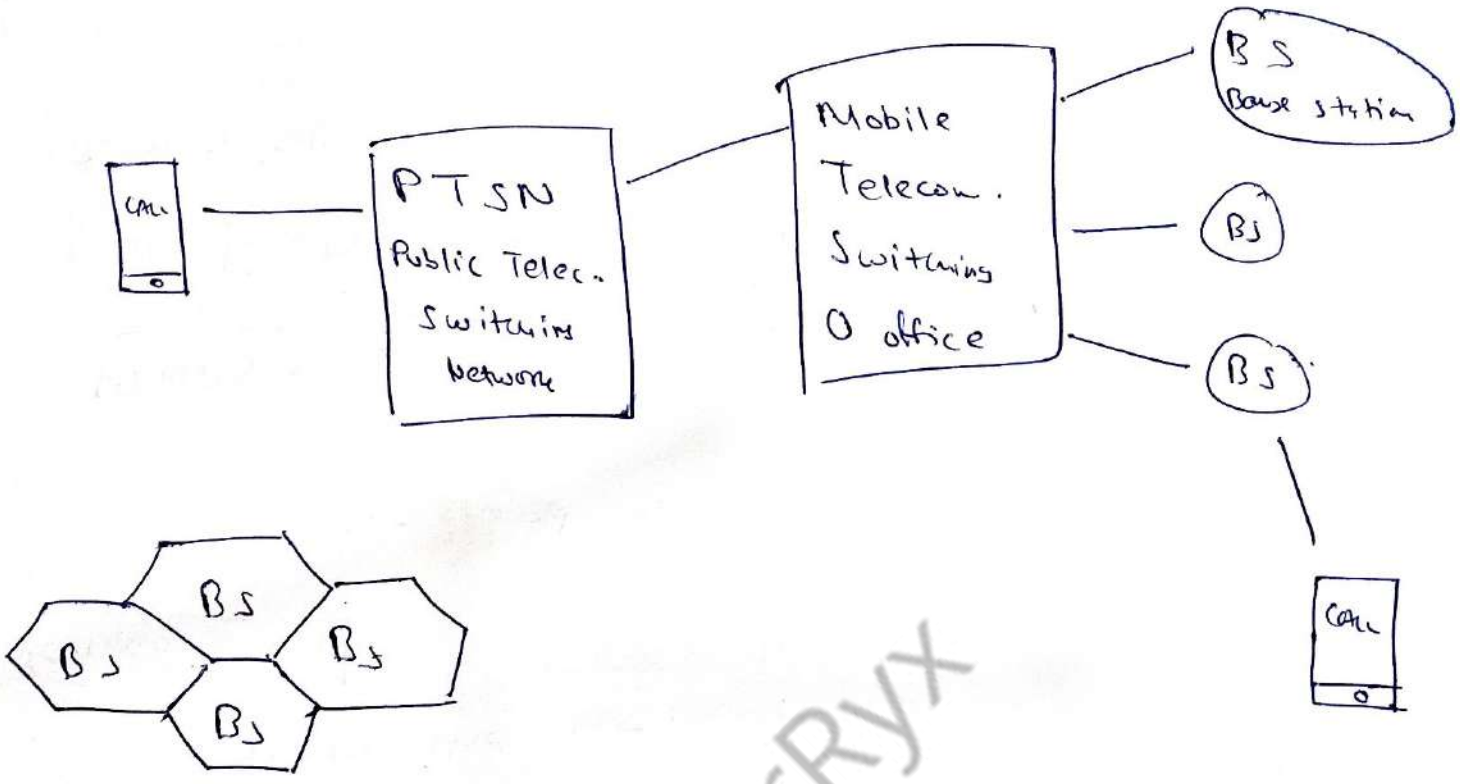
After

Omnidirectional antenna at each 60° opening.

↳ less expensive than cell splitting

Cell splitting	Cell sectoring
(1) Divided into smaller base.	(1) sectored at 60° angle
(2) has co-channel interference	(2) No cochannel interference
(3) Radius = decreased	(3) Radius = same
(4) large cell dedicated for high speed traffic	(4) Sectors are all of same size
(5) No. of handoff reduced.	(5) No. of handoff increased

Annexure No :



(1) Mobile ⟶ ON

(2) SCAN & SELECT ⟶ STRONG BS

(3) HAndshake betn MTSO & Mobile via BS

Call Process :

(S-1) CALL Initialized.

(i) Check ⟶ Channel free or not.

(ii) Send no. to BS

(iii) BS will send req. to MTSO.

② PAGING :

(i) MTSO connects to mobile

(ii) Paging sms sent to BS

(iii) Paging signal transmitted to setup channel

③ Call Accepted

(i) Mobile recognize the no.

(ii) Responds to BS ⟶ sends response ⟶ MTSO

(iii) MTSO sets up ckt. betn 2 BS.

(iv) MTSO selects the traffic channel & allocate it to the ckt.

④ Ongoing Call:

↳ voice exchanged through respective BS & MTSO.

HANDOFF

if one parts goes out of range of selected BS then automatically new BS is selected,

Generations:

(1G) → 1st Gen.

- Analog radio signal ~~~~~
- Basic voice service.
- Speed → 1 - 2 kBps
- 32 bit serial no. & 10 digit phone no.

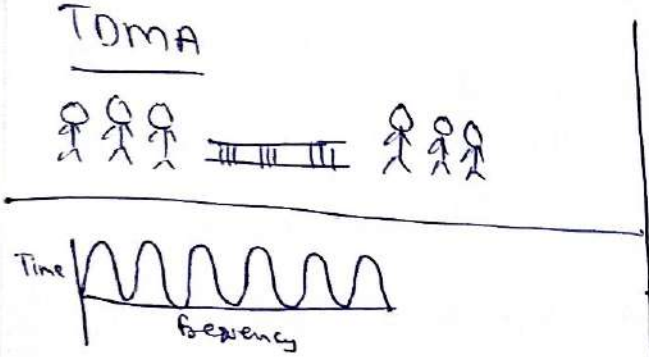
Disad.	Adv.
→ no encryption	→ ckt switching
→ poor sound	→ FM (frequency modulation)
→ no internet	→ cell radius → 2-20km.

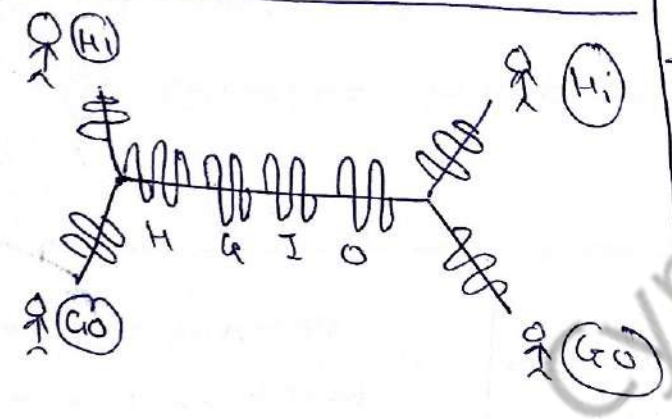
(1) Subscriber initiate call
(2) MTSO validates it
(3) MTSO issues message → traffic channel
(4) MTSO sends ringing → other party
(5) MTSO establish ckt & initiate comms.
(6) One party
dc → release ckt → makes bill.

— CALL Process for 1G.

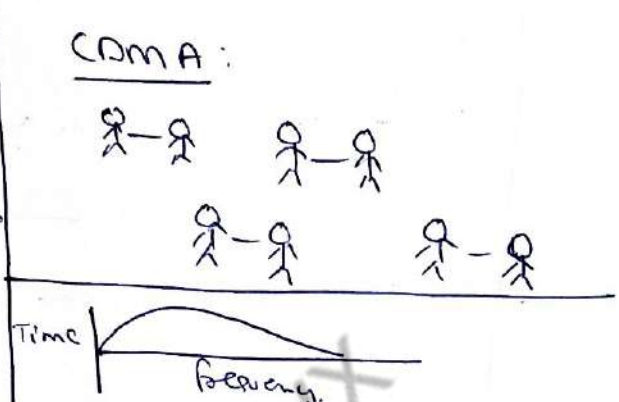
2G :→ TDMA
↳ CDMA

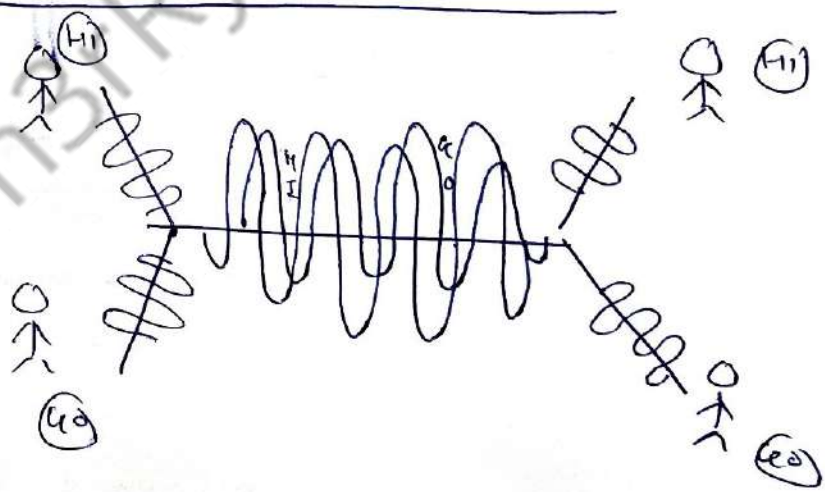
TDMA





CDMA:



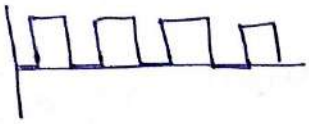


2nd gen TDMA:

Time Divisian Multible Access.

TDMA :

- Users have to share same frequency without interference.



- Digital mobile radio system.
- Divides signals into timeslots & increases the data carrying capacity.

Adv.

1. Flexible rates
2. variable traffic
3. frame by frame
4. no. of slots can be changed

Disadv.

1. complex
2. energy consumption = high
3. inaccuracies
4. synchronization required

CDMA :

- Shared code
- every channel uses full available spectrum.
- better voice
- digital data
- encrypted data

Adv.

1. high quality
2. Flexible
3. not decodable
4. no synchronization req.
5. low power level

Disad.

1. no international roaming
2. stored in phone memory
3. performace degrades with increase users.

3rd Gen:

- 2000 year
- ckt & packet switching
- high speed
- low investment

- 5 -10 mbps
- 15 -25 GHz
- high security

- cost = high
- cost of 3G licence = high

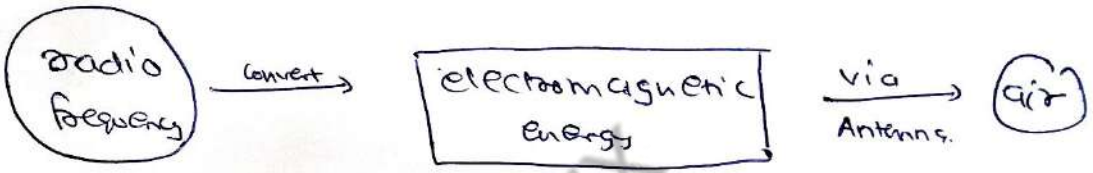
GSM → Global System for mobile comm.

GSM	CDMA
(1) Global system for mobile comms.	(1) Code division multible Access
(2) TDMA & FDMA	(2) only CDMA
(3) High speed = (42mBPS)	(3) High speed = 3.6MBPS
(4) (3G)	(4) (2G)
(5) Stored in (SIM)	(5) stored in (Phone)
(6) Global market share = 75%	(6) Global share = 25%
(7) Support international roaming.	(7) Donot support international roaming.

Antenna

- electrical conductor

Transmission : (i) radiates electromagnetic energy into space.



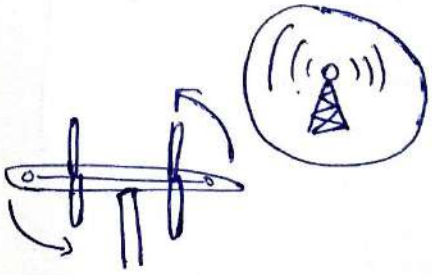
Reception : (i) collects electromagnetic energy from space

" vice versa of above "

2 type of Antenna:

1. isotropic ——→ radiate power equally in all dirns.
   ——→ Used to calculate the gain of antennas.
2. dipole
   - Hertz
   - marconi

   } Antennas



Hertz : length = $\lambda/2$

Antenna gain

Effective area

Ae

(G)

$$\therefore \boxed{G = \frac{4\pi Ae}{\lambda^2}} \quad \text{or} \quad \boxed{G = \frac{4\pi Ae f^2}{c^2}}$$

i.e $\lambda = c/f$

Isotropic : G = (1)

Dipole : G = (1.5)

Propagation mode:

Propagation in form of electromagnetic waves

(1) Ground wave

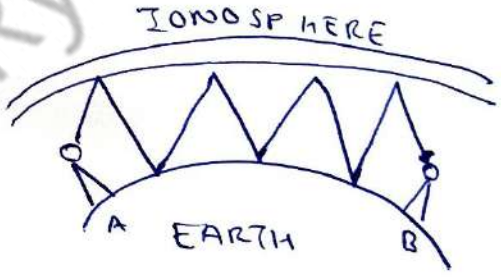
(2) Sky wave

(3) Line of sight

(1) Ground wave :

- EM wave remains close to (earth)
- follows curvature.
- 30kHz and 3MHz : Range
- while passing, ground waves induces current to it : (looses) some (energy)

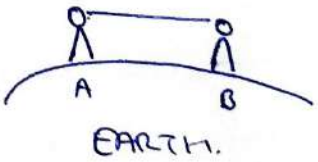
(2) Sky wave :



- signals reflected from ionosphere.
- travels a no. of hops - back & forth
- reflection is caused by refraction.

  eg. Car radio → range is high.

(3) Line of sight wave :



- (min.) distance b/w A & B
- travels till the vision of (naked eye)
- signal [>30MHz] is not reflected back
- Antenna within effective LOS works.
- need amplifier.

eg. Microwave & infrared.

Ryx

1. Attenuation : Strength falls off with distance.
2. free space loss : loss of signal w/ distance
3. Noise : unwanted signals
4. Refraction : bending signal away from reciever
5. multipath : multiple interfering signals
6. Absorption : oxygen, vapour & water absorbs signals

Modulation :

↳ Shifting of [baseband signal] — [pass band signal] range.

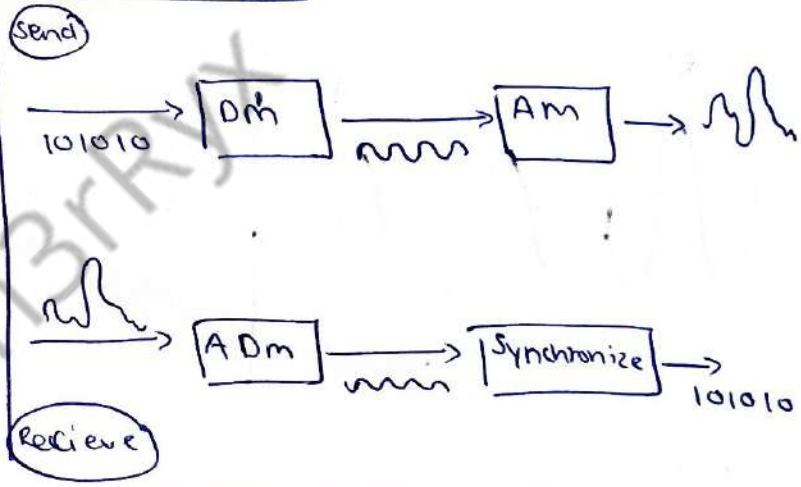
Demodulation :

↳ shifting of [pass band signal] — [baseband freq.] range.

Encoding :

1. Analog – Analog
2. Analog – Digital
3. Digital – Analog
4. Digital – Digital

Modulation : (Radio wave)



Digital – Analog Modulation :

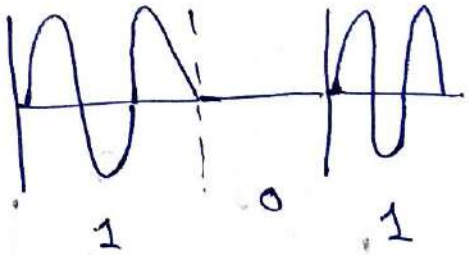
Amplitude Shift keying (ASK)

↳ 2 binary value ⟶ 2 amplitudes

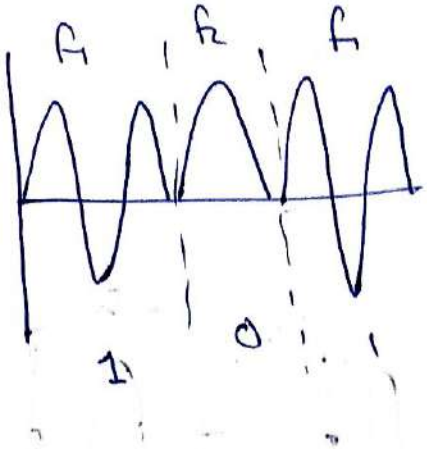
↳ susceptible to interference.

↳ (low bandwidth) requirement.

↳ Not used for wireless radio ⟶ used in wired network (Optical)



FSK: frequency shift keying



↳ 2 binary value ⟶ 2 diff. frequency

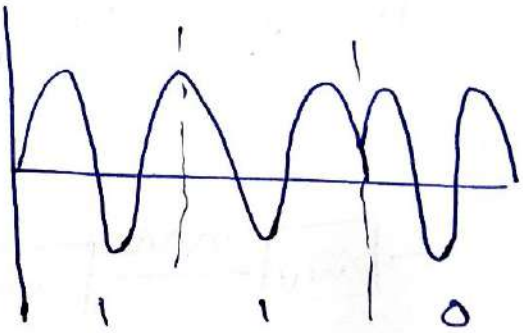
f1 → 0 & f2 → 1

↳ need (larger) bandwidth.

