Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.

2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given more importance (Not applicable for subject English and Communication Skills.

4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.

5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.

6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.

7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1 A Attempt any THREE of the following : 12M

i) Describe a micro cell zone concept.

(Diagram -2Marks Explanation -2Marks)

Ans:

When sectoring is employed, lot of handoffs is required due to this load on switching and control link element of the mobile system increases.

- To solve this problem, a microcell concept for seven cell reuse is used.
- In this scheme, each of three (possibly more) zone sites are connected to single base station. The zone are connected by a co-axial, fiber optic cable or microwave link to a base stations.

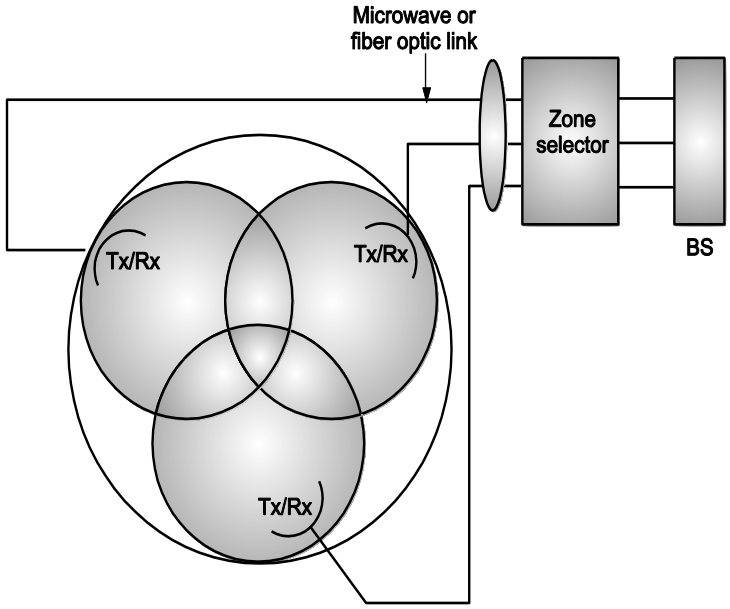


Fig.: The Microcell concept, BS - Base station

Multiple zones and single station make a cell. As mobile travels within a cell, it served by zone with strong signal, this approach is advantageous because of sectoring placed antenna at outer edges of cell, and base station channel is assigned to any zone by the base station.

• As mobile moves from one zone to another zone in same cell, it uses same channel, thus like a sectoring, handoff is not required at mobile switching centre (MSC) when mobile travels within the cell in different zone.

• The base station simply changes the channel from one zone to another zone, and channel is active in particular zone in which mobile is travelling, hence interference is reduced.

- The advantage of zone cell technique is that, cell maintains particular area of coverage; the co-channel interference in cellular system is reduced, as larger control base station is replaced by zone transmitter on edge of cell.

ii) List and describe briefly GSM channel type.
(List 2Marks, Relevant Explanation -2Marks)
Ans:

There are mainly two types of GSM logical channels.

(i) Traffic channels (TCHs).

(ii) Control channels (CCHs).

Traffic channels carry digitally encoded user voice or user data and have identical formats of both forward link and reverse link.

Control channels carry signal and synchronization commands between the base station and mobile station. Other control channels are used only for forward and reverse link.

GSM traffic channel carry digital voice and user data either at half rate or at full rate.

Full Rate Traffic Channels (TCH):

(i) Full-rate speech channel (TCH/FS): This channel carries user speech in digitized form at a raw data rate of 13 kbps. GSM channel coding is added to digitized speech then the full rate speech channel carries 22.8 kbps.

(ii) Full-rate data channel for 9600 bps (TCH/F9.6): This channel carries raw user data which is transfers at 9600 bps with additional forward error correction applied by GSM, the 9600 bps data sent at 22.8 kbps.

(iii) Full-rate data channels for 4800 bps (TCH/F4.8): This channel carries raw user data which is transferred at 4800 bps with additional forward error correction applied by GSM, the 4800 bps is sent at 22.8 kbps.

(iv) Full rate data channel for 2400 bps (TCH/F2.4): This channel carries raw user data which is transferred at 2400 bps with additional forward error correction coding by GSM, the 2400 bps is sent at 22.8 bps.

Half-rate Traffic Channels:

(i) Half-rate speech channel (TCH/HS): This channel carries digitized speech which is sampled at a half rate then the full rate GSM channel coding added to digitized speech and half rate speech channel carry 11.4 kbps.

(ii) Half-rate data channels for 4800 bps (TCH/H4.8): This channel carries raw user data which is to be transferred at 4800 bps. With additional forward error correction applied by GSM, the 4800 bps data sent at 11.4 kbps.

(iii) Half-rate data channels for 2400 bps (TCH/H2.4): This channel carries raw user data which is to be transferred at 2400 bps with additional forward error correction by the GSM, the 2400 bps data sent at 11.4 kbps.

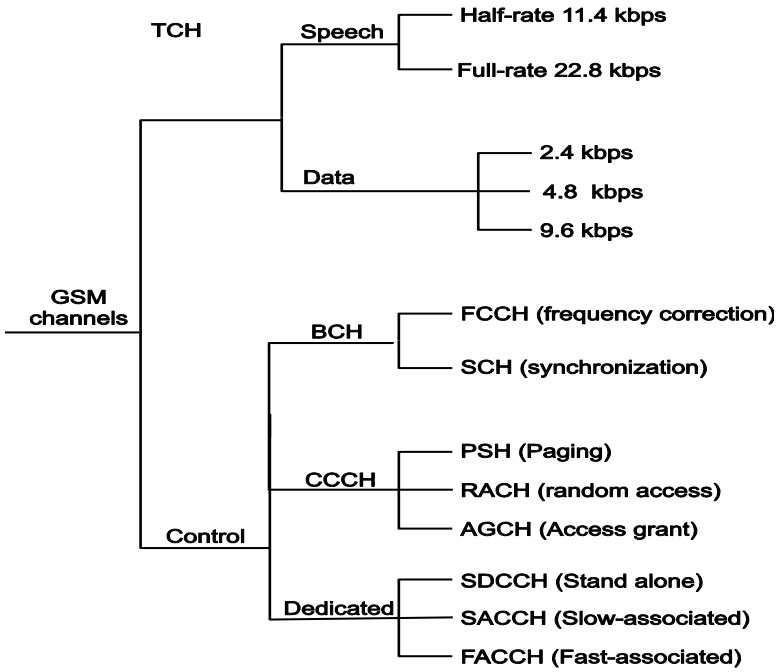


Fig. GSM Channels

GSM Control Channels (CCH):

There are three control channels in GSM:

1. Broadcast control channels.
2. Common control channels.
3. Dedicated control channels.

1. Broadcast control channels (BCH) :

The BTS uses this channel to give information to all MSs within a cell. Information uses by this channel is cell and network identity, current control channel structure, channel availability and congestion. The broadcast control channel also sends the list of channels that are currently used within cell.

2. Common Control Channels (CCCH):

All the information regarding setting up a connection between MS and BS is exchanged via the CCCH. The common control channel occupies TSO (framo) of GSM frame and that is not used by BCH and ideal channels.

3. Dedicated Control Channels (DCCH):

. They have same format and function on both forward and reverse links.

iii) Describe mobility management.

(Relevant explanation 4Marks)

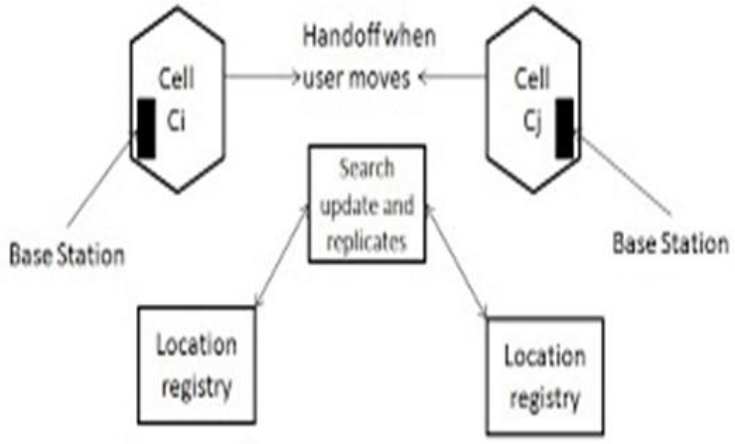
Ans:

Mobility management is nothing but the technique in which uninterrupted signal connectivity is maintained, when a mobile device changes location from cell Ci to Cj or from network Ni to network Nj .

Following are the two important points to ensure constant connectivity:

1. Infrastructure management that connects two or more cells or networks.
2. Location management and registration management by handoff when mobile devices move from one cell to another cell.

The technique of mobility management is as shown in following diagram:



Mobility Management is one of the major functionality of a GSM or a UMTS network. Mobile devices inform the cellular network, whenever it moves from one location area to another. Mobile devices detects the location area codes. When a mobile finds that the location area code is different from its last update, it performs another update by sending to the network, a location update request, together with its previous location, and its Temporary Mobile Subscriber Identity (TMSI) as well. Thus a subscriber enjoys an uninterrupted access to the network. Roaming is the fundamental mobility management procedures of all cellular networks. Roaming is referred as the ability for a customer to automatically make and receive voice calls, send and receive data, or access other services, including home data services, when travelling outside the geographical coverage area of the home network, by means of using a visited network. This can be possible by using a communication terminal. Roaming is always technically supported by mobility management, authentication, authorization as well as billing procedures.

iv) Explain types of attacks in details.

(Relevant explanation (any four attacks) 4Marks)

Ans:

Attacks: A security system is a system to defend our assets from attacks. In the physical world, these attacks are carried out at the weak points in the defence system. When the vulnerability is exploited by some interest or selfish motive, it is an attack on the system.

