A Survey On Wireless Communications : 6g And 7g

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Abstract.
One of the fastest growing sectors is wireless technology, which is evolving in all areas of mobile and wireless communications. Wireless technology has increased greatly in the last decade. 7.5 Generation (G) represents the history of wireless technology today. With 6G and 7G, data transmission rates will be higher over Future Generation wireless technology. With new technologies emerging in all fields of mobile and wireless communications, wireless technology continues to emerge as one of the hottest sectors with a high rate of development. Currently, 5G mobile communications systems are just getting started. Our current infrastructure supports a number of technologies, including voice over IP (VoIP), broadband data access over wireless, and more. This paper discusses several generations of wireless technologies from 0G to 7G. Wireless technology is important and beneficial to society. In this paper, we compare all of the generations and explain how each generation uses technology in its execution, application, and usage.

Keywords: *Cellular generations; Mobile technologies (0G,1G, 2G, 3G, 4G,5G,6G,7G); Networks; Communication; CDMA; TDMA; FDMA; GSM; Broad band.*

I. INTRODUCTION

Every day, mobile communication technologies and wireless technologies are improving very rapidly. Communication that takes place without using wires or other enhanced conductors is known as wireless communication. Wireless networking makes use of cellular telephones, two-way radios, mobile phones, portable audio players, and personal digital assistants (PDAs). There have been several generations of mobile wireless technologies, starting with 0G and continuing with 4G over the past few decades. World Wide Web (WWW) developers have been implementing 7G and 8G technology in advance [1].Since wireless applications are becoming more popular as well as the number of users is increasing exponentially, current wireless communication systems are saturated [2]. In order to determine whether high data rates, wide radio coverage, and a tremendous number of connected devices can provide solutions to these fundamental problems [3], researchers and network designers are compelled to explore solutions. Developing 5G wireless networks will be easier with the use of intelligent and efficient technologies [4].

5G must meet major challenges if it is to provide reliable, secure, and efficient service [5].Even though 5G technology is still not fully implemented, we need to begin to research 6G networks [6]. On March 23, 2019 during the world's first 6G summit in Finland with the world's top communications experts, the world's top communications experts drafted the world's first 6G whitepaper. As a result, 6G became an unofficial research field [6]. In recent years, more and more governments and non-governmental organizations have declared their intent to take part in 6G research. Around the world, governments are investing in technologies and techniques for 6G networks [7]. 6G does not have any set specifications or standards, but a wide range of applications. Some people believe that 6G networks should not be merely faster versions of 5G, but instead represent an improved version of 5G technology [6]. In terms of coverage, although the 5G network has its limitations, it does not have to be limited to the ground. It should also cover underwater surfaces. 6G also features much stronger artificial intelligence (AI). AI is one of the key characteristics of the 6G network, according to many researchers [8].

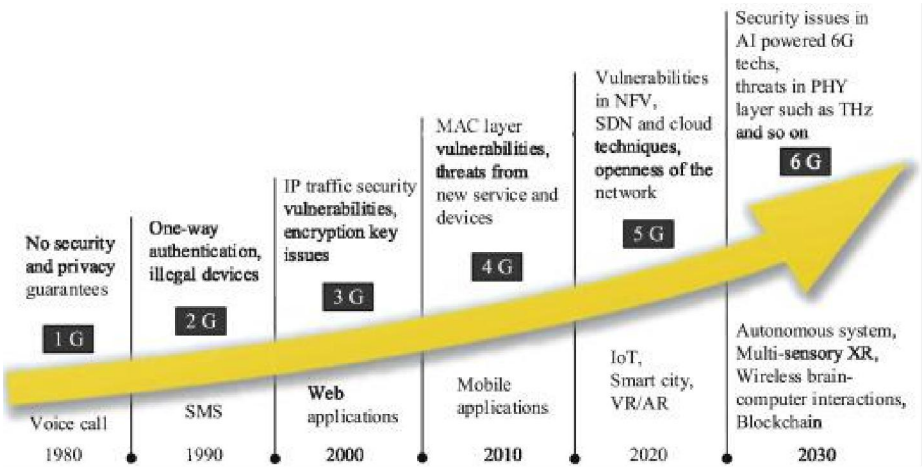

Fig 1. Technological evolution of wireless networks

The standard, capacity, techniques, and innovations that distinguish one generation from another are different for every generation. Mobile telephone subscribers are increasing step by step as a result of these new features. Therefore, wireless communications need to be improved in terms of capacity. Cellular telephone systems are not the only wireless communication systems considered to fall into this category of 7G, which is broadly used across several types of wireless broadband technologies [1].

