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Channels and Identities in GSM

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Abstract
A cellular telephone system links mobile station (MS) subscribers into the public telephone system or to another cellular system's MS subscriber. Information sent between the MS subscriber and the cellular network uses radio communication. This removes the necessity for the fixed wiring used in a traditional telephone installation. Due to this, the MS subscriber is able to move around and become fully mobile, perhaps travelling in a vehicle or on foot. The physical channel is the medium over which the information is carried, in the case of a terrestrial interface this would be a cable. The logical channels consist of the information carried over the physical channel. Also, in GSM, Identities gives uniqueness to the user, on the bases of Subscriber, Location, and Equipment. This paper gives comprehensive review of the channels and identities used in Global System for Mobile Communication (GSM).

Keywords
Cellular Telephone System, GSM Channels, GSM Identities.

I. Introduction

For long distances, Speech and Visual communications cannot be done. Such communications can be performed up to few kilometres using wire communication. Thus wireless communication is needed for long distance Communication. If it is a wireless Communication, needs modulation and demodulation of the signal. Signals like speech, Music, news, pictures, scientific data, business transactions, military actions, entertainment, education, all can be handled electronically. Immediacy and Versatility makes electronic communication a basic key to success and progress. Hence wireless communication is speedy, versatile and secret. When a cellular phone is switched on, it immediately contacts the nearest radio station. This is called location update [1]. The radio station relays this information to the nearest exchange, which stores the information. The radio stations are continually broadcasting a number of information. This information is transmitted with the help of communication channels in GSM. In addition to this, GSM Identities gives uniqueness to the user, on the bases of Subscriber, Location, and Equipment. This paper is a detailed study of the channels and identities used in Global System for Mobile Communication (GSM). In Section II, we have introduced the concept of GSM Channels, and in Section III, a complete study of the GSM Identities has been carried out. Finally in Section IV, we have concluded our review of GSM Channels and Identities.

II. GSM Channels

In order to transmit information, we required the channels. Channels used in GSM are of two types: Physical Channels and Logical Channels. The physical channel is the medium over which the information is carried, in the case of a terrestrial interface this would be a cable [2]. Other Channel next to Physical is Logical Channel which consists of the information carried over the physical channel. Control Channel and Traffic Channel are further of two types of Logical Channel. Block diagram of Type of Channels is shown in fig. 1.

Fig. 1 : Types of Channels

A. GSM Physical Channels

A single GSM RF carrier can support up to eight MS subscribers simultaneously. Each channel occupies the carrier for one eighth of the time. This is a technique called Time Division Multiple Access. Time is divided into discrete periods called "timeslots". The timeslots are arranged in sequence and are conventionally numbered 0 to 7 [4]. Each repetition of this sequence is called a "TDMA frame". Each MS telephone call occupies one timeslot (0–7) within the frame until the call is terminated, or a handover occurs [2]. The TDMA frames are then built into further frame structures according to the type of channel. For such a system to work correctly, the timing of the transmissions to and from the mobiles is critical. The MS or Base Station must transmit the information related to one call at exactly the right moment, or the timeslot will be missed. The information carried in one timeslot is called a "burst". Each data burst, occupying its allocated timeslot within successive TDMA frames, provides a single GSM physical channel carrying a varying number of logical channels between the MS and BTS [3].

B. GSM Logical Channels

GSM Logical Channels consists of two types: Control Channels and Traffic Channels.

1. Control Channels

Control Channels further consists of three Groups namely Broadcast Control Channel, Common Control Channel and Dedicated Control Channel. Types of Control Channels are shown in fig. 2.

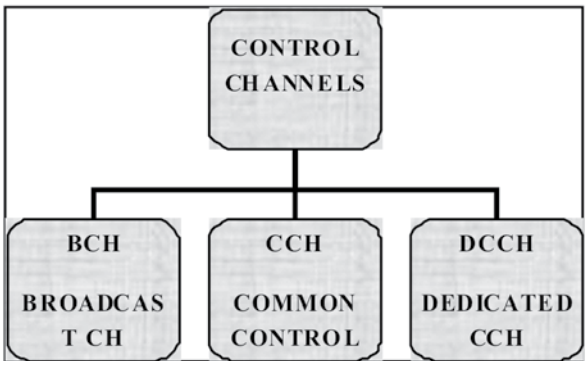

Fig. 2: Types of Control Channels

(i). Broadcast Control Channel:
Broadcast Control Channel is further of three types as shown in fig. 3.

