CHAPTER THREE

Global System Mobility

3.1 Introduction

Global System Mobility (GSM) is the most successful digital mobile telecommunication system in the world today. It is used by over 800 million people in more than 190 countries. GSM permits the integration of different voice and data services and the interworking with existing networks. Services make a network interesting for customers

Listed below are the features of GSM that account for its popularity and wide accepatance.

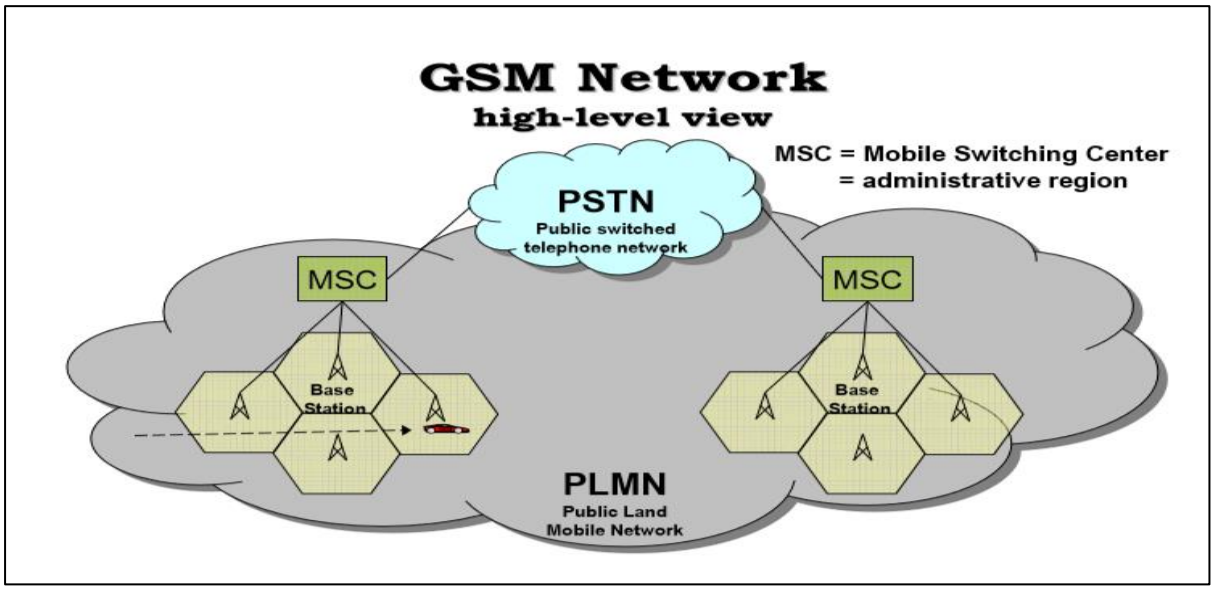
- International roaming
- Low-cost mobile sets and base stations (BSs)
- High-quality speech
- Compatibility with Integrated Services Digital Network (ISDN) and other telephone company services
- Support for new services

3.2 GSM Network Areas

In a GSM network, the following areas are defined:

- Cell: Cell is the basic service area; one BTS covers one cell. Each cell is given a Cell Global Identity (CGI), a number that uniquely identifies the cell.
- Location Area: A group of cells form a Location Area (LA). This is the area that is paged when a subscriber gets an incoming call. Each LA is assigned a Location Area Identity (LAI). Each LA is served by one or more BSCs.
- MSC/VLR Service Area: The area covered by one MSC is called the MSC/VLR service area.

- PLMN: The area covered by one network operator is called the Public Land Mobile Network (PLMN). A PLMN can contain one or more MSCs.



2.3 GSM ARCITECTURE

The GSM technical specifications define the different elements within the GSM network architecture. It defines the different elements and the ways in which they interact to enable the overall system operation to be maintained.

The GSM network architecture is now well established and with the other later cellular systems now established and other new ones being deployed, the basic GSM network architecture has been updated to interface to the network elements required by these systems.

Despite the developments of the newer systems, the basic GSM system architecture has been maintained, and the network elements described below perform the same functions as they did when the original GSM system was launched in the early 1990s.GSM network architecture elements

The GSM network architecture as defined in the GSM specifications can be grouped into four main areas:

1. MS (MOBILE STATION)
2. NSS (NETWORK STATION SUBSYSTEM)
3. BSS (BASE STATION SUBSYSTEM)
4. OSS (OPERATION SUPPORT SUBSYSTEM)

The different elements of the GSM network operate together and the user is not aware of the different entities within the system.

