Evolution Of Mobile Radio Communication

1) Major Mobile Radio System

→ 1934 - Police radio uses conventional AM mobile communication system

→ 1935 - Edwin Armstrong demonstrate FM

→ 1946 - First public Mobile Telephone service, IMTS - half duplex

→ 1960 → Improved Mobile Telephone Service (IMTS) - full duplex

→ Bell lap introduce concept of Cellular Mobile system

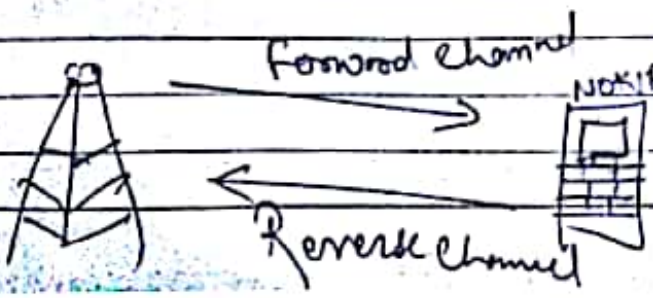
→ 1968 → AT&T propose the concept of Cellular mobile system to FCC.

→ 1976 - Bell Mobile phone service, poor service due to call blocking.

→ 1983 - Advanced Mobile phone System (AMPS), FDMA, AM

→ 1991 - U.S. Digital Cellular (USDC) IS-54, TDMA, DQPSK

→ 1993 - IS-95, CDMA, QPSK, BPSK



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Example of Mobile Radio System

* Examples
  - Cordless phone
  - Remote Controller (DVD Player)
  - Hand-held walkie talkie (which set at certain freq.)
  - Pagers (used in 1990 to sync detailed message)
  - Cellular Telephones (Nokia, Samsung : --)
  - Wireless LAN. (3G dongle, Tata photon)

* Mobile – any radio terminal that could move during operation

* Portable – hand-held is used at walking speed.

* Subscriber – mobile or portable user.

* Classification of Mobile Radio transmission System.

→ Simplex – Communication in only one direction

→ Half duplex → same radio channel for both transmission & reception.
(Push to talk)

→ full duplex → simultaneous radio transmission & reception (FDD, TDD).
FDD → Frequency division duplexing
TDD → Time Division Duplexing.

* FDD uses two Radio channel.
  - forward Channel :- base station to Mobile user
  - Reverse Channel :- Mobile user to base Station

* TDD shares a single Radio channel in time.

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PAGING SYSTEM

↳ Conventional Paging system sends brief messages to a subscribers

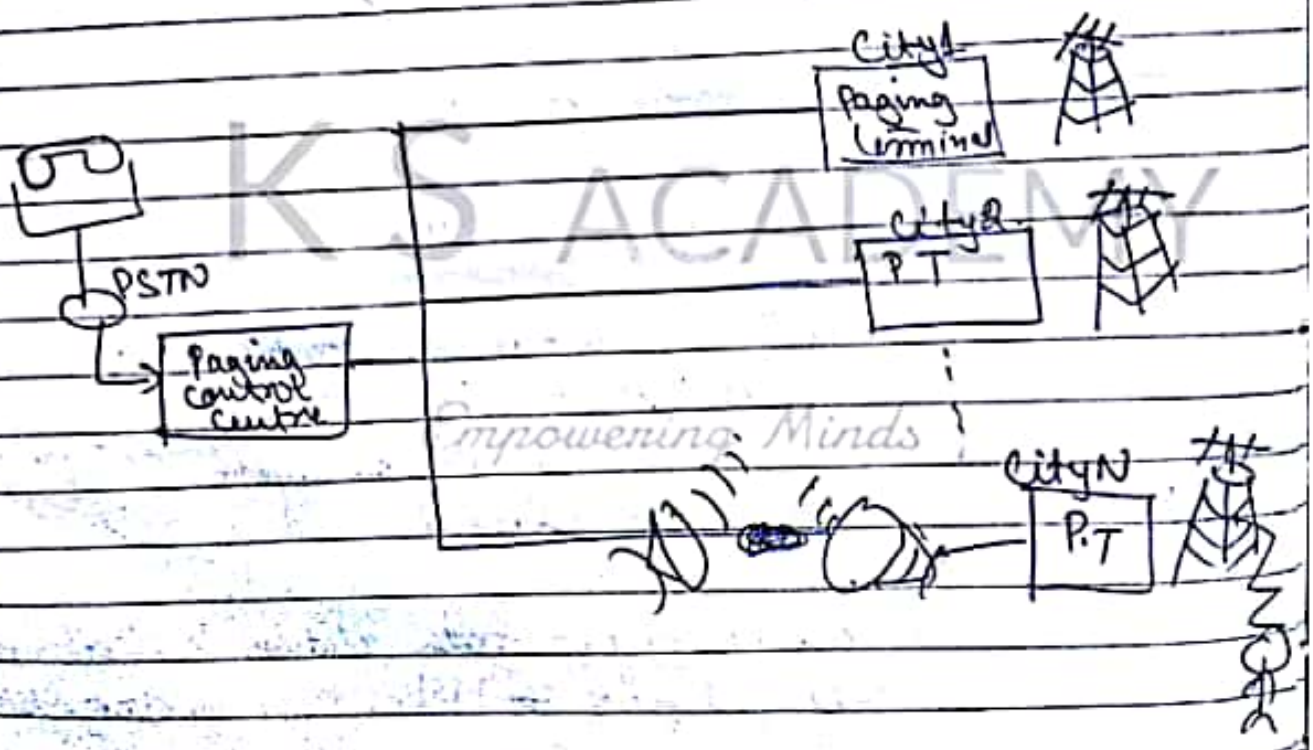
↳ Modern Paging System :- News headline, Stock quotation, faxes may be sent.

↳ Message sent to Paging subscriber by using paging system Access Number (i.e usual toll free no.)

* Issued Message is called Page.
* Message can be numeric, Alphanumeric, Voice, picture any.

↳ Simulcasting :- large radio towers that simultaneously broadcast a page from each base station

↳ Paging system are designed to provide reliable communication to subscriber wherever they are.



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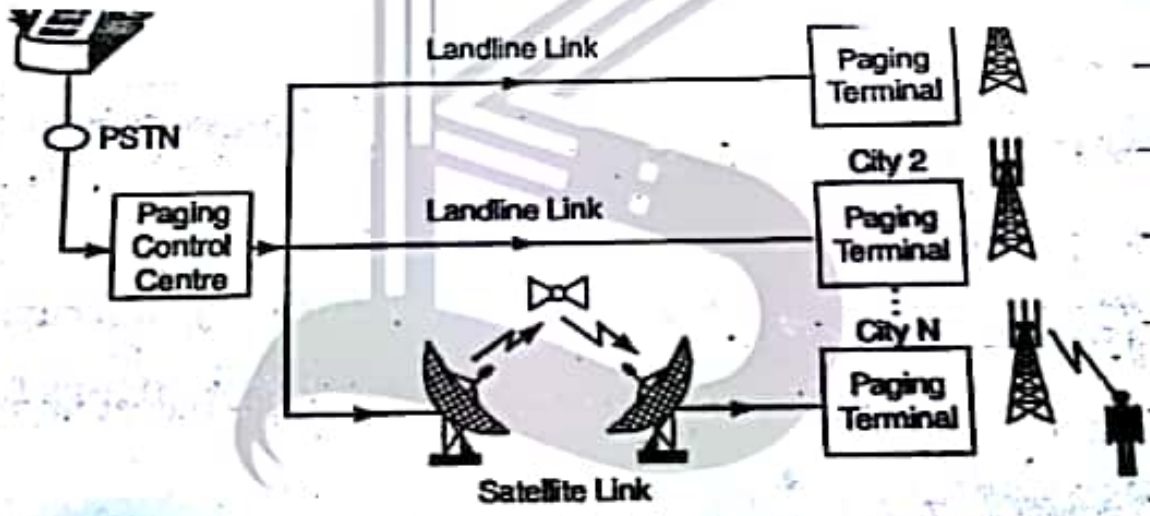

Fig. 1.5. A Wide Area Paging System.

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Cordless Telephone System

↳ First appeared in 1990.

↳ Designed to provide low cost wireless connection to PSTN.

↳ Fully duplex communication that can wirelessly connect a portable handset to dedicate base station which is the connected to dedicated telephone line on the PSTN.

↳ CTO → 1980
CT1 → 1984
CT&1+ → 1987
CT2 → 1989
DECT → 1991 → working at 1800 – 1900 MHz.

↳ In first Generation cordless telephone system
→ in home use
→ Communication to dedicate base unit
→ few ten of meters.