Attacks on dynamic asset can be of the following types:

1. **Interception**: An unauthorized party gaining access to an asset will be part of this attack. This is an attack on Confidentiality like unauthorized copying of files or tapping a conversation between parties.
2. **Modification**: An unauthorized party gaining control of an asset and tampering with it is part of this attack. This is an attack on integrity like changing the content of a message being transmitted through the network.
3. **Fabrication**: An unauthorized party inserts counterfeited objects into the system.
4. **Interruption**: An asset is destroyed or made unusable. This is an attack on availability

Attacks on static assets can be of the following types.

Virus and worms: There are a type of program that replicates and propagates from one system to another.

5. Denial of Service: These are attacks on the system to prevent legitimate users from using the using.

6. Intrusion: these are people or software, which enter into computer systems and perform function without the knowledge of the owner of the asset.

7. Replay Attack: In a replay attack the opponent passively captures the data without trying to analyze the content. At a later time, the same is used in the same sequence to impersonate an event and gain unauthorized access to resource.

8.**Buffer Overflow attack**: In buffer overflow attack, the vulnerability of an executable program is exploitable.

9.**Trapdoor attacks**: These are exploitations of some undocumented features of a system.

Q.1B Attempt any ONE of the following **6M**

i) Write call cancellation algorithm of VLR overflow.

(Diagram 2Marks, Explanation 4Marks)

Ans:

Call termination

Step 1: Location query

Step 1.1: The calling party dials the phone number of u_1, the request is send to call originating switch to PSTN.

Step 1.2: The originating switch sends the location query message to HLR.

Step 1.3: The HLR determines that u_1 is an overflow user and send a query message to obtain its routing information. The user profile information is attached in this message.

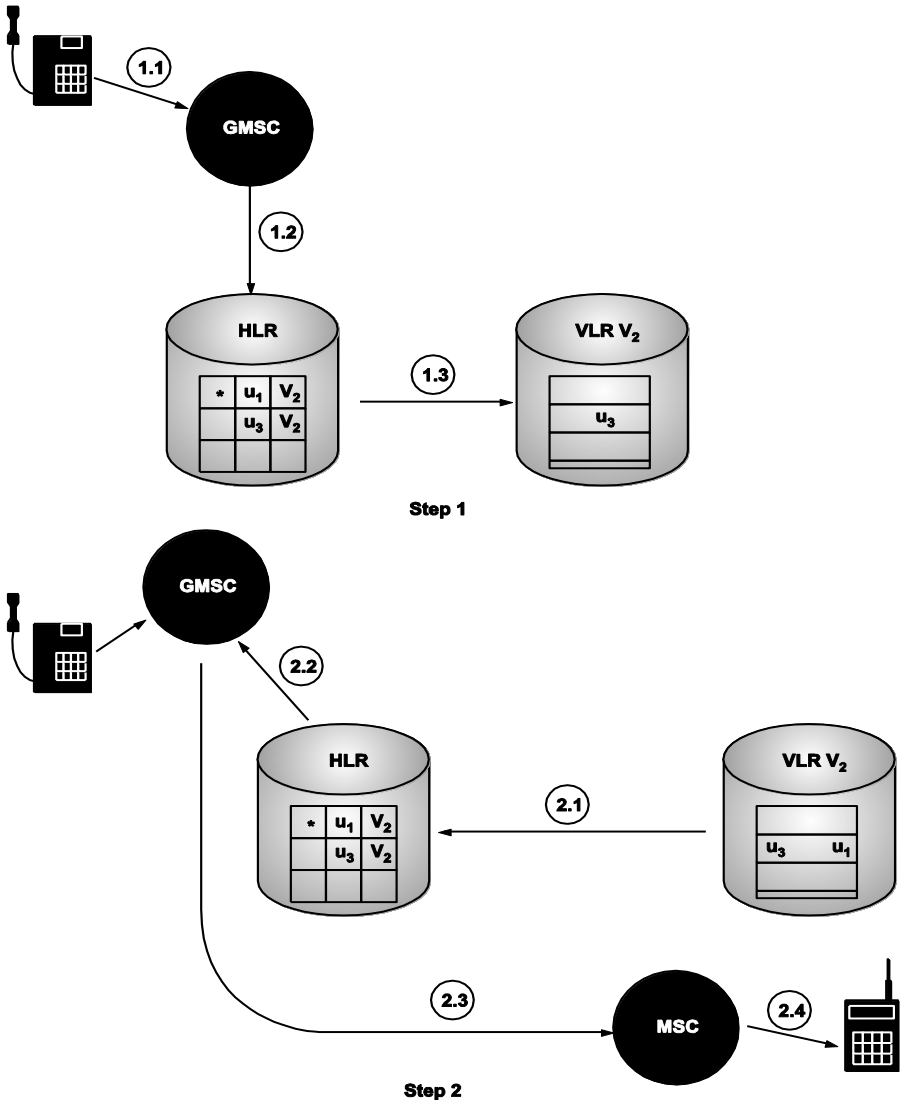
Step 2: Location Response

Step 2.1: If V is not full, a record for u_1 is created. If V is full, a user record is deleted and is used to store u_1's record. V creates routable address of u_1 and send back to HLR, if the VLR record is not available, then refer the detail of routable address. If the record is replaced (u_3 as shown in Fig.), the replacement information is included in the message.

Step 2.2: The HLR returns the routable address to the originating switch. If the record is replaced, the overflow flag are updated in HLR (for u_1 and u_3 as shown in Fig.).

Step 2.3: The originating switch set up the trunk to the MSC based on routable address.

Step 2.4: The MSC pages the mobile phone and the path for the call is established.



Call termination with overflow VLR

ii) Describe Android Life-cycle activity.

(Diagram 2 Marks, Explanation 4 Marks)

In Android, there is one foreground application, which typically takes over the whole display except for the status line.

- When the user runs an application, Android starts it and brings it to the foreground. From that application, the user might invoke another application, or another screen in the same application, and then another and another.

- All these programs and screens are recorded on the *application stack* by the system's Activity Manager. At any time, the user can press the Back button to return to the previous screen on the stack. From the user's point of view, it works a lot like the history in a web browser. Pressing Back returns them to the previous page.
- Internally, each user interface screen is represented by an Activity class. Each activity has its own life cycle. An application is one or more activities plus a Linux process to contain them.
- In Android, an application can be "alive" even if its process has been killed.
- Put another way, the activity life cycle is not tied to the process life cycle.
- During its lifetime, each activity of an Android program can be in one of several states, as shown in

  Let us see commands used in this life cycle taking activity in different states:

- **onCreate(Bundle):** This is called when the activity first starts up. You can use it to perform one-time initialization such as creating the user interface.

- **onStart():** This indicates the activity is about to be displayed to the user.

- **onResume():** This is called when your activity can start interacting with the user. This is a good place to start animations and music.

- **onPause():** This runs when the activity is about to go into the background, usually because another activity has been launched in front of it.

- **onStop():** This is called when your activity is no longer visible to the user and it won't be needed for a while. If memory is tight, onStop() may never be called the system may simply terminate your process.

- **onRestart():** If this method is called, it indicates your activity is being redisplayed to the user from a stopped state.

- **onDestroy():** This is called right before your activity is destroyed. If memory is tight, onDestroy() may never be called, the system may simply terminate your process.

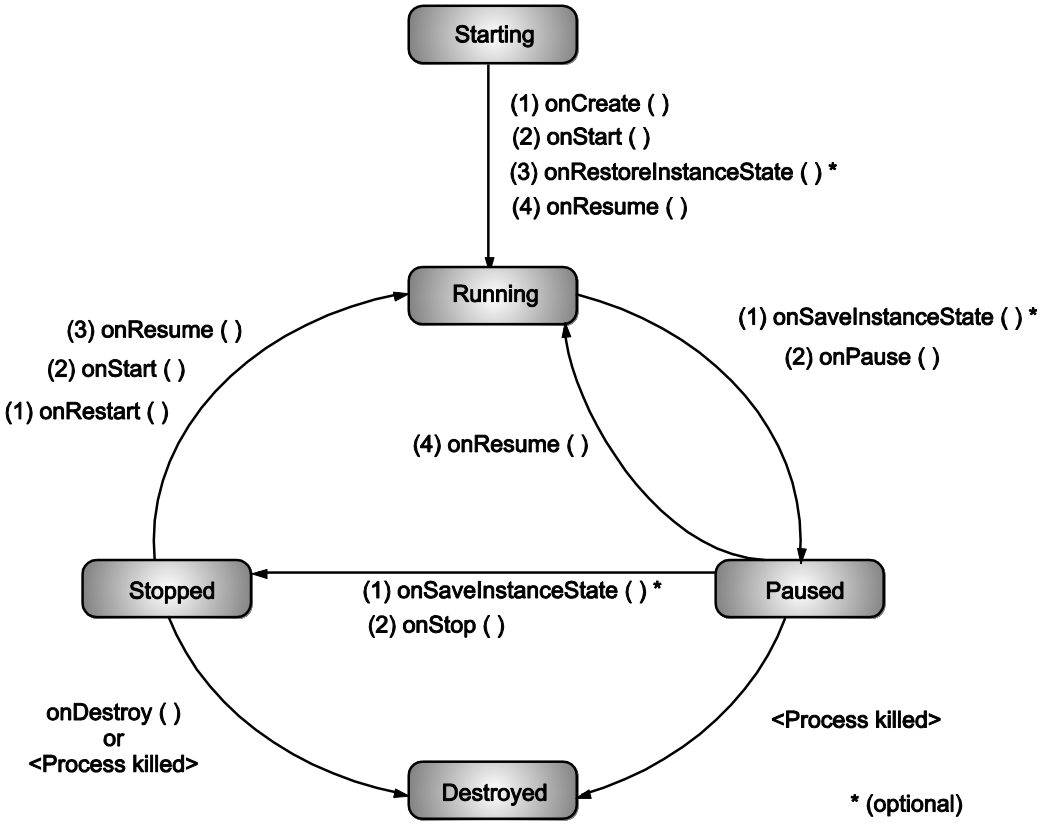


Fig.: Life cycle of an Android activity

- **onSaveInstanceState(Bundle):** Android will call this method to allow the activity to save per-instance state, such as a cursor position within a text field.
- **onRestoreInstanceState(Bundle):** This is called when the activity is being reinitialized from a state previously saved by the onSaveInstanceState() method.

