

# Comparative Study of Mobile Generations

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## ABSTRACT

Today wireless services are the most preferred services of the world. The rapid increase in the service is due to the advancement of technology consecutively. The worldwide revolution in mobile and internet technology have changed our way of living life. Every new technology has come to hide the drawbacks of previous technology. In this paper we throw a light on the various generations of mobile wireless technologies (1G to 5G) and also presents an overview of 5G technology trends in the wireless technology market, a comparative overview of 5G v/s all other previous generation technologies and the major improvements which could be made to 5G technology.

**Keywords:** First Generation, Second Generation, Third Generation, Fourth Generation and Fifth Generation

## I. INTRODUCTION

The era of communication is a vast technology where we see improvement will be day by day grown on. In this advanced technology, the techniques were emerging in all the fields of mobile and wireless communications. With all this the simultaneous existence of the generations, the impact of services on network efficiency have become more critical [3]. As the communication industry has got the custom of classifying the developments into various generations. Likewise the wireless networks are classified into five generations, namely, first generation, second generation, third generation, fourth generation and fifth generation networks. Many more designing scenarios have developed with not only 1G network but also with the evolution of 2G, 3G, 4G and 5G networks. Along with this, inter-operability of the networks has to be considered. The cellular concept was introduced in the 1G technology which made the large scale mobile wireless communication possible. Digital communication has replaced the analog technology in the 2G which significantly improved the wireless communication quality [1]. Data communication, in addition to the voice communication, has been the main focus in the 3G technologies and a converged network for both voice and data communication is emerging. 1G refers to analog cellular technologies and it became

available in the 1980s. 2G denotes initial digital systems, introducing services such as short messaging and lower speed data. 3G requirements were specified by the ITU as part of the International Mobile Telephone 2000 (IMT-2000) project, for which digital networks had to provide 144 kbps of throughput at mobile speeds [2]. The ITU has recently issued requirements for IMT- Advanced, which constitutes the official definition of 4G. Requirements include operation in up-to-40 MHz radio channels and extremely high spectral efficiency. 5G technologies began to be deployed. The Generation blocks are shown below figure 1.

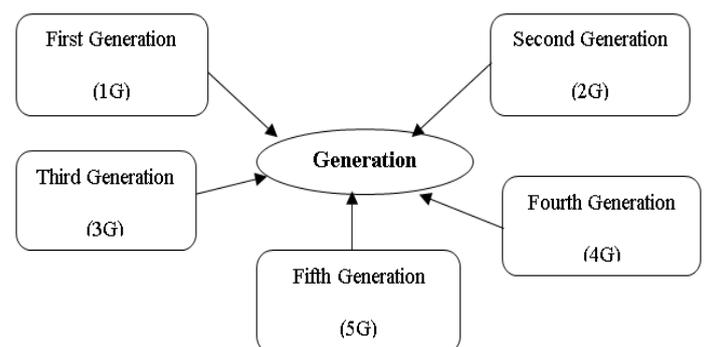


Figure 1: Mobile Wireless Technology

## II. CELLULAR NETWORKS

A cellular network or mobile network is a radio network distributed over land areas called cells, each served by at least one fixed-location transceiver, known as a cell site or base station [1]. In a cellular network, each cell uses a different set of frequencies from neighbouring cells, to avoid interference and provide guaranteed bandwidth within each cell. When joined together these cells provide radio coverage over a wide geographic area. This enables a large number of portable transceivers (e.g., mobile phones, pagers, etc.) to communicate with each other and with fixed transceivers and telephones anywhere in the network, via base stations, even if some of the transceivers are moving through more than one cell during transmission [2].

### III. EVOLUTION OF GENERATIONS

#### A. FIRST GENERATION:

First generation of wireless telephone technique, mobile telecommunication which was first introduced in 1980's and completed in early 1990's. It has speed 2.4 kbps and it allows voice calls in only one country. It uses analog signal. This system used frequency multi-access technique in duplex mode (i.e., transmission and reception possible at the same point). The frequency band employed by many countries during first generation was in the range of 800-900MHz. The first generation cellular mobile communication systems did not have vision of universal operation. Most of the cellular systems developed were localized. This nature of first generation cellular system paved the way for variation in the standards among countries [5]. The features of 1G technology are mobile radio telephones and such technologies as Mobile Telephone System (MTS), Advanced Mobile Telephone System (AMTS), and Improved Mobile Telephone Service (IMTS). Frequency modulation was adopted by many countries. The transmission power was decided according to the size of the cell. Its successor, 2G, which made use of digital signals, 1G wireless networks used analog radio signals. Through 1G, a voice call gets modulated to a higher frequency of about 150MHz and up as it is transmitted between radio towers. This is done using a technique called Frequency-Division Multiple Access (FDMA). In terms of overall connection quality, 1G compares unfavourably to its successors. It has low capacity, unreliable handoff, poor voice links, and no