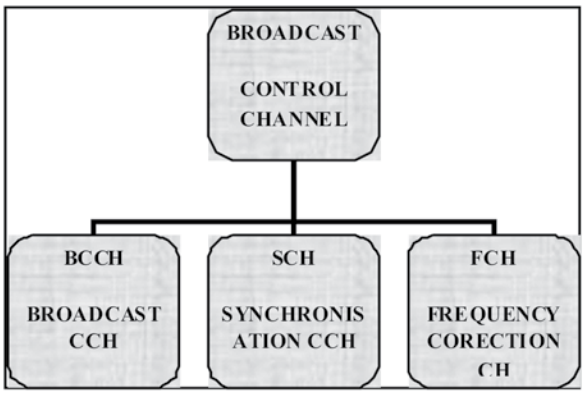

Fig. 3 : Types of Broadcast Channels

- **Broadcast Control Channel (BCH)**
  The Broadcast Control Channels are downlink only (BSS to MS) and it carries the CGI (Cell Global Identity). It also sends control information to MS (Mobile Station). The information carried on the BCCH is monitored by the MS periodically (at least every 30 sec), when it is switched on and not in a call.

- **Synchronization Channel (SCH)**
  The Synchronizing Channel (SCH) helps to synchronise TDMA Frame. It also sends the BSIC value to MS. The MS will monitor BCCH information from surrounding cells and stores the information from the best six cells. The SCH information on these cells is also stored so that the MS may quickly resynchronize when it enters a new cell.

- **Frequency Correction Channel (FCH)**
  Frequency Correction Channel (FCCH) allows the mobile to synchronize its own frequency to that of the transmitting base site. It acts as a flag to the mobile to identify Timeslot 0 because it may only sent during time slot 0 on BCCH carrier frequency.

(ii). Common Control Channel
The Common Control Channel (CCCH) is responsible for transferring control information between all mobiles and the BTS. Types of Common Control Channels are shown in fig.4.

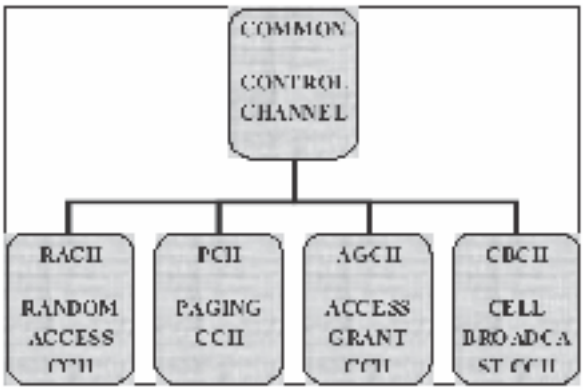

Fig. 4 : Types of Common Control Channels

- **Random Access Control Channel (RACH)**
  Random Access Channel (RACH) helps MS to assign with network and used by the mobile when it requires to gain access to the system [2]. This occurs when the mobile initiates a call or responds to a page.

- **Paging Control Channel (PCH)**
  Paging Control Channel (PCH) helps network to assign with MS and also used by BTS (Base transceiver station) to page MS.

- **Access Grant Control Channel (AGCH)**
  Access Grant Control Channel (AGCH) is used by network to assign signalling upon successful decodation of Burst.

- **Cell Broadcast Control Channel (CBCH)**
  Cell Broadcast Control Channel (CBCH) tells from which BTS (Base Transceiver Station) we are getting coverage (RX Level) also MS has feature of Cell Info Display which display the name of Site ID with which we are latched [4].

(iii). Dedicated Control Channel
Dedicated Control Channels are both Uplink and Downlink and has further categories: SDCCH, SACCH, and FACCH as shown in fig. 5.

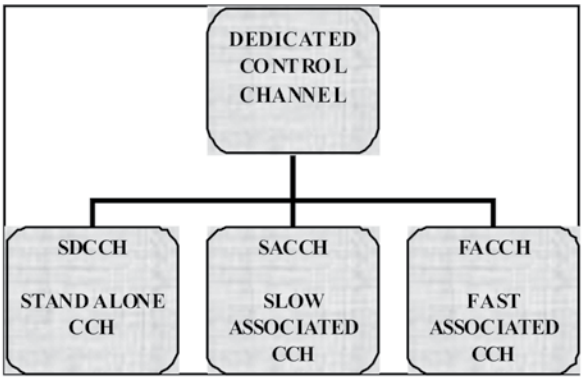

Fig. 5 : Types of Dedicated Control Channels

- **Stand Alone Dedicated Control Channel (SACH)**

Stand Alone Dedicated Control Channel (SDCCH) is used by MS for Location Updation, SMS, and Authentication.

- **Slow Associated Control Channel (SACCH)**

Slow Associated Control Channel (SACCH) sends control information (Power Control) in downlink and measurement reports (Link Quality Reports) in uplink.