↳ In second Generation Cordless phone
→ outdoor
→ Combine with paging system
→ few hundred of meters

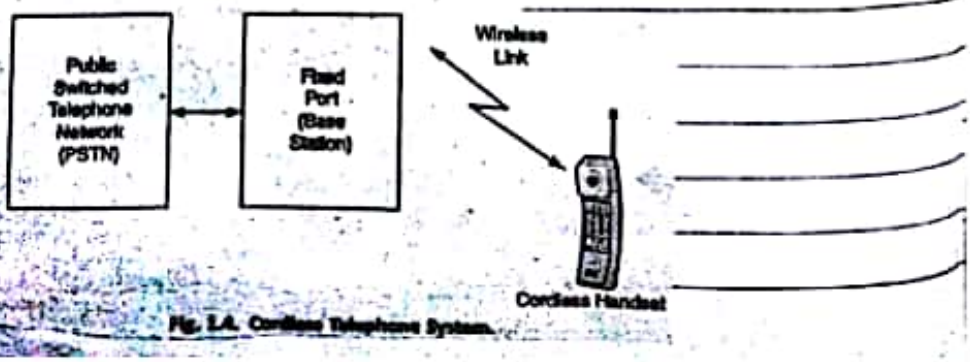

Fig. 1.4. Cordless Telephone System

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CT2 (Cordless Telephone Second Generation)

- Developed in Europe (1989)
- 40 FDMA channels
- 32 Kbps Speech Coding rate
- TDD mode of transmission used.
- Support Data transmission rate of upto 9.4 Kbps through speech Codec & upto 4.8 Kbps with an increased Error rate.

DECT (Digital European Cordless Telephone)

1) Digital European Cordless Telephone is replaced by Digital Enhanced Cordless Telephone for Global acceptance.

- uses TDMA/TDD.
- 12 local channel per frequency carrier.
- it has sleep mode (which saves or conserve power)
- it also moves conversation from one time slot to another to avoid interference.
- This procedure is called time slot transfer.
- also support seamless Handoff.
- DECT is compatible with GSM to allow user mobility

PHS (Personal Handy Phone System).

- it is standard developed in Japan by RCR (Research Development Center for Radio Systems)
- offers telecommunication service to homes, office & outdoor Env.
- uses TDMA/TDD Schemes.
- also has Sleep mode.
- Bandwidth partition into 77 channels. (Each with 300KHz)

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↳ Speech coding rate 32Kbps.
↳ Support hand off.

PACS (Personal Access Communication System).

↳ Designed for wireless local loop.
↳ Uses TDMA with 8 voice channels per frequency carrier
↳ Speech coding rate 32Kbps.
↳ Involved both TDD/FDD.
↳ Roaming Management also Supported.

Table 1.6. Cordless Telephone Systems.

System	CT-2 and CT-2(+)	DECT	PHS	PACS
Region	Europe/Canada	Europe	Japan	United States
Access Method	TDMA/TDD	TDMA/TDD	TDMA/TDD	TDMA/FDD
Frequency band (MHz)	864–868 944–948	1,880–1,900	1,895–1,918	1,850–1,910 1,930–1,990
Carrier spacing (kHz)	100	1,728	300	300
Bearer channels/carrier	1	12	4	8 per pair
Channel bit rate (kbps)	72	1,152	384	384
Modulation	GFSK	GFSK	π/4-DQPSK	π/4-DQPSK
Speech coding (kbps)	32	32	32	32
Average handset Tx power (mW)	5	10	10	25
Peak handset Tx power (mW)	10	250	80	200
Frame duration (ms)	2	10	5	2.5

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Cellular Telephone System

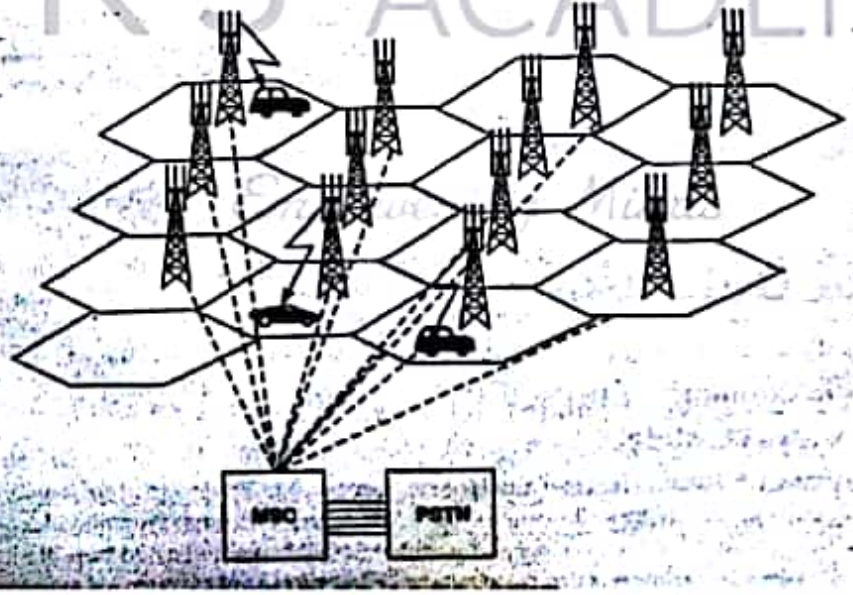
- also known as PCS (Personal Communication System)
- Provide two way communication at high speed with Regional & National Coverage.
- Basic principle → frequency Reuse.

* 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.

*1) The operation within a cell is controlled by a system called base station which consist of several transmitter & Receiver.

2) This are connected to high speed dedicated communication link to MSC which coordinate the activities of all of the base station in limited Region. & provide connection to other fixed network such as PSTN.



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3) CAI (Common air Interface) defines voice & Control Channel for Communication b/w base Station & the mobiles

4) Forward & Reverse Voice Channel Carry Voice Information b/w base station & Mobiles.
while
Forward & Reverse Control Channel Carry Control Informat. b/w Base Station & Mobiles.

four Popular Cellular System.

AMPS (Advanced Mobile Phone Service)
- first Cellular System (1970).
- was designed on basis of frequency reuse Scheme.
- Uses FDMA Scheme.
- It uses 50MHz in 824-849MHz & 869-894MHz
- Spectrum divided into 832 full duplex channel.

GSM (Global System for Mobile Communication)

- Goal → to offer Compatibility of Cellular Service among European Countries.
- Combines both TDMA & FDMA.
- Speech Coding rate = 13Kbps.

D-AMPS (Digital Advanced Mobile Phone Service)

IS-95 (CDMA) Digital Cellular Syste.
- operating in US (1996)
- allow many user to share a common frequency/time Channel for transmission

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Generation Of Cellular System

1) First Generation (1G) – Analog System.

(i) All these system use FDD schemes
↓
i.e two seperate freq. band for forward & reverse links.

(ii) typical allocated band in each direc is 25MHz.

(iii) used Analog Cellular System. Such as AMPS or NMT.

2) Second Generation (2G) – Digital System

↳ 2G System brough with them a shift from Analog to digital System ~~& supported~~

↳ supported all four Sector of wireless network Industry
1) Digital Cellular 3) Mobile data
2) PCS 4) WLAN.

↳ 2G Mobile data Service
2G provides moderate data rate & wide Coverage Area access to packe Switched Network.

↳ 2G WLAN's provides high data rates to provide access to wired LAN's & Internet

3) 3G (Third Generation) – The Internet System.

↳ In Comparision to 2G, 3G System offers better system Capacity, high Speed, wireless Internet access (upto 2Mbps) & wireless Multimedia Service which include Audio, Video, Image & data.

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↳ Information may be in form of voice data & Video format

↳ Enables a person to communicate with anyone at anytime at any place.

↳ Provide more reliable service feature.

4) FOURTH GENERATION (4G) & BEYOND

* In 4G the user has freedom & flexibility to select any desired service with reasonable QOS & affordable price, anytime & anywhere.

↳ High usability → anytime, anywhere & with any technology

↳ Support for multimedia service at low transmission cost

↳ Personalization

↳ Integrated :

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PERSONAL COMMUNICATION SERVICES

PCS ARCHITECTURE

↳ Most popular PCS Technology :- Cellular & Cordless N/w

Basic PCS Architecture Consist of two main parts.

1) a radio network (wireless N/w)
2) wire line transport Network.

RADIO NETWORK

This represent the wireless part of the N/w.

Mobile devices are known as Mobile station (MS)

1) Data, these MS Communicate with nearby base Station.
2) The region in which single base station provide Radio Coverage is Cells.
3) This Cell is divided into two parts
   1) Controller
   2) Radio transmitter/Receiver
4) The Controller is known as Base station Controller in GSM & Radio port Control unit in PACS.
   &
   Radio transceiver are called Base transceiver station (BTS) in GSM & radio ports in PACS.
5) These are Connected to wire line Network Via land or Microwave link.

