GSM Wireless Communication System: A Review Paper

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ABSTRACT: ***Wireless communications grew at a breakneck pace during the last decade, becoming an indispensable aspect of modern civilization. Mobile communication has become one of the fastest growing areas of telecommunications due to its ease and flexibility. During the previous two decades, mobile communication networks have seen remarkable expansion in both the number of users and the breadth of services offered. GSM stands for Global System for Mobile Communications, and it is a pan-European mobile communication system that was originally deployed in the early years of this decade in the 900 MHz band. The survey of GSM for wireless communication, which is one of the most widely deployed second generation wireless cellular systems in the world, is the topic of this paper. While voice was the primary service supplied by early communication systems, today's systems enable a variety of transmission options. The GSM (Global System for Mobile Communication) standard is the basis for one of the most widely used cellular systems. The GSM System configuration and major attributes are briefly discussed. It covers service and features, GSM system architecture, GSM channel and frame structure, GSM security features, and data in the GSM system.***

KEYWORDS: ***Cellular Concept, Characters, GSM, Wireless Communication System.***

1. INTRODUCTION

1.1 An Overview to GSM System:

In recent years, personal communication services (PCS), cellular communications, satellite communications, broadcasting, High-Definition Television (HDTV), Personal Digital Assistant (PDA), wireless LAN, Bluetooth, and other wireless applications have been among the fastest growing industries. The Global System for Mobile (GSM) is a cellular system standard for the second generation. It is the first cellular system to specify digital modulation as well as network and service structures. In the year 1900, the first substantial set of Radio Frequency (RF-ICS) for the GSM standard was released. GSM was originally introduced in Europe in 1991, and it is now the most widely used cellular technology. GSM is currently one of the most extensively utilized digital cellular telecommunications technologies in our country, as well as around the world. GSM wireless communication technology has drawn more and more attention in the sector of mobile telecommunication as the number and demand of GSM subscribers has grown[1]. In Europe, the majority of 3G networks use the 2100 MHz frequency band. See GSM frequency bands for further information on GSM frequency usage around the world. In the year 2021, the first public cryptanalysis of GEA/1 and GEA/2 (also known as GEA-1 and GEA-2) was completed. It was discovered that, although using a 64-bit key, the GEA-1 algorithm only gives 40 bits of security due to a link between two algorithm sections. The researchers discovered that if this association hadn't been planned, it would have been extremely unlikely to occur. This could have been done to comply with European export limits on cryptography programmes. The researchers discovered weaknesses in the widely used GPRS Encryption Algorithms 1 and 2 (GEA/1 and GEA/2, respectively) ciphers and released the open-source "Gprs decode" software for sniffing GPRS networks. They also mentioned that some carriers do not encrypt data (i.e., do not employ GEA/0) in order to discover the use of traffic or protocols they dislike (e.g., Skype), leaving customers vulnerable. GEA/3 is believed to be in use on certain more contemporary networks and appears to be relatively difficult to break.

1.1.1 The Character of GSM System:

For the transmit and receive bands of the mobile system, the GSM System uses two bands of 25MHz, 890-915MHz, and 935-960MHz, respectively; it uses FDD (frequency Division Duplex) and TDMA (Time Division Multiple Access). The receive band is split into 128 channels, each with a bandwidth of 200 kHz. Each channel can have up to eight participants sharing it[2]. The Network and Switching Subsystem (NNS), the Basic Station Subsystem (BSS), and the Operation Support Subsystem (OSS) are the three basic

components of the GSM system. The MSC (Mobile-Services Switching Center) is the nerve centre of the NNS. In 2011, the most widely used GPRS ciphers were publicly decrypted. [27] The researchers discovered weaknesses in the widely used GPRS Encryption Algorithms 1 and 2 (GEA/1 and GEA/2, respectively) ciphers and released the open-source "Gprs decode" software for sniffing GPRS networks. They also mentioned that some carriers do not encrypt data (i.e., do not employ GEA/0) in order to discover the use of traffic or protocols they dislike (e.g., Skype), leaving customers vulnerable. GEA/3 is believed to be in use on certain more contemporary networks and appears to be relatively difficult to break.

1.1.2 Research Motivation:

The expansion of the wireless communication business over the last decade has been distinguished by the proliferation of multiple standards and the demand for low-cost, low-power, on-chip integrated third generation (3G) receivers capable of responding to these various standards. The base-band and RF front-end components are required by many wireless standards, such as the worldwide system for mobile communication.. So, we'll go over the GSM system in further detail because it's both difficult to grasp and quite useful in our country. The purpose of this study is to look into the GSM system's features[3].