II. LITERATURE REVIEW

A literature review of mobile communications from 0G to 4G is presented.

0G : The first mobile telephone technology, which we know as a radio telephone, occurred in the 1940's with Pre-cell phone technology. A single line of communication can be made between the cars and the cellular service provided by the public phone network. They were designed and built for automobiles or trucks. Wireless radio phones were used in military communication. It uses large radio transmitters on top of tall buildings and a single transmission channel to transmit and receive data. During communication from one end to the other, a button was pressed to enable transmission and disable reception [9]. It was called push to talk or press to transmit (PTT) in 1950. Taxis, police cars, and CB-radios used technology. The Improved Mobile Telephone Service (IMTS) was introduced by Bell Systems in 1960.

1G **:** In the 1980s, wireless communications were introduced with data rates of 2.8kbps. Wireless networks were switched by circuit switching. Cellular communications were analog. Analog Mobile Phone Service (AMPS) uses FDM primarily. The networks did not have any security [2].

2G **:** Technologies such as GSM (Global System for Mobile Communication) were introduced in the early 1990s. 2G networks implement digital modulation techniques such as Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA), which can handle both voice and short message applications [6]. A digital voice and data delivery system now allows users to send and receive digital voice and data over the network. The 2G standard also implemented Signaling and Data Confidentiality, as well as Mobile Station Authentication, to guarantee greater security and privacy in telephone calls. Many of the basics we use every day were introduced in the transition from 1G to 2G. In 2000 and 2003, a development in technology led to a broadband data transfer and internet network called 2.5G.

3G **:** This system offers 144 kbps high-speed data transmission and the fastest mobile network available. It is able to transmit data at high speed, access multimedia content, and come with global roaming service [9]. A 3G mobile phone or handset connects to the internet or other IP networks so that voice and video calls can be made, data can be downloaded and uploaded, and the user can browse the internet. Packet switching technology will be used to send data. A circuit switch is used to interpret voice calls. Communication of this size has been happening for the past decade [10]. Technology such as HSUPA, HSDPA, and EVDO are used in 3.5G to achieve faster data rates than 3G. Video quality was improved considerably with this generation [6]. Data rates were highest compared to previous generations [2].

4G **:** Researchers and industries are focusing on developing next-generation mobile wireless technology because of a huge increase in mobile subscriptions. In addition to its low cost, high quality, high

capacity and high speed, 4G technology ensures high service level agreements at high speeds [11]. In addition to operating indoors and outdoors, 4G technology includes capability of 100 Mbps and 1 Gbps speeds. A completely IP-based system was introduced in the fourth generation in 2010. VoIP costs can be reduced with improved security when providers offer high-quality, high-capacity, and high-speed VoIP, multimedia, and internet over IP services. GSM, CDMA2000 and UMTS are examples of GSM-based networks that can seamlessly transition to IP-based networks [6]. In the LTE standard, packet switching and an IP network were introduced. In order for carriers to provide quality of service with LTE, there are significant changes to the infrastructure due to the fact that LTE is not circuit-switched, but uses the RAN architecture instead [6].