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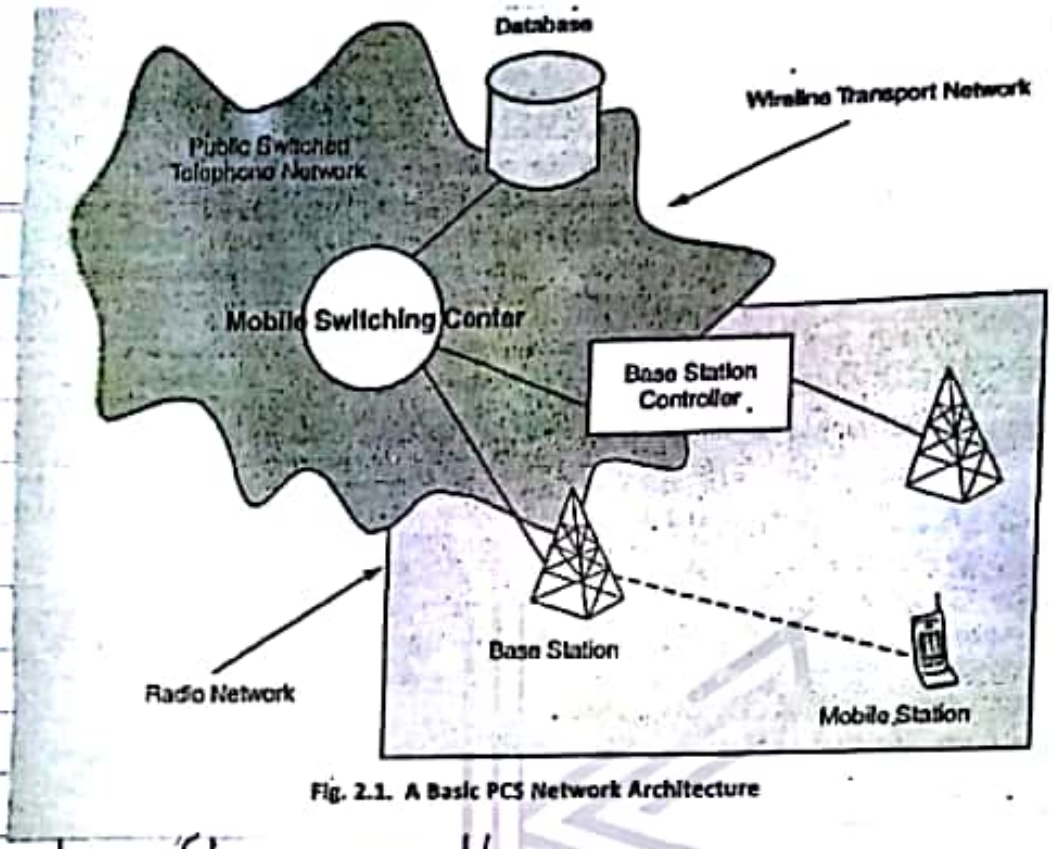

Fig. 2.1. A Basic PCS Network Architecture

WIRE LING TRANSPORT NETWORK

* Multiple base station are connected to a central system known as Mobile switching Centre. (MSC)

* This MSC perform several function like managing BSC in geographical Region, serves a gateway for connection to other fixed N/w like PSTN or ISDN.

* MSC also perform supplementary function such as call forwarding, multi party calls, reverse charging etc.

* It also communicate with mobility Database to track the location of Mobile station.

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MOBILITY MANAGEMENT

Mobility Management Refers to the way the network Manages the Movement of the Mobile Subscriberse which significantly affects the performance of the PCS network.

HAND-OFF

Handoff is the process which Enable a Call to proceed uninterpted when the user moves from one Cell to another or one System to another.

There are two type of Handoff

- Intercell or Inter-BS Handoff
- InterSystem or Inter MSC Handoff

INTER-BS HANDOFF

⇒ The Inter-BS Handoff Required when mobile unit travels from Coverage Region of one base station to Coverage Region of Another while new & old B.S are Connected to Same MSC.

STEPS Followed.

- When the signal received from the current BS is not strong enough, the MS momentarily suspends conversation and initiates the handoff procedure by signaling on an idle channel in the new BS. Then, the conversation on the old BS is resumed.
- When MSC receives the signal, it transfers the information to the selected idle channel of the new BS and new conversation path is setup.
- After the MS has been transferred to the new BS, it signals the network and resumes conversation using the new channel.
- When MSC receives the handoff completion signal, the connection to old BS is terminated and the resources are released.

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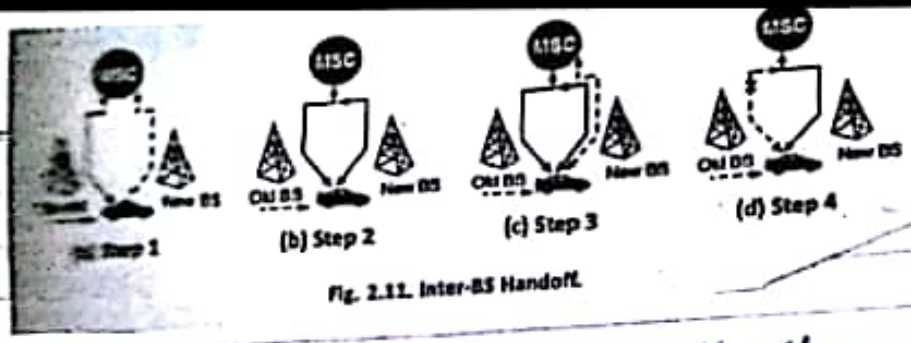


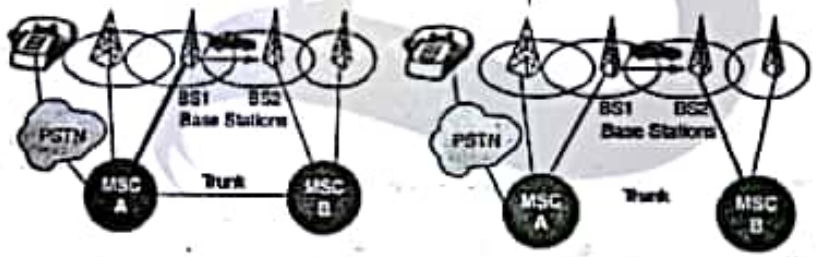
Fig. 2.11. Inter-BS Handoff.

* If the new BS does not have an idle channel, the hand-off call may be dropped.

* To avoid call-termination due to such scenarios channel assignment scheme are used.

Inter System Handoff

Intersystem Handoff is required when a mobile unit travel from one coverage region to the coverage region of another while new & old B.S are connected to diffrent MSC's.



(a) Before the handoff (b) After the handoff

Fig. 2.12. Inter-system Handoff.

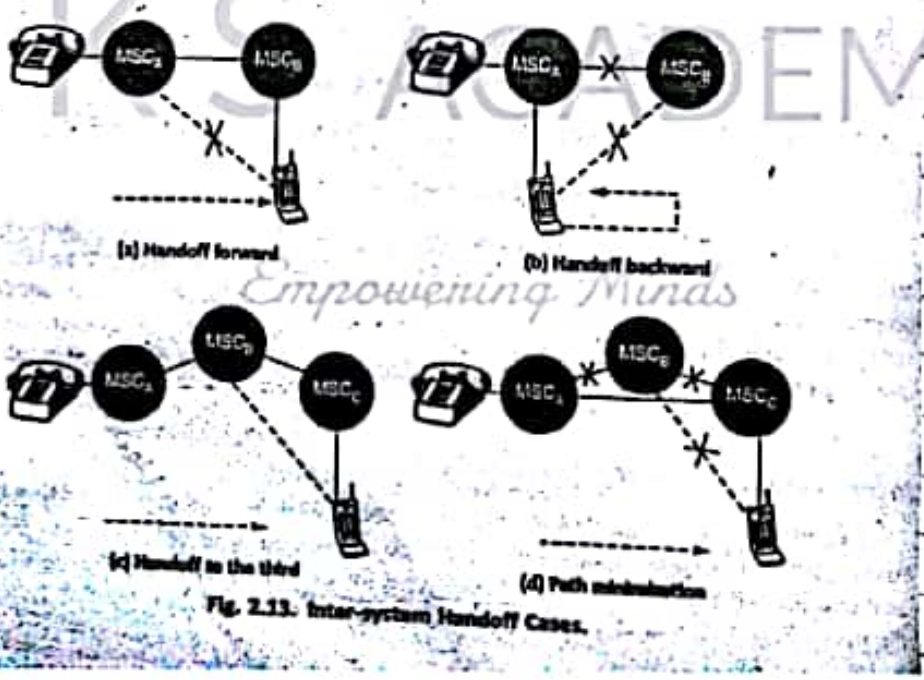


Fig. 2.13. Inter-system Handoff Cases.

