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ADVANCEMENT IN CELLULAR SYSTEM TOWARDS LTE

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ABSTARCT:
Wireless Communication is the transfer of information over long distances without the use of wires. Wireless connectivity is almost everywhere and getting highly affordable even for people who are in the bottom of the pyramid. With the advancement of wireless communication technologies, small size and high performance computing and communication devices have been increasingly used in daily life and computing industry such as laptops, personal digital assistants (PDA) etc.
This paper highlights the technological revolution starting from early mobile radio communication. In this review paper we have presented the evolution of wireless technology as first generation of mobile technology and migration from second generation to fourth generation of mobile technology. We have compared the different technologies of mobile in terms of bandwidth,, data transfer rate, switching technique, architecture etc. LTE (Long Term Evolution) is a transition from 3G to 4G that provides improved performance and is based on OFDM (Orthogonal Frequency Division Multiplexing), it works by splitting the radio signal into multiple smaller sub-signals that are then transmitted simultaneously at different frequencies to the receiver. The fourth generation (4G) wireless networks are all set to turn the current networks into end-to-end IP networks.4G – "connect anytime, anywhere, anyhow" promising network access at high speed to the end users.

Keywords: *Wireless: generation: network*

1. INTRODUCTION

Science and technology plays a vital role in the present fast growing world. In recent years, pervasive computing has enjoyed a tremendous rise in popularity. Wireless connectivity is increasingly pervasive and minimized the gap supporting mobility. A fundamental building block of pervasive computing likely includes wireless mobile networking. Anytime, anywhere communication, computation and collaboration are the new parameters prescribed for every individual to be extremely productive. The ability to communicate with people has evolved enthusiastically and was adopted by the people throughout the world [10]. The number of mobile subscribers has increased tremendously during the last decade. The initial wireless telephone technology is referred to as First Generation and 1G networks use analog signals .It supports only voice services. The second generation is totally digital and supports additional services like SMS (Short Message services).The third generation of mobile technology came into picture to achieve higher data rate and support services like mobile T.V. video calls etc. Finally fourth generation is getting ready to storm the markets [9]. LTE (Long Term Evolution) is developed to cater the increasing demands of higher data rates at decent costs.

2. EVOLUTION OF MOBILE TECHNOLOGIES

2.1. *First generation technology (1G)*

The first generation of mobile technology began with the introduction of analog cellular service called Analog Mobile Phone Service (AMPS) starting in 1981.The first generation of wireless telecommunication technology supports only voice calls which are provided with circuit switching. The limitation is that data is not encrypted and thus prone to miscommunication, sound quality is poor and data transfer rate is 9.6 Kbps. It uses the Frequency Division Multiplexing technique [9].

2.2. *Second generation technology (2G)*

The next generation, quick on the heels of the first, is digital cellular. One standard uses a digital version of AMPS called D-AMPS .The second generation of wireless telecommunication technology supports SMS and MMS services in addition to voice calls. The 2G technology is based on Time Division Multiplexing and Code Division Multiplexing. Based on TDMA, Global System for Mobile communication is the first European standard used by the 2G telephony. The data transfer rate is 14.4 Kbps and a 2G GSM network uses 800/900 MHz frequency spectrum .Data services such as Internet access, text messaging, sharing pictures and video are inherently digital [9].

2.3. *2.5G-GPRS (General Packet Radio Service)*

The 2.5 generation of wireless technology supports multimedia messages and provides the access to Internet. This technology have implemented packet switched domain in addition to circuit switched domain. The introduction of General Packet Radio Service (GPRS) was the first major step in the evolution of GSM networks. The data transfer rate is 115 Kbps. The demand for greater bandwidth right now has spawned intermediate generations called 2.5G and even 2.75G. One such standard is General Packet Radio Services (GPRS), which is an extension of the GSM digital cellular service popular in Europe [9]

