Wireless Communication

Unit - 1

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Wireless communication :

Wireless communication generally works through EM signals that are broadcast by an enabled device within the air, phy environment or atmosphere. The communication between two device occur when the destination or receiving devices captures these signals creating a wireless comm" bridge

It has various forms like

1. Satellite communication
2. mobile communicaton
3. Infrared communication
4. Bluetooth communication
5. Wireless N/w communication

We use wireless communication for

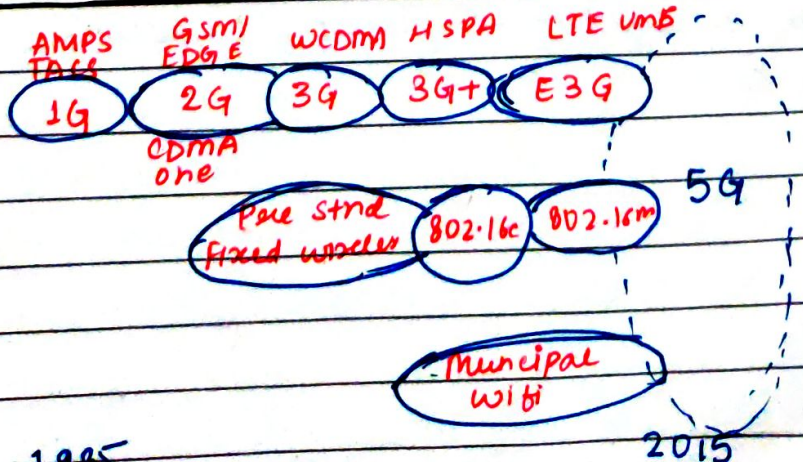
(i) Increased efficiency : High technology comm" systems leads to faster transfer of info

(ii) Rarely out of touch : No need to carry cables or adapters in order to access networks.

(iii) Greater flexibility : Can be networked without a sitting at dedicated PC's.

(iv) Reduced cost : cheaper to install and maintain.

(1) Evolution of Mobile communications :



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(i) 1934 : Police radio uses convention AM mobile comm systen
(ii) 1935 : Edwin Armstrong demonstrated FM
(iii) 1946 : First mobile telephone service – IMTS – full duplex
↳ (drawback was interruption while comm^n)
(iv) 1960 : IMTS (Improved) full duplexed
↳ (Bell lap introduce concept of cellur mobile systen)
(v) 1968 : AT&T propose concept of cellular mobu system to FCC.
(vi) 1976 : Bell mobu phone service, poor service due to cell blocking
(vii) 1983 : Advanced mobile protur system (AMPS), FDMA, FM use
(viii) 1991 : US Digital cellular (USDC) IS-54, TDMA, DQPSK
(ix) 1993 : IS-95, CDMA, QPSK, BPSK

Examples of wireless communication system
(i) Coordless phones
(ii) Remote controller (DVD player)
(iii) Walkie Talkie (certain Range)
(iv) Pagers (1990 to syn detailed msg)
(v) Telephones
(vi) WLAN

(2) Paging Systems:

(i) Conventional paging system sends brief message to subscribers.
(ii) Modern Paging system → News, headline, stock quotation fax may be sent.

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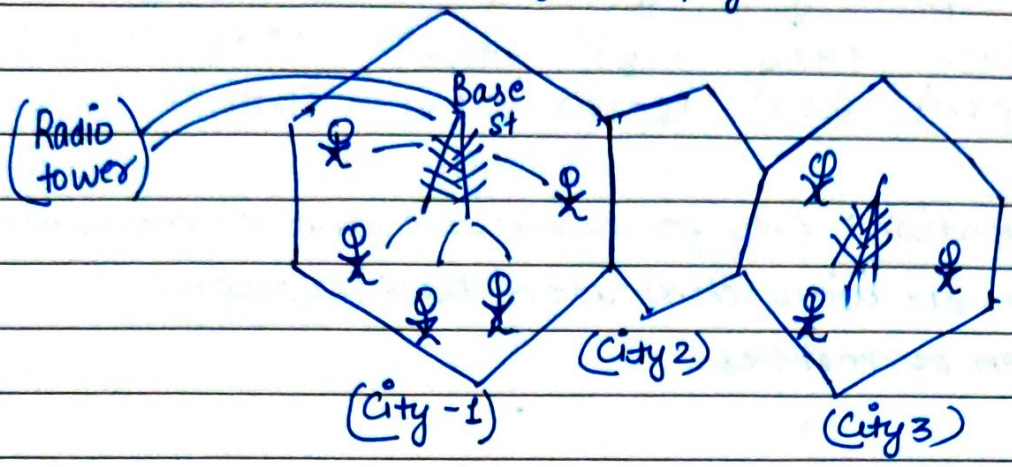
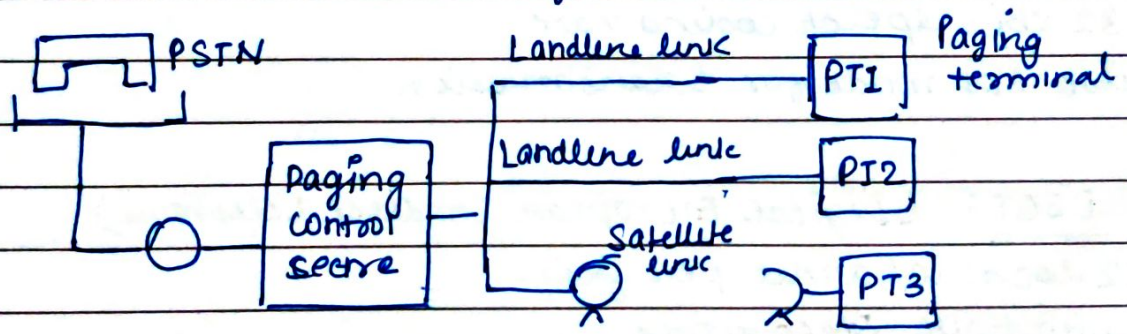
Message sent to paging subscriber by using paging system access no. Issued message → page.



(Radio tower → Base station → subscriber)

Simulcasting: Large radio towers that simultaneously broadcast a page from each base station.

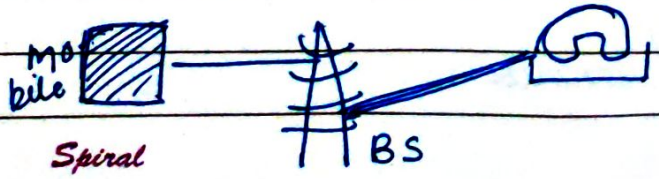
Paging system are designed to provide reliable comm^n to subscribe wherever they are.



(3) Coordless Telephone system:

(i) Designed to provide low cost wireless communicaton to PSTN.

(ii) Fully duplex comm^n that can wirelessly connect a portable handset to dedicare base st which is connected to dedicated telephone levels.



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They are upgraded in 5 phases

1980	1984	1987	1989	1991
(CTO)	(CT1)	(CT1+)	(CT2)	(DECT)

First generation: Only for home use and communication only possible with dedicated base stations.

(ii) few ten of meters.

Second generation: Can be used in out door as well

(ii) combined with paging systems

(iii) few hundred of meters.

→ **CT2:**

(i) Developed in Europe (1989)

(ii) 40 FDMA channel

(iii) 32 Kbps speech coding rate

(iv) Use TDD mode for transmission

→ **DECT:** (Digital European Coordless telephone)

(i) 12 local channel per freq.

(ii) Also have sleep mode

(iii) It conversation from one time slot to another (time slot transfer)

(iv) support seamless handoff

(v) compatible with GSM and allow mobility

→ **DHS:** (Personal handy phone system)

(i) Developed in Japan

(ii) Also have sleep mode

(iii) TDMA / TDD

(iv) BW partition → 77 channels

(v) 32 Kbps coding rate

(vi) support handoff.

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→ **PACS: (Personal access control system)**

(i) designed using WLL (Wireless local loop)

(ii) 32 Kbps speech coding rate

(iii) Use TDMA / FDD

(iv) supports roaming management

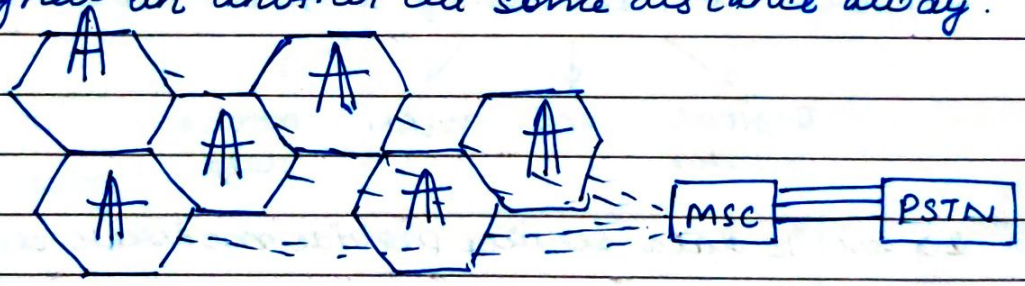
(4) Cellular telephone system:

(i) It is also known as PCS

(ii) Provide two way comm^n at high speed with regional in national coverage.

(iii) Main principle → to reuse frequency

→ The coverage area of cellular system is divided into non overlapping cells where some set of channel is assigned to each cell. This same channel is also assigned in another cell some distance away.



→ The operation within a cell is controlled by BS which consist of Tx and Rx.

(ii) This is connected to high speed dedicated comm^n link to MSC which coordinate the activities of all the B.S in limited region to provide connection to other fixed N/W such as PSTN.

e.g (GSM, AMPS, D-AMPS, IS-95)

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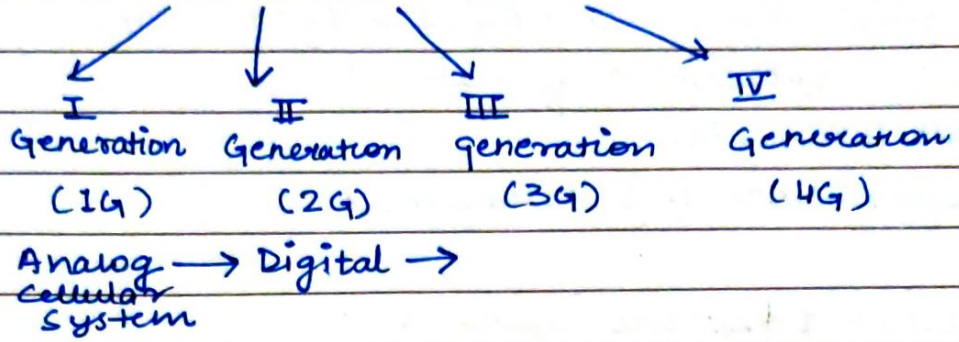
(5) Generation of cellular System:

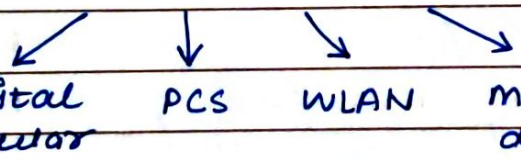


(i) First generation (1G):

(i) uses FDD schemes
(ii) typical allotted bandwidth each direction is 25 MHz.
(iii) uses analog cellular system
e.g AMPS, NMT

→ Second generation (2G):

(i) shift from analog to digital system
(ii) supports all 4 sectors of wireless industry.



(iii) 2G mobile data service provide moderate data rate and wide coverage area access to packet switch N/W
(iv) 2G WLAN provides high data rate.

→ Third generation (Internet system):

(i) It offers better capacity, high speed wireless intern (upto 2Mbps), wireless multimedia services
(ii) Enable person to communicate with anyone at anytime and anyplace.
(iii) provide more reliable service feature

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→ Fourth generation (4G and Beyond):

(i) In this user has freedom and flexibility to select any desired service with reasonable QoS.

(ii) High usability.

(iii) Support multimedia service at low transmission cost

(6) Comparison b/w wireless systems:

Parameter	Coordless	Paging	Cellular
Description	They are telephone with wireless handset that comm^n using radio waves with B.S	Gives indications like musical alert, name calling etc to particular indi. whom system want at telephone	Radio N/W distributed over areas called cells each served by atleast one Tx known as Base station.
Standards	CT2, DECT, PACS, GSM	POCSAG, FEEX, GSC	AMPS, NAMPS, USDC, IS-95
multiple access	FDMA, TDMA	Simplex	FDMA, CDMA, TDMA
Used for	Short distance	Country to country	Within N/W.
Mobile St.	MS coverage area is low	MS coverage area is high.	MS coverage area is high
Infra	Few infrastructure	High infra.	High infra
complexity	moderate complexity	Low complexity	High complexity
	H/W cost is low	H/W cost low	H/W cost moder

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Carrier frequency	1 GHZ	<1GHZ	1-3 GHZ
Functionality	Transciver	Reciever	Transreciver
Coverage range	Low coverage.	High coverage	Low coverage

→ **Personal communication service:**

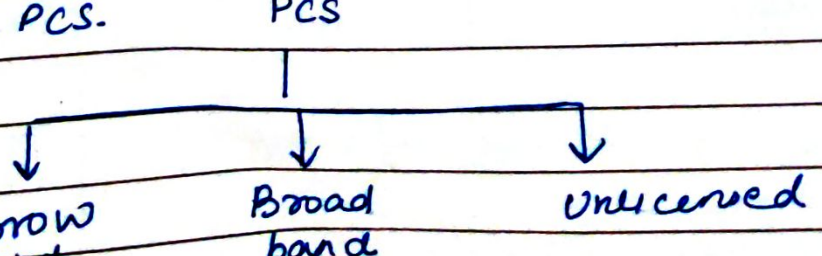
(i) It is a type of wireless mobile service with advanced coverage and that delivers services at a personal level. It generally refers to a modern mobile communication that boosts the capabilities of conventional cellular N/W and fixed line telephony N/W as well.

(ii) Also known as digital cellular

(iii) It works similar to cellular N/W in basic operations but requires more service provider infrastructure to cover a wider geographical area.

(iv) PCS generally includes:
a) Wireless comm^n (data, voice & video)
b) Mobile PBX
c) Paging and Texting
d) Wireless radio

(v) TDMA, CDMA, GSM, 2G, 3G, 4G are common tech used to deliver a PCS.



PSTN → Public switched telephone N/W

MSN → Mobile switching N/W.

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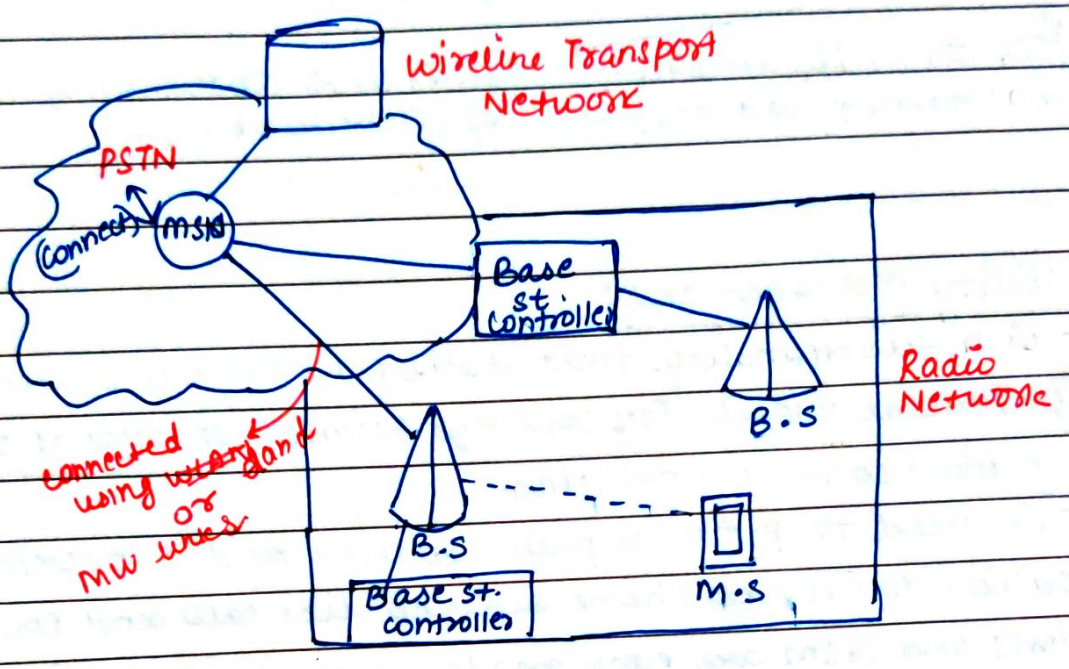
→ PCS architecture :

PCS architecture basically compress of two parts

a) Radio Network

b) Wireline Transport Network



Radio N/W → PCS users carry mobile st. to comm. with a BS in a PCS N/W. MS The radio coverage of a base st. is called cell. In GSM each cell is controlled by BSC which are connected to MSN through BS.