Q.2 Attempt any FOUR of the following : 16M

a) Describe channel assignment strategies.

(Each type Explanation -2 Marks)

Ans:

Types of Channel Assignment strategies:

Fixed channel assignment

Dynamic channel assignment

1. Fixed channel assignment

- Each cell is allocated a predetermined set of voice channel
- Any new call attempt can only be served by the unused channels in the cell.
- The call will be blocked if all channels in that cell are occupied
- Borrowing strategy is a type of fixed channel assignment strategy.
- In this the cell is allowed to borrow channels from neighboring cell if all of its own channels are already occupied.
- The MSC (Mobile switching center) supervises such borrowing procedures and ensures that borrowing of a channel does not disrupt or interfere with any of the calls in progress in the donor cell

2. Dynamic channel assignment

- Channels are not allocated to cells permanently.
- Mobile Switching center (MSC) allocates channels based on request.
- Reduce the likelihood of blocking, increase capacity.
- This requires the MSC to collect real time data on channel occupancy, traffic distribution & Radio Signal strength Indications (RSSI) of all channels on a continuous basis.

b) Draw and describe handoff strategies.

(Diagram 2Marks, Explanation 2Marks)

Ans:

When a user is moving from one cell to another cell, while the call is in progress, is called as handoff.

While performing handoff, mobile station acquires a channel from one base station, how mobile station moves from one cell to another cell, how mobile station requires that base station in new cell will allocate channel to mobile station. If the channel is not available in new cell then the handoff call is blocked.

This type of blocking is known as "handoff blocking". Handoff blocking can be done due to mobility of the user.

New call and handoff call is illustrated in Fig. 1.10. A person is in network 1, in one of the cell called 'd', may move to cell 'C' thus, it perform handoff call within network 1.

A person can also move from one network to another network, for example, a person is moving from cell 'd' of network 1 to cell 'b' of network 2.

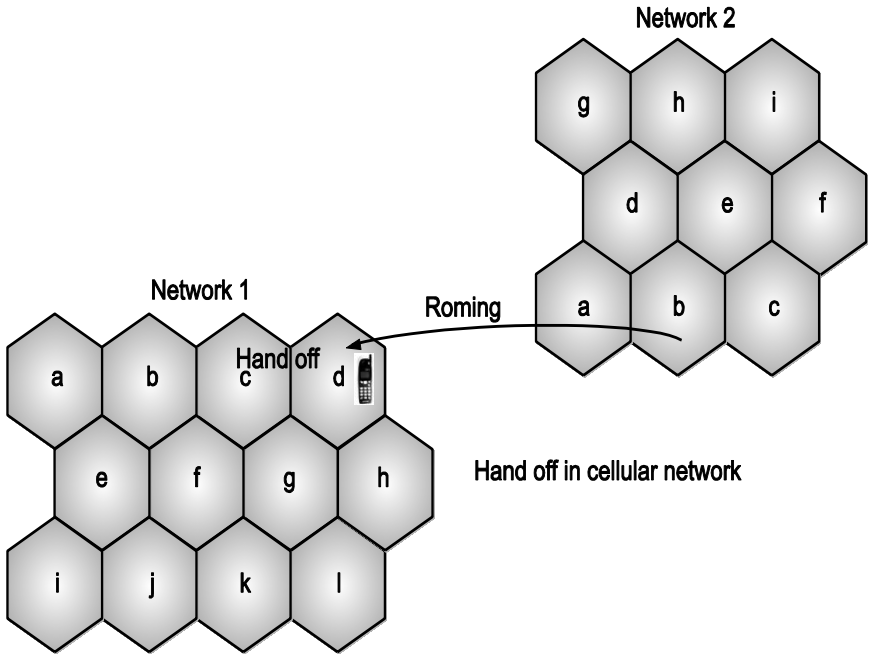


Fig.: Handoff in cellular network

The quality of services (QoS) of cellular network is determined by new call and handoff blocking probability. First, to determining fraction of new call that are blocked and second fraction of admitted call that are terminated permanently due to dropout.

Call blocking can be reduced by increasing capacity of cellular network in terms of reducing the size of cell and increasing the number of channels in each cell.

c) List and describe GSM services.

(List 1Mark, Explanation 3Marks)

Ans:

In GSM terminology, telecommunication services are divided into three broad categories:

List of GSM Service:

- **Bearer services**
- **Tele services**
- **Supplementary Services**

- **Bearer services** are also called as Data services. These are telecommunication services providing the capability of transmission of signals between access points [the user-network interfaces (UNIs) in ISDN]. For instance, synchronous dedicated packet data access is a bearer service.
- **Teleservices are telecommunication services** providing the complete capability, including terminal equipment functions, for communication between users according to protocols established by agreement between network operators.
- **Supplementary Services**.

  In addition to these services, supplementary services are defined that modify or supplement a basic telecommunication service. Supplementary services include several forms of call forward (such as call forwarding when the mobile subscriber is unreachable by the network), caller identification, call waiting, multiparty conversations, charging information, and call barring of outgoing or incoming calls. These call-barring features can be used for example when roaming in another country, if the user wants to limit the communication fees.

d) Explain HLR failure restoration method.

(Diagram 2 Marks, Explanation 2 Marks)

Ans:

HLR Failure Restoration:

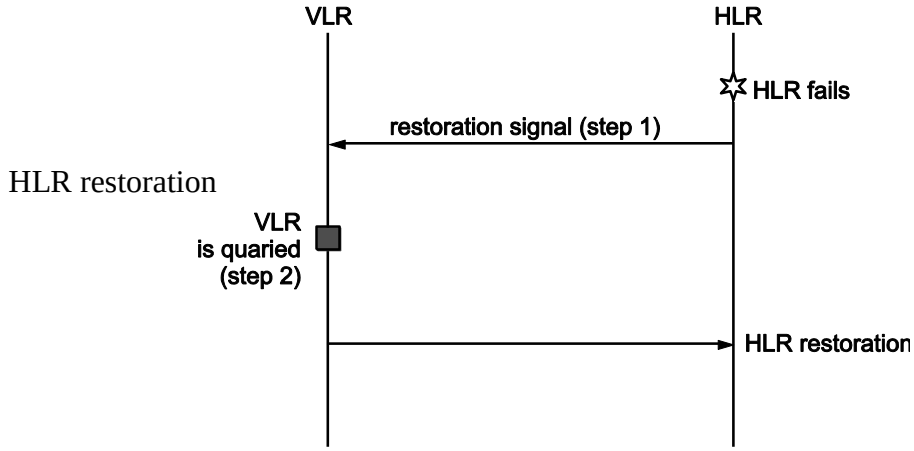
In GSM HLR, it is compulsory to save the update into non-volatile storage. Changes of service information are backup immediately after every update and the location information is periodically transferred from HLR into backup. The service information is update infrequently because not all the subscriber changes their service profile after subscription.

After HLR failure, the data in the backup are reloaded into the HLR. We also have "uncovered period" as a time interval after last backup operation and before the restart of the HLR data that changed in the uncover period cannot be recovered. The following HLR restoration procedure is executed.

Step 1: The HLR sends an signaling system 7 (SS7) TCAP (Transaction Capability Application Part) message. MAP_RESET to the all VLRs where its MSs are located (that is restoration signal).

Step 2: Each VLR that receives the restoration signal from HLR is queried to search the lost location information of user.

Step 3: All the VLRs derived all MSs of the HLR, and for each MS, they send an SS7 TCAP message, MAP_UPDATE LOCATION, to the HLR.



e) List and describe briefly data services in GPRS.

(List 1Mark, Explanation 3Marks)

Ans:

Wide range of corporate and consumer applications are enable by GPRS services. GPRS Service include all normal GSM services but in more efficient way. It also support services like

- Email
- Web browsing
- Enhanced short message
- Wireless imaging with instant picture
- Video service
- Document and information sharing

A user is likely to use either of the two modes of the GPRS network. These are

1. Application mode
2. Tunneling mode

1. Application Mode

- In this mode the user will be using the GPRS mobile phone to access the application running on the phone itself.
- The phone here acts as the end user devices.
- All GPRS phone have web browser as embedded application.
- This browser allows browsing of web sites.

- Some GPRS device support mobile execution environment.

2. Tunneling Mode

- This mode is for mobile computing where the user will use the GPRS interface as an access to the network.
- The end user device will be a large footprint device like laptop computer or small footprint device like PDA's.
- The MS will be connected to the device and used as a modem to access the wireless data network.

Or

At higher speeds GPRS is designed to provide packet-data Services at higher speeds than those available with standard GSM circuit switched data services. In theory GPRS could provide speeds of upto 171 kbps over the air interface, although such speeds are never achieved in practical network. In fact, the practical maximum speed is a little over 100 kbps.

• GPRS speeds are far greater than the 9.6 kbps maximum provided by standard GSM. The greater speeds provided by GPRS are achieved over the same basic air interface (i.e., the same 200 kHz channel, divided into eight time slots). With GPRS, the mobile station (MS) can have access to more than one time slots. Moreover the channel coding for GPRS is somewhat different from that for GSM. In fact, GPRS defines a number of different channel coding schemes, the most commonly used coding scheme for packet-data transfer is Coding Scheme 2 (CS-2), which enables a given time slot in carry data at a rate of13.4 kbps. If a single user has access to multiple time slots, then speeds such as 40.2 or 53.6 kbps become available to that user. Table 4.2 lists the various coding schemes available and the associated data rates for single time slot.

Table 4.2: Coding scheme with data rates

Coding Scheme	Air-interface Data Rate (kbps)	Approximate Usable Data Rate (kbps)
CS-1	9.05	6.8
CS-2	13.4	10.4
CS-3	15.6	11.7
CS-4	21.4	16.0

- The air-interface rates are given in Table 4.2. The transmission of data in GPRS involves a number of layers above the air interface, with each layer adding certain amount of overhead, the amount of overhead generated by each layer depends on a number of factors, such as the size of the application packed to be transmitted for a given amount of data to be transmitted, smaller application packet sizes cause a greater net overhead than larger packet sizes. The result is that the rate for usable data is approximately 20 to 30 percent less than the air-interface rate.
- The most commonly used coding scheme for user data is CS-2. This scheme provides error correction over the air interface. Although CS-3 and CS-4 provide higher throughput, they are more susceptible to errors on the air interface. In fact, CS-4 provides no error correction at all on the air interface.

f) List the components of Information Security and state features of each.