- **Fast Associated Control Channel (FACCH)**

Fast Associated Control Channel is transmitted instead of a TCH. The FACCH "steals" the TCH (Traffic Control Channel) burst and inserts its own information. The FACCH is used to carry out user authentication, handovers and immediate assignment.

2. Traffic Channels
The traffic channel carries speech or data information. It is further of two types: Full Rate and Half Rate which are of again of two types namely Net Rate and Gross Rate [6] as shown in fig.6.

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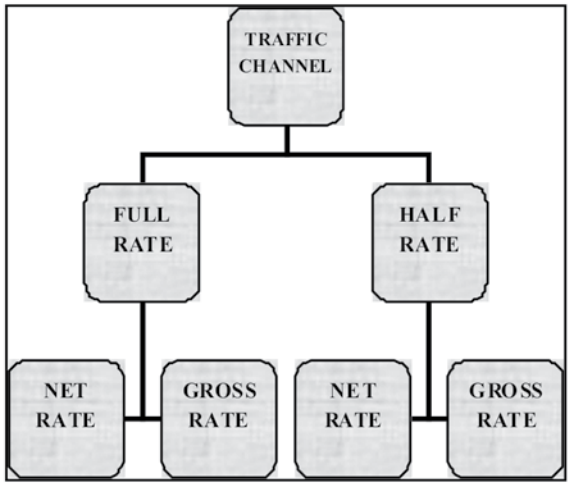

Fig. 6 : Types of Traffic Channels

A. Full Rate/ Half Rate

In Full Rate, 1 Subscriber uses 1 Time Slot which means in TDMA Frame there are total 8 Subscribers while case of Half Rate, 1 Time Slot is used by 2 Subscribers on sharing bases that means 16 Subscribers in 1 TDMA Frame [2].

B. Net Rate/ Gross Rate

Net Rate refers to the Data Rate before Channel Coding while Gross Rate refers to Data Rate after channel coding.

III. GSM Identities

In GSM, we have different types of identities based on Subscriber, Equipment, and Location which are discussed below in detail and shown in fig.7.

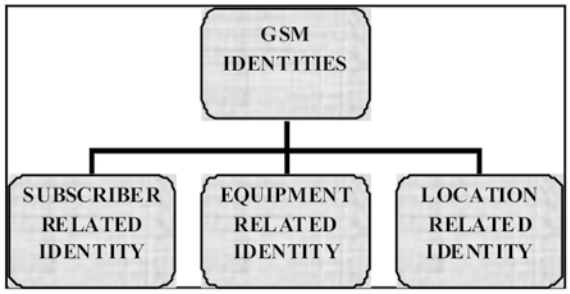

Fig.7 : GSM Identities

A. Subscriber Related Identity

This type of identity is related to Subscriber which makes the subscriber unique. Different types of Subscriber Related Identities are IMSI (International Mobile Subscriber Identity), MSISDN (Mobile Station International Subscriber Dialling Number). These Identities are discussed below:

1. IMSI (International Mobile Subscriber Identity)

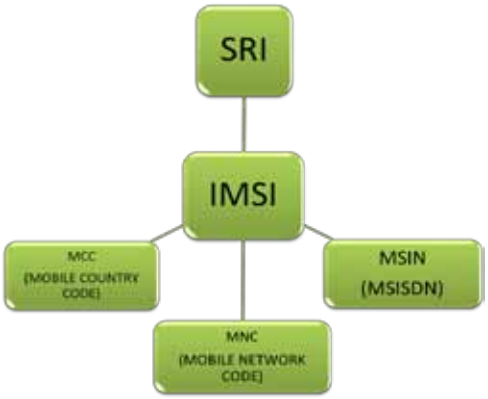

Fig. 8: IMSI

IMSI is stored in HLR (Home Location Register), HLR is Permanent Database which keeps the record of subscriber. It contains MCC (Mobile Country code), MNC (Mobile Network Code), and MSIN (Mobile Station International Number) [5] as shown in fig.8.

2. MSISDN (Mobile Station International Subscriber Dialling Number)

Fig. 9: MSISDN

MSISDN is also stored in HLR (Home Location Register), a Permanent Database and it contains CC (Country Code), NDC (National Destination Code), and SN (Serial Number) shown in fig.9.

B. Equipment Related Identity

This type of Identity is related to Equipment that is our mobile phone. Our Mobile Phone has IMEI (INTERNATIONAL MOBILE EQUIPMENT IDENTITY) which is 15 Digit Number and is unique to all mobile phones.