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- When the signal received from the mobile is not strong enough, the base station BS 1 initiates the handoff procedure by signaling the MSC A.
- Then, MSC A requests MSC B to select a candidate BS (BS2 in this example) and checks the signal quality parameters on the call in progress.
- Then, MSC B returns the signal quality parameters values and other relevant information to MSC A.
- In order to avoid too many handoffs between BS 1 and BS 2, MSC A performs required checks. If check fails, MSC A exits the handoff procedure. Otherwise, MSC A asks MSC B to initiate setting up a voice channel.
- If the voice channel is available, MSC B asks MSC A to start the radio link transfer.
- MSC A sends the call transfer instructions to MS which tune in to the new channel associated with BS 2.
- When MS successfully connects to the BS2, MSC B informs MSC A. Finally, MSC A completes the handoff process by informing the BS 1 to release the occupied channels.

HANDOFF DETECTION STRATEGIES

Three Strategies

- MCHO (Mobile Controlled Handoff)
- NCHO (Network Controlled Handoff)
- MAHO (Mobile Assisted Handoff).

1) MCHO (Mobile Controlled Handoff).

(i) In this MS determines handoff requirement & control handoff process.

(ii) used in inter-BS handoff.

(iii) Popular technique for low-tier radio system. used by DECT & PAC's.

(*) In this method

(i) the MS continuously monitor the signal BS from the current BS & several candidate BS's for handoff.

(ii) when handoff criteria is met, the MS choose the BS with best signal strength & available channel & launches handoff request.

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2) NCHO

↳ In this BS determine the handoff requirements & controls the handoff process.

↳ This scheme is used by low tier CT2 & by high tier AMPS.

(i) In this method, the BS continuously monitors the signal Quality from the MS. When Handoff Criteria is met, the BS informs the MS to arrange for a handoff to another BS.

(ii) The network ask all nearby BS's to monitor signal from the MS.

(iii) Based on the information sent by the BS's, network chooses the BS with Best Signal Strength & the Connection is transferred to the new BS.

MAHO (Mobile Assisted Handoff)

↳ Variant of NCHO in which handoff process is controlled by the network with the help of MS.

↳ used by high tier GSM, IS-95CDMA, IS-136TDMA.

↳ Not used by any low tier

(i) In this Scheme, the network ask MS to measure the signal from surrounding BS.

(ii) MS Sends the information to the old BS using which the network checks for handoff requirement.

If handoff is required it checks for Suitable BS.

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PCS

⇒ PCS refers to wide Variety of wireless access & personal mobility services provided through a small terminal with goal of Enable Communications at any time, any place in any form.

⇒ PCS are Connected to PSTN to provide access to wired telephone

Types of PCS

- High tier (for widespread vehicular & pedestrian) service
  - ↓
  - Eg:- GSM, CDMA, PDC
- Low Tier (Cordless & low Power Standards)
  - ↓
  - Eg:- CT2, DECT, PACS.
- Wideband wireless systems
  - ↓
  - To incorporate Internet & Multimedia Service
  - ↓
  - Eg:- W-CDMA, TD-SCDMA

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CELLS, CLUSTER, FREQUENCY REUSE

CELLS:- The Region in which single base station provide Radio Coverage is called Cells

CLUSTER:- A Cluster is a group of cells, No channel are reused within a cluster.

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HANDOFF FAILURE

Reasons for Handoff failure

↳ No free channel is available on candidate BS's.

↳ Handoff is denied by N/w.

↳ N/w takes to long to setup the handoff after initiation.

↳ Forget links fails during handoff execution.

CHANNEL ASSIGNMENT STRATEGIES

These are classified into two parts: fixed & Dynamic

* Fixed channel Assignment (FCA)

↳ In this each cell is allocated a predetermined set of voice channels.

↳ If a call attempt is made by the user within the cell only available unused channel in that particular cell may be used.

↳ If all the channels in that cell are occupied, the call is blocked & the service is denied.

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* Borrowing Channel Assignment (BCA)
It is a variation of FCA.

In this strategy a cell can borrow channel from neighbouring cell in the situation when all of its own channels are occupied

The MSC supervises this borrowing process. it Ensure that the borrowing of a channel doesnot disrupt or interfere with any of call in progress

* Dynamic Channel Assignment (DCA).

Instead of allocating voice channels to diffent cells permanently, the serving base station has to request a channel from the MSC whenever a call request is made.

MSC follows an algorithm that takes into account the likelihood of future blocking within the cell, the frequency use of the candidate channel, the reuse distance of the channel & other cost fn. & then allocates the channel to requested cell.
Thus DCA reduce likelihood of blocking.

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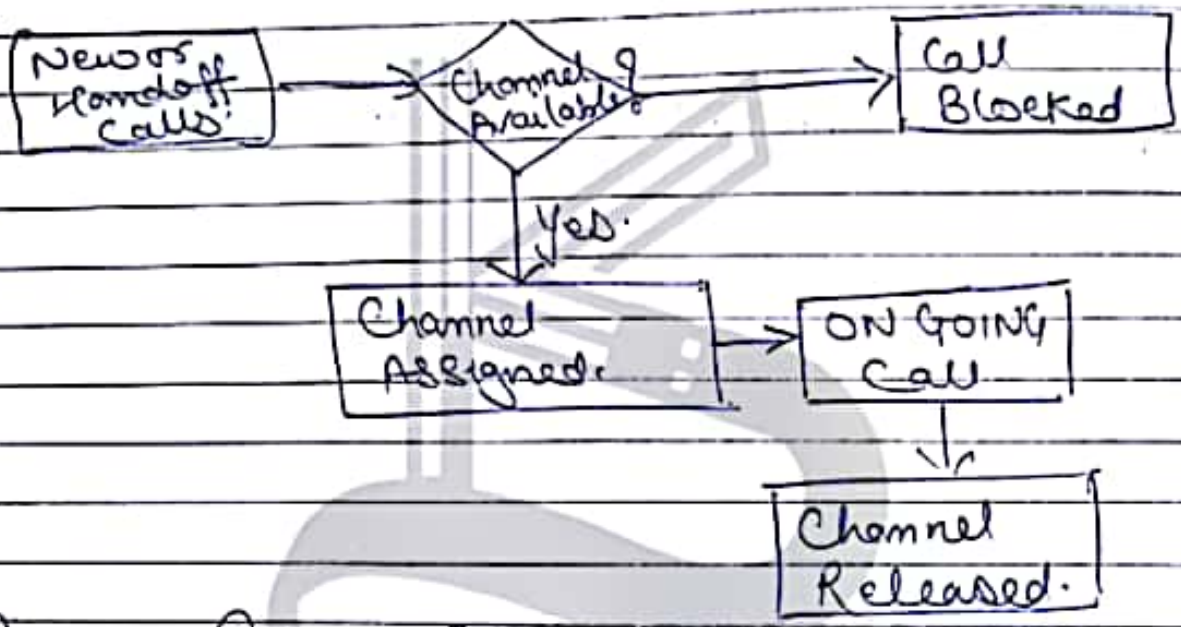
Prioritizing Handoffs

1) Non-Prioritized Scheme (NPS)

↳ In this, a handoff call or a new call, both are handle by BS in same manner i.e the Handoff call is block immidately if no channel is available.



2) Reserved Channel Scheme (RCS)

↳ similar to NPS, the primary diffrence b/w two is

↳ *) In this a few channel in Each BS are reserved for Handoff's.
i.e all the available channel is divided into two groups, the Normal Channels the Reserved Channel.

*) Normal Channel serve both new Calls & Handoff Calls where as Reserved Channel serves only Handoff Calls.

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3) QUEUING PRIORITIZING SCHEME

↳ when free channel is avail it's similar to NPS.

↳ The QPS Exploit the fact that adjacent Cells in Cellular Network are Overlapping. Thus there is Considerable area where a Cell can be handled by either BS of adjacent Cell

↳ The time Spent by a mobile unit in this overlapped Area is refferred to as Degradation Interval.

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(iv) SRS (Subrating Scheme)

↳ Similar when free channel is available work similar as NPS.

↳ when a handoff request come & a free channel is not available, SRS creates a new channel by subrating an existing call.

* subrating means dividing an occupied full rate channel into two channels at half the normal rate.

↳ One sub channel is used to serve the existing call & the other serves the handoff request

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ROAMING MANAGEMENT

When a mobile user moves from one PCS System (Delhi) to another (Mumbai), the system should be informed of current location of user. Otherwise, it would be impossible to deliver service to Mobile User.

↳ In order to ensure continued service MS must inform the system about its current location (location update) & system must track the movement to the MS continuously.

So, there are two basic operation in Roaming Management.

- Registration (or location update) :- the process where MS informs the system of its current location.

- Location tracking :- The process during which the system locates MS location. tracking is required when network attends to deliver call to Mobile User.

THIS LOCATION UPDATE IS DONE IN TWO DATABASE (maintain by MSC)

1) HLR (Home location Register).