2.4. *2.75G-EDGE (Enhanced Data rates for GSM Evolution)*

EDGE is a digital mobile technology which was invented by AT&T and is an extended version of GSM. It supports fast transmission of data with data transfer rate of 236.8 Kbps

2.5. *Third generation technology (3G)*

The third generation of mobile telecommunication technology is based on set of standards defined by ITU (International Telecommunication Union). 3G has proven to be a tough generation to launch. It enables telephones to also become Internet computers, video phones and television receivers; its maturity phase will find it competing with wireless VoIP telephone services on Wi-Fi, WiMAX, WiTV and the new wireless mobile standard 802.20. The data transfer rate of Universal Mobile Telecommunication System, 3G mobile technology is 2 Mbps. It supports services like video calls. Live T.V,
e- mailing and accessing high speed internet [3].

2.6. *Fourth generation technology (4G)*

The development of 4G networks and related technologies in today's scenario is an indicator of advancement in the field of wireless communication and technology. The main features of 4G is that services can be delivered and available to the different users and support the users traffic, radio environment ,air interfaces, and quality of service. The fourth generation of mobile technology is the extension of 3G which offers higher bandwidth. The 4G technology offers high data rates and high quality audio or video streaming over end to end Internet Protocol. In India, the Reliance Industries headed by Mukesh Ambani revealed to The Economic Times to provide 4G connectivity to 700 cities till the mid of 2013.[7]The data transfer rate of 4G technology is 100 Mbps and up to as fast as 1 Gbps. The 4G Mobile communications will be based on the Open Wireless Architecture (OWA) to ensure the single terminal can seamlessly and automatically connect to the local high-speed wireless access systems when the users are in the offices, homes, airports or shopping centers where the wireless access networks are available. When the users move to the mobile zone, the same terminal can automatically switch to the wireless mobile networks. etc. Based on this OWA model, 4G mobile will deliver the best business cases to the wireless and mobile industries. [8]

2.7. *Long Term Evolution (LTE)*

It is 4G wireless communication standard which was developed by the 3rd Generation Partnership Project (3GPP), collaboration between groups of telecommunication associations. The idea was proposed in Toronto conference of 3GPP in 2004 and was started as LTE work in 2006. The aim was to achieve high data rate mobile services [8].

3. BASIC TERMINOLOGY OF WIRELESS TECHNOLOGY

3.1. *Subscriber Identity Module (SIM) card*

The subscriber is identified in the system when he inserts the SIM card in the mobile equipment as it provides flexibility of communication to the subscriber. [9]

3.2. *MSISDN (Mobile Station Integrated Service Digital Network)*

The real telephone number of a mobile station is the mobile subscriber ISDN number (MSISDN).

3.3. *IMSI (International Mobile Subscriber Identity)*

It is stored in the subscriber identity module (SIM) .A mobile station can only be operated if a SIM with a valid IMSI is inserted into equipment with a valid IMEI.

3.4. *TMSI (Temporary Mobile Subscriber Identity)*

The VLR, which is responsible for the current location of a subscriber, can assign a TMSI which has only local significance in the area handled by the VLR.

3.5. *IMEI (International Mobile Equipment Identity)*

It is a kind of serial number which is allocated by the equipment manufacturer.

4. WIRELESS STANDARDS

There are different methods and standards of wireless communication have developed across the world based on various requirements.

4.1. *IEEE 802.11*

In 1997, IEEE created first WLAN standard which supports a maximum network bandwidth of 2 Mbps. It uses either Frequency-hoping spread spectrum (FHSS) or Direct sequence spread spectrum (DSSS). FHSS is a method of transmitting radio signals by rapidly switching a carrier among many frequency channels. DSSS is a transmission technology used in local area wireless network transmissions in which a data signal at the sending station is combined with a high data rate bit sequence, which divides user data based on a spreading ratio.

