A

Seminar report

On

GSM (Global System for Mobile Communications)

Submitted in partial fulfillment of the requirement for the award of degree
of Bachelor of Technology in Computer Science

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Acknowledgement

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Preface

I have made this report file on the topic **GSM** (**Global System for Mobile Communications**);I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to ……..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

Content

Introduction

GSM (**Global System for Mobile Communications**, originally **Groupe Spécial Mobile**), is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe protocols for second-generation (2G) digital cellular networks used by mobile phones. As of 2014 it has become the default global standard for mobile communications - with over 90% market share, operating in over 219 countries and territories.

2G networks developed as a replacement for first generation (1G) analog cellular networks, and the GSM standard originally described a digital, circuit-switched network optimized for full duplex voice telephony.

This expanded over time to include data communications, first by circuit-switched transport, then by packet data transport via GPRS (General Packet Radio Services) and EDGE (Enhanced Data rates for GSM Evolution or EGPRS).

Subsequently, the 3GPP developed third-generation (3G) UMTS standards followed by fourth-generation (4G) LTE Advanced standards, which do not form part of the ETSI GSM standard.

"GSM" is a trademark owned by the GSM Association. It may also refer to the (initially) most common voice codec used, Full Rate.

History

In 1982, work began to develop a European standard for digital cellular voice telephony when the European Conference of Postal and Telecommunications Administrations (CEPT) created the Groupe Spécial Mobile committee and later provided a permanent technical support group based in Paris. Five years later, in 1987, 15 representatives from 13 European countries signed a memorandum of understanding in Copenhagen to develop and deploy a common cellular telephone system across Europe, and EU rules were passed to make GSM a mandatory standard. The decision to develop a continental standard eventually resulted in a unified, open, standard-based network which was larger than that in the United States.

In 1987 Europe produced the very first agreed GSM Technical Specification in February. Ministers from the four big EU countries cemented their political support for GSM with the Bonn Declaration on Global Information Networks in May and the GSM MoU was tabled for signature in September. The MoU drew-in mobile operators from across Europe to pledge to invest in new GSM networks to an ambitious common date. It got GSM up and running fast.

In this short 37-week period the whole of Europe (countries and industries) had been brought behind GSM in a rare unity and speed guided by four public officials Armin Silberhorn (Germany), Stephen Temple (UK), Philippe Dupuis (France), and Renzo Failli (Italy). In 1989, the Groupe Spécial Mobile committee was transferred from CEPT to the European Telecommunications Standards Institute (ETSI).

In parallel, France and Germany signed a joint development agreement in 1984 and were joined by Italy and the UK in 1986. In 1986 the European Commission proposed reserving the 900 MHz spectrum band for GSM. The world's first GSM call was made by the former Finnish prime minister Harri Holkeri to Kaarina Suonio (mayor in city of Tampere) on July 1, 1991, on a network built by Telenokia and Siemens and operated by Radiolinja. The following year in 1992, the first short messaging service (SMS or "text message") message was sent and Vodafone UK and Telecom Finland signed the first international roaming agreement.

Work began in 1991 to expand the GSM standard to the 1800 MHz frequency band and the first 1800 MHz network became operational in the UK by 1993. Also that year, Telecom Australia became the first network operator to deploy a GSM network outside Europe and the first practical hand-held GSM mobile phone became available.

In 1995, fax, data and SMS messaging services were launched commercially, the first 1900 MHz GSM network became operational in the United States and GSM subscribers worldwide exceeded 10 million. Also this year, the GSM Association was formed. Pre-paid GSM SIM cards were launched in 1996 and worldwide GSM subscribers passed 100 million in 1998.

In 2000, the first commercial GPRS services were launched and the first GPRS compatible handsets became available for sale. In 2001 the first UMTS (W-CDMA) network was launched, a 3G technology that is not part of GSM. Worldwide GSM subscribers exceeded 500 million. In 2002 the first Multimedia Messaging Service (MMS) were introduced and the first GSM network in the 800 MHz frequency band became operational. EDGE services first became

operational in a network in 2003 and the number of worldwide GSM subscribers exceeded 1 billion in 2004.

By 2005, GSM networks accounted for more than 75% of the worldwide cellular network market, serving 1.5 billion subscribers. In 2005 the first HSDPA capable network also became operational. The first HSUPA network was launched in 2007. High-Speed Packet Access (HSPA) and its uplink and downlink versions are 3G technologies, not part of GSM. Worldwide GSM subscribers exceeded three billion in 2008.