(List-1Mark, Features 3marks)

Ans:

Information security is an art of keeping the message secret i.e. to encrypt and hide it from others getting to know it. The components are: (CIANATA)

1. Confidentiality
2. Integrity
3. Availability
4. Non-repudiation
6. Authorization
7. Trust
8. Accounting

1. Confidentiality:

It is the property where the information is kept secret so that unauthorized persons cannot get at the information. It is ensured through Encryption of data.

2. Integrity:

Integrity is achieved by adding additional information into a message. It is done though checksums, message digests or digital signature. The receiver of the message checks this extra information to verify whether the message has been tampered.

3. Authentication:

It is a process by which we validate the identity of the parties involved in a transaction.

4. Non-repudiation:

In non-repudiation, we identify these parties beyond any point of doubt. Non repudiation does not allow the sender of the message to refute the claim of not sending that message.

5. Availability

Media Management is part of the larger security framework. It is essential to ensure availability of service.

6. Trust

Trust involves developing a security policy, assigning credentials to entities, verifying that the credentials fulfill the policies.

7. Accounting

It is the process by which usage of service is metered. Based on the usage, the services provider collects the fees either directly from the customer or through home network. This will be true even if the user is roaming in a foreign network and using the services in a foreign network.

Q.3 Attempt any FOUR of the following: 16M

a) Describe cell splitting and sectoring for improvement of coverage area.

(Cell splitting Explanation 1Mark, diagram 1Mark, Cell sectoring Explanation 1 Mark, diagram 1Mark)

Ans:

Methods for improving coverage area in cellular systems

Cell Splitting:

It is the process of subdividing a congested cell into smaller cells, each with its own base station and a corresponding reduction in antenna height and transmitter power. Cell splitting increase the capacity of the cellular system since it increases the number of times that channels are reused. By defining new cells which have a smaller radius than the original cells and by installing these smaller cells (microcells) between the existing cell, capacity increases due to additional channels/ unit area. An example of cell splitting is shown below the base station are placed in corners of the cells, and area served by base station A is assumed to be saturated with traffic. New base stations are therefore needed in the region to increases the number of channels in the area and to reduce the area served by the single base station.

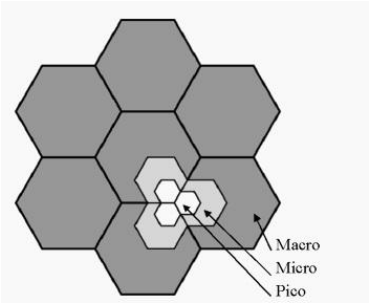


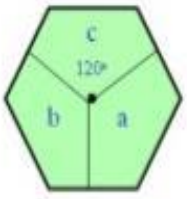
Fig: Cell Splitting

Cell Sectoring:

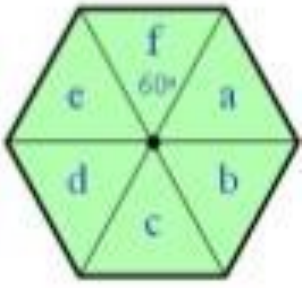
It is a method to increase capacity is to keep the cell radius unchanged and seek methods to decrease D/R ratio. Sectoring increases SIR, so that the cluster size may be reduced. First the SIR is improved using directional antennas, then capacity improvement is achieved by reducing the number of cell in the cluster; thus increasing the frequency reuse. To achieve this, it is necessary to reduce the relative interference without decreasing the transmit power.

There are two types of sectoring in a cell

1. **3 Sectors 120^o each**



2. **6 Sectors 60^0 each**



b) Explain GSM frame structure with neat diagram.

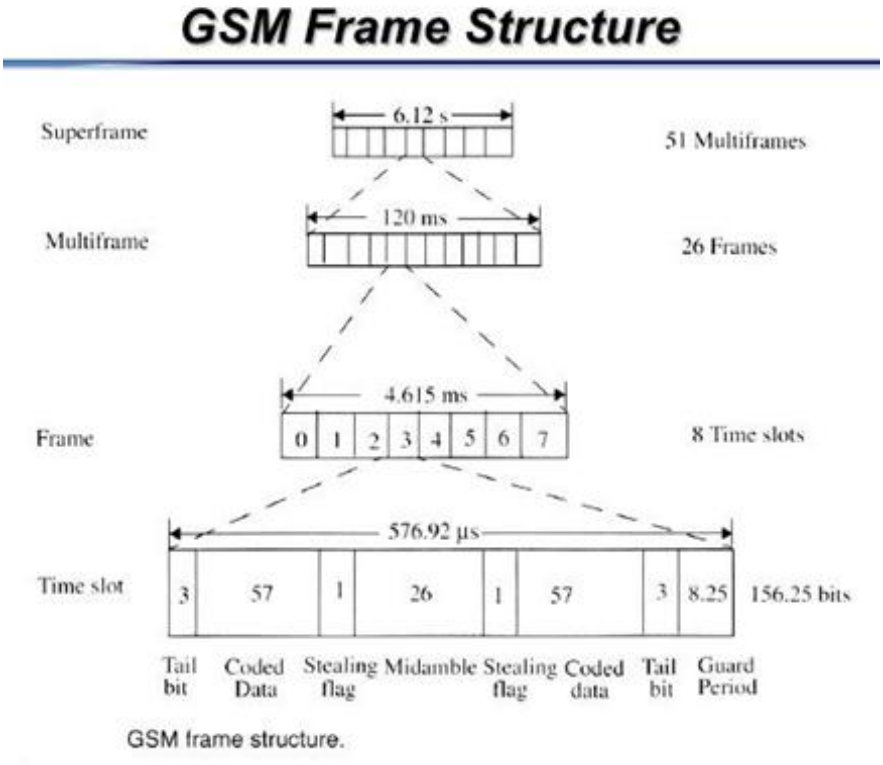
(Explanation 2Marks, diagram 2Marks)

Ans:

Frame structure in GSM:

• The length of GSM frame in a frequency channel is 4.615 ms.

• The frame is divided into 8 bursts of length of 0.577ms
• The timeslots in the uplink are derived from downlink by a time delay of 3 time slots
• This arrangement prevents an MS from transmitting and receiving at the same time
• However, due to propagation delay (when MS is far away from BTS) the 3 TS delay cannot be maintained accurately



GSM frame structure.

GSM Burst structure

• Each burst contains 148 bits (0.546ms) followed by 0.031ms guard time (8.25bits)
• The burst begins with 3 head bits and 3 tail bits (logical Zeroes)
• Two groups are data bits are separated by an equalizer Training sequence of 26 bits
• Each data group consists of 57 bit information bits and 1 flag that indicate whether the information bits are for user speech/ data or signaling.

c) Describe GSM location updates inter LA movement.

(Diagram: 2Marks, Steps 2Marks)

Ans:

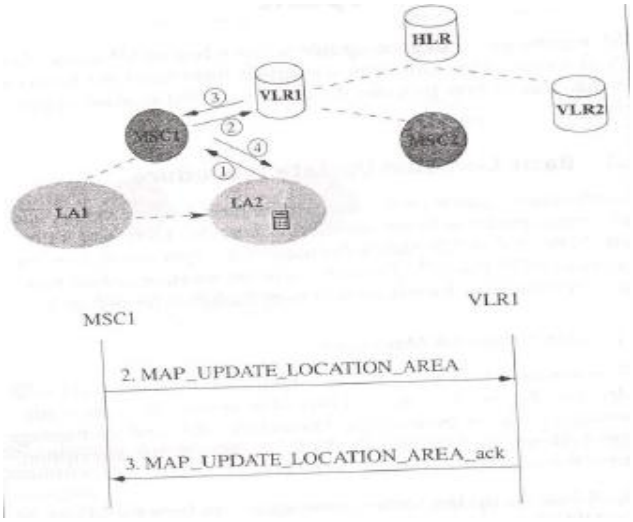
The MS moves from LA1 to LA2, where both Las are connected to same MSC. In GSM specification there are 9 messages exchanged between MS and MSC and 10 messages exchanged between MSC and VLR

Step1: A location update request message is sent from MS to MSC through BTS. This message includes the address of previous visited LA, MSC, and VLR. In this case, addresses of previous MSC and VLR are same as those for new MSC and VLR. Further-more, the MS identifies itself by the temporary mobile subscriber identity (TMSI).

Step2: The MSC forwards the location update request to the VLR by a TCAP message, MAP_UPDATE_LOCATION_AREA.
This message includes:

- Address of the MSC
- TMSI of the MS
- Previous Location area Identification (LAI); for example, the ID for LA1
- Target LA1; for example, the ID for LA2
- Other related information related to GSM

Step 3 and Step 4: The VLR notices that both LA1 and LA2 belong to the same MSC. It updates the LA1 field of the VLR record and replies with an acknowledgement to the MS through the MSC.



d) Describe GPRS network operations.
(SGSN Explanation: 2Marks, GGSN Explanation: 2Marks)
Ans:

There are two Network Operation Nodes in GPRS

1. GGSN: The first is the access point for an external data network and is known as the gateway GPRS support node (GGSN). It contains the routing for GPRS-attached users. With this information, GGSN is capable of delivering the packet data units (PDU) to the user's current access point. The location information can be obtained from the HLR via the optional Gc interface, The Gateway GPRS Support Node (GGSN) is a main component of the GPRS network. The GGSN is responsible for the interworking between the GPRS network and external packet switched networks, like the Internet and X.25networks.

