OM sairam:

Mobile computing: term describing one's ability to use technology while moving.

- Requires wireless network to support outer mobility and handoff from one network to the next network
- It is the mobility of physical and virtual object
- Physical object: wireless device
  Virtual object: data or bit/bytes.
- User of mobile computing environment can access data information and other logical object from any device on any network while moving.
- Allows a user to perform a task from anywhere using a computing device on the public, corporate and personal information space.
- Mobile computing is the process of communication on a mobile device
- Mobile computing - The computing environment is mobile and move along with the user.
- the information is available anywhere all the time
- virtual home environment: an environment on a foreign network such that the mobile user can experience the same computing environment as they have at home or corporate computing environment

Mobile computing Device:

→ Mobile Device: Wide range of consumer electronics

1. Personal Digital Assistant:

→ PDA are handheld device that combine elements of computing, telephone, internet and networking in a device.

→ A typical PDA can function as a cellular phone, fax sender, web browser

PDA began as pen based using style rather than a key board for input mostly.

- Now PDA are available in either a keyboard version called datapad.
- eg Toshiba Pocket, palm pilot

② Smartphone:

-> Smartphone combine both mobile phone and hand held computer into a single device

- It allows user to store information (e.g. email) install programs along with using as mobile phone in one devices.

-

③ Tablet PC:

Personal communication system (PCS)

- PCS stands for personal communication system.
- Objective: to enable communication with a person at any place in any form
- It also manages their individual call service according to their service by providing unlimited reachability and accessibility
- Sprint was first company to set up a PCS network which was a GSM 1900 network in Baltimore, Washington metropolitan area in USA.
- PCS promise to provide a wide range of location and equipment independent service to a large no. of user
- According to term given by US Federal communication system, PCS is the system by which every user can exchange information with everyone at any time in any place through any time of service using single personal telecommunication number (PTN)
- The key features of PCS are
  1. Reachability w.r.t. location
  2. Accessibility w.r.t Device
  3. Management of service

Features:

1. Multiple environment
2. Multimedia service with high quality.
3. Multiuser types.
4. Global roaming capability.
5. Single personal telecommunication number
6. Very high capability
7. Universal handset
8. Service security.

1. Multiple Environment:

It can provided uniform access to service no matter whether the users at home in the office, in the car etc. To achieve this objective, PCS should be able to integrate the current public switch telephone network (PSTN) integrated service digital network (ISDN) the cordless system

2. Multimedia service with high quality:

→ PCS promises to provide a wide range of service to user including high quality voice variable data rate, full motion video, high resolution image etc

→ The common part of those services available in ISDN will also be available in the wireless environment with the same quality.

3. Multi user Type:

PCS will provide service to various users with diff. requirements eg Diff. service delay, diff error performance etc by defining interface for negotiations betn the user and the system

4. Global Roaming capability:

→ PCS will have the capability to support global roaming. The user is no longer tied to one point or one network but one network but can roam throughout the whole system

→ This is very important features of PCS and it is to overcome the regional nature of some current system.

5. Single Personal Telecommunication Number:

→ The user can reach through a single personal number no matter where he is and what kind of device he uses

→ PTN is the basis of personal mobility

6. very high capacity:

→ The potential demand both PCS is estimated to be one connection per adult.

→ The high market penetration will require very high system capacity

7. Universal Handset:

→ A single small handset will be used to access all the available service of the system

→ The design is difficult because of the constraint of low battery power

8. Service security:

→ Single heterogeneous system are integrated and roaming is allowed security threat such as illegal access

→ More advance authentication and protection technology are used

→ Important issue is here is how to implement and manage the database.

PCS ARCHITECTURE:

It consists of 2 parts

-) Radio network

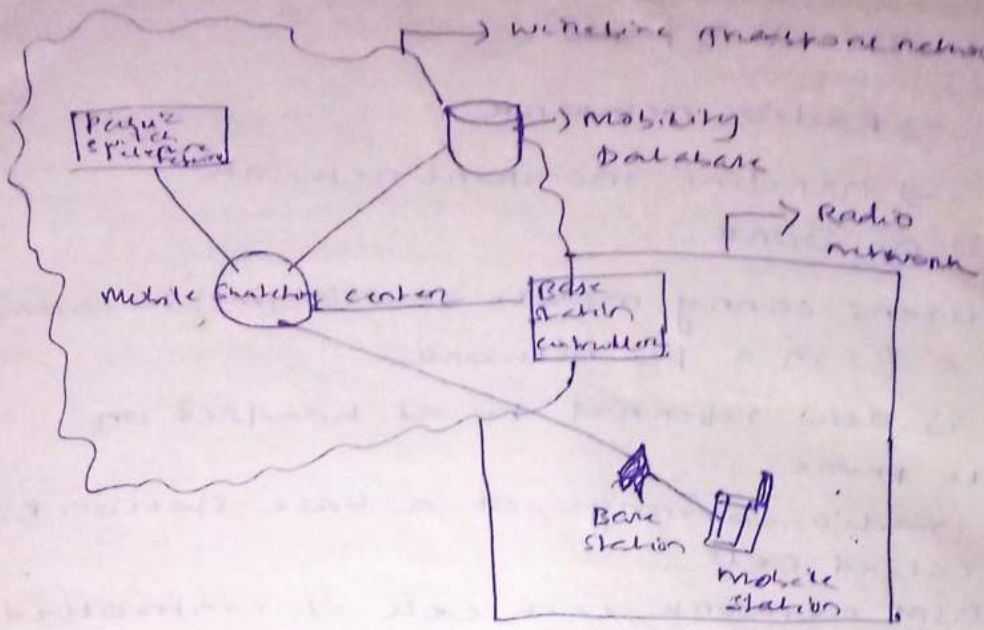
-) Wireline transport network

Radio network:

- PCS users carry mobile station (MS) to communicate with a BS in a PCS network
- MS is also referred to as handset or mobile phone
- The radio coverage of a base station (BS) is called cell
- In GSM network each cell is controlled by BSC which are connected to MS through BS
- The BSC are connected to MSC through landline

Wireline transport network:

- MSC is a telephone exchange configured specially for mobile application
- It interface the MSC (via BS) with PSTN.
- MSCs are also connected with mobility database to track the location of MS and roaming management
- The database are HLR and VLR
- HLR contain the authentication information like IMSI (International Mobile subscriber identity) identification information like name, address of the subscriber, billing information like prepaid or postpaid, operator selection, denial of service a subscriber etc.
- VLR gives information about the location area of the subscriber while on roaming and power off status of the handset



(PCS network Architecture)

Mobility Management:

Mobility management function handles the function that arises due to mobility of the subscriber

- Main objective of MM is location tracking and call setup.
- There are two aspects of mobility in a PCS network
  1. Handoff.
  2. Roaming

Handoffs:

- Depending on the mobility of MS, the handoff is divided into two categories
  i) Inter-BS Handoff / Inter cell handoff
  ii) Inter system handoff / Inter MSC handoff.

Inter-BS handoffs / Inter cell handoff:

- Here MS usually moves from one BS to another BS under one MSC.
- Action taken for communication
  1. The MS momentarily suspend conversion and initiates the hand-off procedure by picking a channel in new BS. Then it resumes the the conversion in old BS.

2. When MSC receives that signal he transfers the information to the new BS and set of new conversion path to MS through that channel.

3. After MS has been transfered to new BS it start the conversion channel with new BS and then MSC disconnects the link with old BS.

Handoff: When a mobile user is engaged in conversion, the MS is connected to a BS via a radio link. If the mobile user move to the coverage area of another BS, the radio link to the old BS is eventually disconnected and a radio link to the new BS should be established to continue the conversion. The process is variously referred to as automatic link transfer, handover or handoff.

Roaming: When a mobile user moves from one PCS system (e.g the system in New Delhi) to another (e.g the system in Mumbai), the system should informed of the current location of the user. Otherwise it would be impossible to deliver the service to the mobile user.

(11) Inter system handoff/ Inter MSC handoff

→ MS moves over from one BS to another connected two diff. MSC

→ Action taken for communication

i) MSC1 request MSC2 to perform handoff measurement on the call in progress.