The GSM Association estimated in 2010 that technologies defined in the GSM standard serve 80% of the global mobile market, encompassing more than 5 billion people across more than 212 countries and territories, making GSM the most ubiquitous of the many standards for cellular networks.

It is important to note that GSM is a second-generation (2G) standard employing Time-Division Multiple-Access (TDMA) spectrum-sharing, issued by the European Telecommunications Standards Institute (ETSI). The GSM standard does not include the 3G UMTS CDMA-based technology nor the 4G LTE OFDMA-based technology standards issued by the 3GPP.

Macau planned to phase out its 2G GSM networks as of June 4, 2015, making it the first region to decommission a GSM network.

GSM - Specification

Specifications for different Personal Communication Services (PCS) systems vary among the different PCS networks. The GSM specification is listed below with important characteristics.

Modulation:

Modulation is a form of change process where we change the input information into a suitable format for the transmission medium. We also changed the information by demodulating the signal at the receiving end.

The GSM uses Gaussian Minimum Shift Keying (GMSK) modulation method.

Access Methods:

Because radio spectrum is a limited resource shared by all users, a method must be devised to divide up the bandwidth among as many users as possible.

GSM chose a combination of TDMA/FDMA as its method. The FDMA part involves the division by frequency of the total 25 MHz bandwidth into 124 carrier frequencies of 200 kHz bandwidth.

One or more carrier frequencies are then assigned to each BS. Each of these carrier frequencies is then divided in time, using a TDMA scheme, into eight time slots. One time slot is used for transmission by the mobile and one for reception. They are separated in time so that the mobile unit does not receive and transmit at the same time.

Transmission Rate:

The total symbol rate for GSM at 1 bit per symbol in GMSK produces 270.833 K symbols/second. The gross transmission rate of the time slot is 22.8 Kbps.

GSM is a digital system with an over-the-air bit rate of 270 kbps.

Frequency Band:

The **uplink frequency range** specified for GSM is 933 - 960 MHz (basic 900 MHz band only). The **downlink frequency band** 890 - 915 MHz (basic 900 MHz band only).

Channel Spacing:

This indicates separation between adjacent carrier frequencies. In GSM, this is 200 kHz.

Speech Coding:

GSM uses linear predictive coding (LPC). The purpose of LPC is to reduce the bit rate. The LPC provides parameters for a filter that mimics the vocal tract. The signal passes through this filter, leaving behind a residual signal. Speech is encoded at 13 kbps.

Duplex Distance:

The duplex distance is 80 MHz. Duplex distance is the distance between the uplink and downlink frequencies. A channel has two frequencies, 80 MHz apart.

Misc:

- **Frame duration:** 4.615 mS
- **Duplex Technique:** Frequency Division Duplexing (FDD) access mode previously known as WCDMA.
- **Speech channels per RF channel:** 8.

GSM - User Services

GSM has much more to offer than voice telephony. Additional services allow you greater flexibility in where and when you use your phone. You should contact your local GSM network operator for information on the specific services available to you.

But there are three basic types of services offered through GSM which you can ask for:

- Telephony (also referred to as teleservices) Services
- Data (also referred to as bearer services) Services.
- Supplementary Services

Teleservices or Telephony Services:

A Teleservice utilises the capabilities of a Bearer Service to transport data, defining which capabilities are required and how they should be set up.

Voice Calls:

The most basic Teleservice supported by GSM is telephony. This includes Full-rate speech at 13 Kbps and emergency calls, where the nearest emergency- service provider is notified by dialing three digits. A very basic example of emergency service is 911 service available in USA.

Videotext and Facsmile:

Another group of teleservices includes Videotext access, Teletex transmission, Facsimile alternate speech and facsimile Group 3, Automatic facsimile Group 3 etc.

Short Text Messages:

SMS (Short Messaging Service) service is a text messaging which allow you to send and receive text messages on your GSM Mobile phone. Services available from many of the world's GSM networks today - in addition to simple user generated text message services - include news, sport, financial, language and location based services, as well as many early examples of mobile commerce such as stocks and share prices, mobile banking facilities and leisure booking services.

Bearer Services or Data Services

Using your GSM phone to receive and send data is the essential building block leading to widespread mobile Internet access and mobile data transfer. GSM currently has a data transfer rate of 9.6k. New developments that will push up data transfer rates for GSM users are HSCSD (high speed circuit switched data) and GPRS (general packet radio service) are now available.