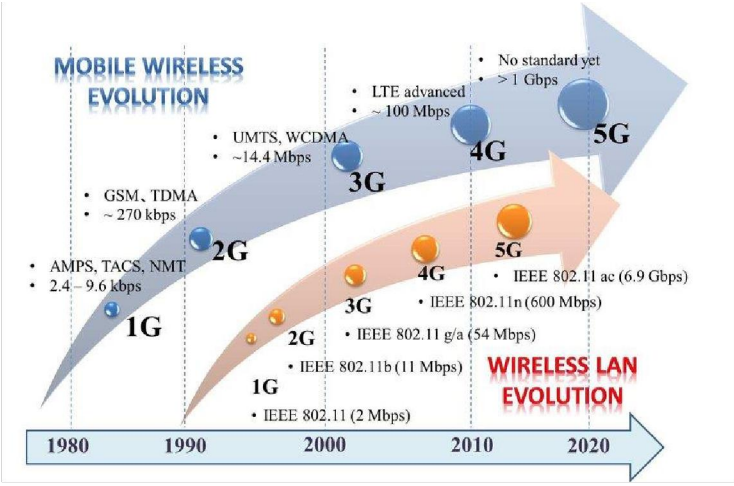

Fig 2. The development of wireless technology

Table 1. Comparison of cellular networks from 1G to 5G

Generation	1G	2G	2.5G	2.75G	3G	3.5G	3.75G	4G	5G
Starts from	1970-84	1990	2000	2003	2001	2003	2003	2010	2015
Data capacity	2kbps	10kbps	200kbps	473kbps	384kbps	2Mbps	30Mbps	200Mbps to 1Gbps	Higher then 1Gbps
Technology	Analog wireless	Digital wireless	GPRS	EDGE	Broad band / IP technology FDD TDD	GSM/ 3GPP		LTE, WiMAX	IP v6
Standards	AMPS	TDMA, CDMA, GSM	Supported TDMA/ GSM	GSM CDMA	CDMA/ WCDMA/ UMTS /CDMA2000	HSDPA/ HSUPA	1xEVDO	IP-broadband LAN/ WAN/ PAN	IP-broadband LAN/ WAN/ PAN &www
Multiplexing	FDMA	TDMA, CDMA	TDMA, CDMA	TDMA, CDMA	CDMA	CDMA	CDMA	MC-CDMA, OFAM	CDMA
Switching	Circuit	Circuit	Packet	Packet	Packet & circuit	Packet	Packet	Packet	All packet
Service	Voice only	Voice data	MMS internet		High speed voice/ data/ video	High speed voice/ data/ video	High speed internet/ multimedia		Dynamic Information access, wearable devices with AI capabilities
Network	PSTN	PSTN	GSM TDMA	WCDMA	Packet network	GSM TDMA		Internet	Internet
Hand off	Horizontal	Horizontal			Horizontal	Horizontal	Horizontal	Horizontal & Vertical	Horizontal & Vertical
Frequency	800-900 MHz	850-1900 MHz (GSM) 825-849MHz (CDMA)	850-1900 MHz	850-1900 MHz	1.6-2.5GHz	1.6-2.5GHz	1.6-2.5GHz	2-8GHz	

III. NEXT GENERATION OF MOBILE COMMUNICATIONS

5G **:** In 5G mobile technology, the bandwidth of mobile phones has been greatly increased. High quality technology has never been available before. The 5G technology includes all types of advanced features that will make it the most popular and most powerful mobile technology. It features at least 1000 lunar modules as well as more power than 5G technology. Using 5G technology a laptop and a 5G phone can access broadband internet simultaneously. A variety of 5G technologies are available, including cameras,

MP3 recorders, video players, large storage, phone dialing speed, audio players, etc [1]. 5G technology releases frequency spectrum using millimeter-wave technology. Moreover, more spectrum is available and the channel bandwidth is larger than ever. There will be just one universal device that will allow all possible 5G applications and will connect with communication basics already existing.

The technology uses software defined radio modulation schemes. It combines different streams of technologies, which in this case means that terminals have to simultaneously access multiple wireless technologies [12].A 5G network is a wireless internet service utilizing OFDM, MC-CDMA, LAS-CDMA, UWB, Network-LMDS, and IPv6 technologies. IPv6 is the standard protocol for both 4G and 5G [13]. Real-world wireless is the five-generation 5G technology. It has no limitations and is also referred to as complete wireless communication. Wireless technology in 5G networks is defined by the physical layer and data link layer. 5G wireless technology, which consists of two layers, functions like open wireless architecture (OWA). Virtual multi-wireless networks will be maintained on 5G mobile phones. Two sub layers must then be created in order to do so. Mobile terminals require the upper network layer, and interfaces require the lower one. Higher bit rates in wireless radio interfaces represent a lost opportunity; in 5G, this loss is reduced by utilizing the open transport protocol (OTP). OTP is commonly used by 5G's transport and session layers. Quality of service is managed in this layer of a network over different types [11].

