**Practical Training Report**

**Undertaken at**

**Mahanagar Telephone Nigam Limited**

**Tis Hazari, New Delhi**

**On**

**GSM Architecture**

**About the  Mahanagar Telephone Nigam Limited**

MTNL was setup on 1st April 1986 by the government of India to upgrade the quality of telecom services, expand the telecom network, and introduce new services and to raise revenue for telecom development needs for India’s leading and one of Asia’s largest telecom operating companies. Beside having a strong financial base, MTNL has achieved the market share of approx. 13% of the Indian telecommunication networking with  a costumer base of over 4.74 million lines.

 The government of India currently holds 56.25% stake is the company.

In 1953 Tis Hazari Exchange (Lothian Exchange ceased this) commissioned

**SCOPE OF TRAINING**

Training is one of the essential parts of engineering studies as it provides us confidence and exposure to the real world problem. In my training I used my learned skills and saw how things work in real world. Now we are quite confident about our fundamentals as we have tested them during our project and have gained experience of working with discipline. Practical training provides us a view of professional and prepares us to face the upcoming challenges.

After achieving the proper goal of the engineer has enter in professional life. According to this life one has to serve an industry, may be public or private or self own. for the efficient work in the field he must be well aware of practical knowledge as well as theoretical knowledge. Since we belong to the electronic field it is really helpful to take training at a place that clears a doubt and inquisitively regarding.

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**INTRODUCTION TO GSM**

GSM is known as Global System for Mobile Communication. A technology developed in 1985 by a French company known as Group Special Mobile.

Cellular radio provides mobile telephone service by employing a network of cell sites distributed over a wide range. A cell site contains a radio transceiver and a base station controller, which manages, sends, and receives traffic from the mobiles in its geographical area to a cellular phone switch. It also employs a tower and its antennas, and provides a link to the distant cellular switch called a mobile telecommunication switching office. This MTSO places calls from land based telephones to the wireless customers, switches calls between cells as mobile travel across cell boundaries, and authenticates wireless customers before they make calls.

            GSM calls are either based on data or voice. Voice calls use audio codes called half-rate, full-rate and enhanced full-rate. Data calls can turn the cell phone into a modem operating at 9600 bps.

            It uses digital technology and time division multiple access transmission methods.

Voice is digitally encoded via a unique encoder, which emulates the characteristics of human speech. This method of transmission permits a very efficient data rate/information content ratio.

            One of its great strength is the international roaming capability that gives consumers seamless and same standardized same number contact ability in more than 170 countries. GSM satellite roaming has extended service access to areas where terrestrial coverage is not available.

GSM technology is continually evolving. Having made great leaps forward in the past 10 years. It is facing an even greater evolution in the years ahead.

**HISTORY OF GSM**

The first mobile telephone service started in 1946 in St. Louis, Missouri, USA as an manually operated system. Between 1950 and 1960, it evolved as an automatic system with reduced cost and increased, but small subscriber base.  Mobile telephony service in its useful form appeared in 1960s.

The period from 1940 – 60

        The 1st mobile telephone service started in 1946 in St. Louis Missouri, USA.

        Between 1950 and 1960 it evolved as an automatic system.

        Mobile telephony service in its useful from appeared in 1960s.

The period from 1980 - 95

* Each country developed its own system
* In 1982 the Conference of European Posts and Telegraphs (CEPT) formed a study group called the Group Special Mobile (GSM) to study and develop a European public land mobile system which had to meet certain criteria :

Good subjective speech quality.

Low terminal and service cost.

Support for international roaming

Ability to support hand held terminals.

Support for range of new service and facilities.

Spectral efficiency.

In 1989, GSM responsibility was transferred to European Telecommunication Standards Institute (ETSI)

GSM specifications were published in 1990 as:-

      Commercial service started in mid – 1991

                              By 1993 there were 36 GSM networks in 22 countries

The First Generation Mobile Communication System appeared in 1970s and remained till 1980s.They used analog transmission techniques for radio link and confined its users to their respective systems areas for which the mobile phone was designed. Capacity of system was limited and roaming between the coverage areas of different systems was impossible. Apart from being very expensive these system provides very poor QoS and supported only voice communication.

The Second Generation Mobile Communication System has grew out of the limitation of first generation systems. They supported large subscriber base, carried both voice and data and have capable of design and deliver new value added services. GSM and CDMA emerged as the trend setting technologies. The domination of 2G systems became apparent in second half of 1990s.