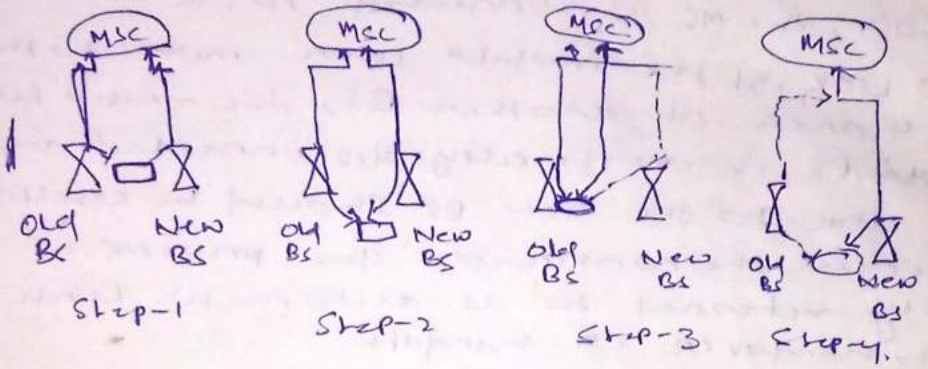
ii) MSC2 then select a BS by interrogating the signal quality and send the information to MSC1

iii) The MSC1 ask MSC2 to set up a voice channel

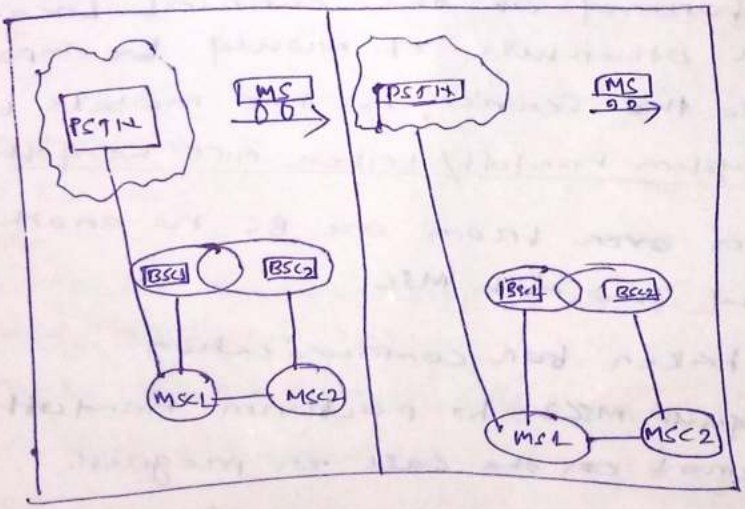
iv) Assuming that the voice channel is available on BSC2, MSC2 instruct MSC1 to start radio link transfer

5. MSC1 send the MS a handoff order. Now MS can access BSC2 of MSC2. MSC2 inform MSC1 that handoff is successful. MSC1 then connect call path to MSC2

6. In the intersystem handoff process, anchor MSC is always in call path before and after handoff.



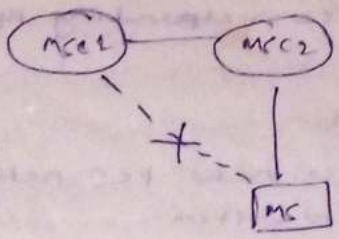
(Inter-BS Link transfer)



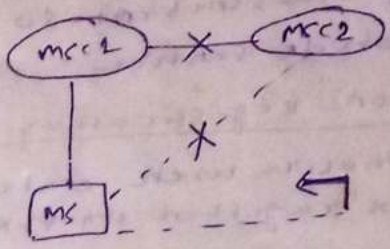
(Inter system handoff)

Path Minimization:

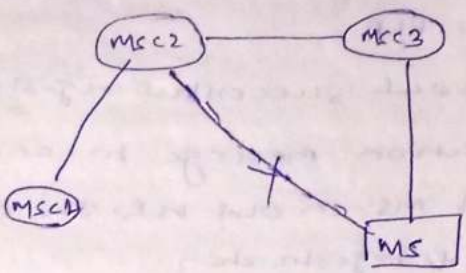
→ When MS moves to MSC3, MSC2 might be removed from the call path. The link b/w MSC1 and MSC2 is disconnected, MC connect MSC3 directly. The process is called path minimization.



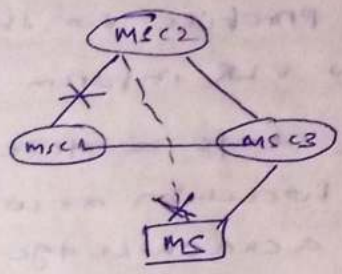
(Handoff forwarded)



(Handoff backward ed)



(Handoff to 3rd)



(path minimization)

Roaming Management:

Two basic operation are performed under roaming management.

1. Registration (location update) - where MS informs the system about its current location

2. Location tracking: process during which a system located MS. Location tracking is required when network attempt to deliver call to a mobile user

→ the roaming management follows a two level strategy where two tier systems of home and visited database are used

→ when a user subscribes to the service of a network, a record is created on the system database called HLR. this is called as home system of the mobile user

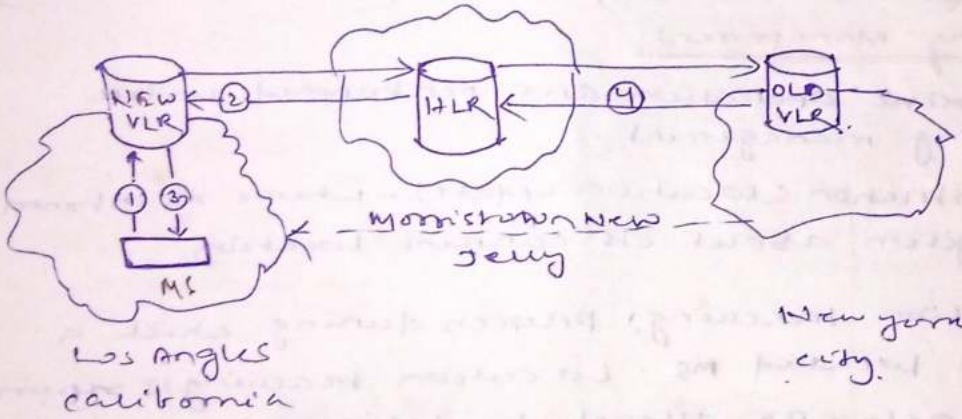
→ HLR is a network database, where MS identity profile, current location, and validation period is stored

→ when the mobile user visits a new network other than home system, a temporary record for the mobile user is created in the VLR of visited system

5. VLR temporarily store information for visiting subscribers so that corresponding MSC can provide service.

Steps for registration process:

1. When mobile user enters into new PCS network it must register in VLR of new system
2. The new VLR informs mobile user's HLR regarding the current location and address of user. The HLR send an acknowledgement which include MS's profile to the new VLR.
3. New VLR inform MS about successful registration
4. HLR sends a deregistration message to cancel the location record of MS in OLD VLR. The OLD VLR acknowledge the deregistration



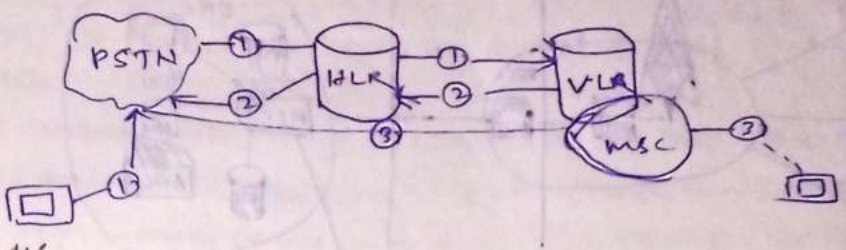
(MS registration process)

→ To originates a call, MS binds contact with MSC in the new PCS network
→ The call request is forwarded to VLR for approval
→ If it is approved MSC sets up the call to the user following the standard PSTN procedure

1. If a wireless PSTN phone attempts to call a mobile subscriber the call is forwarded to switch called the originating switch in PSTN. The switch makes a query to HLR to find out current VLR of MS. The HLR queries the VLR which MS resides to get a communicable address.