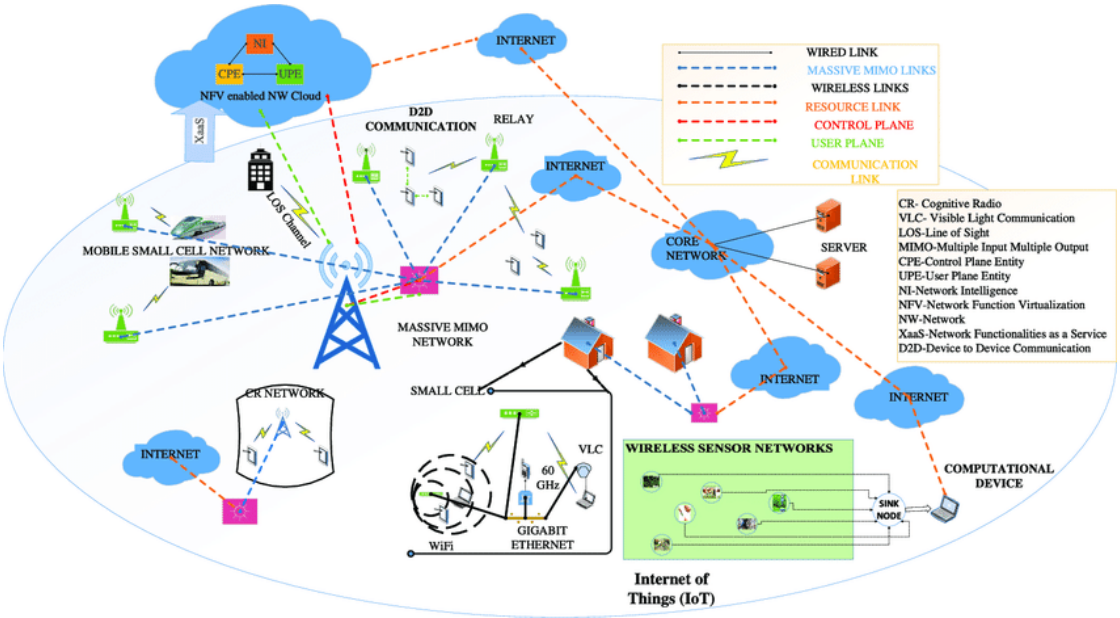

Fig 3. 5G Architecture.