The Third Generation Mobile Communication Systems provide high functionality with seamless global roaming. Apart from providing very high data rates, 3G systems seek to integrate the wire line systems with mobile systems. 3G would provide users consistent voice, data, graphical, multi-media regardless of their location in the network. They also integrate the Intelligent Network (IN) capabilities into mobile systems.

**Cellular Principal And Mobility Issues: -**

 In mobile communication the wired 2W subscriber line is replaced with a wireless mobile link. Once the customer is liberated from the confines of the wire and made free to move, the following issues arise :-

* Demand on the scarce radio resources.
* Authentication of the customer.
* Security and privacy on the radio
* Provide unique service profile.
* Keep track of the user as they move.
* Proving service across networks.
* Billing the customer whenever and wherever he makes and receives calls from.

 An important issue in mobile communication is the need to authenticate the genuineness of the customer whenever he receives or attempts to make communication. Since the media being open space, it is necessary to verify whether the customer is the one whom he claims to be before resources allocation. Security of the mobile account is to be ensured to prevent unauthorized use and also misuse of one’s subscription. Privacy of the communication over radio is to be ensured though the radio signals are available everywhere for interception.

One of the important issues for the customer is the availability of seamless service profile irrespective of his location. This is an essential feature of the mobile communication, particularly when the customer visits a service area served by an operator different from his own. Different dialing codes for accessing the same service in different networks can lay havoc in realizing the services by the customer.

Yet another challenging issue in mobile communication is the need to keep track of the customer’s location so that an incoming call can be connected to him. Equally important is the need to main established

**Cell To Mobile – Down Link**

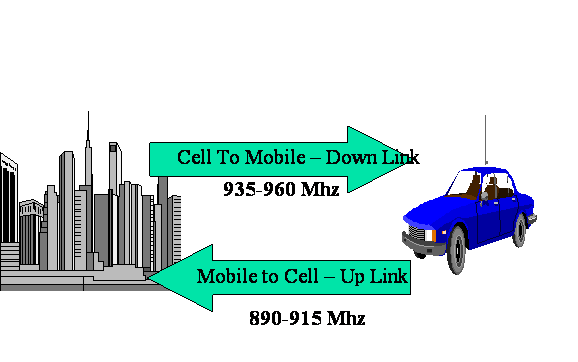
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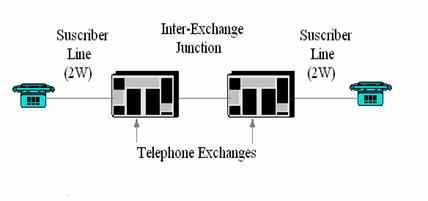
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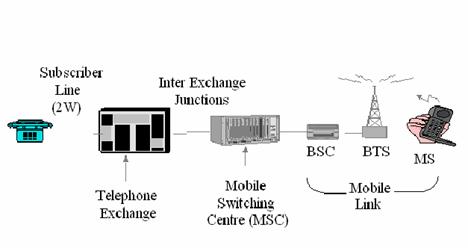
**1805-1880 Mhz**

**890-915 Mhz**

**1710-1785 Mhz**

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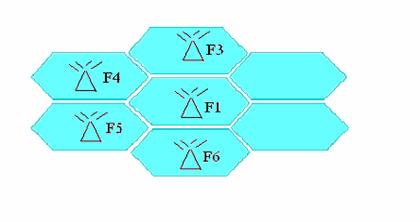




A comparison of typical PSTN and mobile call scenarios is shown in figure

The central concept that made mobile communication as a usable commercial proposition is the cellular principle. BELL Laboratories, US in 1970 first introduced cellular principle Under cellular concept, the service area is divided into a number of CLUSTERS, each cluster consists of a number of CELLS and each cell is assigned as many CARRIERS as required by the traffic in that cell. There is a one-to-one correspondence between the cells in each of the clusters that these cells use the same carrier frequencies.

Since the frequency used being the same, the principle of frequency reuse demands that the interference between them when serving different cells and therefore different customers should be kept within permissible limits



Above figure shows a 7-CELL reuse pattern. The 7 cells, shown as seven different hexagons that are tagged in contiguity are called a cluster. The cluster is repeated in such a manner that the distance between the cells using the same frequency is kept as far as possible.