2. The VLR returns the address to switch through HLR.

3. Based on address, a communication link is established between MS through visited MSC



(PCS call delivery procedure)

HLR: Home Location Register
VLR: Visitor Location Register

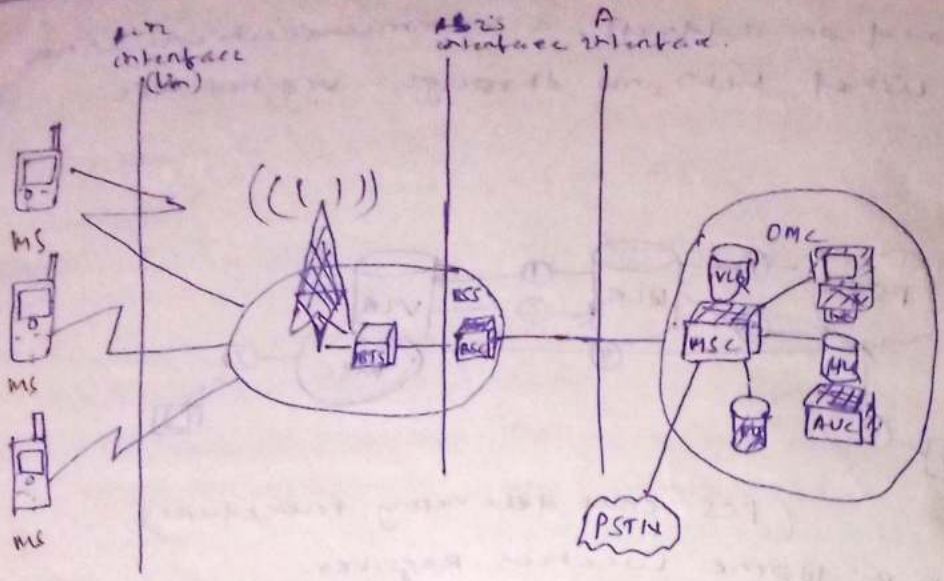
GSM (Global system for mobile communication)

* most popular standard for mobile phone in the world
* widely used in Europe and other part of the world
* It uses a variation of time division multiple access (TDMA) and is most widely used of the 3 digital wireless telephone technologies (TDMA, GSM and CDMA)
* GSM system had to must certain system objective
  - → Support for International Roaming
  - → Good speech quality
  - → Ability to support handheld terminal
  - → Low terminal

→ GSM is a cellular network, which means that mobile phone connect to it by searching for cells.

→ 5 diff. cell size in a GSM network like macro, micro, pico, femto and umbrella cell

GSM Architecture:



GSM network can be divided into 4 groups

1. MS (Mobile station)
2. BSS (Base station subsystem)
3. NSS (Network switching subsystem)
4. OSS (Operation and support subsystem)

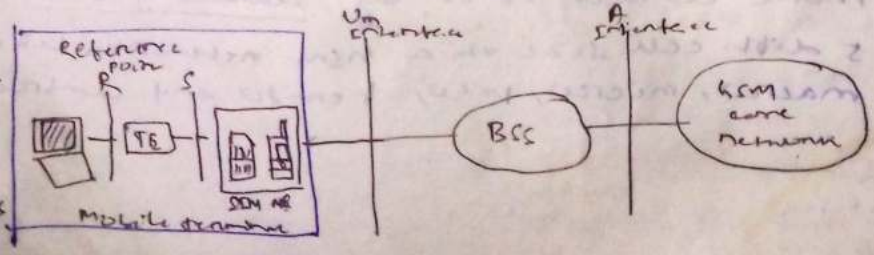
Mobile station:

- → MS is used by a mobile subscriber to communicate with mobile network
- → many types of MS exist to make and receives call
- → manufacture of MS offer a variety of design and features to meet the need of diff. markets
- → Mobile station consists of
  - i) Mobile Equipment
  - ii) Subscriber identity module.

Um → contain mechanism for wireless transmission

A → BSS is connected to NSS via this

MS → combine of Um or Uu MS.



(GSM Mobile terminal)

MS

-) ME has a unique international mobile equipment identity (IMEI) which is used by GSM
-) The no of GSM terminal types are defined within the GSM specification and are distinguished by their power o/p rating
-) The range or coverage area of an MS dependent on the output power capabilities and consequently diff range

e.g handheld MS have a lower o/p power and shorter range than can installed MS with a roof mounted antenna.

SIM

-) SIM card used in phone are smart processor card
-) It process a processor and a small memory
-) SIM stores permanent or temporary data about the mobile, the subscriber and the network
-) It contain serial no, PIN, PUK (Pin unblocking key) an authentication key, EGSM IMSI (International mobile subscriber identity)
-) SIM can be plugged into any GSM mobile terminal thus bring the advantage of security and portability of the subscriber

e.g Subscriber A mobile terminal may have been stolen. However A's own SIM can be used on another person mobile terminal and the call will be charged to subscriber A.

PIN Management:

-) A SIM is required to have a PIN function even tho it is deactivated by a user. PIN consist of 4 or 8 digits
-) An initial PIN is loaded by the network operator at subscription time & afterward the PIN which the length can be changed by the user

§ The user can decide whether to use the PIN function or not by activating an appropriate SIM-ME function called the PIN disabling function and can be blocked by a authorized person

→ If an incorrect PIN is entered the user is informed. After 3 consecutive incorrect the SIM is blocked, even the SIM has been removed

Blocking/unblocking of SIM:

→ When a SIM is blocked, GSM network operation are forbidden and is done using PUK (PIN unblocking key)

→ The PUK is an 8-digit numerical code. If it is entered incorrectly the user is informed

→ The user can make 10 attempts to enter the PUK before the system block entry. In which the subscribers contacts their network operator

Function of MS:

→ transmission of signal from MS to BTS (UP link)

→ Reception of signal from BTS to MS (down link)

BSS:

→ It is responsible for all the radio related function in the system like

* Radio communication with mobile unit in a certain area.
* Handover of calls in progress both cells.
* management of all radio network resource and cell configuration
* Monitors quality
* control the power transmitted by BTS
* Generate a handover to another cell when required.

-) BSS contain two components

* BTS
* BSC

BTS: consists of all radio equipments

-) It is placed in the center of a cell and its transmitting power defines the size of a cell

-) It is connected to MS via Um interface and connected to BSC via Abis interface.

-) It manage the radio resources for BTS. It handles on handover the radio frequency.

-) Function of BTS:

* Radio resources
* Signal processing
* Signalling link management
* Synchronization
* Local maintenance handling.

BSC:

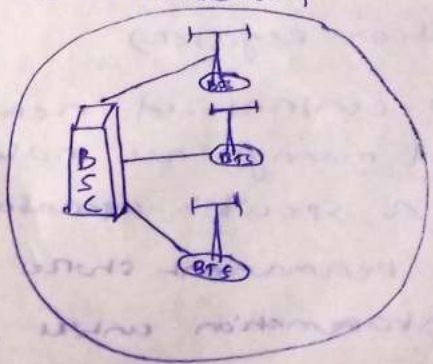
-) It connect BTS and MSC of NSS

-) It manage radio resources for one or more BTS

-) It handle and handover the radio frequency.

Function:

* Radio network management
* BTS management
* Handling MS connection



(BSC and BTS arrangement in GSM system)

6. NSS (Network switching subsystem)

- The NSS combines the call routing switches (MSC and GMSC) with data base registers required to keep track of subscriber movement any use of the system.

→ Key elements of NSS are
  → MSC
  → HLR
  → VLR

→ MSC:

→ The mobile switching center is an exchange which perform all the switching and signaling function for mobile station. Located on a geographical area designated as the MSC area.
→ These are high performance digital ISDN switches
→ It is used for connection betn mobile phone to mobile phone within same network. It is used for connection betn mobile phone to fixed phone within a network
→ It manages BSC within a geographical area.

Function of MSC:

→ switching and call Routing.
→ Service provisioning
→ communication with HLR
→ communication with VLR
→ communication with other MSC
→ Direct access to Internet services.

HLR: (Home Location Register)

→ The HLR is a centralized network database that store and manage all mobile service belonging to a specific corporation
→ It acts as a permanent store for a person subscription information until that subscription is cancelled

→ It provides call routing and roaming by combining with MSC and VLR

→ It is considered as a database which stores information about the subscriber within covering area of MSC.

→ Information include
  * location of the mobile
  * all service providing information when a phone is powered off this information is stored in HLR

→ It is also a database that contains a temporary copy of some important information stored in HLR

→ ~~It is also a database~~ If a new MSC user come into location area, then VLR will provide relevent information by bringing it from HLR

Function of HLR:

→ Subscription of database management
→ communiccation with MSC
→ communication with VLR.
→ Communication with AUC

VLR (Visitor location Register):

→ It is a temporary storage device of GSM network
→ It store subscriber subscription information for MS which are within the particular MSC service area.
→ There is one VLR for each MSC service area
→ The following occur when mobile moves to a new service area
  → the VLR checks its database to determine whether or not it has a record for MS (based on subscription)
  → when the VLR find no record b
  it sends a request to the subsc
  HLR for a copy of the Mobile subs

→ the HLR passes the information to VLR and updates its location information for the subscriber.

→ the HLR instruct the VLR to delete the information it has on the MS.

→ the VLR stores its subscription information for the mobile, including latest location.