A basic diagram of the overall GSM system architecture with these four major elements is shown below:

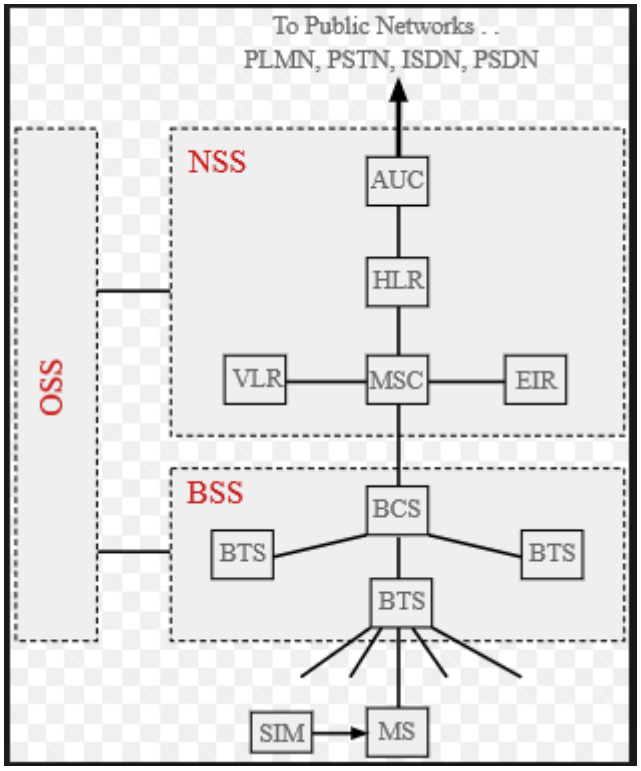


Fig1 : Simplified GSM Network Architecture Diagram

Simplified diagram of the architecture of a typical GSM network showing the main elements in the base station subsystem, network and switching subsystem as well as the operation and support subsystem as showen in figure (1).

1. MS (MOBILE STATION)

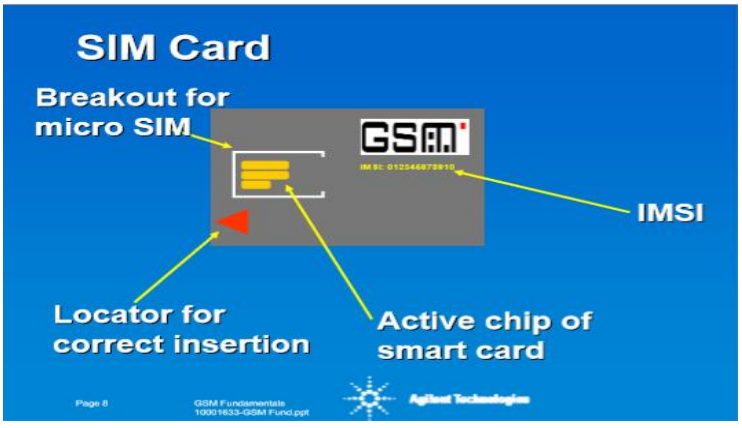
it consist of

1. **Mobile stations (MS)**
2. **Mobile equipment (ME)** or as they are most widely known, cell or mobile phones are the section of a GSM cellular network that the user sees and operates. In recent years their size has fallen dramatically while the level of functionality has greatly increased. A further advantage is that the time between charges has significantly increased.

There are a number of elements to the cell phone, although the two main elements are the main **hardware** and the **SIM.**

The hardware itself contains the main elements of the mobile phone including the display, case, battery, and the electronics used to generate the signal, and process the data receiver and to be transmitted. It also contains a number known as the International Mobile Equipment Identity (IMEI). This is installed in the phone at manufacture and "cannot" be changed. It is accessed by the network during registration to check whether the equipment has been reported as stolen.

The SIM or Subscriber Identity Module contains the information that provides the identity of the user to the network. It contains are variety of information including a number known as the International Mobile Subscriber Identity (IMSI).



2. BSS (BASE STATION SUBSYSTEM)

The Base Station Subsystem (BSS) section of the GSM network architecture that is fundamentally associated with communicating with the mobiles on the network. It consists of two elements:

1. **Base Transceiver Station (BTS):** The BTS used in a GSM network comprises the radio transmitter receivers, and their associated antennas that transmit and receive to directly communicate with the mobiles. The BTS is the defining element for each cell. The BTS communicates with the mobiles and the interface between the two is known as the Um interface with its associated protocols.

