

# A study on development from 0G analog to 7G cloud technology

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**Abstract**— In recent years there is a massive evolution in the field of wireless engineering transmission of data in recent decades. The enormous growth in this field is characterized by the evolution of a chain of mobile generations. The foremost mobile phone service is 0G followed by 1G to 7G. Recently the studies are ongoing for 6G and 7G. 1G, enabling voice call with analog technology, 2G marked the transition to digital voice, 3G wireless internet with video calling and mobile internet services, 4G or LTE is mobile broadband, 5G wireless edge like smart cities, 6G will be able to hold speed of over 1Terabytes/sec, AI technology being fifty times faster than 5G, while response time is projected at 10-100 $\mu$ s [8]. 7G which involves better noise immunity and high pitch oscillator settings using light wave transmission, which are utilized in terahertz transceivers [9]. This paper focuses on evolution from 0G to 7G along with the characteristics and limitations of each generation.

**Keywords**— *wireless technology, communication, mobile broadband.*

## I. INTRODUCTION

Wireless mobile communications systems have gone through crucial changes in the mobile telephony services/generations. These mobile telephone generations propose tailoring to the concepts of framework, speed, technology, frequency, data capacity, delay, etc. Each generation has truly its own standards, different abilities, new approach and new system that make them different from the past. Due to these new features, the number of mobile phone subscribers is increasing rapidly[1]. In wireless communication information is conveyed over long distance without any physical medium. Mobile technologies have evolved to next generation every ten years. The performance of mobile generations have evolved from analog voice communication to digital, IOT, cloud, and further more research in this field. AMPS being the 1G technology, Compressed voice signals allowed in 2G which further led to 2.5 GPRS system, technologies used in 3G were HSPA, WCDMA, HSPA+, max bandwidth in 4G with carrier aggregation, making use of user and control plane in 5G, scenarios in 6G, latest one in research is the 7G.

## II. LITERATURE SURVEY

### A. Zero Generation (0G)

0G is the Bell Lab mobile phone service launched prior to 1G such as radio phones. It was devised in cars. The 80 pound radios were placed in car. The calls were partly carried on Radio and partly on public switched telephone network. This generation is completely operated assisted

involving manual process. Technologies used in 0 G included push to talk, mobile telephone system. Only basic voice communication is allowed in this 0G. A major limitation of the system is that the exact location of the subscriber is required in order to make a call. There is no provision for handoff and so the calls were dropped off frequently. The system was demonstrated on June 17, 1946 [1]. Due to this limited access capability, 1G came into existence which was simple and easy to use.

### B. First Generation (1G)







1G	2G	3G	4G	5G	6G
					
2.4 Kbps	64 Kbps	2 Mbps	100-1000 Mbps	1-10 Gbps	More than 10 Gbps
Voice call Analog signals	SMS Digital signals Larger service	Internet Web Applications Smartphones	High Data Rate Mobile Applications Internet of Applications	Internet of Things Massive Broadband Smart City VR / AR	New Spectrum Energy Efficiency Artificial Intelligence Blockchain
1980s	1990s	2000s	2010s	2020s	2030s

Figure 1. 1G to 6G Evolution

1G refers to first generation of cellular network technology for analog voice transmission. It is the foundation of wireless mobile generation. This system was initially started in Tokyo later on it expanded to Japan 1979 by Nippon Telegraph and Telephone (NTT)[3][4]. The speed of 1G is 2.4 kbps

Characteristics of 1G are as follows:

- 800 to 900 MHz Frequency
- Channel spacing is 30kHz
- FDMA is the access technique
- 30kHz is the channel bandwidth
- Based on Frequency Modulation

Major limitations are analog voice due to which it has poor voice quality. The phone size is large to handle, Poor battery life around 1 to 2 hours and reliability. Security is one of the main concern a single channel carries data from both ends due to which the subscribers can listen each other with no encryption. The system is more susceptible to external interference.

