Evolution and Development of Various Generations of Mobile Wireless Technology

Neha Gupta

Guru Nanak Dev University, Amritsar, Punjab, India
Email: Ngupta25055@gmail.com

Abstract: Mobile communication systems revolutionized the way people communicate. Evolution of wireless access technologies is about to reach its fourth generation (4G) and the 5G mobile networks will focus on the development of the user terminals where the terminals will have access to different wireless technologies at the same time and will combine different flows from different technologies. Looking past, wireless access technologies have followed different evolutionary paths aimed at unified target related to performance and efficiency in high mobile environment. The first generation (1G) has fulfilled the basic mobile voice, while the second generation (2G) has introduced capacity and coverage. This is followed by the third generation (3G), which has quest for data at higher speeds to open the gates for truly "mobile broadband" experience, which was further realized by the fourth generation (4G).The Fourth generation (4G) provides access to wide range of telecommunication services, including advanced mobile services, supported by mobile and fixed networks, which are increasingly packet based, along with a support for low to high mobility applications and wide range of data rates, in accordance with service demands in multiuser environment. Fifth generation should be more intelligent technology that interconnects the entire world. This article provides a high level overview of the Long Term Evolution (LTE) and Worldwide Interoperability for Microwave Access (WiMAX)-the leading technologies for next-generation mobile broadband*.*

Keywords: Wireless communication; ITU; networks; mobile broadband; generation; technology.

1. Introduction

The cellular wireless generation (G) generally refers to a change in the fundamental nature of the service, non-backwards compatible transmission technology, and new frequency bands. New generations have appeared in every ten years, since the first move from 1981-An analog (1G) to analog (2G) network. After that there was (3G) multimedia support, spread spectrum transmission and 2011 all –IP Switched networks (4G) comes. The last few years have witnessed a phenomenal growth in the wireless industry, both in terms of mobile technology and its subscribers. There has been a clear shift from fixed to mobile cellular telephony, especially since the turn of the century. By the end of 2010, there were over four times more mobile cellular subscriptions than fixed telephone lines. Both the mobile network operators and vendors have felt the importance of efficient networks with equally efficient design. This resulted in Network Planning and optimization related services coming in to sharp focus [1]. Next generation mobile networks, commonly referred to as 4G, and are envisaged as a multitude of heterogeneous systems interacting through a horizontal IP-centric architecture [2]. The 5G core is to be a Re-configurable, Multi-Technology Core. The core could be a convergence of new technologies such as Nanotechnology, Cloud Computing and Cognitive Radio, and based on All IP Platform. These new technologies and the above mentioned requirements pose the several challenges

toward 5G development [3]. Mobile Cellular Network evolution has been categorized in to 'generations' as:

1.1 First generation (Analog)

First-generation mobile systems used analog transmission for speech services. In 1979, the first cellular system in the world became operational by Nippon Telephone and Telegraph (NTT) in Tokyo, Japan. Two years later, the cellular epoch reached Europe. In the United States, the Advanced Mobile Phone System (AMPS) was launched in 1982. The two most popular analogue systems were Nordic Mobile Telephones (NMT) and Total Access Communication Systems (TACS). The system was allocated a 40-MHz bandwidth within the 800 to 900 MHz frequency range by the Federal Communications Commission (FCC) for AMPS. In fact, the smallest reuse factor that would fulfill the 18db signal-to-interference ratio (SIR) using 120-degree directional antennas was found to be 7. Hence, a 7-cell reuse pattern was adopted for AMPS. Transmissions from the base stations to mobiles occur over the forward channel using frequencies between 869-894MHz.The reverse channel is used for transmissions from mobiles to base station, using frequencies between 824-849 MHz AMPS and TACS use the frequency modulation (FM) technique for radio transmission. Traffic is multiplexed onto an FDMA (frequency division multiple access) system [3, 5].