M.S
(handsets through which comm" happens)

B.S
(Base st provides signal and faulty for MS all time)

B.S.C
(Base station controller controls the connection b/w MS and nearest BS acc to range)

(checks security, data rate, functions

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b) Wireline Transport N/w → An MSC is a telephone exchange configured specially for mobile app^{n}. It interfaces MS with PSTN. MSC are also connected to mobility database to track the location of MS and roaming management. (HLR and VLR are those databases)

HLR → contains authentication info (names, addr etc)

VLR → (gives info about loc of area of subscriber)

→ **Mobility management:**

(i) It is a functionality that facilitates mobile device opr in Universal Mobile Telecom sys (UMTS) or Global system for mobile comm (GSM) N/w.

(ii) It is used to p·trace physical user and subscriber location to provides phone services like calls and SMS.

(iii) UMTS and GSM are each made up of seperate cells (B.S) that cover specific geographical area.

(iv) The loc. update procedure allows a mobile device to notify when shifting between areas. When a mobile device recognizes that an area code differs from previous update it executes a loc update by sending loc. req. to its N/W, prior loc & specific temp. mobile subscriber Id.

(v) Roaming is among the basic procedures of mobility management. It enables subscribers to use mobile services when moving outside geo. area of a specific N/w.

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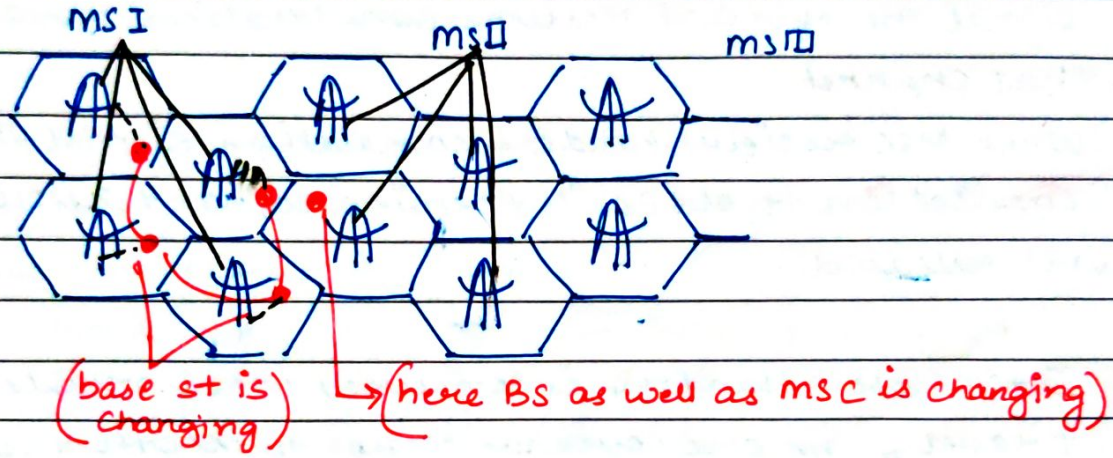
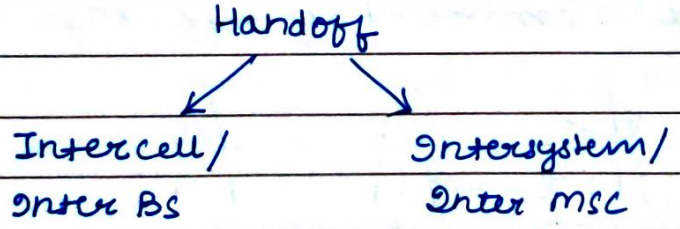
It refers to the way the N/w manages the movement of mobile subscribers which significantly affect peformance of the PCS N/w.

→ **Network signalling:**

Handoff:

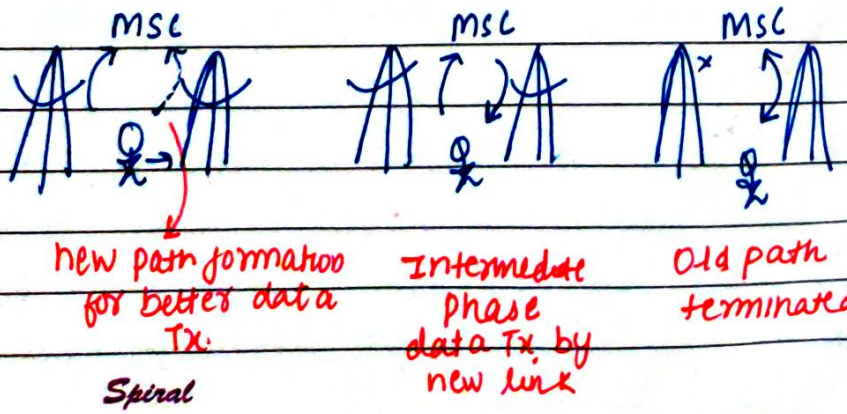
It is the process which Enable call to proceed uninterupted when moved user moves from one cell to another or one system to another.





(1) The inter BS Handoff req. when mobile unit travel from one BS to another BS while old n New connected to same MSC.

Steps for connection:



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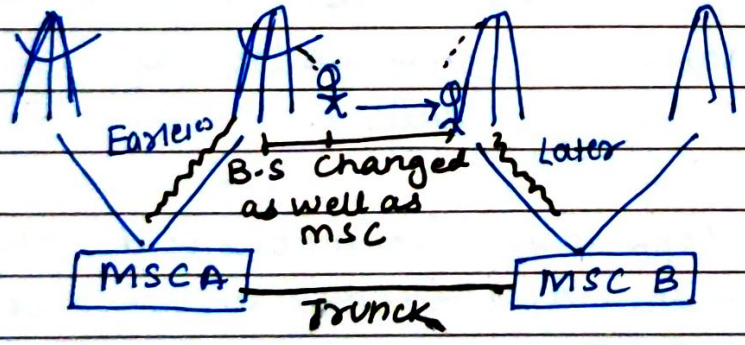
(i) When the signal recieved from the current BS is not strong enough the MS momentarily suspend convo and initiate the handoff procedure by signalling on an idle channel in the new BS. Then convo on old BS is resumed

(ii) When MSC rx the signal it transfers the info to the selected idle channel of the new BS and new conv path is setup.

(iii) After the MS has been transfer to the new BS, it signal the N/w and resume conversation through that channel.

(iv) When MSC recieves handoff completion signal the connection to old BS is terminated and resource are released

(2) Intersystem Handoff is required when mobile unit travel from one coverage region to another while new and old BS controlled by diff. MSC



[after trunk → req. from one msc to another
after this only another msc will send data via it]

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→ **Handoff detection techniques:**

(i) **MCHO:** (Mobile controlled Handoff)

a) In this scheme the MS determine the handoff requirement and control handoff process.

b) In this method

* MS continuously monitors the signal quality from the current BS and several candidate BS for handoff.
* When handoff criteria is met, MS choose the best BS with best signal strength.

(ii) **NCHO:** (Network controlled handoff)

a) In this scheme the BS determine the handoff req and control handoff process.

b) In this BS cont. monitors the signal quality from MS when handoff criteria is met BS inform the MS to arrange the handoff to another BS.

c) The N/w ask all nearby BS to monitor the signal from MS and based on this info BS N/w chooses BS with best signal strength and connection transfered to new BS.

(iii) **MAHO:** (Mobile Assisted handoff)

a) In this handoff procedure is controlled by N/w with help of MS.

b) In this N/w asks MS to measure signal from (each BS) surrounding BS, MS sends info to old BS using which the N/w checks the handoff req.

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→ Channel Assignment strategies:

(i) FCA: (Fixed channel assign)

a) In this each cell is allocated pr determined set of voice channel.

b) If any user calls within a cell only available unused channel may be used

c) If all channel is occupied call is blocked & service denied

(ii) BCA: (Borrowing channel assignment)

a) In this strategy a cell can borrow channel from neighbouring cell when all its own channels are occupied

b) The MSC supervise this borrowing process and ensure borrowing channel does not interfere any call in progress

(iii) DCA: (Dynamic channel assignment)

a) Instead of allocating voice channel to diff cell permanently the serving BS has to req. a channel from MSC whenever call req. is made.

b) MSC follow algo and then allocate channel to req. cell

c) Thus DCA reduces likelihood of blocking.

→ Prioritising Handoffs:

(i) NPS: (Non priority scheme)

In this handoff calls or New call both are handle by BS in same manner, i.e hand off call is blocked. ~~this~~ if no channel is available

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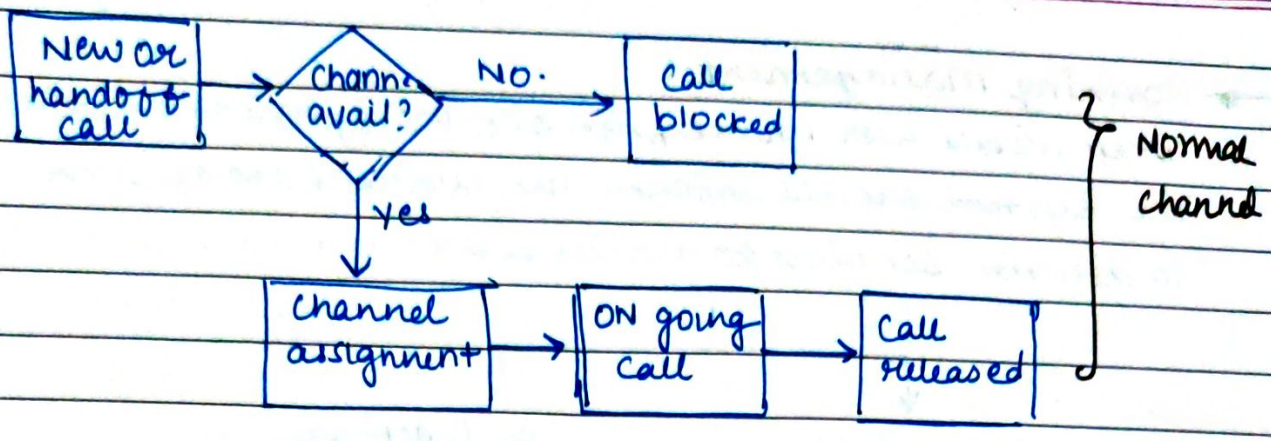
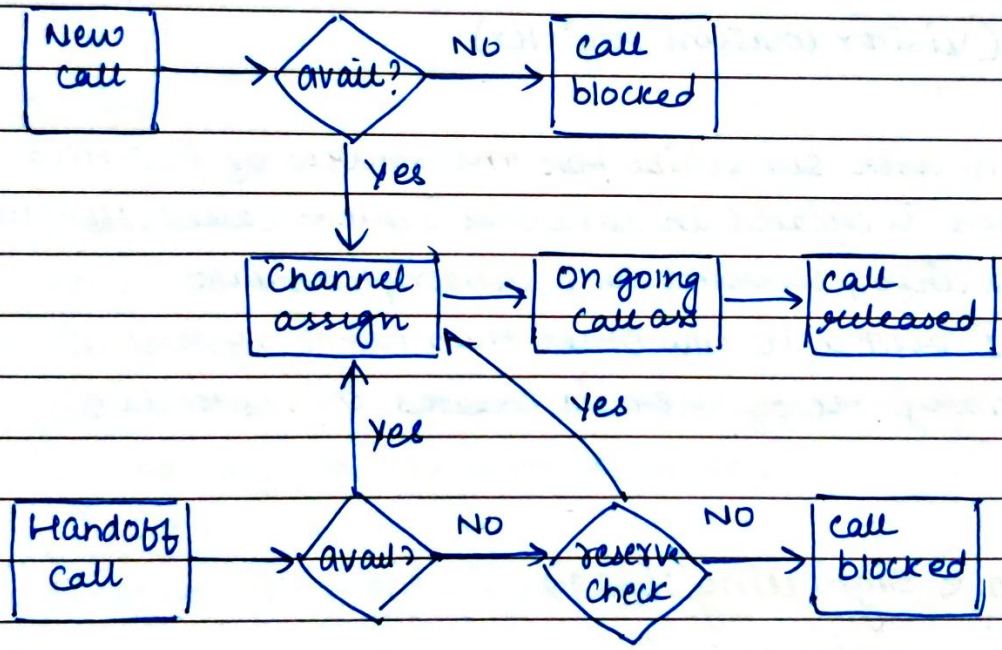


(ii) RCS : (Reserved channel scheme)

In this channel is divided into 2 parts

(i) Normal channel → (for both)

(ii) Reserved channel → (can use hand off call)



(iii) SRS: (Subrating scheme)

(i) When free channel avail work similar NPS

(ii) When handoff req. come and a free channel is not ava SRS creates a new channel by subrating (breaking) in 1/2 existing calls. One will be used for existing calls another for handoff req.

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→ Roaming Management :

When mobile user moves from one PCS system to another the system should inform the current loc of user to deliver services to mobile user.

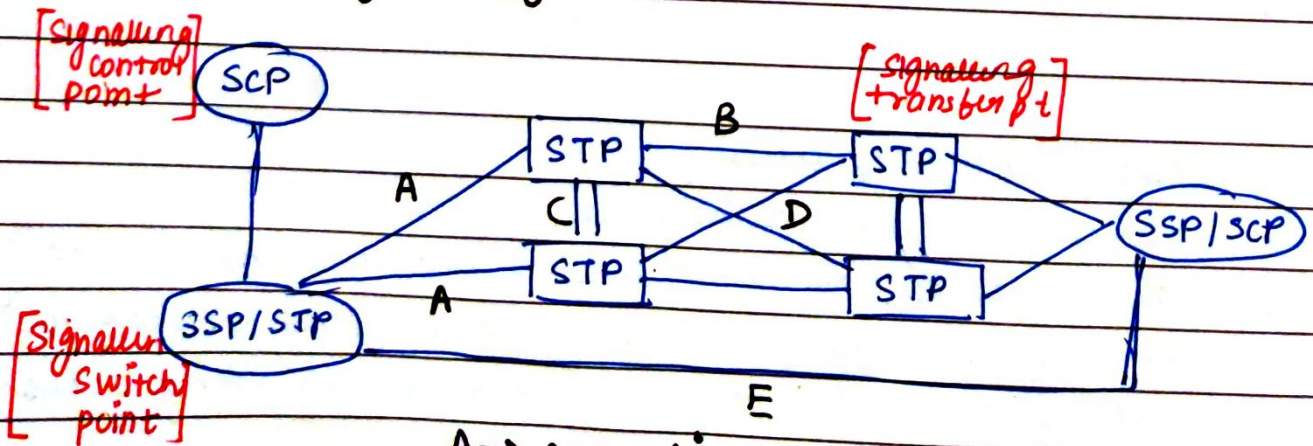
- Loc. update (The process where MS inform system of its location)
- Loc. Tracking (The process where systems locate MS location)

For updating loc. 2 database are there

(i) HLR (Home location register) → (stores data of user)
(ii) VLR (Visitor location register)

(i) When a user subscribe for the service of PCS N/W a record is created in database system called HLR like profile info, current loc, subscription info.
(ii) If MS visit a PC N/W other than home systems a temporary rec of user is created in visitor loc.

→ Network Signalling: (SS7)



A → Access link
B → Bridge link
C → Cross link
D → Diagonal
E → Extended
F → Fully associate

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(i) SSP:

a) It is an interface to telephone N/W
b) It converts voice signal to SST signal link
c) Local exchange to subscriber

(ii) SCP:

a) It is an interface with database
b) Handles database queries and subscribers info.

(iii) STP:

a) It is basically a network node
b) Works as a router

→ A link:

Connects SCP/STP to SSP and provides info of subscriber

→ B link:

Connects STP to STP

→ C link:

Connects STP to STP only and works for route failure and in that case provide another part

→ D link:

Connects STP – STP diagonally.

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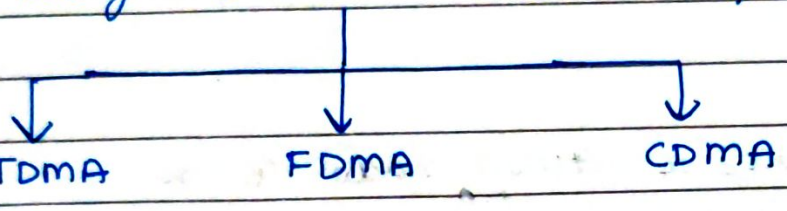
→ Multiple access techniques:

In wireless comm systems it is often desirable to allow the subscriber to send information simultaneously from the MS to BS while receiving info from BS to MS Hence a cellular system divides any given area into cells where a mobile unit in each cell comm with BS.