1.1.3 The Cellular Concept:

The traditional challenge for mobile radio system designers has been balancing the competing needs of area coverage and user capacity. In the 1970s, Bell Mobile networks in New York City could only accept 12 simultaneous calls due to this circumstance. Given the government's limited spectrum allocation, the cellular notion was a logical progression step. It means that instead of having a single transmitter cover a vast region, the area can be divided into smaller coverage zones known as cells[4]. Figure 1 illustrates the frequency reuse concept when N=3.

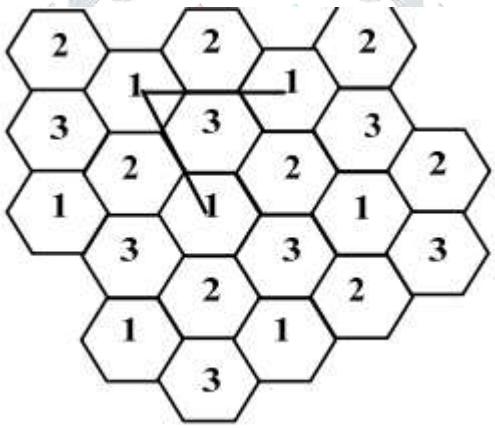

Figure 1: Illustrates the frequency reuse concept when N=3.

The cellular concept was a game-changer in terms of addressing spectral congestion and user capacity. It provided a lot of capacity in a small amount of spectrum without requiring any big technology changes. It is a system-level concept that asks for the replacement of a single, high-power transmitter with a large number of low-power transmitters. One of the wireless communication systems is cellular (WCS). Figure 2 illustrates the GSM system architecture.

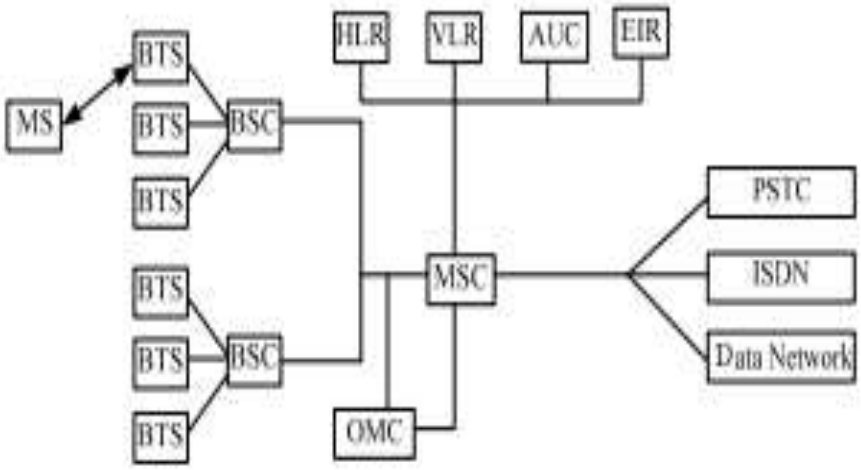

Figure 2: Illustrates the GSM system architecture.

The NSS incorporates end-to-end call equipment and functions, as well as subscriber administration, switching, and communication with other networks like as Integrated Services Digital Network (ISDN) and Public Switched Telephone Network (PSTN). Mobile Switching Center (MSC), Home Location Register (HLR), Visitor Location Register (VLR), Authentication Unit Center (AUC), and Equipment Identity Register (EIR) are all part of the NSS. The MSC is the NSS's main central unit, which handles call setup, routing, switching, and handoff, among other things. HLR is a centralized database that holds subscriber information as well as location data for all users in the MSC's service region.[5]

2. LITERATURE REVIEW

Stathes Hadjiefthymiades et al. in their study suggested that the World Wide Web (WWW) is currently regarded as the most promising and quickly evolving software platform for the deployment of applications in wide area networks and corporate intranets. Wireless communication networks are another technology that is fast gaining traction in such contexts (e.g., GSM, wireless LANs). For the coming years, the combination and merging of the two technologies (i.e., mobile computing based on the WWW) is seen as critical to the computing industry. It is reported on a survey of the research activity in this area throughout the preceding years[6].

Subharthi Banerjee et al. in their study suggested that investigation discovered a trend in the industry to move control plane operations to narrowband frequencies, such as LTE 400/700, while simultaneously utilizing other technologies for passenger broadband access, allowing both user and train control systems to be supported. With traditional systems, a tradeoff was often required, and train control functions were frequently prioritized over passenger amenities. However, because to advancements in communication technologies like LTE-R and cognitive radios, system designers can now provide rich services to passengers while also supporting better train control procedures like positive train control[7].