2. **Base Station Controller (BSC):** The BSC forms the next stage back into the GSM network. It controls a group of BTSs, and is often co-located with one of the BTSs in its group. It manages the radio resources and controls items such as handover within the group of BTSs, allocates channels and the like. It communicates with the BTSs over what is termed the Abis interface.

3. NSS (NETWORK STATION SUBSYSTEM)

The GSM system architecture contains a variety of different elements, and is often termed the core network. It provides the main control and interfacing for the whole mobile network. The major elements within the core network include:

1. MSC (Mobile Services Switching Centre)
2. HLR (Home Location Register)
3. VLR (Visitor Location Register)
4. EIR (Equipment Identity Register)
5. AuC (Authentication Centre)
6. SMS-G (SMS Gateway)
7. GMSC (Gateway Mobile Switching Centre)

1. **Mobile Services Switching Centre (MSC):** The main element within the core network area of the overall GSM network architecture is the Mobile switching Services Centre (MSC). The MSC acts like a normal switching node within a PSTN or ISDN, but also provides additional functionality to enable the requirements of a mobile user to be supported. These include registration, authentication, call location, inter-MSC handovers and call routing to a mobile subscriber. It also provides an interface to the PSTN so that calls can be routed from the mobile network to a phone connected to a landline. Interfaces to other MSCs are provided to enable calls to be made to mobiles on different networks.
2. **Home Location Register (HLR):** This database contains all the administrative information about each subscriber along with their last known location. In this way, the GSM network is able to route calls to the relevant base station for the MS. When a user switches on their phone, the phone registers with the network and from this it is possible to determine which BTS it communicates with so that incoming calls can be routed appropriately. Even when the phone is not active (but switched on) it re-registers periodically to ensure that the network (HLR) is aware of its latest position. There is one HLR per network, although it may be distributed across various sub-centres to for operational reasons.
3. **Visitor Location Register (VLR):** This contains selected information from the HLR that enables the selected services for the individual subscriber to be provided. The VLR can be implemented as a separate entity, but it is commonly realised as an integral part of the MSC, rather than a separate entity. In this way access is made faster and more convenient.
4. **Equipment Identity Register (EIR):** The EIR is the entity that decides whether a given mobile equipment may be allowed onto the network. Each mobile equipment has a number known as the International Mobile Equipment Identity. This number, as mentioned above, is installed in the equipment and is checked by the network during registration. Dependent upon the information held in the EIR,

the mobile may be allocated one of three states - allowed onto the network, barred access, or monitored in case its problems.

5. **Authentication Centre (AuC):** The AuC is a protected database that contains the secret key also contained in the user's SIM card. It is used for authentication and for ciphering on the radio channel.

6. **Gateway Mobile Switching Centre (GMSC**): The GMSC is the point to which a ME terminating call is initially routed, without any knowledge of the MS's location. The GMSC is thus in charge of obtaining the MSRN (Mobile Station Roaming Number) from the HLR based on the MSISDN (Mobile Station ISDN number, the "directory number" of a MS) and routing the call to the correct visited MSC. The "MSC" part of the term GMSC is misleading, since the gateway operation does not require any linking to an MSC.
7. **SMS Gateway (SMS-G):** The SMS-G or SMS gateway is the term that is used to collectively describe the two Short Message Services Gateways defined in the GSM standards. The two gateways handle messages directed in different directions. The SMS-GMSC (Short Message Service Gateway Mobile Switching Centre) is for short messages being sent to an ME. The SMS-IWMSC (Short Message Service Inter-Working Mobile Switching Centre) is used for short messages originated with a mobile on that network. The SMS-GMSC role is similar to that of the GMSC, whereas the SMS-IWMSC provides a fixed access point to the Short Message Service Centre.

