

Review: Comprehensive study of 5G and 6G Communication Network

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Abstract—In past few years, cellular services have gained phenomenal evolution and progress in every aspect such as subscribers, data rates, services, etc. The journey of mobile wireless communication began with 1G followed by 2G,3G,4G, and under research upcoming generations 5G and 6G. The comparison between 4G and 5G wireless technology in relation to its speed, frequency band, switching design basis and forward error connection is studied. The 5G wireless technology helps to solve the problems of poor coverage, bad interconnectivity, poor quality of service and flexibility. In this paper, we presented the difference between till the generations of mobility communication. Our contribution in this paper comparative study of those generations.

Keywords—1G, 2G, 3G, 4G, 5G,6G, Mobile Wireless Communication

I. INTRODUCTION

The development of wireless technologies has improved people's ability to communicate and live in both business operations and social functions. Every wireless technology has some standards, different capacities, new techniques and new features than the previous generations. The first generation (1G) mobile wireless communication network was analog used for voice calls only. 1G is also known as AMPS (Advanced Mobile Phone System). To overcome the drawbacks of 1G a new technology 2G was introduced. The second generation (2G) is the digital technology and is also known as GSM (Global System for Mobile Communication). The third generation (3G) mobile technology provided higher data rate and increased capacity. The fourth generation (4G) mobile wireless technology, which is an evolution of the existing 3G with more improved data speed. To overcome the limitation of 4G a new wireless technology is proposed for the future called 5G. The future technologies such as 5G and 6G has also been shown providing immense scope for innovative research and development.

II. LITERATURE REVIEW

Some of the important studies completed in the mobile generations are discussed below.

Ms. Anju Uttam Gawas (2015), discussed the paper as the Mobile wireless communication took a big revolution over the years. The birth of generation started from 1 and 4G is all over the world. Researches on the 5G,6G and 7G future generation are going, their challenges faced and issues occurred are explained in this paper.

Mamun.A.et al. (2016), have discussed the technology evolution trends seen from 1G to 4G mobile communication system as a future generation networks, threats on 5G implementation and comparative study on 3G,4G and 5G wireless technology.

S. Ramkumar (2018), have discussed the different kinds of mobile generations, and also about the upcoming mobiles generations and their features are mentioned in this paper.

Rahul Singh Karki, Vivek B. Garia(2016), have discussed the evolution of generations from 0G to 4G and various technologies that made every generation better than the previous generations. The paper also highlights the future generations of mobile networks 5G, 6G, and 7G.

Sagarkumar Patel, Harshad Purohit, Shivam Shah (2018), discussed in this paper the different mobile generations and the 5G technologies used.

III. EVOLUTION

Mobile communication has become more popular in last few years due to rapid revolution in mobile technology. The revolution begins with 1G followed by 2G, 3G, 4G, 5G, 6G.

A. First Generation (1G)

1G is the first generation technology was developed in 1980s. It was based on analog system. 1G technology was first used in Japan & spread quickly to the other parts of the world. It was used for voice services and was based on technology known as the Advanced Mobile Phone System (AMPS).

Its basic feature are:

- Speed - 2.4 Kbps
- Allows users to make voice calls in one country
- Based on analog system
- Poor voice quality
- Large phone size
- Low capacity
- Frequency call drop
- No security

B. Second Generation (2G)

2G refers to the second generation and was launched in Finland in 1991. It is based on digital system. 2G technologies enabled the various mobile phone networks to provide the services such as text messages, picture messages and MMS. All text messages sent are digitally encrypted, only the receiver can receive and read it. While radio signals on 1G networks are analog, radio signals on 2G networks are digital. Both systems use digital signaling to connect the radio towers to the rest of the mobile system.

The main features of 2G:

- Data speed up to 64 Kbps
- Based on digital system

- Introduce services such as text messages, picture messages and MMS(Multimedia message)
- Poor video processing
- Weaker digital signal
- Provides better quality and capacity

C. Third Generation (3G)

3G is the third generation technology and was introduced in year 2000. It is based on the International Telecommunication Union (ITU) family of standards under the International Mobile Telecommunication program, IMT-2000. It uses both the packet switching and circuit switching. 3G technologies provides value added services like mobile television, global positioning system & video conferencing.

The main features of 3G are:

- Speed is up to 2Mbps
- Provides faster communication
- Send/receive large email messages
- Superior voice quality
- Good clarity in video conferencing
- Services like video calling, global positioning system, mobile television etc.
- To download a 3 minute MP3 song only 11sec-1.5mins time is required.