### C. Second Generation (2G)

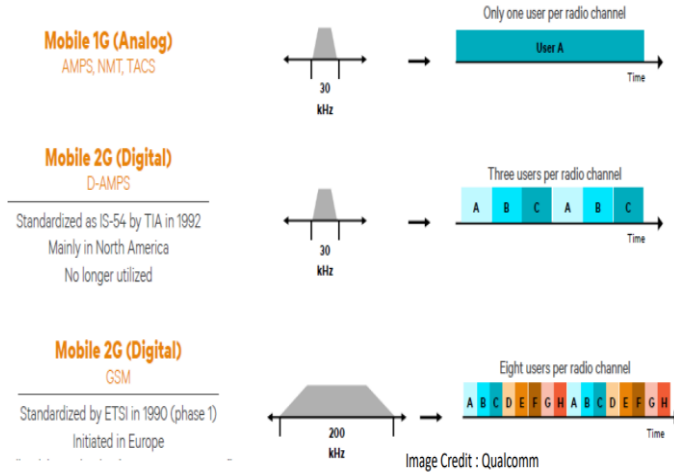


Figure 2. Evolution to 2G

With the introduction of the second generation of mobile communication approach, a new wireless telecommunication technology known as the Global System for Mobile communication (GSM) was introduced. This system involves digital transmission. It was launched in Finland in 1991. In 1G whole bandwidth is utilized for 1 user. In 2G the bandwidth is divided into 8 users per radio channel making it effective utilization. 2G provides digital solutions such as SMS, image message, and multimedia transmission of data. All the messages, data are secured by using encryption techniques [3][4].

Characteristics of 2G are as follows:

- Digital System
- Increased system capacity
- Frequency reuse concept
- Channel spacing is 200kHz
- TDMA is the access technique
- SMS services
- Roaming
- Data Security

Some of the limitations of 2G involve low data rate, fewer features on handheld components, limited number of users allowed.

### D. Third Generation (3G)

The International Telecommunication Union (ITU) defined the third generation of mobile telephony standards International Mobile Telecommunications 2000 (IMT-2000) to simplify growth, increase data transfer rate and support many more different types of application. It provided 144kbps of data rate involving high speed transmission and advance multimedia and global roaming feature. With the advent of 3G smartphones gained worldwide recognition through which a user can gain access to internet. It support uploading / downloading of files, video conferencing. [3][4]

Characteristics of 3G are as follows:

- Channel BW is 5MHz
- Uses WCDMA

- Increased data rate
- Video telephony
- Mobile app
- GPS
- 3D Games

Limitations are high power consumption, infrastructure cost, spectrum license cost.

### E. Fourth Generation (4G)

4G is the fourth generation of wireless technology. It provides a secure IP based communication like voice, data and live streaming will be delivered to the subscriber based on demand. There are two types of 4G. [1][3][4]

- LTE (Long Term Evolution) – 20Mbps to 100 Mbps
- WiMAX (Worldwide Interoperability for Microwave Access) – 128 Mbps for downlink and 56Mbps for uplink

Characteristics of 4G are:-

- Faster Data Rate
- Increased Security
- Online games
- High video streaming

Limitations of 4G include poor signal quality in rural areas, increased battery usage.

### F. Fifth Generation (5G)

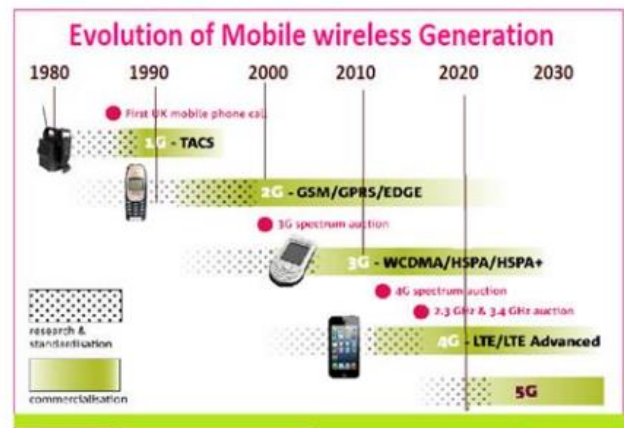


Figure 3. Mobile wireless evolution

5G is ultra-fast, reliable current mobile generation with low latency and huge connectivity got IOT devices. It uses IPv6 technology with data rate of higher than 1Gbps. It is aimed to connect everyone virtually and everything together including machines, objects and devices. 5G technology uses unlicensed airwaves and millimeter waves to obtain greater data rate. 5G will provide more bandwidth and advance antenna technology (MIMO) [3][5], network slicing for more data transmission. 5G is 20 times faster than 4G.

