

Evolution of Wireless Technology: From 1G to 5G

Nguyen Thi Mai Lan*

Faculty of Electrical and Electronics Engineering, Ho Chi Minh City Industry and Trade College, Vietnam.
Corresponding Author Email: ntmilan@hitu.edu.vn*



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ABSTRACT

The discovery of mobile phone has changed people's life. Along with the advent of mobile phone devices, generations of wireless connection networks have developed like an unstoppable revolution. This article refers to the comparative analysis of wireless technology network generations from generation 1 (1G) to generation 5 (5G). Each generation of mobile networks is briefly summarized in terms of development history, technical specifications as well as technology standards, speed and frequency data, thereby demonstrating the development of public mobile networks, technology and its development over the years.

Keywords: Mobile; Generation; 1G; 2G; 3G; 4G; 5G; AI.

1. Introduction

Nowadays, mobile phones are very important devices in daily life. Mobile phones have become "inseparable objects", a useful tool for everyone in work and entertainment. There are many benefits of mobile phones in daily work. First of all, mobile phones help people to quickly communicate with each other about work, about urgent problems that need to be resolved through direct calls, or send messages via email, zalo, facebook. Next, mobile phones with integrated software are tools to pay for banking services quickly and conveniently. With the global GPS (Global positioning system) positioning feature, mobile phones are a useful tool in finding directions or setting the most convenient route to your destination. Not only that, we can also find convenience stores, restaurants, ATMs or gas stations easily through accompanying applications [1].

Mobile phones are also effective planning and reminder devices. For those who have a habit of sleeping late or are absent-minded, now there is no need to worry anymore because there are smartphones. It will help you set a daily alarm and schedule it to remind you about an important event, plan or task. From there, you will no longer be late for work or miss other important to-do tasks. Mobile phones are effective learning tools when we learn foreign languages, look up information related to scientific knowledge, and knowledge for daily work. Mobile phones are language tools that integrate translation software to help us overcome language barriers to work and communicate with people around the world with different languages [2]. With the integration of health care software, mobile phones are tools in measuring and controlling heart rate, blood pressure, and blood sugar levels. The final benefit of mobile phones is an entertainment tool while we are sitting on the bus to school, to work, while waiting for administrative work to be resolved. Instead of having to wait in boredom, now with a phone you can kill useless time by playing games, watching movies, and listening to music [3].

2. Evolution of wireless networks

Wireless mobile networks have undergone a long period of development since the first 1G systems were introduced in 1981 [4]. The symbol "G" stands for Generation. The names 1G, 2G, 3G, 4G, 5G are generations and versions of

mobile network technology. Increasing numbers mean the network is more upgraded and newest. Over the past 40 years, mobile network technology has evolved through many generations of network technology from 1G, 2G, 3G, 4G, and 5G.

2.1. 1G wireless mobile network

This is the first generation [5] of mobile networks deployed in 1980 in Japan to provide calling services with access speeds of only 2.4 Kbps. 1G networks use data transmission over Analog signals based on a technique called FDMA (Frequency Division Multiple Access). The 1G network has an operating frequency of about 800 - 900 MHz with channel capacity limited to 30 KHz. 1G network capacity is limited, so signal reception is poor, which is always accompanied by ambient noise. The advantage of a 1G network is that it has a simple infrastructure and requires fewer network components to develop. The technology standards used in 1G are illustrated in Figure 1.



Figure 1. First generation of wireless networks (1G)

2.2. 2G wireless mobile network

In 1992, the 2G wireless mobile network was born using Digital signals to replace Analog. 2G network has many advantages compared to 1G network such as being able to send SMS messages, data transmission speed has increased to 64Kbps. Supports the use of multiple people on the same frequency band, making information more secure because all calls are encrypted. Furthermore, 2G was the first mobile network technology to support international roaming and provided better network coverage than 1G. The advent of 2G networks standardized frequency bands, allowing mobile devices to operate on both the 900 MHz and 1800 MHz bands. This means users can switch between carriers without changing devices or SIM cards, as long as the new carrier also supports the same frequency bands [6]. A summary of the application parameters of the 2G network is depicted in Figure 2.