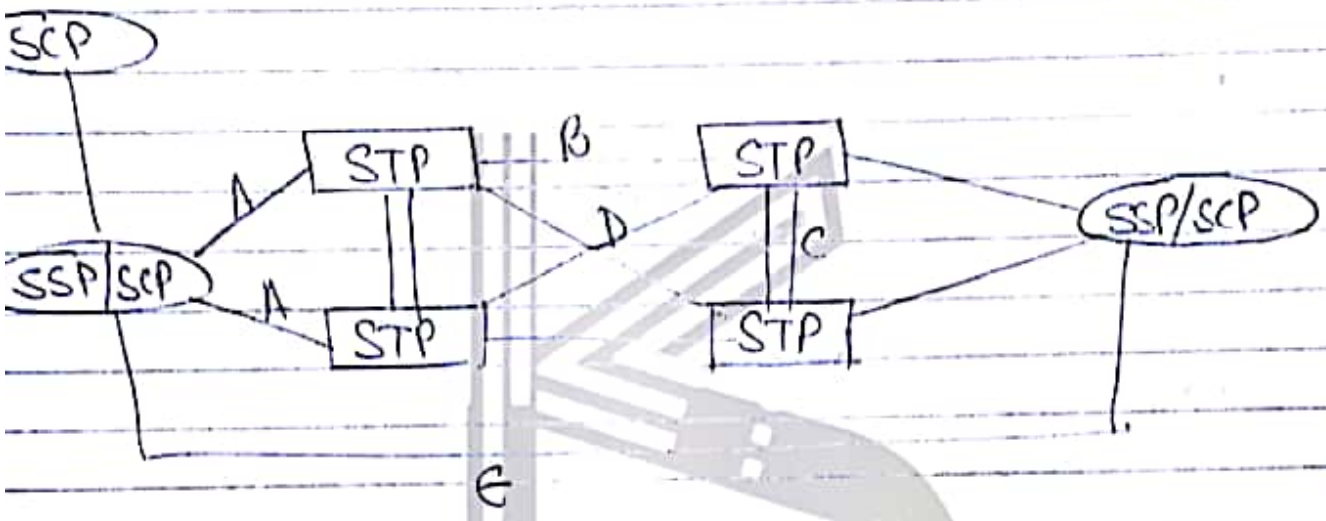
↳ When a user subscribes to a service of PCS Network, a record is created in system Database called Home location Register.

→ This is supported [illegible] systems of mobile user

NETWORK SIGNALLING

SS7

Signalling System No. 7 Architecture



STP ⇒ Signaling Transfer Point

SCP ⇒ Signaling Control point

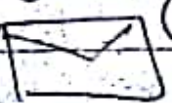
SSP ⇒ Signaling Switching Point.

SL ⇒ Signaling link → Digital tx channel → 64kbps

Signaling Point ⇒ Each & every signaling point is identify by (NPC) Numeric Point Code.

STP
SCP
SSP
} — SP — NPC

Carried by Signalling messages.



Source — Destination

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SSP

- it is local exchange to subscriber or
- Interface to Telephone N/w
- Converts voice signaling to SS7 Signalling link.

STP

- it is basically a N/w Node
- works as router.
  to perform routing of msgs b/w diff SP.

SCP

- Interface with databases like HLR, VLR.
- Handle Database queries & Subscriber info.

Signaling link types:-

A → Access link → SSP/SCP — STP.
B → Bridge " → STP — STP.
C → Cross "
D → Diagnal "
E → Extended "
F → fully associated "

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A link

SCP/SSP — STP
as subscriber info. has to be retrieved by STP.

B link
STP — STP.

Diagonal link
STP
STP.

Cross link
STP = STP
use in STP root failure as we provided another path.

Extended link

SSP — alternate STP.

Fully Associated
SSP — SSP
SCP — SCP.

SLS → Signaling link set → set of various Signaling links

SLS
A
B
C
D
E

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SR / SRS
↓ Signaling Route ↓ Signaling Route Set.

SLC → Signaling link code
CIC → Circuit Identification code.

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FREQUENCY DIVISION MULTIPLE ACCESS

1) In this scheme, the available bandwidth is divided into various frequency bands.

2) Each station is allocated a band to send its data when service request is made.

3) Thus, each band is reserved for a specific station, & it belongs to the station during the period of the call, no other user can share the same frequency band.

4) To Avoid frequency Overlapping, small gaps in the frequency bands are required which are called guard bands.

↳ This scheme is used to allocate band to a station & is used with either FDD or TDD to enables two way communications.

TIME DIVISION MULTIPLE ACCESS

* No. of FDMA channel ⇒

$$N = \frac{B_t - 2B_g}{B_c}$$

B_t = Complete Spectrum

B_g = Guard band at the Edge of spectrum

B_c = Channel Bandwidth.

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TIME DIVISION MULTIPLE ACCESS

↳ In this scheme, there is No division of Bandwidth

Each station is allocated a complete bandwidth to send its data when service request is made

However bandwidth is allocated only for certain amount of time.

Note: i.e all the senders use same frequency but at different points in time.

* Guard Space which now represent in time gaps have to Seperate the diffent period when the senders use the medium.

Efficiency of TDMA

$$b_{OH} = N_r b_r + N_t b_p + N_t b_g + N_r b_g$$

N_r = No. of reference burst per frame

N_t = No. of traffic burst per frame.

b_r = No. of overhead bits per reference burst

b_p = No. of Overhead bits per preamble in Each slot

b_g = No. of Equivalent bits in Each guard time interval.

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No. of Channel in TDMA :-

$$N = \frac{M(B_t - 2B_g)}{B_c}$$

M = maximum no. of time slot (or user)

CODE DIVISION MULTIPLE ACCESS

OR

DIRECT SEQUENCE MULTIPLE ACCESS

↳ uses (DSSS) technique for providing channel access to multiple user.

↳ The primary feature of CDMA is that only one channel carried transmission for all the user simultaneously

↳ In DSSS, each bit in the user signal is replaced by a particular code or chip to create a high bandwidth signal.

↳ these codes are different for different users or stations.

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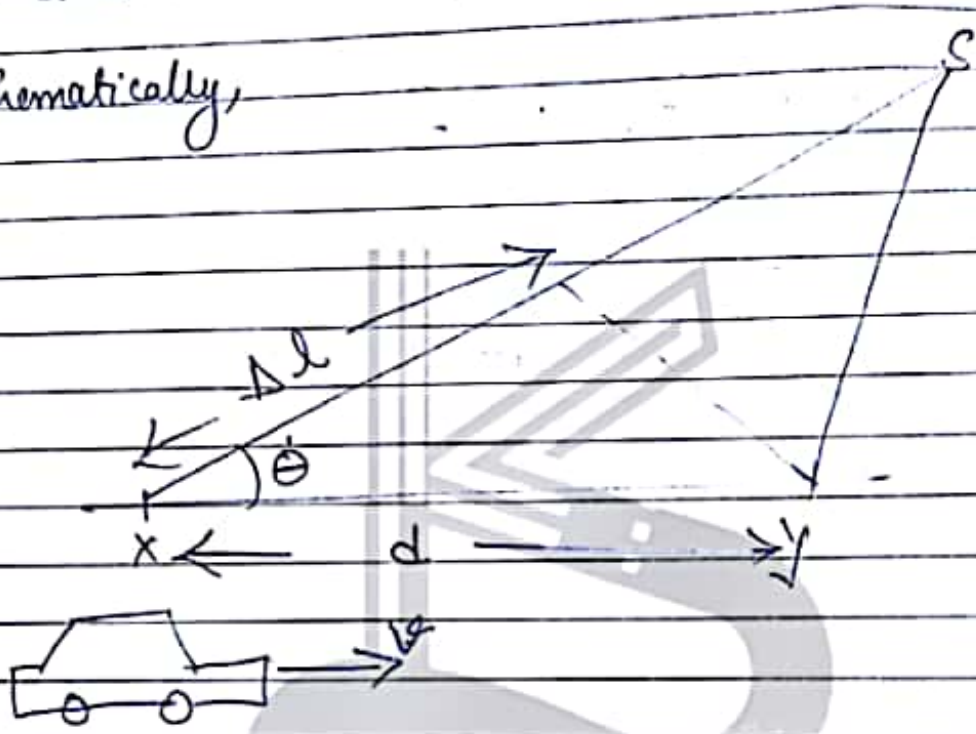
DOPPLER SHIFT

↳ It refers to a change in frequency of a transmitted electromagnetic signal due to relative motion of receiver with respect to the transmitter.

Mathematically,



Let a mobile moving with velocity v in the direction of y.

The difference in path length travelled by waveform

$$\Delta l = d\cos\theta = v\Delta t\cos\theta \quad \left[\text{as } d = v \times \Delta t\right]$$

Also, phase change,

$$\Delta\phi = \frac{2\pi\Delta l}{\lambda} = \frac{2\pi v \cdot \Delta t\cos\theta}{\lambda}$$

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hence apparent change in frequency. i.e Doppler Shift

$$f_d = \frac{1}{2\pi}\frac{\Delta\phi}{\Delta t} = \frac{v}{\lambda}\cos\theta$$

hence

$f_d \propto v$

f_d ∝ to the direction of motion of receiver & the direction of arrival of waves. i.e $\cos\theta$.