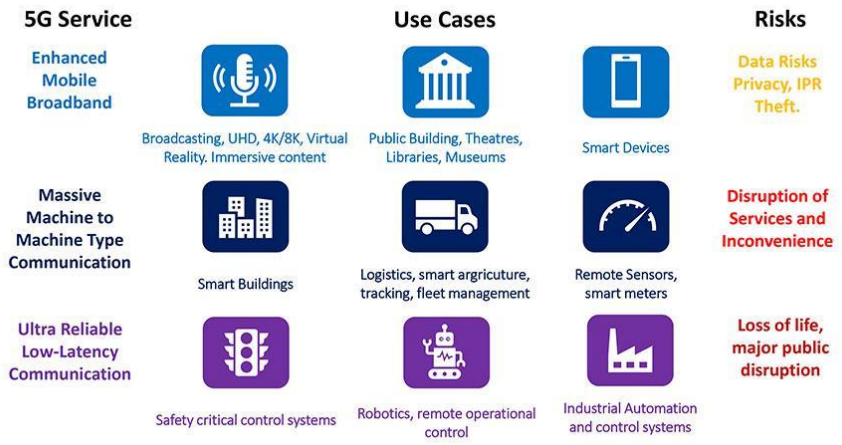

Fig 4. Features of 5G

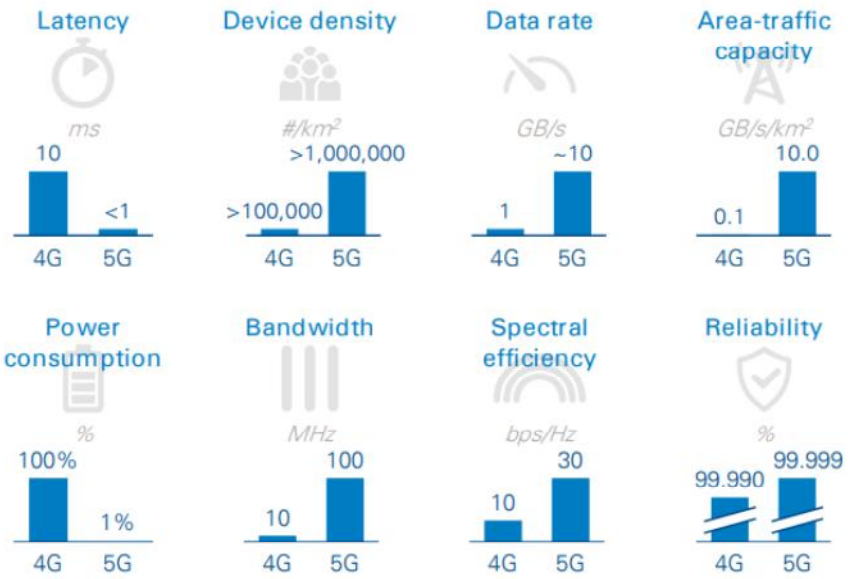

Fig 5. Comparison between 4G and 5G

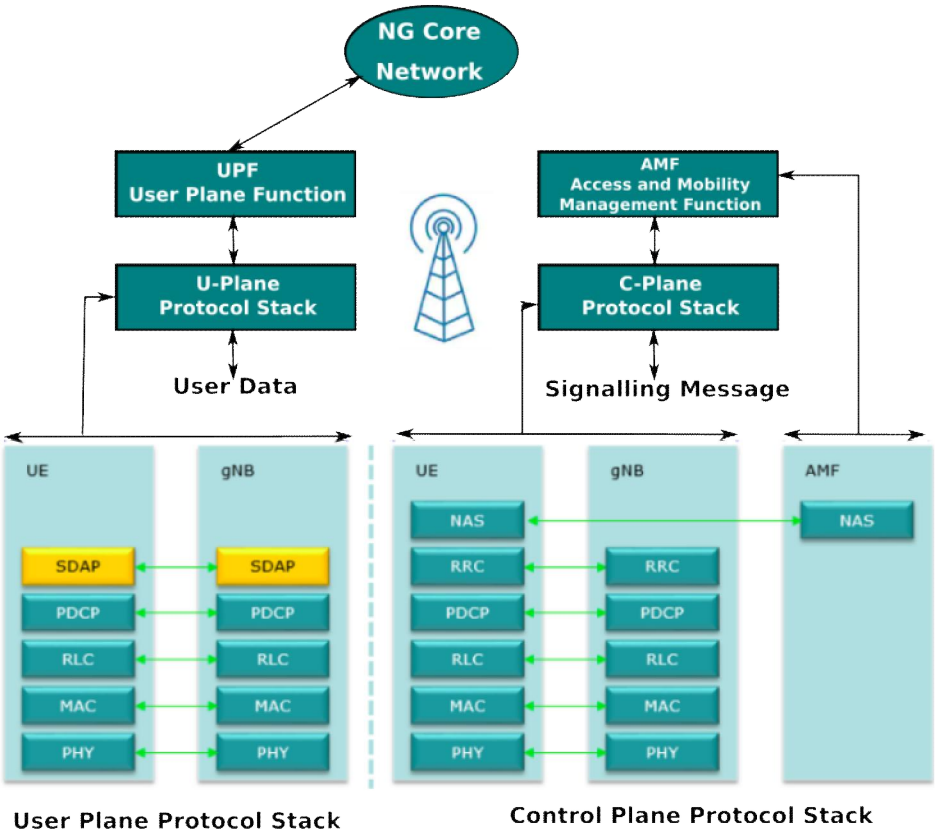

Fig 6. 5G Protocol Stack

***6G* :** Satellites will be used to provide global coverage on wireless mobile communication networks of the sixth generation (6G). Four countries have developed systems to achieve global coverage. US developed GPS, China developed COMPASS, EU developed Galileo, and Russia developed GLONASS System. The difficulty of roaming in space is resulting from these independent systems. Wireless mobile communication networks of the seventh generation (7G) are going to unite [14]. Fiber optics and radio are combined to create 6G Internet. Their service is based on Line of Sight (LOS) transmission. Because the copper cable is no longer necessary or our speed based on distance from the exchange, they don't have to rely on the copper cable. A 6G network also offers greater security and lower cost. Satellite and 5G wireless mobile systems will be integrated to provide global coverage. In addition to satellite networks used for communication, earth imaging satellite networks and navigation satellite networks are also available [15]. As the 6G network transitions from satellite to satellite and has four distinct standards, hand-off and roaming