Technology	Speed	Calling	Messaging	VAS
2G	 Download up to 236 Kbps; Upload up to 236 Kbps	 Voice calls	 Text messaging, Basic MMS	 Caller Ring Back Tunes, Ringtones, etc.

Figure 2. Second generation of wireless networks (2G)

2.3. 3G wireless mobile network

3G network is considered a data revolution because it shows the remarkable progress of mobile network technology in the world [7]. In 2001, 3G network was introduced to the world and officially commercialized in 2003. 3G network with data rate of 144 Kbps for mobile users, 384 Kbps was achieved for walking users and 2 Mbps for mobile users. successful home users. 3G network with broadband, sending and receiving large emails easily; Watch videos and chat online securely without interruption. The technology standards used in 3G are shown in Figure 3.

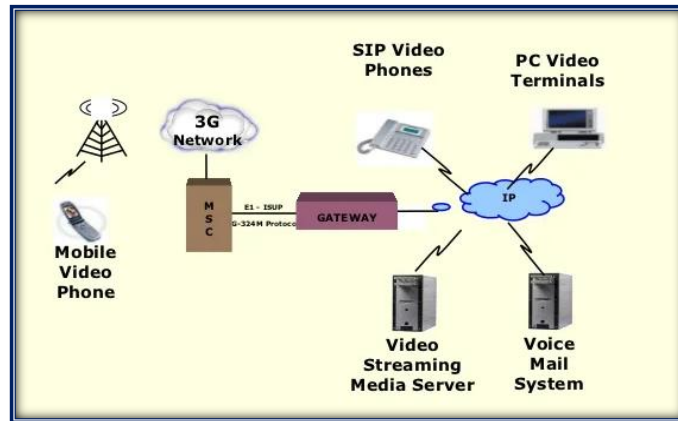


Figure 3. Third generation of wireless networks (3G)

2.4. 4G wireless mobile network

4G network can be said to be a mobile network that is popularizing very quickly and is extremely popular with users [8]. Launched in 2013, after 10 years the 3G network has become reliable, so the 4G network quickly became popular and almost all mobile devices registered to use the 4G network. 4G network has many outstanding features such as extremely fast access speed that can be 20 times higher than 3G and can reach 1.2 Gbps. 4G networks allow downloading large files and streaming high-quality videos without interruption on mobile devices. 4G networks operate on the 700 MHz, 1800 MHz and 2600 MHz frequency bands with better coverage and can improve call quality, allowing the development of many new services such as mobile payments, video conferencing. Cloud-based gaming and visualization (Figure 4).

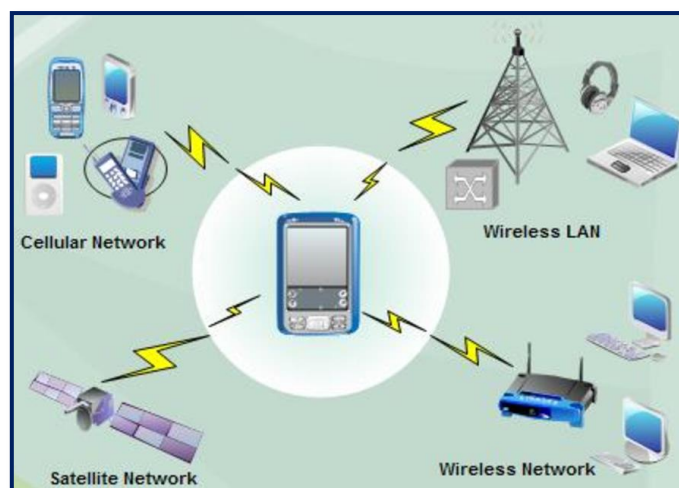


Figure 4. Standard technology of fourth generation 4G

2.5. 5G wireless mobile network

5G is the 5th mobile network launched since 2020 and is quickly accepted and deployed by many countries around the world for a new technological advancement [9]. 5G network Can access strong internet without slowness or interruption. In addition, 5G technology will create a modern society when it is applied to self-driving car and virtual reality technologies (Figure 5).



