



# PAST AND FUTURE GENERATIONS OF WIRELESS TECHNOLOGY

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**Abstract:** Wireless communication has become an essential aspect of our lives. We rely on technology in nearly every aspect of our daily lives, from mobile phones to GPS systems. Year after year, network generations have improved significantly. The transition from 0G, which began with two-way radios, to 4G, which we all use today, brought about significant improvements in our lives. Now we can effortlessly speak with our loved ones who live far away, play online games, exchange films, check emails from anyplace, and much more. The world has shrunk significantly in size. Furthermore, research is being conducted on network generation to make them faster and more dependable while costing less. This paper provides insight into all of the network generations we have been introduced to thus far, as well as a glimpse into future generations and the technologies being developed to support them. In this paper, we provide an overview of several Wi-Fi technologies, notably 5G, 6G, and 7G, as well as specific comparisons between them.

**Index Terms – Wireless, mobile communication, 1G, 2G, 3G, 4G, 5G, 6G, 7G**

## I. INTRODUCTION

Today is an era of wireless technology. Everything around us is heading towards being “without wires”. The term wireless is basically used for a network without any physical connection between two devices, instead medium like microwaves, radio waves or infrared rays are used for communication over any distance. Network Interface Cards (NICs), routers and switches are the main equipments of wireless networking [1].

One of the fast growing and popular industry in wireless networking is mobile communication. It has seen a sharp increase in past few years with new trends coming now and then. Mobile communication is defined as talking or sending and receiving text, images or videos over a mobile wireless network. Important files or data (work related or personal) can be sent to anyone anywhere in the world within seconds [2]. Almost everyone prefers to rely on mobile devices for communication as they are handy and can be used anywhere and at any time. As a result their availability is widening day by day providing latest features and technologies to make our lives easy. With the increasing demand, the aim of mobile communication is to connect as many users it can in fastest way possible. This has reduced the distance among humans.

The invention of mobile phones goes back to 1940s by AT&T engineers when they came up with the development of cells for base stations of mobile phones. Earlier mobile phones were just radios, not actual phones. Motorola introduced first mobile phones in 1970s; it was equal to the size of a brick and was not for commercial use. The first commercial mobile phone was “Nordic mobile telephone” developed in 1981 [3]. From here onwards there is no looking back in mobile phone industry. Many different generations of mobile communication has been developed starting from 0G and moving towards 7.5G. Each generation being better than the previous one in speed and providing more features.

## II. GENERATIONS TILL NOW

The very first generation to be known to us is 0G. It consists of mobile radio telephones which were invented much before present day mobile phones. They were basically two-way radios which work at very high frequency of 160 MHz. 0G was further improved and named as 0.5G. Its data rate was between 14.4-19.2 Kbps [1].

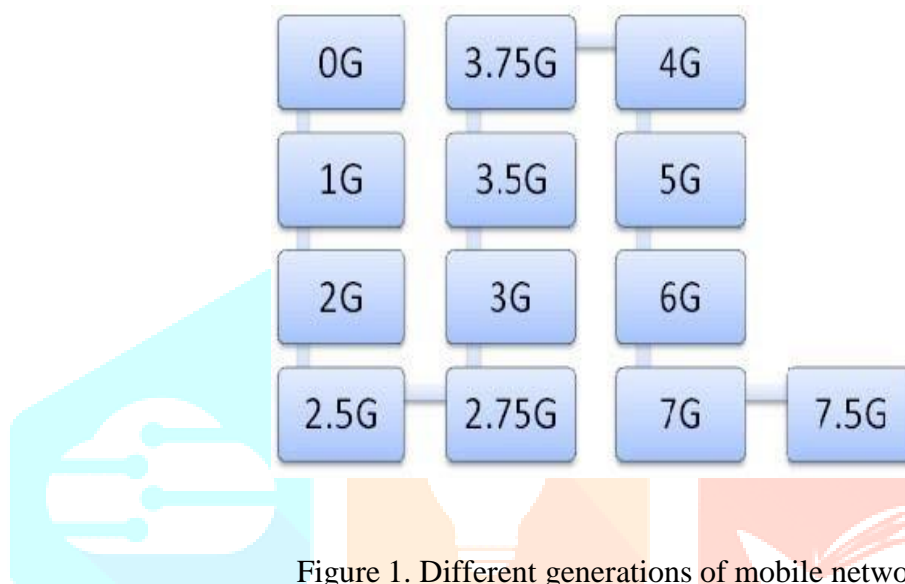


Figure 1. Different generations of mobile network

1G stands for first generation. It was first launched commercially in 1970s and was then launched in Denmark, Norway, Finland and Sweden in 1980s. 1G was used to make voice calls within one country only; no calling between people sitting in different countries was possible. No data transfer and roaming were there. It uses analog signals and allowed speed up to 2.4 kbps with the frequency of 800-900 MHz. Poor voice links and no provision for security were the main problems faced by this generation.