**INTRODUCTION**

A GSM system is basically designed as combination of 3 major subsystems:

* Network subsystem
* Radio subsystem
* Operation support subsystem

In order to ensure that network operators will have several sources of cellular infrastructure equipment, GSM specify not only the air interface, but also the main interfaces that identify different parts.

**GSM NETWORK STRUCTURE**

Every telephone network needs a well designed structure in order to route incoming called to the correct exchange and finally to the called subscriber. In a mobile network, this structure is of great importance because of the mobility of all its subscribers. In GSM system, network is divided into following partitioned areas:-

***GSM service area*** :- It is the total area served by the combination of all member countries where a mobile can be serviced.

***PLMN service area*** :-  Based on its size these can be several within a country. All incoming calls for a GSM/PLMN network will be routed to a gateway MSC which works as an incoming transit exchange. The gateway MSC consists the inter working functions to make these connections.

***MSC service area*** :-  There  can   be   several   MSC / VLR   in   one         PLMN . To route a call to a mobile subscriber, the path through links to MSC in the MSC area where the subscriber is currently located. The mobile location can be uniquely identified since the MS is registered in a VLR, which is generally associated with an MSC.

***Location areas*** :- LA’s are several within a MSC/VLR combination. A LA is a part of the MSC/VLR service area in which a MS may move freely without updating location information to the MSC/VLR exchange that control the LA. In a LA a paging message is broadcast to find the called mobile subscriber. LA can be identified by using the location area identity. LA is used to search for the subscriber in an active state.

***Cells* :**- It is an identity served by one BTS The MS differentiate between cells using BSIC (Base Station Identification Code) that the cell site broadcast over the air.

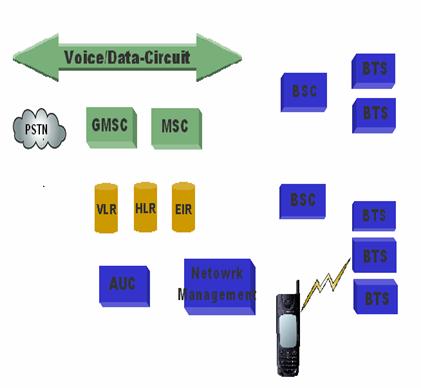
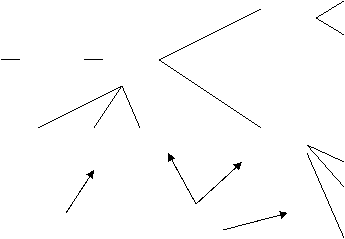


Figure shows an overview of GSM Architecture

**MOBILE STATION**

The mobile station (MS) includes radio equipment and the man machine interface that a subscriber needs in order to access the service provided by the GSM PLMN. The MS may include provisions for the data communication as well as voice. A mobile transmits and receives message to and from the GSM system over the air interface to establish and continue connections through the system.

Each MS is identified by an IMEI that is permanently stored in a mobile unit. Upon request, the MS sends this number over he signaling channel to the MSC. The IMEI can be used to identify mobile units that are reported stolen or operating incorrectly.

The mobile subscriber ISDN number (MS ISDN) is the number that the calling party dials in order to reach the subscriber. It is used by the land network to route calls towards an appropriate MSC. The international mobile subscriber identity (IMSI) is permanently assigned to him. Temporary mobile subscriber identity (TMSI) is also assigned by the GSM system which can be periodically changed and protect the subscriber from being identified by those attempting to monitor the radio channel.

**FUNCTIONS OF MOBILE STATION**

        The primary functions of MS are to transmit and receive voice and data over the Air interface of the GSM system. MS performs the signal processing function of digiting, encoding, error protecting, encrypting, and modulating the transmitted signals. It also performs the inverse functions on the received signals from BS.

* In order to transmit voice and data signals, the mobile must be in synchronization with the system.
* To achieve this, the MS automatically tunes and synchronizes to the frequency and TDMA timeslot specified by the BSC.
* The MS monitors the power level and signal quality, determined by the BER for known receiver bit sequences from both its current BTS and up to six surrounding BTSs. This data is received on the downlink broadcast control channel. The system then uses this list for best cell handover decisions.
* MS keeps the GSM network informed of its location during both national and international roaming, even when it is inactive.
* MS includes an equalizer that compensates for multi path distortion on the received signal
* The MS can store and display short received alphanumeric messages on the LCD. These messages are limited to 160 characters in length.

