



Survey of development trends in 5G mobile wireless networks

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ABSTRACT

5G networks are the up and coming age of mobile web availability, offering quicker speeds and progressively solid connections on smartphones and different gadgets than at any other time. The general execution of 5G mobile correspondence network has gained extraordinary ground compared to the 4G network. This paper is focused on all foregoing generations of mobile technology, developmental aspect of 5G technologies and the basic architecture/concept behind this mobile technology trend. Combining cutting-edge network technology and the latest high-spec's devices, 5G should offer connections that are multitudes faster than previous mobile technology, with average download speeds of around 1Gbps expected to soon be the norm. The 5G frequency band is between 3GHZ to 300GHz, top notch video communication, top quality sight and sound spilling, interactive media papers, HD online TV, and so forth which causes this innovation to vary and one of a kind among all the accessible existing mobile technologies around the world. 5G depends on IPv6, level IP and VoIP (Voice over IP) technologies and through these components, client will encounter a significant level of information transmission and call volume administration.

Keywords: LTE, 5G, 5G Architecture, Mobile Technology, WWW, OTA

1. INTRODUCTION

The development of wireless technology started in early 1970's. In the past four decades the development of mobile wireless technology projected from 1G to 5G technology. 5G technology is the 5th generation technology for mobile wireless technology. 5G Technology is a highly intelligent technology which adds up a large number of specifications to the 4G technology and makes it completely wireless without any limitation. Based on the 4G network, 5G mobile communication will be able to provide users with better services through the Internet platform and wireless transmission technology.

The fifth generation wireless mobile technologies offer tremendous data capabilities and unrestricted calls and in addition an infinite data broadcast with latest mobile operating system. The idea of WWW (World Wide Wireless Web)

started with 4G technology and is completed with the 5G mobile technology. This innovation helps in making the world connected with continuous access to data, correspondence, and diversion. This will change our ways of life in a noteworthy way.

2. Evolution Of Mobile Network Technologies
The step for wireless communication was led by an Italian inventor, G. Marconi by communicating a letter up to distance of 3km (from starting point to its destination point) with the help of electromagnetic waves. After this initiation, wireless communication became a very important part of present styles of living. With the passing of time a number of modifications kept on taking place as per the need to provide technology solutions, architectures, and standards (Table 1). This trends in mobile technologies depict different phases (Fig. 1) leading to the evolution of 5G Network.

Table 1: Mobile Network Technologies Evolution

Generation	Speed	Technology	Time Period	Features
1G	14.4 Kbps	AMPS, NMT, TACS	1970-1980	During 1G Wireless, phones are used for voice only.
2G	9.6/ 14.4 Kbps	TDMA,CDMA	1990-2000	2G capabilities are achieved by allowing multiple users on a single channel via multiplexing. During 2G Cellular phones are used for data also along with voice.
2.5G	171.2Kbps 20-40 Kbps	GPRS	2001-2004	2.5G the internet becomes popular and data becomes more relevant.2.5G Multimedia services and streaming starts to show growth. Phones start supporting web

				browsing though limited and very few phones have that.
3G	3.1 Mbps 500- 700 Kbps	CDMA 200 (1xRTT, EVDO) UMTS, EDGE	2004-2005	3G has Multimedia services support along with streaming are more popular. In 3G, Universal access and portability across different device types are made possible. (Telephones, PDA's, etc.)
3.5G	14.4 Mbps 1-3 Mbps	HSPA	2006-2010	3.5G supports higher throughput and speeds to support higher data needs of the consumers
4G	100-300 Mbps. 3-5 Mbps 100 Mbps (WiFi)	WiMax LTE Wi- Fi	2009-present	Speeds for 4G are further increased to keep up with data access demand used by various services. High definition streaming is now supported in 4G. New phones with HD capabilities surface. It gets pretty cool. In 4G, Portability is increased further. World-wide roaming is not a distant dream.
5G	1Gbps	GPRS/EDGE, LTE, 3G, WLAN	1 April 2020	The 5G provides 10 times more capacity than other existing systems. It expected speed will be up to 1Gbps. It is completely wireless communication with almost no limits supporting Wireless World Wide Web (WWW). It is more reliable and faster in lower cost. It provides high capacity, large phone memory, faster data transmission, supports interactive multimedia, etc.

