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Basic Introduction to GSM Architecture and Call Flow

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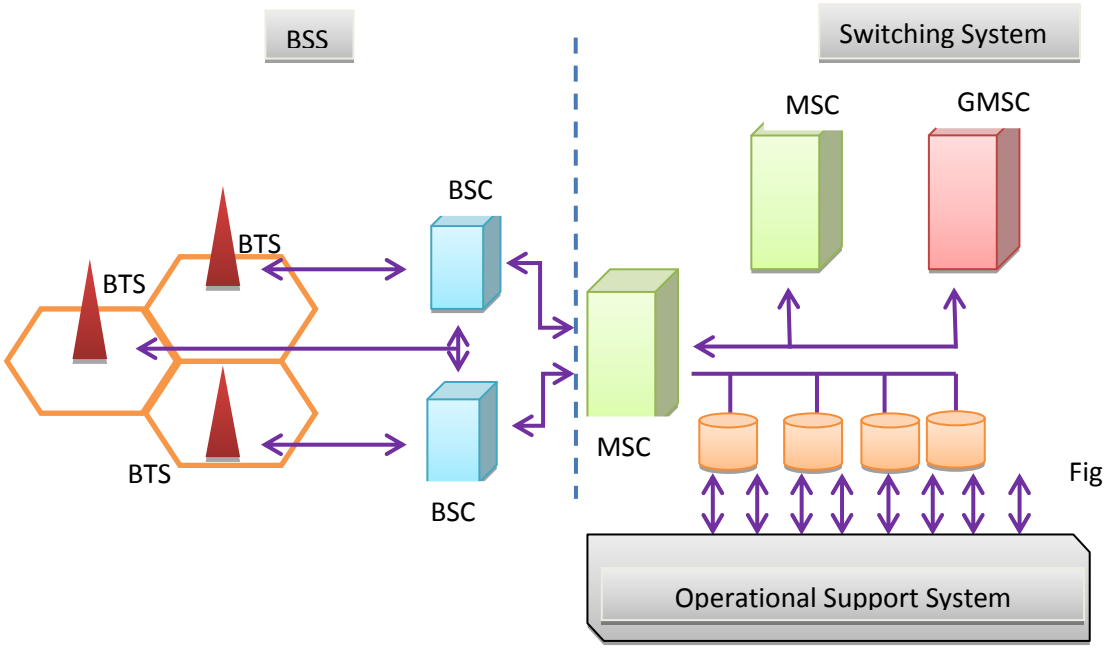
Abstract-GSM Architecture is the architecture on which our telecommunication system depends on. It has highly evolved from the 2G to 3G and now moving on 4G in India and 5G worldwide. The development of this architecture is not only in terms of infrastructure but also in the terms of software and coding to encrypt and secure the data. The 3G – 4G transition is only for data speed, keeping the voice constant.

Index Terms-Network element, call and sms flow, Billing System
Objective-The objective of this paper is to provide basic introduction and application of the GSM Architecture.

GSM Architecture and Call Flow



Fig

GSM Architecture : It refers to set of logically arranged network elements required for making and receiving calls from mobile station to another. It is divided in 3 parts :

a) Base Station Subsystem(BSS)
b) Switching System
c) Operational Support System (OSS)

From the above figure we can easily determine the call flow. In a normal call flow scenario, the user when making a call activates the mobile phone (mobile station) which sends signal to the closest

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BTS. While using the telecom service when we are on move, it is at the BTS that the handover takes place. Handovers occur to ensure that we are connected to the network even when we are moving.

The closest BTS then sends a signal to the BSC which connects BTS to the other network element. BSC is responsible for making the handover. Handover occurs amongst the BTS but the decision is made by the BSC. BTS and BSC combine to form BSS (Base Station Subsystem). BSC then sends the call signal to the MSC where the MSC recognizes and authenticates the subscriber information and establishes the call. MSC has 4 main elements:

a. **Home Location Register (HLR),** It maintains all the data related to a subscriber in its database. In HLR we find out whether the subscriber is eligible for a few services like able to make international calls and etc.

b. **Visitor Location Register (VLR)** - It maintains records of all those subscribers which are present at MSC location but their data is not present in HLR. During the first usage by the subscriber, the VLR is updated with the subscriber information and along with VLR, HLR is also updated for future reference.

c. **Equipment Identity Register (EIR)** - It just keeps track of all the Black list, White list and Grey list. All the blocked IMEI are in black list. All the IMEI 'under monitor' are in grey list and allthe authenticated IMEI are under white list.

d. **Authentication Center (AUC) -** It authenticates each SIM card that tried to have a connection with the GSM network.

After the call has reached MSC, MSC checks in VLR for the subscriber information, if the information is unavailable there it goes and checks in HLR. MSC authenticates all the subscriber details; once the authentication is complete the call is transferred to the MSC of the destination where the call has to end (Bnumber).

There are two types of calls:

a. Onnet: Where the calling party and the called party are of the same operator

b. Offnet: Where the calling party and the called party are of different operator whether it is international or local call.

From the revenue perspective, the onnet – offnet calls and the difference is very important. As the operators pay a fee (pre-decided in the contract) when their call is being terminated over the other operator or the carrier (We will learn about this in detail later). Hence the terminating calls are considered revenue generating.