will be big challenges. Due to this, handoffs and roaming are required between those four networks. Wireless devices use 6G technology to provide very fast internet speeds on the air, potentially up to 11Gbps [18]. Different locations will be equipped with nano-antennas specially designed for 6G. Using 6G technology, fly sensors will decorate the globe. A fly sensor will transmit information to its remote control stations, which will further monitor any activity on a special area, such as that of intruders, terrorists, etc. High-speed optic fiber lines will be used to amplify and secure information transmitted from transmitter to destinations along point-to-point wireless communication networks [16].

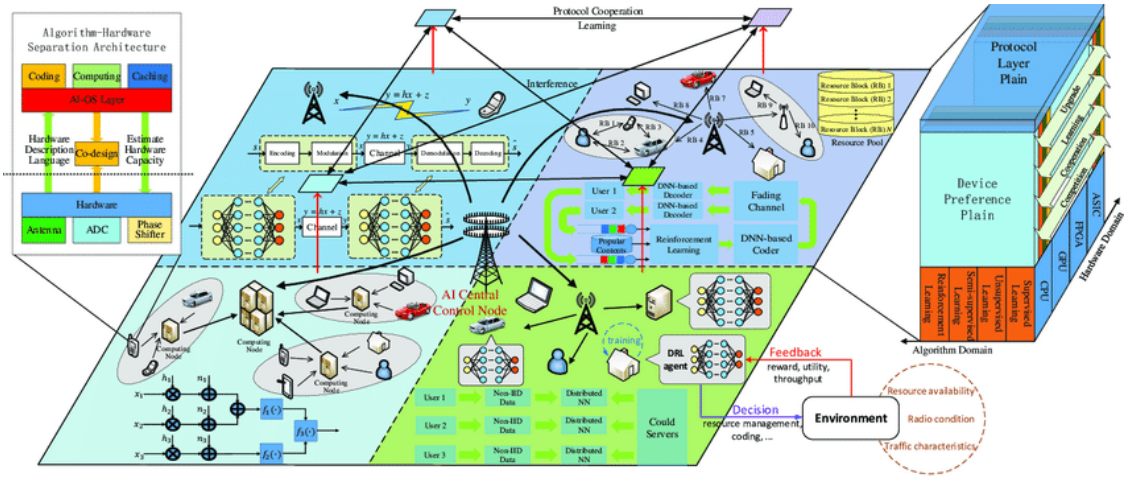

Fig 7. 6G Architecture

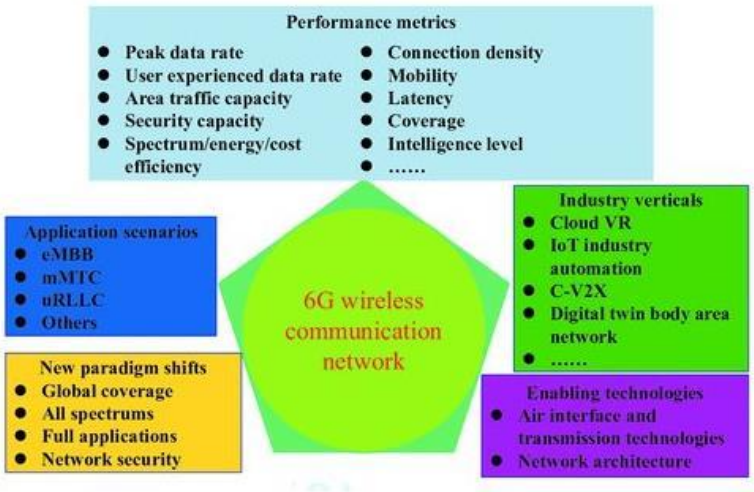

Fig 8. Overview of 6G.