↳ less susceptible to errors.

implementation by : switching b/w 2 oscillators, one w/ f1 & other w/ f2.

PSK : Phase shift keying



↳ more (complex)

↳ just opposite phases / freeform signals for 2 values

↳ robust against interference

ANALOG — ANALOG

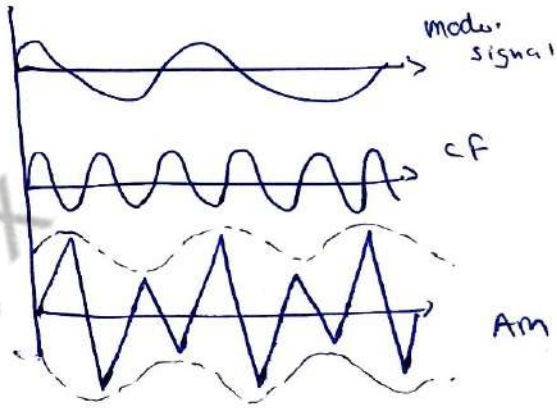
Modulation is needed iff bandpass in nature or iff bandpass channel is available.

Types :

(1) Amplitude modulation:

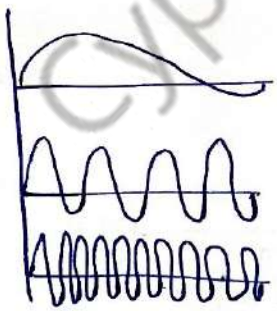
↳ carrier signal modulated → Amplitude value.

↳ modulating signal → envelope of carrier.



Required bandwidth = $2B_K$ ← bandwidth of modulating signal

(2) frequency modulation:

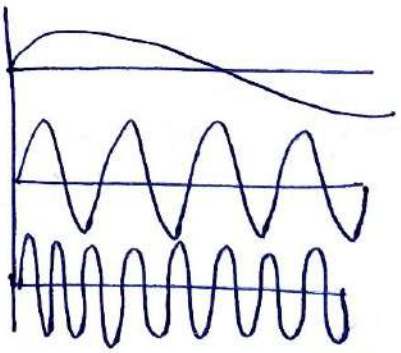


↳ Bandwidth is (high).

↳ 10x of signal frequency.

↳ modulating signal ↓ (change) fc of carrier signal

(3) Phase modulation:



↳ modulating signal ↓ change Phase of CS

↳ bandwidth is higher than for (Am).

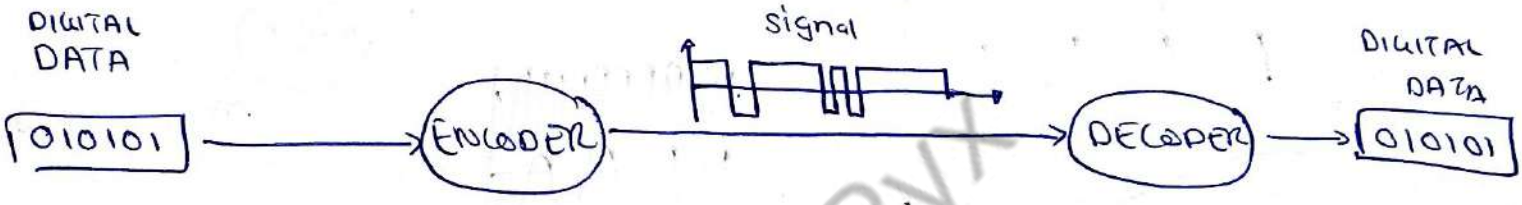
Digital – Digital conversion:

① Line coding:

↳ converting 1's & 0's into **sequence of signals.**

High voltage = +V or 1

low voltage = −V or 0

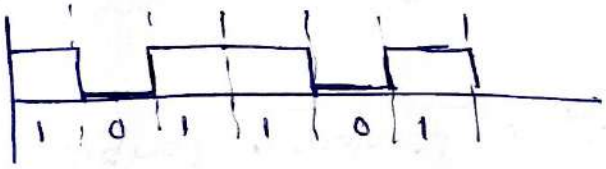


DATA SIGNAL Mapping:

1 ⟶ +V

0 ⟶ −V

UNIPOLAR: All signals are either above or below.



NRZ

↓ ↓

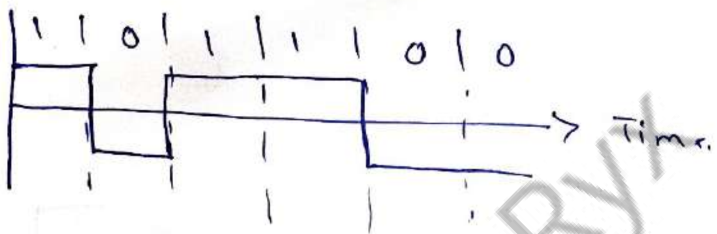
non return to zero

POLAR NRZ : voltages are on both sides of the time axis.

+V → 1

−V → 0

2 version : <u>NRZ-L (NRZ-level)</u> : +ve voltage → one signal
−ve voltage → one signal

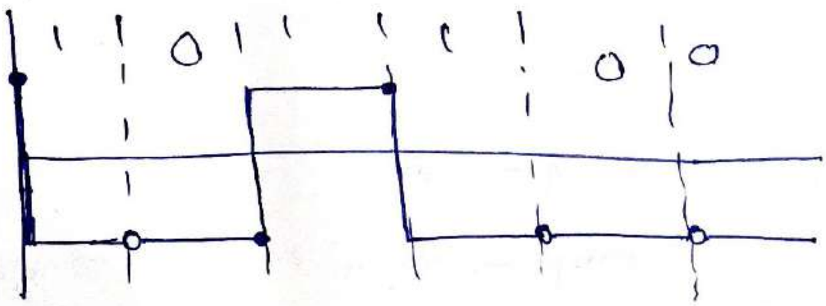


<u>NRZ-I (NRZ-inversion)</u> : "1" inverts the polarity
"0" dont " " "

means jya jya one ave ette signal change karvi devano.

eg. 101100 : Upar NRZ-L no reference.

<u>NRZ-(I)</u>



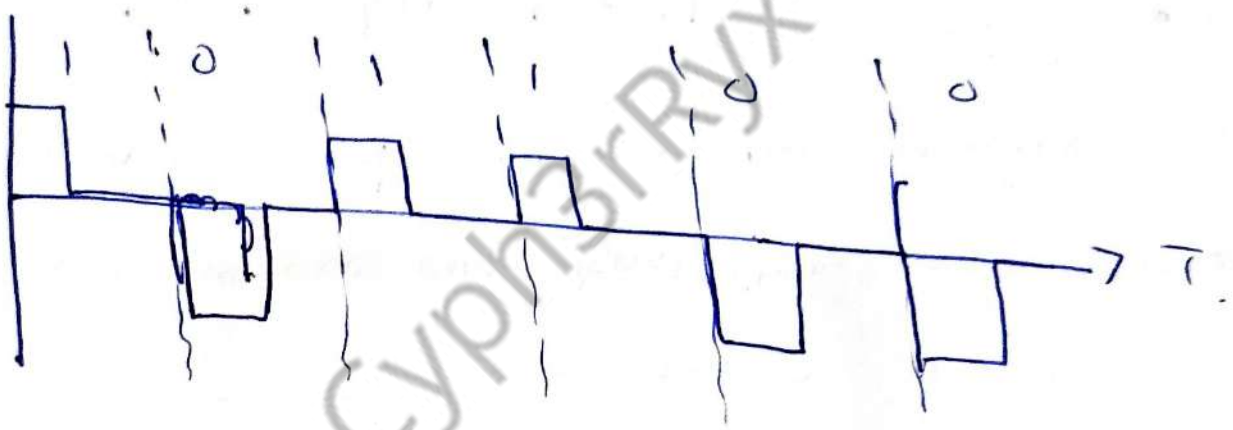
• → change the phase

0 → dont change the phase.

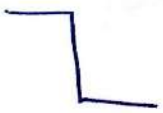
jya "one" ave ette phase change baki chalva do

Polar RZ : Return to Zero

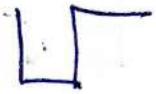
- 3 value +, 0, −
- each symbol has transition in middle
  - (1) either from high → low
  - (2) " " low → high
- complex.



for 1

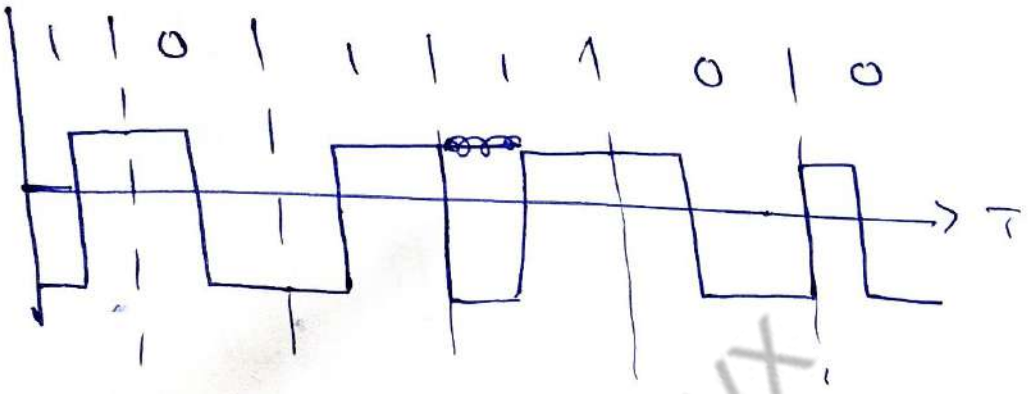


for 0

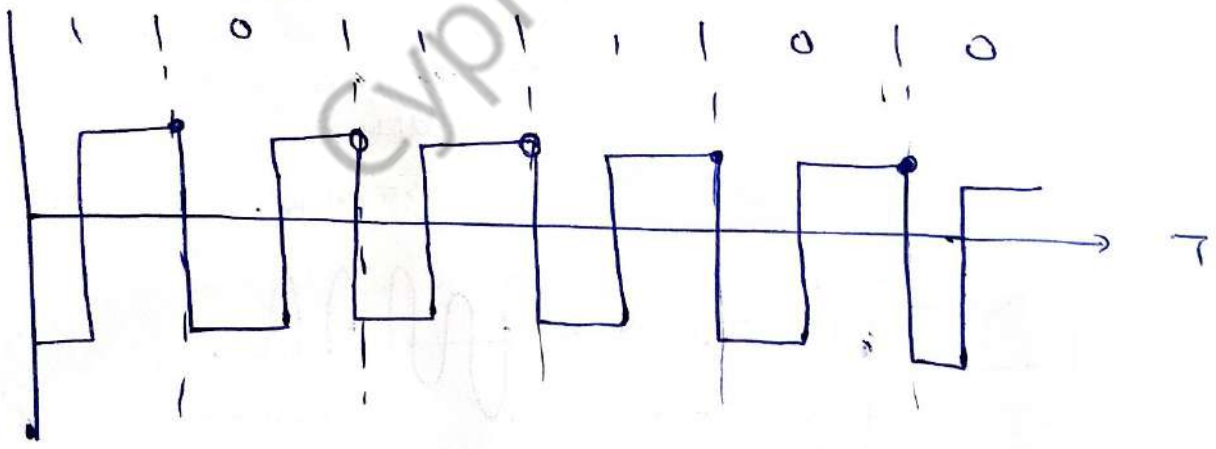


Polar Biphase:

Manchester:



Differential: 0 ⟶ next bit is 1 ●⟶ next bit is 0



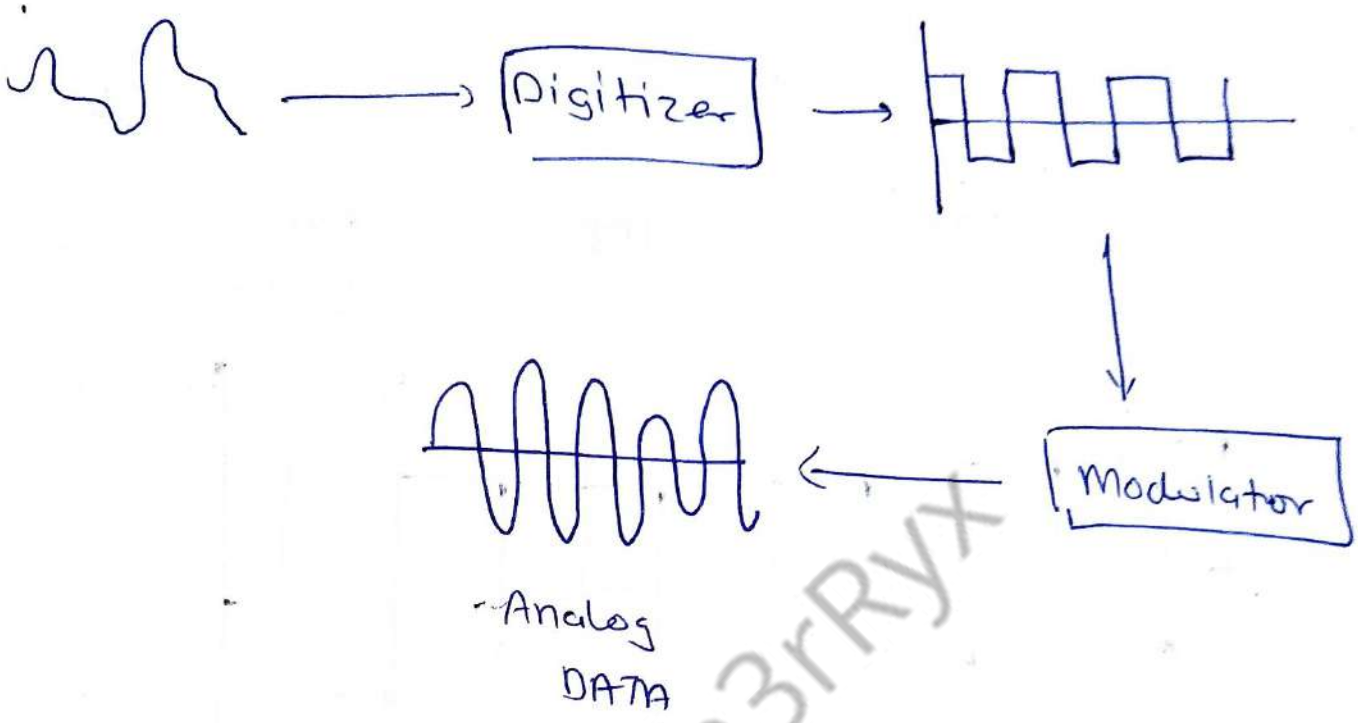
aa undhu che NRZ - (I) karta.

"1" ma change nai levano

"0" ma change lavano.

Ryx

Analog to Digital



Annexure No :

SPREAD SPECTRUM :

In wireless conventional communication,

"A fixed frequency is used & this frequency doesn't change over time"

eg. 93.5 FM & 98.3 FM will always transmit the radio wave on those selected frequencies only.

Problem:

(i) **interference** :

When another signal → transmitted → on very near frequency

eg. 98.3 FM & 99.1 FM can collide.

(ii) **interception** :

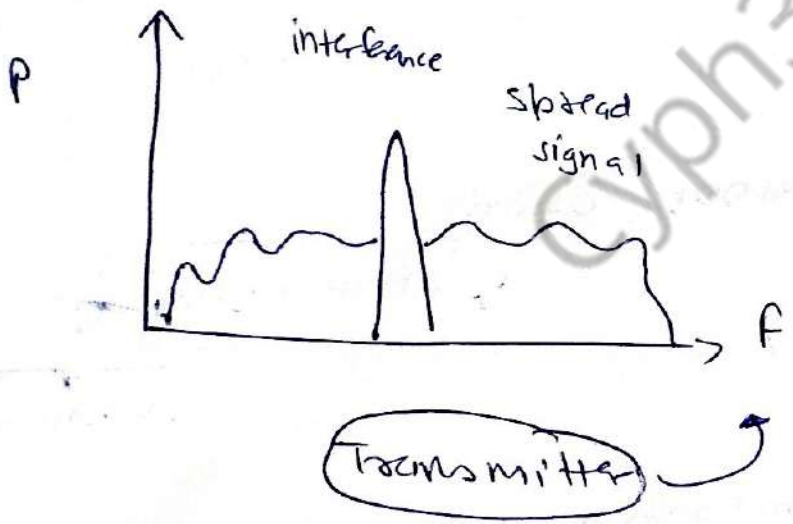
A middleman listening to the frequency

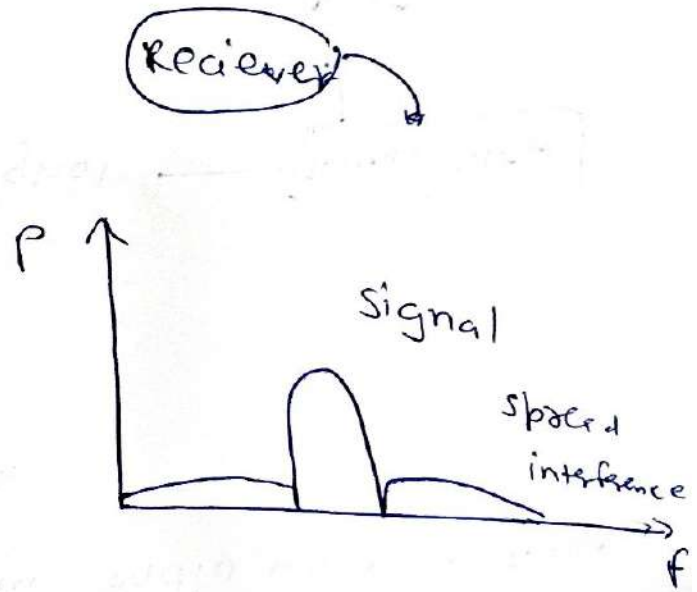
SOIN is SPREAD SPECTRUM TECH

↳ Spread [narrow band] ⟶ [broad band] using special code.

↳ expansion

↳ spread data signal on frequency spectrum.





