



Study & Comparison of 4G , 5G & 6G Technology

Rahul Chatterjee

EasyChair preprints are intended for rapid dissemination of research results and are integrated with the rest of EasyChair.

January 9, 2022

Study & Comparison of 4G , 5G & 6G Technology

Mr. Rahul Chatterjee

Ph.D. Scholar, Computer Science, and Engineering, National Institute of Technology
Silchar, Assam, India. rahul21_rs@cse.nits.ac.in

Abstract:

From the last few years, the growth of Wireless networks has been tremendous. And with this flow from the fourth generation to the sixth generation, Speed is a matter which has improved a lot, along with speed latency also decreased. Wireless Technology FG (Future generation) is the most demanded topic, and this is going to improve Speed a lot compared with the fifth generation. In 4G, the technology which has come is LTE which does follow packet switching but never supports circuit switching. In the fifth generation (5G), the main technology is OFDM (orthogonal frequency division multiplexing), and 6G technology is air fiber technology with masts and transceivers on a tall building. Here we are discussing the Speed, frequencies, latencies and advantages, disadvantages of 4G,5G, and 6G, and we are actually discussing the need for the invention of the new generation of technologies and the changes that are happening with advances of technologies.

Keywords: 4G,5G,6G,Technology

Introduction:

Mobile communication and wireless network are becoming faster day by day. Wireless information communication is the transfer of information over a long distance without the use of electrical conductors or "wires" When the context is clear, and the term is often shortened to "wireless," It composed of various types of fixed, mobile, and portable two-way radios, cellular telephones, Personal Digital Assistants (PDAs), and wireless networking. In the past few decades, wireless networking has witnessed many generations of technologies, from 0G,1G,2G, to 6G. Consumers are demanding more advancement of technologies. In each generation of technology, standards are increasing and making technology easier to use. And that's the reason subscriber numbers are increasing a lot .for that; there is a huge need for capacity improvement of the wireless network. The 4G integrates 3G with fixed Internet bandwidth to support wireless mobile Internet, which is an evolution to overcome all the limitations of 3G and also raises the QoS, increases the bandwidth and reduces the cost of resources. The 5G brings forward a real wireless world- Wireless World Wide Web (WWW) while 6G is proposed technology to integrate 5G with satellite networks for global coverage.

Fourth Generation(4G) of Wireless Technology

Fourth-generation uses voice technology, and also it is IP based.LTE(long-term evolution), UMB(ultra mobile broadband), and IEEE 802.16(WiMax)are considered as 4G technology. If we consider the peak value of download, then LTE speed 100 Mbit/s and LTE advanced speed 1000Mbps and WiMax 128 Mbps. And in peak upload speed, LTE 50 Mbps, LTE advanced 500 Mbps and WiMax 56 Mbps. Initially,

LTE was named as 4G, but that does not support a circuit-switched network. And 4G network are the pillar as it integrates several radio access network with fixed networks. And peak speed of 4G is 100 Mbps for high mobility communication like trains, cars, etc., and the peak speed at low mobility is 1Gbps. The key technology behind 4G is open wireless architecture(OWA) which supports multiple wireless air interfaces in an open architecture platform. SDR is used to define the radio and make a common platform that can be used across a number of areas. And, it will develop multi-band, multi-standard base stations and terminals. In the future, this terminal will adapt the air interface to the available radio access technology. The advanced level architecture of LTE is comprised of UE(user equipment), E-UTRAN(Evolved UMTS Terrestrial Radio Access Network), EPC(Evolved Packet Core).

User Equipment(UE)-

internal architecture of UE is almost the same as the mobile equipment of GSM.this is comprised of some important factors. These are –

- Mobile Termination (MT)
- Terminal Equipment (TE)
- Universal Integrated Circuit Card (UICC)
-

The E-UTRAN (The access network)-

the E-UTRAN manages the radio communications between mobile and the evolved packet core and just has a single component, the evolved base stations, called eNodeB or eNB. Each eNB is a base station which controls the mobiles in one or more cells. The eNB sends and receives radio transmissions to all the mobiles. The eNB controls the low-level operation of all mobiles by sending them signaling messages such as handover commands

The Evolved Packet Core (EPC-The core network)-

The Evolved Packet Core (EPC-The core network) system consists of a few things like Earthquake and Tsunami Warning System (ETWS), the Equipment Identity Register (EIR), and Policy Control and Charging Rules Function (PCRF).

Main features of 4G—

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

5G Technology

5G is not an official term used for any particular specification or in any official document yet made public by any telecommunication companies or standardization bodies such as 3GPP, WiMAX Forum, or ITU-R.

The Speed of 5G is many times higher than 4G; a Higher capacity would allow a higher density of mobile users, ultra-reliability, and massive communications. The greatest thing about 5G is 5G aims at lower suspension and low battery consumption. 5G is designed for WWW (World Wide Wireless Web).

5G core concept would possess three technologies:

- Nanotechnology
- Cloud computing and,
- All flat IP platform

5th wireless mobile Internet networks are the real wireless world which shall be supported by LAS-CDMA, OFDM, MC-CDMA, UWB, Network-LMDS, and IPv6. IPv6 is the basic protocol for running on both 4G and 5G. Bandwidth optimization control protocol and a mix-bandwidth data path for future 5G real wireless world. The Bandwidth Optimization Control Protocol (BDCP) is implemented in between the MAC layer and TCP/IP layer. New mobile generations are typically assigned new frequency bands and wider spectral bandwidth per frequency channel (1G up to 30 kHz, 2G up to 200 kHz, 3G up to 5 MHz, and 4G up to 40 MHz)

5G technologies follow some new computing concepts such as –

- Pervasive networks
- Group cooperative relay
- Cognitive radio technology
- Wireless mesh networks and dynamic Ad hoc networking
- Smart antennas

The main features of 5G are:

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

Challenges of 5G—

- **Technical challenges**
 1. Inter-cell Interference
 2. Efficient Medium Access Control
 3. Traffic Management.