Fig 9. 6G Challenges

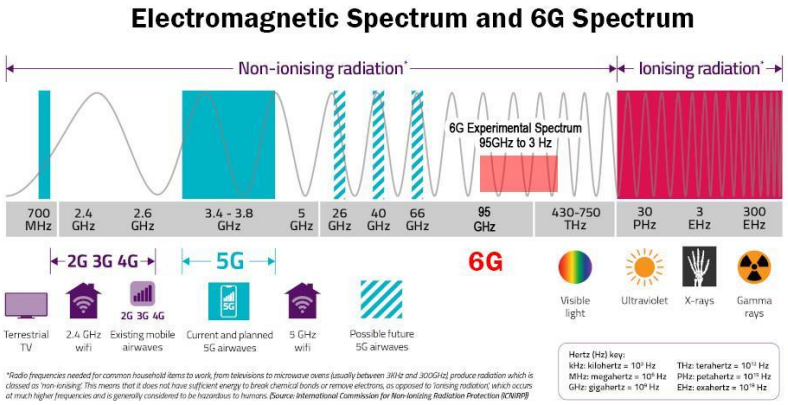

Fig 10. 6G spectrum

***7G* :** Mobile communication networks will be more advanced with 7G. 7G aims to receive space roaming for mobile wireless networks. World demand for wireless networks is growing, enabling always-on, high-speed, increased bandwidth, and low-cost access to information at anytime, anywhere. 7G technology will bring us unprecedented levels of mobility. Although the satellite functions for mobile communications are similar to the 6G for global inclusion, it will differentiate itself from 6G with its satellite functions [16]. Standardization of protocols and standards is essential to enable 7G to be realized. Space roaming is the principle goal of the technology. The global navigation satellite system can support the 7G technology [18]. Next generation after 7G may be called 7.5G or 8G.

Once 7G fixes all its weaknesses, the capacity range and hand-off issues will no longer be an issue. The user will only be concerned at that time with the cost of mobile phone calls and the services they offer. Once again, this issue will introduce fundamental changes in standards and technology, and will open up new opportunities for research in computing. It is known as 7.5G or 8G and it will revolutionize the way mobile phone services are offered [15]. In terms of technology, 7G lies at least 20 years in the future. In early 2030s, 6G will be available, and we have yet to fully understand its capabilities. Some recent research papers offer some clues, but the technology we need to implement it will not mature for years.

Table 2. Expected features and issues in 7G

Expected features of 7G	Expected 7G Critical Issues in Public Safety solution
➢ High speed signal transmission	➢ Threat detection
➢ AGI core networking	➢ Crime control
➢ Non-existent latency	➢ Mind reading
➢ AI-powered network management	➢ Health monitoring
➢ Virtual space environment with realistic sensations	➢ Facial recognition/expressions
➢ Internet cognition	➢ 3D Image synthesis
➢ Continuous computing	➢ Air quality measurements
➢ Remote access for diagnosis, learning, education, etc	➢ Disaster preparedness
➢ Internet of Everything(IOE)	➢ Gas and toxicity sensing
➢ 7G is proposed to integrate with satellite networks for	➢ IOT device management

Table 3. Comparison of 6G to 7G

Technology	Frequency	Service	Multiplexing	Switching Type	Core network	Data rate	Pros	Time period	Handoff
6G	95GHz -3THz	Secured and global cellular services	CDMA	All packet	Internet	About 11 Gbps	Global coverage system	Soon probably	Horizontal and vertical
7G	95GHz -3THz	Secured and global cellular services	CDMA	All packet	Internet	About 11+Gbps	No issue of data capacity coverage and hand off left behind, low cost of call	Soon probably 2035	Horizontal and vertical

IV. CONCLUSION

The current and future generations of wireless mobile communication have been discussed in this paper. Wireless mobile communications are rapidly expanding. Its growth has been remarkable over the past

few years. In an effort to combine multiple technologies into a single standard, 5G, 6G, and 7G have been proposed. Creating a fast and reliable mobile network is the main objective of this generation. 6G integrates 5G with satellite networks to create a truly wireless world. 5G aims for a wireless world without limitations. There will be a problem with handoff and roaming with 6G because of differing technologies and standards. Wireless networks are aiming to acquire space roaming through 7G, which is the next generation of mobile networks. As the world moves towards being fully wireless, people demand better quality, higher speed, and increased bandwidth with reduced costs at anytime, anywhere. In the future, satellite networks will be used with 6G mobile communication systems. With these growing techniques, we are moving towards a wireless world with endless benefits. This paper analyzed how mobile wireless technologies differ from each other.

