

# 0G to 5G Mobile Technology: A Survey

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**Abstract:** The main objective of this paper is a detailed and comprehensive study about the evolution of the different mobile generation technologies in the wireless communication. The paper deals with evolution of mobile generation which helped in developing the mobile and telecommunication sector. The first generation has fulfilled the basic needs of voice, while the second generation has introduced high capacity and vast coverage area. The third generation included transmission of data at much higher speed giving its users' 'mobile broadband experience'. The fourth generation will provide access to wide range of telecommunication services, including advanced mobile services, supported by mobile and fixed networks. The fifth generation of mobile technology is based on IEEE 802.11 wireless technology. 5g technology includes Wireless Local Area Network (WLAN), Wireless Metropolitan Area (WMAN) and AD-hoc wireless technology.

**Keywords::** WLAN, 1G, 2G, 3G, 4G.

## 1. INTRODUCTION

With the rapid advances and development in the field of mobile and telecommunication sector, the evolution of generation bands has proved to be one of the greatest technologies ever seen. It all started with 1G mobile system which was used to transmit only the analog signals followed by the 2G mobile technologies which transmitted digital signals. The 3G or the third generation technology came after 1G and 2G mobile technology. Its successor 3G included high data transmission speed compared to 2G. The fourth Generation of mobile technology (4G) was known as Long term Evolution(LTE). 4G included many services such as entertainment, multimedia, mobile applications and many more. 5G mobile technology was based on OWA (Open Wireless Architecture) and Open Transport Protocol (OTP).

## 2. ZERO GENERATION MOBILE TECHNOLOGY (0G)

Wireless telephones started with what you might call 0G. 0G refers to pre-cell phone mobile technology. Such as radio telephones that some had in cars before the advent of cell phones. Mobile radio telephone systems preceded cellular mobile telephony technology. Since their arrival was before

the First generation of technology, these systems are called Zero generation of mobile technology.

In 0G, different technologies used include PTT(push to talk), MTS(Mobile telephone system), IMTS(Improved Mobile telephone system), AMTS(Advanced Mobile telephone system), OLT(Norwegian for offending landmobil Telefoni public land mobile Telephony) and MTD(Swedish abbreviation for Mobiletelefoni system D).[12]

## 3. FIRST GENERATION MOBILE TECHNOLOGY

The First generation of wireless mobile communication is totally based on analog signal. Analog system was first implemented in North America, were known as Analog Mobile Phone System(AMPS), while the system was implemented in Europe and rest of the world as typically identified as a variation of Total Access Communication System(TACS). Where as this type of analog mobile system is Primary based on circuit switched technology and design for voice only, not for data. The First Generation are Analog Telecommunication standard that were introduced in 1980s And continued until being replaced by Second Generation Digital Telecommunication[2].

Its successor, second generation (2G) which made use of digital signals, 1G wireless networks are used as analog radio signals. Through 1G, a voice call can be modulated at higher frequency about 150 MHz and above as it transmitted radio towers. This is done by using the technique Frequency-Division Multiple Access (FDMA). In terms of overall connection quality 1G, compares unfavorably to its successors. It has low capacity, unreliable handoff, poor voice links, and no security at all since voice call are played back to radio towers, making this call are quite susceptible to unwanted eavesdropping of third parties.

## 4. SECOND GENERATION MOBILE TECHNOLOGY (2G)

The second generation 2G system, fielded in late 1980s and finished in late 1990s, was planed mainly for voice transmission with digital signal and speed up to 64kbps.



**Fig.1 1G Mobile Phone [1]**

2G wireless mobile services are a step ahead of 1G service by providing facility of short message services (SMS) unlike 1G whose prime focus was on only voice transmission services. The bandwidth required for 2G transmission is about 20-200KHz. During the second generation, mobile telecommunication industry experienced exponential growth of usage of the both subscribers and valued added services [2].

2G phones developed which introduce the GSM technology. Global system for mobile communication or GSM uses digital modulation to improve the voice quality but the networks offer the limited data services. As the demand drove uptake of the cell phone, 2G carrier continued to improve the transmission quality and coverage. 2G technologies can be bifurcate into Time Division Multiple Access (TDMA) based and Code Division Multiple Access (CDMA) based standards depending on the type of multiplexing used. 2G makes use of the CODEC (compression decompression algorithm) to compress and multiplex Digital voice data.