Mudit Ratana Bhalla et al. in their study suggested that the evolution and development of many generations of mobile wireless technology, as well as their relevance and benefits over one another, in this paper. Mobile wireless technologies have gone through four or five stages of technological revolution and progress in the last few decades, from 0G to 4G.The current focus of mobile wireless technology research is on the advanced deployment of 4G and 5G technology. Currently, the word "5G" is not in use. World Wide Wireless Web (WWWW), Dynamic Ad hoc Wireless Networks (DAWN), and Real Wireless World are all being researched in 5G[8].

Chieme Azubuike et al. in their study suggested that as a result, this study uses a descriptive survey research methodology, with a questionnaire delivered to 500 respondents selected at random from five rural villages in Rivers State, Nigeria, as the primary data collection instrument. The findings clearly show that wireless

communication via GSM has a significant impact on the economic lives of Nigerian rural users, as well as being a major tool for job creation, therefore reducing the rate of crime in that area[9].

3. DISCUSSION

3.1 GSM Technology:

The Global System for Mobile (GSM) is a second-generation cellular system standard designed to overcome the fragmentation difficulties that afflicted the first generation. GSM was the world's first cellular system to include digital modulation, network lever topologies, and services specifications. It is now the most widely used international standard for new cellular radio and personal communications equipment. The GSM (Group Special Mobile) committee was tasked with defining a uniform 900 MHz mobile communication system for Europe. For marketing purposes, GSM has recently been renamed the Global System for Mobile Communications. Parallel to this, in 1984, France and Germany signed a collaborative development agreement, which was later joined by Italy and the United Kingdom in 1986. The European Commission proposed in 1986 that the 900 MHz spectrum band be reserved for GSM. On July 1, 1991, former Finnish Prime Minister Harri Holkeri made the world's first GSM call, dialling Kaarina Suonio (deputy mayor of Tampere) over a Nokia and Siemens network managed by Radiolinja. The first short messaging service (SMS or "text message") message was sent the next year, and Vodafone UK and Telecom Finland signed the first international roaming agreement for authentication (AUC). A secret key is issued to each subscriber, with one copy saved in the SIM card and the other in the AUC. In addition to the mobile subscriber, another security lever is introduced by the mobile equipment itself. Each GSM terminal is identifiable by a unique International Mobile Equipment Identity (IMEI) number, as previously stated. The Equipment Identity Register stores a list of IMEI on the network (EIR). Following that, the 3GPP produced third-generation (3G) UMTS standards, which were followed by fourth-generation (4G) LTE Advanced and fifth-generation (5G) 5G standards, which were not included in the ETSI GSM standard. The GSM Association owns the trademark "GSM." It could also refer to Full Rate, the (at the time) most popular voice codec .The acronym "GSM" was temporarily used as a generic word for mobile phones in France, the Netherlands, and Wallonia, Belgium, due to the network's extensive use across Europe. The researchers discovered weaknesses in the widely used GPRS Encryption Algorithms 1 and 2 (GEA/1 and GEA/2, respectively) cyphers and released the open-source GPRS decode software for sniffing GPRS networks. They also mentioned that some carriers do not encrypt data (i.e., do not employ GEA/0) in order to discover the use of traffic or protocols they dislike (e.g., Skype), leaving customers vulnerable. GEA/3 is believed to be in use on certain more contemporary networks and appears to be relatively difficult to break. Users will be safeguarded in the medium term if used with USIM to prevent connections to fake base stations and downgrade assaults, while migration to 128-bit GEA/4 is still suggested.

3.2 Applications:

Base Station Subsystem (BSS), Network and Switching Subsystem (NNS), and Operation Support Subsystem (OSS) are the three major subsystems of the GSM network architecture. The Mobile Station (MS) is also a subsystem, but for architectural purposes, it is commonly considered to be part of the BSS. The radio subsystem, also known as the BSS, supplies and manages radio transmission channels between mobile stations and the Mobile Switching Center (MSC). The BSS is also in charge of managing the radio interface between mobile stations and all other GSM subsystems[2]. Base Station Subsystem BSS, Network and Switching Subsystem NNS, and Operation Support Subsystem OSS are the three major subsystems of the GSM network architecture. The Mobile Station (MS) is also a subsystem, but for architectural purposes, it is commonly considered to be part of the BSS. The radio subsystem, also known as the BSS, supplies and manages radio transmission channels between mobile stations and the Mobile Switching Center (MSC). The BSS is also in charge of managing the radio interface between mobile stations and all other GSM subsystems. It is made up of a number of Base Station Controllers BSCs, each of which is in charge of a number of base transceiver Stations BTS.