1.2. Second Generation (Digital)

Second-generation (2G) mobile systems were introduced in the end of 1980s. Compared to first-generation systems, second-generation (2G) systems use digital multiple access technology, such as TDMA (time division multiple access) and CDMA (code division multiple access). Consequently, compared with first-generation systems, higher spectrum efficiency, better data services, and more advanced roaming were offered by 2G systems. In the United States, there were three lines of development in second-generation digital cellular systems. The first digital system, introduced in 1991, was the IS-54 (North America TDMA Digital Cellular), of which a new version supporting additional services (IS-136) was introduced in 1996.Meanwhile, IS-95 (CDMA One) was deployed in 1993 [3]. 2G communication is generally associated with global system for mobile (GSM) services; 2.5G is usually identified as being fueled by general packet radio service (GPRS) along with GSM [6].

1.3. Third Generation (WCDMA in UMTS, CDMA2000 & TD-SCDMA)

3G uses Wide Brand Wireless Network with which clarity is increased. 3G telecommunication networks support services that provide an information transfer rate of at least 2Mbps.In EDGE, high-volume movement of data was possible, but still the packet transfer on the air-interface behaves like a circuit switches call. Thus part of this packet connection efficiency is lost in the circuit switch environment. Moreover, the standards for developing the networks were different for different parts of the world. Hence, it was decided to have a network which provides services independent of the technology platform and whose network design standards are same globally. Thus, 3G was born [7]. 3G is not one standard; it is a family of standards which can all work together.An organization called 3rd Generation Partnership Project (3GPP) has continued the work by defining a mobile system that fulfills the IMT-2000 standard. In Europe, it was called UMTS (Universal Terrestrial Mobile System), which is ETSI-driven. IMT2000 is the ITU-T name for the third generation system, while cdma2000 is the name of the American 3G variant. WCDMA is the air-interface technology for the UMTS. The main components includes BS (Base Station) or nod B, RNC (Radio Network Controller), apart from WMSC (Wideband CDMA Mobile Switching Centre) and SGSN/GGSN. 3G networks enable network operators to offer users a wider range of more advanced services while achieving greater

network capacity through improved spectral efficiency. The first commercial 3G network was launched by NTT Do Co Mo in Japan branded FOMA, based on W-CDMA technology on October 1, 2001 [8].

1.4. Fourth Generation (All-IP)

The first successful field trial for 4G was conducted in Tokyo, Japan on June 23rd, 2005. NTT Do Co Mo was successful in achieving 1Gbps real time packet transmission in the downlink at a moving speed of about 20km/h. To use 4G services, multimode user terminals should be able to select the target wireless systems. In current GSM systems, base stations periodically broadcast signaling messages for service subscription to mobile stations. However, this process becomes complicated in 4G heterogeneous systems because of the differences in wireless technologies and access protocols. To provide wireless services at anytime and anywhere, terminal mobility is a must in 4G infrastructure. Terminal mobility allows mobile clients to roam across geographic boundaries of wireless networks. There are two main issues in terminal mobility: location management and handoff management. With location management, the system tracks and locates a mobile terminal for possible connection. Location management involves handling all the information about the roaming terminals, such as original and current located cells, authentication information etc. On the other hand, handoff management maintains ongoing communications when the terminal roams. Mobile IPv6 (MIPv6) is a standardized IP-based mobility protocol for IPv6 wireless systems. In this design, each terminal has an IPv6 home address. Whenever the terminal moves outside the local network, the home address becomes invalid, and the terminal obtains a new IPv6 address (called a care-of address) in the visited network [9]. The design and optimization of upcoming radio access techniques and a further evolution of the existing system, the Third Generation Partnership Project (3GPP) had laid down the foundations of the future Long Term Evolution (LTE) advanced standards-the 3GPP candidate for 4G [10]. The target values of peak spectrum efficiency for LTE Advanced systems were set to 30bps/Hz and 15 Bps/Hz in downlink and uplink transmission respectively. Apart from the multiple access schemes, enhanced multiple-input multiple-output (MIMO) channel transmission techniques and extensive coordination among multiple cell sites called coordinated multipoint (CoMP) transmission/reception were accepted as the key techniques for LTE [11].