From the external networks' point of view, the GGSN is a router to a sub-network, because the GGSN 'hides' the GPRS infrastructure from the external network. When the GGSN receives data addressed to a specific user, it checks if the user is active. If it is, the GGSN forwards the data to the SGSN serving the mobile user, but if the mobile user is inactive, the data are discarded. On the other hand, mobile-originated packets are routed to the right network by the GGSN. To do all this, the GGSN keeps a record of active mobile users and the SGSN the mobile users are attached to. It allocates IP addresses to mobile users and last but not least, the GGSN is responsible for the billing.

2. SGSN: The second is the SGSN that serves the need of mobile users. When a user is GPRS-attached, the SGSN establishes a mobility management (MM) context containing information pertaining to routing, security and mobility, such as the identity of RA and LA where the MS is residing, and the MS's MM states, etc. The SGSN also ciphers PS traffic, given that the base transceiver station (BTS, in GPRS, BTS replaces the BS in GSM.) is only responsible to cipher CS traffic

The *Serving GPRS Support Node* (SGSN) is a main component of the GPRS network, which handles all packet switched data within the network, e.g. the mobility management and authentication of the users. The SGSN performs the same functions as the MSC for voice traffic. The SGSN and the MSC are often co-located. The SGSN is connected to the BSC. The SGSN is the service access point to the GPRS network for the mobile user. On the other side the SGSN relays the data between the SGSN and relevant GGSN (and vice versa). The SGSN handles the

protocol conversion from the IP used in the backbone network to the sub-network-dependent convergence protocol (SNDCP) and logical link control (LLC) protocols used between the SGSN and the mobile users. These protocols handle compression and ciphering. The SGSN is also responsible for the authentication of GPRS mobiles. When the authentication is successful, the SGSN handles the registration of the mobile to the GPRS network and takes care of its mobility management.

e) Draw and describe Android architecture.
(Architecture diagram: 2 Marks, Explanation: 2 Marks)
Ans:

Android operating system is a stack of software components which is roughly divided into five sections and four main layers as shown below in the architecture diagram.

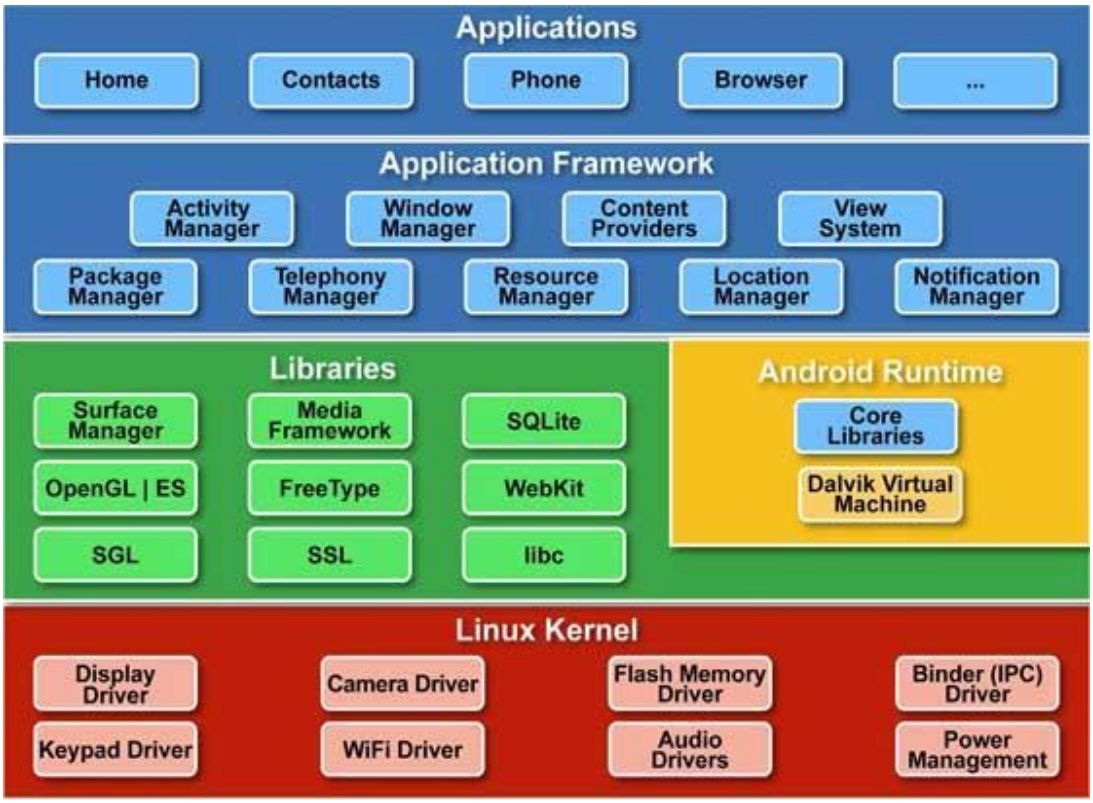


Fig: Android Architecture

Linux kernel

At the bottom of the layers is Linux - Linux 2.6 with approximately 115 patches. This provides basic system functionality like process management, memory management, device management like camera, keypad, display etc. Also, the kernel handles all the things that Linux is really good at such as networking and a vast array of device drivers, which take the pain out of interfacing to peripheral hardware.

Libraries

On top of Linux kernel there is a set of libraries including open-source Web browser engine Web Kit, well known library libc, SQLite database which is a useful repository for storage and sharing of application data, libraries to play and record audio and video, SSL libraries responsible for Internet security etc.

Android Runtime

This This section provides a key component called **Dalvik Virtual Machine** which is a kind of Java Virtual Machine specially designed and optimized for Android. The Dalvik VM makes use of Linux core features like memory management and multi-threading, which is intrinsic in the Java language. The Dalvik VM enables every Android application to run in its own process, with its own instance of the Dalvik virtual machine. The Android runtime also provides a set of core libraries which enable Android application developers to write Android applications using standard Java programming language.

Application Framework

The Application Framework layer provides many higher-level services to applications in the form of Java classes. Application developers are allowed to make use of these services in their applications.

Applications

All the Android application work at the top layer. Examples of such applications are Contacts Books, Browser, and Games etc.

Q.4 A Attempt any THREE of the following : 12M

i) Describe channel assignment types for wireless systems.

(Types 1Mark, Explanation of each strategy 1 ½ Mark each)

Ans:

Types of Channel Assignment strategies:

1. Fixed channel assignment

2. Dynamic channel assignment

- **Fixed channel assignment**
  - Each cell is allocated a predetermined set of voice channel
  - Any new call attempt can only be served by the unused channels in the cell.
  - The call will be *blocked* if all channels in that cell are occupied
  - Borrowing strategy is a type of fixed channel assignment strategy.
  - In this the cell is allowed to borrow channels from neighboring cell if its own entire channel is already occupied.
  - The MSC (Mobile switching center) supervises such borrowing procedures and ensures that borrowing of a channel does not disrupt or interfere with any of the calls in progress in the donor cell.
- **Dynamic channel assignment**
  - Channels are not allocated to cells permanently.
  - Mobile Switching center (MSC) allocate channels based on request.
  - Reduce the likelihood of blocking, increase capacity.
  - This requires the MSC to collect real time data on channel occupancy, traffic distribution & Radio Signal strength Indications (RSSI) of all channels on a continuous basis.

ii) List the features of GSM.

(Any four features 1Mark each)

Ans:

Subscriber Identity Module: It is a memory device that stores info such as subscriber identification no., the networks & countries where the subscriber is entitled for service, privacy keys and other user specific information. The SIM gives the GSM subscriber unit their identity

On –the- air privacy: The privacy is made possible by encrypting the digital bit stream sent by GSM transmitter, according to a secret cryptographic key that is known only to cellular carrier. This key changes with time for each user

The features of GSM are:

- **Call Waiting** - Notification of an incoming call while on the handset
- **Call Hold**- Put a caller on hold to take another call
- **Call Barring** - All calls, outgoing calls, or incoming calls
- **Call Forwarding**- Calls can be sent to various numbers defined by the user
- **Multi Party Call Conferencing**- Link multiple calls together
- **Calling Line ID** - incoming telephone number displayed
- **Alternate Line Service**

- One for personal calls
- One for business calls

- **Closed User Group** - call by dialing last for numbers
- **Advice of Charge** - Tally of actual costs of phone calls
- **Fax & Data** - Virtual Office / Professional Office
- **Roaming:** services and features can follow customer from market to market

iii) Draw neat diagram and explain 3G PP security architecture.
(Diagram: 2Marks, Explanation: 2Marks)
Ans:

Fig gives an overview of the complete 3G security architecture.

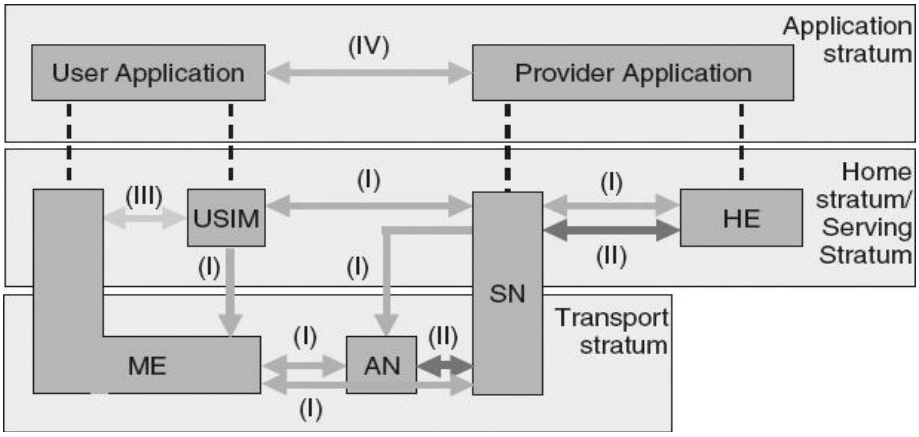


Fig: Overview of the 3G security architecture

From Fig, Four security feature groups are defined. Each of these feature groups meets certain threats, accomplishes certain security objectives:

1. **Network access security (I):** The set of security features that provide users with secure access to 3G services, and which in particular protect against attacks on the (radio) access link.

2. **Network domain security (II):** The set of security features that enable nodes in the provider domain to securely exchange signaling data, and protect against attacks on the wireline network.