2G is the second generation launched in 1991 in Finland. Unlike 1G which uses analog radio technology, 2G made use of digital technology. This leads to improving security on both ends of communication, better sound quality and reliability. It allows both voice and data (pictures, text and multimedia messages) services [4]. It was in 2G only, the trend of SMS (Short Message Service) started. All SMSs sent were digitally encrypted. With this generation, a lot of growth was seen in the number of users using mobile communication. 2G made use of two technologies: TDMA (Time Division Multiple Access) that divides the signal into time slots and another one is CDMA (Code Division Multiple Access) that assigns every user with a special code so that they can communicate over a multiplex physical channel. 2G is still used in some parts of the world.

2G family consist of two more generations: 2.5G and 2.75G. These generations emerged in around 2000 and 2003 respectively. 2.5G uses GPRS (General Packet Radio Service) and have a speed of 115 Kbps with the frequency of 850-1900 MHz. Whereas, 2.75G make use of EDGE (Enhanced Data GSM Environment) technology which have a speed almost three times as that of GPRS i.e. 384 Kbps. The frequency of 2.75G is similar to that of 2.5G. Both 2.5G and 2.75G supports MMS, SMS, games, search and many more features to make daily tasks easy.

Along with an era of 2G, the new generation was developing in 2003, 3G. 3G was basically for multimedia or smart phones that we use today. The need for 3G was to increase the rate of data transmission with good Quality of Service, as more and more people were now connecting to the mobile network. The main features provided by 3G are: video calls, online video streaming, location services, email, multimedia services, mobile TV, web browsing and high speed web access. The speed of 3G is 384 Kbps to 2 Mbps with frequency of 8-2.5 GHz.

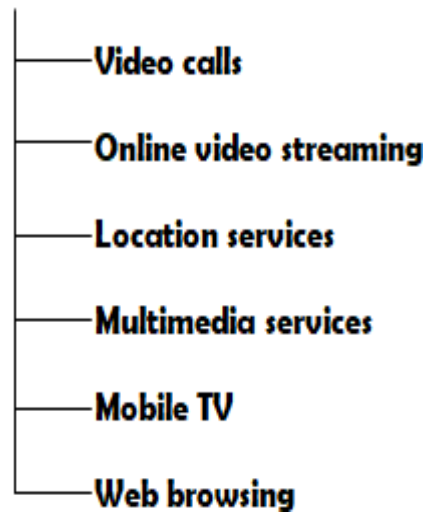
**3G**

Figure 2. Features of 3G

The main aim of 3G was to provide high data transmission rate at low cost along with roaming around the globe. 3G uses packet switching technology to send data and circuit switching for voice calls. In packet switching, data is divided into small packets and then each packet follows its own route to reach the destination. There is no fixed path for data to travel. Packet switching makes data travelling reliable and fast. On the other hand in circuit switching, first of all a fixed circuit is made on which the data has to travel to reach the destination.

Like 2G, 3G also have two more members in the family: 3.5G and 3.75G. 3.5G is also known as High Speed Download Packet Access (HSPDA). It provides a download speed of around 14 Mbps. 3.75G is HSPDA+ and it provides a download speed of 168 Mbps. 3.75G make use of MIMO (Multiple Input and Multiple Output) to provide high speed and latency. Most of the users in the world today are of 3G generation only. A shift is being seen in the past few years from 3G to 4G, as mobile network operators are now providing 4G network at lowest rates possible.

Advancement of each technology aims at accommodating more users along with high speed, good quality and low rates. The latest network technology used by a common man today in day to day life is 4G. It is also termed as MAGIC which means: M=mobile multimedia, A=anytime and anywhere, G=global mobility support, I=integrated wireless solution and C= customized personal service [3] and it is said that 4G is originally “3.9G”. 4G technology uses IP (Internet Protocol) network system along with LTE (Long term Evolution) and WiMAX (Worldwide Interoperability of Microwave Access) for its efficient working. It provides the speed of 100 Mbps to 1Gbps with the frequency of 2-8 GHz which allows roaming in any part of the world. 4G supports all the cellular and broadband multimedia services, like video calls, mobile TV, MMS, High Definition television, wireless web access, online gaming and much more. Anytime, anywhere service of the 4G is possible due to its mobile terminal. It also introduced a radio interface called Evolved Universal Mobile Telecommunication System Terrestrial Radio Access (E-UTRA) and Evolved Packet Core (EPC), a new packet switching which helps to provide obstruction free networking.