Main aim : To able to inc the capacity of channel as possible in given BW with sufficient quality of service



(i) TDMA (Time division multiple access):

In the cases where cont. Tx is not req. there TDMA

a) is used. It divides a single channel into time slots where each user makes use of non overlapping slots.

b) TDMA is not continuous but occur in bursts hence handsoff is simple.

c) Duplexers are not req as Tx and Rx occur at diff slots

d) BW can be supplied or demand to diff users by concatenating or reassigning slots based on priority.

In this division of calls happens on time basis. System first digitizes calls then combines convo in unified digital stream on single radio channel. Then it divides each channel into time slots and is assigned to each call during convo.

(Digital technique)

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(ii) FDMA: (Freq. Division multiple access)

It is basic technology for advanced mobile phone services.

a) It allots diff sub band freq to each diff user to access N/w
b) If FDMA is not in use, channel is left idle instead of alloting to others
c) Implemented in Narrow band system (Analog technique)
d) Less complex than TDMA.
e) Filtering is done to reduce interferance
d) BS and MS rx and tx data continuously

(iii) CDMA: (Code Division multiple access)

It is an example where several transmitters use a single channel to send info simultaneously.

a) every user use full avail. spectrum
b) recomended for voice and data comm
c) while multiple codes occupy same channel, users having same code can comm with each other.
d) Handsoff is very well handled.

In this every bit of a convo is tagged with specific and unique code. Now the data is split into small parts and is tagged with unique code. Now this data in small pieces is sent over discrete freq avail at any time in the range.

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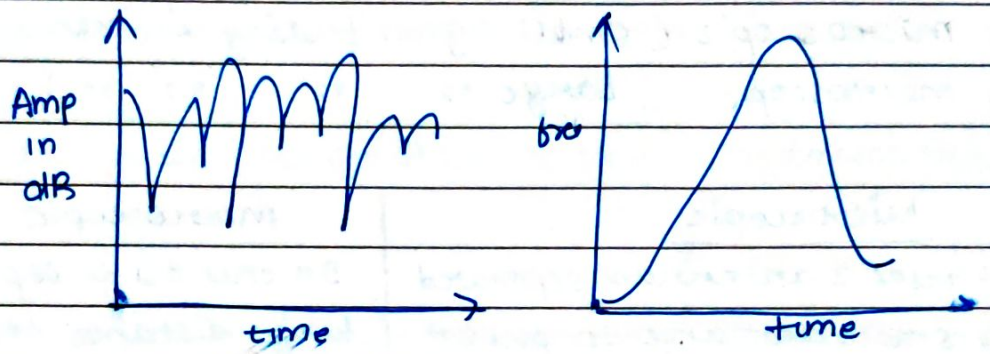
→ Rayleigh fading:

(i) It is assumed that variation in signal passed through Rayleigh fading channel would follow rayleigh distribution

(ii) This model assumes that the mag of signal passed through a Tx medium will vary randomly or fade acc to Rayleigh distribution – the radial comp of sum of 2 uncorrected gausian random variable

(iii) It is caused by multipath reception (reflected and scattered waves)



It is commonly used to describe statistical time varying nature of rx ~~signal of~~ flat fading signal and can be given as bellow:

$$s(r) = \begin{cases} \frac{r}{\sigma^2} \exp\left(\frac{-r^2}{2\sigma^2}\right) & 0 \le r \le \infty \\ 0 & r < 0 \end{cases}$$

→ BER performance in Fading Channel: (Bit error rate)

(i) BER is a function of E_b/N_0 and is plotted for various fading channel.

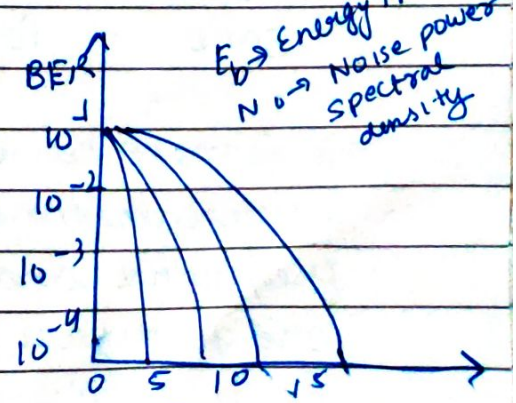
(ii) As BER ↓ E_b/N_0 ↑

(iii) AWGN exhibit good perform (conc)

(iv) Rician Good performance

(v) Rayligh Poor performance

(vi) Flat fading Poor performance



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→ Diversity modelling :

(i) This was introduced to compare and overcome deep fading.

(ii) As in deep fading if we have a single channel the connection will get interrupted or link will degrade due to fading. Hence to remove this problem

(iii) multiple links is applied b/w Tx and Rx which will affect comm. even after fading.

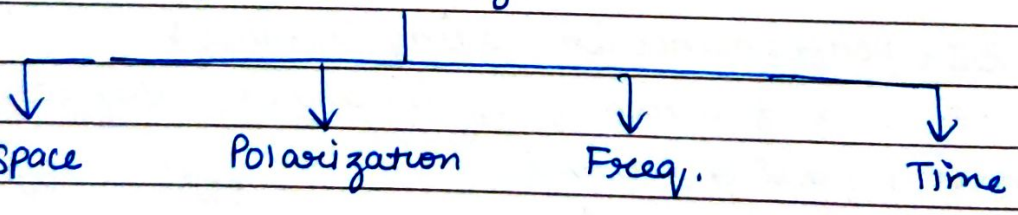
(iv) Diversity modelling is divided into 2 parts

a) Microscopic (small signal fading is men)

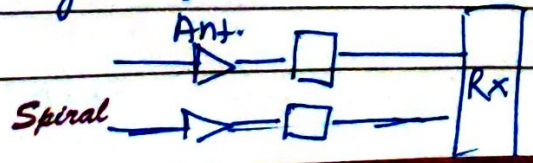
b) Macroscopic (Large " " " ")

Microscopic	Macroscopic
(i) It uses 2 antennas seperated by small distance to prvent small scale fading	In this BS is seperated by large distance that is not shadowed hence mobiles can acquire better SNR. Such contracting reduces large scale fading.
(ii) By selecting strong signal at all time a rx can mitigate small scale fading	

Types of Diversity



(i) This is most conventional method in which we have several antennas which are seperated by diff freq. band and they reach to reciever. Even if one got degrade rest will reach to rx



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There are 4 types of subdivision:

a) selection diversity
b) Feedback diversity
c) maximum ratio diversity
d) Equal gain diversity

(ii) This is used where signal is transmitted using pair of polarized antenna and rx by another pair of antenna. when fading channel can be rx hence this diversity is used
→ Circular and linear diversity antenna is used

(iii) In this info is sent on carriers from transmitter end to receiver end.

(iv) In time diversity info is transmitted repeatedly after a specific time. It leads to repetion of signal also.

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→ **Wireless channels and fading:**

Wireless comm is prone to noise, interference and other channel obstruction which change over time unpredictably resulting degradation of signal.

Losses in signal arises both in Tx of signal in short distances as well as long distances.

Long distances

Here loss is due to path loss and shadowing.

Path loss → degradation of signal due to dissipation in path because of propogation effects

Shadowing → caused by obstacles that absorbs power.

small scale fading

short distances

Here loss is caused due to multipath delay and dopplers spreading.

multipath spreading → addn of constructive & deconstructive signal components while prop

Doppler's spread → change in freq of EM due to relative motion of rx wrt Tx. & velocity and direction of motion of rx wrt arrival of wave.

(1) **Small scale Fading:**

(i) Describes rapid fluctuations of amplitude of RF signal over a short period of time and distance.

(ii) Fading is the phenomenon caused due to interference b/w two or more versions of Tx signal which arrives at the rx at slightly diff times.

These are delayed versions of Tx signal caused due to mov and called multipath waves.

Signal

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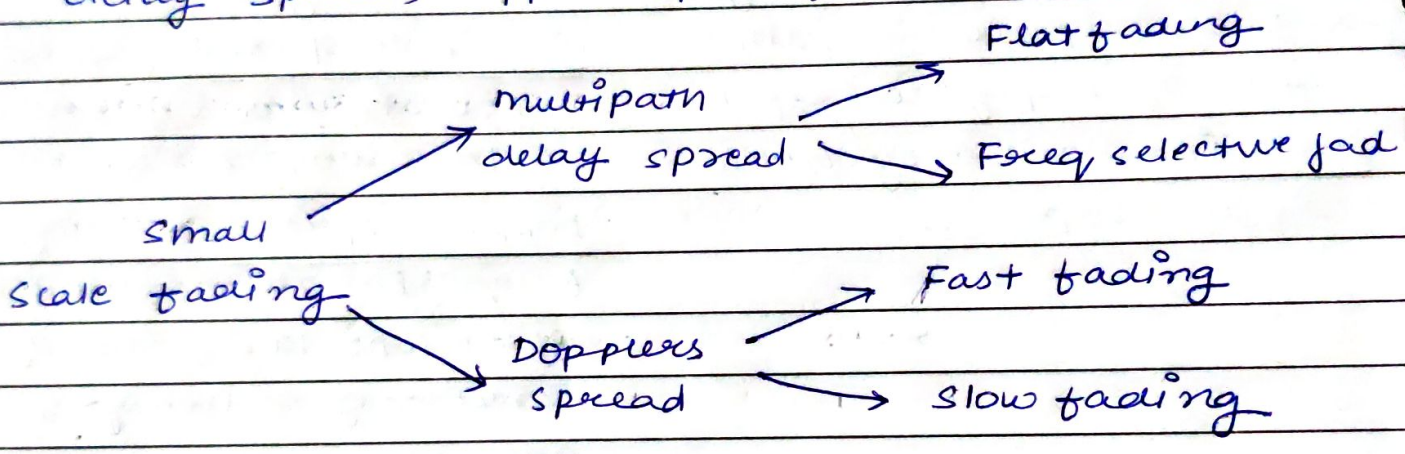
Reasons of small scale fading

(i) Rapid change in signal strength over small distance
(ii) Random freq mod. effects due to doppler shifts
(iii) Time dispersion due to multipath delays.

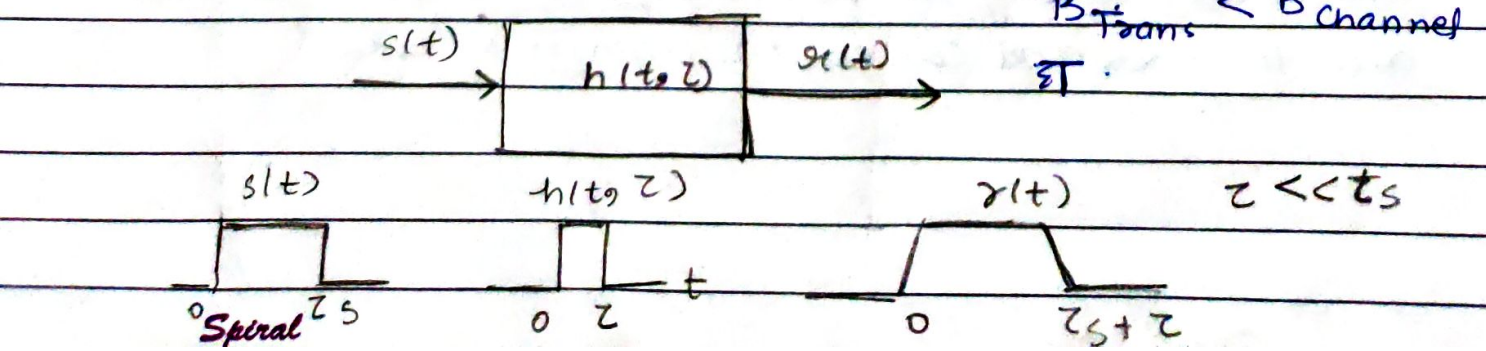
Types of Small Scale Fading:

Type of fading experienced by Tx signal depends on the nature of Tx signal wrt characteristics of channel. i.e (depends on relation b/w signal parameters i.e BW, symbol period etc and channel parameters i.e delay spread, doppler spread).



(i) Flat fading channel →

→ caused by time dispersion due to multipath compone
→ occurs in rx signal if channel has const gain and linear phase response over BW > BW transmitted signa
→ most common type of fading
→ In this spectral charac. of Tx signal is preserved in rx signal while strength changes with time



Date.....

Conditions for flat fading

(i) $B_{transmitted\ signal} < B_{channel}$

(ii) ~~$T_{signal} > T_{channel}$~~ (Rate of change of ~~channel~~ ~~slowed~~ ~~be faster than signal~~)

(iii) Delay spread < symbol period

(ii) Freq. selective fading channel :

→ caused due to time dispersion due to delayed multipath components.

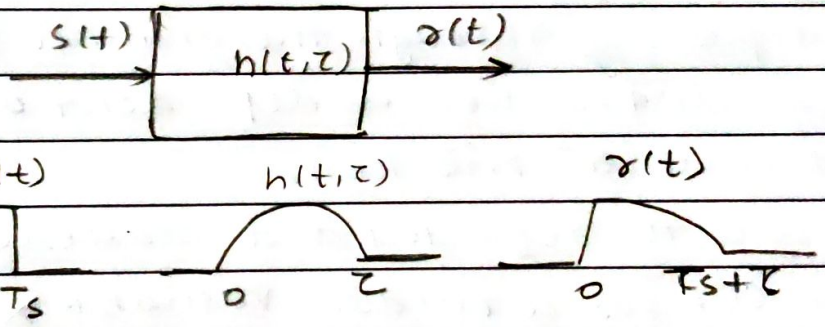
→ occurs in rx signal if channel has constant gain and linear phase response over BW channel < BW signal.

Condition for selective fading

(i) BW signal > B channel

(ii) ~~$T_{channel} > T_{signal}$~~ Delay spread > symbol period

→ Received signal includes faded and delayed signal tor hence signal is distorted and Intersymbol Interference is induced.



(iii) Fast fading channel :

→ caused due to freq dispersion due to doppler spread

→ Rate of change of channel is faster than rate of change of Tx signal.

→ Doppler spread is greater than Tx signal.

(i) $T_{signal} > T_{channel}$ (T_s → symbol period)

(ii) $B_{signal} < B_{doppler\ spread}$

(iv) Slow fading channels :

→ Caused due to freq dispersion due to doppler spread
→ Rate of change of channel is slower than Tx signal
→ Impulse response is static
→ Doppler spread is smaller than Tx signal
(i) $T_s << T_c$ (T_c → coherence time)
(ii) $B_{signal} >> B_{doppler}$ (T_s → symbol period)

(2) Rayleigh and Rician fading channels :

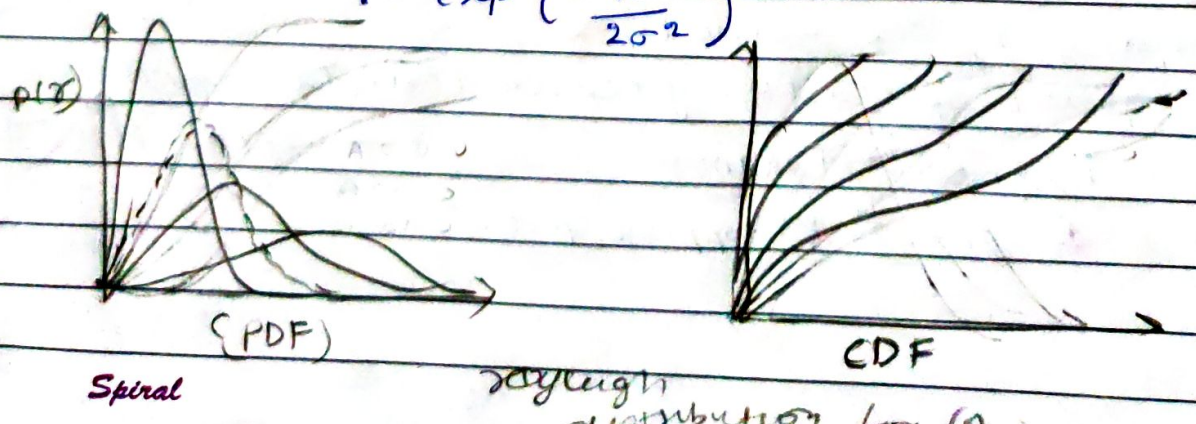
These fadings occur to a signal as a result of effect of propogation channel.