1.5. Fifth Generation (WiMAX, WWWW, RAT)

The 5G (Fifth Generation Mobile and Wireless Networks) can be a complete wireless communication without limitation, which bring us perfect real world wireless – World Wide Wireless Web (WWWW). 5G denotes the next major phase of mobile telecommunications standards beyond the 4G/IMT-Advanced standards. At present, 5G is not a term officially used for any particular specification or in any official document yet made public by telecommunication companies or standardization bodies such as 3GPP, WiMAX Forum, or ITU-R. Each new release will further enhance system performance and add new capabilities with new application areas. Some of the additional applications, benefiting from mobile connectivity are home automation, smart transportation, security, and e-books [2]. IEEE 802.16 is a series of Wireless Broadband standards authorized by the Institute of Electrical and Electronics Engineers (IEEE). It has been commercialized under the name "WiMAX" (from "Worldwide Interoperability for Microwave Access") by the WiMAX Forum industry alliance. IEEE 802.16 standardizes the air interface and related functions associated with wireless local loop [12]. 5G mobile technology has changed the means to use cell phones within very high bandwidth. User never experienced ever before such a high value technology. The 5G technologies include all type of advanced features which make 5G mobile technology most powerful and in huge demand in near future. For children rocking fun Bluetooth technology and Pico nets has become available in market. Users can also hook their 5G technology cell phones with their Laptop to get broadband internet access. 5G technology includes camera, MP3

recording, video player, large phone memory, dialing speed, audio player and much more one can never imagine [13]. In fifth generation, Network Architecture consists of a user terminal (which has a crucial role in the new architecture) and a number of independent, autonomous radio access technologies (RAT) [14]. 5G mobile system is all-IP based model for wireless and mobile networks interoperability. Within each of the terminals, each of the radio access technologies is seen as the I Plink to the outside Internet world [15]. Comparative account of all generations (1G-5G) has been depicted in Table 1 [16].

2. Challenges in next generation communication

The challenge in the design of the terminals is connected to the management of trade between the flexibility of how to use the spectrum and needed space and power to given platform. New methods offer design dimensions that allow the system to adapt to the opportunities and requirements of the terminals in a manner that shall maximize the spectral efficiency and also maximize the battery power. As a result of growing level of acceptance of the wireless technologies in different fields, challenges and types of wireless systems associated with them are changing. In heterogeneous wireless networks the concept is "always best connected" (always associated with the best quality), aimed at client terminals, and is proposed in different researches [17]. In 4G business models, important issues are related to privacy and security, creating industry standards of excellence and meeting them in all facets of the technology, dealing with handset limitations, improving poor use experience reported by users for many different phones and importantly the lack of awareness of mobile data services among people. 5G Wireless Access key challenges include avalanche of Traffic, explosion of number of devices and diversity of requirements such as latency, reliability and low cost and energy consumption. This multiplicity of requirements is in turn stretching the limits of available technologies. Vision of Super Core is based on IP platform. All network operators (GSM, CDMA, Wi-Max, Wire line) can be connected to one Super core with massive capacity. This is realization of single network infrastructure. The concept of super core will eliminate all interconnecting charges and complexities, which right now network operator is facing. It will also reduce number of network entities in end to end connection, thus reducing latency considerably [18]. 5G network will not be only of more speed but also capable of carry more data. This generation is expected to be rolled out around 2020. In 5G, network might solve the problem of frequency licensing and spectrum management issues. The 5G terminals might have software-defined radios. Also, it has different modulation schemes and error-control schemes. It provides hundreds of channel without streaming [5].

3. Applications of next generation network

The next generation applications are set to evolve in a multiplatform environment. 4G applications will be available across various wireless technologies like LTE, Wi-Fi, etc. and also in devices like cell phones, laptops, e-readers, digital cameras, printers and so on. 4G applications are very likely to be extended and improved versions of the existing 3G services, but it is still unclear what the capacity of 4G will hold for the mobile world. Some of the applications of next generation networks are [19-22]:

3.1 Virtual Presence

This means that 4G and 5G provide user services at all times, even if the user is off-site. Virtual navigation: 4G provides users with virtual navigation through which a user can access a database of the streets, buildings etc. of large cities. This requires high speed data transmission.