Annexure No :

Type :

① FHSS : frequency hoping Spread spectrum

eg. WLAN

SPACE Application.

↳ multiple frequency ⟶ transmit data

↳ freq. periodically modified following a special sequence

↓

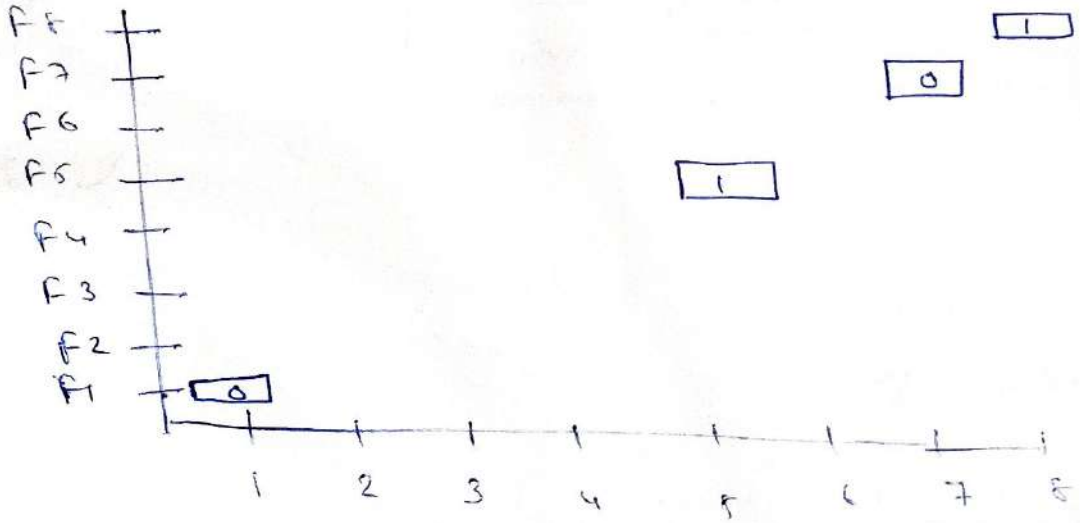
hoping sequence

Amount of time spent on each frequency

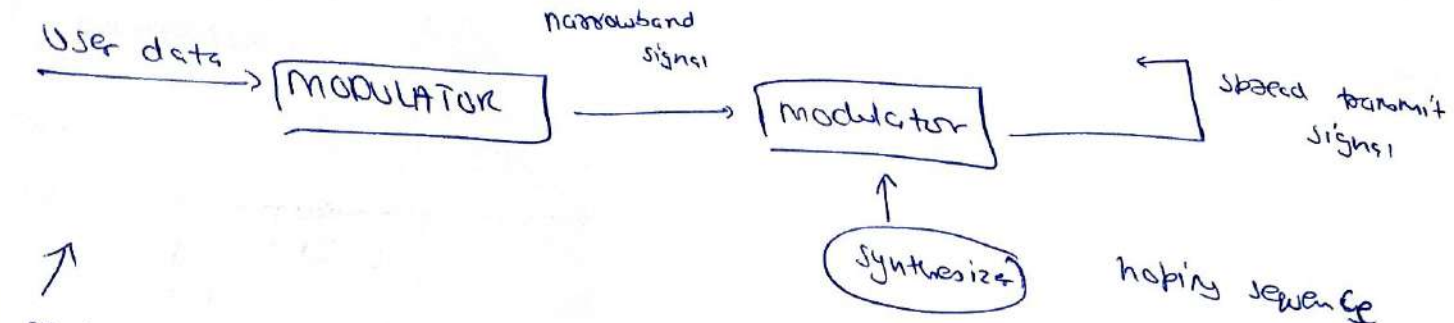
↳ "dwell time"

User "A" wanna sent 0101 to B

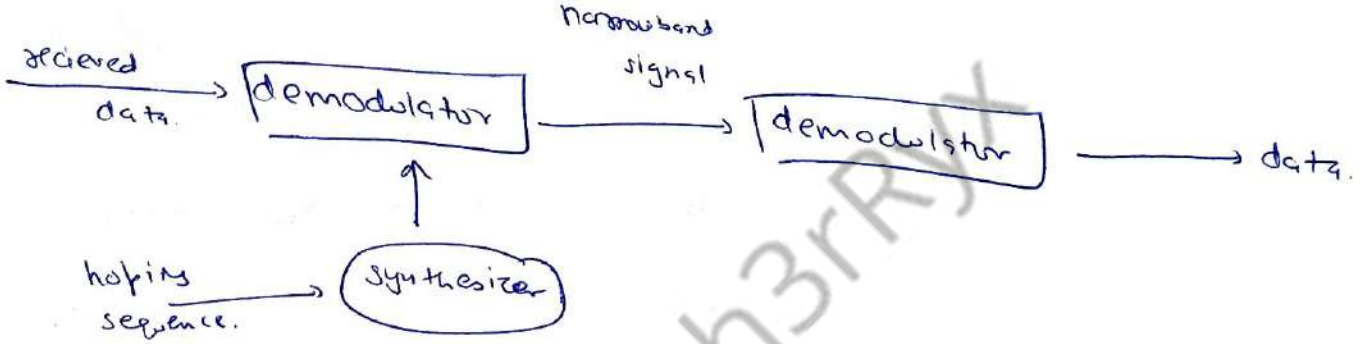
so., let say hoping sequence of A is. f1, f5, f7, f6



Ryx



reciever



Advantage:

(1) Resistance from interference & interception

(2) multipath propagation

Disadvantages:

(1) more difficult to synchronize

(2) High latency.

(2)

Annexure No :

DSSS : Direct sequence spread spectrum.

↳ every user is assigned a **code**

↓

encode → (signal)

Code

↳ multiplied with (M) → [Result] → transmitted

Reciever

↳ use **same code** → decode [M]

Eg. 010111

Here 0 is represented via −1

∴ (−1, 1, −1, 1, 1, 1) ⇒ [spreading code]

Adv.

(1) Resistant from interference & interception

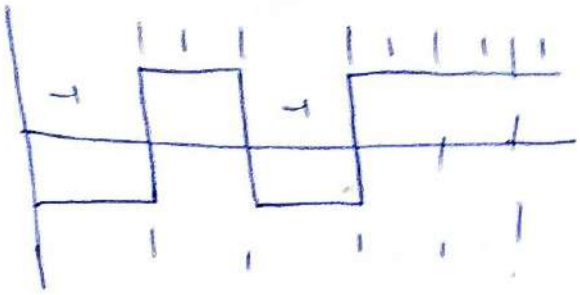
(2) More reliable

Disad.

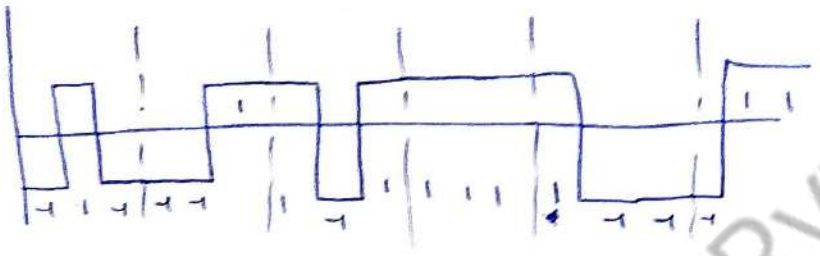
(1) Design is hard.

Ryx

eg. (-1, 1, -1, 1, 1, 1)



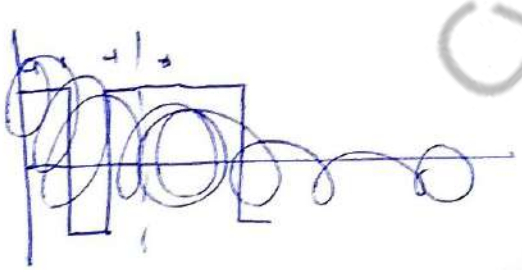
Low bandwidth

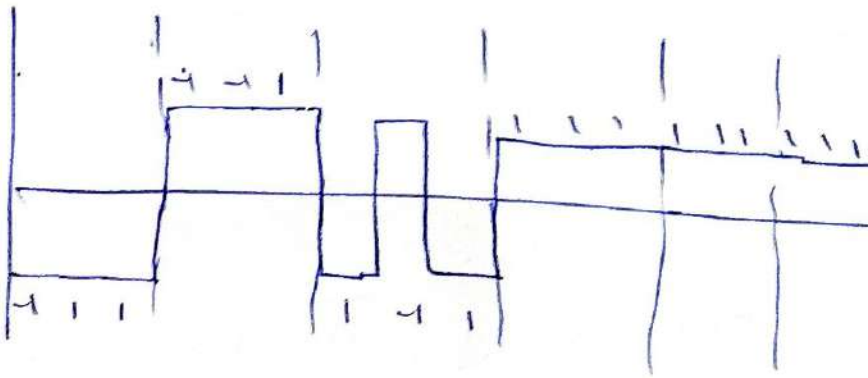


high bandwidth

Now multiply (1 x 1 => same

1 x -1 => opposite)



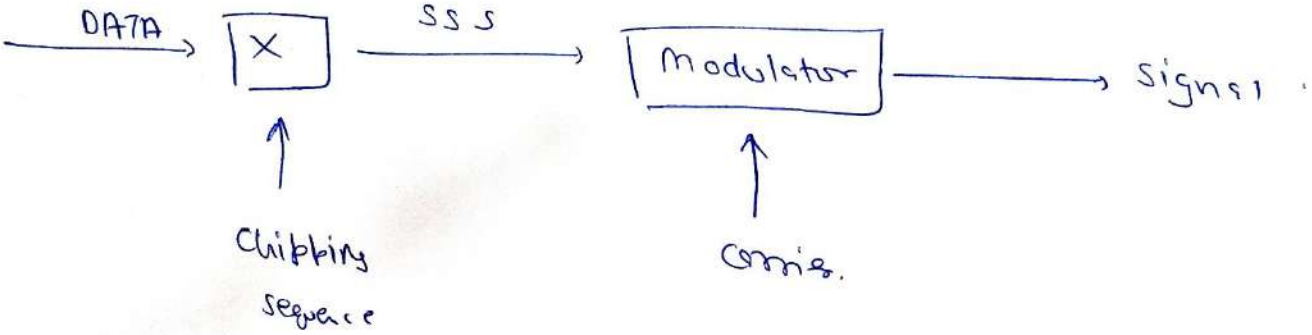


for decoding

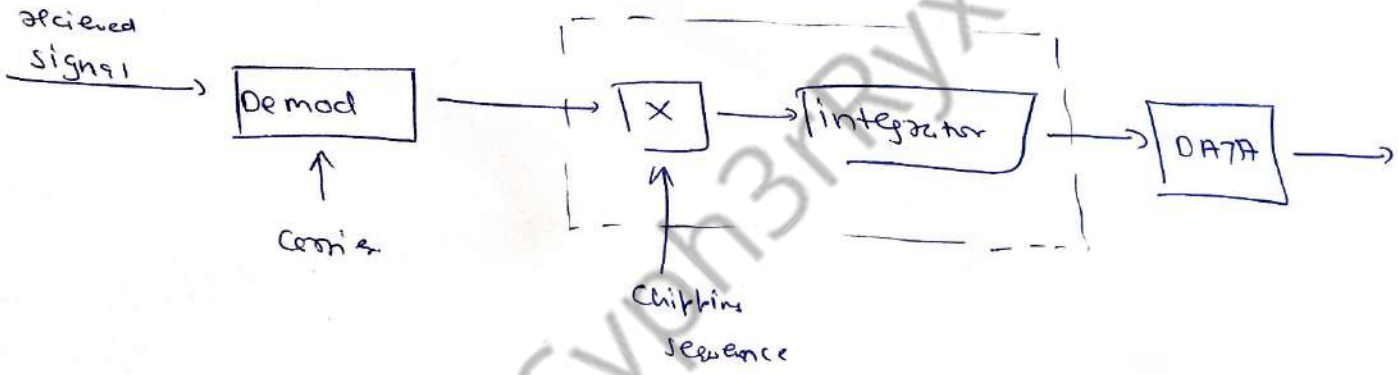
send the result and the high bandwidth &

multiply => Low bandwidth

SENDER:



RECIEVER:



CH:3

GSM = Global System for Mobile Comms.

- GSM - 900 MHz → 890 - 915 → uplink
  → 935 - 960 → downlink
- (Digital Cellular) GSM - 1800 MHz → 1710 - 1785 → uplink
  → 1805 - 1880 → downlink
- Ccsm - 1900 MHz (Personal Comms)
  - 1850-1915 → uplink
  - 1930-1990 → downlink

Characteristic :

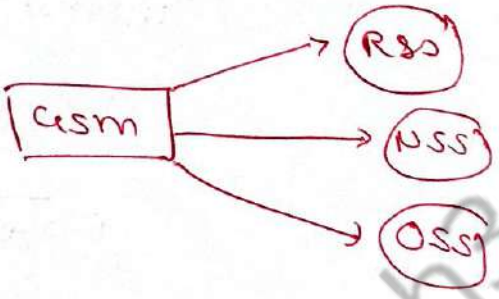
- Communication
- Total mobility
- Worldwide connectivity
- High capacity
- Security fxns
- High transmission quality

GSM → based on [set of standards] formulated in the early (1980's) by Companies [NOKIA, MOTOROLA, etc]

Gsm Architecture

Divided into 3 parts:

1. Radio / Base station Subsystem (RSS & BSS)
2. Network switching subsystem (NSS)
3. Operation support subsystem (OSS)



Additional Component

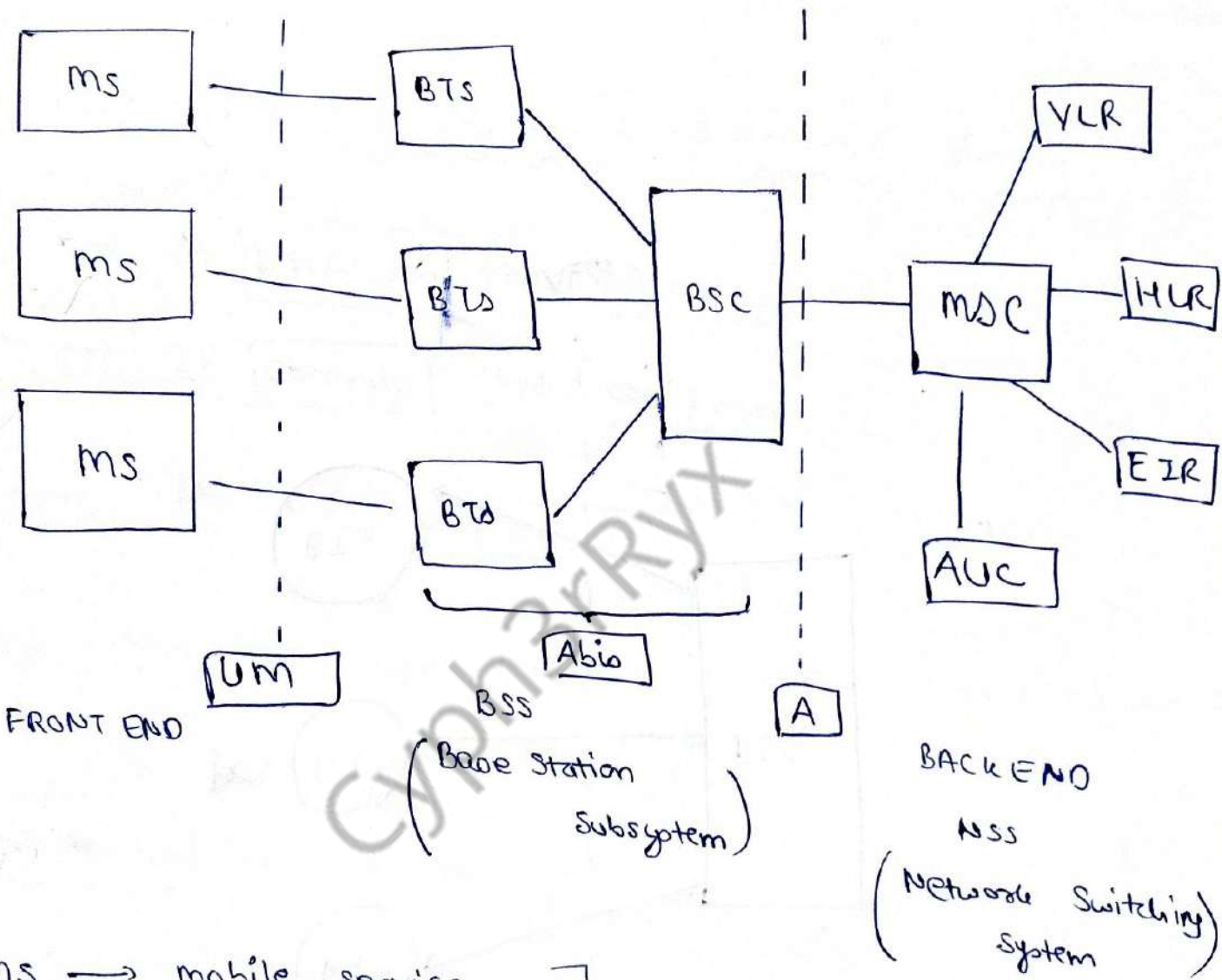
- HLR => Home Location register.
- VLR => Vistor Location register
- EIR => Equipment Identity register
- AUC => Authentication center

(HLR, VLR, EIR, AUC) — register / database.

- SMS SC => SMS serving center
- Gmsc => Gateway MSC
- CBC => ChargeBack center
- TRAU => Transcode & Adaptation Unit.

~~Structure~~

Architecture



MS → mobile service
BTS → Base Station Service
→ Connected via (Um) interface

(Tower) BTS → Base Transreciever Station
BSC → Base Station Controller
→ Connected via (Abis) interface.

MSC → mobile Station Controller
→ Connected via (A) interface.