security at all since voice calls were played back in radio towers, making these calls susceptible to unwanted eavesdropping by third parties. However, 1G did maintain a few advantages over 2G. In comparison to 1G's analog signals, 2G's digital signals are very reliant on location and proximity. If a 2G handset made a call far away from a cell tower, the digital signal may not be strong enough to reach it. While a call made from a 1G handset had generally poorer quality than that of a 2G handset, it survived longer distances. This is due to the analog signal having a smooth curve compared to the digital signal, which had a jagged, angular curve. The carrier spacing of the channel was 25 to 30 kHz. Therefore the first generation system developed did not cater to the needs of all four kinds of information like voice, picture, data, and text.



Figure 2: 1G Technology

#### B. SECOND GENERATION:

Second generation is based on GSM (Global System Module). It is launched in Finland in year 1991. This generation standards provide to the needs of all four types of information text, picture data and voice. The second generation standards were developed for digital cellular, PCS, mobile data and WLAN. Code division multi-access was introduced at the fag end of second generation [5]. Even the second generation wireless standards did not provide the needs of international standards. It cannot normally transfer data, such as email or software, other than the digital voice call itself, and other basic ancillary data such as time and date. Nevertheless, SMS messaging is also available as a form of data transmission for some standards. Second generation 2G cellular telecom networks were commercially launched on the GSM standard. 2G technologies can be divided into Time Division Multiple Access (TDMA) based and Code Division Multiple Access (CDMA) based standards depending on the type of multiplexing used. Through this technology, a 2G network can pack more calls per amount of bandwidth

as a 1G network. 2G cellphone units were generally smaller than 1G unit, since they emitted less radio power.

Some benefits of 2G were Digital signals require consume less battery power, so it helps mobile batteries to last long. Digital coding improves the voice clarity and reduces noise in the line. Digital signals are considered environment friendly. The use of digital data service assists mobile network operators to introduce short message service over the cellular phones. Digital encryption has provided secrecy and safety to the data and voice calls. The use of 2G technology requires strong digital signals to help mobile phones work. If there is no network coverage in any specific area, digital signals would be weak.



Figure 3: 2G Technology

### C. THIRD GENERATION

The migration to the third generation mobile system was to develop an international standard by deriving benefits for many ideas and technologies available worldwide. The first and second generation standards were developed to cater to the needs of speech and low bit rate data services. Any enhancements to new services were not matching them [5]. 3G technologies enable network operators to offer users a wider range of more advanced services while achieving greater network capacity through improved spectral efficiency. Services include wide area wireless voice telephony, video calls, and broadband wireless data, all in a mobile environment. 3G technologies make use of TDMA and CDMA. 3G (Third Generation Technology) technologies make use of value added services like mobile television, GPS (global positioning system) and video conferencing. The basic feature of 3G Technology is fast data transfer rates. 3G technology is much flexible, because it is able to support the 5 major radio technologies. These radio technologies operate under CDMA, TDMA and FDMA. CDMA holds for IMT-DS (direct spread), IMT-MC (multi carrier). TDMA

accounts for IMTTC (time code), IMT-SC (single carrier). FDMA has only one radio interface known as IMT-FC or frequency code. Third generation technology is really affordable due to the agreement of industry. This agreement took pace in order to increase its adoption by the users. 3G system is compatible to work with the 2G technologies. The aim of the 3G is to allow for more coverage and growth with minimum investment. As a relative comparison the third generation mobile systems attempted on the following qualities of services:

- Better system capacity
- Wireless internet cess up to 2Mbps
- Wireless multimedia networking including audio, video , text and data information.
- Better speed in information transformation.



Figure 4: 2G Technology

### D. FOURTH GENERATION:

It is basically the extension in the 3G technology with more bandwidth and services offers in the 3G. The expectation for the 4G technology is basically the high quality audio/video streaming over end to end Internet Protocol. If the Internet Protocol (IP) multimedia sub-system movement achieves what it going to do, nothing of this possibly will matter. WiMAX or mobile structural design will become progressively more translucent and therefore then acceptance of several architectures by a particular network operator ever more common. Some of the companies trying 4G communication at 100 Mbps for mobile users and up to 1 Gbps over fixed stations. They planned on publicly launching their first commercial wireless network around 2010. As far as other competitor's mobile communication companies working on 4G technology even more quickly. Sprint Nextel was planned to launch WiMAX over 4 G broadband mobile networks in United States. Some of the other developed countries like United Kingdom stated a plan to sale via auction of 4G

