

5 G Wireless Technologies: A further development compared to 3 G and 4 G Systems

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Abstract: In this paper, an attempt has been made to review the various existing generations of mobile technology in terms of their features, performances, advantages and disadvantages. The paper throws light on the network architecture and layers of fifth generation technology. In fifth generation researches are being made on development of World-Wide Wireless Web (WWWW) and focuses on (Voice Over IP) VOIP-enabled devices that user will experience a high level of call volume and data transmission. The 5G design is based on user-centric mobile environment with many wireless and mobile technologies on the ground.

Keywords: Mobile technology, Fifth generation technology, Network connection, Data transmission, Architecture.

1. INTRODUCTION

5G Wireless Technology stands for 5th Generation Mobile technology. 5G mobile technology will change the means to use cell phones within very high bandwidth. Users have never experienced ever before such a high value technology. Nowadays mobile users have much awareness of the cell phone (mobile) technology. The 5G technologies include all type of advanced features which makes 5G mobile technology most powerful and in huge demand in near future [1].

5G technology is going to be a new mobile revolution in the mobile market. 5G technology has extraordinary data capabilities and has ability to tie together unrestricted call volumes and infinite data broadcast within latest mobile operating system. 5G technology has a bright future because it can handle best technologies and offer priceless handset to their customers. May be in coming days 5G technology takes over the world market. 5G Technologies have an extraordinary capability to support Software and Consultancy. The Router and switch technology that will be used in 5G network will provide high connectivity. The 5G technology distributes internet access to nodes within the

building and can be deployed with union of wired or wireless network connections. The current trend of 5G technology has a glowing future. According to some research papers, the main features of 5G technologies that would have are as follows:

1. Greater speed and capacity (1,000 times capacity of 4G).
2. Reduced Latency (stop delays).
3. Provides high resolution and larger bandwidth.
4. It will gather all networks on single platform.
5. Provide uninterrupted and consistent connectivity.
6. 5G will have better coverage area and high data rate at the edge of the cell.
7. Energy efficiency and spectral efficiency are good [2].

2. Comparison from 1G to 5G Technology

Mobile communication has become more popular in last few years due to fast revolution in the mobile technology. This revolution is due to very high increase in telecoms customers. This revolution is from 1G- the first generation, 2G- the second generation, 3G- the third generation, and then the 4G- the fourth generation, 5G- the fifth generation which will come in the recent years [4]. A detailed comparison of all these generations with respect to their features, performances, advantages, disadvantages have been tabulated and discussed below:

1G refers to 1st generation of mobile telecommunication:

- It was developed in 1980s and completed by early 1990s.
- It provides a speed up to 2.4kbps.
- It is based on analog system.
- It allows user to make call in one country.
- It has low capacity, unreliable handoff, poor voice links, and no security at all since voice calls were played back in radio towers, making

PARAMETERS	1G	2G	3G	4G	5G
Deployment	1982	1992	2000	2010	Expected by 2020
Bandwidth	30kHz	200kHz	5MHz	20MHz	39GHz
Technology	Analog	Digital	Broadband/ CDMA /IP	LAN /WAN/WLAN	4G+WWW
Service	Mobile telephony	Text, picture & multimedia message	High quality, audio, video data	Dynamic information access across variable devices	Dynamic information access across variable devices with all capabilities
Multiplexing	FDMA	FDMA/TDMA	CDMA	CDMA	CDMA
Switching	Circuit	Circuit – circuit for access network and network interface	Packet except for air interface	All packets	All packets
Handoffs	Horizontal	Horizontal	Horizontal	Horizontal/ Vertical	Horizontal/ Vertical

Table 1: Different Parameters of 1G to 5G Technology

these calls susceptible to unwanted eavesdropping by third parties [6].

2G refers to 2nd generation of mobile telecommunication:

- It was developed in late 1980s and completed in late 1990s.
- It is based on digital system.
- It provides a speed of up to 64 kbps.
- It provides services like Text, picture & multimedia message.
- Major prominent technologies were GSM, CDMA, and IS95 [6].

3G refers to 3rd generation of mobile telecommunication:

- NTT DoCoMo launched the first commercial 3G network on 1 October 2001, using the CDMA technology
- It operates at a range of 2100MHz and has a bandwidth of 15-20MHz and has a bandwidth of 128 Kbps for mobile stations, and 2 Mbps for fixed applications.
- It provides services like voice calls, data services, Global roaming, High-speed internet services, video calling, multimedia services.
- The data are sent through the technology called Packet Switching. Voice calls are interpreted through Circuit Switching [6].