FAST FADING CHANNEL

↳ Caused because of frequency dispersion due to Doppler spreading.

↳ In the fast fading channel, the rate of change of the channel is faster as compared to that of the transmitted baseband signal.

or

In simple words

↳ the Coherence time of the channel is Smaller than the symbol period of the transmitted signal.

↳ In frequency Domain term,

In a fast fading channel Doppler spread is greater than the transmitted signal bandwidth.

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Summarize fast fading channel.

$T_s > T_c$ & $B_s < B_d$

T_s = Symbol period. B_s = Symbol Bandwidth

T_c = Coherence Time B_d = doppler's Spread of Channel.

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RAYLEIGH FADING

↳ it is most common statistical model to represent the effect of propogational channel on a transmitted signal in a wireless communication system.

↳ it is based on Rayleigh distribution which is commonly used to describe the statistical time varying nature of the received waveform of a flat-fading signal or that of an individual multipath component.

↳ In simple words, it is assumed that the variation in a signal passing through a Rayleigh fading channel would follow Rayleigh distribu

RICIAN FADING

↳ The effect of a dominant signal arriving with many weakers multipath signals give rise to rician distribution & thus in such situation channel may be modelled by Rician distribution.

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BER PERFORMANCE IN FADING CHANNELS

↳ BER performance is a fn. of $\frac{E_b}{N_0}$ & is plotted below for various fading Models

↳ It can be observed that as $\frac{E_b}{N_0}$ ratio increases the bit Error rate drops.

↳ Following conclusion can be obtained from the graph about different fading channels.

with a reasonably high $\frac{E_b}{N_0}$ ratio, an AWGN wireless channel exhibits fairly good performance

↳ A rician fading channel model exhibits provides good performance with larger values of K.

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↳ the Rayleigh fading channel model provides relatively poor performance.
This situation is same for slow as well as flat fadding.

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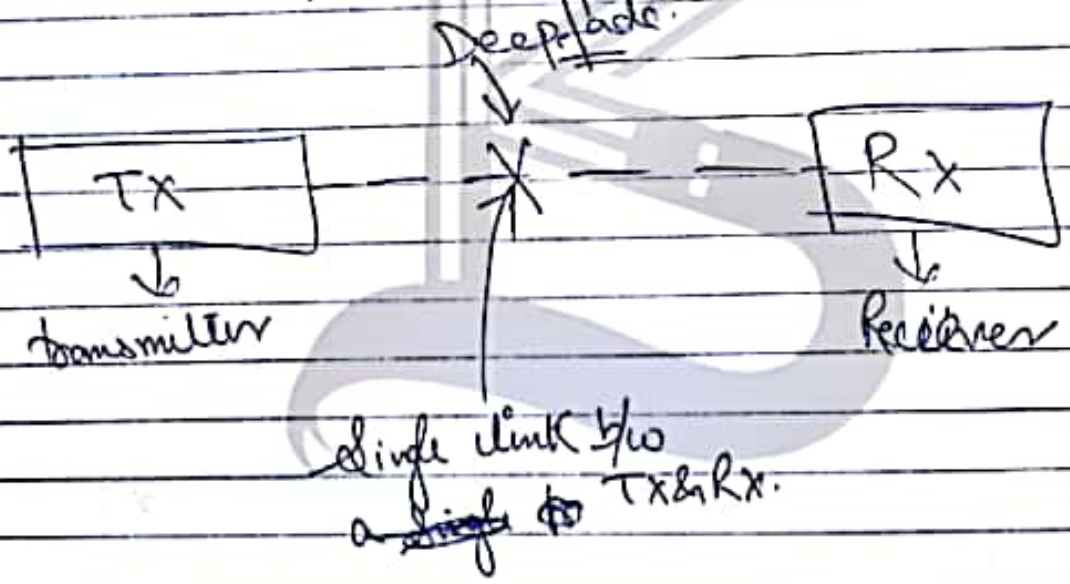
DIVERSITY MODELLING OF WIRELESS COMMUNICATION

↳ Diversity can be Employed to overcome fading
  ↳ to overcome effect of deep fade.
  ↳ Combat fading of wireless Communication

↳ PRINCIPLE



* if single link is in deep fade then there is no transmitter link. & hence it disrupts Communication
&
also there is no alternative to transmit signal from TX to Rx.

& ie if single link is in deepfade the performance is bad.

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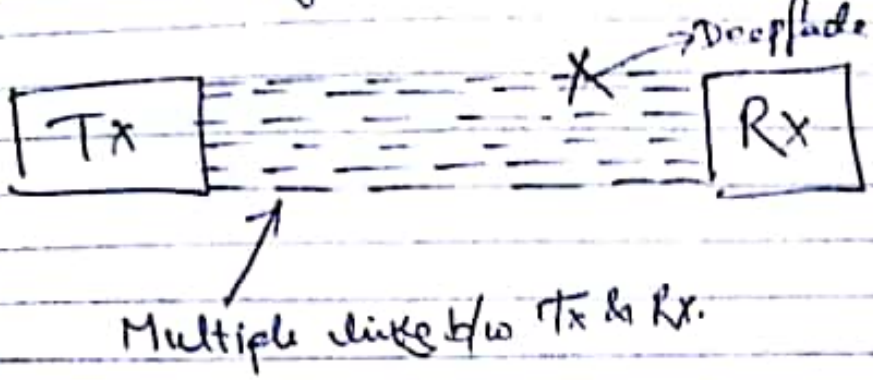
Consider a system with multiple link.



Now if two of the links is in deep fade there are alternative paths, so,
communication is not disrupted.

So, this implies that there is Diversity in the system.

This is the principle of Diversity

DIVERSITY

MICROSCOPIC

1) Small signal fading can be minimized by this technique.

2) It can prevent small signal fading by using two antennas seperated by small distance. one antenna may receive deep faded signal while the other receives a strong signal.

3) By selecting strong signal at all time, a recr can mitigate small-scale fading effect.

MACROSCOPIC

In large signal fading, the signal strength reduces because of shadowing proces.

In Cellular Systems, BS are seperated by large distance, by choosing a BS that is not shadowed when compare to other the mobile unit can aquire a better signal to Noise Ratio.

such Counteracts reduces large scale signal fades

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SPACE DIVERSITY
OR
ANTENNA DIVERSITY
OR
PATH DIVERSITY

↳ In Conventional method of wireless Communication, the availablity of direct path b/w transmitter & receiver is not assured. Hence Rayleigh fading will be present

↳ In this Space diversity Scheme, the receiver Configuration is quite Simple.
Several spatially seperated antennas are installed to provide diversity reception
Seperation are on the order of Several wavelength.
Thus a no. of diversity branch are selectable.

* this type of Diversity Can be used at base station or mobile or at both Ends.

Space diversity

- Selection Diversity
- Feedback Diversity
- Maximal Ratio Combining Technique
- Equal gain Diversity

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Selective diversity

↳ In this technique the branch having strongest signal is selected.

↳ In this method, a no of demodulator with adjustable gains are used.
Their gains are adjusted to give same average signal to Noise Ratio (SNR) for Every diversity branch.

Then the antenna are sampled & the best signal that possess good signal strength is sent to single demodulator.

Feedback / Scanning Diversity

↳ In this method, a no of signal are scanned in a proper sequence to monitored to pick a signal in the sequence whose strength which is above the preset threshold values & the Scanning process is initiated again.

adv
1) Easier Implementation

Disadv :- fading level Reduction is however less than other diversity techniques.

Maximal Ratio Combining technique

In this Method all the Diversity branch signal are Combined Coherently with necessary weighing coefficient, in order to improve fading reduction & Consequently lead to overall improvement

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on system performance.

↳ In the output the signal of maximum ratio combiner will be such that the sum of individual SNR will be equal to SNR of output signal.

adv
↳ Generates Good SNR value
↳ Accuracy is high
↳ Best reduction of fading.

Equal Gain Combiner Technique.

↳ In this technique all the diversity branches are coherently added with a same weighing factor (unity) for all the branches.

[This is done in such cases when it is not convienent to provide variable weighing factor for each diversity branch.].

↳ This scheme co-phases all diversity branches & add them up.

*) POLARIZATION DIVERSITY

↳ if a signal is transmitted by a pair of polarized antenna & they are received by another pair of antennas, the two uncorrelated fading channel will received.

↳ Circular & linear polarized antennas have been used for polarization diversity & it is interesting the radio path meet an obstacle the polarization

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diversity was found to decrease the multipath delay spread without significant reduction in the power received.

*) FREQUENCY DIVERSITY

↳ In this Information is transmitted on many Carrier frequencies

↳ The Idea behind this is simple, if the Separation b/w the transmission frequency is more than Coherence bandwidth of the Channel ~~they~~ if then they will not experience same fading status.