### 5. 2.5G –GPRS (GENERAL PACKET RADIO SERVICE)

2.5G, which stand for "second and half generation", is cellular wireless technology developed in between its predecessors 2G and its successors 3G. The term "second and half generation" are used to describe the General Packet Radio Services. GPRS provides the data rate from 56Kbit/s to 115Kbits/s. It can be used for services

Such as Wireless Application Protocol (WAP), Access Multimedia Messaging Services (AMMS), and for internet communication services such as Email and World Wide Web

Access. GPRS data transfer is charged typically megabyte of traffic transferred, while data communication via traditional circuit switching is billed per minute of connection time.

2.5G networks may be support services like that WAP, SMS, MMS, Mobile games and Search and Directory.

### 6. THIRD GENERATION MOBILE TECHNOLOGY (3G)

The third generation (3G) technology was invented in year 2000. Comparing 1G&2G technology to 3G, in 3G Data transmission speed increased from 144Kbps-2Mbps. 3G technology is for the multimedia cell phone, typically it is called smart phone. In 3G, bandwidth and transfer rate were increased to accommodate web-based application and audio and video files. Speed in 3G is very high compared to 2G (3 min mp3 song download in 11sec). In 3G, there are three type of cellular access technology.

CDMA 2000: based on 2G code division multiple Accesses. In CDMA 2000 1.25 MHz channel width and speed is 144Kbps, proposed by North America wireless Telecommunication standards groups.



**Fig.3 3G Mobile phone [3]**

WCDMA (UMTS): Wide band code division multiple access. 5MHz channel width and speed is 2Mbps. The world's first commercial W-CDMA service FOMA was launched by NTT Do Como in Japan in 2001.

TD-SCDMA: Time Division synchronous code division multiple accesses proposed by China wireless Telecommunication standards groups [5].



**Fig .4 First commercial 3G phone [4]**

In above fig., the first commercial 3g phone LG K 8000, which was mainly used in European WCDMA networks.3G phone commonly having two cameras

Which is called front camera so it is used for video calling and that camera capturing him? Some disadvantage of 3g phone it is more expensive and large cell phone so making it difficult to carry.3G spectrum licenses occur in number of countries in 2000 and 3G services began in Japan October 2001.

Fast Communication Internet, Mobile T.V, Video Conferencing, Video Calls, Multi Media Messaging Service (MMS), 3D gaming, Multi-Gaming etc. are also available with 3G phones.

HSDPA (High speed Downlink packet access) is a mobile telephony protocol also called 3.5G.It is providing higher speed than 3G.8.1Mbit/sec data transmission.

HSUPA (High speed Uplink packet access) is a complementary of HSDPA. It is advanced person to person data application with higher and symmetric data rate, like email, person to person gaming [6].

## **7. FOURTH GENERATION MOBILE TECHNOLOGY (4G)**

Fourth Generation of mobile technology offers a speed of 100Mbps.4G contains the same features as those in 3G but along with that provided new services like MMS, entertainment services, Digital television in High Definition.LTE was developed which was considered a part of 4G technology.

### **MIGRATION TO 4G MOBILE SYSTEMS**

4G network being ubiquitous everywhere consists of some research areas that possess key challenges to migrate from the

current used system to the 4G system. The major key challenges are Mobile station, system and service.

The design of new terminals is necessary in order to make the 4G system functional. The 4G mobile system must accept seamless to wireless networks with each and every network having its own set of defined rules and procedures. Auto reconfiguration mode must also be enabled which in a turn downloads the configuration software or system update software from available networks within the range. The choice among various wireless networks is also a key challenge in shifting to 4G.

Terminal mobility plays an important role in developing the 4G systems, but it contains two major issues Location management and handoff management. Location management mainly deals with the tracking of the device, authentication, and information regarding present and future cells and QoS assurance. Handoff management is normally caused when the network switches to other networks which are beyond the boundary. In the 4G system, vertical and horizontal handoffs both are caused due to the mobile client moving between its GSM network and Wireless Fidelity.

Services are also necessary for the success of the 4G systems. Even though same operator exists, the networks can access data using network technologies. Along with the services, the billing systems will also be one of the key aspects.