4G refers to 4th generation of mobile telecommunication:

- It was developed in the year 2010.

- It is faster and more reliable.
- It provides speed up to 100mbps.
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- It provides high performance like uploading and downloading speed.
- It provides easy roaming as compared to 3G.
- Use of a higher Layer Protocol (IP) as transport medium affords intelligence at every stage within the network relative to a service [6].

5G refers to 5th generation of mobile telecommunication:

- It will be the next major phase of mobile telecommunication & wireless system.
- It will be 10 times faster than 4G.
- It has an expected speed of 1gbps.
- Lower cost than the previous version.
- 5G support to Internet of Thing, Smart Home Appliances, Autonomous Car and it will be also applicable in following - Health, Transport, Agriculture and Education.
- It is expected to come around the year 2020 [8].

3. 5G Network Architecture

As it can be seen in the image given above, the system model of 5G is entirely IP based model designed for the wireless and mobile networks.

- System uses a terminal and number of independent Access technologies.

- Each of the Radio Access Technologies (RAT) seen as the IP link to the outside internet world.

- The system comprises of a main user terminal and then a few independent and autonomous 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 enough 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.

- Moreover, to make accessible routing of packets should be fixed in accordance with the given policies of the user.

(A) GPRS (General Packet Radio Service)

- It is used to transmit data at 60kb/sec.
- It consumes less battery during sending & receiving mail or browsing internet.

(B) EDGE (Exchanged Data Rate for GSM Evolution)

- It is an advance version of GPRS.
- It provides a data speed of 473kb/sec.

(C) 3G

- 3G makes it possible to do video call on mobile network.
- It also provides efficient way to browse internet on mobile networking.

(D) WLAN (Wireless LAN)

- WLAN is a wireless computer network that links two or more devices using wireless connection to form a local area network (LAN) within a limited area such as homes or offices.

- This gives the users the ability to move around within the area and still be connected to the network.

- Most modern wireless LAN are based on IEEE802.11 standards and marketed under the Wi-Fi brand name.

(E) LTE (Long Term Evolution)

LTE is standard for mobile communication for high speed data transmission for mobile network. Its Speed is up to 100mb/sec. The LTE supports only packet switching across all its IP network.

(F) Streaming Server

Streaming server typically delivers files to us with a little help from the web server. First, we go

to Web page, which is stored on the Web server. When we click the file you want to use, the Web server sends a message to the streaming server, telling it which file you want. The streaming server sends the file directly to you, bypassing the Web server.

(G) Data Server

A data server (DS) is a software program/platform used to provide database services like storing, processing and securing data. These database services are consumed by other software programs or components.

(H) Server for Real time Communication

A real time application server executes programs, routines or scripts that supports application construction. It supports any web application including dynamic content and a modern UI. It includes web server within a complete integrated application server frame network.

(I) Control System Policy Server

The policy server accepts access control requests, processes them against a formal set of statements that define how the network's resources are to be allocated among its clients (known as the policy), and returns access control responses.

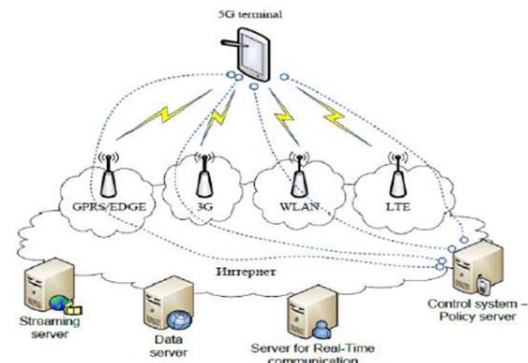


Fig.2. Architecture of a 5G Network System

4. 5G Network Layers

5G will be completely user centric i.e. nothing is hidden from user. It will have new error prevention schemes that can be installed through internet anytime and have modulation methods and software defined radio (SDR). 5G will be a collaboration of networks and individual network handle user mobility. This network will be based on Open Wireless Architectures as it has Physical Access Control Layer i.e. OSI Layer. OSI layer along with 5G network layers are shown in the figure (2).

Open Wireless Architecture

- OWA stands for Open Wireless Architecture this layer is used to be used as combination of physical layer and data link layer.

- For these two layers, the 5G technology is likely to be based on Open Wireless Architecture [3].