4. OSS (OPERATION SUPPORT SUBSYSTEM)

It is the center for allthe operation and support by:

1. Planning The Network
2. Operating The Network
3. Maintainance The Network
4. Supervising The Network
5. Developing The Network

And Implement the the operations and maintenance center (OMC)

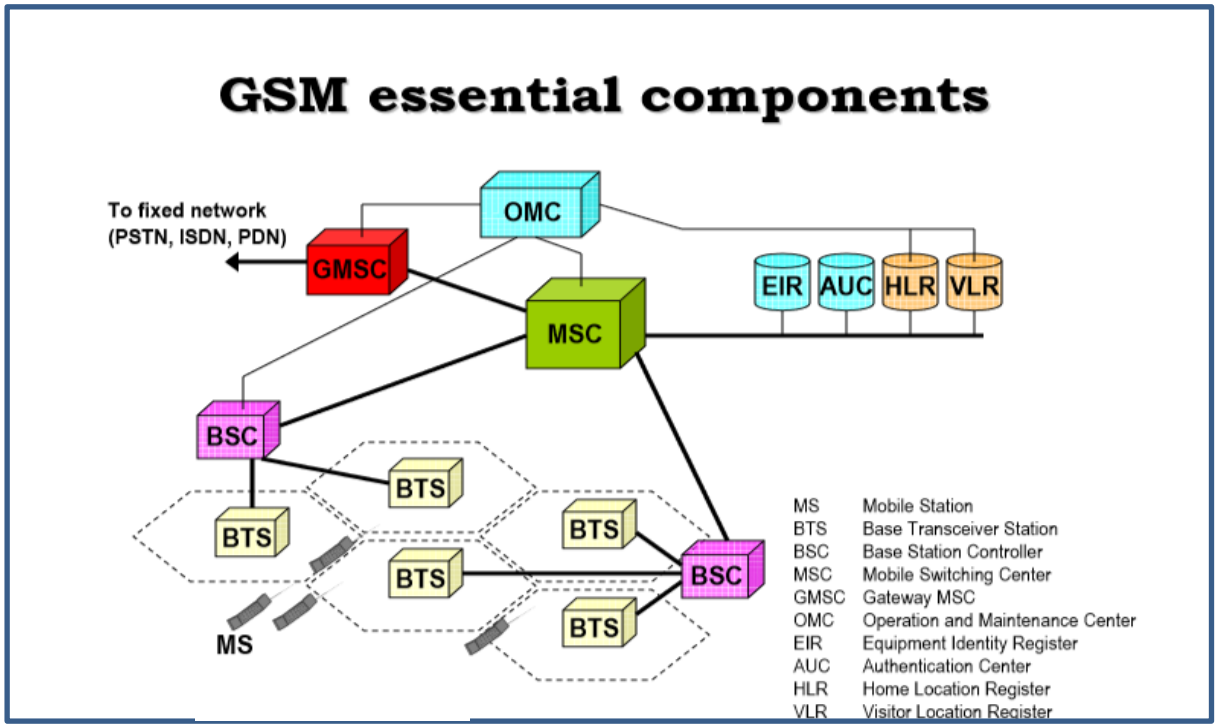
Operations And Maintenance Center (OMC) is connected to all equipment in the switching system and to the BSC. The implementation of OMC is called the operation and support system (OSS).

Here are some of the OMC functions:

- Administration and commercial operation (subscription, end terminals, charging and statistics).
- Security Management.
- Network configuration, Operation and Performance Management.
- Maintenance Tasks.

3.4 GSM Operations

Once a Mobile Station initiates a call, a series of events takes place. Analyzing these events can give an insight into the operation of the GSM system.



1. Mobile Phone to Public Switched Telephone Network (PSTN)

When a mobile subscriber makes a call to a PSTN telephone subscriber, the following sequence of events takes place:

1. The MSC/VLR receives the message of a call request.
2. The MSC/VLR checks if the mobile station is authorized to access the network. If so, the mobile station is activated. If the mobile station is not authorized, then the service will be denied.
3. MSC/VLR analyzes the number and initiates a call setup with the PSTN.
4. MSC/VLR asks the corresponding BSC to allocate a traffic channel (a radio channel and a timeslot).
5. The BSC allocates the traffic channel and passes the information to the mobile station.
6. The called party answers the call and the conversation takes place.
7. The mobile station keeps on taking measurements of the radio channels in the present cell and the neighboring cells and passes the information to the BSC. The BSC decides if a handover is required. If so, a new traffic channel is allocated to the mobile station and the handover takes place. If handover is not required, the mobile station continues to transmit in the same frequency.

2. PSTN to Mobile Phone

When a PSTN subscriber calls a mobile station, the following sequence of events takes place:

1. The Gateway MSC receives the call and queries the HLR for the information needed to route the call to the serving MSC/VLR.
2. The GMSC routes the call to the MSC/VLR.
3. The MSC checks the VLR for the location area of the MS.
4. The MSC contacts the MS via the BSC through a broadcast message, that is, through a paging request.
5. The MS responds to the page request.