(i) Rayleigh fading channel :

→ Based on Rayleigh distribution which is used to describe statistical time varying nature of rx waveform of a flat fading signal
→ signal passing through this channel follows rayleigh distn
→ Rayleigh distribution is dependent on Gaussian and Normal distribution.
→ Caused due to reflected and scattered waves
→ PDF and CDF for a random variable x following Rayleigh distribution is given as

$$p(r) = \begin{cases} \frac{r}{\sigma^2} \exp\left(\frac{-r^2}{2\sigma^2}\right) & 0 \le r \le \infty \\ 0 & r > 0 \end{cases}$$

$$P(r) = 1 - \exp\left(\frac{-R^2}{2\sigma^2}\right)$$



Spiral

Rayleigh distribution for (A)

Date.....

(ii) Rician fading channels:

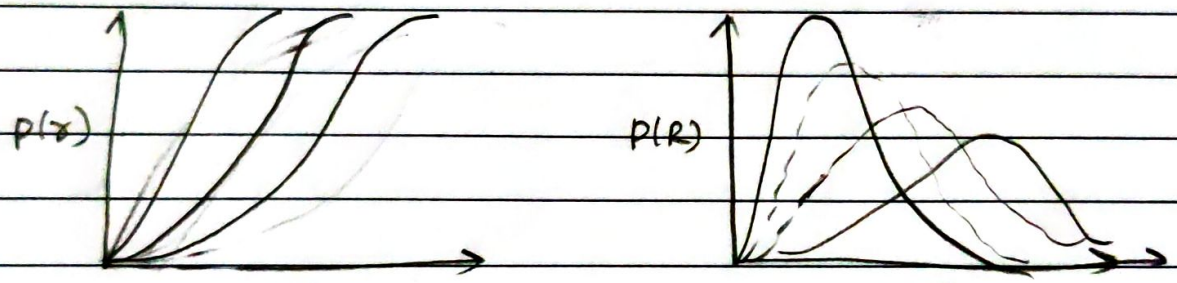
→ A wireless channel modelled when there exists non-fading signal, LOS propagation path, radion multipath components and these are superimposed on a non-fading signal.

→ At the receiver the o/p signal having effect of all these components resulting weaker signal following Ricean distribution.

→ PDF and CDF are given as

$$p_r = \frac{r}{\sigma^2} e^{\frac{(r^2+A^2)}{2\sigma^2}} I_0\left(\frac{Ar}{\sigma^2}\right) \quad A>0 \; r>0$$

$$P(R) = 1 - Q\left(\frac{A}{\sigma}, \frac{r}{\sigma}\right)$$



(Ricean distribution)

(3) BER performance in fading channels:

(i) BER stands for bit error rate per bit transfered.

(ii) It is a function of E_b/N_0 plotted for various channel

(iii) BER ↓, E_b/N_0 ↑

(iv) In Rician fading the chan

UNIT-II

Date.....

→ IS-136 (D-AMP/TDMA):

It stands for Interim std-136. The second generation of the TDMA digital cellular system. First introduced in 1994 is also known as 'Digital AMPS'.

IS-136 is a mobile comm interim std which extends the functions of dual mode system std IS-54B.

IS-136 expands the capabilities of IS-54B to include:

→ SMS for both point to point & broadcast info
→ Greatly improved security
→ Sleep mode for decreased battery use

Features:

→ 6 Time Slots per channel.
→ Data Structure : TDMA
→ Posses both digital and analog control channel.
→ 3 full rate, 6 half rate, 9 future users per channel.
→ Data rate of 1 ~~Sym~~ 24300 symbols/sec.

→ IS-95 (CDMA):

It is a second generation mobile telecomm std based on CDMA tech which guarantees multiple access when sending voice and data b/w cell sites.

→ Operates in 800 MHz and 1900 MHz freq band
→ First Qualcomm std under CDMA
→ Rx data from mobile phones in PPP protocol.
→ Implement high speed data services
→ More privacy

Date.....

→ **2G Wireless N/w:**

(i) It started replacing analog system by digital system
(ii) Speed of comm increased
(iii) Data encryption started being possible
(iv) Functions like call processing introduced

→ **Global system for mobile (GSM):**

(i) It is just 2G cellular Network
(ii) Improved QOS
(iii) Introduced service portability
(iv) Secured the system
(v) Freq. utilized (Reuse)
(vi) Cost

} requirements of GSM

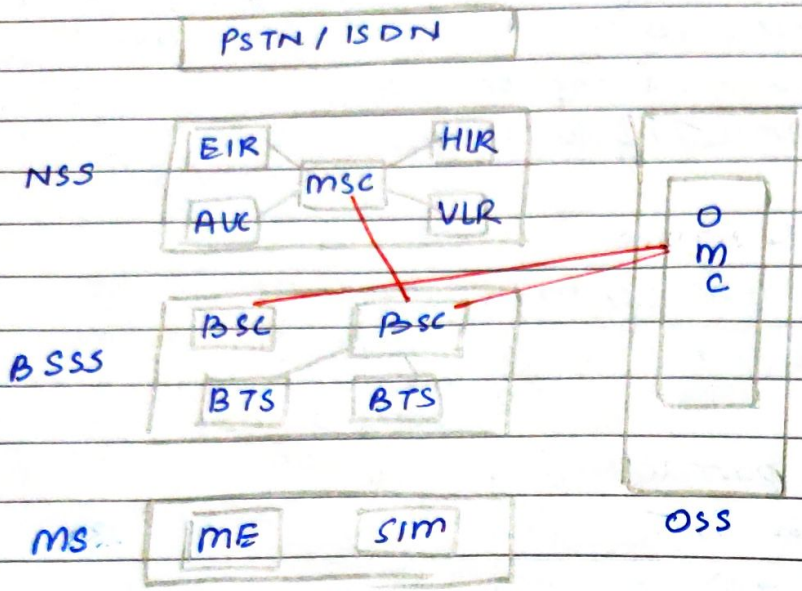
GSM service

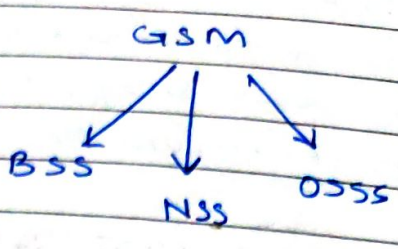
- Bearer service (related to 1, 2 and 3 layer of OSI)
- Telephone service (provides voice Tx, msg service and data comm.)
- Supplementary service (call redirecting forwarding)

→ GSM is a digital mobile N/w widely used in phones
→ It uses a variation of TDMA and most widely used for 3 digital wireless telephony.
→ It basically digitizes and compress data & when send it down a channel with 2 other streams of user data each in its time slot.

Date.....

→ GSM architecture:





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This section of 2G GSM N/W arch is fundamentally associated with comm with the mobiles on N/W

It consists of 2 elements

(i) BTS (Base Transreciver St): It comprises the radio into of transmitter receivers and their associated antennas that tx and rx to directly comm with mobile

→ It is the defining element of each cell

→ It comm with the mobiles and the midway interface is called Um interface

(ii) BSC (Base St. controller):

→ It manages BTS

→ It manages handoff, paging and RF assignment

Date.....

↔ The base st. subsystem utilise the radio access tec to enable a no. of users to access a system concurrently.

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② **NSS (Network Subsystems):**

→ Provide the main control and interfacing for whole N/w

→ It comm makes connections blw Public N/w

→ Handoffs blw BSS.

It has the below major elements

(i) **MSC (Mobile service switching centre):**

→ It is the main element within the core of GSM N/w

→ Acts like normal ~~the~~ switching node within PSTN or ISDN

→ Provides facilities like authentication, call loc, reg, inter msc handover etc.

→ Also provides interface to PSTN so that calls can be routed from mobile N/w to a phone connected to landline

(ii) **HLR (Home Loc register):**

→ Contains all administrative info about subscriber

→ Subscribers location.

→ By using this info GSM N/w is able ~~to~~ route calls to relevant ~~BSS~~ ~~MS~~ BS for MS.

→ Acc to the last updated loc by HLR the BTS the phone comm with us identified to route the calls

Date.....

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→ Protected database that contains secret key also contained in user's SIM.
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→ Connected to NSS and BSC
→ Used to ~~control~~ and monitor and maintainance Overall GSM N/w
→ Also control traffic load on BSS.
It has a subcomponent OMC which also maintain peryormance of MS, BSC, BC, MSC etc.

(4) MS (Mobile Station):
→ Contains the equipment user see and operates.
ME → contains IMEI (Inter mobile eq. identity)
SIM → Info that provides the identity to user on N/w

UNIT-2

Date.....

(1) D-AMPS (IS-54 and IS-136):

→ In late 1970 advance mobilephone services (AMPS) was developed however this I generation analog system was not designed to support high capacity demands

→ Hence to improve capacity digital mod. techniques were developed to support max users in fixed spectrum and was standardise by IS-54 and IS-136 is introduced as the successor to IS-54

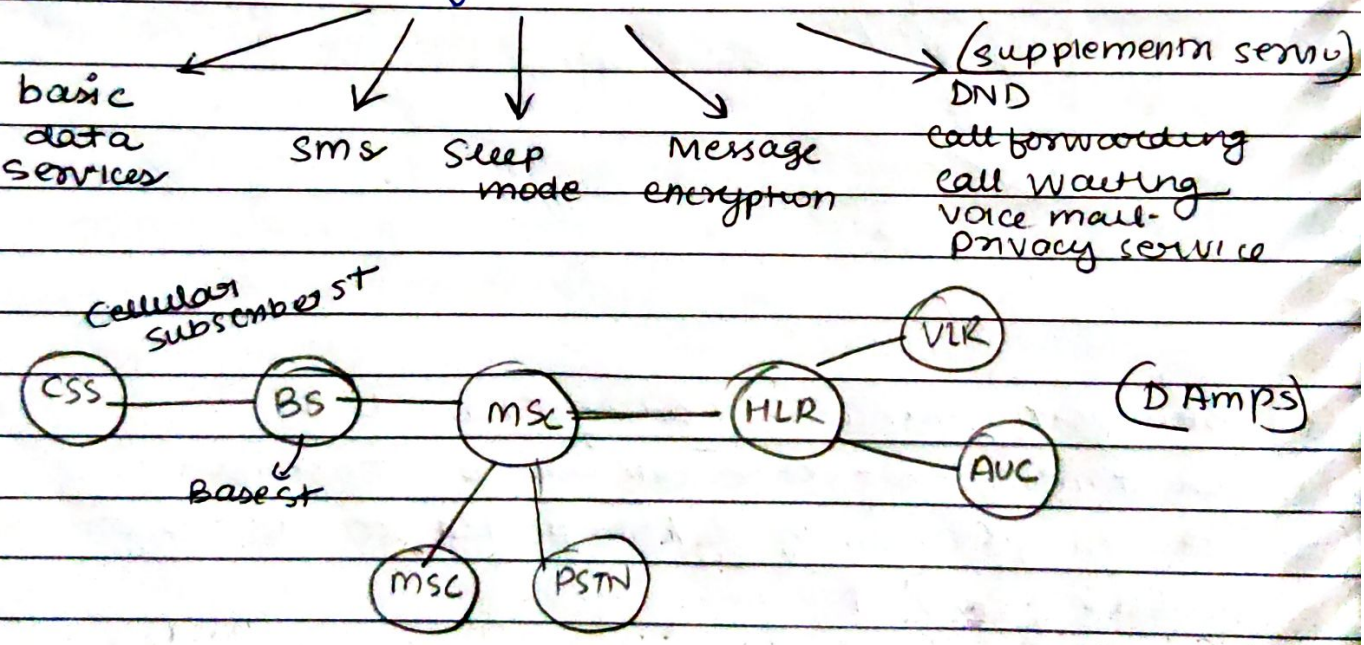
→ IS-136 Standard insure following features:

(i) Compatability with AMPS in DAMPS

(ii) Frequency sharing and reuse

(iii) Dual mode smooth transition.

Services provided by DAMPS includes:



The DAMPS channels includes

→ 42 primary channels & 42 secondary control channel

→ 30 KHz BW for voice channels in both fwd and reverse links

→ Supports max 3 user

→ Support TDMA scheme & provide 6 slots.

Date.....

(2) IS-95 CDMA:

→ The CDMA digital technique is titled as standard 95. It is a direct spread spectrum CDMA system

→ The main advantage of IS-95 over analog system (AMPS) is to provide 20 times inc in system capacity

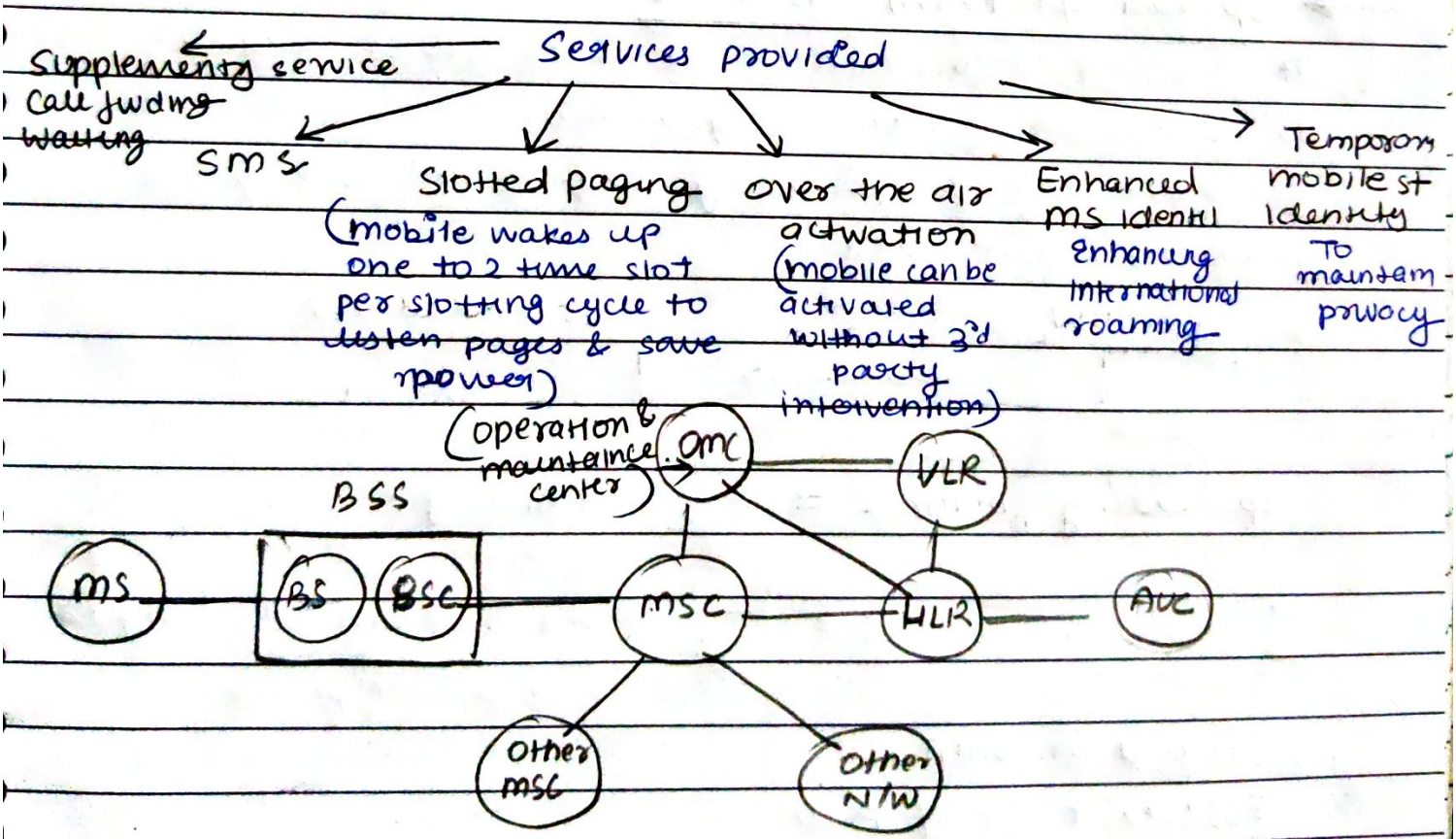
→ In IS-95 each user within a cell and neighbouring user is provided with same channel bcoz it is based on DSSS (Direct seq spread spectrum). Hence can reduce the need for freq planning

→ Uses diff modulation and spreading tech for fwd and backward link connection.

