Global System for Mobile Communications

GSM (Global System for Mobile communication) is a second-generation digital mobile network that is widely used by mobile phone users in Europe and other parts of the world. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies: TDMA, GSM and code-division multiple access (CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 megahertz (MHz) or 1,800 MHz frequency band.

GSM, together with other technologies, is part of the evolution of wireless mobile telecommunications that includes High-Speed Circuit-Switched Data (HSCSD), General Packet Radio Service (GPRS), Enhanced Data GSM Environment (EDGE) and Universal Mobile Telecommunications Service (UMTS).

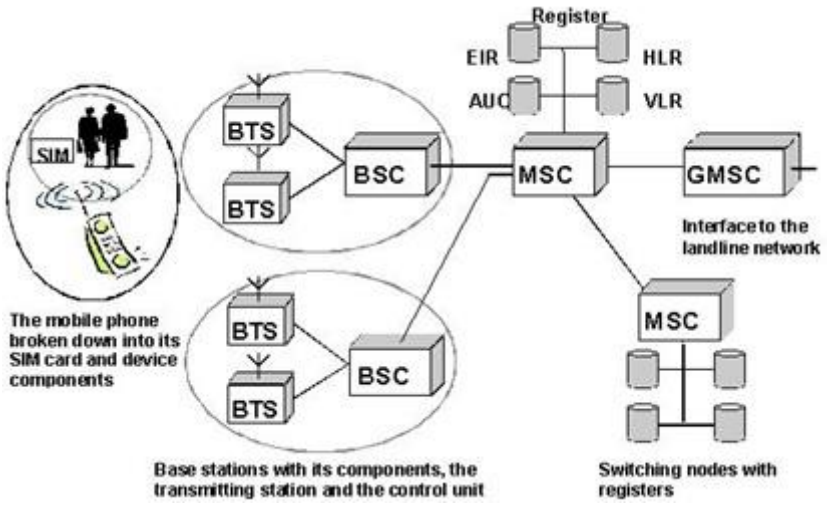
GSM - Architecture

The GSM network has four separate parts that work together to function as a whole:

- The Mobile Station (**MS**) the mobile device itself.
- the Base Station Subsystem (**BSS**) controls the radio link with the mobile station.
- the Network Switching Subsystem (**NSS**) performs the switching of calls between the mobile users and other mobile and fixed network users.
- the Operation and Support Subsystem (**OSS**).

The mobile device connects to the network via hardware. The subscriber identity module (SIM) card provides the network with identifying information about the mobile user.

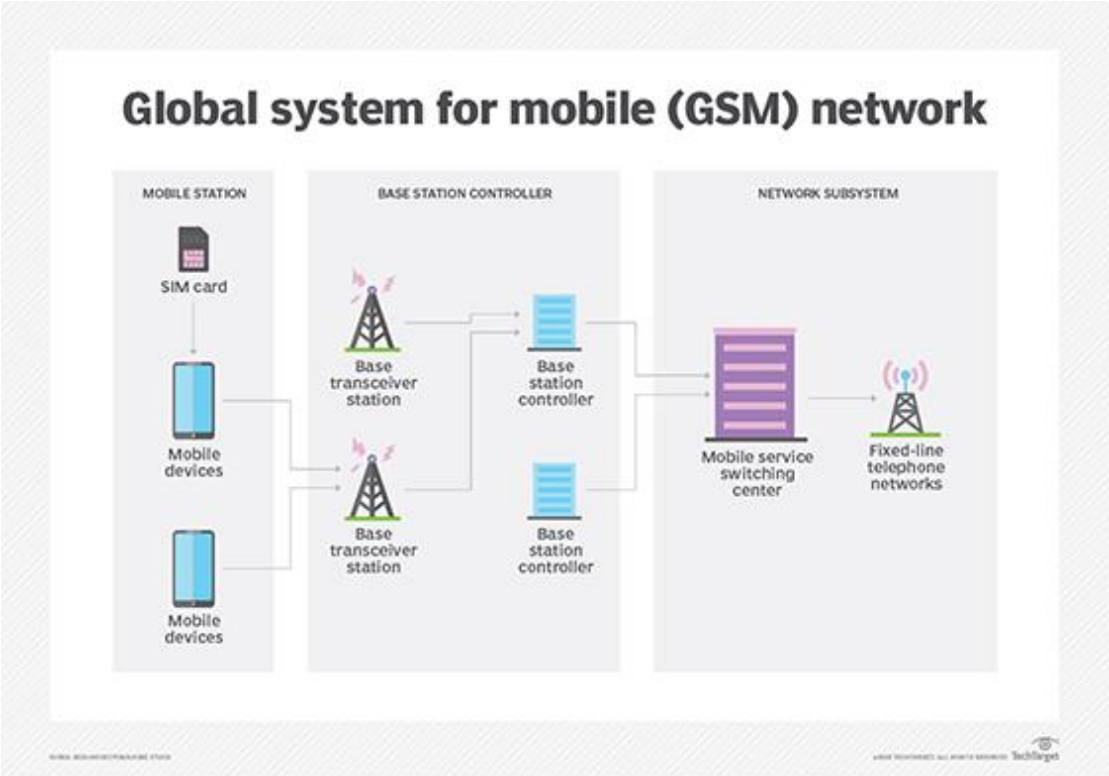
Here is the flow chart of GSM architecture:



GSM architecture diagram

SIM : Subscriber Identity Module

HLR : Home Location Register
MS : Mobile Station
VLR: Visitor Location Register
BTS: Base Transceiver Station
EIR: Equipment Identity Register
BSC: Base Station Controller
AC: Authentication Center
MSC: Mobile services Switching Center
PSTN: Public Switched Telecomm Network
VLR: Visitor Location Register
ISDN: Integrated Services Digital Network



- The NSS portion of the GSM network architecture, often called the core network, tracks the location of callers to enable the delivery of cellular services. Mobile carriers own the NSS. The NSS has a variety of parts, including mobile switching center (MSC) and home location register (HLN). These components perform different functions, such as routing calls and Short Message Service (SMS) and authenticating and storing caller account information via SIM cards.

Mobile Station (MS)

The mobile station consists of: -

A. Mobile equipment (ME):

- It is a portable, vehicle mounted, hand held device.
- It is uniquely identified by an International Mobile Equipment Identity IMEI number.
- It is used for voice and data transmission. It also monitors power and signal quality. 160 characters long SMS can also be sent using Mobile Equipment.

The MS Functions

B. Subscriber Identity module (SIM):

- It is a smart card that contains the International Mobile Subscriber Identity (IMSI) number used to identify the subscriber to the system, a secret key for authentication and other information.
- It allows users to send and receive calls and receive other subscriber services.
- The SIM card may be protected against unauthorized use by a password or personal identity number PIN.
- It contains encoded network identification details. it has key information to activate the phone.
- It can be moved from one mobile to another.

Base Station Subsystem (BSS**)**

The base station controller manages the radio resources for one or more base transceiver stations. It is the connection between the mobile station and the mobile services switching center. The BSS handles traffic between the cell phone and the NSS.

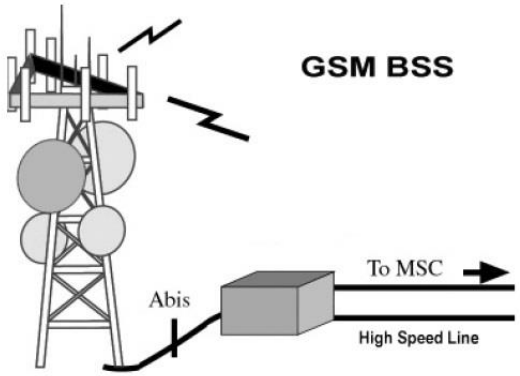
The base station subsystem is composed of two parts:

- the **Base Transceiver Station (BTS)**.
    - It encodes, encrypts, multiplexes, modulates and feeds the RF signal to the antenna.

- It consists of transceiver units.
- It communicates with mobile stations via radio air interface and also communicates with BSC via Abis interface.
- The BTS contains the equipment that communicates with the mobile phones, largely the radio transmitter receivers and antennas.

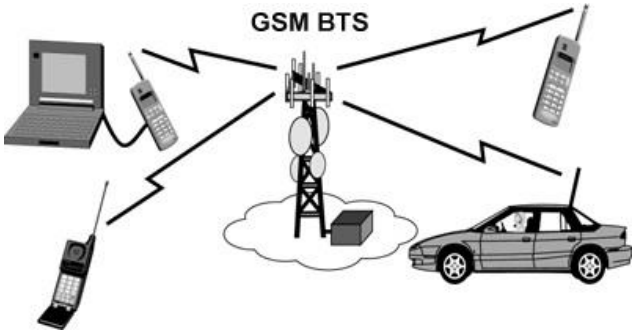
- the **Base Station Controller (BSC)**.
  - It manages radio resources for BTS. It assigns frequency and time slots for all mobile stations in its area.
  - It handles call set up, transcoding and adaptation functionality handover for each MS radio power control.
  - It communicates with MSC via an interface and also with BTS.
  - the BSC, is the intelligence behind BTS. The BSC communicates with and controls a group of base transceiver stations.