3. **User domain security (III):** The set of security features that secure access to mobile stations.

4. **Application domain security (IV):** The set of security features that enable applications in the user and in the provider domain to securely exchange messages.

iv) Describe symmetric key cryptography with its components.
(Description: 2 Marks, Any 4 Components: ½ Mark Each)
Ans:

An encryption system in which the sender and receiver of a message share a single, common key that is used to encrypt and decrypt the message. Symmetric-key systems are simpler and faster, but their main drawback is that the two parties must somehow exchange the key in a secure way. Public-key encryption avoids this problem because the public key can be distributed in a non-secure way, and the private key is never transmitted. Symmetric-key cryptography is sometimes called secret-key cryptography. The most popular symmetric-key system is the Data Encryption Standard (DES).

The Key components of symmetric key Cryptography

1. Plaintext: The original data or text is called plaintext.

2. Ciphertext: The original message changed to another unreadable format using some algorithm is called Ciphertext.

3. Key: Key is a number on which algorithm is based, like the Caesar cipher uses key no 3.

4. Encryption algorithm: This algorithm is required at sender's side for changing the original message (Plaintext) to unreadable format (Ciphertext) to protect the data from other non- valid receivers.

5. Decryption algorithm: Required at receiver's side for retrieving the original message that is to change the ciphertext to plaintext.

6. Hashed message Authentication code: In this case the copy of the key is added along with data and combination is hashed using the key less hash function such as SHA 1.Result of this Is HMAC which is then again prep ended with that same key and result is again hashed using that algorithm. At receiver side the receiver creates its own HMAC and compares it with delivered to validate and check for authentication.

7. Digital signature: Like in case of banks when user signs a cheque, they check your signature for authentication to see that the user is valid. To understand the concept of Digital signature, let us take an example there are two users A and B.A send message to B and B checks that the message came from A not anyone else. B can ask A to sign the message so that it can be proved that A is the actual sender and B verifies the authenticity. This is known as digital signature.

For implementing cryptography we need encryption algorithm for changing plaintext to ciphertext and decryption algorithm at receiver's side for changing Ciphertext to plaintext.

Q.4B Attempt any ONE of the following **6M**

i) Describe location tracking and call setup in GSM.

(Location Tracking: 2 Marks, Call setup: 2 Marks, Diagram: 2Marks)

Ans:

Location Tracking: A GSM network is divided into cells. A group of cells is considered a location area. A mobile phone in motion keeps the network informed about changes in the location area. If the mobile moves from a cell in one location area to a cell in another location area, the mobile phone should perform a location area update to inform the network about the exact location of the mobile phone.

Home Location Register (HLR) The HLR maintains a database for the mobile subscribers. At any point of time, the HLR knows the address of the MSC VLR that control the current location area of the mobile. The HLR is informed about a location area update only if the location area change has resulted in a change of the MSC VLR.

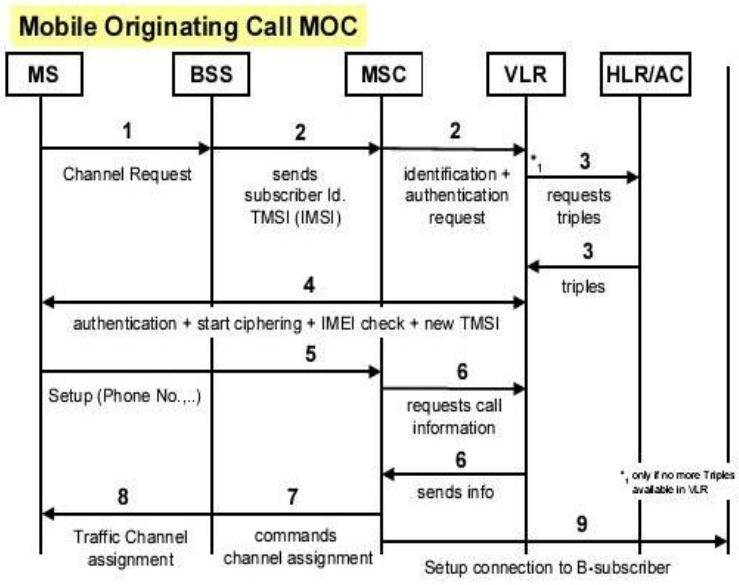
Mobile Switching Center - Visitor Location Register (MSC VLR) The MSC VLR is responsible to switching voice calls and it also keeps track of the exact location area where the mobile user is present

Call Setup in GSM:

Mobile Originating Call (MOC): Call setup, which are initiated by an MS

1. Channel Request: The MS requests for the allocation of a dedicated signaling channel to perform the call setup.
2. After allocation of a signaling channel the request for MOC call setup, included the TMSI (IMSI) and the last LAI, is forwarded to the VLR.
3. The VLR requests the AC via HLR for Triples (if necessary).

4. The VLR initiates Authentication, Cipher start, IMEI check (optional) and TMSI Re-allocation (optional).
5. If all this procedures have been successful, MS sends the Setup information (number of requested subscriber and detailed service description) to the MSC.
6. The MSC requests the VLR to check from the subscriber data whether the requested service an number can be handled (or if there are restrictions which do not allow further proceeding of the call setup).
7. If the VLR indicates that the call should be preceded, the MSC commands the BSC to assign a Traffic Channel (i.e. resources for speech data transmission) to the MS
8. The BSC assigns a Traffic Channel TCH to the MS.
9. The MSC sets up the connection to requested number (called party)



Request Access

- The MS sends a *Channel Request* (CHAN_REQ) message on the RACH.
- The BSS responds with a radio resource assignment (IMM_ASS_CMD) on the AGCH.
- The MS sends a *Service Request* (CM_SERV_REQ) message to the BSS on the SDCCH.

ii) Compare similarities, differences and unique features of Windows CE and Android mobile operating system

(Any 2 Difference: 2Marks, Any 2 Similarities: 2 Marks, Any 2 Unique Features: 2Marks)

Ans:

Differences:

1. Android is an open source, free, Linux-based operating system for smartphones and tablets. The system was designed and developed by Android Inc., which was funded and later purchased by Google in 2005. Windows Phone is a series of proprietary software developed and marketed by Microsoft Corporation. Windows Phone is a closed-sourced, which means that it is solely developed by the company and protected by copyright.

2. Windows CE does not support gadgets as many as android does, especially for mobile devices.
3. Androids are expensive compared to the pure licensed windows CE operating system. Android is more expensive is because it has additional feature and compatibility with many hardware and software application brands.
4. Androids offer a large range of applications and car stereo radio applications to its users. While windows do not provide special installations and setups for Google chromes, Android does.

Similarities:

1. Android and Windows CE both support Multiple language support
2. Android and Windows CE both allows Email services, Web services, Remote Login
3. Android and Windows CE allows **Alternate Keyboards** which supports multiple keyboards and makes them easy to install

Unique Features:

Android Mobile OS

1. Near Field Communication (NFC): Most Android devices support NFC, which allows electronic devices to easily interact across short distances.

2. Custom ROMs: Android operating system is open source, developers can tweak the current OS and build their own versions, which users can download and install in place of the stock OS. Some are filled with features, while others change the look and feel of a device. Chances are if there's a feature you want, someone has already built a custom ROM for it.

3. Widgets: Apps are versatile, but sometimes you want information at a glance instead of having to open an app and wait for it to load. Android widgets let you display just about any feature you choose, right on the home screen—including weather apps, music widgets, or productivity tools that helpfully remind you of upcoming meetings or approaching deadlines.

4. Custom Home Screens: While it's possible to hack certain phones to customize the home screen, Android comes with this capability from the get-go. Download a third-party launcher like Nova, Apex or Slide and you can add gestures, new shortcuts, or even performance enhancements for older-model devices.

Windows CE Mobile OS

1. Windows CE Mobile runs on an ARMv6 processor and it is 32 bit OS
2. Windows CE provides Process Management, Thread Management, Memory Management, File Management.
3. Office: A new iteration of the Office Mobile suite, Office for Windows

Q.5 Attempt any TWO of the following : 16M

a) Explain the process of GSM to PSTN Call and PSTN to GSM call.

(GSM to PSTN Explanation - 4Marks, PSTN-GSM Explanation 4 Marks)

Ans:

Mobile call organization in GSM

1. The subscriber unit must be synchronised to the nearby base station as it monitors the BCH.
2. By receiving FCCH, BCCH messages, the subscriber would be locked on to the system and the appropriate BCH.
3. User dials the intended digit combination and presses "Send" on GSM phone.
4.The mobile transmits a burst of RACH data.
5. The base station then responds with an AGCH message on CCCH which assigns the mobile unit a channel for SDCCH connection.
6. Once tuned to SDCCH, the subscriber will wait for SACCH frame to be transmitted which informs the mobile of any required timing advance and transmitter power command.

The base station is able to determine the timing advance and the signal level from mobiles earlier RACH transmission.

7. Upon receiving and processing the timing advance info in the SACCH, the subscriber is now able to transmit normal burst messages as required for speech traffic.
8. The SDCCH sends message between the mobile unit and the base station, taking care of authentication & user validation.
9. PSTN connects the dialled party to the MSC and the MSC switches the speech path to the serving base station.

Data is transferred on both the forward and reverse links. The calls is successfully underway and SDCCH is vacated.

PSTN to GSM

When calls are organised from PSTN, the process is similar. The base station broadcast a PCH message during TSo within an appropriate frame on the BCH. The mobile station locked onto that same ARFCN, detects its page and replies with a RACH message acknowledging receipt of the page. The BS then uses the AGCH on the CCCH to assign the mobile unit to a new physical

channel for connection to the SDCCH & SACCH while the network and the serving base station are connected. Once the subscriber establishes timing advance & authentication on the SDCCH, the base station issues a new physical channel assignment over the SDCCH, and the TCH assignment is made.

b) Describe the applications and limitations of GPRS.

(Any 4Applications 4 Marks, Any 2 Limitations -4 Marks,

Ans:

There are many applications suitable for GPRS. Many of them are of generic types, some are specific to GPRS.