TIME DIVERSITY

↳ In this scheme, the Information is transmitted repeatedly at specific time spacing which exceeds the Coherence time of the Channel.

This leads to repetition of signal several time at the receiver irrespective of fading condition

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2G WIRELESS NETWORK

↳ 2G wireless N/w Marked the beginning of digital wireless Communication

↳ The switch to digital Communication technology brought along other benefits such as high Speed Communication, data encryption, multiplexing Capabilities, noise immunity, better Call processing Capabilities.

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GSM (GLOBAL SYSTEM FOR MOBILE)

↳ it is a 2G digital Cellular N/w.

↳ developed to solve the fragmentation problem of first generation Cellular System.

↳ it provides a common set of compatible services & capabilities to all mobile user world wide

↳ it was the world first Cellular System which specify digital modulation & Network level architecture & services.

Basic Requirements

Service potability :- a) The GSM must provide service potability.
b) Thus MS can access communication service in all participating countries.

Quality Of Service :- The voice quality of GSM must be as good as previous Analog System.

Security :- The GSM system must provide secure on air transmission by Information Encryption without significantly increasing cost

Radio frequency Utilization :- The GSM system must permit high spectrum efficiency & be capable of operating in the Entire allocated freq. band.

NETWORK :- The GSM network plans must be based on relevant ITU recommendation.

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Cost & The system parameter must be chosen with focus on reducing the cost of the complete GSM system.

GSM SERVICES

Bearer (Data) Service	Telephone Service	Supplementary Service
1) These Service related to layer 1, 2, 3 of OSI model.	Include Voice oriented telephone service. including encrypted voice transmissions, message service & basic data comm.	like user identification Call redirection Call forwarding multiparty comm.
2) provide data rates from 300bps to 9.6 Kbps		
3) provide transparent, Non-transparent, ~~Bearer~~, ~~Non-bearer~~ Synchronous Non-Synchronous data transmission	also include Emergency Calling facsimile, SMS, MMS soon.	

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System Architecture

↳ It consist of three major interconnected subsystem.

1) BSS (Base station subsystem)
2) NSS (Network & switching subsystem)
3) OSS (Operation suppot subsystem).

↳ 1) The BSS also known as the radio subsystem which suppot & manages radio transmission path b/w MS & MSC.
Mobile Station — Mobile Switching Center

2) The BSS also manages the radio interference b/w the MS & other subsytem of GSM System.

↳ Each BSS consist of many BSC (Base Station Controller) which are connected the MS to the NSS by MSC.

↳ The NSS Manages the switching function of the system & allows the MSC to communicate with other N/w such as PSTN & ISDN N/w

↳ The OSS supports the operation & maintainance of GSM & suppot system Engineer to monitor, diagnosis & troubleshoot all aspect of the GSM System.

This subsystem interacts with other GSM subsystem & is provided solely for the staff of the GSM operating system or Company which provides service facilities for the N/w.

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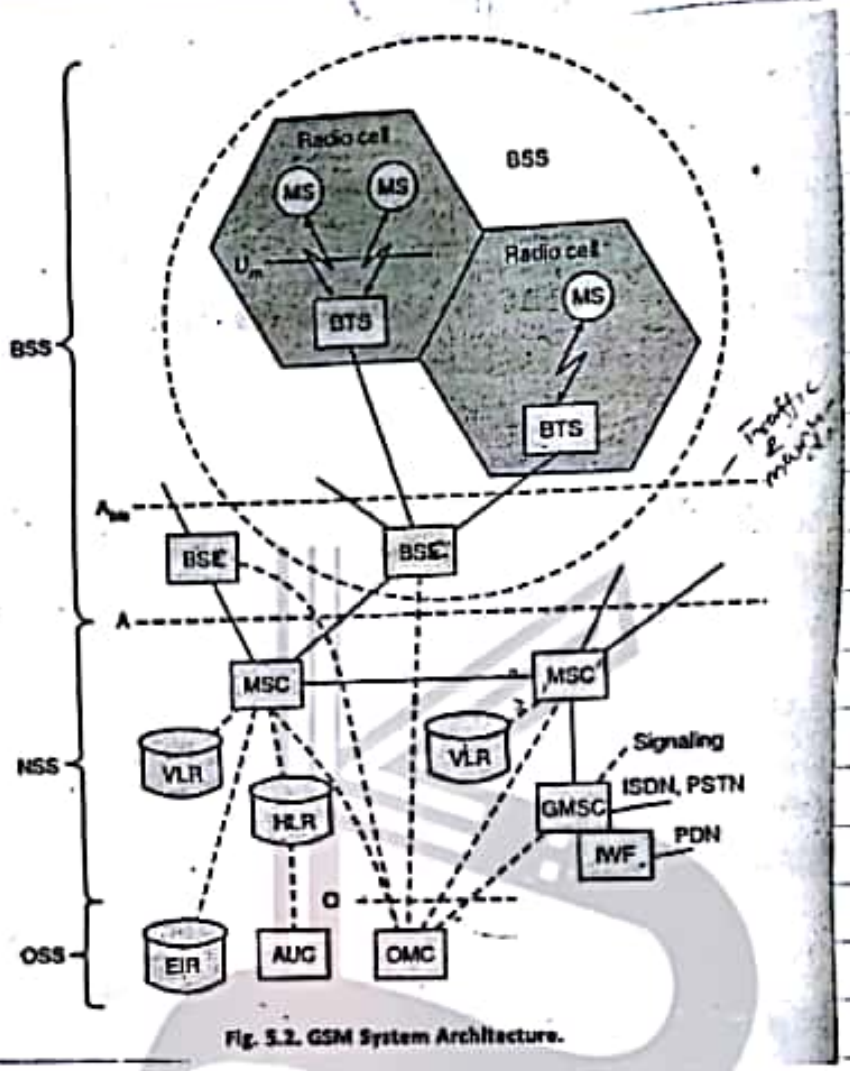

Fig. 5.2. GSM System Architecture.

Various Entities in GSM

1) **BSS**:- Base station Subsystem is perform all function necessary to maintain wireless communication connection to MS, coding decoding of voice & rate adaption to wireless N/w apnt.

1.1) **BTS**:- Base transceiver station is consist of all radio Equipment which are necessary for wireless transmission
it connects to MS via Um interface
& BSC via Abis interface

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1.2) BSC :- Base station Controller :-

1) The Control part in BSS is handled by BSC. which manages Many BTS.

2) function
   - ↳ radio frequency assignment
   - ↳ handoff from one BTS to Another.
   - ↳ paging of the MS.

1.3) MS

2) NSS :- Network Subsystem

- Various fn. such as Connection with standard Public N/w, Handoff b/w diff. BSS's, support Charging etc.

2.1) MSC
2.2) HLR
2.3) VLR

3) OSS :- Operation subsystem :-

perform Various fn. for N/w operation & Maintainance

3.1) OMC (Operation & Maintainance Centre)
It monitors all other N/w Entities via O Interface & perform fn. such as traffic monitoring

3.2) AuC (Authentication Centre)
This system protects the user data identity & data transmission. It contains various Algo & Keys for authentication & Encryption.