**III.FUTURE GENERATIONS**

5G is not formally used but its deployment has started and is expected to emerge by 2020. Many companies are investing in this new technology. The speed of 5G connection is likely to be thrice as compared to 4G. It is a kind of completely wireless real world communication system which has no limits. 5G uses IPv6 standards. It is not only faster in speed than the previous technologies but also provide more multimedia options, more responsiveness, very low latency, more reliability and more devices/gadgets can be connected compared to previous generations.

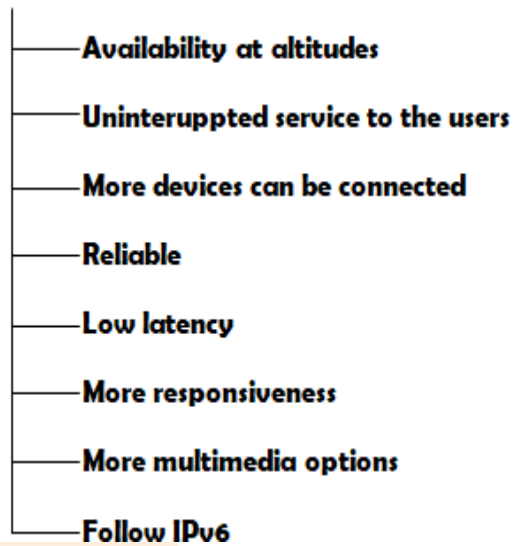
**5G**

Figure 3. Features of 5G

5G is expected to have wider frequency of 3-300GHz and the speed of around 1-10Gbps. Its architecture is advanced in the sense that it can adapt itself according to the environmental changes so that it can provide uninterrupted service to the users. A common problem seen with the mobile networks is that they are not properly available at the altitudes. 5G will make it possible at higher altitude also. We have seen that there are many advantages of 5G but along with these there are some disadvantages also. The speed of 1-10Gbps as claimed by 5G may not be achieved in some parts of the world due to less technological advancement. And another being, in some companies it may be the case that the old devices/gadgets may not be compatible with the new technology so they need to be replaced which incurs cost.

5G technology will take time to implement but researches and investigation on 6G has already started. 6G will have 5G as its base. It combines 5G with satellite technology so that it can give full global coverage and claims speed of around 10-11Gbps even in remote areas. 6G's communication network basically consist of three satellite networks: telecommunication satellite network, earth imaging satellite network and navigation satellite network [1, 4]. These satellite networks works together to provide positioning using Global Positioning System (GPS), voice call, data, internet, multimedia and weather forecasting to avoid any natural calamity. These satellites are mainly developed by four countries USA, China, European Union (EU) and Russia [5]. The idea of global position identification in 6G at high speed will be the result of nano antennas placed at different locations. Any activity can be checked anywhere by flying sensors which will report to the base stations about any mishappening in the area. 6G will revolutionized our whole concept of living, it will introduce smart homes, home automation, defense technology will be improved, natural calamities will be controlled and super-duper fast internet.

#### IV.7G NETWORK GENERATION

The most advance generation in network technology is 7G. It combines the 6G network system with satellite (telecommunication satellite, navigational satellite and earth image satellite) for communication. The functioning of each satellite is similar to that of 6G i.e. telecommunication satellite for voice data and multimedia, navigational satellite for determining the position of the user and earth image satellite for weather conditions and information of the particular location [1, 3, 4, 5]. 7G will provide global roaming from one country to another but there is an issue like, it is satellite based and satellites moves in a particular orbit at constant speed. So, it may require two different satellite systems to make this possible. But satellite system is much costlier than the normal cellular system; this will result in costly setup. Another problem 7G is facing is that its standards and protocols are not well defined; it may take some time to define them properly and have a clear view.

Once all the issues are resolved, 7G will bring an evolution in mobile networking. It will provide more coverage and data capacity, the only demand will be of calls and its services.

The extended 7G i.e. 7.5G is expected to have very high upload and download data speed which can be possible only with high bandwidth. It will make communication possible even in the deep sea [4]. Orthogonal frequency-division multiplexing and Forward Error Correction methods along with satellite technology will help in achieving this goal.

## V. CONCLUSION

This paper is a survey on different networking generation and how they grew with time. We have seen that each new generation is better than the previous one adding more and more features to make wireless communication easy. The main aim of the wireless communication is to provide fast and reliable data communication at low cost, so anyone can use it at anytime. Future generations are also discussed here, on which our researchers are working hard to introduce it to the world as soon as possible. A table comparing all the generations has been prepared to give you a review on the details discussed in the paper.