Characteristics of 5G are:-

- Minimum time lag
- Increased security[8]

- c. Cloud based structure
- d. Increased efficiency

Limitations include technology still under process, old devices would not be compatible with 5G so all them need to be replaced with new one, high cost in developing infrastructure, security and privacy issue.

### G. Sixth Generation (6G)

6G, the next generation technology facilitates advance data analysis tools such as AI leading to innovative changes in social-economic life. It is the successor of 5G expected to be ready by 2030. This is based on internet of things devices [6][7].

Characteristics of 6G are:-

- a. Higher frequency bands such as terahertz and sub-terahertz
- b. AI and Machine learning
- c. Intelligent reflecting surfaces
- d. Human physical and virtual environment

Limitations include high energy consumption, costly infrastructure, and risk of being misuse.

### H. Seventh Generation (7G)

7G will be the most advanced generation in mobile communication network. It is similar to 6G for global coverage but it will also define satellite functions for mobile communications. 7G is an inescapable intelligent cellular technology the future of cellular technology.

Characteristics of 7G are:-

- a. Very high bandwidth
- b. Lower latency
- c. AI integration
- d. Quantum computing
- e. Satellite to satellite communication

Limitations include capacity range, hand off issues.

Table 1. Comparison of 5G, 6G, 7G

Generation	5G	6G	7G
Starts from	2015	Soon Possibly	Possibly by 2035
Frequency range	Low band up to 1GHz  Mid band up to 6GHz  High band up to 100GHz	95GHz – 3THz	95GHz – 3THz
Service	Dynamic Information access, wearable devices with AI compatibilities	Secure and Global Cellular Service	Secure and Global Cellular Service
Multiplexing	CDMA	CDMA	CDMA

Switching Type	All packets	All packets	All packets
Data rates	Higher than 1 Gbps	About 11 Gbps	About 11+ Gbps
Handoffs	Intra-domain and inter domain	Intra-domain and inter domain	Intra-domain and inter domain

### III. LITERATURE SURVEY

In this paper the author reviewed the different generations & types of cellular technology [1], Paper [2] discusses the significant development route of 6G based on 5G technology. The author also discusses about the new antenna technology and the spectrum sharing techniques. The authors in paper [3] have done a study of cellular system architectures from 1G to 5G. It also discusses about multiple access techniques used from 1G to 5G. Until now the user demands have increased so to satisfy that, there is a technology behind each generation which is also discussed. Specially, emerging technologies for 5G is provided which is based on latest trends. The author has done a study on challenges and future research guidelines. It also discusses about the emerging technology MIMO for 5G. Paper [4] discuss about the study for evolution from 1G to 6G along with the spectrum allocation. It also discusses about the potential problems. Another key concept in transmission is the topologies which is presented in [5], emphasizing their powers, faults, and distinctive features. It also highlights the crucial adjustments and resemblances in interface management among the three generations of network from 4G to 6G, as well as the emerging developments and upcoming investigation guidelines in this technology advancement. Paper [6] compares 1G to 6G along with multiple access techniques. The author also presents some simulation results based on different multiple access schemes. Wireless communication is embedded with Internet of Things (IOT). Paper [7] explores this concept of IOT. The study also examines the probable circumstances and threats that may impact the usage of IOT. It also compares different communication technology. In any type of communication security is a major concern. Paper [8] discusses about the security and privacy for 6G over physical connection. Since 7G is the future and in research. The author in paper [9] discusses about the continuous transformation from terahertz frequency band and optical fiber communication systems based on light wave transmission.

### IV. CONCLUSION

There has been a lot of research in evolution from 1G to 6G. The authors mentioned in the literature survey discuss the evolution from first generation. Here in this paper the survey has been done from 0G which is basically the Bell labs having operated assisted mobile phones that too the receivers installed in cars. So this paper, discusses about the characteristics and limitations for each generation. 1G being the analog voice transmission. Later on the research being conducted with respect to digital voice and data transmission. Currently 5G is the next generation. 6G

and 7G are the future generations involving IOT, cloud, Block chain and cloud technologies. Still, the security remains the main concern for the future generation cellular technology. The future scope would be to study the advance technology of 7G.

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