OSS (Operation and support subsystem)

→ It contains necessary function for network operation and maintenance.

→ The key element of OSS are
- OMC
- EIR
- AUC

OMC: (Operation and maintenance center):

→ It is connected to diff. components of NSS and BSC. It control the traffic load of BSS

EIR: Equipment Identity Register:

→ A database that contains a list of all valid ~~terminals~~ mobile equipment within the network where each MS is identified by IMEI

→ EIR contains a list of IMEI of all valid terminal

→ An IMEI is marked invalid if it is stolen

→ EIR allows the MSC to forbid calls from the stolen terminals.

→ The equipment identification procedure uses the identity of equipment itself to ensure that the MS terminal equipment is valid.

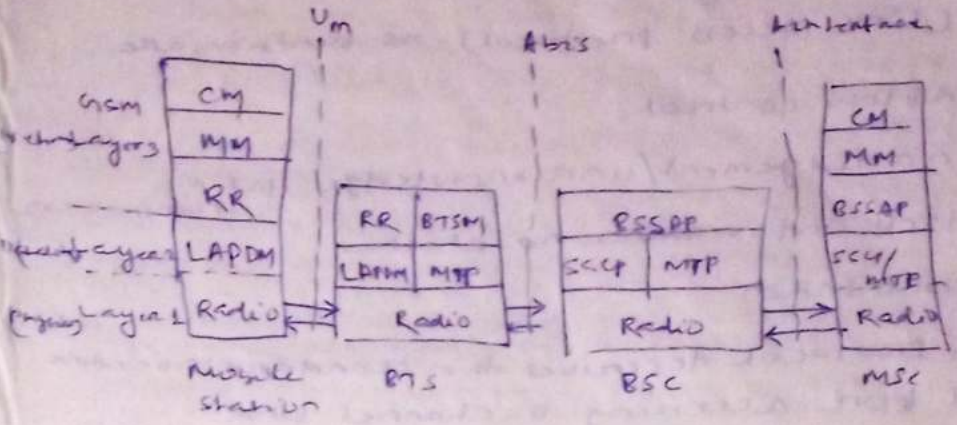
AUC: (Authentication center)

→ It is defined to protect user identity and transmission

→ It is a protected database and stores a copy of secret information stored in SIM card.

→ The data help to verify user identity.

GSM Network signaling



LAPDM – Link access procedure D– link management

RR – Radio resource

MM – Mobility management

CM – call management

BTSM – BTS management

BSSAP – BSS Application protocol.

MTP – message transfer protocol.

Signaling protocol in GSM is structure into 3 layer

→ Layer 1

→ Layer 2

→ Layer 3

→ The physical layer bet MS and BTS is called Um interface it performs the following function

→ Full and half duplex

→ provides TDMA, FDMA and CDMA

→ ~~Hoar~~ → Framing of data.

→ Here the datalink control the flow of packets to and from network layer and provides access to various service like

→ connection: Provides connection bet two terminals

→ Tele service: service offer by a mobile network user like MMS, SMS box etc.

→ The datalink layer present betn MS and BTS is LAPDm (Link Access Protocol). Its functions are

→ Dataflow control

→ Acknowledgement/unacknowledge data transmission

→ Address and sequence no check

→ Segementation

→ LAPDm Protocol describes the standard procedure in GSM for accessing D-channel link

→ Network layer has 3 sublayer

CM:

→ Support call establishment, maintenance, termination

→ Support function for MS

→ Support DTMF (Dual tone multiple frequency)

MM

→ Control the issue regarding mobility management location updating and registration

RRM:

→ Manage radio resource such as frequency assignment signal measurement

BTS - BSC Signaling Protocol:

- The physical layer betn BTS and BSC is called Abis interface where voice is coded by using 64kbps PCM
- The connection betn BTS and BSC is through a wired network
- The data link layer is LAPDm
- Network layer protocol is called BTS-management which interact with BSSAP.

BSC - MSC

- physical layer between BSC and MSC is called A-interface
- DATA LINK protocol betn BSC and MSC is MTP (Message transfer protocol) and SCCP (Signalling Connection control protocol)

-> MTP and SCCP are part of SS7

GSM Interface:

1) Radio interface (MS to BTS)

-> Um radio interface (between MS and BTS) is most important in any mobile radio system
-> It addresses the demanding characteristics of the radio environment
-> The physical layer interface to the data link layer

-> The physical interface comprises a set of physical channel accessible through FDMA and TDMA
-> radio resource layer manage the dialog between the MS and BSS concerning the management of the radio connection, including connection establishment, control, release, and a change during handover.
-> the mobility management layers deal with supporting function of location update, authentication and encryption management in a mobile environment
-> Abis interface:
-> Abis is a standard interface which performs interconnection between BTS and BSC.
-> The primary function are
    -> traffic channel transmission
    -> terrestrial channel management
    -> radio channel management
-> The interface supports two types of communication link
    -> traffic channel at 64 kbps carrying speech or user data from a cell
    -> signaling channel at 16 kbps carrying information between BSC-BTS and BSC-MSC signalling

two types of message are handled
- transparent (betn MS and BSC-MSC and doesn't require BTS analysis)
- non transparent (required BTS analysis)

→ A interface:

→ It allow interconnection betn the BSS radio base system and MSC

→ The physical layer of A interface is a 2Mbps standard consultative committee on telephone and Telegraph digital connection

→ Signaling transport use message transport part (MTP) and signaling connection control part SCCP of SST

Mobility management in GSM:

→ Mobility management function handles the function that arises due to mobility of the subscriber.

→ Main objective: i) Location tracking
ii) call setup

→ The current location of MS is maintained by a 2-level hierarchical strategy with HLR and VLR

→ when an MS visited a new location it register in VLR of visited location. HLR is informed about the registration.

→ The registration process of MS moving from one VLR to another VLR follow the following step

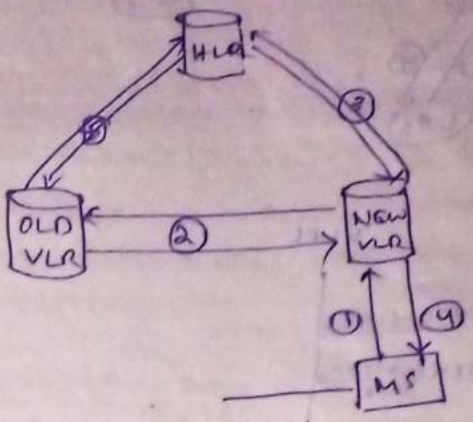
1. MS periodically listens to the BCCH (broadcast control channel) broadcast from BSS. If the MS detect that it has entered into a new location area, it send a registration message to the new VLR by using SDCCH (Standalone dedicated control channel)

2. The new VLR communicate with old VLR to find HLR of MS. The new VLR then perform authentication process

3. After MS is authenticated new VLR sends a registration message to HLR. If the registration request is accepted, the HLR provided new VLR with all relevant subscriber information

4. the new VLR informs the MS of successful registration

5. Then the HLR sends a deregistration (cancellation) message to old VLR. The old VLR cancel the record from MS and sends an anknowledgement to the HLR regarding cancellation



(1) GSM Location update:

→ Location update occurs when an MS move from one LA to another

→ Basic location update procedure handles

- Inter-LA
- Inter-MSC
- Inter-VLR.

→ Case-1: (Inter-LA):

→ MS moves from LA_1 to LA_2 when both LA are connected to same MSC

① A location update request message is sent from MS to MSC through BTS in the new location MS is identified by TMSI (temporary mobile subscription identity) which is alias of MSID

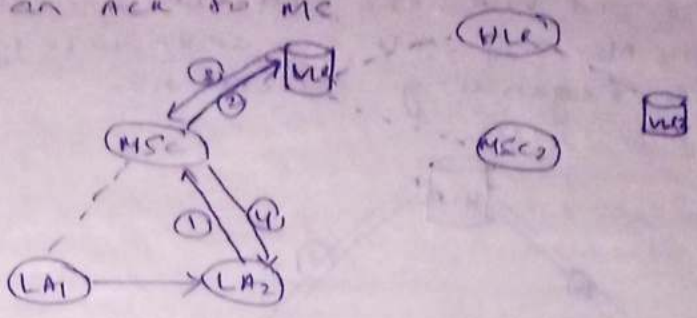
② the MSC forwards the location update request to VLR by a message

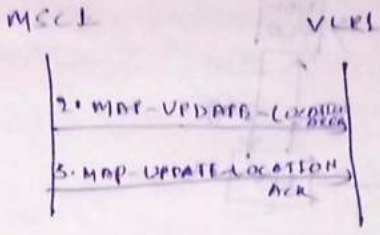
MAP-UPDATE-LOCATION-AREA

This message include

* Add of MSC
* TMSI of MSC
* Previous LAI (LA Identity)
* Target LA.

