A comparative Study of the Evolution Different Mobile Generations for Wireless Communication

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Received: 25/11/2020 Accepted: 13/12/2020 Published: 2020

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Abstract:

The mobile communication system has revolutionized human life and made the world a small village through communications and data transmission in the form of voice calls, messages or videos with very high download speeds. This paper discusses the different communication technologies for mobile phone generations, starting from the first generation of primitive to the second and third generation, in terms of mobile voice technologies, then the fourth generation as signs of rapid data download speed started, as the speed of connection to the fourth generation networks is ten times higher than the generation connection The third, which led to the improvement of data traffic in the communications network, the high mobility recipe for people who make calls, in addition to improving global system management and improving voice quality, then the great revolution in the fifth generation that is characterized by covering all geographical areas with an increase in the high-frequency spectrum, which is characterized at high frequencies starting from 6 GHz to 100 GHz, in addition to comparing all these generations through illustrative tables.

Keywords: Mobile generations, FDMA, AMPS, EDGE, UMTS, CDMA2000 4G- LTE

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1. Introduction:

During the past 20 years, most wireless communications have seen dramatic changes in the quality of technology used, data capacity, speed of data transmission, improved audio and video, conference calling, and 3D gaming technologies. These capabilities have changed from generation to generation, as the first generation appearance in 1981[1]was limited to the analog communication system and voice calls until the second generation of engineers who used digital communication technology and text messaging support, in addition to some improvements in the level of speed, and for the sake of tremendous scientific progress, the generation was produced The third is to support high speed rates[2] in data transmission and increase capacity, in addition to supporting interactive social media until the advent of the fourth generation, which led to a boom in data transfer rates over the Internet depend on IP network [3]and was ahead of all the complications that appeared in previous generations in reducing production costs and increasing bandwidth Then, the dreams of mankind expanded in the field of device automation and entering the world of the Internet of things[4] to appear the fifth generation, and thanks to this technology, the doctor can perform surgeries after using robots and manage them remotely, as is the case in car and aircraft factories, etc. ... The fifth-generation, which will change civilian life to the furthest limits in the world of communications and infrastructure creation, will provide more than four million job opportunities for managing tower stations.

2. First Generation

The first generation (1G) of mobile communications (analog) appeared in the year 1980, and since then they have witnessed tremendous growth. Cellular networks have not been able to interoperate between countries [5].This system does not allow simultaneous listening and speaking, the voice quality was not at the level of the ambiance in addition to the mobile phone's battery life was limited. Its communication system capacity is restricted [6].

As the main concept of the first generation cellular networks that the geographical area is distributed among cells. The cell is 10-25 km long and each cell has its base station [7].

The frequency range is 824-894 MHz, the channel capacity is 30 kilohertz, and it depends on frequency division multiple access (FDMA) technology. It

was based on a system called advanced mobile phone service (AMPS), which relates to voice services [8]. The table below shows the details of 1G.

Table1: Details of first generation

1G	Data
Period	1990 – 2000
Bandwidth	Analog
Frequency	30 KHZ
Data Rate	2.4kbps TO 14.4Kbbps
Characteristic	First wireless Communication
Technology	Analog cellular

3. Second generation

Second generation (2G) become digitally made and dynamic and efficient, and has short message service with picture message. 2G has become fully GSM dependent [9]. Individual conversations are encoded with a random number sequence. Multiple conversations are conducted simultaneously by sending all communications in bits mixed with each other [10]. Table 2 illustrates the bandwidth, frequency, data rate and other details .

Table2: Details of 2G

2G	**Data**
Period	**1000 – 2000**
Bandwidth	**25.MHZ**
Frequency	**200 KHZ**
Data Rate	**144kbps**
Characteristic	**digital**
Technology	**digital cellular GSM**

4.Third generation

The third generation (3G) of smartphones under international mobile communication (IMT-2000) [11] that depend on GSM has revolutionized the globalization of applications in addition to the quality of office services in

new forms of communication that meet the local market of the producing country and globally for importing countries, and called Global System for mobile communications in Europe, while the system is called code division multiple access (CDMA2000) in America. There have been some improvements from new technologies added to this new generation of mobile as shown in this table3 (A, B).

Table 3(A): New technology improvements Table 3(B) New technology improvements

3G	Data
Period	2000-2010
Bandwidth	25MHZ
Frequency	5 MHZ
Data Rate	3.1kbps s
Characteristic	Digital broad band increased speed
Technology	CDMA, EDGE, UMTS

Speed of General Packet Radio Service (GPRS)	Speed of Enhanced Data Rates for Global Evolution(EDGE)	Download Speed	Speed of Evolved Radio Access (EUTRA)
up to 144 Kbps	up to 38 Kbps	Up to 1.92 Mbps	up to 100 Mbps

The communication spectrum between 400 Mhz and 3Ghz has been allocated to the 3G spectrum[12,13]. G3 Internet Protocol (IP) is using packet data services [11].

The term 4G long term evolution (4G- LTE) refers to a wireless cellular network service, as this service began in 2009 in the United States of America, and it appeared after the service of the third-generation (3G) networks to increase the .need for faster service, It has the advantage of providing high-speed, improved, and multimedia service based on the Internet protocol (IP) completely [14].

5. Fourth Generation

Fourth- generation of mobile provides an international platform for wide broadband mobile services at anytime and anywhere [15].