Generic applications are applications like information services, internet access, email, web browsing, which are very useful while mobile. Due to higher bandwidth, mobile Internet Browsing will be better suited to GPRS.

GPRS Specific Applications:

Chat: Groups of like minded people use chat services as a means to communicate and discuss matters of common interest. GPRS offers by integrating Internet chat and wireless chat using SMS and WAP.

Multimedia Service: Multimedia objects like photographs, pictures, postcards, greeting cards and presentations, static web pages can be sent and received over the mobile network.

Virtual Private Network: GPRS network can be used to offer VPN services. Many blank ATM machines are VSAT (Very Small Aperture Terminal) to connect the ATM system with the banks server.

Personal Information Management: Personal diary, address book, appointments, engagements etc. Are very useful for a mobile individual..

Vehicle Positioning: This application integrates GPS (Global Positioning System) that tell people where they are. Vehicle Positioning system can be used to deliver several services including remote vehicle diagnostics, stolen vehicle tracking. It can be used in logistics industry.

Limitations of GPRS:

There are some limitations with GPRS which can be summarized as:

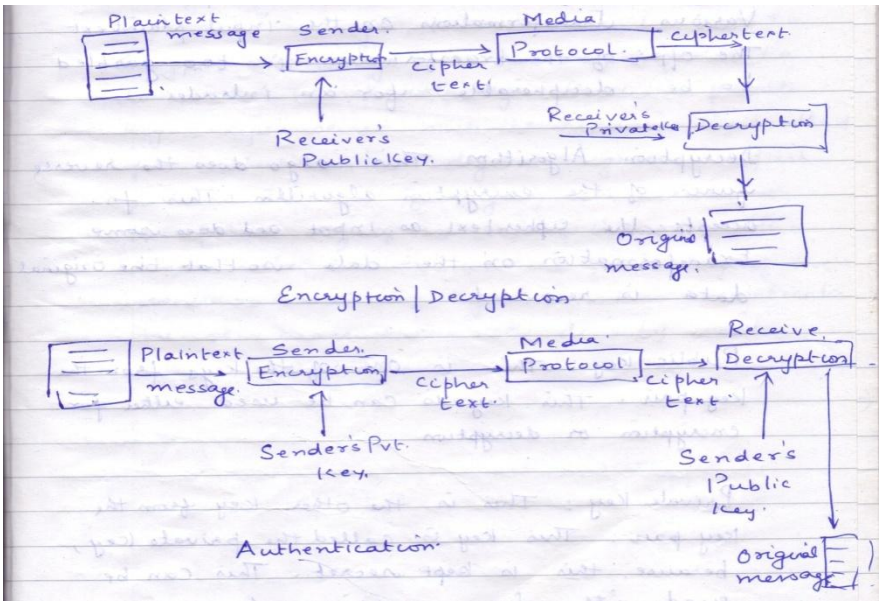
Limited Cell Capacity for All Users: Only limited radio resources can be deployed for different uses. Both Voice and GPRS calls use the same network resources.

Speed Lower in Reality: Achieving the theoretical maximum GPRS data transmission speed of 172.2 kbps would require a single user taking over all eight time slots without any error protection.

Support of GPRS Mobile Terminate Connection for a mobile server not supported: As of date, a GPRS terminal can only act as a client device. There are many services for which server has to be mobile.

c) What is public key cryptography and what are its components? Explain the Diffie-Hellman Algorithm.
(Diagram- 2Marks, Components- 3Marks, Algorithm- 3Marks)
Ans:

Public key Cryptography:
In this cryptography two different keys are used for encryption and decryption. Thos is also called as Asymmetric key cryptography. It is based on mathematical functions rather than permutation & substitution. The encryption key and decryption key form a key pair. One of the key from the key pair is made public and the other is kept private or secret.
There are six main components



Plaintext:
Human readable message or data given to public key algorithm as input for encryption.

Ciphertext:

This is the scrambled data produced as output of the format of data produced as output of the encryption algorithm. This is unique data and depends only on the unique key used for encryption.

Encryption Algorithm:

It does computation and various transformations on the input plain text. The output of the transformation is too garbled to be decipherable for an intruder.

Decryption Algorithm:

This algorithm does the reverse function of the encryption algorithm. This function accepts the cipher text as input and does some transformation on the data so that the original data is recovered.

Public Key:

This is one of the keys from the key pair. This key can be used either for encryption or decryption.

Private key:

This is the other key from the key pair. This key is called the private key, because this is kept secret. This can be used either for encryption or decryption.

Diffie Hellman Algorithm:

1. Firstly, Alice and Bob agree on two large prime numbers, n and g. These two integers need not be kept secret. Alice and Bob can use an insecure channel to agree on them.
2. Alice chooses another large random number x, and calculates A such that:
   $A = g^x \bmod n$
3. Alice sends the number A to Bob.
4. Bob independently chooses another large random integer y and calculates B such that:
   $B = g^y \bmod n$
5. Bob sends the number B to Alice.
6. A now computes the secret key K1 as follows:
   $K1 = B^x \bmod n$
7. B now computes the secret key K2 as follows:
   $K2 = A^y \bmod n$

Q.6 Attempt any FOUR of the following : 16M

a) Describe three-tier mobile computing architecture.

(Diagram 1Mark , 3 layers, 1Mark each)

Ans:

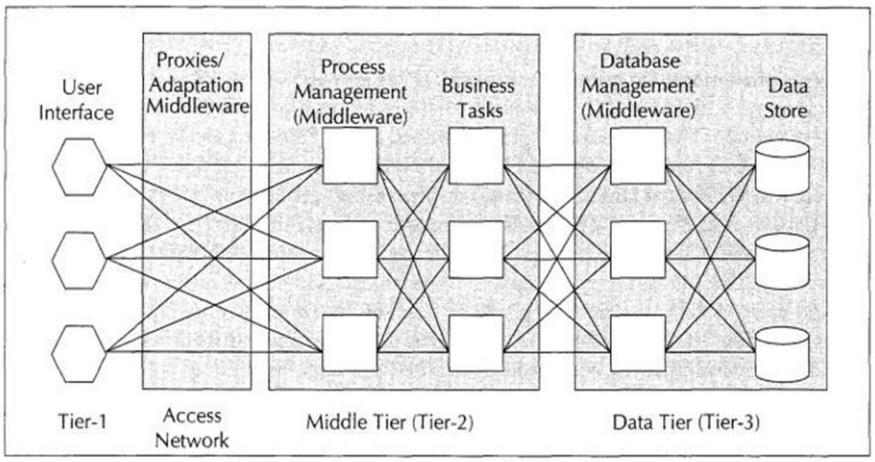


Figure 2.1 Three-tier Architecture for Mobile Computing

First Tier/ Layer

- User Interface/Presentation Layer – deals with the user facing device handling & rendering.
- This tier includes a user interfacing components like Textbox, Labels, Checkboxes, etc.

Second Tier/Layer

- Process Management/application Layer – deals with Business logic & Rules.
- It is capable of accommodating hundreds users.
- The middle process management tier controls transactions & asynchronous queuing to ensure reliable completion of transaction

Third Tier/Layer

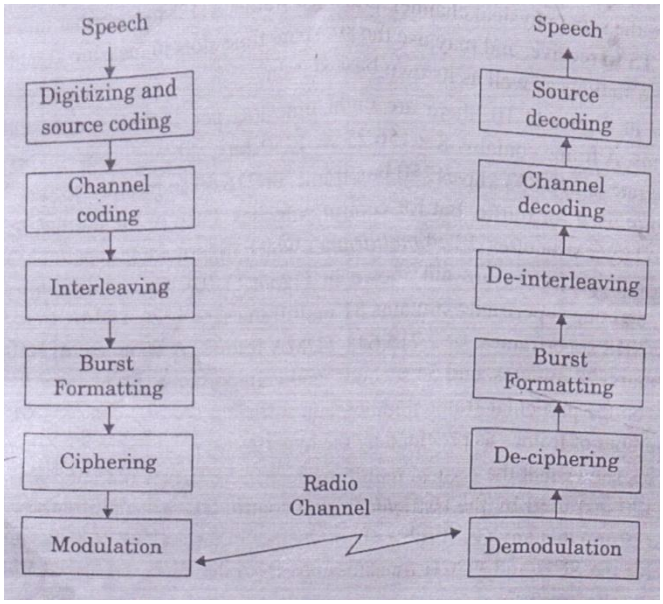
- Database Management/Data Tier – deals with DB management & access.
- The three tier architecture is better suited for an effective networked client / server design
- It provides increased performance , flexibility, maintainability, reusability, & scalability
- These characteristics encertain the use of 3 tier architecture useful for internet applications & net centric systems
- To design a system for mobile computing , we need to keep in mind that the system will used through any network, any bearer, any agent, any device etc..

b) Describe signal processing in GSM.

(Diagram- 2Marks, Explanation -2Marks)

Ans:

Signal Processing in GSM



Speech Coding:

The coder provides 260 bits for each 20ms blocks of speech, which yield a bit rate of 13kbps.

Channel Coding:

The output bits of the speech coder are ordered into groups for error protection, based on their significance in contributing to, speech quality. Out of the total 260 bits in a frame, the most important 50 bits called (Ia bits) have 3 parity check (CRC) bits added to them. This facilitate the non correctable errors at the receiver. The next 132 bits (Type Ib) along with 53 bits are reordered and appended by providing a data block of 189 bits. This block is then encoded for error using rate ½ Convolution encoder. The least important 78 bits (Type 2) are not error protected and are just joined to form 456 bits in a 20 ms frame.

Interleaving:

The 456 bit in 20ms speech frame is broken into Eight 57 bit sub blocks. They form the consecutive TCH time slots.