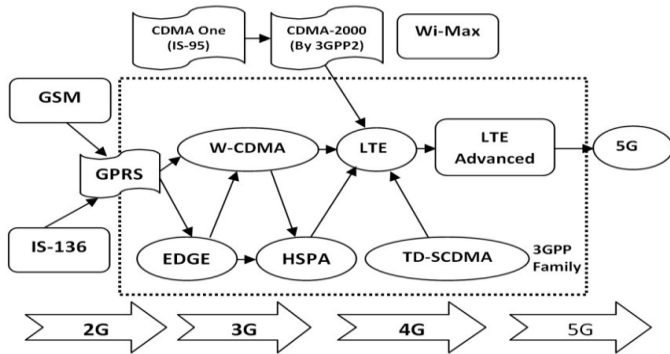


Fig. 1: Evolution Phases of Mobile Network Technology

1. Overview Of 5G Network Technologies

The latest generation of wireless technologies, 5G networks, promises an era of ubiquitous, secure, and high-capacity radio networks. With extremely low latency levels, high energy efficiency, and a comprehensive Gbps capacity, the applications of 5G technology extend to a plethora of industries and fields beyond traditional telecom. Some of the exciting 5G applications include self-driving vehicles, VR/AR, smart manufacturing, telehealth services, smart cities, and many more.

The 5G provides 10 times more capacity than other existing systems. It expected speed will be up to 1Gbps, with almost no limits supporting Wireless World Wide Web (WWW). It is more reliable and faster in lower cost. It provides high capacity, large phone memory, faster data transmission, supports interactive multimedia, etc. The 5G mobile communication system itself has very strong flexibility and can be automatically adjusted. Under the background of rapid development of various

technologies and different industries, 5G mobile communication systems can still cope with such trends. Combined with the above content, 5G mobile communication will completely replace 4G mobile communication into the mainstream communication network in the future, so as to ensure that the different needs of different users can be better satisfied.

3.1 NEEDSFOR 5G MOBILE TECHNOLOGY

A few deformities and inaccessibility of certain properties or functionalities in the current framework turns into the requirement for the improvement of the people to come. 4G technology is fundamentally about the incorporation of various technologies and systems. 4G technologies join different existing and future wireless technologies to guarantee the opportunity of development starting with one technology then onto the next. 4G can bolster 100Mbps (Table 1) information rate in full mobility wide region inclusion and 1Gbps information rate in low mobility neighborhood. 4G coordinates all entrance technologies, administrations, and applications boundlessly to go through wireless over wireline utilizing IP address. In any case, when we talk about 5G, it will bring us impeccable certifiable wireless or WWW: World Wide Wireless Web. The possibility of 5G technologies began with 4G technologies. Talking about the working of 4G, although LTE provide benefits certain people with wide range of effective wireless communication technology. LTE is fundamentally for use in business territories so it can't be utilized for making a situation to be utilized by average folks for downloading reason, video call, and so forth. Along these lines, this turned into the fundamental explanation for the improvement of 5G technology. Other than the various advantages of 4G technologies the most significant idea of 5G technology is buyer situated rather than administration driven and administrator

arranged. In this technology, need is given to purchasers when contrasted with other existing portable technologies. So being client arranged, a few highlights: less expensive traffic charges, security, rapid, computerized reasoning (AI), stockpiling, and so forth, turned into the purpose behind the improvement of 5G technologies. 5G technology will give high bandwidth. It incorporates every propelled include which will make it generally predominant in not so distant future. Significant highlights which lead the advancement of 5G technology and movement from 4G technology among others includes:

- Security
- Multi Mode User Terminal
- Choice of selection of the best network among the various available wireless communication systems
- Charging and Billing
- Data Encryption
- Attack on Application Level
- Device to Device Communication

3.2. Analysis of the Development Trend of 5G Mobile Communication

1. Virtual Reality Aspects

In recent years, virtual reality and related technologies have received extensive attention in the society. By definition, virtual reality mainly combines visual and auditory, and then simulates certain scenes for users to ensure that users can immerse them. With the increasing use of virtual reality technology in games, interactions, etc., users have put forward higher requirements for the experience gained from virtual reality. With the support of 5G technology, users' interaction experience between virtual and real world will be greatly improved.