On Fwd link → BS simultaneously Tx data for all mobiles in a cell using diff spread seq

On Bkwd link → all mobiles have const signal from BS

→



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The key features of IS-95 are as follows:

(i) System capacity → Improved system capacity as compared to analog systems

(ii) Soft handoffs → CDMA system enables soft handoffs as system is capable of simultaneous deliver to a mobile through more than one cell. Employs make before break procedure which reduces ~~capability~~ possibility of call drop

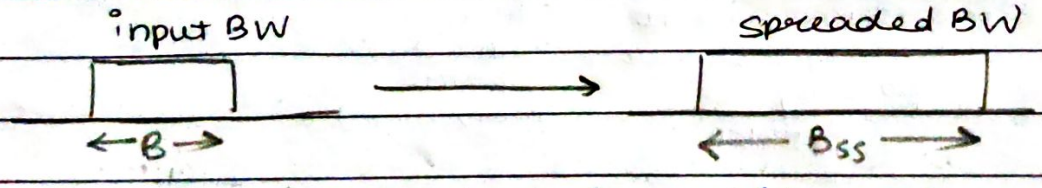
(iii) Diversity → ~~Rake~~ Diversity methods are there so as to prevent deep fading.

(iv) Power control → Deploy open & closed loop controls for enabling power control

→ Spread Spectrum systems:

(i) It is a modulation tech in which Tx BW is larger than the information signal BW.

(ii) Hence bit rate of spreading seq is much higher than the input data.



Spreading factor $L = \frac{B_{ss}}{B}$ (Analog)

$L = \frac{T_b}{T_c}$ → $\frac{\text{Bit time Period}}{\text{chip time period}}$ (Digital)

(iii) Used in CDMA

(iv) Efficient use of BW

(v) Safe and Secure data (Encryption)

(vi) Resistance to narrowband interference

Immuned to jamming

Spiral Multiple access

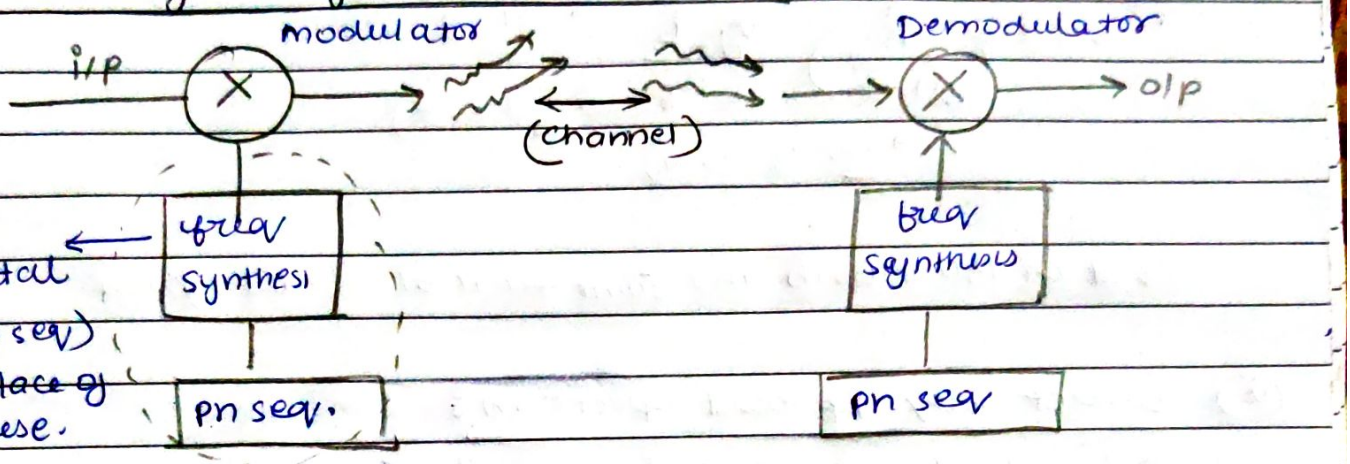
High gain

Date.....

Need of spread spectrum:

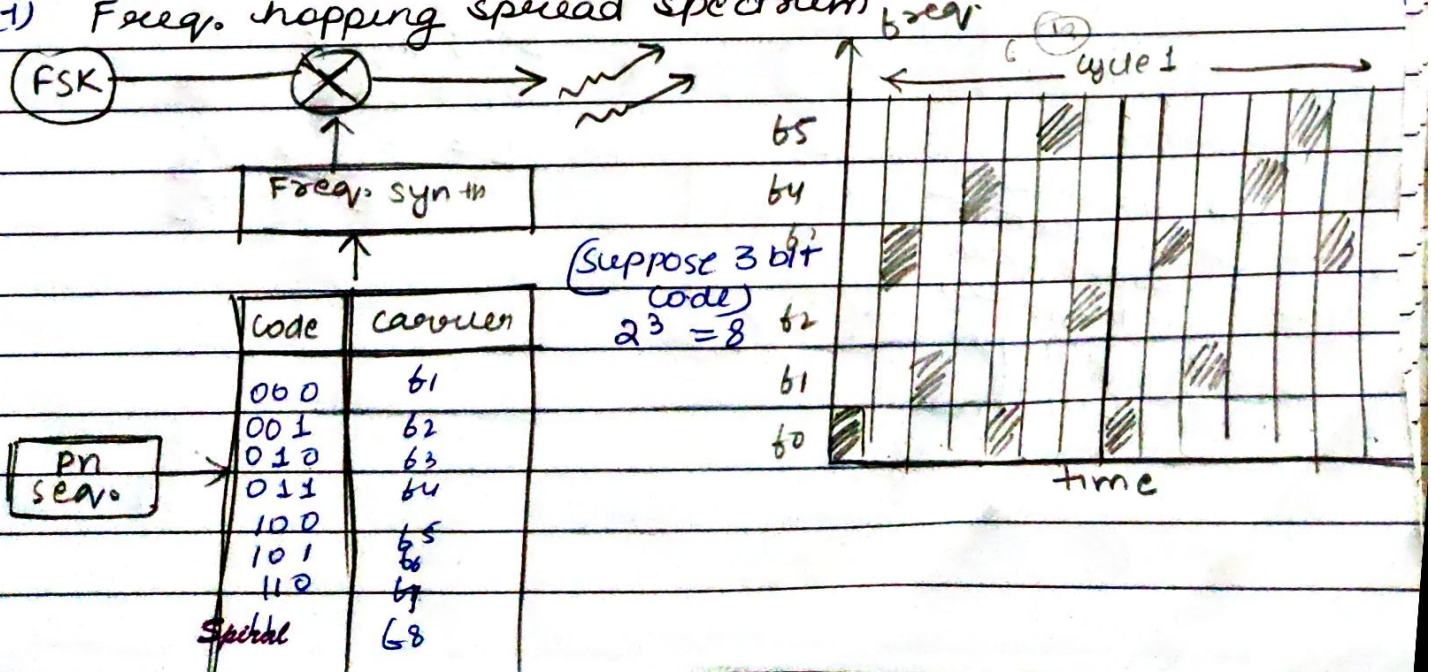
(i) Improves the limitation of FDMA and TDMA which are
→ limited bandwidth it req high spectral efficiency
→ concentrated spectrum
→ Narrowband spectrum

Block diagram of spread spectrum:



Additional freq. from freq synthesizer is Tx to with the input data based on the data in pn sequence to spread the spectrum of data. and reverse happens at the reception end.

There are two types of spread spectrum systems
(i) Freq. hopping spread spectrum



Date.....

Modulation technique:

→ There are effective digital mod^n methods like PSK, QAM and PAM but these are not effective and costly for coherent detection and hence FSK is used.

(Proper) If $T_c < T_b$ (fast hopping) $T_c \rightarrow$ Chip period
$T_c > T_b$ (slow hopping) $T_b \rightarrow$ Bit period

$$SIR = \left(\frac{B}{M-1}\right)\frac{\log_2 L}{L R_b}$$

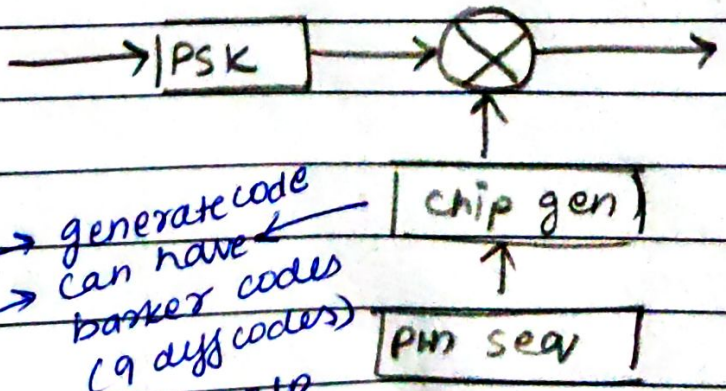
B → BW
L → ortho code
R_b → (Bit rate)
(M−1) → (No. of users)

Used in Bluetooth and Joint tactical Radio systems

(ii) Direct seq. spread spectrum:

→ I/p signal can be mod with PSK / QPSK / QAM
→ Digital spread spectrum tech.

In FHSS following drawbacks are there
→ Non-coherent detection
→ Poor BW efficency
→ Poor BER

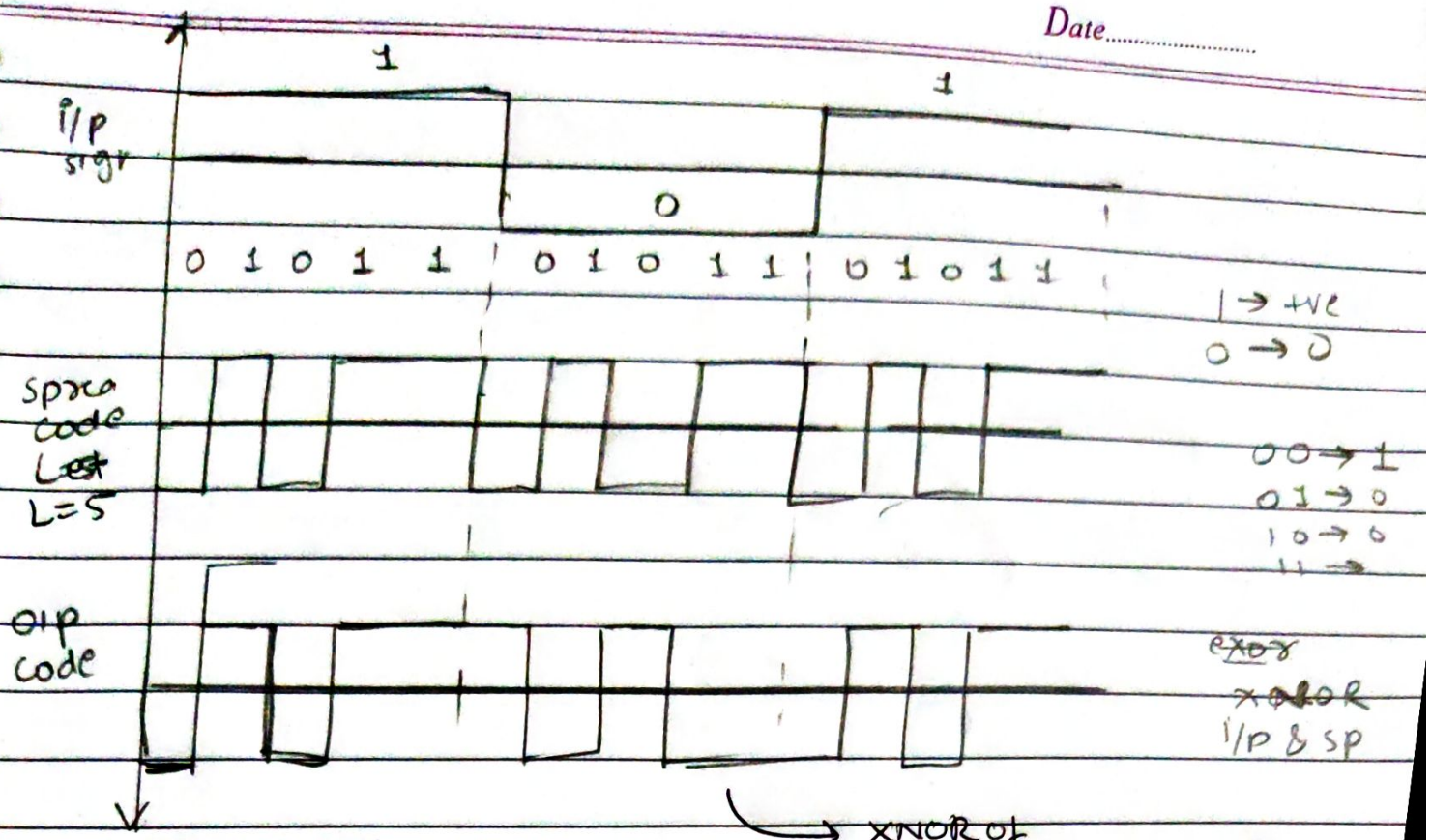


→ generate code
→ can have barker codes (9 diff codes)
→ digital o/p [+1, -1]

DSSS signal
$B_{ss} = LB$

$$L = \frac{B_{ss}}{B} = \frac{T_b}{T_c}$$

Date.....



→ XNOR of i/p signal & spread code

(Advantage

→ Better Security

→ Immunity against jamming

used in CDMA — 2G, 3G (Applications)

Date.....

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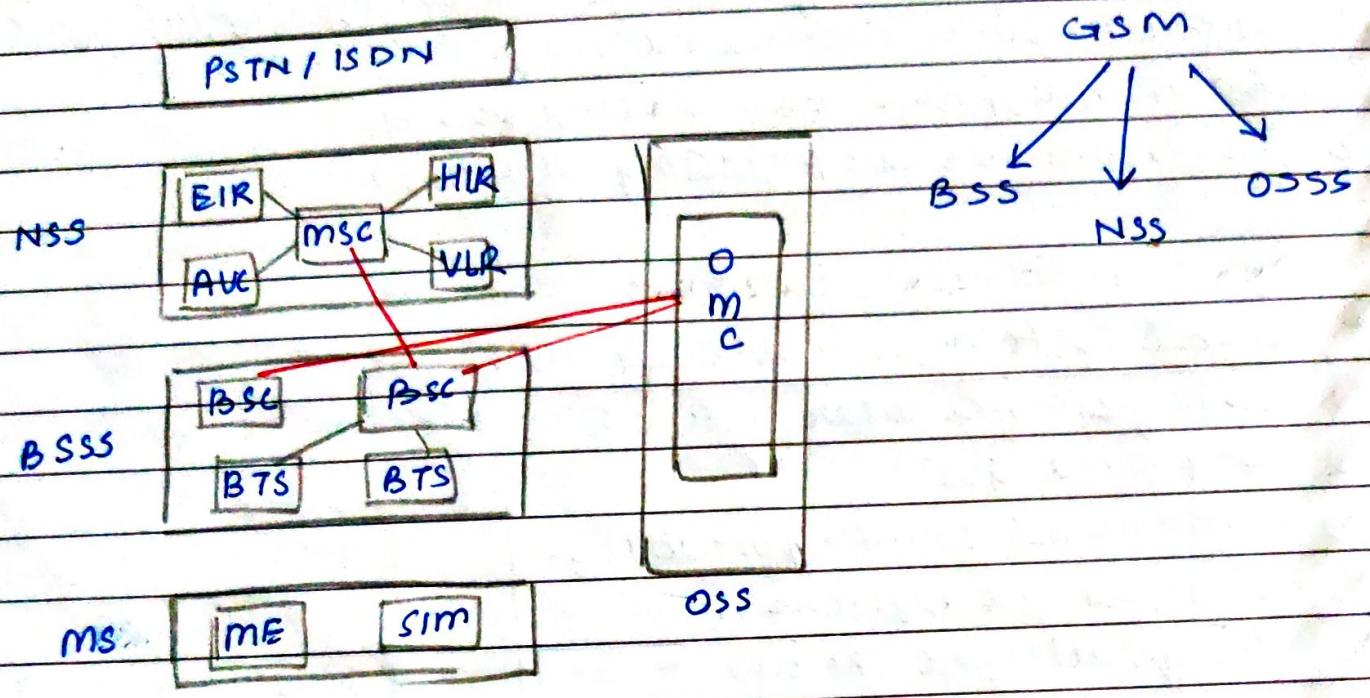

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Date.....

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Date.....

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UNIT-3

Date.....

→ 2.5 G mobile Data Networks :

2.5G standards were introduced because of the following drawbacks in 2G technologies

(i) As the 2G tech use circuit switched modems users faced limitation of a single circuit switched voice channel

(ii) As result data transmitted and data rate were limited

(iii) 2G was quite slow for various data applications e.g web browsing, email.

So as to inc data rates and throughput new standards were introduced called 2.5 G.

(i) Allows 2G equipment to be modified with new base st. add ons and subscriber unit S/W upgrade.

(ii) Supports higher data rate tx for email, browsing etc.