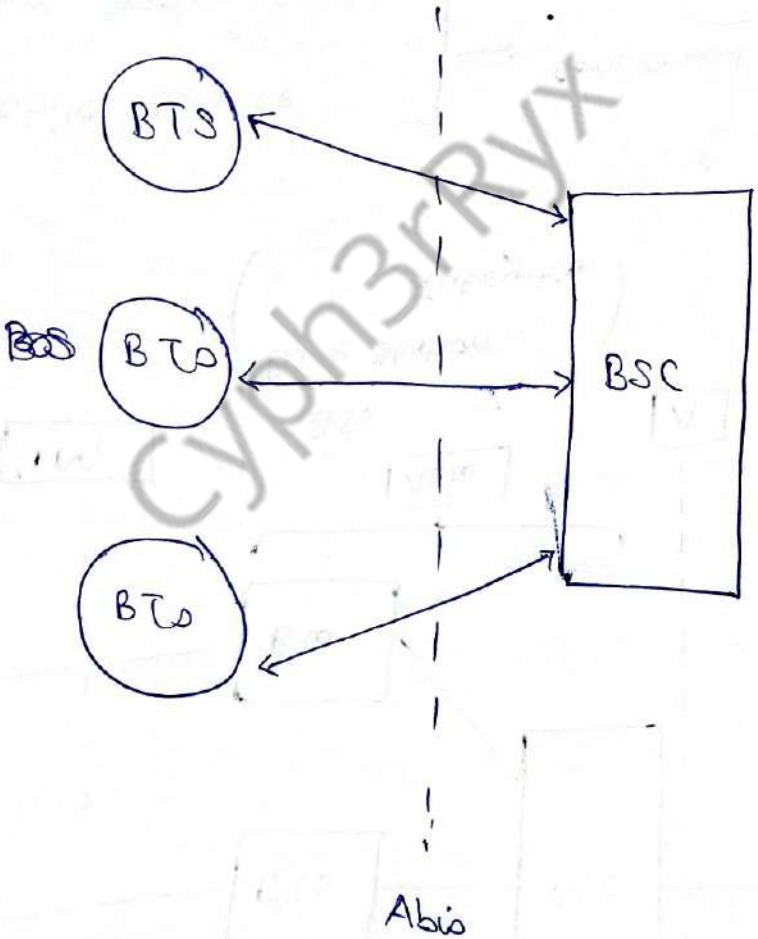
Here, MS — front end → mobile service] children's child

BTS — middle logic → Base Transceiver service] Child

BSC — middle logic → Base station controller] Parent

MSC — Back end → Mobile station controller.] Grand Parent

BSS :



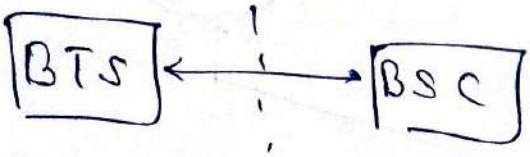
BTS is like a "Tower of mobile"

- TRX → Transmit & Recieve signals.
- It processes the signals.
- It controls the equipment.
- It also has antennas

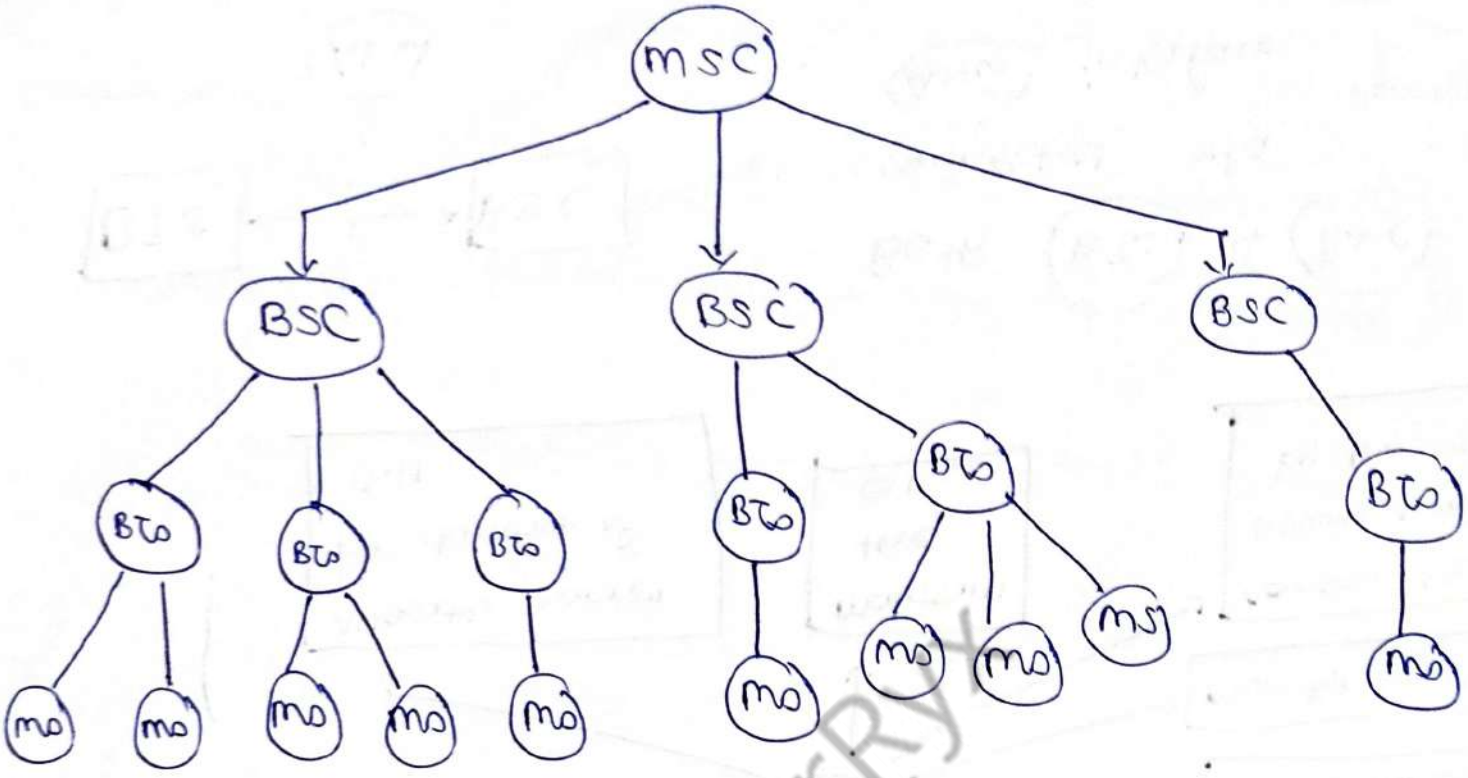
Lets say you call your friend, you need some medium for the call.

That medium is set by BSC

- handle handover
- monitor quality
- control the power transmitted by BTs or MS
- Allocates channel for duration of call
- maintain the call



Both BTs & BSC are connected via Abis interface.



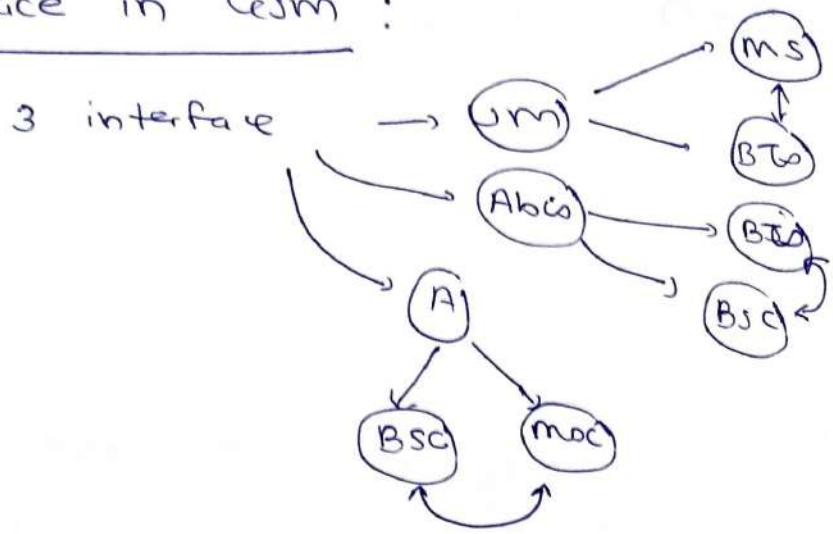
MSC = Root node

BSC's = Children node

BTs = Siblings

ms = leaf node.

Interface in GSM :



(1) Um interface :

- ↳ betn (MS) & (BTS)
- ↳ Uses (CDMA)
- ↳ Transmit & recieve info / traffic

(2) ABIS interface :

- ↳ betn (BTS) & (BSC)
- ↳ Transmit Traffic & inform [BSC] & [BTS]
- ↳ Uses [Link ACCESS Protocol]

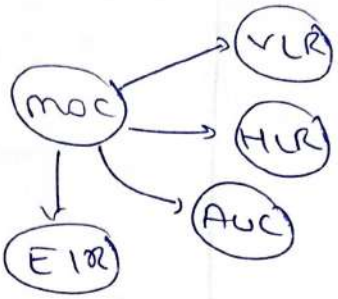
LAP →

(3) A interface :

- ↳ between (BSC) & (MSC)
- ↳ manages (BSS)
- ↳ Call handling
- ↳ manages mobility
- ↳ Bandwidth max. [2Mbps]

Enrollment No :

MSC Register



(1) HLR : Home Location Register

↳ stores permanent data about subscriber (profile, location, status)

↳ stores subscription info of registered user is stored

SIM info goes to HLR

(2) VLR : Visitor Location Register

↳ Stores temporary data about subscriber

↳ Integrated with MSC

↳ works in co-ordination with HLR

me = Gujarat

me move to Assam

ASSAM HLR = no info of me

so ASSAM HLR contact GUJARAT HLR

Info transmission

then I get service in Assam.

(3) AuC => Authentication Center.

↳ Protected Database

↳ Stores a copy of secret key

↳ Used for authentication

↳ protection from fraud.

(4) EIR => Equipment Identity Register.

↳ A type of database

⇓

Contains a list of all mobile on network.

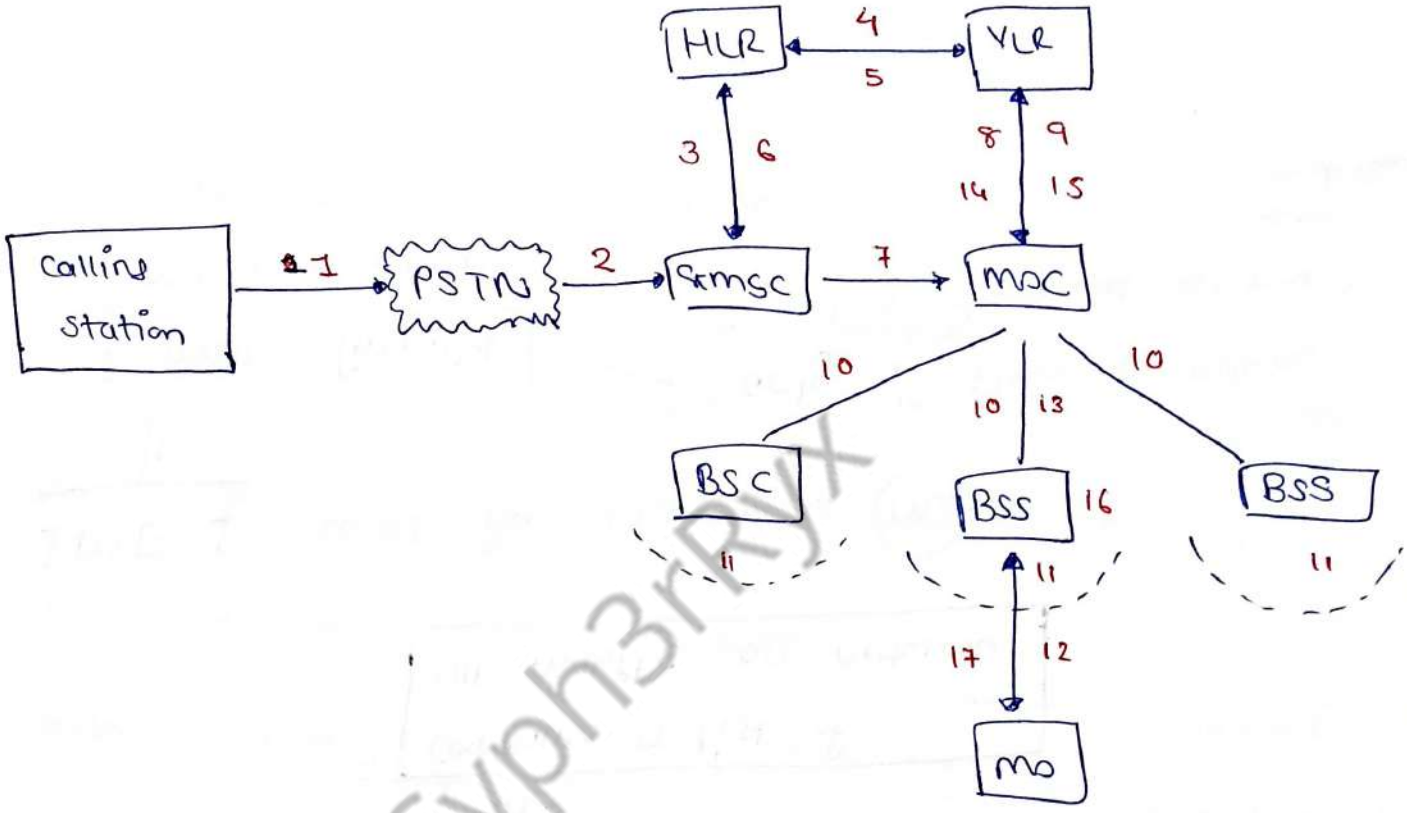
↳ IMEI used for identifying (no)

⇓

if marked invalid → only if phone is either stolen, destroyed or not in good condition.

no work work.

Call routing in GSM : (MTC)



1 ⇒ Calling a GSM subscriber.

2 ⇒ forward a call to GMSC

3 ⇒ signal call setup to HLR

4, 5 ⇒ Request VLR

6 ⇒ forward MSC to GMSC

Annexure No :

7 => forward call to current MSC

8, 9 => get current status of MSC

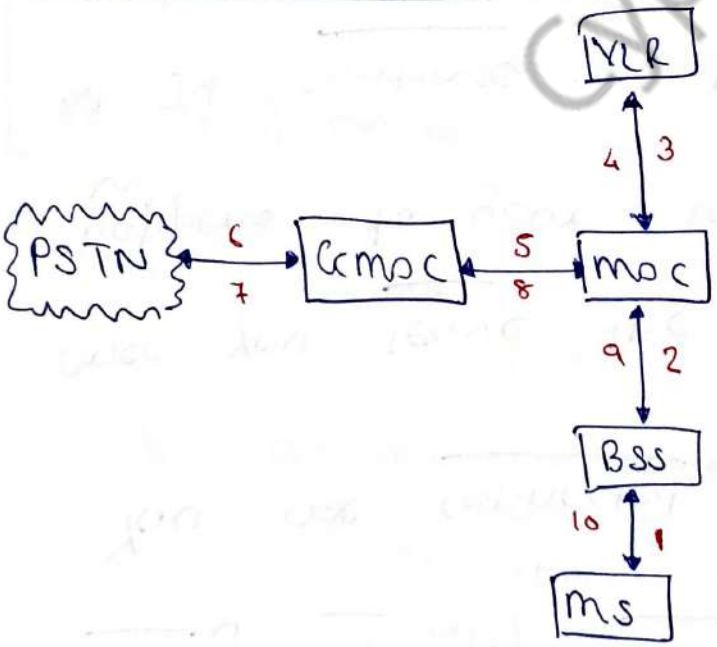
10, 11 => Paging of MS

12, 13 => MS Answer

14, 15 => security checks.

16, 17 => connexn setup.

Call from mobile: (MOC)



1, 2 : Connexn request

3, 4 : security check

5, 8 : resource check (if ckt is free or not)

9, 10 : call setup

Handover:

Suppose you are in a car and you are talking w/ your friend on mobile phone

You are connected to Base Station - (1)

Once you leave the radius of BS-(1), what happens to your call?

- It continues and find the Base Station - (2) which is nearest to your location and it will directly connect you with that BS and call continues.

Whole above process is called "Handover".

Annexure No :

How it happens ?

MS & BTS provide info for handover

↓

weak link & quality check

Measurement info —send→ every 0.5 second

↳ contain quality of current link & quality of certain channel in neighbouring cell

Once MS moves away from BTS (old) to new BTS (closer)

Handover decision don't depend on actual value of recieved signal

but on average value

BSC collect values of [bit error rate, signal level] from BTS & MS

(i) MS —send→ measurement report ——→ BTS(old)

(ii) BTS(old) —send→ measurement result ——→ BSC(old)

IF HO is required then.,

(iii) BSC(old) —send→ MSC

(iv) MSC —request→ for HO ——→ BSC new

(v) BSC(new) will allocate resources

(vi) BSC(new) —send→ Channel activation —request→ BTS(new)

(vii) BTS(new) —send→ Acknowledgement ——→ BSC(new)

(viii) BSC(new) —HO Request / Ack→ MSC

(ix) MSC —HO Command→ BSC(old)

(x) BSC(old) —HO Command→ BTS(old)

(xi) BTS(old) —HO Command→ MS(old)

(xii) HO Access from old MS ——→ new BTS

Link established & HO complete w/ clear commands

Annexure No :

GSM Address & Identifier :

1. Mobile Station International ISDN number :

- MSISDN
  - has country code
  - national dest. code
  - subscriber no.

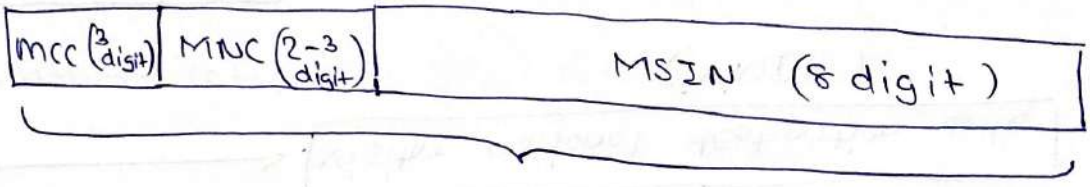
GSM user main part PHONE NO.