D. Fourth Generation(4G)

4G is the fourth generation wireless technology and was developed in 2010. LTE (Long Term Evolution) is considered as 4G technology. 4G provides additional services like Multimedia Newspapers, to watch T.V programs with and send data much faster than previous generations.

The main features of 4G are:

- High quality video streaming
- High security
- High speed, high capacity
- Low cost per-bit
- Speed up to 100 Mbps
- It uses packet switching for voice and video calls instead of circuit switching.

Application of 4G

- Mobile Web Access
- Video Streaming
- Video Conferencing
- Gaming Services
- 3D Television

Drawbacks of 4G

- Battery uses is more
- Hard to implement
- Need complicated hardware
- Expensive equipment required to implement next generation network.

Countries have 4G

- Except for the Scandinavian countries(Northern Europe that includes Denmark and two of the nations of Scandinavian, Norway and Sweden), a few countries have started the 4G .
- In the US, Sprint Nextel and Germany, Spain, China, Japan and England are also using the 4G services and mobiles.

4G | LTE ARCHITECTURE

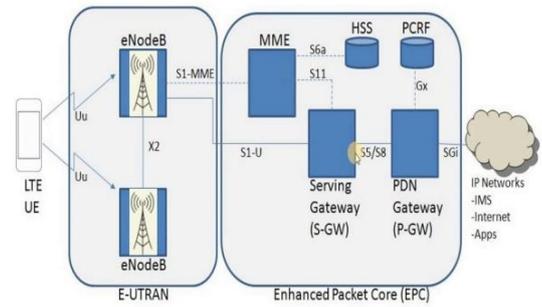


Fig.1. 4G Architecture

Radio Access Technology for LTE-E-UTRAN

The E-UTRAN handles the radio communications between the mobile and the evolved packet core and it has one component, the evolved base stations, called eNodeB or eNB. Each eNB is a base station that controls the mobiles in one or more cells. The base station that is communicating with a mobile is known as its **servicing eNB**.

LTE Mobile communicates with just one base station and one cell at a time and there are following two main functions supported by eNB:

- The eNB sends and receives radio transmissions to all the mobiles using the analogue and digital signal processing functions of the LTE air interface.
- The eNB controls the low-level operation of all its mobiles, by sending them signaling messages such as handover commands.

Each eNB connect with the EPC by the S1 interface and it can also be connected to nearby base stations by the X2 interface, which is mainly used for signaling and packet forwarding during handover.

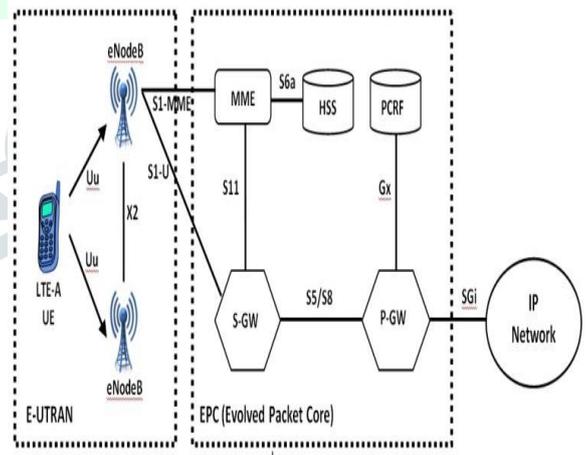


Fig.2. Architecture of Evolved Packet Core (EPC)

Core network for LTE

Core Network is the brain of the system. It is formed of telephony switches that enable the different services for the mobile users. Core network devices connect the mobile devices in the mobile network. They also connect the mobile network with the fixed telephony network and internet. The LTE core network is called EPC (Evolved Packet Core) or System Architecture Evolution (SAE). The core network is formed from the five nodes:

MME: Mobility Management Entity or MME is the central control node in the EPC network. It is responsible for mobility and security signalling, tracking and paging of mobile terminals.

S-GW: Serving Gateway or S-GW transports the user traffic between the mobile terminals and external networks. It also interconnects the radio access network with the EPC network. It is connected to the P-GW.

P-GW: PDN (Packet Data Network) Gateway connects the EPC network to the external networks. It routes traffic to and from PDN networks.

HSS: HSS (Home Subscriber Server) is the database of all mobile users that includes all subscriber data. It is also responsible for and call and session setup.

PCRF: PCRF (Policy and Charging Rules Function) is node responsible for real-time policy rules and charging in EPC network.