- **Common challenges**
 1. Multiple Services
 2. Infrastructure
 3. Communication, Navigation, & Sensing –
 4. Security and Privacy
 5. Legislation of Cyberlaw

Application of 5G

- To avail of the super Speed up to 11Gbps.
- Latency will be It will make the unified global standard for all.
- Network availability will be everywhere and will facilitate people to use their computers 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 the world a real Wi-Fi zone.
- -Its application will facilitate people to avail radio signals at higher altitudes as well.

Sixth Generation(6G)

The 2030 intelligent information society will be highly digitized, intelligence inspired, and globally data-driven, enabled by near-instant and unlimited full wireless connectivity . The sixth generation of wireless technology uses air fiber technology with masts and transceivers on a tall building and lamp posts to create a local network. This method will be the best method to broadcast more secured information from transmitters to destinations. 6G Internets use a great combination of the latest in radio and fiber optics technology. They deliver through via line of sight (LOS). The telecommunication satellite is used for data, voice, video broadcasting, Internet, and the earth imaging satellite network is for weather and environmental information collection. The navigational satellite network is for Global Position System (GPS).

Advantages of 6G

- High-speed Internet access.
- Speed up to 10-11Gbps.
- Microsecond latency and unlimited bandwidth.
- Satellite to Satellite Communication for the development of mankind technological advancement. .
- Smart Homes, Cities, and Villages.
- Home-based ATM systems

- Natural Calamities will be controlled through 6G networks.

There are Four-Tier Network Descriptions, these are –

- Space-network tier
- Air-network tier
- Terrestrial-network tier
- Underwater-network tier

Challenges:

- 1) massive sensing objects, such as humans, things, and environments, for various vertical applications
- 2) complicated communications resources, including multidimensional radio and x-haul resources
- 3) multilevel computing resources, including cloud, fog, and edge computing (i.e., x-computing)
- 4) multilevel cache resources.

Comparison of different technologies—

	4G	5G	6G
Frequency	2-8 GHz	4G Frequency	95GHz-3THz
Service	Wi-Fi, VoIP, LTE, WiMAX	WWW	Secured and global cellular services
Multiplexing	OFDMA	All with AI capabilities, MIMO,CDMA	CDMA
Switching type	Packet switching (All packer)	IPv6 but advancements are still to be done	All packet
Core network	Internet	Internet	Internet
Data rate	100-300 Mbps	About 100+Mbps	About 11 Gbps
Pros	Speed, high speed hand offs, MIMO tech, global tech	Better coverage area, low battery consumption, availability of multiple data transfer path, energy and spectral efficiency is more and has a high security	Global coverage system
Cons	Hard to implement, complicated hardware required	It is still under process and research on its viability is going on, it is difficult to achieve because of the incompetent technological support in most parts of the world, developing infrastructure needs high cost, security and privacy issue yet to be solved	Difficulty for space roaming, high cost of mobile call and similar with 5G disadvantages
Location of first commercialization	South Korea	Not yet	Not yet
Time period	Now	Soon probably 2020	Soon probably 2030
Handoff	Horizontal and vertical	Horizontal and vertical	Horizontal and vertical

Conclusion

With the advancement of technology from 4G to 6G, several changes of technology have come, as well speed, Latency, frequency, mobility, bandwidth has changed. The world is trying to become totally wireless, demanding uninterrupted access to information anytime and anywhere with better quality, increased bandwidth, high speed, and reduction in cost. Here we have made a sharp comparison between 4G,5G, and 6G wireless technology. Many of the previous problems have been solved with the advancement of new generation technologies. And also, the challenges we have faced while discussing 6G hope will be resolved in further next generations.

Reference-

1. A Survey Report on Generations of Network: 1G, 2G, 3G, 4G, 5G (2006).
2. Khutey R (2015) Future of wireless technology 6G and 7G. Int J Electr Electron Res 3: 583-585.
3. Mobile Technology: Evolution from 1G to 4G electronics for you.
4. Kachhavay MG Ajay PT (2014) 5G Technology-evolution and revolution. Int J Comput Scie Mobile Comput 3: 1080-1087.
5. Ms. Anju Uttam Gawas, "An overview on Evolution of Mobile Wireless Communication Networks: 1G-6G", (IJRITCC), Volume 3, Issue 5, May 2015.
6. Arockia Panimalar.S, Monica.J, Amala.S, Chinmaya.V," 6G Technology", (IRJET), Volume 04, Issue 09, Sep- 2017.
7. M. Latvia-aho, "Radio access networking challenges towards 2030," in Proc. 1st International Telecommunication Union Workshop on Network 2030, New York, Oct. 2018. [Online]. Available: https://www.itu.int/en/ITU-T/Workshops-and-Seminars/201810/Documents/Matt_Latvaaho_Presentation.pdf



Rahul Chatterjee ,got his B.Tech. degree from M.A.K.A.U.T.,West Bengal in 2020, now doing Direct PhD from NIT Silchar .And his area of research is Computer Networks.