**SIM CARD**

GSM subscribers are provided with a sim card with its unique identification at the very beginning of the service. The suscriber is identified in the system when he inserts the SIM card in the mobile equipment. The smart card SIM is potable between Mobile equipment (MS) units. The user only needs to take his smart card on a trip because it can be used in any GSM specified mobile set. He can then a ME unit at the destination, even in the another country, and insert his own SIM. Also, the GSM system will be able to reach him at the ME unit he is currently  using.

The SIM is a removable card, containing an integrated circuit chip with a microprocessor, random access memory (RAM), and read only memory (ROM). The subscriber inserts it in the MS unit when he or she wants to use the MS to make or receive a call.

**INTERNATIONAL MOBILE SUBSCRIBER IDENTITY**

An IMSI assigned to each authorized GSM user. It consists of a mobile country code (MSC), mobile network code (MNC), and a PLMN unique mobile subscriber identification number (MSIN). The IMSI is not hardware-specific. Instead, it is maintained on a SC by an authorized  subscriber and is only absolute identify that a subscriber has within the GSM system.

**TEMPORARY  MOBILE SUBSCRIBER  IDENTITY**

A TMSI is a MSC-VLR specific alias that is designed to maintain user confidentiality. It is assigned only after successful subscriber authentication.  The correlation of a TMSI to an IMSI only occurs during a mobile subscriber’s initial transaction with an MSC (for example, location updating). Under certain conditions (such as traffics system disruption and malfunctioning of the system), the MSC can direct individual TMSIs to provide the MCS with their IMSI.

**THE MOBILE STATION ROAMING NUMBER (MSRN)**

The MSRN is allocated on temporary basis when the MS roams into another numbering area. The MSRN number is used by the HLR for rerouting calls to the MS. It is assigned upon demand by the HLR on a per-call basis. The MSRN for PSTN/ISDN routing shall have the same structure as international ISDN numbers in the area in which the MSRN is allocated. The HLR knows in what MSC/VLR service area the subscriber is located. At the reception of the MSRN, HLR sends it to the GMSC, which can now route the call to the MSC/VLR exchange where the called subscriber is currently registered.

**BASE STATION SYSTEM**

The BSS is a set of BS equipment (such as transceivers and controllers) that is the entry responsible for communication with Mobile Stations in a certain area. A BSS may consist of one or more BS. The BSS includes two types of machines: -

* The BTS in contact with the MSs through the radio interface.
* The BSC the latter being in contact with the MSC.

**BTS**

A BTS compares radio transmissions and reception devices, up to and including the antennas, and also all the signal process specific to the radio interface.

A BTS is a network component that serves one cell and is controlled by a BSC. A BTS is typically able to handle 3 to 5 radio carriers, carrying between 24 and 40 simultaneous communications.

An important component of the BSS that is considered in the GSM architecture as a part of the BTS is the Trans coder/Rate Adapter Unit (TRAU). The TRAU is the equipment in which coding and decoding is carried out as well as rate adoption in case of data. Although the specifications consider the TRAU as a subpart of the BTS, it can be sited away from the BTS (at MSC), and even between the BSC and the MSC.

**FUNCTIONS OF BTS**

* The primary responsibility of BTS is to transmit and receive radio signals from a mobile over as air interface. To perform this function completely the signals are encoded, encrypted, multiplexed, modulated and then fed to the antenna system at the cell site. Transcoding to bring 13-kbps speech to a standard data rate of 16kbps and then combining four of these signals to 64 kbps is essentially a part of BTS.
* The received signals from the mobile is decoded, decrypted, and equalized for channel impairments.
* Random access detection is made by BTS, which then sends the messages to BSC. The channel subsequent assignment is made by BSC.

**BSC**

BTS to notify the MS to advance the timing such that proper synchronization takes place The BSC is connected to the MSC on one side and to the BTS on the other. The BSC performs the Radio Resource (RR) Management for the cells under its control. It assigns and release frequencies and timeslots for all MSs in its own area. It also reallocates frequencies to the BTSs in its area to meet locally heavy demands during peak hours or on special events. The BSC controls the power transmission of both BSSs and MSs in its area. The minimum power level for a mobile unit is broadcast over the BCCH. The BSC provides the time and frequency synchronization reference signals broadcast by its BTSs. The BSC also measures the time delay of received MS is not centered in its assigned timeslot at the BTS, the BSC can direct the.

**FUNCTIONS OF BSC**

* The BSC also performs traffic concentration to reduce the number of transmission lines from the BSC to its BTSs, as discussed in the last section.