wireless frequencies couple of years back. The word “MAGIC” also refers to 4G wireless technology which stands for Mobile multimedia, Any-where, Global mobility solutions over, integrated wireless and Customized services. The emergence of new technologies in the mobile communication systems and also the ever increasing growth of user demand have triggered researchers and industries to come up with a comprehensive manifestation of the up-coming fourth generation (4G) mobile communication system. 4G refers to the fourth generation of cellular wireless standards [5]. It is a successor to 3G and 2G families of standards [6]. The nomenclature of the generations generally refers to a change in the fundamental nature of the service, non-backwards compatible transmission technology and new frequency bands. The first was the move from 1981 analogue (1G) to digital (2G) transmission in 1992. This was followed, in 2002, by 3G multi-media support, spread spectrum transmission and at least 200 kbit/s, soon expected to be followed by 4G, which refers to all-IP packet-switched networks, mobile ultra-broadband (gigabit speed) access and multi-carrier transmission.



Figure 5: 4G Technology

## E.FIFTH GENERATION

As the successor of 1G 2G was far better than 1G but still it lags very much to compete with 5G. 2G provides facility of messaging as well as data transfer. But the speed of 2G internet was very slow as compared to 5G; the 2G did not allow the high data transfer rate for streaming multimedia whereas 5G provides a HD video streaming. 5G technology has changed the means to use cell phones within very high bandwidth. User never

experienced ever before such a high value technology. Nowadays mobile users have much awareness of the cell phone (mobile) technology. The 5G technologies include all type of advanced features which makes 5G technology most powerful and in huge demand in near future. The gigantic array of innovative technology being built into new cell phones is stunning. 5G technologies which are on hand held phone offering more power and features than at least 1000 lunar modules. A user can also hook their 5G technology cell phone with their Laptop to get broadband internet access. 5G technology including camera, MP3 recording, video player, large phone memory, dialling speed, audio player and much more you never imagine. For children rocking fun Bluetooth te5G technology has changed the means to use cell phones within very high bandwidth. User never experienced ever before such a high value technology. Nowadays mobile users have much awareness of the cell phone (mobile) technology. A new revolution of 5G technology is about to begin because 5G technology going to give tough completion to normal computer and laptops whose marketplace value will be effected. There are lots of improvements from 1G, 2G, 3G, and 4G to 5G in the world of telecommunications. The new coming 5G technology is available in the market in affordable rates, high peak future and much reliability than its preceding technologies. The 5G technologies include all type of advanced features which makes 5G technology most powerful and in huge demand in near future.



Figure 6: 5G Technology

## IV.COMPARISION OF GENERATIONS

The comparison of all generations are shown in below table in which the 5G technology is up grading one when compared to other technologies. And the

evolution of all generation 1G, 2G, 3G, 4G, and 5G technologies are shown in following figure 6.

multimedia streaming with speed up to 40Mbps. Further we conclude that the upcoming 5G technology will be the most important and the fastest technology of the wireless communication world for an example a movie can be downloaded within a seconds. It is a real wireless world with no more limitation with access and zone issues.

Table 1: Comparison of Mobile Generations

Genera tion	Deployment	Bandwidth	Multiplexing	Switching	Service	Core Network	Technology
1G	1970/1984	2kbps	FDMA	Circuit	Mobile Telephony	PSTN	Analog cellular
2G	1980/1999	14-64kbps	TDMA/CDMA	Circuit	Digital Voice, Short Messaging	PSTN	Digital cellular
3G	1990/2002	2Mbps	CDMA	Packet except Circuit for air interface	Integrated high quality audio, video	Packet Network	Broad bandwidth/ CDMA/IP Technology
4G	2000/2010	200Mbps	CDMA	All Packet	Dynamic information access	Internet	Unified IP & seamless combo of LAN/WAN/WLAN/ PAN
5G	2014/2015	>1Gbps	CDMA	All Packet	Dynamic information access, variable devices	Internet	4G+WWW



Figure 7: Evolution

#### IV. CONCLUSION

Mobiles have become very essential part of our everyday life. Their current development is the outcome of various generations. In this paper we have focused on 1st, 2nd, 3rd and 4th generations of mobile communication technology and predicted about upcoming 5th generation. 1G was based on analog signal and usually used for voice call only with speed up to 10kbps. The 2nd generation is based on digital signal. In 2G one additional feature of text messaging is present in context to 1G with speed up to 64kbps. Further 3G is introduced and in comparison to 2G it is much better because of faster speed than 2G. 3G is based on high broad band data and provides digital navigation as well as video access. After 3G, 4G is introduced with HD

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