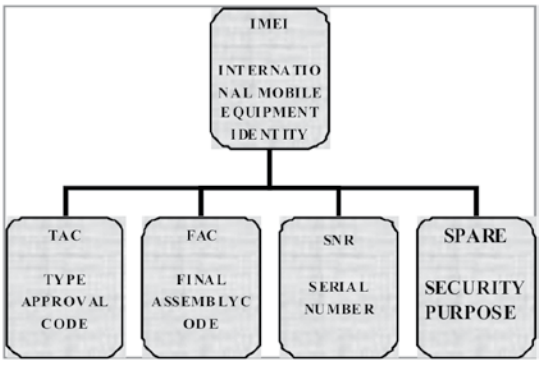

Fig. 10 : IMEI Number

IMEI Number has four components TAC (Type Approval Code) +FAC (Final Assembly Code) +SNR (Serial Number) + Spare (For Security Purpose) [5]. Type Approval Code (TAC) tells whether phone is GSM or CDMA, Final Assembly Code (FAC), tells about company of phone, Serial Number (SNR) gives the serial number of manufacturing of phone, Spare is used for security purposes as shown in fig.10. Table 1 shows the number of digits of various components of IMEI Number.

Table 1: Showing Number of Digits of Various Components of IMEI Number

Component	No. of Digits
TAC	6
FAC	2
SNR	6
SPARE	1

C. Location Related Identity

This type of identity is related to Location of subscriber and this type of identity consists of LAI (Location Area Identity), CGI (Cell Global Identity), MSRN (Mobile Subscriber Roaming Number), and TMSI (Temporary Mobile Subscriber Identity).

1. LAI (Location Area Identity)

It consists of MCC (Mobile Country Code), MNC (Mobile Network Code), and LAC (Location Area Code). Table 2 shows the number of digits of various components of LAI.

Table 2: Showing Number of Digits of Various Components of LAI.

Component	No. of Digits
MCC	3
MNC	2-3
LAC	16

MCC consists of 3 Digits, MNC consists of 2-3 Digits and LAC consists of 16 Digits as shown in fig. 11. Also Table 3 shows the number of digits of various components of LAI.

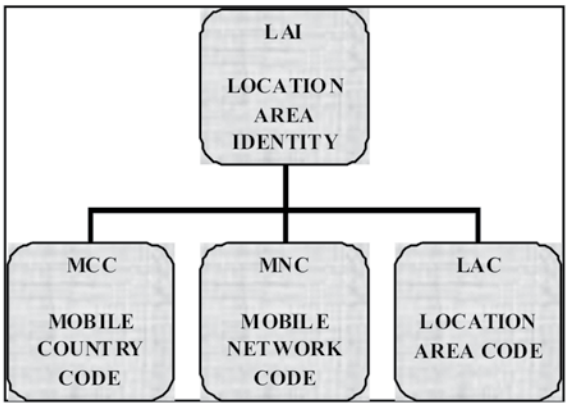

Fig. 11: LAI

Table 3: Showing Number of Digits of Various Components of LAI.

Component	No. of Digits
MCC	3
MNC	2-3
LAC	16

2. Cell Global Identity (CGI)

We can track any subscriber with the help of CGI and it consists of MCC (Mobile Country Code), MNC (Mobile Network Code), LAC (Location Area Code), and CI (Cell ID). CGI is provided by channel BCCH (Broadcast Control Channel) as shown in fig. 12.

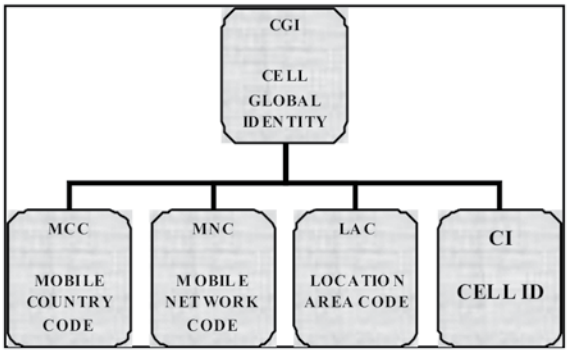

Fig. 12: CGI

3. Mobile Subscriber Roaming Number (MSRN)/ Temporary Mobile Subscriber Identity (TMSI)

MSRN is used to protect subscriber identity in air interface, when subscriber is in roaming while TMSI is used when subscriber is not in roaming that is in Home Network [7].

IV. Conclusion

Wireless communication is an inevitable choice for the long distance Communication. A cellular telephone system links mobile station (MS) subscribers into the public telephone system or to another cellular system's MS subscriber. Information sent between the MS subscriber and the cellular network uses radio communication, due to which, the MS subscriber is able to move around and become fully mobile. The physical channel is the medium over which the information is carried, in the case of a terrestrial interface this would be a cable. The logical channels consist of the information carried over the physical channel. Also, in GSM, Identities gives uniqueness to the user, on the bases of Subscriber, Location, and Equipment. This paper gives comprehensive review of the channels and identities used in Global System for Mobile Communication (GSM).

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