**SWITCHING SUBSYSTEMS**

**MOBILE SWITCHING CENTRE AND GATEWAY SWITCHING CENTRE**

The network and the switching subsystem together include the main switching functions of the GSM as well as the databases needed for the subscriber data and the mobility management (VLR). The main role of the MSC is to manage the communication between the GSM users and other telecommunication network users. The basic switching functions are performed by the MSC whose main function is to coordinate setting up calls to and from GSM users. The MSC has interface with the BSS on the one side and the external networks on the other. The main difference between MSC and EXCHANGE in a fixed network is that the MSC has to take into account the impact of the allocation of RRs and the mobile nature of subscribers and has to perform.

**VARIABLE LOCATION REGISTER**

The VLR is collocated with an MSC. A MS roaming in an MSC area is controlled by the VLR responsible for that area. When a MS appears in a LA it starts a registration procedure. The MSC for that area notices this registration and transfers to the VLT, the identity of the LA where the MS is situated. A VLR may be in charge of one or several MSCs LA’s. the VLR constitutes the databases that support the MSc in the storage and retrieval of the data of subscribers present in that area. When an MS enters the MSCs area borders, it signals its arrival to the MSC that stores its identity in the VLR. The information necessary to manage the MS is contained in HLR and is transferred to the VLR so that they can be easily retrieved if so required.

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**PLMN may contain VARIABLE LOCATION REGISTER**

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**HOME LOCATION REGISTER**

* HLR is a database that permanently stores data related to a given set of subscribers.
* Various identification numbers and addresses as well as authentication parameters, services, special routing information are stored.
* Current subscriber status including a subscriber’s temporary roaming number and associated VLR if the mobile is roaming are maintained.
* HLR is responsible for storage and provision of SIM authentication and encryption parameters form the AUC.
* one or several HLRs.

**AUTHENTICATION CENTER**

* The AUC stores information that is necessary to protect communication through the air interface against intrusions, to which the mobile is vulnerable.
* The legitimacy of the subscriber is established through authentication and ciphering, which protects the user information against unwanted disclosure.
* Authentication information and ciphering keys are stored in a database within the AUC which protects the user information against unwanted disclosure and access.

**EQUIPMENT IDENTIFY REGISTE**R

EIR is a database that stores the IMEI numbers for all registered ME units. The IMEI uniquely identifies all registered ME. There is generally one EIR per PLMN. It interfaces to the various HLR in the PLMN. The EIR keeps track of all ME units in the PLMN. It maintains various lists of message. The database stores the ME identification and has nothing do with subscriber who is receiving or originating call. There are three classes of ME that are stored in the database, and each group has different characteristics.

* ***White List***: contains those IMEIs that are known to have been assigned to valid MS’s. This is the category of genuine equipment.
* ***Black List***: contains IMEIs of mobiles that have been reported stolen.
* ***Gray List***: contains IMEIs of mobiles that have problems (for example, faulty software, wrong make of the equipment). This list contains all MEs with faults not important enough for barring.

**INTERWORKING FUNCTION**

GSM provided a wide range of data services to its subscribers. The GSM system interface with the various forms of public and private data network currently available. It is the job of the IWF to provide this interfacing capability.

The IWF, which is essence is a part of  MSC, provides the subscriber with access to data rate and protocol conversion facilities so that data can be transmitted between GSM Data Terminal Equipment (DTE) and a land-line DTE

**ECHO CANCELER**

EC is use on the PSTN side of the MSC for all voice circuits. The EC is required at the MSC PSTN interface to reduce the effect of GSM delay when the mobile is connected to the PSTN circuit. The total round-trip delay introduced by the GSM system, which is the result of speech encoding, decoding and signal processing is of the order of 180 ms. The standard echo canceller cancels about 70 ms of delay.

 As the GSM round-trip delay added and without the EC the effect would be irritating to the MS subscriber.