CASE I – Onnet

When the call is onnet, it is very easy and convenient for the operator as the expense is very less. The operator is using its own network element to originate (Anumber) as well as to terminate (Bnumber) the call.

So in onnet scenario, the operator sends the call from MSC to the other MSC (or BSC if the Anumber and Bnumber come under first MSC) which then forwards the call to the closest BSC. The BSC then transfers the signal to the closest BTS letting the call terminate at the MS of the called number (Bnumber)

CASE II – Offnet

When the call is offnet, the MSC transfers the call to the GMSC (Gateway MSC) which then sends the call to the MSC of the called party (Bnumber for local call) or transfers the call to the Carrier

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(international call). The carrier carries the call to the MSC of the Bnumber which like previous case, takes the call to the BSC. BSC then takes the call to BTS which then finally transfers it to the MS of the called party (Bnumber).

In an offnet(local) call the call originating operator pays the call terminating operator. Whereas, in the offnet(international) call the call originator pays the carrier, who then pays to call terminating operator. As we are here to generate revenue and increase the income, the rates for international calls are much higher than the local calls. The payment is done on the predefined currency. Every operator and carrier has a contract which defines the rate at which they will pay to each other. Normally, the payment is done in relation to the duration of the calls travelled from the operator to the carrier and vice versa.

Once the call is complete (Onnet or Offnet)MSC and OCS generate a ticket called CDR – Call Detail Record or Call Data Record. The CDR primarily contains:

a. Anumber- Calling Party
b. Bnumber- Called Party
c. Timestamp – At what time did the call originate
d. Duration – How long did the call last for

There are various other fields are also generated but the above 4 fields are very important to help in generation of bill (for postpaid) or deducting balance (for prepaid) in OCS- Online Charging System.

Operational Support System (OSS)- The purpose of OSS is to offer the operator with cost effective support for centralized, regional and local operations. It is used to control and monitor the system and various network elements. It facilitates the maintenance activities that are required for a GSM network. It provides the following:

a. Provide network overview and support maintenance
b. Fault management and alarm surveillance

The above THREE subsystem establish an end to end GSM Architecture.

GSM Architecture and SMS flow

Short Message Service (SMS) - It is a service provided by the operator to send text messages. This service is provided by MSC like network element called SMSC (Short Message Service Center). SMSC acts like a 'store and forward' element as it stores the message if the receiving mobile phone is switched off. Once the phone is switched on, the message is sent to it.

Once the subscriber (Anumber) sends a message, it travels through its MSC and lands in the SMSC from where the SMS is further routed to Bnumber. The [illegible] w forwards the message to the MSC of the receiving subscriber (Bnumber), which in tu [illegible] sends the message to the receiving subscriber.'

Fig 6

Other elements of GSM:

- Billing System – It is used to bill the usage of the postpaid subscribers, where they pay after using the services. The rate is predetermined by the operator, and depending on the rate and after removing the discounts final amount is billed to the subscriber.
- Mediation Device - It is a device between MSC and the billing system. Its main function is to convert the MSC generated CDR into a format which can be read by the billing system. The mediation receives these CDRs on a regular interval of time.

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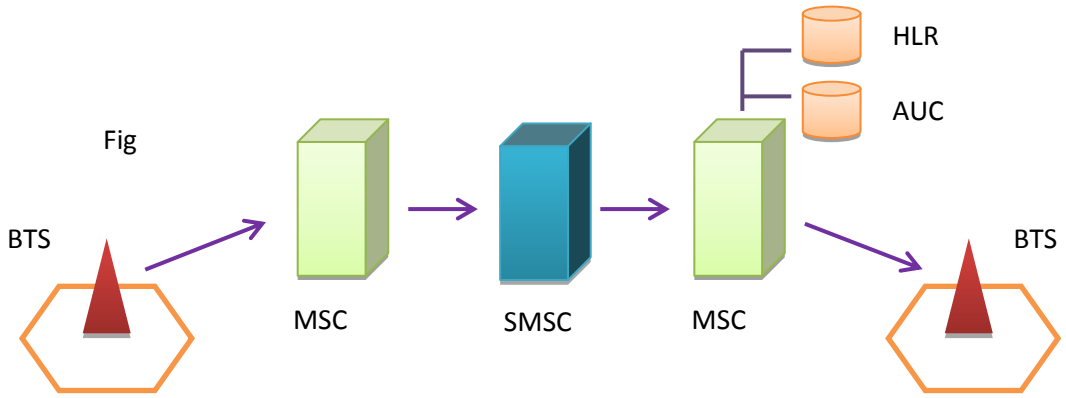

- Intelligent Network (IN) – It controls the prepaid subscribers. When the subscriber tries to use the service, the MCS pings the IN and determines whether the `subscriber has enough balance to avail the service or no. The IN keeps deducting balance on real time basis. If the subscriber runs out of balance, IN informs the MSC and hence the call is terminated.
- Interactive Voice Response (IVR)– It is a recorded message, which is heard when the subscriber makes a mistake like dialing an invalid number or if the called party (Bnumber) is busy etc.

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