E. Fifth Generation(5G)

5G is the latest generation of cellular mobile communication which was started from late 2010s. 5G performance targets high data rate, reduced latency, energy saving, cost reduction, higher system capacity, and massive device connectivity. The main focus of 5G will be on World-Wireless World Wide Web (WWWW). It is a complete wireless communication with no limitations.

The main features of 5G are:

- Capable of supporting WWWW (Wireless World Wide Web).
- High speed, High capacity
- Faster data transmission that of the previous generation.
- Large phone memory, more dialing speed, more audio/video clarity.
- Low cost, high connectivity
- Capable of latency less than a millisecond.
- More effective & attractive.

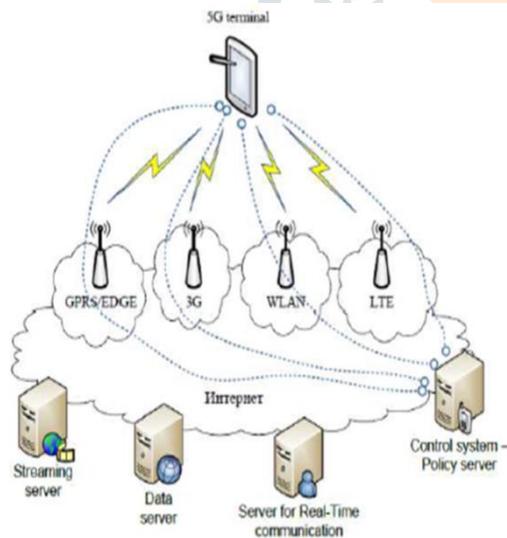


Fig.3. Architecture of 5G

The system model of 5G is IP based model designed for the wireless and mobile networks. The system comprising of a main user terminal and a number of radio access technologies. Each of the radio technologies is considered as the IP link for the outside internet world. The IP technology is designed exclusively to ensure sufficient control data for appropriate routing of IP packets related to a certain application connection i.e. sessions between client applications and servers somewhere on the Internet.

Table.1. Comparison of 4G & 5G

Specifications	4G	5G
Full form	Fourth Generation	Fifth Generation
Peak rate	1Gbps	10Gbps
Data Bandwidth	2Mbps to 1Gbps	1Gbps and higher
Spectral Efficiency	30 b/s/Hz	120 b/s/Hz
Latency	10ms(radio)	<1ms(radio)
Mobility	350Kmph	500Kmph
Connection Density	1000/Km ²	1000000/Km ²
Frequency Band Data	2 to 8 GHz	3 to 300 GHz
Multiple Access	CDMA	CDMA, BDMA
Handoff	Horizontal and vertical	Horizontal and vertical
Initiation from	2010	2015

Challenges of 5G

a) Technical challenges

- **Inter-cell Interference** – This is one of the major technological issues that need to be solved. There is variations in size of traditional macro cells and concurrent small cells that will lead to interference.
- **Efficient Medium Access Control** – In a situation, where dense deployment of access points and user terminals are required, the user throughput will be low, latency will be high, and hotspots will not be competent to cellular technology to provide high throughput. It needs to be researched properly to optimize the technology.
- **Traffic Management** – In comparison to the traditional human to human traffic in cellular networks, a great number of Machine to Machine devices in a cell may cause serious system challenges, which will cause overload and congestion.

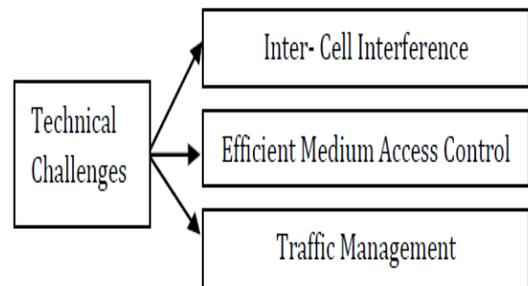


Fig. 4. Technical challenges of 5G

b) Common challenges

- **Multiple Services** – Unlike other radio signal services, 5G would have a huge task to offer services to heterogeneous networks, technologies, and devices operating in different geographic regions. So, the challenge is of standardization to provide dynamic, universal, user-centric, and data-rich wireless services to fulfil the high expectation of people.
- **Infrastructure** – Researchers are facing technological challenges of standardization and application of 5G services.
- **Communication, Navigation, & Sensing** – These services largely depend upon the availability of radio spectrum, through which signals are transmitted. Though 5G technology has strong computational power to process the huge volume of data coming from different and distinct sources, but it needs larger infrastructure support.
- **Security and Privacy** – This is one of the most important challenges that 5G needs to ensure the protection of personal data. 5G will have to define the uncertainties related to

security threats including trust, privacy, cybersecurity, which are growing across the globe.