**FUNCTIONS OF MSC**

* As stated, the main function of the MSC is to coordinate the set up of calls between GSM mobile and PSTN users. Specifically, it performs functions such as paging, resource allocation, location registration, and encryption.
* The MSC is a telephony switch that performs all the switching functions for MSs located in a geographical area as the MSC area. The MSC must also handle different types of numbers and identities are used in the fixed part of the network, such as, for routing.
* The call-handling function of paging is controlled bt MSC. MSC coordinates the set up of paging is controlled in different registers: IMSI, TMSI, ISDN number and MSRN. In general identities are used in  the interface between the MSC and the MS, while numbers are used in the fixed part of the nrtwork, such as, for routing.
* The call-handling function of the paging is controlled by MSC. MSC coordinates the set up of call to and from all GSM subscribers operating in its areas. The dynamics allocation of access resources is done in coordination with the BSS. More specifically, the MSC decides when and which types of channels should be assigned to which MS. The channel identity and related radio parameters are the responsibility of the BSS; The MSC provides the control for the subscriber authentication procedure.
* The MSC supervises the connection transfer between different BSSs for MSs, with an active call, moving from one call to another. This is ensured if the two BSSs are connected to the same MSC but alsowhen they are not. In this later case the procedure s more complex, since more than one MSC is involved.
* The MSC performs billing on calls for all subscribers based in its areas. When the subscriber is in roaming elsewhere, the MSC obtains data for the call billing from the visited MSC.
* Encryption parameters transfers from VLR to BSS to facilitate ciphering on the radio interface are done by MSC. The exchange of signaling information on the various interface toward the other network elements and the management of the interfaces themselves are all controlled by the MSC.
* The MSC serves as a SMS gateway to forward SMS messages from Short Message Service Centers (SMSC) to the subscribers and from the subscribers to the SMSCs. It thus acts as a message mailbox and delivery system.

**OVER VIEW OF THE GSM INTERFACE :-**

For the connection of the different nodes in GSM network, different interface are defined in GSM specifications which are discussed as below :-

***Air Interface Or U m – Interface :-***

This interface is between the BTS (Base Transceiver Station) and the MS (Mobile Station). To achieve a high spectral efficiency in a cellular network a combination of :-

        *FDMA* (Frequency Division Multiple Access)

        *TDMA* (Time Division Multiple Access)

***A Bis -- Interface* :-**

The A Bis – interface is the interface between the BSC (Base Station Controller) and the BTS. The interface companies traffic and control channels.

***A – Interface* :-**

The a – Interface is the interface between the BSC and the MSC.

***Logical Channels on the Um-Interface :-***

One or more logical channels may be transmitted on physical channel. The different type of logical channel is determined by the function of the information transmitted over it.           The following types of logical channels are defined :-

        Traffic channels

        Broadcast Channels

        Common Control Channels

        Dedicated Control Channels

The first channel type carries speech and data and the other types control information (signaling).

**GSM Network Overview**

**ME**

SIM

**BTS**

**BTS**

**B SC**

**BSC**

**MSC**

**HLR**

**EIR**

**VLR**

**AuC**

Mobile Station

Base Station Subsystem

Network Subsystem

**PSTN ISDN**

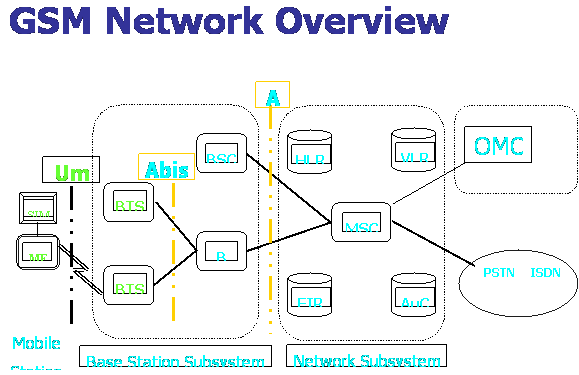
**PSPDN CSPDN**

**Um**

**Abis**

**A**

OMC



The network attachment process consists of the following tasks :-

***Cell Identification:-***

When mobile station is switched on, it attempts to make contacts with a

GSM PLMN by performing the following tasks:-

·        Measure the BCCH channel

·        Search for a suitable cell

***PLMN Selection :*-**

The particular PLMN to be contacted can be selected either in one of

 the following modes :-

        Automatic Mode

        Manual Mode

***Cell Selection:-***

The mobile station attempts to find a suitable cell by passing through

the list in descending order of received signal strength

         It should be cell of the selected PLMN

        It should not be ‘barred’.

        The radio path laws between the MS and the selected BTS must be below a  threshold set by the PLMN operator.

        It should not be in ‘ forbidden LA’s for roaming ‘

***No Suitable Cell Found:-***

If the MS is unable to find a suitable cell to access, it attempts to

access a cell irrespective of the PLMN identity, and enters a ‘limited

services’ state in which it can only attempt to make emergency calls.