2. International Mobile Subscriber Identity

- IMSI
  - mobile country code
  - mobile network code
  - MSIN

Used for internal unique identification of a subscriber.

Sim card



15 digit MAX.

3. Temporary Mobile Subscriber Identity

- TMSI
  - selected by current VLR
  - valid temporarily with VLR area
  - VLR change TMSI periodically

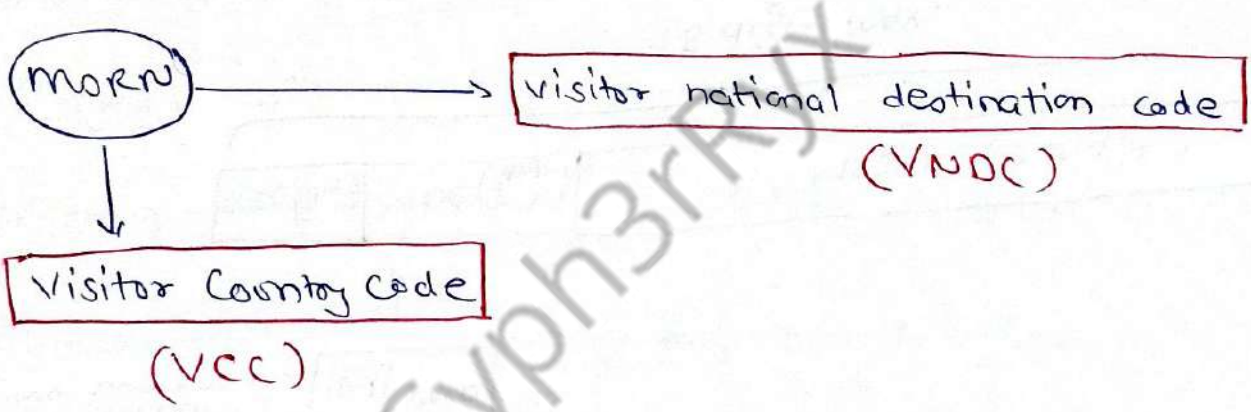
To hide IMSI, GSM uses (4) byte TMSI

4. Mobile Station Roaming Number (MSRN):

VLR generates MSRN on request from MSC

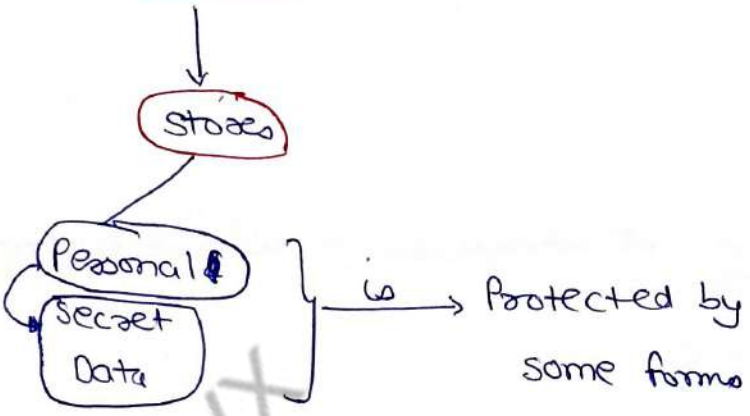
Address stored in HLR

Temporary address hides [identity & location] of a subscriber.



Gsm security :

↳ offer security using confidential information stored in AuC and SIM



Forms of security :

① Confidentiality :

↳ All user data = encrypted

↳ After authentication BTS & MSC APPLY encryption To Voice, data

② Authentication :

↳ Before a subscriber uses any service he / she must be authenticated

Based on SIm which stores

Ki = individual key

IMSI = user identifi.

Algorithm

③ Anonymity :

↳ All data must be encrypted before transmission

Algorithm

A3 ⟶ Authentication

A5 ⟶ Encryption

A8 ⟶ Generate Cipher keys

Annexure No :

GPRS → General Packet Radio Service

- New version of GSM
- GPRS deals with both data & voice

It greatly improves & simplifies wireless access to packet data networks.

GPRS → applies → Packet radio Principals → TO → TRANSFER

TRANSFER → USER DATA PACKETS → between → MS & External Network

Benefits :

1. New Data service
2. High speed Data
3. Constant Connectivity
4. Ckt switching & Packet switching can be used parallelly.

Packet Mode Transfer :

Exhibits Traffic Patterns as,

(i) frequent transmission of small volumes

(ii) Provides the selection of QoS parameter for service requesters

(iii) Also allow for [broadcast, multicast & unicast]

(iv) Network provider should be charging money on volume and not on connection time like in GSM.

GPRS QoS :

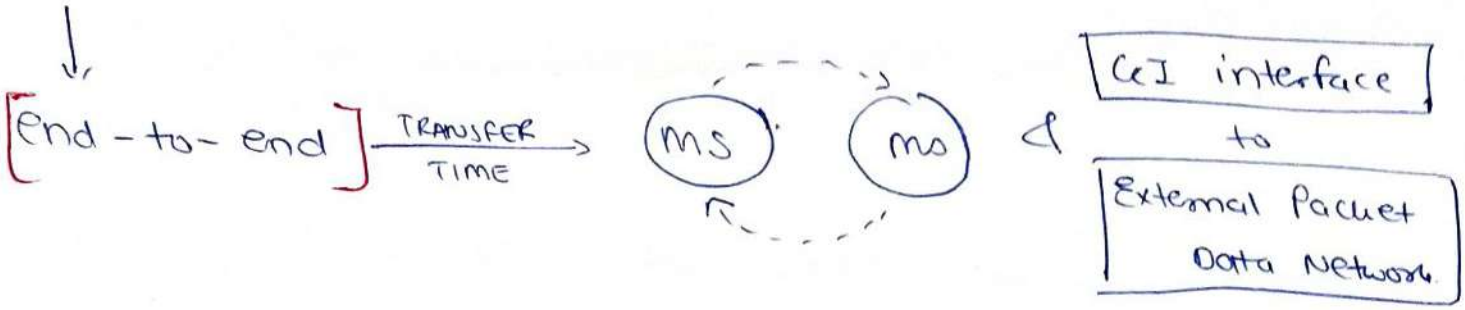
Parameter : Reliability

Classes defined → guarantees → max. value for

- Probability of loss
- Duplication
- missequencing
- corruption of packets

Annexure No :

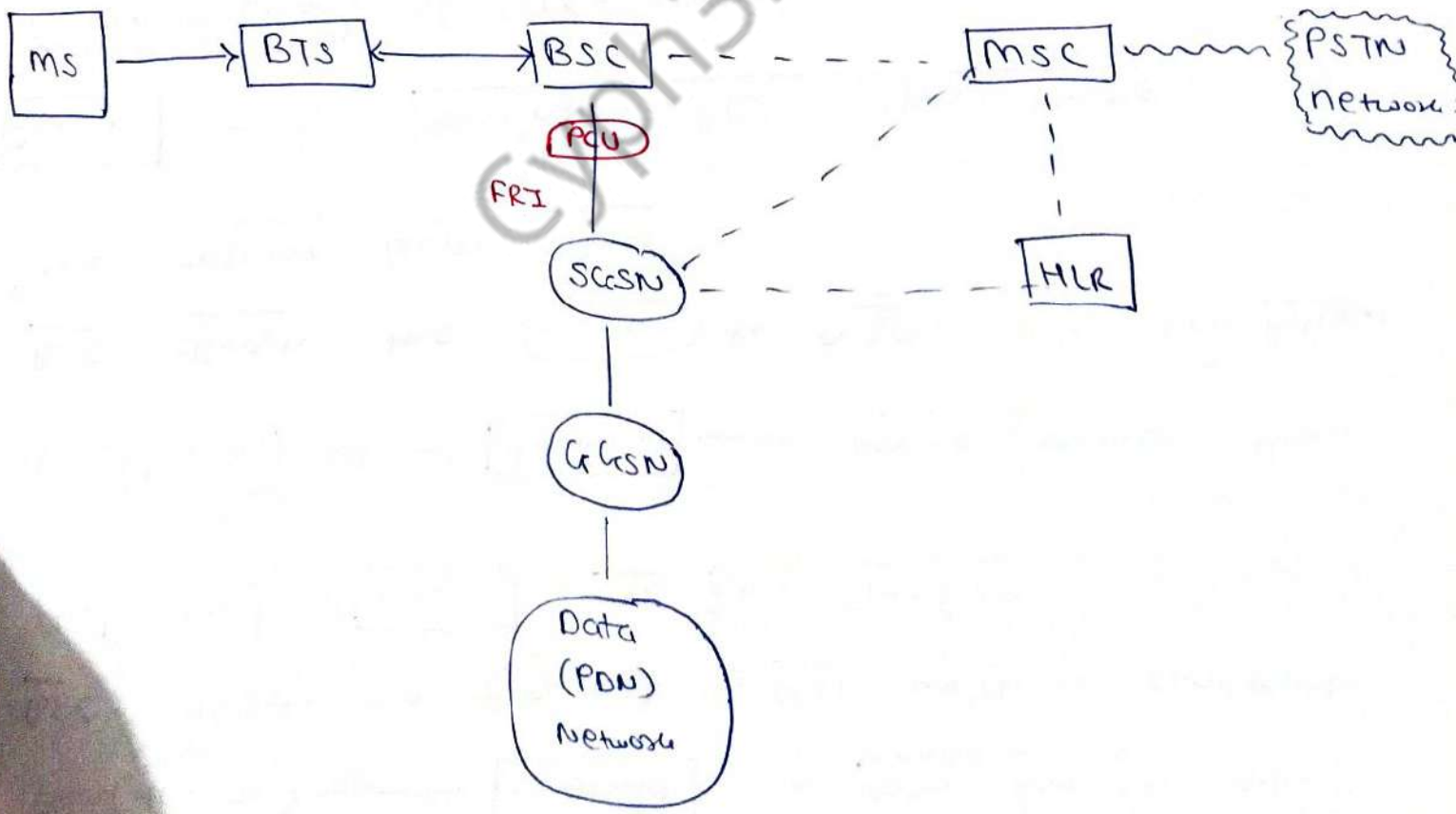
Delay



Throughput :

- max. bit rate
- mean bit rate

GPRS Architecture :



Enrollment No :

Page No :

PCU → Packet Control Unit

↳ if device ⟶ demand ⟶ data services then BSC divert the request to PCU which is connected to SGSN & GGSN via FRI interface.

↳ if device ⟶ demand ⟶ voice services then BSC divert the request to MSC which then follow the regular com flow.

SGSN ⟶ Serving GPRS Support Node

↳ Authentication of GPRS user

↳ Data Compression

↳ Registration of mobile in network

↳ keep track of individual's Location.

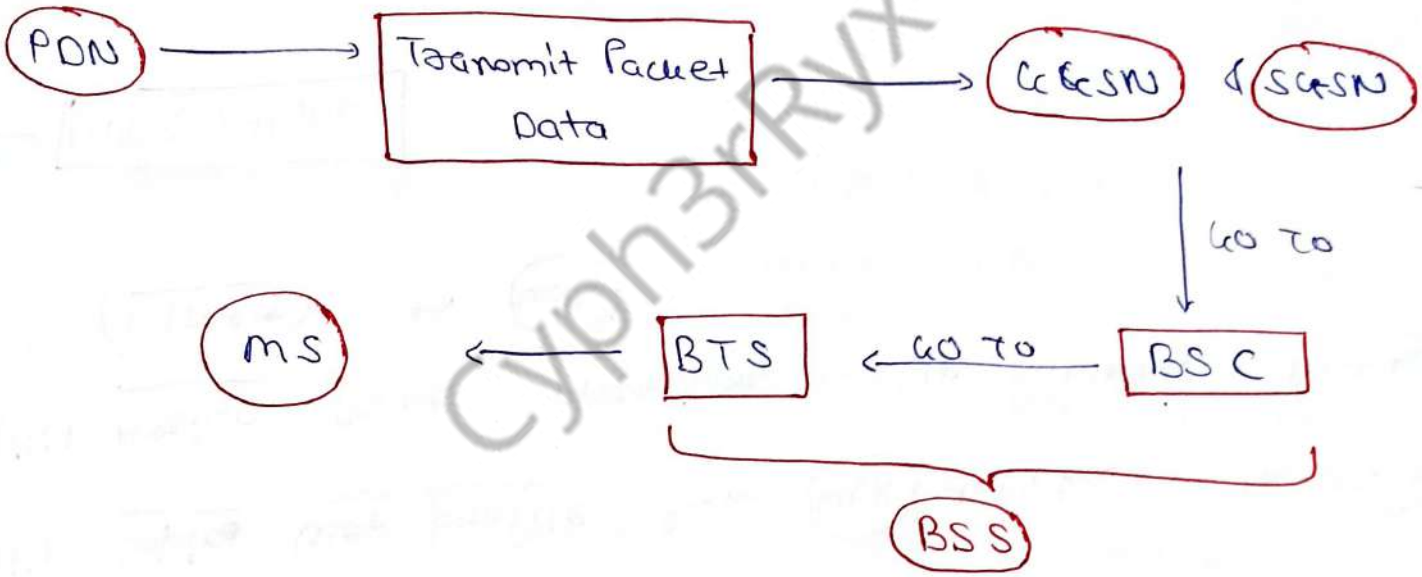
↳ keep track of billing information.

GGSN → Gateway GPRS Support Node

↳ mediator between PDN and SGSN

- routing information for GPRS users
- perform address conversion
- Data Tunneling via Encapsulation

Working :



GPRS Operations

1. Attachment & Detachment
2. Mobility management
3. Routing
4. Communication with IP network.

(1) GPRS Attachment & Detachment operations:

Before a (MS) uses (GPRS) service,

MS must register with (SGSN) of GPRS network.

Network,

(i) Check Authorization of user

(ii) Copies user profile from (HLR) data base to (SGSN)

(iii) Assign Packet Temporary mobile Subscriber Identity (PTMSI) to (user)

GPRS Attach

GPRS Detach also works in similar way & it is used for disconnecting from network.

(2) Mobility Management :

↳ main task → To → keep track → user location

↳ (MS) send location update to (SGSN)

so that network can be aware of current location of MS

↳ (3) States exist & diff. strategies applied

LOCATION UPDATE

(MS) Crosses border → LA (Location Access) & RA (Routing Area) should be done.

(MS) moves within same (LA) but diff. (RA) → RA Update

" " " same (LA) & (RA) → Cell update

Packet sent to MS = Paging required

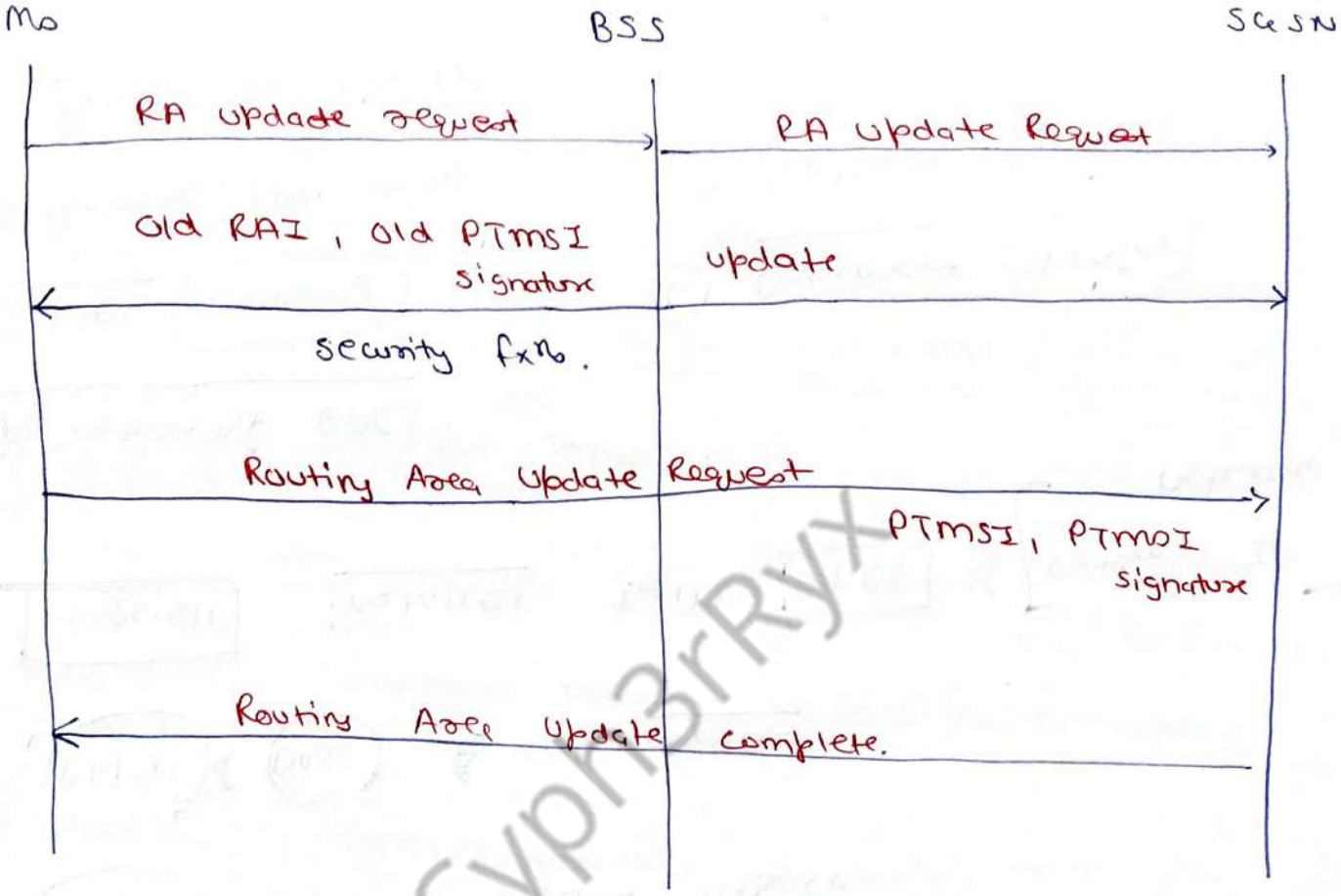
↳ to find accurate location.