## **8. FIFTH GENERATION MOBILE TECHNOLOGY (5G)**

5G stands for Fifth Generation Mobile technology.5G mobile technology has not been cited officially by any institution or has not been defined precisely by any standardized institution. The researches so far carried out in the 5G are based on IEEE 802.xx standard. The most important technologies of them being 802.11

Wireless Local Area Network (WLAN), 802.16 Wireless Metropolitan Area Network (WMAN) and AD-hoc Wireless Personal Area Network (WPAN).The 5G mobile system is specifically designed so as to give user the best possible services in order to satisfy their needs. The concept is seen inclined more towards the user rather than the operator.5G mobile architecture consists of OWA(Open Wireless Architecture),OTP(Open Transport Protocol) and along with it many services like Multimedia, applications, entertainment, radio broadcasting, Digital Television etc..

## **9. CHALLENGES IN MIGRATION TO 5G**

### **9.1 Multi mode user terminals**

By means of 4G, a need will arise to design a single user terminal which will be able to operate in different wireless

networks and will overcome the design troubles such as restrictions on the size of the device. This trouble can be easily solved by using software radio approach.

**9.2 Choice among various wireless systems**

With the rapid advancements in the wireless systems, each and every wireless system has its distinctive characteristics and roles. The choice for the most appropriate technology will be dependent for a specific service at a specified place and at specified time. The most appropriate technology will be chosen which meets the demands and the best possible fit of consumer QoS (Quality of Service) requirements.

**9.3 Security**

Reconfigurable, adaptive and lightweight protection mechanisms should be designed.

**9.4 Network infrastructure and QoS support**

Integrating the current non-Internet Protocol and Internet Protocol based systems and providing QoS assurance for end-to-end services that engage different systems is a challenge.

**9.5 Charging and Billing**

It becomes extremely difficult to bring into account, collect and handle the Consumers’ account information from many service providers. In the same way consumers’ billing is also a difficult task.

**9.6 Attacks on Application Level**

Software applications which will offer some new features to the consumer but will also start and produce new bugs.

**9.7 Spoofing and Jamming**

Spoofing is a fake GPS signal being sent out, in which the GPS receiver considers that the signals arrives from the satellites and computes the wrong coordinates. Such wrong computation can lead to more criminal activities and increase the crime rate. Jamming occurs when a transmitter sending out signals at the same frequency shifts a GPS signal.

**9.8 Data Encryption**

If a GPS receiver will communicate with the main transmitter then the communication link between these two is easy to break and the consumer must use the encrypted data [7].

**Fig. 11. Comparison among 1G, 2G, 3G, 4G, 5G [11]**

Technology Features	1G	2G	3G	4G	5G
Start/Deployment	1970 - 1980	1990 - 2004	2004 - 2010	Now	Soon(Probably .....2020)
Data Bandwidth	2Kbps	64Kbps	2Mbps	1Gbps	Heigher then 1Gbps
Technology	Analog celluar Technology	Digital celluar Technology	CDMA 2000 (1X RIT,EVDO) UMTS,EDGE	WiMax LTE Wi-fi	WWW(coming soon)
Service	MobileTelephony (voice)	Digital voice SMS Higher Capacity Packetized data	Integrated high Quality audio Video and data	Dynamic information access,Wearable devices	Dynamic information access,Wearable devices with AI capabilities
Multiplexing	FDMA	TDMA,CDMA	CDMA	CDMA	CDMA
Switching	Circuit	Circuit,packet	Packet	All Packet	All Packet
Core Network	PSTN	PSTN	Packet N/W	Internet	Internet

The table above shows the comparison between different mobile technologies that evolved through years. The table gives a detailed description about features, start/deployment time, data bandwidth, services and the type of core network.

The table indicate significance rise of data bandwidth from 1G to 5G along with inclusion of FDMA, TDMA, CDMA technologies. The services were also given more priority compared to its previous generations.

## 10. CONCLUSION

From the above paper, we have studied about the different wireless technologies and generation bands of 1G, 2G, 3G, 4G, 5G. The paper shows how the evolution of wireless technologies occurred and how they came into existence. Advanced Wireless technologies have proved to be of great boon to the telecommunication sector in developing it. With latest research and advances, the purpose of the user has been served more rather than the operator making it more reliable for the user. As a result, the user centric networks are given more priority nowadays giving the provided services which the user may not have experienced before.

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