- **Legislation of Cyber law** – Cybercrime and other fraud may also increase with the high speed and ubiquitous 5G technology.



Fig.5. Common challenges of 5G

Application of 5G

- To avail the super speed up to 11Gbps.
- Latency will be It will make unified global standard for all.
- Network availability will be everywhere and will facilitate people to use their computer and such kind of mobile devices anywhere anytime.
- Because of the IPv6 technology, visiting care of mobile IP address will be assigned as per the connected network and geographical position.
- Its application will make world real Wi Fi zone.
- Its application will facilitate people to avail radio signal at higher altitude as well.

Advanced Features

In comparison to previous radio technologies, 5G has following advancement –

- Practically possible 1 millisecond (end-to-end round trip).
- 1,000x bandwidth per unit area.
- Feasibility to connect 10 to 100 number of devices.
- Worldwide coverage.
- About 90% reduction in network energy usage.
- Battery life will be much longer.
- Whole world will be in Wi Fi zone.

F. Sixth Generation (6G)

Sixth generation (6G) of wireless mobile communication is the futuristic technology. 6G is also sometimes called 5g Long Term Evolution. It is proposed to integrate 5G technology for a global coverage. 6G offers terabits per second, along with microsecond latency.It provides high data rates and fast Internet speed to access on air through wireless and mobile devices with data range up to 11Gbps when travelling far distances. For resource monitoring and weather information multimedia video and high-speed Internet connectivity and the Earth imaging satellite networks are used. 6G will be based on All-IP network and real wireless world. 6G won't replace the existing mobile

networks. It will create a blend of existing and emerging generations too.

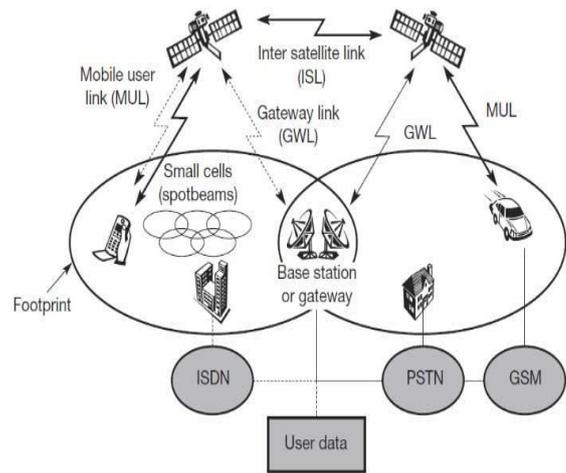


Fig.6: Typical satellite system for global mobile communications across the world

Advantages of 6G

- High speed Internet access.
- Speed up to 10-11Gbps.
- Microsecond latency and unlimited bandwidth.
- Smart Homes, Cities and Villages.
- Home based ATM systems.
- Satellite to Satellite Communication for the development of mankind.
- Natural Calamities will be controlled with 6G networks.

Table.2. Comparison of 5G & 6G

Features	5G	6G
Year	2015	After 5G onwards
Speed	1Gbps and Higher	10 to 11Gbps
Technology	4G+WWW	5G+Satellite
Core Network	Internet	Internet
Standards	WiMAX LAS CDMA,OFDM, MC-CDMA, UWB, Network-LMDS,IPv6	GPS, COMPASS, GLONASS, Galileo systems
Handoff	Horizontal & Vertical	Horizontal & Vertical

IV. CONCLUSION AND FUTURE WORKS

In this paper we discussed about different technologies that evaluate the trends from 1G to 4G mobile communication. In addition, the paper highlights the future generations of mobile networks 5G& 6G.The first generation mobile network was all about voice. 2G was about voice and texting; 3G was about voice, texting, and data; 4G was everything in 3G but faster; and we go through the needs for the 5G technology expected in 2020 and 5G will be even faster, better battery life, very low latency than 4G. The millisecond levels of latency that 5G will offer isn't going to be enough ,6G will emerge to satisfy the expectation not met with 5G. 6G is the futuristic technology with highspeed Internet access and microsecond latency.We have limitation of capacity of storage systems for that reason many researchers focusing on find new technics & algorithm to handle overload on the servers. For future work we planning to add more factors and parameters for comprehensive study of all generations of mobile network communication.

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