(iii) Also supports new web browsing format called WAP (Wireless App. Protocol) → support std web pages to be viewed in compressed format.

Three TDMA upgrades were used in 2.5 G

(i) HSCD → High Speed Ckt Switched Data

→ Ckt switched technique that allows a single mobile subscriber to use cont. time slots in GSM std.

→ It also relaxes error control coding algo

→ Ideal for dedicated streaming Internet access or real time interactive sessions

(ii) GPRS → General Packet Radio Service

→ As easy ~~data~~ access and high data rates were not supported by GSM systems GPRS was introdu

Date.....

→ Packet based data NW suited for non real time internet usage including recovering of Email, faxes, asymmetn web browsing (where user downloads more than upload).
→ Supports multiuser N/w sharing of individual radio channels and time slots. (use bursty style tech)
→ retains orignal modulation formats from 2G TDMA Std but uses a redefined interface for better packet handling

(iii) EDGE → Enhanced Data rates for GSM
→ more advanced upgrade to GSM std and requires addn of H/w and S/w std at base stations.
→ developed from the desire of GSM and IS-136 operators to have a common tech for 3G high speed data access
→ introduced new digital mod format 8PSK used in addn to GSM's std GSMK mod. format.
→ allows 9 diff air interface formats, known as multiple mod. and coding schemes (MCS) with various degrees of error control protection.

→ General Packet Radio Services:
(i) As For easy access and high speed data rates GPRS was introduced as it was not supported by GSM
(ii) GPRS tech is considered as a bridge b/w GSM & 3G N/w
(iii) It refuses existing GSM infrastructure to provide end to end packet switched services
(IV) Offers fast data transmission via a GSM N/w
(V) This tech makes possible for user to make calls and Tx data at same time.

Date.....

(vi) Employes packet switching which means that GPRS mobile phones have no dedicated ckt assigned to it. It's physical channel is created only when data is tx. and after data has sent assigned to other users.

(vii) Most efficient use of N/w.

(viii) Includes new Tx and signaling procedures & protocols

(ix) Ciphering algorithm is optimized for data packet Tx

(x) Inexpensive, quick & efficient data service

GPRS functions:

(i) N/w access: provides the std point to point data transfer and anonymous access (without authentication and encryption)

(ii) Packet routing & transfer: Includes routing of data b/w mobile system and destination through serving and gateway GPRS support Nodes.

(iii) Logical link Mgmt: Maintainace of comm" channel b/w MS and Gsm network.

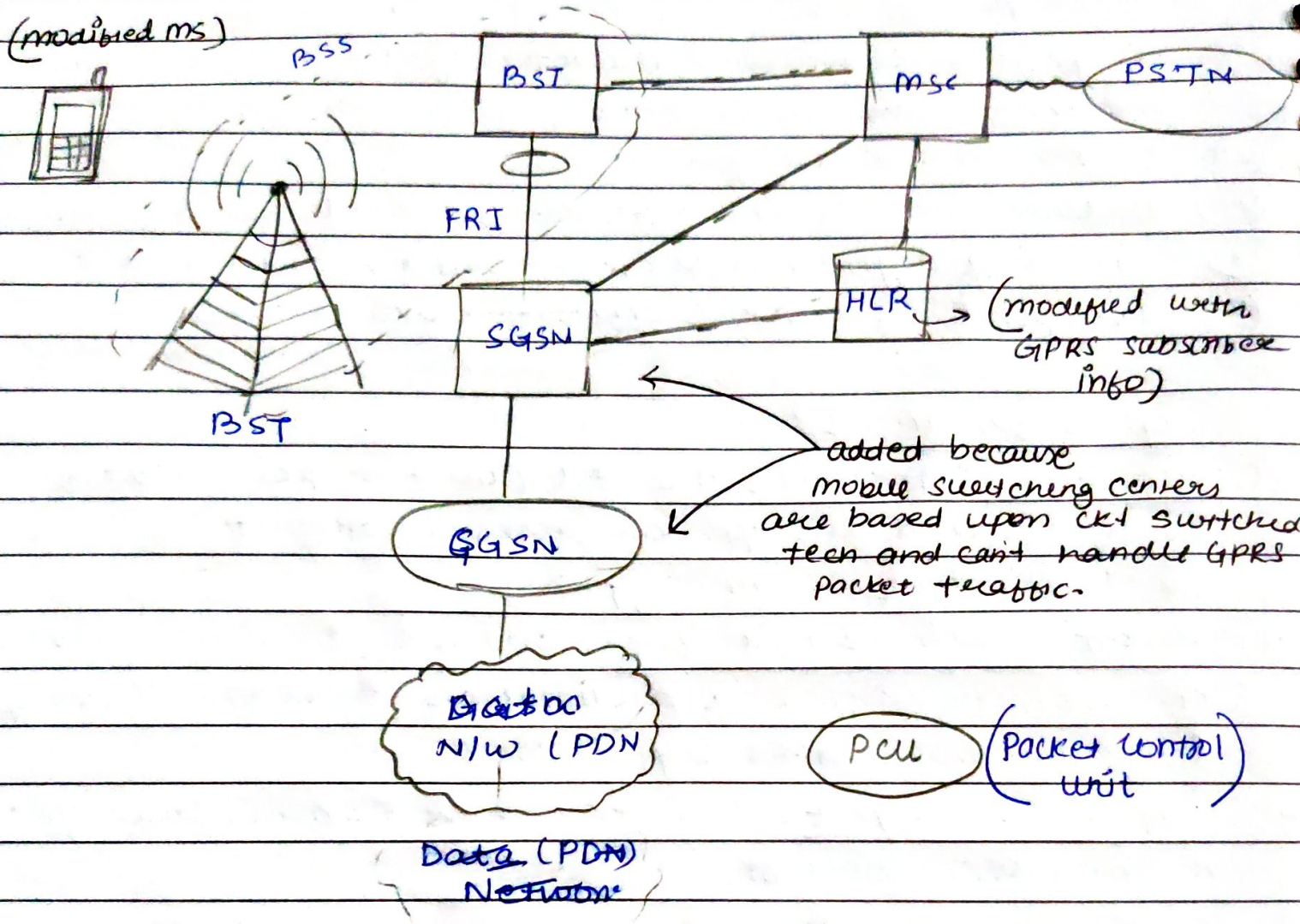
(iv) Radio resource mgmt: Allocation and maintenance of radio comm" paths.

(v) Mobility mgmt: includes keeping track of the current location of an MS. When MS enters a new cell tasks like cell update, area update needs to be performed

(vi) N/w mgmt: provides mechanism to support operations, administration and maintainence functions related to GPRS.

Date.....

→ GPRS architecture :



(i) The mobile st requests and this req is transferred via BTS to BSC by using air interface

(ii) BSC configures the kind of request made. Requests can be of 2 types → voice calls.
→ Data access

If a req is made for voice call the BSC will opt the GSM submodule for request handling and for data access BSC divert this request to PCU and to SGSN.

Date.....

(iii) The SGSN stands for Serving GPRS Support Node. It's functions includes:

(i) Authentication of GPRS user → to check that user can access that data or not.

(ii) Data compression → compress the data and forwards the req data only and rejects the rest

(iii) Registration of mobile in N/w

(iv) Then comes the Gateway GPRS support node it act as a router and a interface, it routes the data from whole architecture to data N/w using routing algorithms, tables etc

(v) The last component is data packet N/w which makes data access in terms of data packets

(1) GPRS mobile stations:

(i) In GPRS mobile st. higher data tx speed can be acheived due to availability of more than one channel.

(ii) They are the equipments by which the user can request its needs to the network. There are several types of phones based on no. of slots they used for Tx such as:

	Rx slot	Tx slot	max^m no. of slot
Class 1 →	1	1	2
Class 2 →	2	1	3
Class 3 →	2	2	3
Class 5 →	2	2	4
Class 8 →	4	1	5
Class 12 →	4	4	5

Sajal

Date.....

(iii) The GPRS mobile phones may also be classified on the bases of possible simultaneous calls (via GSM) and data transmission (via GPRS).

→ Class A : Simultaneous calls (GSM) & data Tx (via GPRS)
→ Class B : Automatic switching b/w GSM & GPRS mode is possible acc. to telephone settings.
→ Class C : Hand operated switching b/w GSM & GPRS mode

(2) Base Station Subsystem:

(i) used when mobile to decide where to divert the request made by the MS on the bassis of type of req.
(ii) It consists of BTS and BSC with a new component called PCU (Packet control unit) used to enable data packet transmission.
(iii) BSC forward the requests to MSC (if voice req) and to SGSN (if data access req).
(IV) A BSC can only connect to 1 SGSN
(V) This whole subsystem perform functions such as paging, mobility management, resource managmen

(3) GPRS Support Nodes (GSN):

GPRS consists of two kinds of GSN i.e SGSN & GGSN

(i) SGSN : Serving GPRS support node.
→ It forwards the data packet access request to data N/w and delivers packets to ms
→ It authenticate user by obtaining profile info of subscriber by HLR.
→ It also register a new subsriber
→ Performs mobility management, loc mgmt and encryption service for security.

Date.....

(ii) GGSN: Gateway GPRS support node.
→ Used as an interface to ext IP networks
→ Translates data formats, add^n info and signalling protocols to permit comm^n b/w diff N/w's.
→ Maintain routing info
→ One (or more) GGSN can provide support to multiple SGSN
→ provides address mapping, subscriber screening too

(4) HLR and VLR: (Home loc register & Visitor Loc register)
(i) In GPRS module new fields are accomodated to previous HLR's and VLR's from GSM systems such as subscription and routing info.
(ii) used to associate MS with GGSN
(iii) Update the SGSN of the MS
(iv) store fixed IP add^n and QoS profile of Tx path.

→ EDGE: (Enhanced Data rates for GSM Evolution)
(i) Modulation method for GSM interface and designed to use in connection with GPRS as EGPRS etc.
(ii) Also can be used with HSCD forming EHSD.
(iii) When used with GSM creates quality of sound & ↑ data rate improved very much for transmission. The N/W based on the combination of GSM & EDGE is called GERAN
(iv) EDGE changes principle of modulation technique but interface specification and data bit ~~rates~~ Transmiss remains unchanged.
(v) Expensive technique.
(vi) Requires min S/W level changes

mod tech in GSM → GMSK
" " " EDGE → 8PSK
} (change)

Spiral

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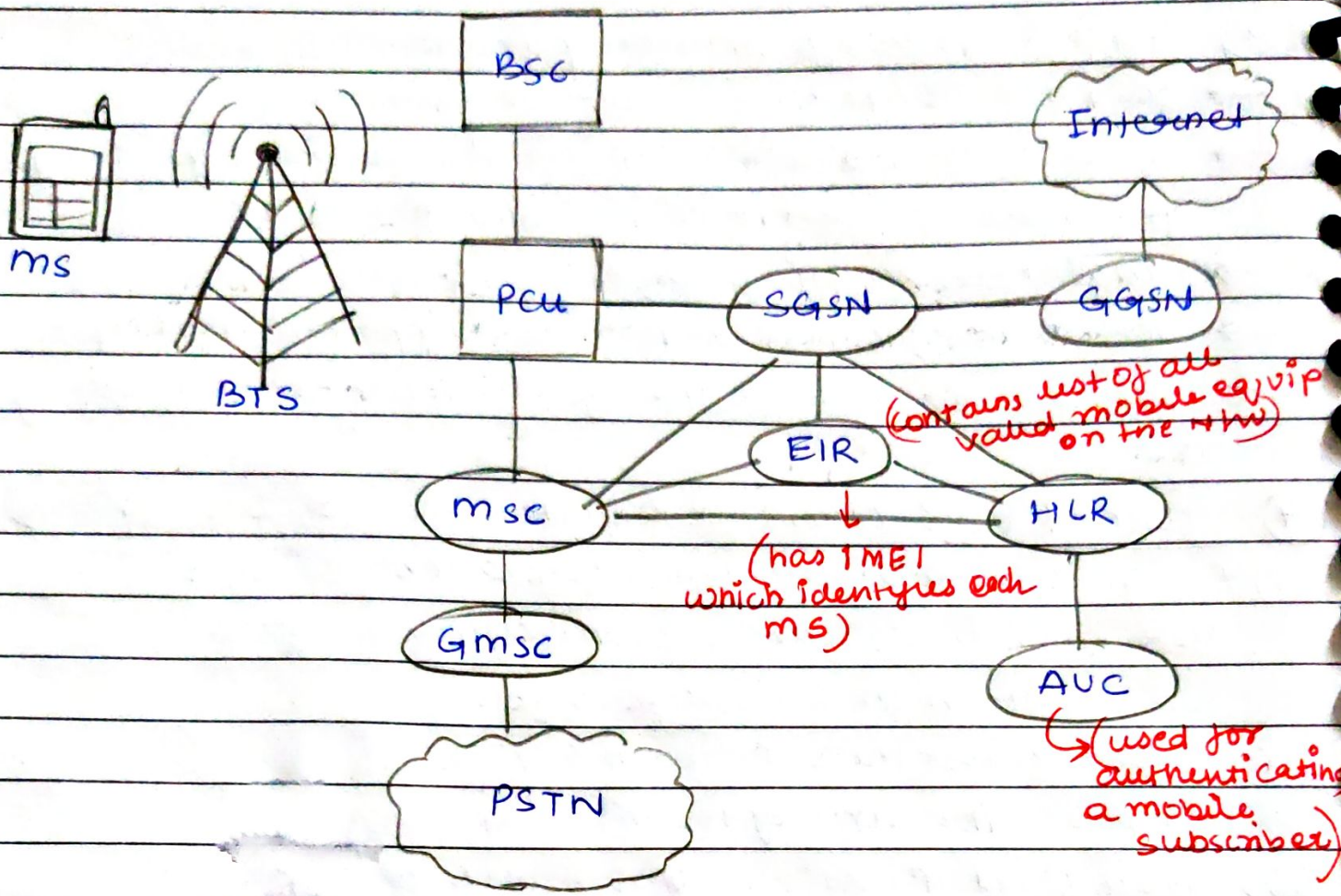

(i) The MS requests and BTS redirects it to BSC and the PCU decides where to direct this req depending upon type of req i.e data access req or voice calling req.

(ii) For voice calling req directing to PSTN module and for data access to SGSN-GGSN module and rest happens like GPRS.

→ **WLAN's:**

(i) It is a wireless computer N/w connecting two or more devices using wireless distribution within a limited area.

(ii) Provides mobility within coverage area

(iii) 2 major Std's IEEE & ETSI

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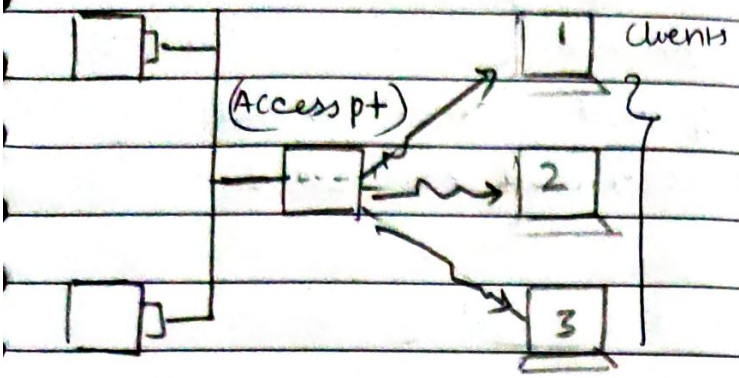
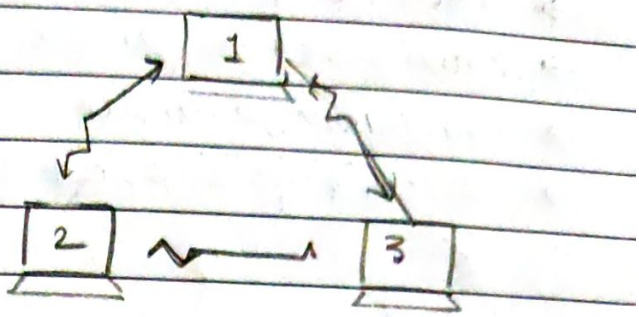
There are basically 2 types of WLAN's used

Infrastructure WLAN N/W



Adhoc wireless N/W



(i) Wireless devices can't communicate with each other directly but only by access points	(i) Devices can communicate directly and do not need access points
(ii) Access point act as a bridge b/w wired and wireless N/W	(ii) No such bridge present as comm is b/w wireless devices only.
(iii) Simpler design	(iii) Complex design
(iv) Low flexibility	(iv) High flexibility
(v) Infrastructure req.	(v) Not required

IEEE (802.11):

(i) First WLAN standard developed. Originated as a part of IEEE 802.4 but later renamed as IEEE 802.11 to define Physical (PHY) & medium access control (MAC) layers which are adopted for spl requirements of WLAN

(ii) Primary goal was specification of simple and robust WLAN which offers time bounded and async services with need to support mobility and security.