4.2. *IEEE 802.11a*

The IEEE 802.11 adopted OFDM technique and uses 5 GHz band. It has the fastest transmission speed and uses 5 GHz frequency and thus limiting interference from other devices. The drawback is that higher frequency radio waves are absorbed by obstacles resulting in poor performance. [3]

4.3. *IEEE 802.11b*

It is less susceptible to multipath propagation interference and its speed is 11 Mbps having the best signal range. It provides access to few users simultaneously and the transmission speed is low.

4.4. *IEEE 802.11g*

It offers data transfer speed up to 54 Mbps allowing for more simultaneous users It is compatible with 802.11b and is not easily obstructed. It uses 2.4 GHz frequency same as some of the household items resulting in the problem of interference.

4.5. *IEEE 802.11i*

This standard provides improved security and encryption methods.1It provides integration of 802.1x authentication protocols as well as advanced encryption mechanisms such as AES (Advanced Encryption Standard).

4.6. *IEEE 802.11n*

It uses multiple transmitter and receiver antennas to allow for increased data throughput and range without requiring additional power or radio frequency band allocation. [3]

5. ANALYZING THE GENERATIONS OF MOBILE TECHNOLOGIES

5.1. *2G technology*

The second generation technologies are Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA). In TDMA, the signal is divided into time slots. In CDMA each user is allocated a special code to communicate over a multiplex physical channel. TDMA is a narrow band of 30 KHz wide and its technologies are GSM (Global System for Mobile) which originated in Europe and is now globally used, IDEN (Integrated Digital Enhanced Network) is introduced by the Motorola used in US and Canada, IS-136 (Interim Standard-136), prevail in the South and North America, PDC (Personal Digital Cellular) is used in Japan. CDMA supports the Interim Standard (IS-95) and operates at the frequency bands of 800 MHz and 1900 MHz [9]
The 2g technology uses digital signals which consume less battery power. Digital coding provides improved voice clarity and digital encryption results in improved security.

5.2. *3G technology*

The 3g technology transmits packet switch data efficiently and at increased bandwidth. It offers more advanced services to the end users with better spectral efficiency. The 3g is also known as IMT-2000.It supports services like mobile television, video conferencing and GPS (Global Positioning System). The 3g (WCDMA/UMTS) is a component of IMT-2000 which uses wideband code division multiple access to offer high spectral efficiency and bandwidth to the users. The 3G (TD-SCDMA) is approved by the ITU and is based on the time synchronization with CDMA. [9]

5.3. *4G technology*

There are two technologies which are based on the features of 4g; Wi-MAX and LTE. WiMAX refers to interoperable implementations of the IEEE 802.16 family of wireless-networks standards. It is similar to Wi-Fi, but it can enable usage at much greater distances. LTE [5] stands for Long Term Evolution. It is designed to achieve very fast mobile data services. It's an all IP architecture support QOS for real time packet data services like VoIP & live video streaming. LTE uses OFDM for the downlink – that is, from the base station to the terminal. The LTE uplink transmission scheme for FDD and TDD mode is based on SC-FDMA (Single Carrier Frequency Division Multiple Access). [8]

The features of 4g technology are:

- To support advanced services and applications.
- Enhanced peak data rates (100 Mbps for high mobility and 1 Gbps for low mobility).
- Low latency, improving the consumer experience.
- Flexible network connections, efficient use of spectrum and impressive user applications.
- Worldwide roaming capability.
- Compatibility of services within IMT and with fixed networks.
- Capability of interworking with other radio access systems.
- High quality mobile services.
- User equipment suitable for worldwide use.[1]

There are several challenges which are faced by 4g technology:

1. Security and Privacy

   In the development of 4G Networks, security measures must be established that enable data transmission to be as safe as possible. Specifically, "The 4G core addresses mobility, security, and QOS through reuse of existing mechanisms while still trying to work on some mobility and handover issues" [4]. Therefore, it is necessary for the organization to develop an effective series of tools that support maximum 4G security measures as a means of protecting data that is transmitted across the network from hackers and other security violations. Because of the nature of the 4G network, there is an increased likelihood of security attacks, and therefore, multiple levels of security, including increased requirements for authentication, will be necessary to protect data and information that is transmitted across the network.