Figure 5. Fifth generation of wireless networks (5G)

3. Differences between network generations

Nowadays, no one talks about 1G or 2G networks anymore because almost all network operators have started shutting down old networks and only deploying new networks. Therefore, many people are interested in how 3G, 4G, and 5G are different so they can choose the right network carrier. Thus, mobile networks have evolved significantly over the past few decades. Each generation of mobile networks brings new features and innovations, such as improved call quality, higher data transfer speeds, and lower latency. Below is a table summarizing the main concepts of each generation of mobile networks (Figure 6).

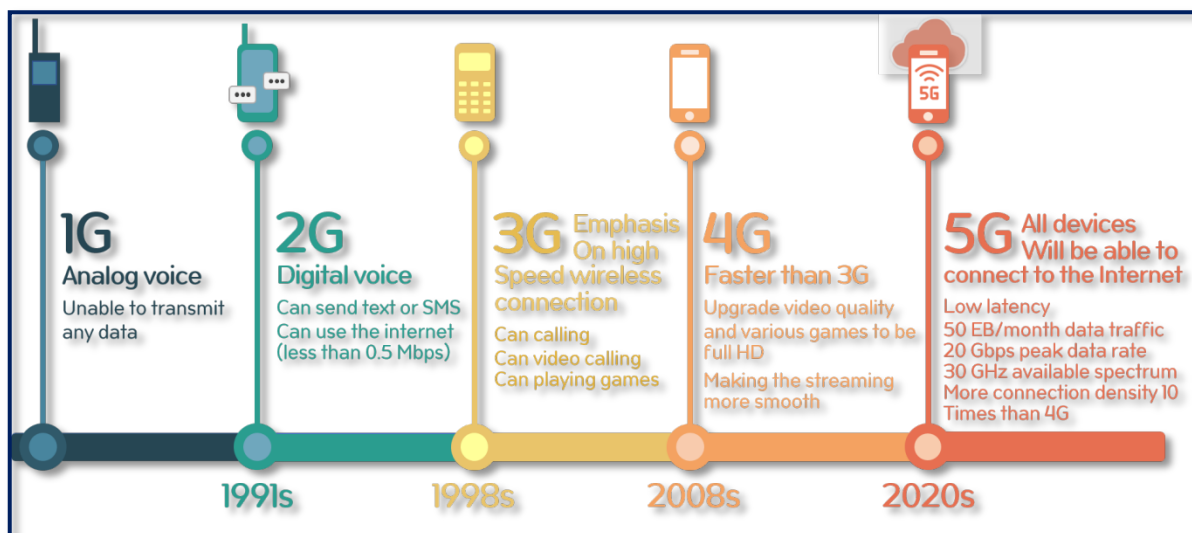


Figure 6. Comparison of different generations of wireless network

4. Conclusion

Wireless mobile technology with the advent of 1G networks, was later upgraded to 2G with the conversion of analog signals into enhanced signals to improve transmission quality. 3G network provides internet giving users better speed in advanced work. 4G network is an improvement of 3G technology, in which, data speeds are further improved to provide faster internet and video calling. The 5G network that is being deployed promises to change the field of wireless communications with higher data speeds to transmit data from source to destination in real time. It will also offer artificial intelligence features and unprecedented speed with better performance along with battery longevity of the devices. AI services such as automatic driving, automatic sales, and automatic control will be developed in this generation of mobile networks.

Declarations

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Competing Interests Statement

The author has declared no competing interests.

Consent for Publication

The author declares that he/she consented to the publication of this study.

Author's Contribution

Author's independent contribution.

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