→ VLR notice that both LA1 and LA2 belong to same MSC so update the LA1 field of VLR and replies an ACK to MSC



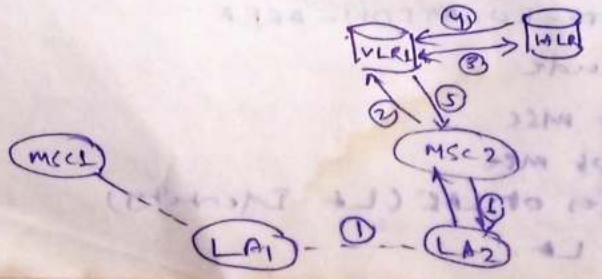


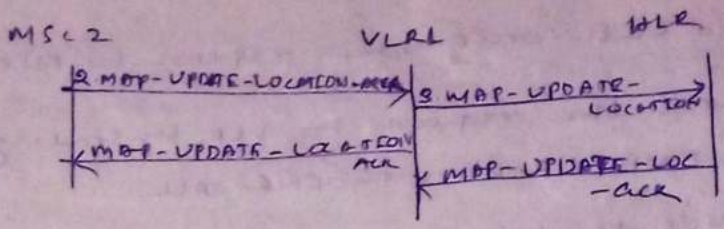
(Inter LA registration message flow)

case 2: (Inter MSC):

→ the two LAs belong to different MSCs of same VLR

1. The location update request is sent from MS to VLR.
2. The VLR notice that previous LA and target LA belong to MSC1 and MSC2. Both MSC are connected to same VLR. The VLR update LA1 and the MSC field of the VLR record and derives the HLR address of MS. The VLR send the MAP-UPDATE-LOCATION message to the HLR
3. By using the received IMSI, the HLR searches the MS's record. The MSC number field of the record is updated. An acknowledgement is sent to VLR
4. The acknowledgement is forwarded to MS



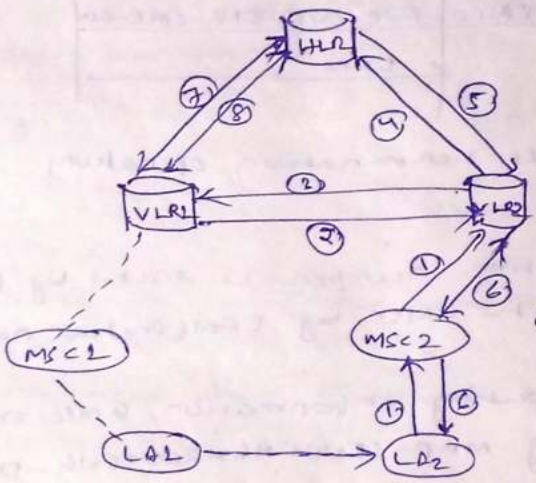


(Inter MSC registration msg flow)

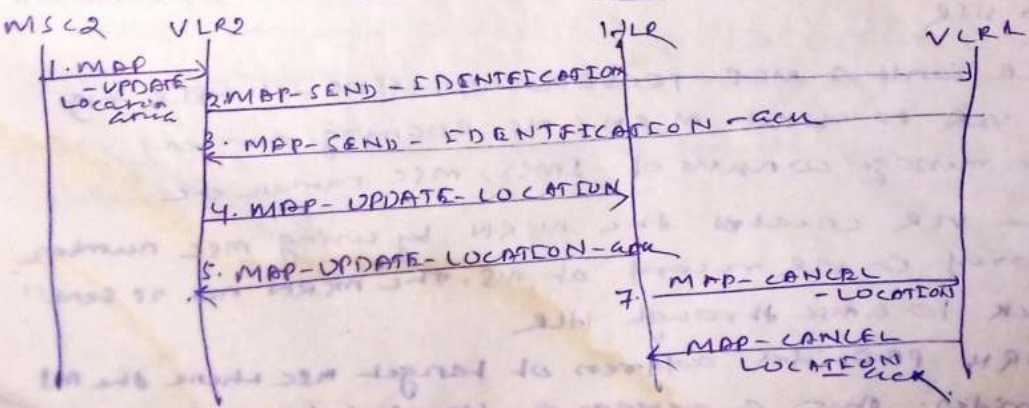
Case 3: (Inter VLR)

→ Here two LA belong to diff. VLR

1. The location update request is sent from MS to VLR.
2. From MAP-UPDATE-LOCATION-AREA msg, VLR2 identifies the previous VLR of MS i.e VLR1.
3. It send a message MAP-SEND identification to HLR. This message provides previous TMSI of MS which is used to identify MS in VLR
4. VLR2 creates a VLR record for MS and send registration message to update HLR.
5. The obsolete record of MS in VLR1 is deleted.

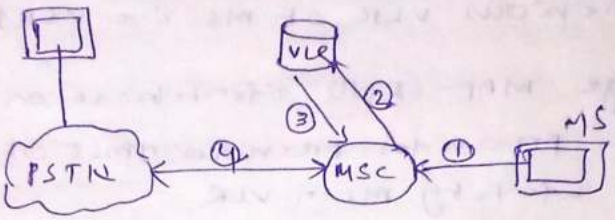


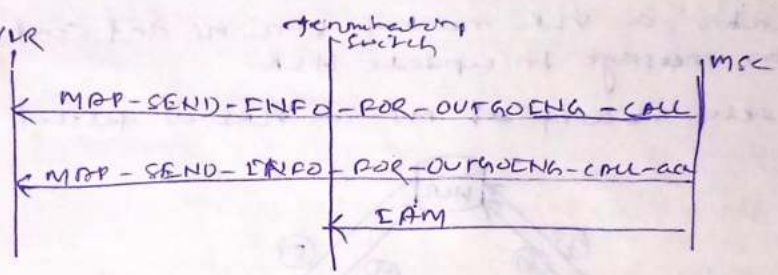
(Inter VLR registration message flow)



GSM call origination:

1. MS send the call origination request to MSC
2. MSC forwards the request to VLR by sending MAP-SEND-INFO-FOR-OUTGOING-CALL
3. VLR check MS's profile and send an ACK to MSC to grant call request
4. MSC setup communication link according to standard PSTN call setup procedure



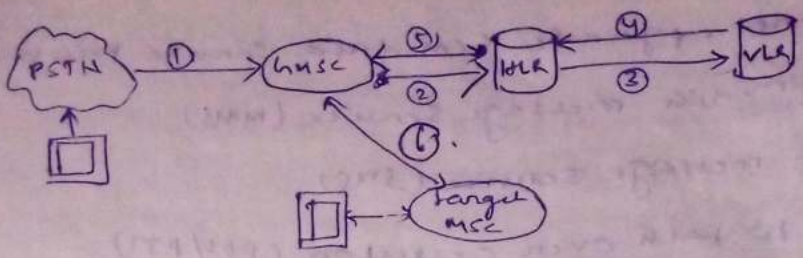


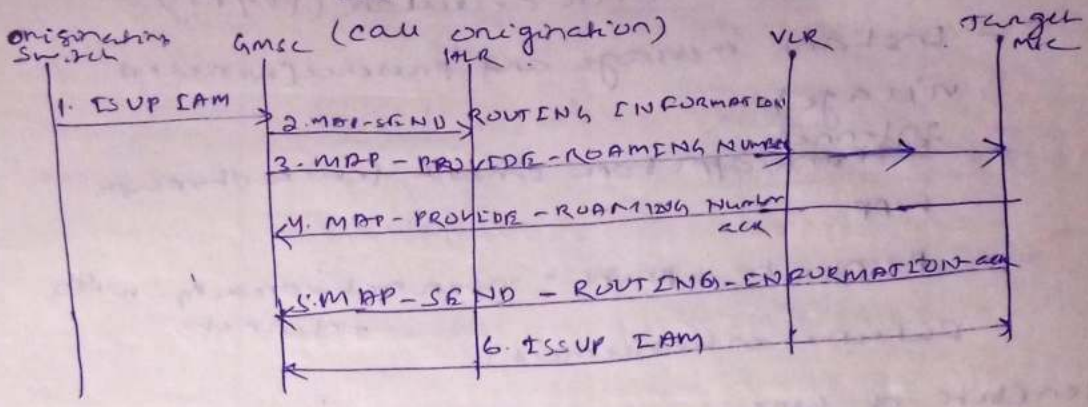
(GSM call termination operation)