The aims of this generation to access information anywhere and at any time, and the possibility of easy communication with a wide range of information and services, and the exchange of information, data, images, video in a greater quantity [16], online gaming[17]. Table 5 shows the characteristic of 5G.

Table 5: Characteristic of 5G

4G	Data
Period	2010 current
Bandwidth	100MHZ
Frequency	15 MHZ
Data Rate	100kbps s
Characteristic	Digital broad band increased speed
Technology	CDMA, EDGE, UMTS

The fourth-generation (4G) networks do not meet all the ambitions of services and aspirations of the future, as the fifth-generation network will be more flexible and faster than the fourth-generation networks [18]. Table 6 shows the difference between 3G and 4G.

Table 6: The difference between 3G and 4G

Peak Upload Rate	50 Mbit/s	50 Mbit/s
Peak Download Rate	100Mbit/s	1Gbit/s
Switching Technique	packet switching/circuit switch	packet switching, message switching
Network Architecture	Wide Area Cell Based	Integration of wireless LAN and Wide area
Services And Applications	CDMA 2000, UMTS,EDGE etc	Wimax2 and LTE-Advance
Forward error correction (FEC)	3G uses Turbo codes for error correction	Concatenated codes are used for error corrections in 4G
Frequency Band	1.8 – 2.5GHz	2 – 8GHz

6.Fifth generation

5G networks power the next generation of networks, providing high bandwidth as well as more reliable connections to other smartphones [19]. It will be faster at a data rate of 20 GB per second and with a low battery, and has enormous capabilities in remote control of the (IoTs) and allows downloading high-definition movies in a few seconds [20]. The 5G is designed with compatible mobile batteries to create a stable internet connection. The first set of cell phones supporting the 5G network became available in Europe [21], and the completion of the 5G network in Europe in the future is considered one of the most important building blocks of society's digital economy in the next decade.

5G- generation technologies are expected to connect people, things, data, applications, transportation systems, and cities in smart, networked communications environments. It should transmit a vast amount of data much faster, connect very large numbers of devices reliably, and process huge amounts of data with minimal delay.

5G technologies are expected to support applications such as (smart home buildings, cities, 3D video, work and play in cloud computing, telemedical services, virtual reality, augmented reality, and mass machine-to-machine communications for industrial automation) [22]. The table below show some features of 5G. Table 7 shows the low band, download speed, etc.

Table 7: Characteristics of the speed of 5G network

Low band	600 MHz, 800 MHz, and 900 MHz
Maximum download speed is 100 Mbps	2.5 GHz - 4.2 GHz
Higher band uses multiple bands ranging	24 GHz to 47 GHz
Mid-range speed	1 GB per second
Maximum speeds	10 GB per second

7. Conclusions:

In this research, we discussed different communication technologies for mobile phones, from the first generation to the second and third generation, then the fourth and fifth-generation, and through comparisons as shown in the table 8 .

Table 8: Comparative between the generations

1G	2G	3G	4G	5G
				
First mobile phone Basic voice services Limited coverage expensive	Voice and text Digital mobile Quality voice More coverage More affordable	Voice, data and access internet(email, audio and video) First mobile use broadband and iPhone Introduced begin using their phone as computers	Voice data, high speed, to the internet phones True mobile unlimited plans devices used as hotspots Online gaming	Smart vehicles, remote controlled devices, faster phone, broadband and access everywhere smart homes, IoT

And it turns out that the fifth generation is the highest quality and speed in transferring data from the remaining generations. The fifth-generation revolution in the world of mobile communication networks, the launch of the world of the Internet of things, and the control of global, medical, and societal movements for this industry. The fifth-generation will create millions of jobs as well as change the infrastructure of the mobile towers and their equipment.

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دراسة مقارنة لتطور اجيال اجهزة النقال اللاسلكية

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المستخلص:

أحدث نظام الاتصالات المتنقلة ثورة في حياة الإنسان وجعل العالم قرية صغيرة من خلال الاتصالات ونقل البيانات في شكل مكالمات صوتية أو رسائل أو مقاطع فيديو بسرعات تنزيل عالية جدًا. تناقش هذه الورقة تنقاش تقنيات الاتصال المختلفة لاجيال الهاتف المحمول ، بدءا من الجيل الأول البدائي إلى الجيل الثاني والثالث ، حيث تقنيات الصوت المتنقلة ، ثم الجيل الرابع اذ بدات علامات السريعة في سرعة تنزيل البيانات، حيث أن سرعة الاتصال بشبكات الجيل الرابع أعلى بعشر مرات من اتصال الجيل الثالث ، مما ادى الى تحسين حركة البيانات في شبكة الاتصالات ، وصفة التنقل العالي للأشخاص الذين يجرون المكالمات ، بالاضافة الى تحسين إدارة النظام العالمي وتحسين جودة الصوت ،ثم الثورة الكبرى في الجيل الخامس الذي يتميز بتغطية جميع المناطق الجغرافية مع زيادة الطيف عالي التردد ، والذي يتميز بترددات عالية تبدأ من 6 كيكاهرتز إلى 100 كيكاهرتز، بالإضافة إلى مقارنة كل هذه الأجيال من خلال الجداول التوضيحية. الكلمات المفتاحية: اجيال الموبايل، الوصول المتعدد بتقسيم التردد، نظام الهاتف النقال المتطور، معدلات البيانات المحسنة لتطور ال (GSM)، نظام الاتصالات المتنقلة العام،الوصول المتعدد بتقسيم الشفرة-2000، التطور الطويل الامد- للجيل الرابع