- The BSS uses the Abis interface between the BTS and the BSC. A separate high-speed line (T1 or E1) is then connected from the BSS to the Mobile MSC.



The Base Transceiver Station (BTS)

The BTS houses the radio transceivers that define a cell and handles the radio link protocols with the MS. In a large urban area, a large number of BTSs may be deployed.



The BTS corresponds to the transceivers and antennas used in each cell of the network. A BTS is usually placed in the center of a cell. Its transmitting power defines the size of a cell. Each BTS has between 1 and 16

transceivers, depending on the density of users in the cell. Each BTS serves as a single cell. It also includes the following functions −

The Base Station Controller (BSC)

The BSC manages the radio resources for one or more BTSs. It handles radio channel setup, frequency hopping, and handovers. The BSC is the connection between the mobile and the MSC. The BSC also translates the 13 Kbps voice channel used over the radio link to the standard 64 Kbps channel used by the Public Switched Telephone Network (PSDN) or ISDN.

It assigns and releases frequencies and time slots for the MS. The BSC also handles intercell handover. It controls the power transmission of the BSS and MS in its area. The function of the BSC is to allocate the necessary time slots between the BTS and the MSC. It is a switching device that handles the radio resources.

The additional functions include−

- Control of frequency hopping
- Performing traffic concentration to reduce the number of lines from the MSC
- Providing an interface to the Operations and Maintenance Center for the BSS
- Reallocation of frequencies among BTSs
- Time and frequency synchronization
- Power management
- Time-delay measurements of received signals from the MS

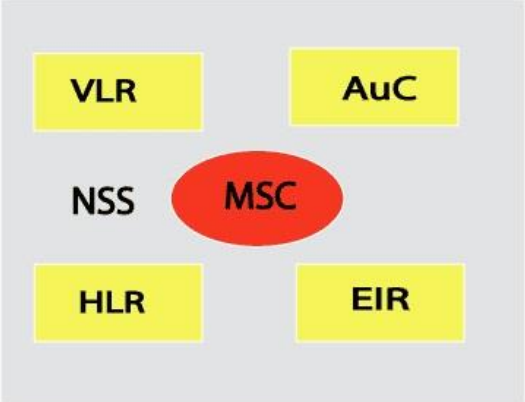
Network Subsystem

The central component of the network subsystem is the mobile services switching center. This acts like a normal switching node of the **PSTN** (Public Switched Telephone Network) or **ISDN** (Integrated Services Digital Network) and connects the mobile signal to these fixed networks. It additionally provides all the functionality needed to handle a mobile subscriber, such as registration, authentication, location updating, handovers and call routing to a roaming subscriber.

GSM - The Network Switching Subsystem (NSS)

The Network switching system (NSS): -

- performs the switching of calls between the mobile and other fixed or mobile network users, as well as the management of mobile services such as authentication.
- it manages the switching functions of the system and allows MSCs to communicate with other networks such as PSTN and ISDN.



The switching system includes the following functional elements −

Home Location Register (HLR)

The HLR is a database used for storage and management of subscriptions. The HLR is considered the most important database, as it stores permanent data about subscribers, including a subscriber's service profile, location information, and activity status. When an individual buys a subscription in the form of SIM, then all the information about this subscription is registered in the HLR of that operator.

Mobile Services Switching Center (MSC)

- It is a heart of the network. It manages communication between GSM and other networks Every MSC is identified by a unique ID.
- It manages call set up function, routing and basic switching.
- It performs mobility management including registration, location updating and inter BSS and inter MSC call handoff.
- It provides billing information.
- MSC does gateway function while its customers roam to other network by using HLR/VLR.

Visitor Location Register (VLR)

The VLR is a database that contains temporary information about subscribers that is needed by the MSC in order to service visiting subscribers. The VLR is always integrated with the MSC. When a mobile station roams into a new MSC area, the VLR connected to that MSC will request data about the mobile station from the HLR. Later, if the mobile station makes a call, the VLR will have the information needed for call setup without having to interrogate the HLR each time.

Authentication Center (AUC)

The Authentication Center is a protected database that stores a copy of the secret key stored in each subscriber's SIM card, which is used for authentication and ciphering of the radio channel. The AUC protects network operators from different types of intruders found in today's cellular world.