Supplementary Services

Supplementary services are provided on top of teleservices or bearer services, and include features such as caller identification, call forwarding, call waiting, multi-party conversations, and barring of outgoing (international) calls, among others. A brief description of supplementary services is given here:

- **Multiparty Service or conferencing:** The multiparty service allows a mobile subscriber to establish a multiparty conversation, i.e., a simultaneous conversation between three or more subscribers to setup a conference call. This service is only applicable to normal telephony.
- **Call Waiting:** This service allows a mobile subscriber to be notified of an incoming call during a conversation. The subscriber can answer, reject, or ignore the incoming call. Call waiting is applicable to all GSM telecommunications services using a circuit-switched connection.
- **Call Hold:** This service allows a subscriber to put an incoming call on hold and then resume this call. The call hold service is only applicable to normal telephony.
- **Call Forwarding:** The Call Forwarding Supplementary Service is used to divert calls from the original recipient to another number, and is normally set up by the subscriber himself. It can be used by the subscriber to divert calls from the Mobile Station when the subscriber is not available, and so to ensure that calls are not lost. A typical scenario would be a salesperson turns off his mobile phone during a meeting with customers, but does not with to lose potential sales leads while he is unavailable.
- **Call Barring:** The concept of barring certain types of calls might seem to be a supplementary disservice rather than service. However, there are times when the subscriber is not the actual user of the Mobile Station, and as a consequence may wish to limit its functionality, so as to limit the charges incurred. Alternatively, if the subscriber and user are one and the same, the Call Barring may be useful to stop calls being routed to international destinations when they are routed. The reason for this is because it is expected that the roaming subscriber will pay the charges incurred for international re-

routing of calls. So, GSM devised some flexible services that enable the subscriber to conditionally bar calls.

- **Number Identification:** There are following supplementary services related to number identification:
    - **Calling Line Identification Presentation:** This service deals with the presentation of the calling party's telephone number. The concept is for this number to be presented, at the start of the phone ringing, so that the called person can determine who is ringing prior to answering. The person subscribing to the service receives the telephone number of the calling party.
    - **Calling Line Identification Restriction:** A person not wishing their number to be presented to others subscribes to this service. In the normal course of event, the restriction service overrides the presentation service.
    - **Connected Line Identification Presentation:** This service is provided to give the calling party the telephone number of the person to whom they are connected. This may seem strange since the person making the call should know the number they dialled, but there are situations (such as forwardings) where the number connected is not the number dialled. The person subscribing to the service is the calling party.
    - **Connected Line Identification Restriction:** There are times when the person called does not wish to have their number presented and so they would subscribe to this person. Normally, this overrides the presentation service.
    - **Malicious Call Identification:** The malicious call identification service was provided to combat the spread of obscene or annoying calls. The victim should subscribe to this service, and then they could cause known malicious calls to be identified in the GSM network, using a simple command. This identified number could then be passed to the appropriate authority for action. The definition for this service is not stable.
- **Advice of Charge (AoC):** This service was designed to give the subscriber an indication of the cost of the services as they are used. Furthermore, those Service Providers who wish to offer rental services to subscribers without their own Subscriber Identity Module (SIM) can also utilize this service in a slightly different form. AoC for data calls is provided on the basis of time measurements.
- **Closed User Groups (CUGs):** This service is provided on GSM to enable groups of subscribers to only call each other. This type of services are being offered with special discount and is limited only to those members who wish to talk to each other.
- **Unstructured supplementary services data (USSD):** This allows operator-defined individual services.

GSM - Architecture

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.

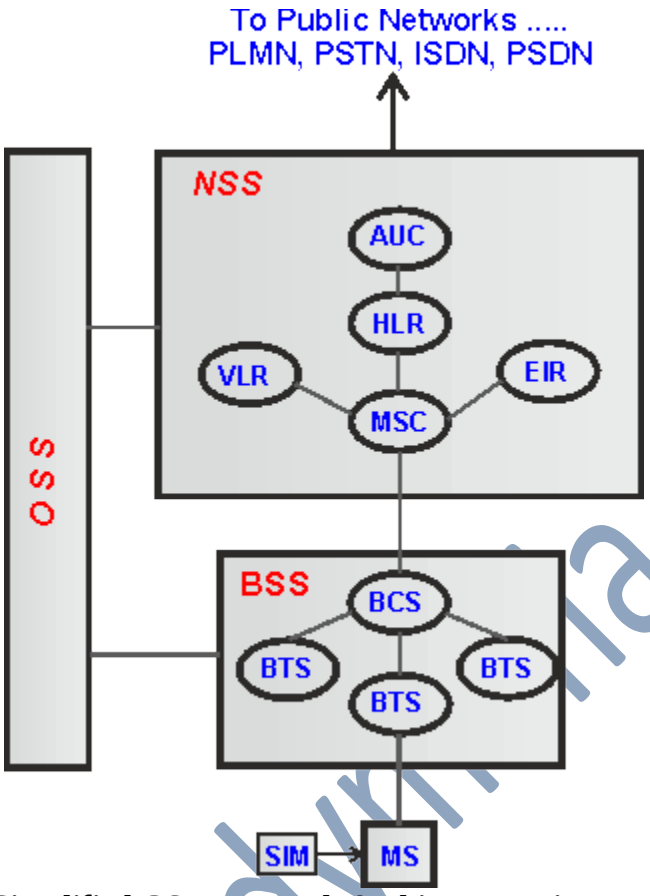
Despite the developments of the newer systems, the basic GSM system architecture has been maintained, and the network elements described below perform the same functions as they did when the original GSM system was launched in the early 1990s.GSM network architecture elements