Call termination

- When mobile station number is dialed by PSTN user call is routed to GMSC by IAM (Initial Address message)

1. To obtain routing information, GMSC interrogate HLR by sending MAP-SENDING-ROUTING-INFORMATION to HLR
2. HLR sends a MAP-PROVIDE-ROAMING-NUMBER msg to VLR to obtain MSRN (MS Roaming number) The message consists of IMSI, MSC number etc
3. The VLR creates the MSRN by using MSC number stored in VLR record of MS. The MSRN no. is sent back to GMSC through HLR
4. MSRN provides address of target MSC where the MS resides. Then a message is directed from GMSC to target MSC to set communication link





(call origination process)

GPRS:

→ General packet radio service is a packet oriented mobile data service available to user of the 2G cellular communication system for mobile communication

→ In 2G system GPRS provides data rate of 56-114 kbits/s

→ GPRS is a mechanism to transport high speed data over GSM

→ GPRS is a speed enhanced data transmission service design for GSM system

→ Speed enhanced data transmission take place by packetizing of data

→ GPRS standard is defined by ETSI (European Telecommunication Standard Institute)

→ GPRS is a packet oriented service for mobile data transmission

Services:

→ GPRS supports different GSM data services such as
- multimedia message service (MMS)
- short message service (SMS)
- point to point circuit (PTP)
- instant message and presence (wireless village)
- internet application for smart devices through WAP
- point to point : interworking with internet.
- Future enhancement:

Benefits of GPRS

→ High data rate

→ Use of GPRS benefits from instantaneous time and higher data rates.

→ In conventional GSM the connection set up takes several seconds and rate of data transmission may are restricted to 9.6 kb/s.

→ GPRS in practice often session establishment time below one-second.

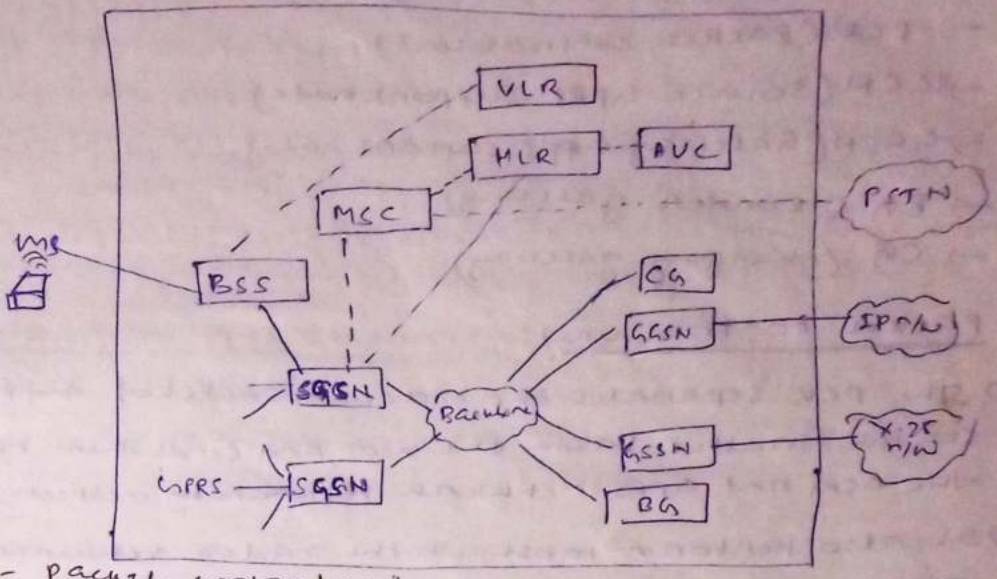
→ Easy billing:

→ GPRS packet transmission offers a more user friendly billing than that offered by circuit switched service

→ In circuit switch services billing is based on the duration of the connection

→ Again in packet switch services billing is based on the amount of transmitted data.

GPRS Architecture:



PCU - Packet control unit
CG - Charging gateway
SGSN - Service GPRS support node
GGSN - Gateway GPRS support node
BG - Border gateway

→ GPRS uses GSM architecture for voice.
→ GPRS support a class of n/w node to offer packet data
→ These nodes are called GPRS support node.
→ GPRS support node are responsible for delivery and routing of data packet betn MS and external packet data network
→ An MS having GPRS capability stores CKSN (Cipher key sequence no) similarly cipher key store in SIM and GSM
→ It also stores a TLLI (Temporary Logical Link identity) similar to TMSI
→ BSS system existing on the network node need enhancement to recognize and packet data
→ BTS also needs to be upgraded to support packet data transportation. HLR needs enhancement to register GPRS user profile and respond to queries originating from GSN.

→ The GPRS system bring some new network element to an existing GSM n/w.

→ PCU (Packet control unit)
→ SGSN (Service GPRS support node)
→ GGSN (Gateway GPRS support node)
→ BG (Border gateway)
→ CG (charging gateway)

1. Packet control unit:

→ The PCU separates the circuit switched and packet switch traffic from the user and sends them to the GSM and GPRS network ~~separately~~ respectively.
→ It also perform most of the radio resource management function of the GPRS network.
→ PCU can be ~~located~~ either located on the BTS, BSC or some other point btwn MS and MSC.
→ There will be atleast one ~~GPU~~ PCU that serves a cell in which GPRS service will be available.
→ Frame Relay technology is being used at present to interconnect the PCU to the GPRS core.

2. Service GPRS support node:

→ SGSN is the most important element of the GPRS network.
→ SGSN of the GPRS is equivalent to GSM or MSC
→ There must be atleast on SGSN in a GPRS n/w.
→ one coverage area is associated with every SGSN. As the network expands and the number of subscriber increases, there must be more than one SGSN in a network.
→ The SGSN has the following function
  → protocol conversion
  → ciphering of GPRS data btwn MS and SGSN
  → Data compression is used to minimize the size of transmitted data unit
  → Authentication of GPRS user
  → Mobility management as the subscriber move from one area to another and possibly one SGSN to another

- Routing of data to the relevent GGSN when a connection to an external network is required.
→ Interaction with the NSS (i.e MSC/VLR, HLR, EIR) via the SS7 network in order to retrieve subscription information.
→ Collection of charging data pertaining to the use of GPRS users
→ Traffic statistics collection of network management purpose

3. Gateway GPRS support Node (GGSN):

→ GGSN is the gateway to external networks. Every connection to a fixed external data network has to go through a GGSN.
→ GGSN acts as the anchor point in a GPRS data connection even when the subscribers moves to another SGSN during roaming.
→ GGSN may accept connection request from SGSN that is another PLMN. Hence the concept of coverage area does not apply to GGSN.
→ The area usually two or more GGSNs in a network for redundancy purpose and they backup each other up in case of failures.
→ The function of GGSN are
  → Routing mobile destined packet coming from external network to the relevent SGSN.
  → Routing packet originating from a mobile to the correct external network
  → Interface to external IP network and deal with security issues
  → Allocates dynamic or static IP address to mobile either by itself or with the help of at a DHCP
  → Involved in the establishment of tunnel with the SGSN.
→ GGSN is a simple a router to an IP subnetwork
→ When the GGSN receives data address to a specific user in the mobile network, it first check if the address is active.

4. Borden gateway:

→ The BG is a router that can provide a direct GPRS tunnel betn different operator GPRS network. This is called inter-PLMN data network

→ It is more secure to transfer data between two operator PLMN networks through a direct connection, rather than via the public Internet

→ The Borden gateway will commence operation once the GPRS Roaming agreement between various operator have been signed

→ It will essentially allow a roaming subscriber to connect to company intranet through the home GGSN via the visiting PLMN network

5. Charging gateway:

→ GPRS users have to be charged for the use of the network

→ In GSM network charging is based on the destination, duration and time of call

→ GPRS offer connectionless service to user, so it is not possible to charge subscriber on the connection duration

→ Charging has to be based on the volume, destination, QoS and other parameter of a connectionless data transfer.