Equipment Identity Register (EIR)

The Equipment Identity Register (**EIR**) is a database that contains a list of all valid mobile equipment on the network, where its International Mobile Equipment Identity (**IMEI**) identifies each MS. An **IMEI** is marked as invalid if it has been reported stolen or is not type approved.

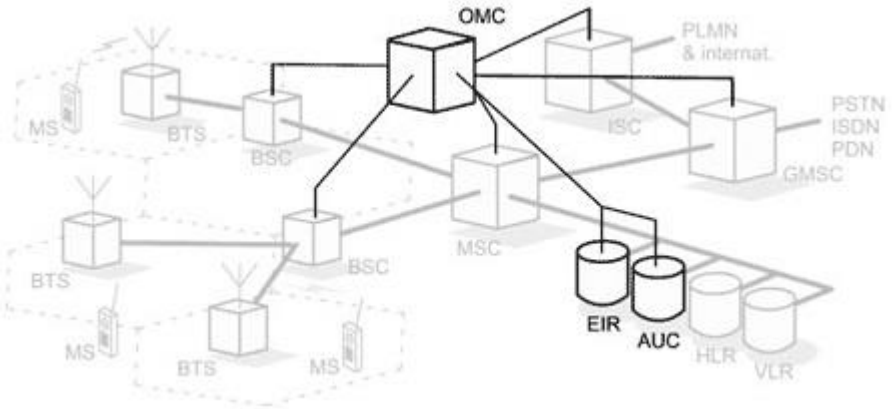
It is made up of three sub classes- the white list, the black list and the gray list.

GSM - The Operation Support Subsystem (OSS)

The operations and maintenance center (OMC) is connected to all equipment in the switching system and to the BSC. It supports the operation and maintenance of GSM and allows system engineers to monitor, diagnose and troubleshoot all aspects of GSM system. It supports one or more Operation Maintenance Centers (OMC) which are used to monitor the performance of each MS, Bs, BSC and MSC within a GSM system. Here are some of the **OMC** functions:

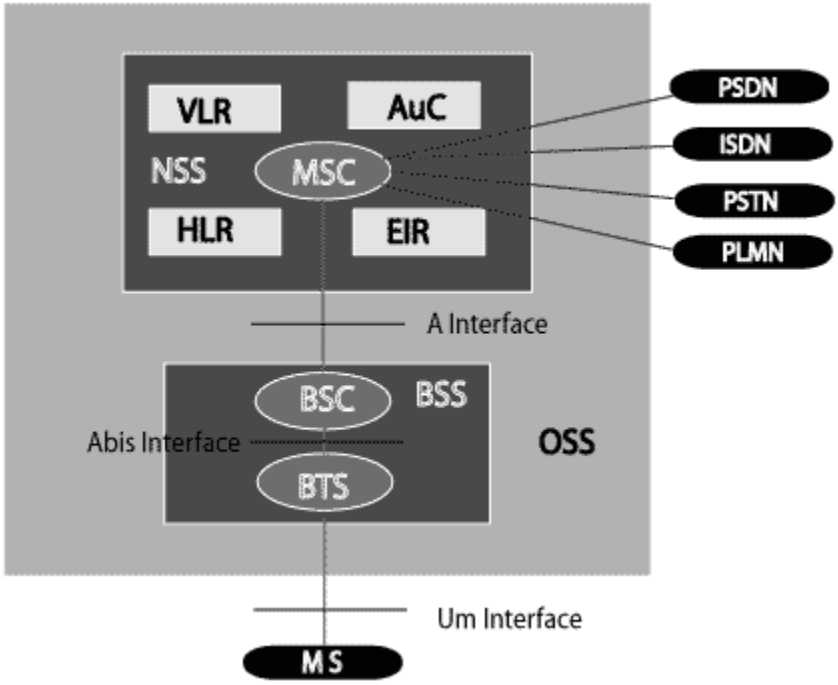
- To maintain all telecommunication hardware and network operations with a particular market. (Maintenance Tasks)
- To manage all charging and billing procedures (Administration and commercial operation).
- To manage all mobile equipment in the system.
- Security Management.
- Network configuration, Operation, and Performance Management.

Following is the figure, which shows how **OMC** system covers all the **GSM** elements.



The **OSS** is the functional entity from which the network operator monitors and controls the system. The purpose of **OSS** is to offer the customer cost-effective support for centralized, regional, and local operational and maintenance activities that are required for a **GSM** network. An important function of **OSS** is to provide a network overview and support the maintenance activities of different operation and maintenance organizations.