2. HD Video

With the continuous development of computer technology and network technology, users have put forward higher requirements for video clarity. There are also a large number of high-definition and ultra-clear devices on the market. For these devices, the transmission speed and transmission quality are the main factors that determine whether these devices can provide the corresponding clarity [2]. In this regard, the transmission speed of 5G mobile communication is very fast, generally reaching Gigabit. Under such a background, HD video will be transmitted under unrestricted conditions, ensuring that users can access anytime, anywhere can watch HD videos.

3. Smart City

The concept of a smart city is no stranger to people. Through the construction of a smart city, people's daily production and living activities will be more convenient, and the effectiveness of local government management work can be improved. Combined with the application effect of the smart city at this stage, since this system needs to cope with the needs of thousands of users in a city, the throughput and transmission rate of the mobile communication network itself must meet the requirements, and then in the future development process. Ensure that the construction of a smart city can achieve the desired results.

4. Internet of Things

Combined with the status quo, the Internet of Things has been applied to a certain extent in all walks of life in China, and has facilitated the development of related work, but as the scope of the Internet of Things continues to increase, the network included in the Internet of Things the object will naturally become more. This trend means that with the continuous development of the Internet of Things and related technologies, the Internet of

Things system will face more communication and security problems in the actual application process. The combination of 5G mobile communication network and Internet of Things is the main way to avoid the above problems. With the support of 5G mobile communication technology, all kinds of information in the Internet of Things will be processed in a wireless and high-speed way [3], information problems arising during transmission and interaction can naturally be well

5. User Experience

In addition to meeting the needs of users in communications, data transmission, etc., 5G mobile communications must be able to provide a better user experience on the original basis. On the other hand, under the experience-based service mode, the user's recognition of mobile communication will be better improved. Therefore, in the future development process, research on 5G mobile communication and related technologies must be able to put the user experience in an important place to consider.

Usage And Application Of 5G Technology

International Telecommunication Union's Radio communication Sector (ITU-R) defines three significant areas of usage and application (Fig. 2) as parts of its 5G initiative:

- Enhanced Mobile Broadband: Cater to the growing demand for ubiquitous broadband connectivity with enhanced data rates, connection density, and mobility.
- Massive Internet of things (IoT): Connectivity for millions of devices transmitting sensitive data. Availability of low-cost devices with long battery lives.
- Ultra-Reliable Low Latency Services (URLCC): Reliable connectivity with stringent requirements on latency and throughput.

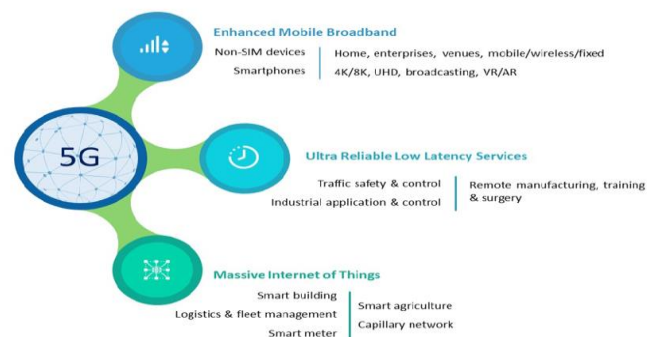


Fig. 2: Usage and application of 5G

3.3. Technologies powering 5G networks

The entire ecosystem of 5G comprises of a transformed telecom core, radio, and OSS to support new requirements. This non-standardized system involves concepts like network slicing, a virtualized cloud-based core, new radio technologies, and end-to-end management and orchestration to facilitate automation.

Further, they can be grouped into two broad categories viz:

5G radio network technologies:

1. Massive MIMO Communications
2. Millimeter-Wave Mobile Communications
3. Non-Orthogonal Multiple Access (NOMA) for Future Radio Access
4. New Multicarrier Modulations for 5G

5. Generalized Frequency Division Multiplexing
6. Multi-Carrier Waveform for 5G
7. Spectrally Efficient Frequency Division Multiplexing for 5G
8. Full-Duplex Wireless Communications for 5G
9. Device-to-Device Communications

5G core network technologies:

1. Programmable networks
2. Network Slicing & network slice
3. Software-defined networking
4. Multi-domain orchestration
5. Automation
6. Dynamic deployment
7. Real-time data analytics
8. Closed loop automation
9. Cloud Technologies
10. Network Function Virtualization, Containers, Micro-services
11. Edge computing/ Fog computing

3.4. KEY BENEFITS WITH 5G:

Peak 5G speeds are expected to be up to 100x faster than the speed of 4G LTE networks. Reduced latency will support new applications that leverage the power of 5G, the Internet of Things (IoT), and artificial intelligence. Increased capacity on 5G networks can minimize the impact of load spikes, like those that take place during sporting events and news events.