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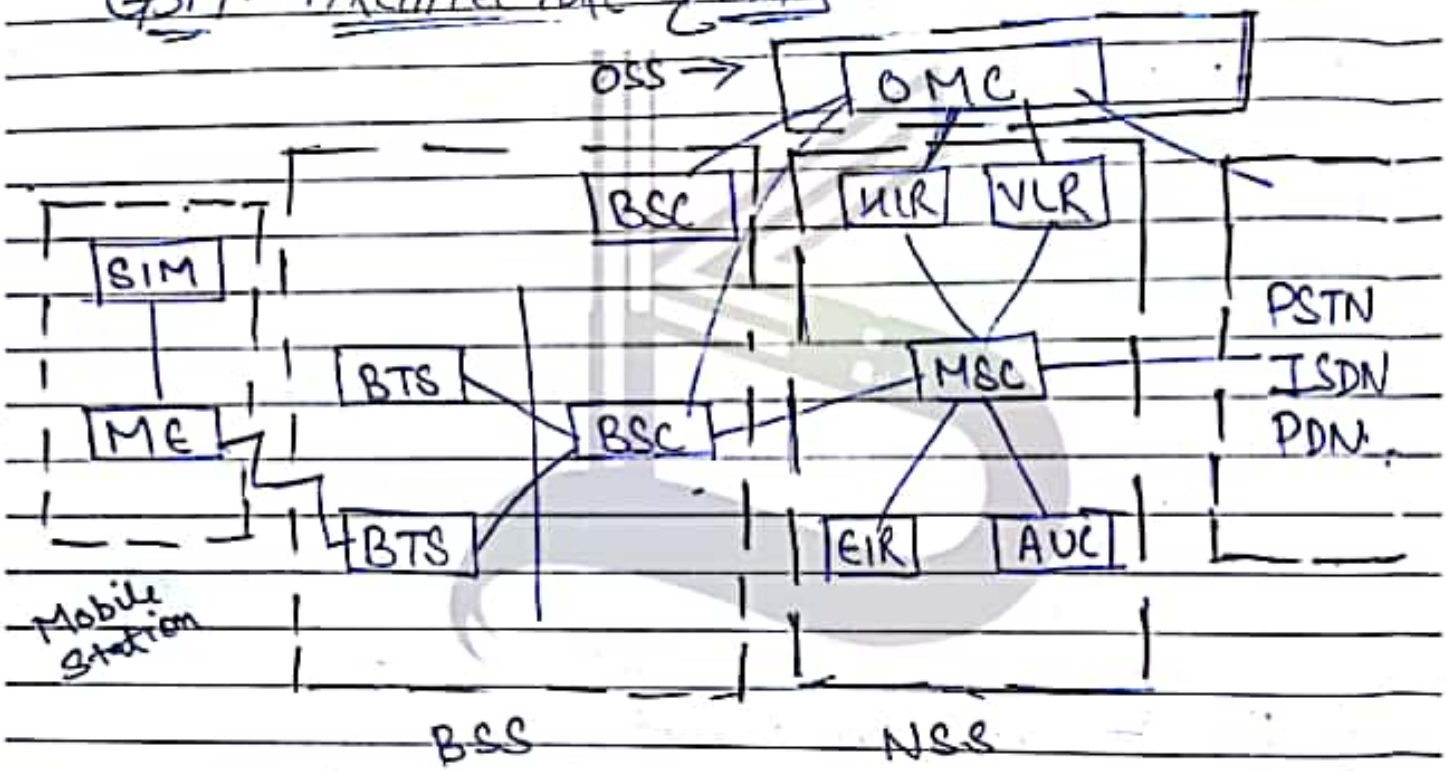
3.3) EIR (Equipment Identity Register)

This database store all the IMEIs of the devices registered ~~for~~ for the associated N/w.

for instance if MS is stolen, the EIR blacklist the IMEI of that MS.

GSM – ARCHITECTURE DIAGRAM



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MOBILITY MANAGEMENT

Mobility Management Refers to the way the network Manages the Movement of the Mobile Subscriberse which significantly affects the performance of the PCS network.

HAND-OFF

Handoff is the process which Enable a Call to proceed uninterpted when the user moves from one Cell to another or one System to another.

There are two type of Handoff

- Intercell or Inter-BS Handoff
- InterSystem or Inter MSC Handoff

INTER-BS HANDOFF

⇒ The Inter-BS Handoff Required when mobile unit travels from Coverage Region of one base station to Coverage Region of Another while new & old B.S are Connected to Same MSC.

STEPS Followed.

- When the signal received from the current BS is not strong enough, the MS momentarily suspends conversation and initiates the handoff procedure by signaling on an idle channel in the new BS. Then, the conversation on the old BS is resumed.
- When MSC receives the signal, it transfers the information to the selected idle channel of the new BS and new conversation path is setup.
- After the MS has been transferred to the new BS, it signals the network and resumes conversation using the new channel.
- When MSC receives the handoff completion signal, the connection to old BS is terminated and the resources are released.

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Q) Mobile Call Originating

A Steps

1) The MS sends the dialed no. to the MSC via BSS.

2) The MS checks from VLR if MS is allowed the requested service.
If so, MSC ask BSC to allocate necessary resources.

3) If call is allowed MSC route call to GMSC.

4) GMSC routes the call to local Exchange of called user.

5) The LE alerts (applies ringing) the called terminal

6) Answer back (ring back tone) from called terminal to LE.

7) Answer back signal is routed back to MS through the observing MSC which also complete the speech path of MS.

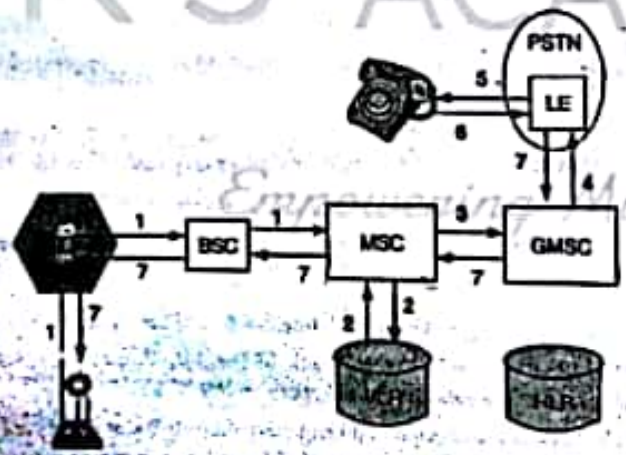

Fig. 5.10. Mobile Call Origination in GSM.

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3) Mobile Call termination

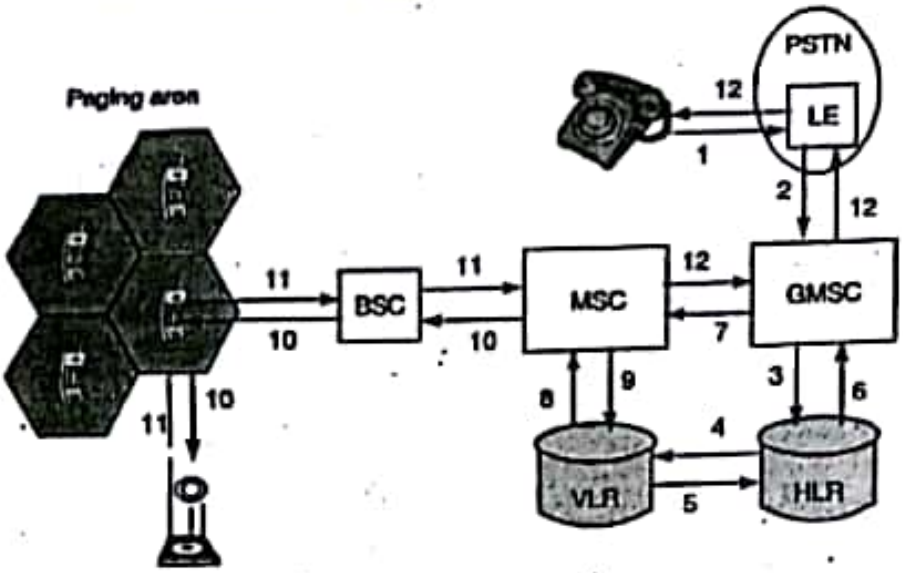

Fig. 5.11. Mobile Call Termination in GSM.

4) HAND OFF

In GSM, there are four possible handover scenarios:

- **Intra-cell handoff:** It occurs within a cell due to narrow-band interference. When this happens, the BSC changes the carrier frequency.
- **Inter-cell, intra-BSC handoff:** It occurs when the mobile station moves from one cell to another, but stays within the control of the same BSC.
- **Inter-BSC, intra-MSC handoff:** It happens when the mobile station leaves the coverage region of one BSC (which controls a limited number of cells) and enters the coverage region of another BSC. Here, the handoff has to be controlled by the MSC.
- **Inter MSC handoff:** It happens when the mobile station leaves the coverage region of one MSC and enters the coverage region of another MSC. Now, handoff process is controlled by both the MSCs together.

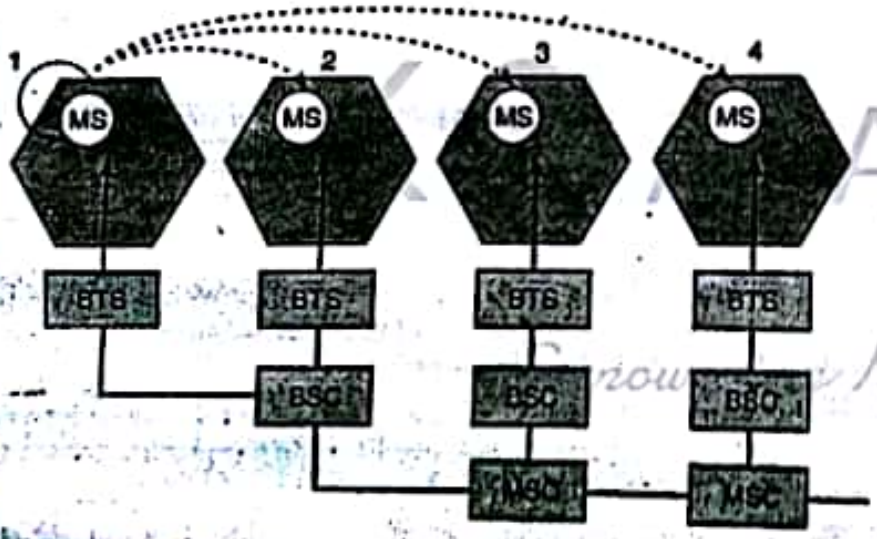

Fig. 5.12. Handoff Scenarios in GSM.

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