- Uplink wasted for paging response
- Downlink requires paging for delay

RA Update :

- MS moves to new RA sends Routing Area Update Request (RAU)
  - including Routing Area Identity (RAI)
    - To Old RA
- Request recieved at BSS
  - it adds Cell identifier (CI) to new cell
- Based on RAI & CI data ⟶ SGSN give new RAI
- Also SGSN assigns a new PTMSI to user.

3. Routing



Inter SGSN Routing :

MS moved to an RA ⟶ Diff. SGSN

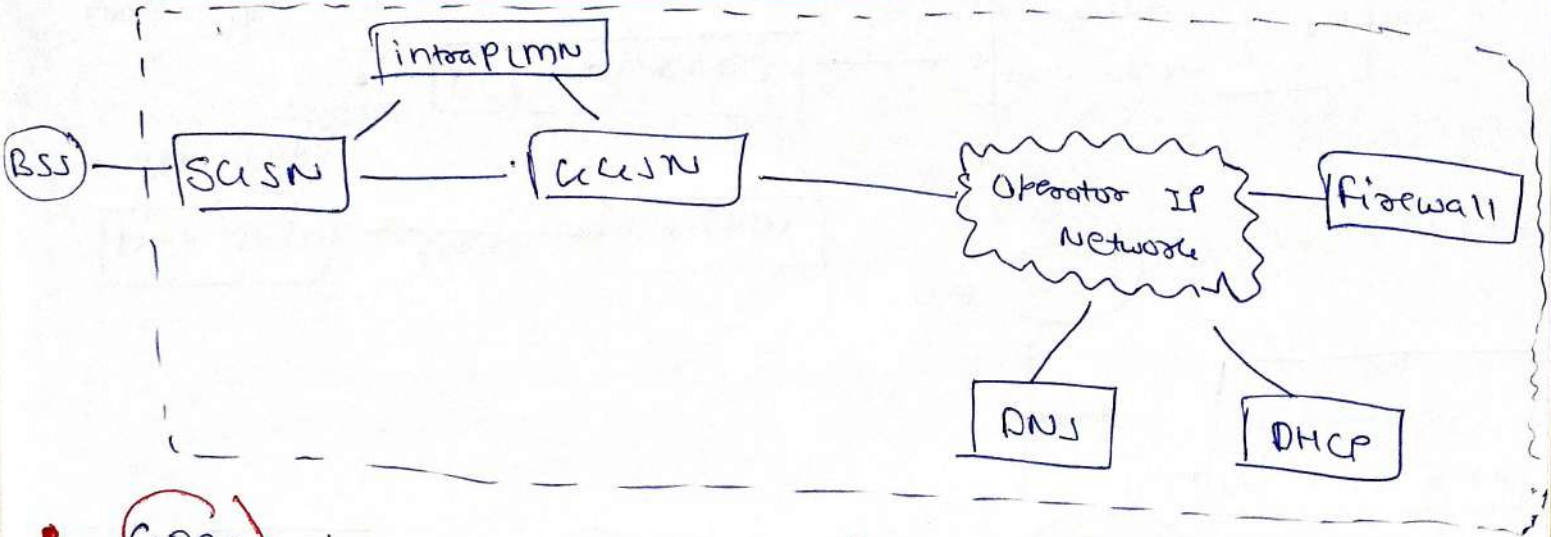
- new SGSN have no profile of MS
- contacts old SGSN

New SGSN ⟶ Request ⟶ old SGSN

↳ for PDP

- PDP recieved ⟶ new SGSN inform GGSN & network

(4) Communication with IP networks



- GPRS inter connected w/ internet network.
- GGSN is a router device
- DHCP & DNS are servers.
- Firewall installed betn GPRS & [external IP network.]

Application of GPRS:

(1) Web browsing
(2) Remote LAN access
(3) Vehicle positioning
(4) Document sharing
(5) Internet email

Billing & charging in GPRS

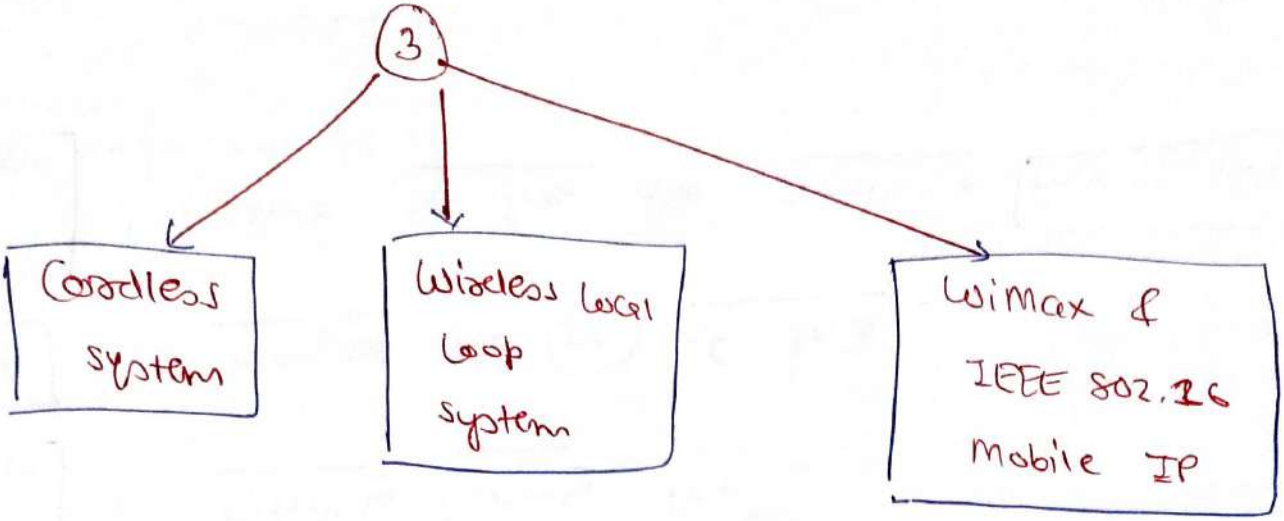
GGSN & SGSN collect billing info in CDR

CDR → Charging Data Records.

FACTORS:

1. Volume : Amount of data uploaded / downloaded.
2. Duration : session length
3. Time : which time data was used
4. Final Destination : charged according to location network
5. Location : Current position of MS
6. QoS : Charged according to service quality
7. Flat rate : monthly / yearly fee
8. SMS : Charged via no. of SMS
9. Free of charge : Some services are available free of cost

Wireless operation & Standards:



Cordless System:

(1) Residential : A single (BS) provide in house voice & Data support

(2) Office : small office => single (BS)
large office => multiple (BS)

(3) Telepoint : A (BS) for public place
eg. Airport, Railway, etc.

- Frequency limited
- Inexpensive Handset
- low power design

Wireless Local Loop (WLL):

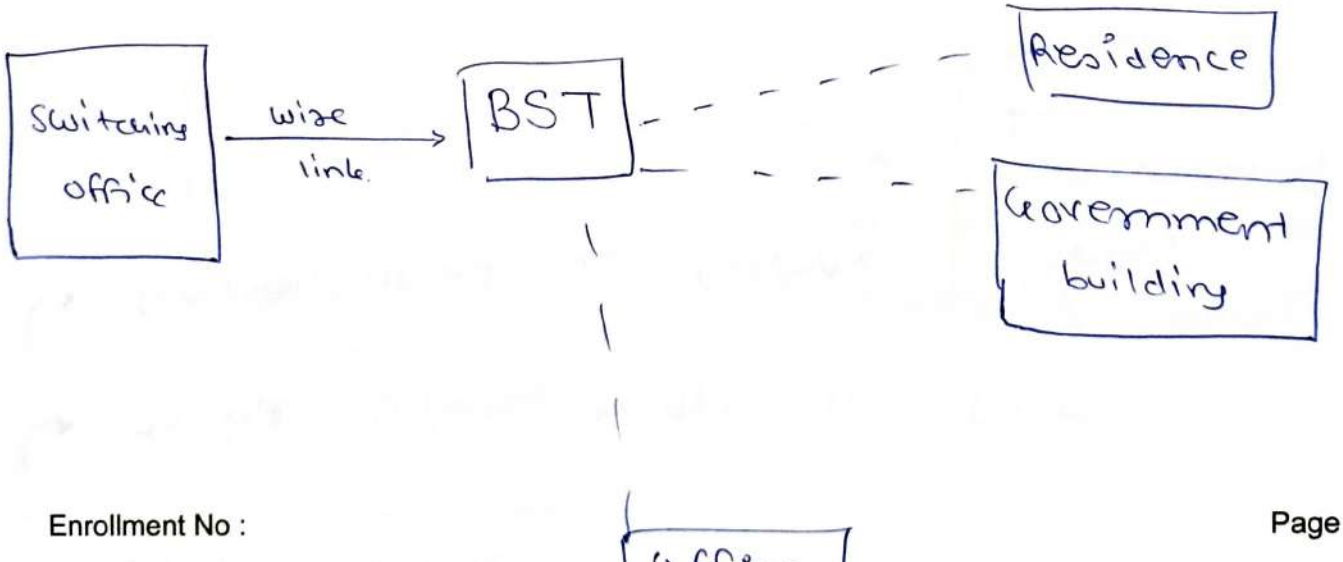
Use of wireless communication link as [last mile / first mile] (link) to deliver [POTS (Plain Old Telephone service)]

or to deliver [Internet Access] to customer.

wired tech need reliable, high speed access by [residential, buisness & government]

Eg. ISDN, Cable modems

Wireless local loop : • replace existing telephone service
• give high speed 2-way [voice & data]



802.16 / WiMax

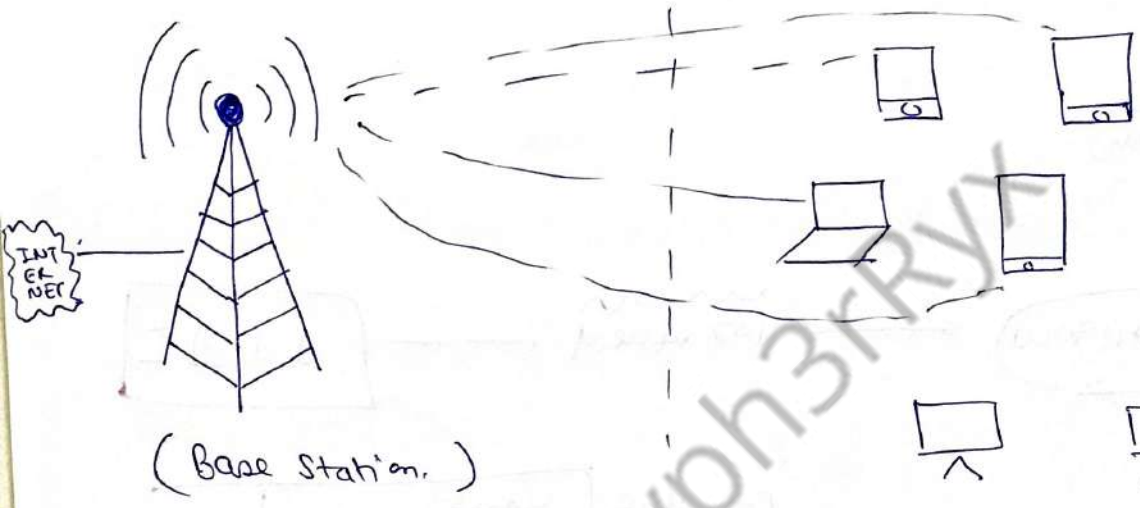
- Called Wireless MAN in IEEE
- Commercialized as WiMAX [Wireless Interoperability for Microwave Access]
- Develops "system profiles" which define [mandatory & optional] features of standard.

Annexure No :

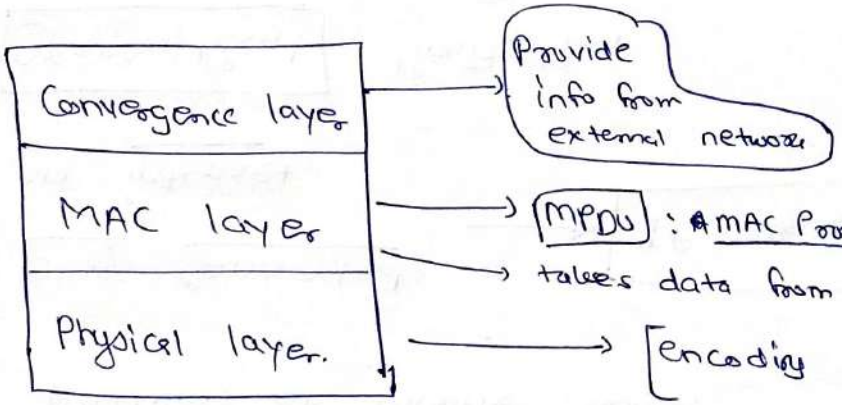
802.16 Standards Development

- Data rate : 70mbps
- Provide high speed over WAN
- Point to Point
- multiple Physical layer & MAC option

Services
- IP
- Bridged LAN
- Voice transport
- Data transport



Layers :



Enrollment No :

Page No :

Mobile IP :

↳ Developed as a means for transparency dealings with problems of mobile users.

To stay connected on internet → IP required

- No geographical limitation
- Support Security
- No modification required

IETF → protocol → mobile device

mobile device → Change position in network

Change position in network → without changing IP

Requirements:

(1) Compatability:

- Support same 2 layer protocal as IP
- no change in current system & router required.
- MS can communicate w/ fixed system.

(2) Security:

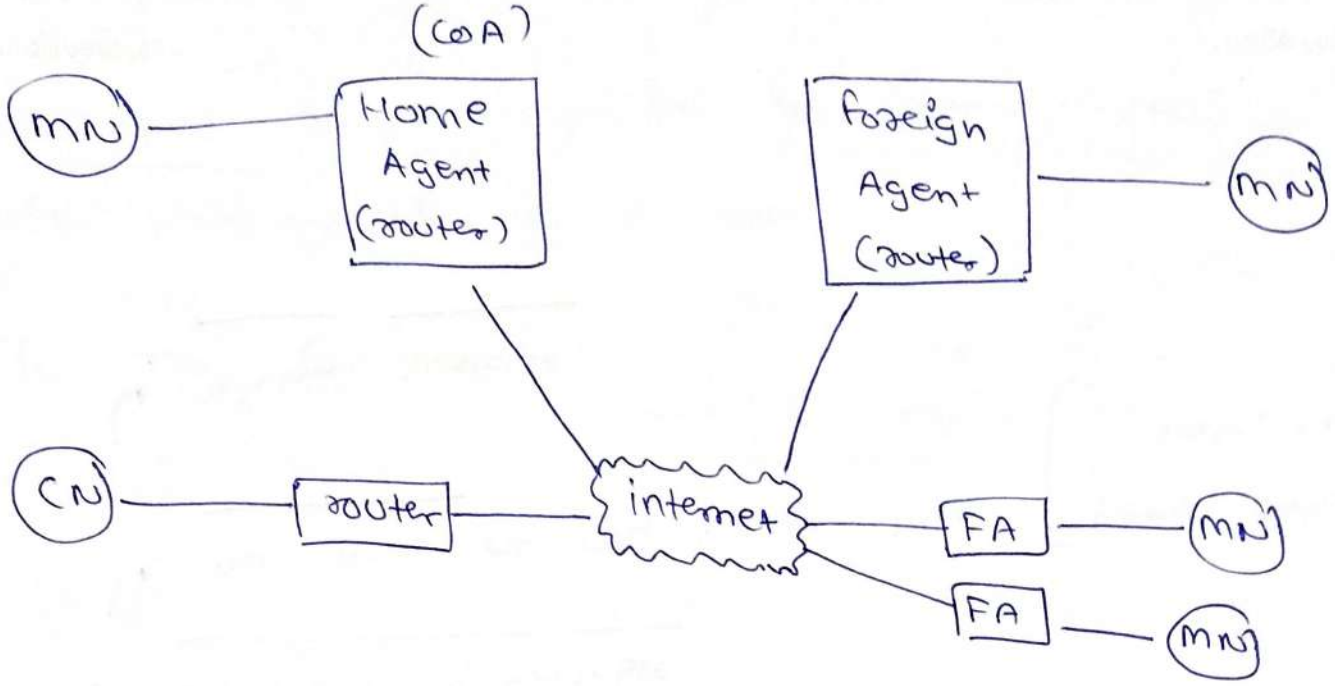
- Authentication of all registration message is necessary.

(3) Transparency:

- Only MS keeps IP address & share them
- continuity in communication is maintained.

(4) Efficient & Scalable:

- no effect at any factor like [speed, data, rate, etc.]
- highly scalable.



MN = Mobile Node

HA = House Agent

FA = Foreign Agent

CN = Correspondant Node.

(i) MN : End User device using mobile IP [can change their point of connxn without changing IP]

(ii) CN : Other node for communication.

(iii) HA : House Agent → home router

(iv) FA : Foreign Agent → foreign router.

(v) CoA : Care of Address

- Defines current location of IP.
- Position changes → Packets to CoA & not to MN

Working :

-

Registration | Discovery | Tunnelling

(I) Agent Discovery :

↳ Used when mobile Node (isn't) in Home network.
thus we need to find foreign agent.

2 methods.

① Agent Advertisement

↳ (FA) & (HA) advertise their presence via periodic messages

↳ message has info, address.