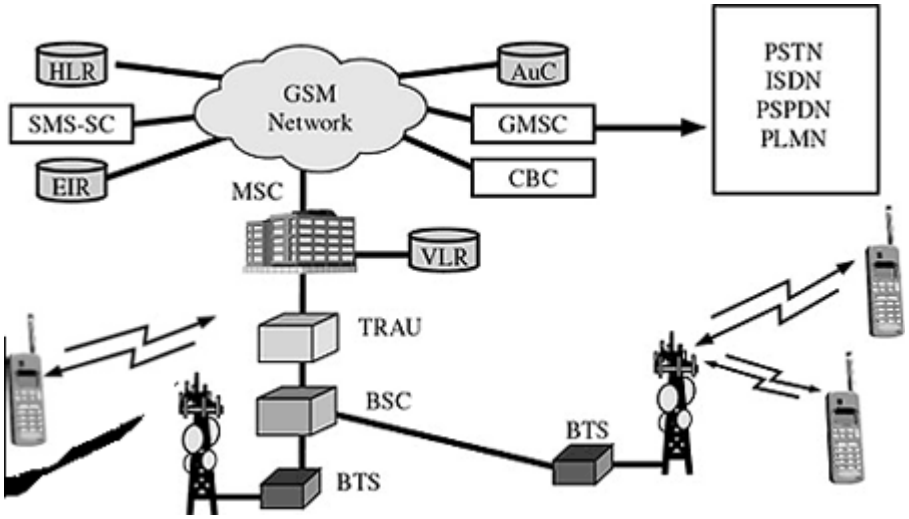
A simple pictorial view of the **GSM** architecture is given below −



The additional components of the **GSM** architecture comprise of databases and messaging systems functions: -

- Home Location Register (**HLR**)
- Visitor Location Register (**VLR**)
- Equipment Identity Register (**EIR**)
- Authentication Center (**AuC**)
- SMS Serving Center (**SMS SC**)
- Gateway MSC (**GMSC**)
- Chargeback Center (**CBC**)
- Transcoder and Adaptation Unit (**TRAU**)

The following diagram shows the **GSM** network along with the added elements −



The **MS** and the **BSS** communicate across the Um interface. It is also known as the *air interface* or the *radio link*. The **BSS** communicates with the Network Service Switching (**NSS**) center across the *A* interface.

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**.

Interfaces used for GSM network:

1)UM Interface –Used to communicate between BTS with MS.

2)Abis Interface— Used to communicate BSC TO BTS.

3)A Interface-- Used to communicate BSC and MSC.

4) Singling protocol (SS 7)- Used to communicate MSC with other network.

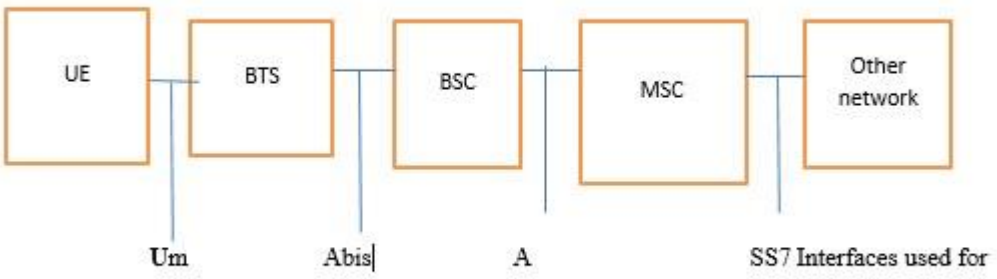


Fig 2 GSM network Interfaces

Features

- Original 2G standard was a digital, circuit-switched, full duplex network.
- GSM is part of the evolution of wireless mobile telecommunications including High-Speed Circuit-Switched Data (HSCSD), General Packet Radio Services (GPRS), Enhanced Data GSM Environment (EDGE), and Universal Mobile Telecommunications Service (UMTS).
- GSM operates at either 900 MHz or 1800 MHz frequency bands of the electromagnetic spectrum. It provides improved spectrum efficiency.
- It uses a variation of time division multiple access (TDMA) for placing multiple calls simultaneously over the same channel.
- It gives support for a number of new services like
    - International roaming
    - Compatibility with integrated services digital network (ISDN)
    - Short message service (SMS)
    - SIM phonebook management
    - Fixed dialing number (FDN)
- Digital technology assures high-quality voice communications and advanced encryption of voice and data signals that prevents eavesdropping.