3.3 Advantage:

The GSM system uses two 25-MHz paired bands The uplink or reverse link, in which the mobile transmits to the base station, is 890-915 MHz, while the downlink or forward link, in which the mobile transmits to the base station, is 935-960 MHz. Each of these two bands is divided into 200 KHz channels.After removing a guard band of 200 KHz from the lower end of each band, there will be 124 paired duplex channels with 45 MHz spacing. The carrier frequency for each of the 124 channels is different. Two bursts of 58 bits each take up the majority of the slot's transmission time[10]. Figure 3 illustrates the security architecture in GSM.

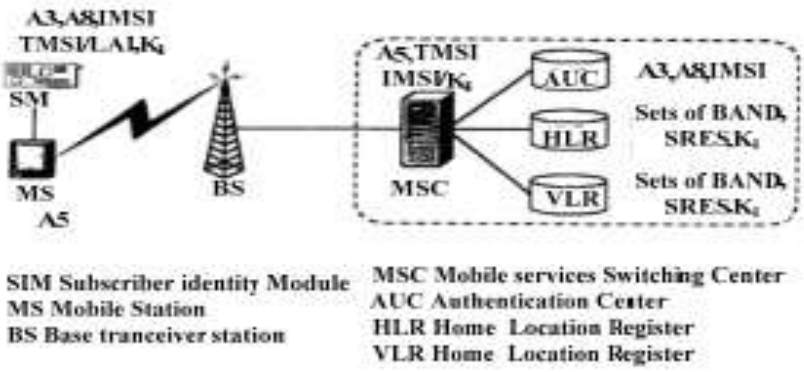

Figure 3: Illustrates the security architecture in GSM.

Because anybody can access the radio medium, user authentication is a critical component of a mobile network. The SIM card in the mobile phone and the Authentication Center are both used for authentication (AUC). A secret key is issued to each subscriber, with one copy saved in the SIM card and the other in the AUC. Aside from the mobile subscriber, the mobile equipment itself adds another layer of protection. As previously stated, each GSM terminal is identified by a unique International Mobile Equipment Identity (IMEI) number. A list of IMEI on the network is kept in the Equipment Identity Register (EIR).

3.4. Working:

The GSM system includes a decent facsimile service, a two-way paging function or short messaging service SMS that can send up to 160 text characters, and Cell Broadcast services CBS that can send messages to a specified geographic region. GSM data services can be either transparent or opaque. The existing GSM system has a throughput of 9.6 kbps and may provide data service. Several evolutionary steps to deliver services with a significantly higher bit rate are already in the final phases of standardization. There were five sections to the GSM services. It's utilized in things like the Internet, mobile fax, secure corporate LAN access, cell broadcast, and short messages.

4. CONCLUSION

The features of the GSM (Global System for Mobile Communications) network are the subject of this research. The GSM system is now a global standard for second-generation mobile telephony. The GSM system is extremely popular and important all over the world. It comes with a slew of perks and benefits. As a result, third-generation GSM and other cellular networks strive to deliver high-quality data services at a higher bit rate to as many users as feasible at the lowest possible cost.. Mobile telephony is transitioning from 2G to 3G, or GSM to UMTS networks, in general and in Europe in particular. Both GSM and UMTS technologies will coexist and have to work together as long as UMTS is not widely deployed interoperate. Future wireless networks will support 100 GBPS communication between people, devices, and the "Internet of Things," with high reliability and uniform coverage indoors and out. The shortage of spectrum to support such systems will be alleviated by advances in massive MIMO and mm W technology as well as cognitive radios. Analysts believe the market for connected devices and associated services will reach nearly $263 billion by 2025. The combination of Wi-Fi 6 and cloud-based management gives CSPs the best opportunity to develop the connectivity and services that consumer's demand. Wired networks are generally much faster than wireless networks. This is mainly because a separate cable is used to connect each device to the network with each cable transmitting data at the same speed. A wired network is also faster since it never is weighed down by unexpected or unnecessary traffic. The future of mobile wireless communication networks will be experienced several generations as which have been experienced. This kind of development will drive the researches of information technology in industrial area. In this paper, we predict the future generations of mobile wireless communication networks including 4th, 5th, 6th and 7th generations.

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