REFERENCES

[1] Shrikant R Tripathi and Sushil Khaparde, " Analysis and Survey on Past, Present and Future Generation in Mobile communication", National Conference on Recent Trends in Computer Science and Information Technology (NCRTCSIT-2016) , ***IOSR Journal of Computer Engineering (IOSR-JCE),*** pp.30-36.

[2] Karthik Kumar Vaigandla and Dr.N.Venu, "A Survey on Future Generation Wireless Communications - 5G : Multiple Access Techniques, Physical Layer Security, Beamforming Approach", ***Journal of Information and Computational Science***, Volume 11 Issue 9, 2021, pp.449-474.

[3] Jos´e David Vega S´anchez, Luis Urquiza-Aguiar, Martha Cecilia Paredes Paredes, Diana PamelaMoya Osorio, "Survey on physical layer security for 5G wireless networks", Annals of Telecommunications, pp.155–174, 2021.

[4] Liu D, Hong W, Rappaport TS, Luxey C, Hong W (2017) What will 5g antennas and propagation be? IEEE Trans Antennas Propag 65(12):6205–6212

[5] Gao Y, Hu S, Tang W, Li Y, Sun Y, Huang D, Cheng S, LiX (2018) Physical layer security in 5g based large scale social networks: opportunities and challenges. IEEE Access 6:26350–26357

[6] Karthik Kumar Vaigandla, SandyaRani Bolla , RadhaKrishna Karne, "A Survey on Future Generation Wireless Communications-6G: Requirements, Technologies, Challenges and Applications", ***International Journal of Advanced Trends in Computer Science and Engineering***, Volume 10, No.5, September - October 2021, pp.3067-3076, https://doi.org/10.30534/ijatcse/2021/211052021

[7] P. Yang, Y. Xiao, M. Xiao, S. Li, 6g wireless communications: vision and potential techniques, IEEE Network 33 (4) (2019) 70–75.

[8] K.B. Letaief, W. Chen, Y. Shi, J. Zhang, Y.-J.A. Zhang, The roadmap to 6g: Ai empowered wireless networks, IEEE Commun. Mag. 57 (8) (2019) 84–90.

[9] Sarmistha Mondal, Anindita Sinha, Jayati Routh, "A Survey on Evolution of Wireless Generations 0G to 7G", ***International Journal of Advance Research in Science and Engineering- IJARSE***, Vol-1, Iss-2, pp.5-10.

[10] Xichun Li, AbudullaGani, RosliSalleh, Omar Zakaria The Future of Mobile Wireless Communication Networks, International Conference on Communication Software and Networks, 2009

[11] Muhammad Farooq, Muhammad Ishtiaq Ahmed, Usman M Al, " Future Generations of Mobile Communication Networks", ***Academy of Contemporary Research Journal***, Volume 2, Issue 1, 2013, 24-30.

[12] Mishra, Ajay K. "Fundamentals of Cellular Network Planning and Optimization, 2G/2.5G/3G…Evolution of 4G", John Wiley and Sons, 2004.

[13] Xichun Li, AbudullaGani, RosliSalleh, Omar Zakaria The Future of Mobile Wireless Communication Networks, 2009 International Conference on Communication Software and Networks.

[14] Tutorialspoint 5G Network Architecture (2019).

[15] Estifanos Tilahun Mihret and Getamesay Haile, "4G, 5G, 6G, 7G and Future Mobile Technologies", ***American Journal of Computer Science and Information Technology,*** Vol. 9 No. 2, 2021.

[16] Shoewu, O.O, Ayangbekun Oluwafemi J, " Insights into the development trends in 7G mobile wireless networks***", Journal of Advancement In Engineering and Technology***, Volume 8 / Issue 1, 202, pp.1-4.

[17] Rani P. Tidke, Pritee S. Uttarwar, Deepak S Dandwate, Umesh J. Tupe, " A Literature Review On: Wireless Technologies From 0G to 7G", ***IRE Journals***, Volume 4 Issue 6, 2020, pp.59-64.

[18] Kruthik M S, D Khasim vali, "A Survey on Evolution of Mobile Communication from 1G to 7G", DOI: https://doi.org/10.21467/proceedings.1.61