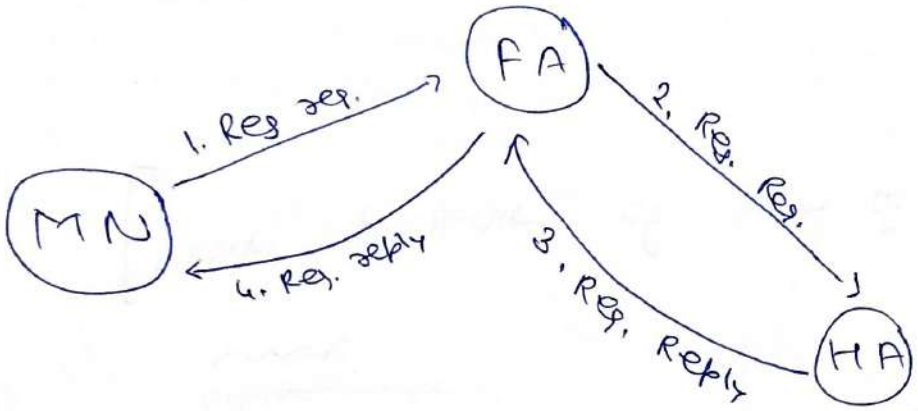
② Agent Solicitation :

↳ Used when (MN) don't get any (CoA)

↳ no flooding of message [1 mess. / second]

[main purpose of both is to find FA.]

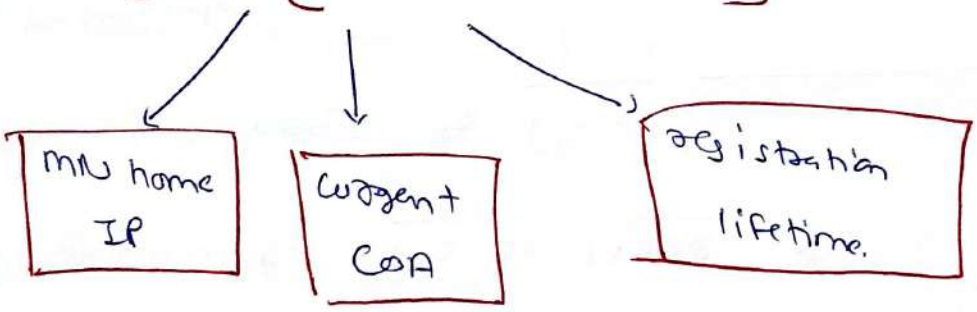
(II) Registration:



↳ MN register w/ HA when CoA is known.

↳ Informs HA about MN current location

- MN send request to FA
- HA setup [mobile binding]



(III) Tunneling & Encapsulation :

↳ Virtual pipe is established for data packets

betn [HA (start)] & [FA (end)]

Sending Packet via [Tunnel] &

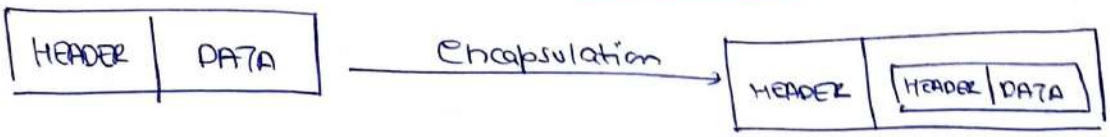
Acheived via [Encapsulation]

⇓

(Wrapping) current [packet data] + [header]

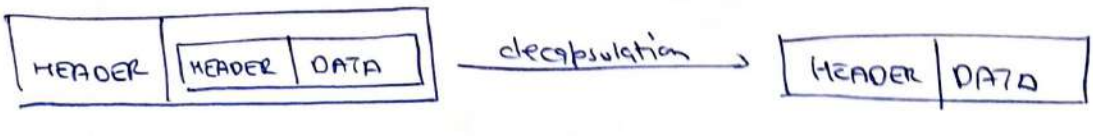
into [another packet].

Original PACKET :



(Encapsulation)

Decapsulation



CH:4 Wireless LAN → WIFI

Wireless LAN

- wireless transmission
- issues addressed like [high price, licensing, low data rate, etc.]

Requirements :

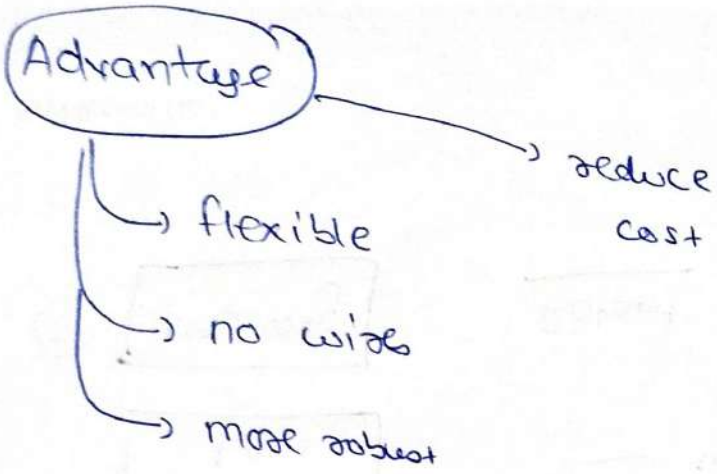
(1) **Area** : 100 – 300 m

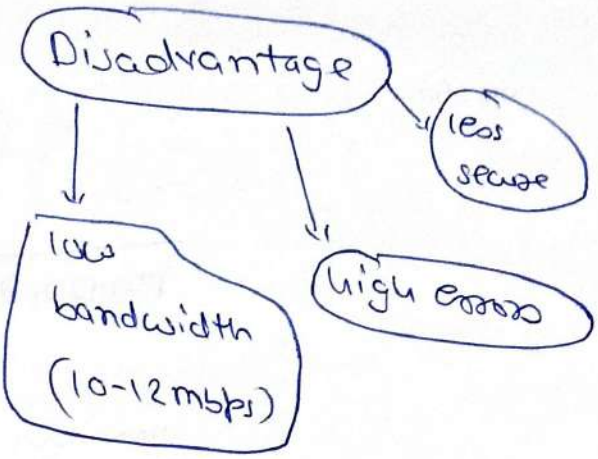
(2) **No. of nodes** : hundred of node across multiple cell

(3) **Power consumption** : low for battery life

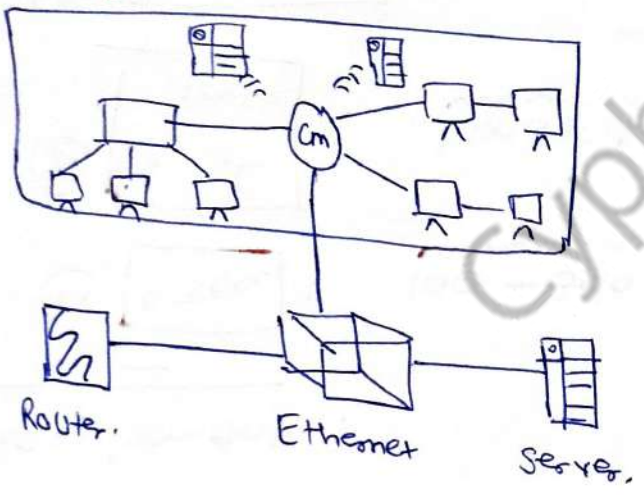
(4) **Connxn to LAN** : using control module

(5) **Security** : Robust & Protected

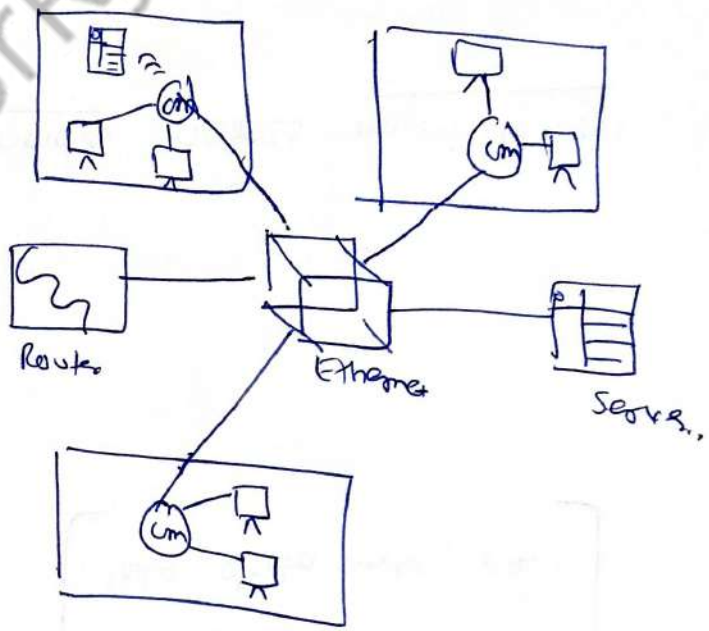




Single cell LAN



Multi cell LAN

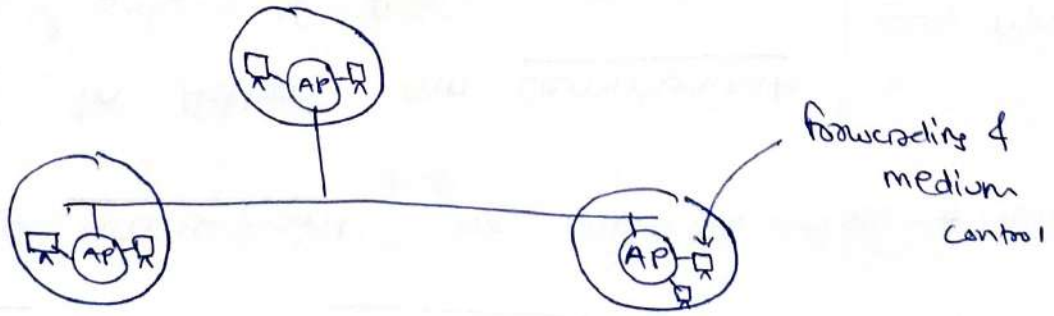


Infrastructure based Network

↳ Provide Access to other network w/ [forwarding fxn, medium access control]

- Comms with only wireless nodes & Access points
- Collison occurs if medium access control is not Coordinated
  but if Access Point control MAC = no collision.
- not used in disaster

Eg. cell phone network
satellite phone network.



Ad hoc network

↳ no need of infrastructure to work.

↳ no access point or medium access necessary

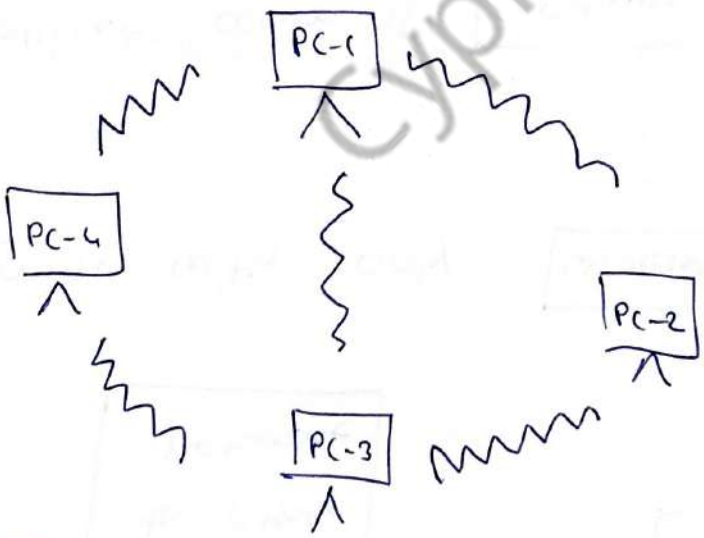
[Nodes in Adhoc can communicate only & only if they are physically reachable] ⇒ most important.

i.e in each other radio range

- Complexity = higher

[each node has medium access mechanism]

eg. needed for unexpected meetings.



AdHoc network

in short: temporary network for comms in wireless form.

IEE 802

↳ It Provides 2 type of Service.

(i) BSS (Basic Service Set)

↳ Station & AP are within same radio coverage.

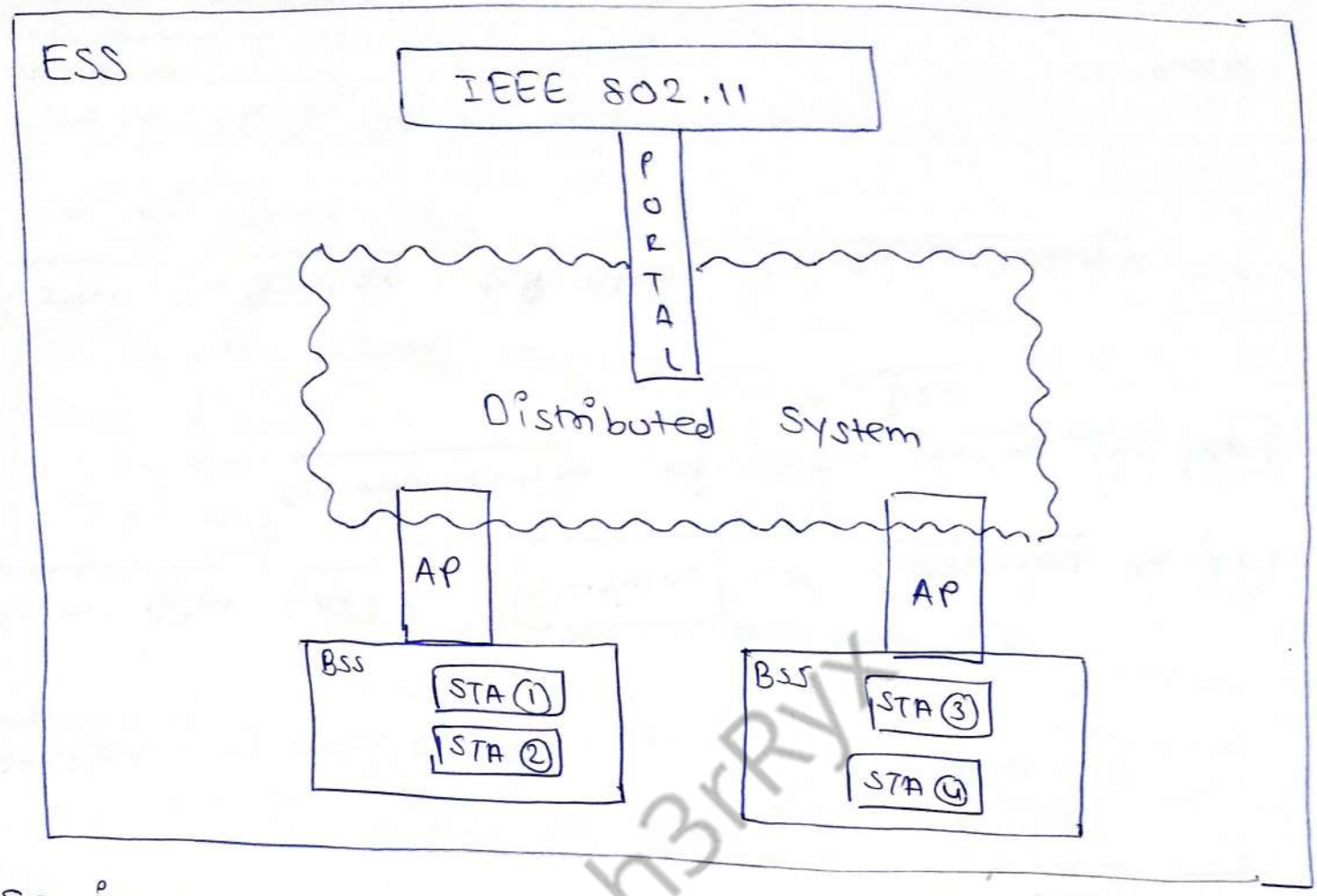
(ii) ESS (Extended Service Set)

↳ Collection of BSS is ESS & we need connect through AP.

Station : mobile node

Access Point (AP) : Stations are connected to (AP). Communication of every station via AP to BSS

Portal : Bridge to other wired network.



· Services :

Defines 9 services by 802.11

↳ equivalent to wired connxn.

AA DDD I M P R

Annexure No :

Service	Provider	Used to support
Association	Distributed System	MSDU Delivery
Authentication	STATION	LAN Access & security
De authentication	STATION	LAN Access & security
Disassociation	Distributed System	MSDU Delivery
Distribution	"	"
Integration	"	"
MSDU Delivery	STATION	MSDU Delivery
Privacy	STATION	LAN Access & security
Reassociation	Distributed System	MSDU Delivery.

Message Distribution

Distribution Service :
- used by station
- exchange MAC frames.
- if station is in same BSS (DS) goes to single AP of that BSS (refer diagram)

Integration Service : Data Transfer betn [802.11 & 802.x]

Association : establish initial association betn STATION & AP

Disassociation : By STATION or AP

Reassociation : Transfer Association (to) another AP

Medium Access Control : (MAC)

Reliable Data Delievery , Access Control , Security

↓↓

MAC layer data exchang w/ noise & interference

∴ not reliable

↳ Thus it include frames exchange protocol.

↓↓

STATION recieve ACK

if not recieve retransmit.