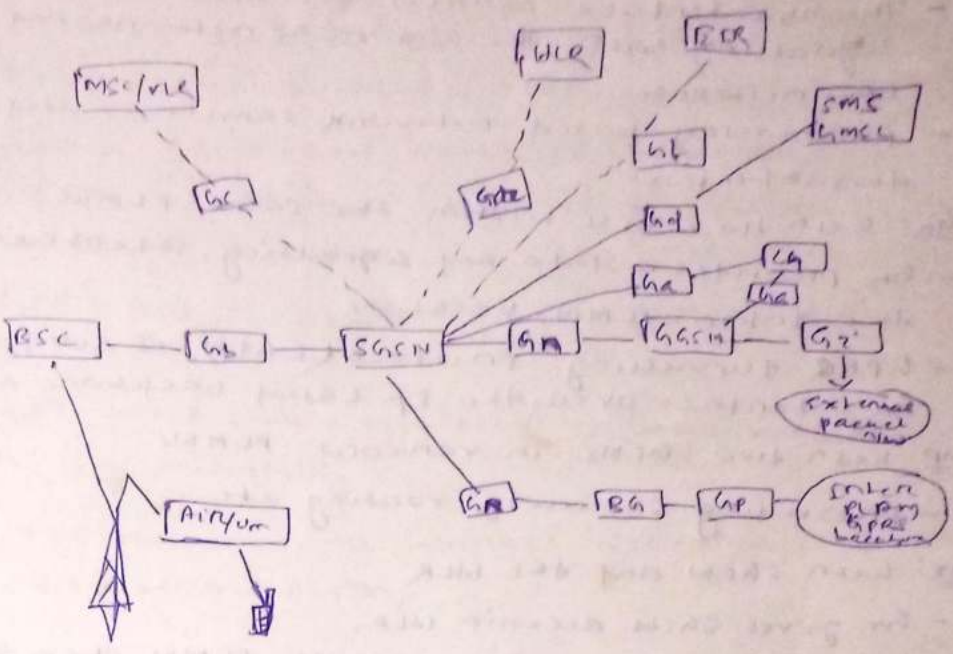
→ GPRS charging data are generated by all the SGSN and GGSN in the network. The data is called charging Data Records.

→ On data session may generate a no. of CDRs which need to be collected and processed

→ The CG collects all of those Record, sort them process it and pass it on to Billing system.

→ Here the GPRS subscriber is billed for the data transaction

GPRS Interfaces:



- Signalling and data
- ···· Signalling
- GPRS system introduces new interface to the GSM network
- Connections from the GPRS system to the NSS part of the GSM network are implemented through the SS7 network.
- GPRS element interfacing with the NSS is SGSN. The important interface to the NSS are SGSN - HLR (Gr), SGSN - EIR (Gf), and SGSN - MSC/VLR
- The other interface are implemented through the Intra-PLMN backbone network (Gn), the inter-PLMN backbone network (Gp) or the external network (Gi)

→ The interface used by the GPRS system are

Um: Between an MS and GPRS fixed network part.

- Um is the access interface the MS uses to access the GPRS network
- The radio interface to the BTS is the same as used by the existing GSM network, with some GPRS specific changes

Gb: between a SGSN and a BSS
- The Gb interface carries the GPRS traffic and signaling between the GSM radio network and the GPRS network
- Frame relay based network service is used for this interface

Gn: between two GSN within the same PLMN
- Gn provides a data and signaling interface in the Intra-PLMN backbone
- GPRS Tunneling Protocol (GTP) is used in the Gn interface over the IP based backbone network

Gp between two GSNs in various PLMNs
- providing security, routing etc.

Gr: between SGSN and the HLR
- Gr gives SGSN access to HLR.
- HLR can be located in a diff. PLMN, than the SGSN (MAP)

Ga: between ~~GSNs~~ GSNs and CG inside the same PLMN
- Ga provides a data and signalling interface
- used for sending the charging data records generated by GSNs to the CG.

Gs: between SGSN and a MSC
- SGSN can send location data to the MSC or receiving paging request from the MSC via this optional interface.
- improve the effectiveness of the radio and network resources.

Gf: between the SMS-GMSC and an SGSN and between SMS-IWMSC and an SGSN
- used for more efficient use of the SMS service (MAP)

Gf: between SGSN and EIR
- used for equipment information.

Gc: between the GGSN and HLR.
- this interface is used if the GGSN needs to know end packet to an MS that is not reachable

There are two reference points in the GPRS network.

→ Gi is GPRS specific but R is common this with the circuit switched GSM network

→ Gi between a GGSN and external network

- The GPRS network is connected to an external data network via the interface.
- The GPRS not a standard interface but merely a reference point.
- R between terminal equipment and mobile ~~predata~~ termination.
- This reference point connect terminal equipment to mobile termination,

WIRELESS LAN:

→ It is a LAN without wire.

→ Goal: is to replace obtrusive cabling to enable quicker access to internet and to high flexibility communication.

→ WLAN Application:

→ WLAN is best suited for dynamic environment the application are.

1. Cross building Interconnect:
   - → used to connect LAN in nearby building using a point-to-point wireless link
   - → using bridges and router devices.

2. Nomadic access:
   - → is a wireless link between LAN hub and a mobile data terminal equipped with an antenna such as laptop or notepad.
   - → useful in extended environment.

3. Adhoc networking:
   - → is a peer-to-peer network setup temporarily to some immediate need.
   - e.g a group of employees, each with a laptop computer, may convene in a conference room for business
   - → Link for network is done for the duration of the meeting.

WLAN requirement:

→ Throughput: MAC protocol should make as efficient use as possible of wireless medium to maximum throughput

→ No. of nodes: need to support no. of nodes across multiple cells

→ connection to backbone LAN:

→ Service area:

→ License type of operation

→ Handoff/roaming

→ Dynamic configuration

→ Battery power consumption

WLAN Advantage:

→ mobility
→ Low implementation cost
→ Installation speed
→ Network expansion
→ Reliability
→ Scalability
→ Usage of ISM band.

WLAN Technology:

1. Infrared LAN:

→ Limited to a single room, as IR light does not penetrate wall
→ 3 transmission techniques are used
   (1) Direct beam IR to create point-to-point link
   (2) Omnidirectional configuration
   (3) diffused configuration.

2. Spread Spectrum LAN:

→ make use of a multiple cell arrangement.

1. Hub technology: hub is mounted on the ceiling and connected to backbone wired LAN.

2. Peer-to-peer technology: No hub is there MAC algorithm such as CSMA is used to control access

3. Narrowband microwave:

WLAN operate at microwave frequencies but do not use spread spectrum.

Types of WLAN:

1. IEEE 802.11

→ In 1997 IEEE finalized the initial specifications for WLAN

→ Specification 2.4GHz frequency band data rate of 2Mbps

2. Hyperlan:

→ Began in Europe in 1996 by ETSI (Europ Telecom standard institute)

→ 5 GHz frequency band 24 Mbps bandwidth

3. Bluetooth:

→ Promoted by big industry leader like IBM, Ericsson Nokia

→ Was named after Harold Bluetooth

→ 1 Mbps data rate 2.4GHz band

→ Also known as PAN.

4. MANET:

→ It is a working group to investigate and develop the standard for MANET

IEEE 802.11

→ It specifies the most known family of WLANs in which many products are available.
The no. in the standard indicates it belonging to the group of 802.x LAN standard.

→ Primary goal: the specification of a simple and robust WLAN which obtains some bounded and asynchronous services

Architecture:

→ BSS (Basic service set) is the smallest building block of WLAN, which consists of some no. of station executing the same MAC protocol

→ BSS may be isolated or it may be connected to a backbone distribution system (DS) through an access point

→ The AP function as a bridge and a relay point.

→ If one station in BSS wants to communicate with another station in the same BSS, the MAC frame is first sent from originating station to the AP and from AP to destination station.

→ IBSS

→ When all the station in the BSS are mobile stations with no connection to other BSS, the BSS is called an independent (IBSS)

→ IBSS is an adhoc network

ESS (Extended service set)

→ An ESS consists of two or more basic services set interconnected by a distribution system.

→ DS is a wired backbone LAN but can be any communication network. The ESS appears as a single logical LAN to the logical link control level.

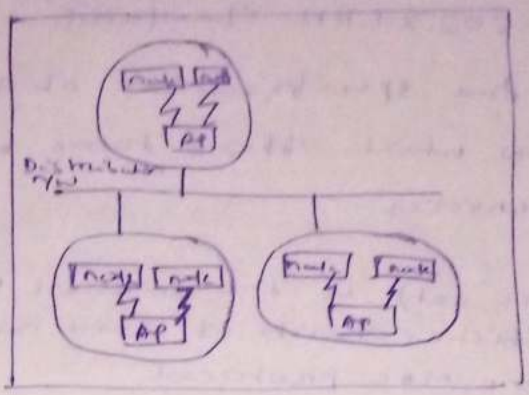
AP (Access point)

→ AP is implemented as part of a station

→ AP is the logic within a station that provides access to DS by providing DS service in addition to acting as a station.