Table1:Detailed Comparison of 5G,6Gand 7G

### DETAILED COMPARISON OF 5G,6G &7G

S.No	5GCellular	6GCellular	7GCellular
Master network	The Net	The Net	The Net
Data Rate	100+Megabitspersecond	11Gegabitspersec ond	11+Gegabitaper second
Frequency	24–47GegaHz	95GHz-3THz	95GHz-3THz
Handoff	Vertical & Horizontal	Vertical & Horizontal	Vertical & Horizontal
Location of first commercialization	Not yet	Not yet	Not yet
Multiplexing	Orthogonal frequency division multiplexing(OFDM)	CDMA	CDMA
Service	Wireless World Wide Web(WWW)	Secured Services& global services	Global cellular services & Secured Services
Switching type	IPv6	All packet	All packet
Time period	Possibly2020	Possibly2030	Possibly2030
Advantages	<ul style="list-style-type: none"> <li>• It provides better coverage area and higher protection.</li> <li>• Low battery intake</li> <li>• It has high energy and spectral efficiency</li> </ul>	<ul style="list-style-type: none"> <li>• It will provide global coverage system</li> </ul>	<ul style="list-style-type: none"> <li>• It will provide low cost of calls</li> <li>• No problem of data, Capacity coverage and handoff left behind</li> </ul>

Disadvantages	<ul style="list-style-type: none"> <li>• Difficult to achieve due to inefficient technical</li> <li>• The issue of security and privacy remains to be resolved</li> <li>• Requires high cost for infrastructure development</li> <li>• It is still under process and its Feasibility is under research</li> </ul>	<ul style="list-style-type: none"> <li>• High cost of mobile calls</li> <li>• Difficulty in space roaming</li> <li>• Similar to 5G disadvantages</li> </ul>	<ul style="list-style-type: none"> <li>• Similar to 5G and 6G disadvantages</li> </ul>
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Table 2. Comparison between different generations

Sr. No.	Generations	Year	Services	Technology	Speed	Frequency	Description
1.	0G	Around 1960s (before cellular system)	Voice only	Mobile radio telephone system	14.4-19.2 Kbps	160 MHz	Two way radios were there working at very high frequency
2.	1G	1980	Voice only	Analog	1-2.4 Kbps	800-900 MHz	No security was there and the voice links were very poor.
3.	2G	1990	Digital voice	TDMA (Time Division Multiple Access), CDMA (Code Division Multiple Access), Digital wireless	14-64 Kbps	850-1900 MHz	SMS service was provided along with voice calls, facilities like roaming, call forwarding and call hold were introduced.
4.	2.5 G	2000	MMS, Internet	GPRS	115 Kbps	850-1900 MHz	MMS, mobile gaming, access to emails, video conferencing were part of it.
5.	2.75 G	2003	MMS, Internet	EDGE	384 Kbps	850-1900 MHz	Services provided by 2.75G are similar to those of 2.5G.

6.	<b>3 G (UMTS)</b>	2000	Voice, data, internet, videos, gaming at high speed	CDMS, Broadband	384 Kbps to 2 Mbps	8-2.5 GHz	3G is a single standard with multiple modes. Provides high data transmission at low cost along with many other multimedia services.
7.	<b>3.5 G</b>	2003	Voice, data, internet, videos, gaming at high speed	HSPDA	14 Mbps	8-2.5 GHz	Services similar to 3G.
8.	<b>3.75 G</b>	2003	Multimedia and internet at high speed	HSPDA+	168 Mbps	8-2.5 GHz	Services similar to 3G
9.	<b>4 G</b>	2010	Gaming, HD TV, wearable devices, cloud, anywhere web access	LTE, Wi MAX	100 Mbps to 1Gbps	2-8 GHz	It is a perfect real world wireless networking system.
10.	<b>5 G</b>	2020	Artificial intelligence, remote diagnostics, parallel services, availability of network at high altitudes	IPv6	1-10 Gbps	3-300 GHz	It will provide more device connectivity, less energy usage by the network and more signal efficiency.
11.	<b>6 G</b>	2030	Smart homes, super fast internet, home automation	Combination of 5G with satellite technology	10-11Gbps	-	It is proposed to provide fast internet while travelling and even in remote areas.
12.	<b>7G</b>	2040	Satellite communication, global roaming	Satellite communication	Expected to be very high (in process)	-	Global roaming from one country to another
13.	<b>7.5G</b>	2045	Satellite communication, global roaming	Orthogonal frequency-division multiplexing, Forward error correction methods	Expected to be very high (in process)	-	Very high upload and download data speed, even in deep sea

				along with satellite technology			
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