Network Layer

- Separation of network layer into two sub layers:

- 1) Lower network layer (for each interface)
- 2) Upper network layer (for mobile terminal)

- All mobile network will use IP & each mobile terminal will be FA(Foreign Agent).

- A mobile can be attached to several mobiles or wireless networks at the same time.

- Network Layer is used to route the data from source to destination [3].

Open Transport Protocol

- Wireless network differs from wired network regarding the transport layer.

- In all TCP versions the assumptions are that lost segments are due to network congestion.

- In wireless the loss is due to higher bit error , ratio in the radio interface.

- 5G mobile terminals will have transport layer that is possible to be downloaded & installed [3].

Application (Service) layer

- Provides intelligent Quality of Services (QoS) management over variety of networks.

- Selects the best wireless connection for given services.

- QoS Parameters such as- delay, losses, bandwidth, reliability will be stored in database of 5g mobile.

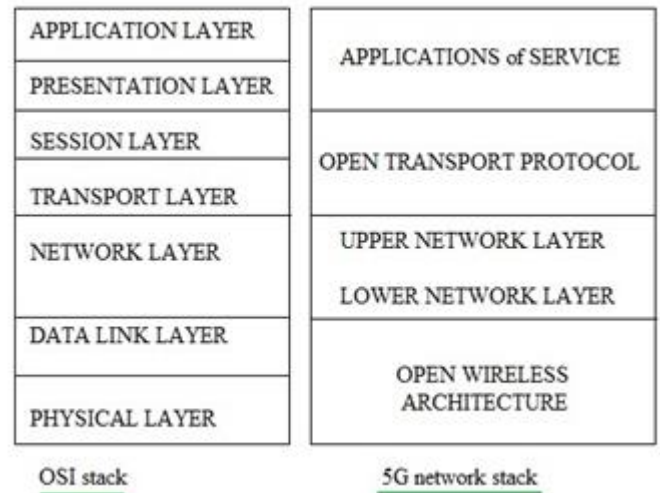


Fig.3. Layers of 5G Network System

5. Requirements Of 5G Technology

Many industries initiatives that have progressed with works on 5G technology identify a set of eight requirements:

- Up to 10Gbps data rate > 10 to 100x improvement over 4G and 4.5G networks.
- 1-millisecond latency.
- 1000x bandwidth per unit area.
- Up to 100x number of connected devices per unit area (compared with 4G LTE).
- 99.999% availability.
- 100% coverage.
- 90% reduction in network energy usage.
- Up to 10-year battery life for low power IoT devices [9].

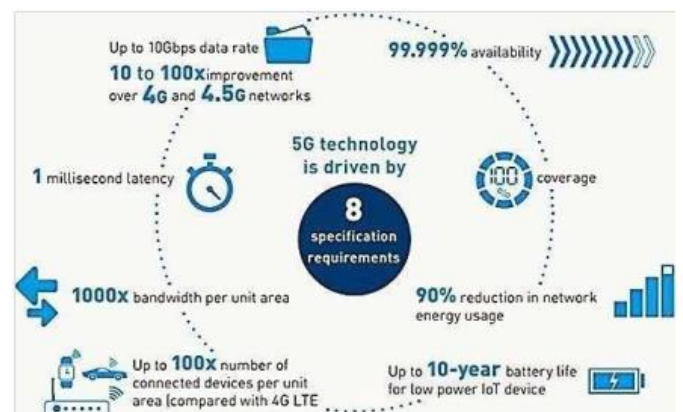


Fig.4. Requirements of 5G Network System

6. Why do we need 5G?

- 5G will deliver superior user experience and better network energy efficiency, as well as increased.
 - Operational performance.
 - Mostly due to video streaming, mobile data traffic is rising rapidly.
 - Each user has a growing number of connections with multiple devices [12].
 - The emergence of the IoT (Internet of Things) means networks must handle billions of more devices.
 - Network operators are under pressure to reduce operational expenditure.
 - Operators also need new applications for mobile technology which opens up new revenue streams [8].

7. The new Risks with 5G

5G makes all kinds of technologies possible - but also raises the stakes. If our car is being operated via a cloud-based autonomous driving system over 5G, we don't want to lose the signal right at the precise moment this is about to tell our vehicle to slam on the brakes [1]. Operators and technology organizations know that (and are considering the insurance implications). So they are aiming to cut out the network latency to confirm that such an event doesn't happen. The necessity for low latency will have a profound effect on how networks are developed, according to Huawei's head of Wireless Research, Dr. Wen Tong. Packet error rates will need to sort out [11].