-> WLAN come in 2 types

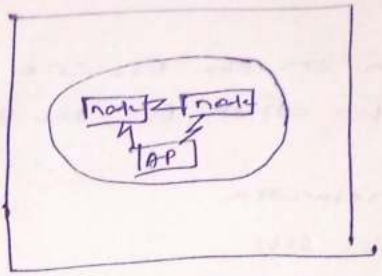
1. Infrastructure mode
2. Adhoc mode



WLAN in infrastructure mode.

-> Here MSC are connected with BS or access point
-> This is similar to star network communication takes place between wireless node and access point but not directly between wireless device.
-> Here access point acts as a bridge to other network

Adhoc mode:



- In adhoc mode there is no access point
-> A no. of MS connect can communicate directly with each other
-> nodes can communicate directly with each other physically i.e they are given each other radio range

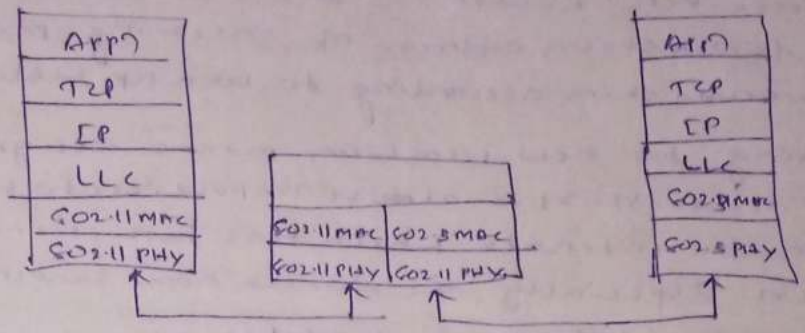
Protocol Architecture:

-> 802.11 bits into other 802-X standard for wired LAN
-> WLAN is connected to switched IEEE 802.3 ethernet via bridge.

→ Appn should not notice many any difference apart from lower bandwidth and higher access time from the wireless LAN

→ Appn layer TCP, IP are same both for the upper layer of data link control (DLC)

→ The logical link control covers the difference of the medius access control layer needed for diff. media



→ For 802.11 standard only covers physical and medius access layer

→ The physical layer is subdivided into physical layer convergence protocol (PLCP) and physical medius dependent (PMD)

→ MAC layer performs medium access fragmentation and encryption.

→ PLCP provides carrier sense signal called as CSA (clear channel assement) and provides common PHY service for access point (SAP)

→ PMD handle the modulation and encoding, decoding.

→ physical layer support 3 different transmission (infrared and two radio transmission)

→ MAC management support association and reassociation of station to an access point and roaming betn diff. access point

→ It also control authentication, encryption, and synchronization of a station with regard to an access point

Mobile IP

→ It support the mobility of host in internet.
→ Support mobility is a diff. task.

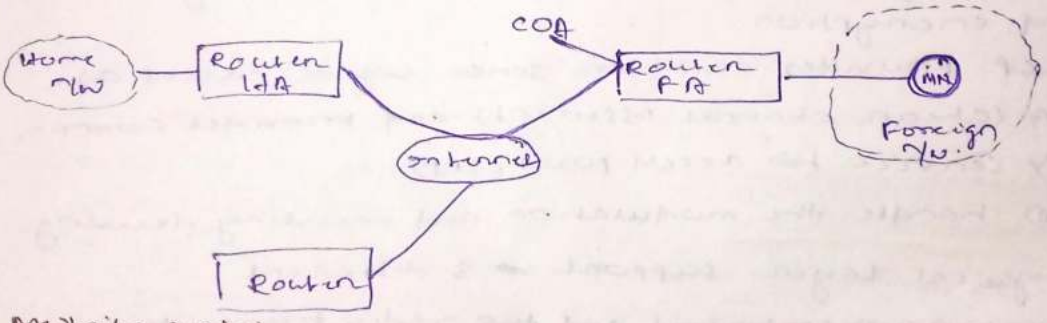
(1) A host send an IP packet with header containing a destination address and other field. the destination address not only determines the receiver of the packet but also physical subnet of the receiver. Router in the internet look at the destination address of incoming packets and forwarded them according to look up table.

(2) Moving to new location means assigning of new address. It is almost impossible to keep a host on the internet which has just changed its address. Especially the domain name service needs sometime before it updates its internal tables.

(3) Router are built for extremely fast forwarding but not for fast update of routing table.

Example of mobile IP:

The following defines several entities and terms need to understand mobile IP.



Mobile node:

→ A mobile node is an end system or Router that can change its point of attachment to the internet using mobile IP.
→ The MN keeps its IP address and can continuously communicate with any other system on the internet as long as the link layer connectivity is given
→ MNs are not necessarily small devices such as laptop with antenna or mobile phone.

Corresponding node:

A host that is needed for communication. Here CN represent that partner host MN. The CN can be a fixed or mobile node.

Home network:

- The network is the subnet the MN belongs to w.r.t its IP address
- No mobile IP support is needed within the home network.

Foreign network:

- It is the current subnet the MN visits and which is not the home network

Foreign Agent:

- FA can provides several services to the MN during its visit to the foreign network.
- FA can have the COA acting as tunnel endpoint and forwarding packets to MN
- FA can be the default router for the MN
- FA can also provide security services because they belong to the foreign network as opposed to the MN which is only visiting
- FA mobile IP functioning, FA are not necessarily needed. Typically an FA is implemented on a router for the subnet the MN attached to

Care of address (COA)

-> It defines the current location of the MN from an IP point of view.

-> All IP packets sent to the MN are delivered to the COA not directly to the IP address of the MN.

-> Packet delivery towards the MN is done using a tunnel.

-> COA marks the tunnel endpoint, i.e the address where packet exit the tunnel.

-> There are diff. possibilities for the location of the COA

1. Foreign agent COA:

-) The COA could be located at the FA i.e the COA is an IP address of the FA

-) The FA is the tunnel end point and forwarded packet to the MN. Many MN using the FA can share this COA as common COA

2. Co-located COA:

-) COA is located at the MN temporarily acquire an additional IP address which acts as COA.

-) This address is now topologically correct and the tunnel endpoint is at the MH.

-) Co-located addresses can be acquired using services such as DHCP.

-) Problem associated is: need for additional addresses if MNs request a COA

Home agent:

-) HA provides several services for the MN and is located on the home network.

-) Tunnel for packet towards the MN starts at the HA

-) HA maintains a location register in which it is informed of the MN location by the current COA

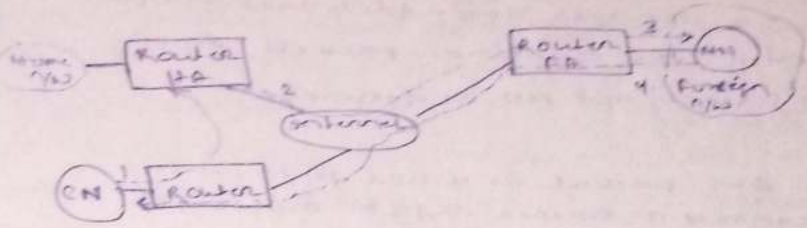
-) Three alternatives for the implementation of an HA exists.

1. HA can be implemented on a router that is responsible for the home network

2. HA can also be implemented on an arbitrary node in the subnet. One disadvantage of this solution is the double crossing of the router by the packet if MN is in a foreign network

3. HA could be a agent on the router but this time only acting as a manager for MN. belonging to a virtual home network

IP - packet delivery:



A mobile node is an end system or router that can change its point of attachment to internet using mobile IP

- The partner to MN for communication is called correspondent node
- The home network is the subnet to which the MN belongs to with respect to its IP address
- Foreign network is the current network to the MN visits

Packet delivery steps:

Step-1: A CN want to send an IP packet to the MN. Mobile IP has to support hiding the mobility of the MN.

→ So CN doesn't let to know anything about MN's location. It sends the packet as usual to the IP address.

Step-2: The packet router routes the packet to the router responsible for the home network of MN

- The HA gets the information that MN is not present in its home network
- Then the packet is not forwarded into the subnet as usual
- An extra header is added to the packet containing the address of new network. The process is called encapsulation
- Then the packet moves to the foreign network showing; the COA as new destination.

Step-3: the foreign agent now decapsulates the packet i.e removes the additional header and forwarded the original packet to MN with CN as source and MN as destination

Step-4:

- MN sends the packet as usual with its own fixed IP address as source and CN address as destination
- the router with the FA acts as default router and forwards the packet in the same way as it would do for any other node in the foreign nw.