(iii) ~~Defined~~ 802.11 need provisions for connection management, reliability management & power mgmt (was not present in 802 std) ↳ and security

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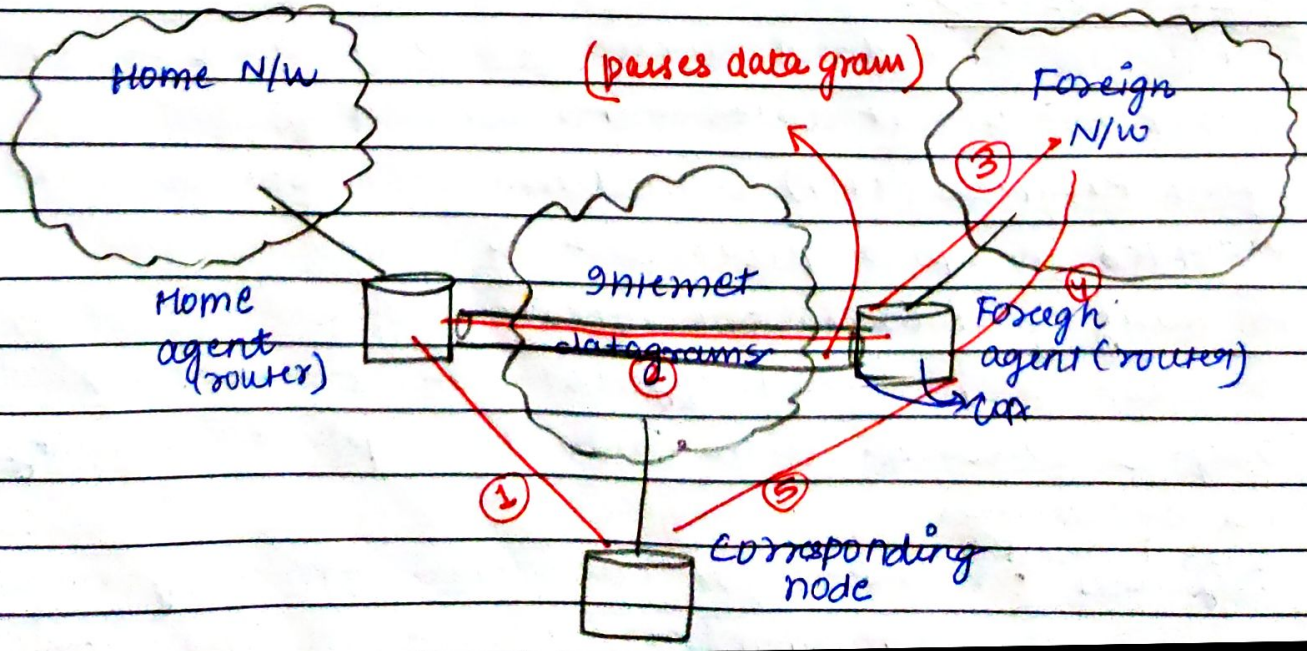
(iv) It satisfy following req:
→ Single MAC to support multiple physical layer
→ mech. to allow multiple overlapping N/w in same area
→ Provisions to handle interference.
→ Provisions to handle security and access control
→ Options to support time bounded services

→ **Mobile IP:**

It is an Internet Engineering Task force std protocol defined to allow mobile devices users to move from one N/w to another without changing their IP address.

Design goals of mobile IP includes:

(i) was developed as a means of transparently dealing with problems of mobile users.
(ii) Designed to make the size and freq of req. routing updates small as possible
(iii) Designed to make it simple to implement mobile no
(iv) Designed to avoid soln that requires mobile nodes to use multiple address



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(i) First corresponding node is registering the mobile node at the Home N/w to home agent

(ii) Hence when mobile node is moving from home N/w to foreign N/w then home agent is passing mobile node's info in form of datagrams through tunnel.

(iii) At end point tunnel has COA (care of address) which defines where to send data and Tx to respective foreign ~~network~~ agent.

(IV) The foreign agent passes the info (IP add^{n}) etc to the mobile node in foreign N/w and mobile node passes back to foreign agent and to corresponding node to restart when mobile node is again in home Network.

(even when mobile node changes IOC by Mobile IP ≠ remains constant due to comm b/w home agent and foreign agent).

(Similar the data is transmitted b/w mobile nodes)

(i) While transmitting data through tunnel the data is encapsulated by adding header to wrap data. The header specify how to send encapsulated datagram to the care of address

(ii) The default encapsulation method used is IP Encapsulation within IP commonly abbreviated IP in IP. Others are

→ Minimal encapsulation within IP
→ Generic routing Encapsulation

} To use these mobile node must request these while registration request

Date.....

(IMT-2000)

→ International Mobile Telecomm (2000):

(i) 3G systems aims to provide global mobility and service delivery & integration of wired & wireless N/W in mobile telecomm. but they must offer better system capacity, increased QoS, higher Tx speed in order to support wireless Internet access & wireless services

(ii) The International Telecom Union (ITU) working for development of International std for wireless access worldw and this std is known as IMT-2000. 2000 indicates the target availability date & operational RF band.

(iii) IMT-2000 aimed for 3G wireless systems

IMT-200 visions:

→ IMT was developed to provide capability which represent significant improvements, like

(i) Global mobility of users

(ii) High speed data services

(iii) High speed multimedia & internet.

→ Developed to be a family of systems rather single N/w

→ IMT-2000 includes complete range of mobile comm. applications.

→

Key features of IMT-2000 vision includes

(i) Common spectrum worldwide (1.8-2.2 GHz)

(ii) multiple feasible radio environe (cellular, cordless

(iii) wide range of services (voice, data, internet) LAN's etc)

(iv) High data rates

(v) Global mobility

(vi) Enhanced security & performance

(vii) Integration of satellite systems

Date.....

→ WCDMA and CDMA-2000 :

(1) WCDMA → WideBand Code Division multiple Access

(i) It is a 3G standard that employs the direct sequence code division multiple access channel method and the freq division duplexing (FDD) method to provide high speed and high capacity service & path for GSM sys.

(ii) It is also known as Universal mobile Telecom System (UMTS) and is a visionary air interface std developed in 1996

(iii) It assure backward compatability with 2G GSM, IS-136 and TDMA technologies as well as 2.5 GTDMA tec.

(iv) The 3G WCDMA interface std had been designed for 'always on' packet based wireless service so that wireless devices may all share the same wireless N/W and be connected to the Internet everytime, anywhere for any pup

(v) It provides high quality data, multi media, streaming audio/vdo etc to consumers with conference facility too.

(vi) W-CDMA demands min spectrum allocation of 5MHz and data rates from as low as 8 Kbps to as high as 2mbps can be carried simultaneously.

(vii) WCDMA features 2 modes

Freq Division Duplex (FDD)	Time DIVISION Duplex (TDD)
Seperate users by employing both codes as well as freq. One freq is used for uplink and another for downlink	Seperate users by codes, freq. and time wherein same freq is used for both uper and down link

(viii) WCDMA req costly new base st equipment hence installation likely to be slow & gradual.

Date.....

(2) CDMA-2000

(i) CDMA-2000 provides seamless and evolutionary high data rate upgrade for users of 2G and 2.5G CDMA std which basically centers on the original 2.5G CDMA channel BW of 1.25 MHz per radio channel for Tx.

(ii) Based upon IS-L95, IS-95A CDMA Standard (IS-95B too) the CDMA-2000 3G std support wireless carriers to introduce high data rate Internet access capabilities in existing systems while maintaing these updates being backward compatible with IS-95B, IS-95A equipment too.

(iii) NO need to change entire Base stations or reallocate spectrum system.

(iv) CDMA-200 supports instantaneous data rates of upto 307 kbps/user in packet mode & yeild throughput rates 144 kbps/user depending on quality, velocity of users and propogation conditions.

(v) It can support upto twice user as 2G CDMA Std and also two times long lasting battery life for subscriber unit. Also twice as Voice channel from IS-95.

(Basically CDMA-2000 std uses 3 adjacent 1.25 MHz radio channels that are used togetner to provide instantaneous data packet max throughput, inc data rates, long battery life for subscriber unit and backward compatabilis)

WCDMA	CDMA-2000	IS-95
(i) carrier spacing is 5MHz	Carrier Spacing is 3.75 MHz	Spacing is 1.25 MH

Date.....

(ii) chip rate = 3.84 Mcps	chip rate = 3.68 MHz	chip rate = 1.28 MHz
(iii) Power control freq = 1500HZ	Freq = 800MHZ	Freq = Around 800
(iv) most data rate	medium data rate	Least data rate
(v) Frame size = 10MS	5ms, 10ms, 20ms	20ms
(vi) Costly equipments required.	Less cost needed	less cost needed
(vii) Supports medium Channels	Supports twice as voice channels as IS-95	Supports comparatively less channels
(viii) Can be operated in two modes	NO such provision	NO such provision

→ Quality of Service:

(i) Earlier 2G N/w such as GSM only had one QoS option i.e speech at full coding rate but later a half rate service introduced offering a new QoS. This was though introduced to save N/w capacity hence serving more user.

→ In this user was not offered the choice, instead mobile phones capable of half rate were put onto that. without knowing the subscriber.

(ii) Later on in 2.5G N/w such as GPRS mechanisms where Subscriber can request diff QoS was introduced. but the requirement can be established at beginning of data transf and the N/w accept or reject the request.

(iii) Later on in 3G better data rates, voice and data services, increased capacity as well as QoS facilities in support of multimedia service applications were introduced. In this 3G the user → of the following improvements must carry out

Date.....

→ N/W services are considered end to end.
→ Here it is the user that decides the provided QOS.
→ Bearer service includes provision of contracted QoS.
→ and to change QoS when required.
→ Efficient utilization of resources

Date.....

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UNIT-IV

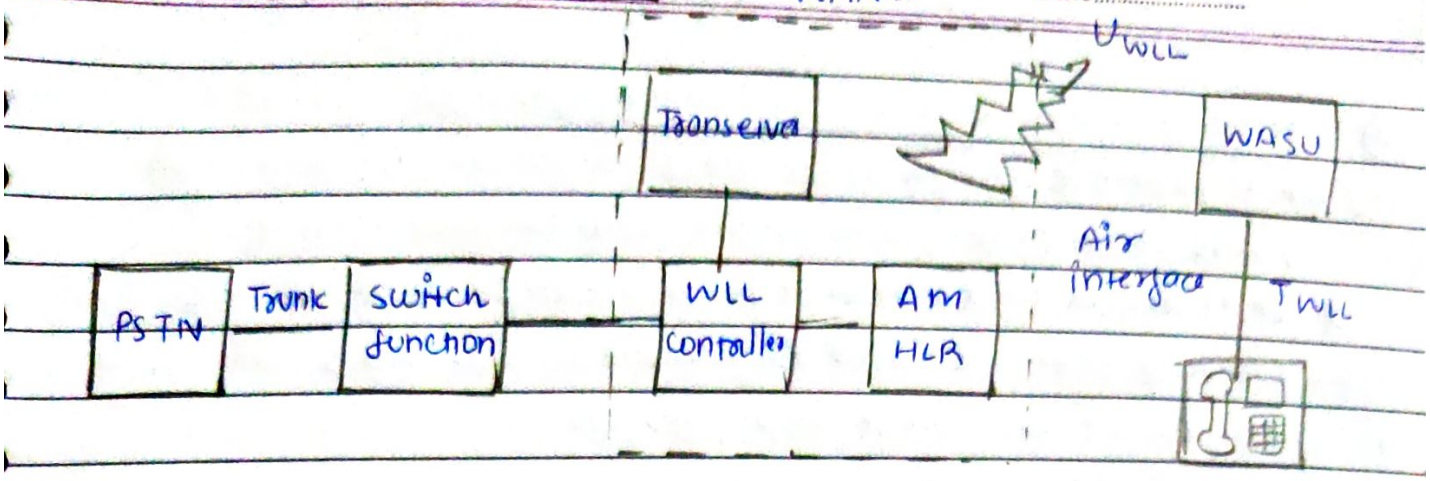
→ **Introduction to WLL architecture:**

Fixed Wireless communication systems were introduced due to the increased demands of inexpensive, reliable, rapidly deployable broadband connectivity.

→ They were well suited because of their time invarient nature of propogation channel b/w fixed Rx & Tx.
→ They were provided with MW and radio freqye band with 3 times more carrier freq than 3G.

One such wireless technology is Wireless Loop technology

(i) It provides two way comm service to stationary or slow moving users with a small service area. and was developed to replace wireline local loop technology
(ii) It is a cost effective, easy installation service and mainly is best suited for low mobility environments
(iii) Low mobility allows reduced interferance, low delay voice, and low data high quality data capability.



(i) Firstly user use PSTN to initiate call to 'n' user located in WLL coverage.

(ii) Then call will go through trunk data through switching function which will forward it to appropriate WANU.

(iii) WANU act as an interface b/w wired and wireless system and uses 2 interface U_{WLL} towards network site and T_{WLL} towards 'n' users side.

(iv) Call is forwarded via WASU over wireless link and initiated by WASU and finally towards to wired channel to the phone.

(1) Wireless Access Network unit (WANU):

(i) Acts as an interface b/w wired and wireless system.

(ii) Takes and delivers data across wired & wireless domain

(iii) It basically consists of BS transceivers, Radio port control unit and access manager (AM) and a HLR

(iv) It provides functionalities like

→ Authentication access

→ Privacy via interface

→ call management

→ Routing and switching.

Date.....

(2) Wireless Access Subscriber Unit (WASU):

(i) It support 2 interfaces. UWLL towards the N/W and TWLL interface towards the subscriber device.

(ii) It ensures traditional phones can be used in WLL

(iii) It's key feature is to translate b/w wired & wireless signals

(iv) Interfaces in WASU also provides

→ protocol conversion and signalling functions

→ Transcoding

→ Authentication

(3) Switching Function (SF):

It is associated with switch that can be digital switch with or without Advanced Intelligent N/W capability, ISDN switch or a mobile switching centre

The transmission backhaul b/w WANU & SF can be leased line, cable or MW.

→ WLL Technologies:

There are no definite standards for WLL hence diff categories of wireless tech are available. Diff tech serve some app. better than others but ultimately the appropriate tech. will depends on

(i) size and population density of area

(ii) Service needs of subscriber bas (residential Vs business)

some of the ~~technologies are~~: Std can be used are

(i) Analog cellular has some limitations in terms of capacity & functionality. It is best suited for low density market that do not require landline type features.

Date.....

(ii) Digital cellular is expected to play an important role in WLL it can support higher capacity subscriber area and better suited for best suited to offers better capabilities of advanced wireless N/W.

(iii) GSM currently dominates in mobile digital cellular and provides high quality services but carries a large amount of overhead that makes it her unwieldy & costly.

(iv) CDMA appears to be std best suited as it offers higher capacity than other stds. The main disadvantage is that now it is only beggining to be deployed on a wide scale.

WLL Systems are based on following 4 technologies:

(i) Satellite Based Systems: Provide telephony services for rural and isolated area and are specialised to support low cost mobile terminals for low bit rate.

(ii) Cellular Based Systems: Provide high power, wide range, med subscriber density & med. ckt quality WLL services. They are basically used to expand telephony services.

(iii) Low tier PCS or Cellular based: Provide low power, Narrow range, high subscriber density & high circuit quality WLL service.

(iv) Fixed Wireless Access Systems: Designed for fixed applic. It covers local telephone area directly from PSTN Switch. They generally replace part of loop distribution.

→ Advantages Of WLL:

(i) Less expensive

(ii) Quick Installation

(iii) Selective Installation (Radio Transx are installed on for user who needs services

Date.....

WLL	Mobile Wireless	Wireline
(i) Rician Fading	Rayleigh fading	No fading
(ii) Narrowbeam anten	Omnidirectional antenna	Expensive wires
(iii) High channel reuse	Less channel reuse	Reuse limited
(iv) Simple design	Expensive to control	Expensive to build
(v) Low mobility	Support high mobility	Low mobility
(vi) Weather conditions affects	Not very reliable	Very reliable

→ **Wireless Personal Area N/W (WPAN):**

(i) It is a short range N/w setup to connect comp, periphe and other devices wirelessly.

(ii) It facilitates point to point and direct comm with comm devices without cabling or infra cost.