Being the operator whose network did not deliver the signal to turn right at the crucial moment or left a family stranded on a remote road because of problems of connectivity is a possibility no one wants to face. Network access time will have to be cut out dramatically. Network controllers, for example, will need to be far more local to us — think single digit kilometres — to design autonomous cars a reality. Advances in coding and modulation will also be necessary.



Fig.5. Self-driving cars will demand the low latency that 5G promises

8. Technological Challenges

(A) Inter-cell Interference:

This is caused due to the variations in size of traditional macro cells and concurrent small cells [5].

(B) Efficient Medium Access Control:

The user throughput will be low, latency will be high, and hotspots will not be competent to cellular technology to provide high throughput where dense deployment of user terminals are required [9].

(C) Traffic Management:

Compared to traditional human to human traffic in cellular networks, overload and congestion can be caused

Due to system challenges i.e. RAN challenges when the number of Machine to Machine (M2M) devices in a cell increases.

7. A New Trust Model for the 5G Era

- How to cope up with new data protection challenges necessitating a fabric of trust across 5G virtualized networks.
- How to provide a trustworthy 5G IoT device lifecycle management.
- How wireless modules can address new 5G IoT use cases (e.g. massive IoT, high speed & ultra-reliable communications)
- Which new roles the 5G eSIM will approve.
- How software licensing will help in VNF consumption monitoring and fraud prevention [13].

8. Future Prospects

If there was a single thread that crisscrossed through the world's biggest mobile trade show this week, it was 5G. Walking the halls of Fira Gran Via, visitors could either be wowed by the potentiality or roll their eyes at the hype. The world's telecoms, phone manufacturers and tech giants were all pitching it—each putting their brand's unique spin to show how it will be relevant to all parts of life in the near future.

Here's a look at some ways that companies think 5G will transform digital societies around the world:

(A) Smart Cities

Instead of building the standard trade show booth, Nokia crated its own sprawling area to resemble a smart city—with streets, buildings and rooms all showing how faster connectivity could

help people in the future. There was a booth to visualize how low latency can help prevent car crashes. Another told how it will help banks communicate. Yet another visualized a futuristic living room, where AI and three-walled screens could someday combine with high-speed internet to capture what someone is in the mood to watch.

(B) Virtual Reality and 360-Degree Video

While Ericsson pitched 5G by explaining how frustrating virtual reality can be without it, SK Telecom used VR to show what a big fun it can be with it. At the South Korean company's booth, visitors tried on Samsung Gear VR headsets to demo SK's Oksusu Social VR platform, which lets users hang out together as avatars in a VR theater at the time of watching 2-D sporting events, movies and concerts on a virtual big screen.

(C) Smart Phones

As phones tend to be the focus of Mobile World Congress, it becomes clear that 5G would focus on them.

U.S. telecoms started announcing 5G roll-out plans for which they plan to install it, with Sprint, AT&T and T-Mobile all naming their important cities. But even when they're planning to build the networks, there's still a necessity for devices that can connect to it.

(D) Smart Cars

One of the often-cited paths 5G might be used is in self-driving or other kinds of connected cars. Faster connectivity, experts say, will allow for the repeated connection that lets cars "communicate" to each other and the streets, streetlights and other sensors around it.

Even non-autonomous vehicles could benefit. Intel showed off its 5G-connected car that was capable to download the data equivalent of two high-definition movies a second.



(A)



(B)



(C)



(D)

Fig.6. Future Applications of 5G Network System: (A) Smart Cities, (B) 360 Degree Videos, (C) Smart Phones,(D) Smart Cars

Conclusion

In this paper thus, it can be concluded that , many challenges and requirements are needed for the successful implementation of 5G Technology into the market and it seems to create revolution in the communication era and will minimize the problems that we have seen in the previous technologies. Since, 4G framework is still by all accounts an innovative work stage, even though it has been propelled in some spots, it might take additional time for 5G to develop.

Likewise, less or no confirmation is distributed that can demonstrate the disadvantages of 5G since there could be some amid the early phase of each innovation. While some of the provided data could well change between now and 2020, we can be certain that 5G will be worth the wait. It will also have some flaws, notably overall cost and lack of use between current devices. However, by the time 5G launches, most people will simply upgrade to the newest model that has 5G compatibility. 5G would very well change the world. By increasing the speed at which all data is transferred, improving response times (latency), and providing more capacity for the millions (if not billions) of devices, superfast mobile internet will no longer be a user luxury: it'll be a way of living.

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