- 4 frame exchange :

(1) Source issue a RTS frame to destination.
(request to send)

(2) Destination responds with CTS frame
(Clear to send)

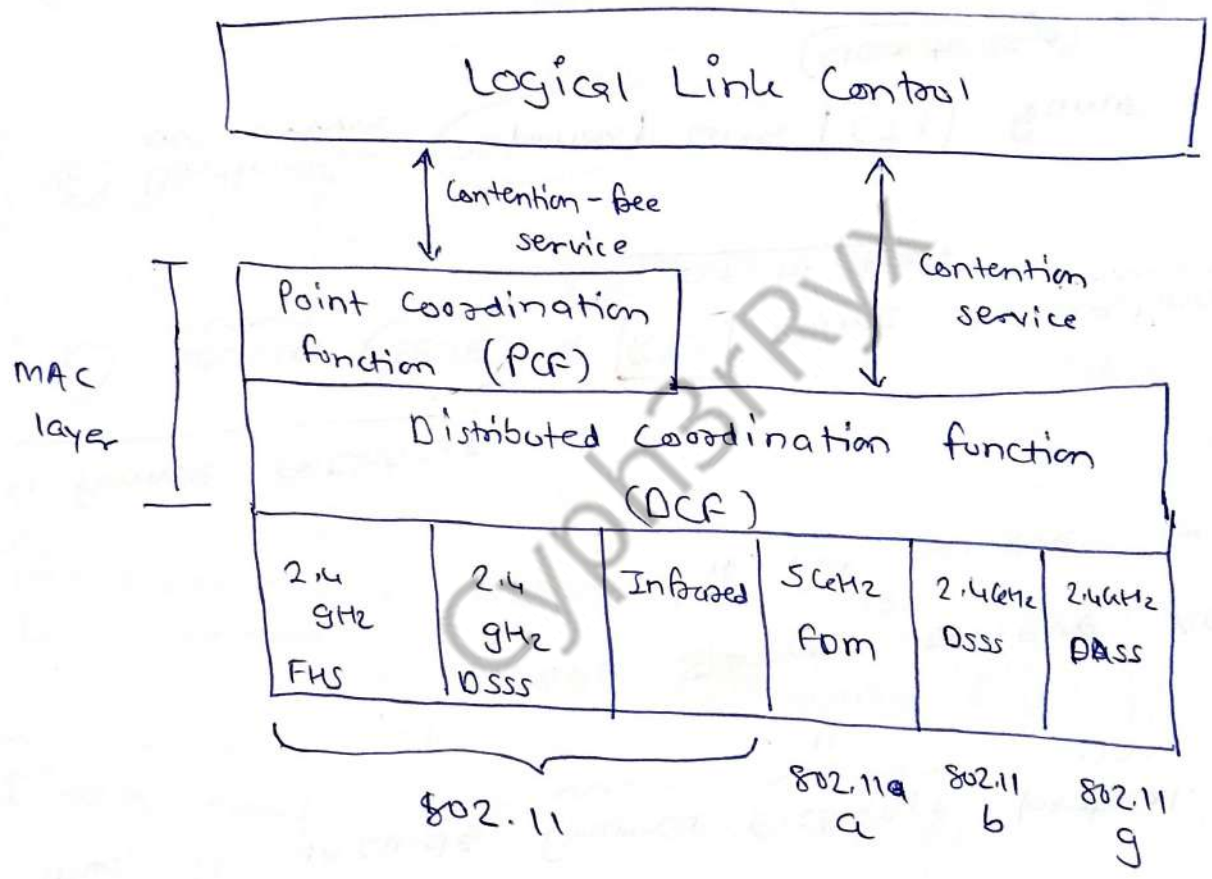
(3) After recieving CTS , source transmit data

(4) Destination reply with ACK

for no collison

RTS alert source
CTS alert destination
] — that data is being transmitted.

MAC Architecture:



* DCF (Distributed Coordination fxn)

if STATION has frame to send
it checks if medium is IDLE to send
if (yes) then it gives permit to it
but if (no) then it waits for transmission to complete.

No collison occurs

* PCF (Point Coordination fxn)

Alternative of DCF

- It (AP) act as coordinator & manages access of device.

Divide time into (2) types

(1) CFP (Contention free period)

(AP) polls each device to determine its transmission needs & grant (permit) to transmit data.

(2) CP (Contention Period)

(Devices) contend for access to the wireless medium using (CDMA/CA) protocol

PCF has Control frames

RTS , CTS , ACK remains same.

PS => Power saving mode ⟶ frame sent to request any buffer frame

RTS => Request to send [Ask Permission]

CTS => Clear to send [Permission Granted]

ACK => succesful transmission

CFP => Announce the end of transmission

CF-End + CF-ACK => ACknowledge the end & release the connxn

DATA frames :

4 ⟶ upper level

DATA ⟶ simple data frame

DATA + CF-ACK ⟶ Data & acknowledgement of contention free period

DATA + CF-Poll ⟶ Point coordinator uses it to deliver data & request Send

DATA + CF-ACK + CF-Poll ⟶ Combine above (all)

Other (4) frames don't carry user data. ⇒ NULL fxn.

802.11 a

1. 5 GHz = frequency
2. max. Data = 54 mbps
3. orthogonal frequency Division multiplexing (OFDM)
4. Shorter range
5. few device connxn
6. High Data rate
7. Less interference
8. Not backward compatible

802.11 b

1. 2.4 GHz = frequency
2. max. Data = 11 mbps
3. Direct sequence spread Spectrum (DSSS)
4. Longer range
5. more device connxn
6. Low data rate
7. High interference
8. Is backward compatible

Authentication

↳ Establish station identity

- Wireless LAN require one more [stage of authentication.]

Schemes = handshaking
public key encryption.

De Authentication

↳ involve existing authentication once credential expires.

- Prevent unauthorized access to transmission.
- Better Privacy & High security.

CH: 5 Bluetooth (IEEE 802.15)

Short range | wireless | comms | technology

simple , secure & everywhere

- Advantage → less power consumption
  - → cheap
  - → less complicated

V1 → 1999

V1.1 → 2002

V1.2 → 2003 [1 Mbps]

V2 → 2004 [3 Mbps]

V3 (High speed) → 24 Mbps [2009]

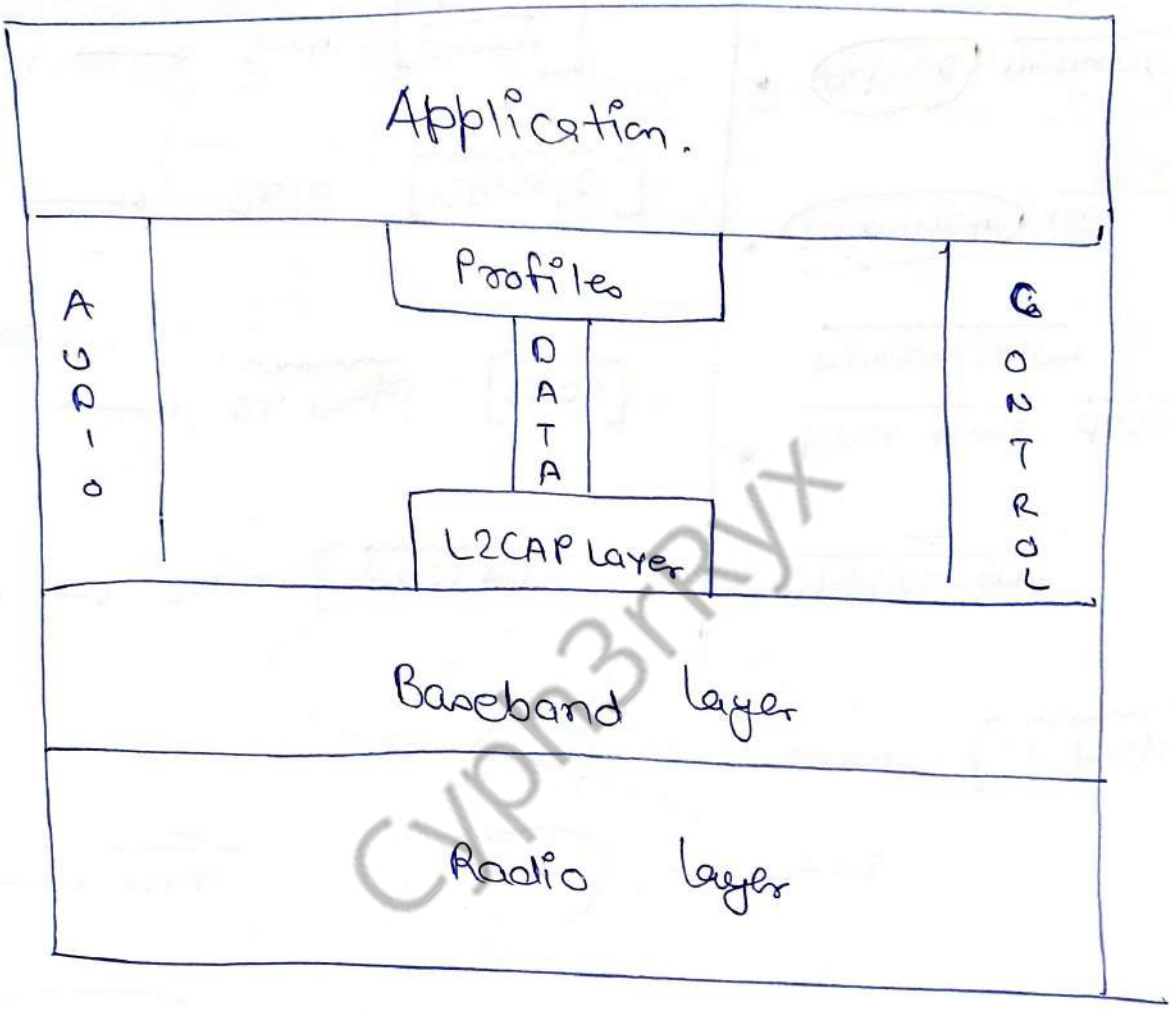
V4 → 2010 [Classic]

V4.2 → 2014 [smart, fast, IoT]

Application:

- Real time data & voice transmission
- Eliminate cable work
- Adhoc networking

Bluetooth layers:



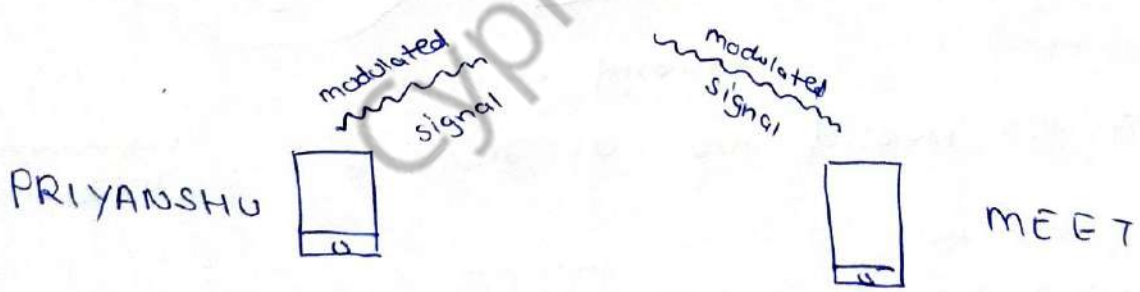
① Physical Radio (RF) layer: (Connxⁿ less layer)

↳ Performs modulation & demodulation of data into RF signal (Radio frequency signal)

↳ Data to radio signal.

↳ Bluetooth (act) as Transreciever.

eg. Priyanshu want to send song to Meet via Bluetooth



Here Priyanshu's mobile converted the song into signal = modulation

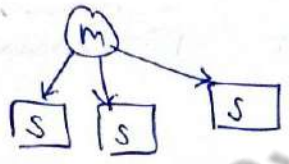
Meet's mobile Captur that signal & 'convert it into song = demodulation

(2) Baseband link layer:

It establish the connxn in the piconet

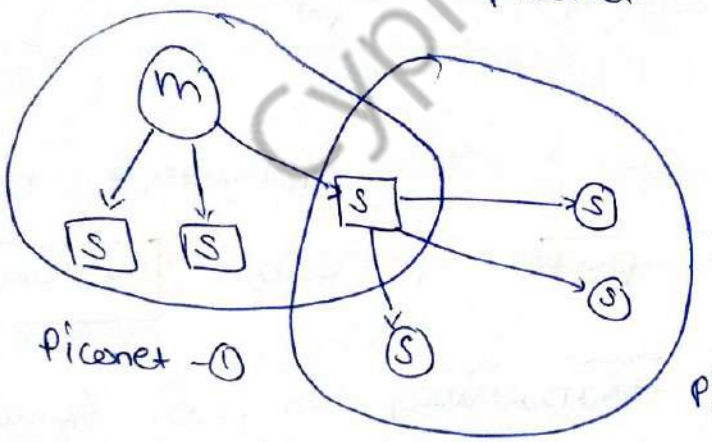
2 type of Bluetooth network:

(i) PICONET: One master - diff. slaves (8 connxn max)



one way only
(master can only send the data)

(ii) SCATTERNET: A slave in one piconet can be master in other piconet



NOTE:
- Slaves can not communicate w/ each other

(3) LINK MANAGER:

↳ Performs management of already established links.

↳ Translates commands into operations & manage them.

What else it do?

(i) Attach Slaves to Piconet
(ii) Detach Slaves to Piconet
(iii) Configure branches
(iv) Controlling test mode
(v) Power consumption control
(vi) Establish ACL (Data) & SCO (voice) link

A Link manager is the one that communi-cate with other Link manager of diff. Bluetooth device via Link Manager Protocal (LMP)

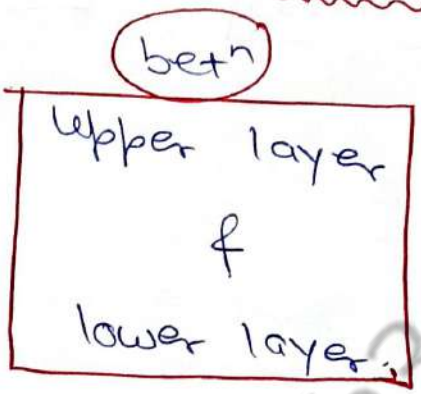
messages as LMP PDU (Protocol Data Unit)

Enable link manager → To → maintain the connxn

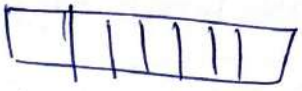
(4) Logical Link Control Adaptation Protocol :

↳ (Heart) of Bluetooth layers (Protocol stack)

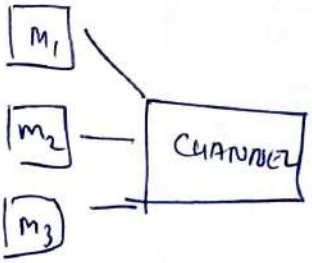
↳ Allows proper communication



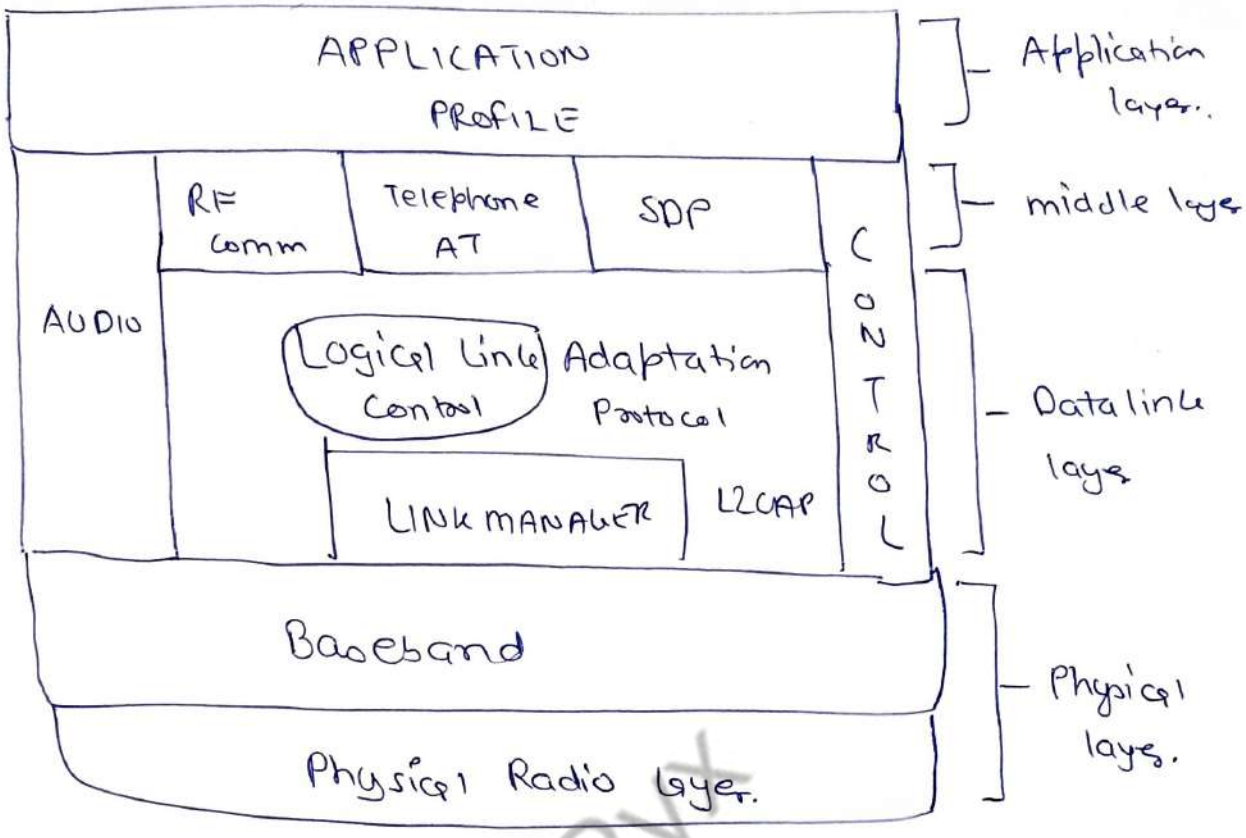
↳ segmentation & multiplexing is done here.



Huge data into small packets



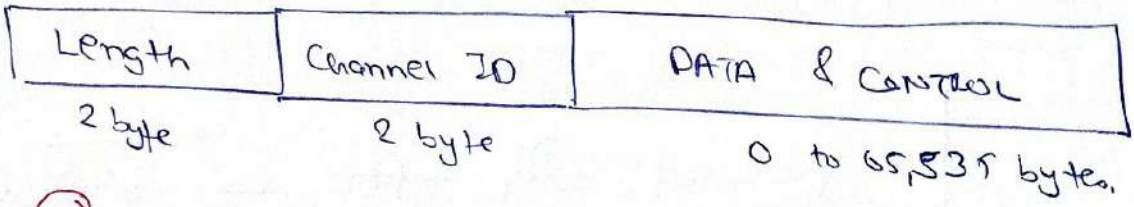
multiple message in single channel.



fxns of L2CAP:

1. Multiplexing higher layer protocol
2. Segmentation & reassembly
3. Group management
4. QoS for upper layer protocol

L2CAP Data format :



↳ 16 bit length field defines the size of data in bytes coming from upper layer.

↳ Channel ID => unique identifier for virtual channel