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

- Mobile station (MS)
- Base-Station Subsystem (BSS)
- Network and Switching Subsystem (NSS)
- Operation and Support Subsystem (OSS)

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:



Simplified GSM Network Architecture Diagram

Mobile station

Mobile stations (MS), 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).

Base Station Subsystem (BSS)

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:

- **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.
- **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.

Network Switching Subsystem (NSS)

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:

- **Mobile Switching services 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.
- **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.
- **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.

- **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.
- **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.
- **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.
- **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.

Operation and Support Subsystem (OSS)

The OSS or operation support subsystem is an element within the overall GSM network architecture that is connected to components of the NSS and the BSC. It is used to control and monitor the overall GSM network and it is also used to control the traffic load of the BSS. It must be noted that as the number of BS increases with the scaling of the subscriber population some of the maintenance tasks are transferred to the BTS, allowing savings in the cost of ownership of the system.

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. This is the area that is paged when a subscriber gets an incoming call. Each Location Area is assigned a Location Area Identity (LAI). Each Location Area 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 PLMN. A PLMN can contain one or more MSCs.

Advantages

• Worldwide Roaming

Since GSM service is obtainable in added than 200 countries, clienteles are capable to roam globally without altering their devices or their facility plans. Messaging facilities and other progressive services, such as data, too endure obtainable. Cellular businesses sort partnership contracts with suppliers overseas, so businesses are capable to roam globally at reduced roaming charges.

• Security

GSM facilities are extremely protected, with skills in place that can defend against both snooping and service riding. GSM devices and facilities cannot be duplicated as simply as other skills. The SIM card or Subscriber recognize Unit card which transmits subscriber and exchange info, secures purchaser info. These cards also permit consumers to handover their subscription info and telephone book info from one receiver to add at any period.

• Reasonable Devices and Facilities

GSM suppliers switch a huge portion of the cellular marketplace and so are capable to deliver a huge diversity of reasonable devices and facilities. Constructors are capable to afford numerous diverse kinds of devices for reasonable values since the huge capacity of purchases aids to energy down the trade costs. The change of strategies and facilities request to consumers as well, since they need to try the latest and maximum exciting yields.

• Extensive Spectrums Obtainable

The GSM expertise usages five bands of MHz rate; 450, 850, 900, 1800 and 1900 MHz. Builders are capable to yield devices that can choice up two or three diverse occurrence bands. Those receivers can then shift between those rates routinely as desirable, in order to preserve a network linking almost wherever. The signals obtainable with GSM facility are effectual, meaning that an excessive deal of data can transfer diagonally the frequency bands without dipping the efficiency of the signs.

Disadvantages

• Released and Missed Calls

Conferring to Cellular Newscast, call superiority difficulties, with dropped calls and missed calls are shared difficulties with GSM expertise. These difficulties outcome right from the expertise in use. GSM expertise cannot provide accommodations as numerous callers on a lone cell tower as the more current CDMA technology.

• Safety Issues

ZDNet UK rumors that GSM has a grave safety flaw, established by a hacker who was capable to interrupt telephone calls from an amount of GSM-based cellular headphones. The tricky is founded right on the technology conferring to this hacker and the key was to “shot off” the GSM technology that is normally recovered by individuals all over the universe.

• Competence

Added tricky with GSM is a system problem somewhat than a customer problem, though it is a customer tricky for those who don’t need to see a creation of cellular towers. As earlier eminent, GSM technologies can knob rarer callers on a lone cellular tower.

Conclusion

Hope, now you are aware of GSM Technology. We have taught you all the basic concepts related to GSM technology.

You have learnt about GSM basic overview, its architecture along with a description about all important GSM elements and a brief GSM specification. You have gone through all the important GSM Addresses and Identifiers also.

Further, we have given a short description of GSM protocol stack and available GSM services and their billing techniques.

Reference

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