2. Quality of Service

   With respect to network quality, many telecommunications providers are promising that there will be enhanced connectivity, and the quality of data that is transmitted across the network will be of the highest possible quality. As a result, it is important for providers to develop an effective approach to the 4G Network that will enhance quality, provide effective security measures, and will ensure that all users are provided with extensive alternatives for downloading video, music, and picture files without delays.[7] The main challenge that 4G networks are facing is integrating non-IP-based and IP-based devices. It is known that devices that are not IP address based are generally used for services such as VoIP. On the other hand, devices that are IP address based are used for data delivery. 4G networks will serve both types of devices. Consequently, integrating the mechanisms of providing services to both non-IP-based as well as IP-based devices is one of key challenges 4G networks have to address. [5]

3. Complex Architecture

   3.1. .Multimode End-User Terminals

   To reduce operating costs, devices that operate on 4G networks should have the capability to operate in different networks. This will not only reduce the operating cost but will also simplify design problems and will reduce power consumption. However, accessing different mobile and wireless networks simultaneously is one of the major issues 4G networks have been addressing. One mechanism that has been proposed to handle this problem is termed "multi-mode devices". This mechanism can be achieved through a software radio that allows the end-user device to adapt itself to various wireless interfaces of the networks.

   3.2. System Discovery and Selection

   Due to the heterogeneity of 4G networks, wireless devices have to process signals sent from different systems, discover available services, and connect to appropriate service providers.[5] Various service providers have their own protocols which can be incompatible with each other as well as with the user's device. This issue may complicate the process of selecting the most appropriate technology based on the time, place and service provided, and thus, may affect the Quality of service provided to the end user.

   One solution to resolve this issue is called "System-initiated discoveries". This mechanism allows automatic download of software modules based on the wireless system the user is connected to. [2]

3.3. Service and Billing

Managing user accounts and billing them has become much more complicated with 4G networks. This is mainly due to heterogeneity of 4G networks and the frequent interaction of service providers. [7]

6. COMPARISON

Table 1. Comparing the mobile technologies

	1G	2G	3G	4G
Generation	1G is the first generation that existed in 1980s	2G is the second generation that existed in late1980s	3G is the third generation that existed in 1990s	4G is the fourth generation that evolved in late 1990s
Type of comm.	It is based on analog signals.	It is based on digital voice	It based on high capacity broadband data	It is based on wireless comm. which is IP based.
Security	Poor or no security.	Safe for consumers to use.	Secured	High security.
Peak Speed	Peak speed up to1.9 kbps.	Peak speed may be up to 14.4 kbps.	Peak speed up to 2 Mbps	Peak speed up to 150 Mbps.
Access Technique	.It uses FDMA	It uses TDMA and CDMA	It uses WCDMA	It uses OFDMA
Switching Technique	It supports circuit switching	It supports circuit switching	It supports packet switching	It supports packet as well as message switching.
Services	It supports only voice calls	It supports data services & voice calls	It provides video access	It provides HD video access

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7. CONCLUSION

Mobile phone penetration worldwide is approaching. 60%. Voice communication has become mobile in a massive way. The first generation of wireless telecommunication technology supports only voice calls. The second generation of wireless telecommunication technology supports SMS services in addition to voice calls. The third generation of mobile telecommunication technology finds application in wireless voice telephony, mobile internet access, video calls and mobile T.V.

LTE is already meeting the requirements of next generation mobile requirements. It enables operators to offer high -performance, mass-market mobile broadband services, through a combination of high bit-rates and system throughput –in both the uplink and downlink –with low latency.
LTE infrastructure is designed to be as simple as possible to deploy and operate, through flexible technology that can be deployed in a wide variety of frequency bands.

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