Ciphering:

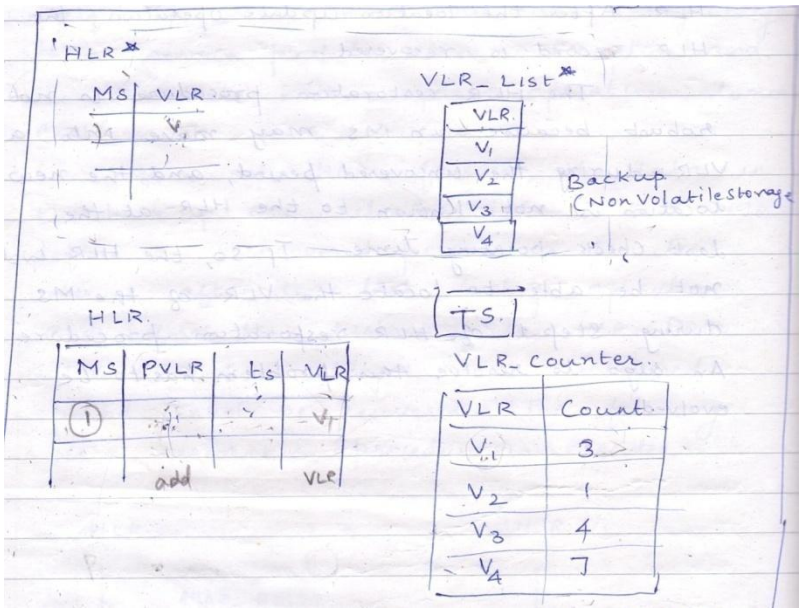
It modifies the contents of the eight interleaved blocks through the use of encryption techniques known only to a particular mobile station and bas transceiver.

Burst Formatting:
Adds binary data to the ciphered blocks to help synchronization and equalization of the received signal.

Modulation:
It is 0.3 GMSK. It is a type of digital FM. 1's and 0's are represented by shifting the RF carrier by +- 67.708 KHz.

Demodulation:
The appropriate TS is demodulated with the aid of synchronization data provided by the burst formatting.
After demodulation, the binary info is deciphered, de-interleaved, channel decoded and speech decoded.

c) Describe VLR identification algorithm.
(Diagram- 1 Mark, Each procedure -1Mark)
After an HLR failure the following algorithm helps to identify the exact VLRs to be contacted by the HLR after an HLR failure.
We assume that every VLR covers exactly one MSc. To implement VIA, extra data structures are required in the HLR, as shown in the figure.



In the backup the extra data structure is a set VLR-list* of VLR's that have been modified during the uncovered period. After an HLR failure, the HLR only needs to send the MAP_ RESET messages to the VLRs listed in the VLR_LIST*.

In HLR, every record includes two extra fields
1) The ts field indicates the last time of location update. In some GSM implementations, this field already exists for other purposes.
2) The PVLR field contains the address of the VLR where the MS is resided at the last check pointing time. Thus, for any MS p, we have

HLR* [p].VLR = HLR[p].pVLR

Two extra data structures are introduced to the HLR.
1) TS is the last check pointing or back up time.
2) VLR_Counter is a set of (VLR, Count) pairs, where count represents the "effective number" of MS entering the VLR (VLR) during the uncovered period. An MS is not effective to the VLR if it is entered the VLR area then left the area during the uncovered period. For e.g. in the fig., there are three effective MS in VLR V1.
[VLRs recorded in VLR_counter are the VLRs in VLR_LIST*]

In VIA information of the HLR is periodically saved into the backup by using the following check point procedures.

VIA Procedure 1: Check Pointing
Step 1: For every location entry p in HLR * do:
HLR[p]*.VLR ← HLR[p].VLR;
Step 2: TS ← Current time.
Step 3: For every location entry p in HLR do
HLR[p].ts ← TS; HLR[p].PVLR ← HLR[p].VLR
Step 4: VLR-Counter ← φ, VLR_LIST*←φ;

In procedure 1, every location entry is saved into the backup at Step 1. The clock TS is set to the time of check pointing at Step 2. The timestamp field, ts of every location entry in HLR is set to TS to indicate that the last location of the MS was updated no later than the latest check pointing time TS at Step3. The PVLR is set to the current VLR address to the MS.
At Step 4, both VLR_ counter * VLR_LIST* are set to empty to indicate that no VLR has new roaming MS at TS.
Suppose the MS p moves into VLR area V_{new} at time t. Then a message MAP_UPDATE_LOCATION is sent from V_{new} to the HLR. Procedure 2 at HLR is triggered to perform registration process.

VIA Procedure 2: Registration
Step 1: Update HLR:
V_{old} ←HLR[p].VLR;
Send message, MAP_CANCEL_LOCATION, to cancel the entry of p at V_{old}:
HLR[p].VLR ← Vnew;
t_{old} ← HLR[p].ts;
HLR[p].ts ←t;

Step 2 Update the V_{new} count field in VLR_Counter: If
HLR[p].VLR ≠ HLR[p].PVLR

Step 2.1 If VLR_Counter [V_{new}] exists then:
VLR_Counter [V_{new}].Count ← VLR_Counter [V_{new}].Count+1;

Step2.2 Else Create VLR_Counter [Vnew] and VLR_LIST* [Vnew];
VLR_Counter [Vnew] ←;

Step 3 Update the Vold Counter entry:
If t_{old} > TS and V_{old} ≠ HLR [p].PVLR then,

Step 3.1 VLR_Counter [V_{old}].Count ← VLR_Counter [V_{old}].Count-1;

Step 3.2 If VLR_counter [V_{old}].Count=0 then,

Step 3.2.1 Delete VLR_Counter [V_{old}] and VLR_LIST* [V_{old}];

At Step1 of procedure 2, the location information of the MS is updated and its location record at the old VLR, V_{old}, is cancelled by the deregistration message MAP_CANCEL_LOCATION. The last update time told is saved to be used in Step 3.

At step 2& 3 of procedure 2, VLR_Counter[] is used to count the "effective" number of the MSs that enters the VLRs during the period [TS, t]. Note that if the MS was in V_{new} before TS [i.e HLR[p].VLR=HLR*[p].VLR=HLR[p].PVLR], then the HLR may consider that the MS never moves out of the VLR, and there is no need to increment the VLR counter, and step 2 is skipped.

If MS moved into V_{old} during the uncovered period that is ts_{old} > TS – it implies that the movement into V_{old} is not effective because the MS has moved out of V_{old} at t. Thus the V_{old} counter, should be decremented by 1.

When the VLR Counter [V].Count >1, then any update to VLR_Counter [V] will not invoke modifications to VLR_LIST*[ ]. In other words, access to the HLR backup is avoided. The purpose of procedure 2 is to avoid updating the backup for every registration operation.

After an HLR failure, Procedure 3 is executed to restore the HLR. In this procedure, the HLR restores the location entries from the backup and request current status of the MSs from all VLRs that have updated MS information between the last check pointing time and the HLR failure time.

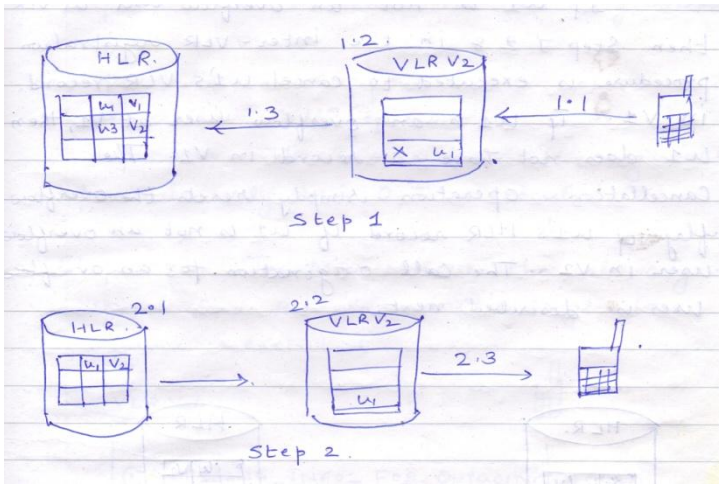
d) Describe the Registration algorithm of GSM/VLR.
(Diagram -2Marks, Explanation – 2Marks)
Ans:

Algorithm O-I Registration
Suppose that an MS moves into the area controlled by the VLR V_2. If V_2 is not full, then the registration procedure described is executed. If V_2 is full, following steps are executed.
Step1: Registration request

Step 1.1: This is the same as Step1 of the normal registration procedure.

Step 1.2: The database is full. V_2 follows a replacement policy to select a record to be deleted (u3 in the fig). The storage for the deleted record is used to store the u1's information. The selected user (i.e. u3) is called the overflow user.
The replacement policy may be based on various heuristics. For e.g. V_2 may select a record randomly, select the oldest record or select an inactive record. (i.e. the user has not had call activities recently) V_2 may select u1 as the overflow user (i.e. u3 = u1) and does not create a VLR record for u1.

Step 1.3: V_2 forwards the registration request to the HLR with the indication that u3's record is deleted due to database overflow.



Step 2: Registration Response

Step 2.1: The HLR updates the location of u1, and sets the overflow flag in u3's record (to indicate that V_2 does not have a VLR record for u3)
Step 2.2: The HLR acknowledges the registration operation and sends u1's profile to V_2)
Step 2.3: V2 sends an acknowledgement to the MS.

e) Describe CDMA 2000 technology.
(Relevant Explanation -4Marks)
Ans:

It is a 3rd generation version of cdma one or IS-95. The cdma 2000 Radio Transmission Technology (RTT) is a spread spectrum, wideband radio interface. It uses CDMA technology. Cdma2000 meets the specification for ITU & IMT 2000. It addresses the specification for indoor, indoor to outdoor, pedestrian & vehicular environment. Cdma 2000 can operate in wide range of environments viz,

Indoor / Outdoor picocell (<50 m radius)
Indoor / Outdoor microcell (upto 1km radius. E.g shopping mall)
Outdoor macrocell (1-35 km radius)
Outdoor megacell (>35 km radius)
Wireless in Local loop (WILL)

Two types of data services are currently under consideration for cdma 2000. These are packet data and high speed circuit switched data. Packet data will be used for burst traffic like internet of mails. The circuit switched data can be used for delay sensitive real time traffic. Video applications are potential candidates for circuit switch data as they need a dedicated channel for the duration of the call.

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