3.5. Security of 5G networks

5G employs a virtually distributed, layered security design and wireless technology to create a highly secure, resilient, and agile system which comprises of:

1. Distributed Denial of Service (DDoS) detection and mitigation.
2. Stronger encryption for over-the-air interface and encryption of IMSI for each device
3. Security Edge Protection Proxy to mitigate vulnerabilities in prior technology and probable attacks when subscribers are roaming between different carriers.
4. Virtualized Network operations through NFV & SDN- which enable adaptable security.

4.0. NETWORK ARCHITECTURE OF 5G MOBILE TECHNOLOGY

The model of 5G technology is entirely IP based model for both mobile and wireless communication. The various components involved in the architecture making it very fast, secure and famous among the customers in all over the world are as follows:

1. **GPRS:** General Packet Radio System (GPRS) is basically a step developed for internet access during third generation. It is the first step towards the end to end wireless communication. It provides data rates from 56Kbps to 114Kbps. It also promises to provide continuous connection of internet to mobile and computer users. It consumes comparatively less battery during internet access.
2. **EDGE:** Enhanced Data GSM Environment (EDGE) provides an evolutionary path from 3G technology to GSM and TDMA. It provides maximum data transmission rate up to 473 Kbps. It is developed to increase the bandwidth of GPRS technology.
3. **3G:** 3 Generation (3G) technologies developed to access wireless communication. It provides high quality, cost effective, wireless multimedia application, greater security

features, video calls/ conferences and enhanced wireless application as compared to previously available services.

4. **WLAN:** Wireless Local Area Network (WLAN) provides the facility of wireless connection and communication among the devices. It uses high frequency radio waves, micro waves, etc. for its functionality. Use of WLAN increases mobility, productivity, scalability as it provides high speed
5. **LTE:** LTE stands for Long Term Evolution. LTE works by using all IP network architecture. It supports data as well as voice communication. LTE supports MIMO (Multiple Input Multiple Output), because of which higher data rate is achieved. As a result LTE is a standard for high speed data transmission for mobile networks, providing a high speed up to 100 mbps. As it uses improved architecture, handoff from one region to other is smooth. This results in smooth data flow without any interruption.

4.1. Key challenges in the 5G rollout

5G technology promises transformative applications, new services, and seamless end-user experience for industries and users alike with improved network performance and reliability. However, despite the potential benefits, 5G networks are still evolving, and operators are skeptical about the ROI - given the heavy investment needed to deploy them. Here are some of the key challenges that are to be addressed before 5G networks are widely adopted:

1. Small cell deployment challenges
 - i. Planning and permission delays from local authorities
 - ii. Human exposure to radio frequency electromagnetic fields (EMF)
 - iii. Access and code powers to install antennas on public properties like the lampposts
2. Fiber backhaul (Deploying the fiber networks)
 - i. Poor availability of fiber networks in cities
 - ii. Refused or delayed planning permissions
 - iii. Complex way leave processes
3. Spectrum availability and network deployment feasibility
 - i. Allocation & identification of globally harmonized spectrum across a range of frequencies
 - ii. Efficient reuse of available spectrum
 - iii. Cost of procuring fresh spectrum
 - iv. Deployment fees demanded by regulators
4. Rapidly changing specifications & no interoperability
 - i. Lack of interoperability and coordination within the ecosystem (device & chip manufacturers, equipment vendors, and network design teams) for developing new standards and services.
 - ii. 5G standards are still evolving with active testing across many 5G test-beds.
5. Other factors
 - i. 5G compatible device availability.
 - ii. Net Neutrality

5. CONCLUSION

In rundown, this paper chiefly investigates the improvement pattern and key technologies of 5G mobile communication. The current work of 5G technology is focused upon providing specified services with WWW functionalities in most reduced expense ever, keeping the clients in the highest point of the need. There are part more to come, which is certainly going to change the ways of life of societies.

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