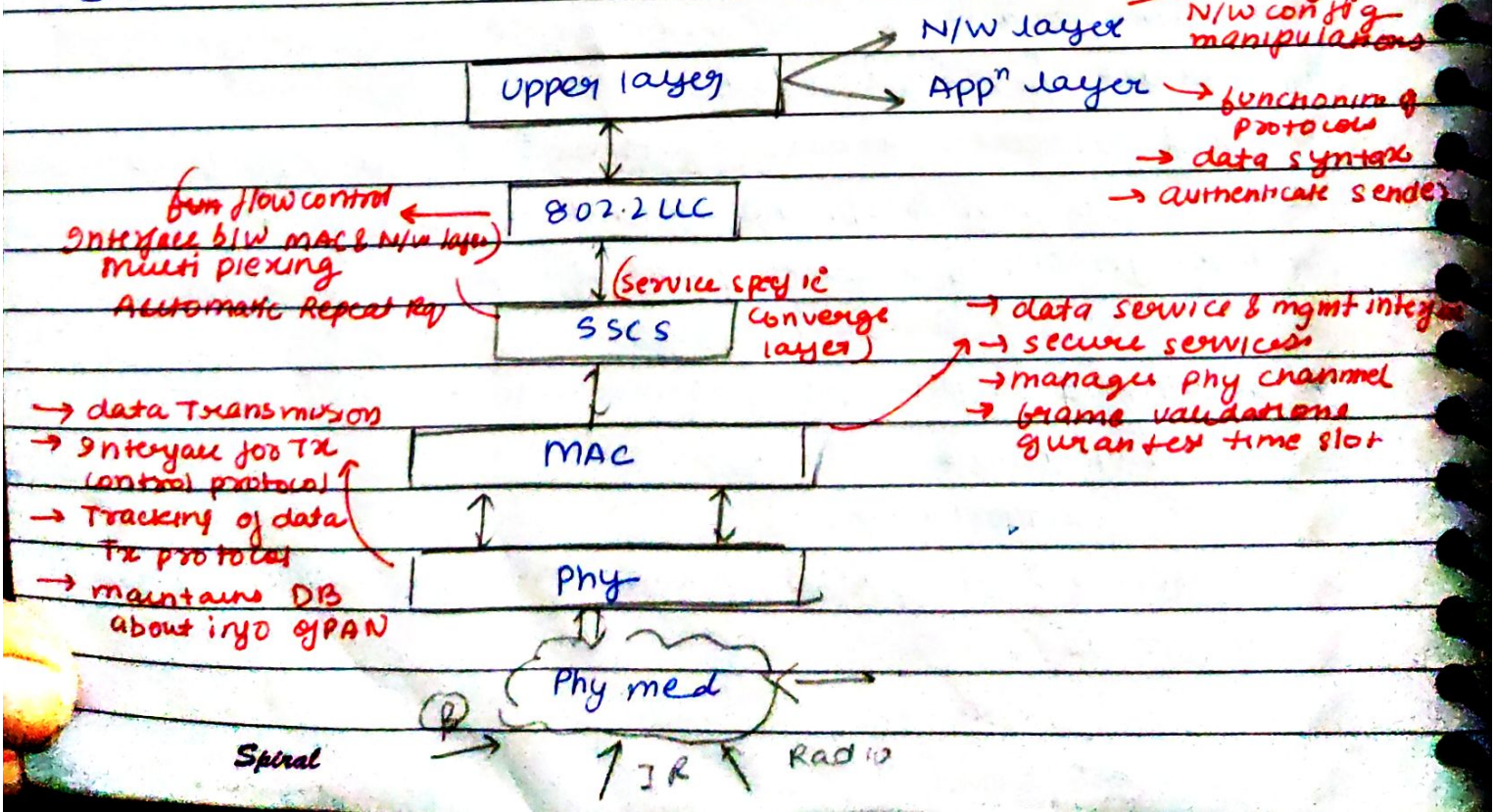
(iii) We can connect personal devices to larger N/w e.g www

(iv) Comm ranges from 1-10 m

(v) Used in wireless headphone, mouse etc.

(vi) Bluetooth and Zigbee are 2 major technologies used

(vii) Offers high speed data Tx b/w 1-3 mbps



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→ **Bluetooth :**

(i) It is a low power consuming, tech short range wireless connection tech. for electronic devices BL enable,

(ii) Operates within 10 m to 30 feet

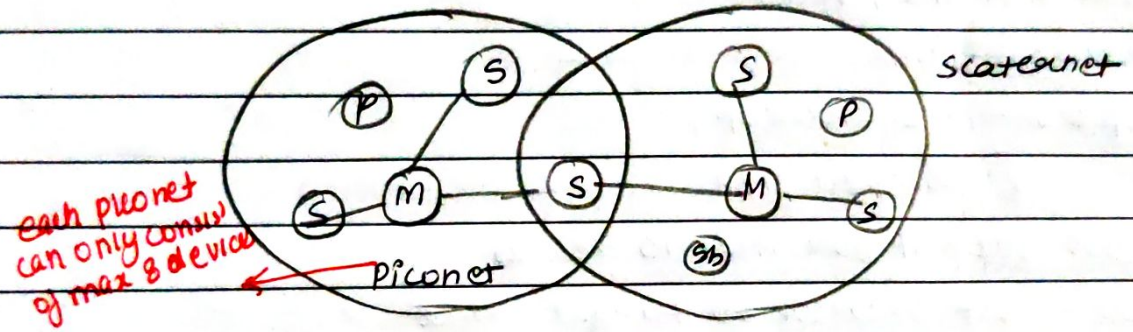
(iii) Data rate Tx is 1Mbps

(iv) Operates on 79 channels, works on IEEE 802.1 std.

(i) Device need not be in LOS
(ii) No cabling cost and no USB
(iii) Range Extended to 100m
(iv) Low power consumption
(v) Negligible Interference

} (advantages)

→ **Architecture :**



There are 2 major components in Bluetooth architecture

(1) **Piconets:** It is a small network consisting of bluetooth devices synchronised to same hoping seq. Various devices in piconet have various roles

(i) master → Hoping pattern decide by master

(ii) Slave → All devices connected to master are slaves and they need to sync to hopping pattern decided

(iii) Parked → Devices that may exist which can't actively participate in piconet but can be reactivated.

(iv) Stand by → Do not participate in piconet

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(2) **Scatternet:** Bluetooth follow scattered adhock topology consists of several piconets. With one piconet all devices share same channel.

→ As no. of piconet ↑ throughput per user ↓

→ Grouped piconets for ↑ BW is called scatternet. only those piconets will make a scatternet who will Tx data exchange data.

→ multiple piconets with overlapping coverge can exist

→ IEEE 802.15 :

The 802.15 std includes short distance wireless N/w used for N/w portable devices introduced in 19999.

The orginal functional req of this std include

(i) Power management
(ii) Range 0-10m
(iii) Speed - 19.2 - 100 kbps
(iv) Small & compact size
(v) N/w support for min 16 devices
(vi) Lost cost relative to target device

diff as

The 802.15 group was divided into 4 grps for focusing of diff aspects of WPAN.

IEEE 802.15.1
→ Standardization of bluetooth
→ layers for tx (Phy, data link)
→ services & description

IEEE 802.15.2
→ focused on coexistence of WPAN and WLAN

802.15.3
→ focused on high data rates with low power & cost

802.15.4
→ Standardiza for extremly low power

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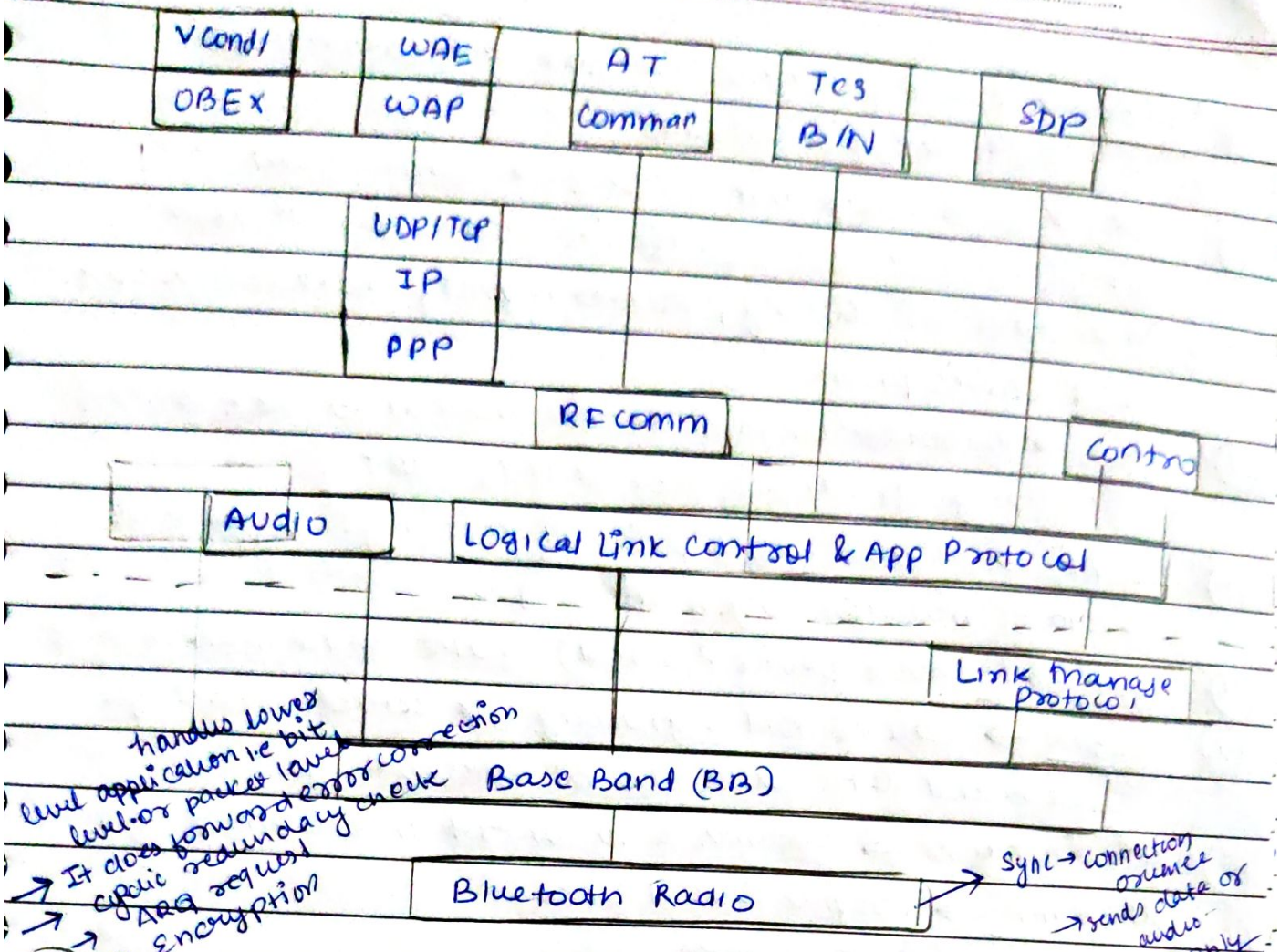


(1) OBEX : (Object Exchange)
Responsible for reliable data transfer
Consists of objects & operations

(2) V Card / VCal → Electronic & Business Card & calender formats

(3) BT radio → It has packets which is tx in time shed manner using HFSD technique for BW utilization and we also have sync connection oriented & asyn connectionless physical link : When Packets is sent in first both data & audio but for the later data only
Operates in 2.4 GHz freq band

(4) Base band → Handles lower level operation i.e bit and packet level, It handles CRC, fwd correction, ARQ and encryption and have 79 carrier and uses freq hoping spread spectrum technique

Date.....

(5) Audio → Direct interface with BB, each connection is over 64 Kbps SCO link.

(6) LMP → Link setup and release → Connection establishment and release in piconets. It also manages traffic scheduling, power mgmt, authentication and encryption.

(7) HCI → Provides uniform access method to BB, control register etc via USB, & PCI, UART.

(8) L2CAP → Higher layer protocol mixing. Deals with protocol multiplexing, SAR, segmentation and reassembly, QOS.

(9) SDP → (Service Device Protocol) locates service provide by BT d

(10) TCSBIN → Call control signalling for establishment of speech and data calls b/w BT devices.

(11) AT commands → commands to control mobile phone or mode

(12) RFcomm → Provide serial links.

(13) PPP → Fwd IP packets

(14) TCP-IP → Datagram delivery & ~~Data packets~~ DB lookup

(15) UDP → Data base lookup.

→ WiMax:

(i) WPAN and WLAN user's mobility is confined to small area whereas in WAN it offers more mobility within an are this issue was addressed by IEEE 802.16

(ii) IEEE 802.16 provides 5 broadband wireless access

IEEE 802.16 → Enable fixed Broadband wireless access and used mostly in LOS

IEEE 802.16a → Evolution of 802.16 with mac and Phy layer specification. Uses 2-11 freq band and can

→ work in NLOS conditions.

→ Supports mesh topology

→ Spiral ARQ technique.

IEEE 802.16 d → combines 802.16 and 802.16a) with modifications in mac and phy layer

IEEE 802.16e → Evolution of 802.6d with Mobility support.

→ IEEE 802.16 a is popularly known as Wimax tech. (worldwide Interoperability for mw access).

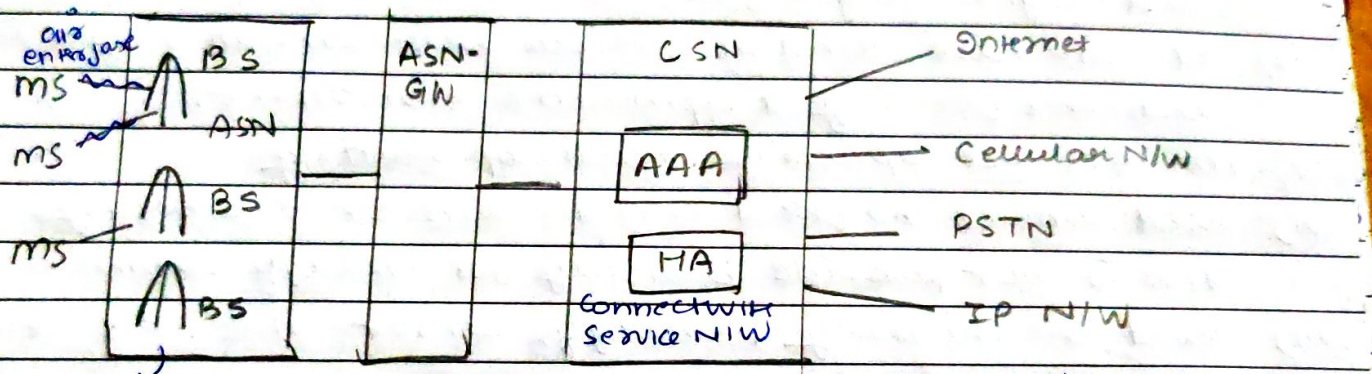
→ Appropriate tech for last mile connections

→ It defines new phy layer and modification in 802.16 mac layer

→ Provide high range, BW, data rate and can operate in NLOS

→ Wimax is suitable tech for last mile connection as a replacement for wireline connections and are fast, convenient and cost effective.

→ Can be used for disaster recovery.



air interface to ms
Mobility mgmt
Handoffs
Session mgmt
resource mgm

Access service N/W gateway
→ paging of devices
→ Caching subscriber profile

This gateway update details of subscriber every time a req is made either by cache or by registering new subscriprive

Connects different tech
AAA → Auth authorization and auditing of resources
HA → Home agent.

→ MANET :

→ It is a collection of mobile nodes which forms a temporary N/W without centralised administration or std support.

→ Generally have a limited Tx range & each node seeks assistance of neighbouring node in fwding packets and hence nodes can act as router & hosts

Date.....

→ Each device in MANET is free to move independently and therefore change its links to other devices freq.

Characteristics of Manet:

(i) Each node can act as host or router and is autonomous in behaviour
(ii) Nodes can join and leave the NW anytime making N/W topology dynamic in nature.
(iii) Mobile nodes are characterised with less memory, power and light weight features.
(iv) All nodes have identical features with similar responsib and hence forming a symmetric environment.
(v) MANETs are capable of multi hop routing
(vi) used where no fixed infra exists or deploying N/W is not possible basically for emergy comm
(vii) used in military, emergy, sensor NW (e.g wall
(viii) ~~The~~

Advantages	Disadvantages
(i) Less expensive	(i) Limited range of Tx
(ii) Can be used for emergency comm	(ii) Packet losses
(iii) N/W can be set at anywhere	(iii) Freq N/W partitions
(iv)	(iv) Limitation of mobile node
	(v) Time varying
	(vi) Limited BW