3.2 Tele-Medicine

4G and 5G will support remote health monitoring of patients. A user need not go to the hospital instead a user can get videoconference assistance for a doctor at anytime and anywhere.

3.3 Tele-geoprocessing applications:

This is a combination of GIS (Geographical Information System) and GPS (Global Positioning System) in which a user can get the location by querying.

3.4 Crisis management

Natural disasters can cause breakdown in communication systems. In today's world it might take days or weeks to restore the system. But in 4G it is expected to restore such crisis issues in a few hours.

3.5 Education

For people who are interested in lifelong education, 4G provides a good opportunity. People anywhere in the world can continue their education through online in a cost effective manner.

3.6 Artificial Intelligence

More applications combined with artificial intelligent (AI) as human life will be surrounded by artificial sensors which could be communicating with mobile phones.

3.7 Travelling

Introducing the launch of new mobile phone apps; the use of Bluetooth & NFC technology integrated smart phones in the passenger travel process. Technology is likely to play a role in re-ordering these phases over the next decade, allowing, for example, people to experience a destination virtually before transit, or to seek inspiration and share information live, while they are travelling and experiencing a place.

3.8 Security

This layer also branches across all the layers of the 4G and 5G network architecture which perform the function of authentication, authorization, encryption, establishment and implementation of service policy agreement between the various vendors.

3.9 Economic growth:

Economic growth is supported because these technology changes allow consumers and businesses to benefit from high-value wireless data and content services. This relationship had not yet been explicitly quantified yet.

4. Future prospective of 5g communication

In the 5G system, each cell phone will have permanent "Home" IP address and "care of address" which represents its actual location. When a computer on the Internet wants to communicate with cell phone after that first, it sends a packet to the home address and subsequently server on home address send a packet to the actual location through the tunnel. Server also sends a packet to the computer to inform the correct address so that future packets will send on that address [5]. Cloud computing is a technology that uses the internet and central remote server to maintain data and applications. In 5G network this central remote server will be our content provider. Cloud computing allows consumers and business to use applications without installation and access their personal files at any computer with internet access. The same concept is going to be used in nano-core where the user tries to access his private account from a global content provider through nano-core in form of cloud [23]. The development of cloud computing provides operators with tremendous opportunities. The advanced billing interfaces of 5G technology makes it more attractive and effective with the following future perspectives [24].

• 5G technology provides subscriber supervision tools for fast action.

• The high quality services of 5G technology based on Policy to avoid error.

• 5G technology is providing large broadcasting of data in Gigabit which supports almost 65,000 connections.

• 5G technology offers transporter class gateway with unparalleled consistency.

• The traffic statistics by 5G technology makes it more accurate.

• Through remote management offered by 5G technology a user can get better and fast solution.

• The remote diagnostics is also a great feature of 5G technology.

• The 5G technology is providing up to 25 Mbps connectivity speed.

• The 5G technology also support virtual private network.

• The new 5G technology will take all delivery service out of business prospect.

• The uploading and downloading speed of 5G technology touching the peak.

• The 5G technology network offering enhanced and available connectivity just about the world.

5. Conclusion

Mobile Wireless Communication Technology is going to be a new revolution in mobile market. With the coming out of cell phone alike to personal data assistant (PDA) now our whole office is in our finger tips or in our phone. 5G technology has a bright future because it can handle best technologies and offer priceless handset to their customers.5G will promote concept of Super Core, where all the network operators will be connected through one single core and have one single infrastructure, regardless of their access technologies.4G and 5G techniques provide efficient user services with lower battery consumption, lower outage probability (better coverage), high bit rates in larger portions of the coverage area, cheaper or no traffic fees due to low infrastructure deployment costs, or higher aggregate capacity for many simultaneous users.

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