**RADIO RESOURCES MANAGEMENT**

* This layer establishes link, both radio and fixed, between MS and MSC.
* Main Functional Components :- MS, Base Station Subsystem, MSC.
* RR layer concerns with the management of RR session. This session is initiated by MS either for an outgoing call or in response to a paging message.

**MOBILITY MANAGEMENT**

The Mobility management layer (MM) is built on top of the RR layer, and handles the functions that arise from the mobility of the subscriber, as well as the authentication and security aspects. Location management is concerned with the procedures that enables the system to know the current location of a powered – on mobile station so that incoming call routing can be completed.

**LOCATION UPDATE**

A powered-on mobile is informed of an incoming call by a paging message sent over the PAGCH channel of a cell. One extreme would be to page every cell in the network for each call, which is obviously a waste of radio bandwidth. The other extreme would be for the mobile to notify the system, via location updating messages, of its current location at the individual cell level. This would require paging messages to be sent to exactly one cell, but would be very wasteful due to the large number of location updating messages. A compromise solution used in GSM is to group cells into *location areas*. Updating messages are required when moving between location areas, and mobile stations are paged in the cells of their current location area.

The location updating procedures, and subsequent call routing, use the MSC and two location registers: the Home Location Register (HLR) and the Visitor Location Register (VLR). When a mobile station is switched on in a new location area, or it moves to a new location area or different operator's PLMN, it must register with the network to indicate its current location. In the normal case, a location update message is sent to the new MSC/VLR, which records the location area information, and then sends the location information to the subscriber's HLR. The information sent to the HLR is normally the SS7 address of the new VLR, although it may be a routing number. The reason a routing number is not normally assigned, even though it would reduce signaling, is that there is only a limited number of routing numbers available in the new MSC/VLR and they are allocated on demand for incoming calls. If the subscriber is entitled to service, the HLR sends a subset of the subscriber information, needed for call control, to the new MSC/VLR, and sends a message to the old MSC/VLR to cancel the old registration.

**COMMUNICATION MANAGEMENT**

The Communication Management layer (CM) is responsible for Call Control (CC), supplementary service management, and short message service management. Each of these may be considered as a separate sub layer within the CM layer. Call control attempts to follow the ISDN procedures specified in Q.931, although routing to a roaming mobile subscriber is obviously unique to GSM. Other functions of the CC sub layer include call establishment, selection of the type of service (including alternating between services during a call), and call release.

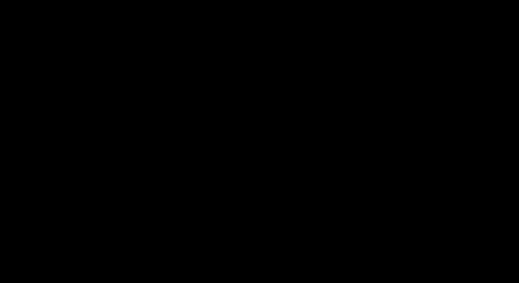
**CALL ROUTING**

Unlike routing in the fixed network, where a terminal is semi-permanently wired to a central office, a GSM user can roam nationally and even internationally. The directory number dialed to reach a mobile subscriber is called the Mobile Subscriber ISDN (MSISDN), which is defined by the E.164 numbering plan. This number includes a country code and a National Destination Code which identifies the subscriber's operator. The first few digits of the remaining subscriber number may identify the subscriber's HLR within the home PLMN.

An incoming mobile terminating call is directed to the Gateway MSC (GMSC) function. The GMSC is basically a switch, which is able to interrogate the subscriber's HLR to obtain routing information, and thus contains a table linking MSISDNs to their corresponding HLR. A simplification is to have a GSMC handle one specific PLMN. It should be noted that the GMSC function is distinct from the MSC function, but is usually implemented in an MSC.

The routing information that is returned to the GMSC is the Mobile Station Roaming Number (MSRN), which is also defined by the E.164 numbering plan. MSRNs are related to the geographical numbering plan, and not assigned to subscribers, nor are they visible to subscribers.

The most general routing procedure begins with the GMSC querying the called subscriber's HLR for an MSRN. The HLR typically stores only the SS7 address of the subscriber's current VLR, and does not have the MSRN (see the location updating section). The HLR must therefore query the subscriber's current VLR, which will temporarily allocate an MSRN from its pool for the call. This MSRN is returned to the HLR and back to the GMSC, which can then route the call to the new MSC. At the new MSC, the IMSI corresponding to the MSRN is looked up, and the mobile is paged in its current location area.



 Call Processing And SMS :-

***Mobile originated (MO) call***: - There are four types of distinct phase

* Setup phase
* Ringing phase
* Conversation phase

        Release phase

Setup phase is the most important phase and includes

* Authentication of the subscriber
* Ciphering of data over radio interface
* Validation of mobile equipment
* Validation of subscriber data at VLR for requests service
* Assignment of a voice channel

The MS hears the ringing tone from the destination local exchange through the establishment voice path.

**MOBILE CALL SETUP: -**

Mobile call setup involves exchange of no. of message between the various elements in the system. For setting up a mobile call following process is involved. It deals with two examples: -

* Terminating call when the MS is in the HPLMN.
* Terminating call when the MS is roaming.

The call set up broadly involves the following steps: -

* PSTN subscriber dials MSISDN
* Call is routed by PSTN network to GMSC of HPLMN of the dialed mobile             subscriber.
* GMSC interrogates HLR for verification of the access privileges profile and for obtaining the location details if the call is permitted.
* HLR directs the call to VLR of MSC area in which the mobile customer is currently located.
* MSC interrogates VLR to obtain exact location of the MS.
* VLR provides LAC to the MSC.
* MSC translates the LAC code into BTS identity.
* BSS pages all the BTSs identified by MSC within which MS is located using IMSI .
* MS responds to the paging
* Call is connected .
* In case of roaming call MS will be located in a VPLMN
* In such case steps are as follows:
* On registration with VPLMN ,HLR will place a pointer in the data base for MS indicating the current VLR address.
* On interrogation by GMSC of the HPLMN ,HLR will in turn interrogate VLR of VPLMN using the already stored pointer
* VLR in VPLMN will assign a roaming number called in MSRN . To enable the HPLMN to route the call to the VPLMN
* Using MSRN , call is routed back from HPLMN to VPLMN and VMSC interrogates the VLR
* VLR provides the LAC and call proceeds exactly in the same manner as for the call in.

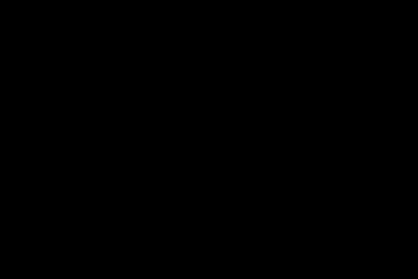


Figure depicts the different network elements involved in the call setup

**SERVICES PROVIDED BY GSM**

Telecommunication services can be divided into bearer services, teleservices, and the supplementary services.

The most basic teleservice supported by GSM is telephony. As with all other communications, speech is digitally encoded and transmitted through the GSM network as a digital stream. There is also an emergency service, where the nearest emergency-service provider is notified by dialing three digits no. similar to 911

A variety of data services is offered. GSM users can send and receive data, at rates up to 9600 bps, to users on POTS (Plain Old Telephone Service), ISDN, Packet Switched Public Data Networks, and Circuit Switched Public Data Networks using a variety of access methods and protocols, such as X.25 or X.32. Since GSM is a digital network, a modem is not required between the user and GSM network, although an audio modem is required inside the GSM network to interwork with POTS.

A unique feature of GSM, not found in older analog systems, is the Short Message Service (SMS). SMS is a bi-directional service for short alphanumeric (up to 160 bytes) messages. Messages are transported in a store-and-forward fashion. For point-to-point SMS, a message can be sent to another subscriber to the service, and an acknowledgement of receipt is provided to the sender. SMS can also be used in a cell-broadcast mode, for sending messages such as traffic updates or news updates. Messages can also be stored in the SIM card for later retrieval.

Supplementary services are provided on top of teleservices or bearer services. In the current (Phase I) specifications, they include several forms of call forward (such as call forwarding when the mobile subscriber is unreachable by the network), and call barring of outgoing or incoming calls, for example when roaming in another country. Many additional supplementary services will be provided in the Phase 2 specifications, such as caller identification, call waiting, multi-party conversations

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**WEBSITE:-**

[www.delhi.mtnl.in](http://www.delhi.mtnl.in/)

<http://www.mtnl.org>

**CONCLUSION**

After undergoing a practical training we concluded that on the basis of our theoretical knowledge we can develop any complex utility. In GSM Architecture I studied high functionality of seamless global roaming. In call processing I was taught about call origination and call termination. Also various new feature and services provided by the third generation.