IOSR Journal of Engineering (IOSR JEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 16-23

Study on Fifth Generation Wireless Technology (5G)

Ms.Abinaya.R
Department of computer science, Annai women's college, Karur
E-mail id: abinayarls.14@gmail.com

Abstract: *Now a days the world isgrowing fast to the new technology in mobile communication.The 5G mobile communication system provides a far higher level of performance then the previous generation of mobile communication system.The new technology is not just a next version of mobile communications, evolving from 1G to 2G, 3G, 4G and now 5G. Instead of 4G, 5G technology is very different. Previous system had evolver driven more by what could be done with the last technology. In this paper an attempt has been made to provide an over view of evolution of mobile generation, concept of 5G, requirements, features, benefits, and hardware and software requirements.*

Keywords: *Network, 5G, Technology, Challenges, Applications, Hardware and software.*

I. Introduction

In the last few years mobile wireless communication networks have experienced a remarkable change. The mobile wireless Generation (G) generally refers to change in the nature of the system speed, technology, frequency, data capacity ect.5G stands for the 5th generation mobile technology and is going to be a new revolution in a mobile market which has changed the means to use cell phones with in very high bandwidth. User never experienced ever before such high value technology which includes all type of advanced features and 5G technology will be most powerful and in huge demand in future.

II. Evoluvation Of Network

Mobile communication has become more popular in last few years due to fast reform from 1G to 5G in mobile technology. This reform is due to service compatible transmission technology and very high increasing telecoms customers. In 1980 the mobile cellular system had started, and since the mobile communication have changes and experienced massive growth.

1G	2G	3G	4G	5G
1981	1992	2001	2010	2020(?)
2 Kbps	64 Kbps	2 Mbps	100 Mbps	10 Gbps
Basic voice service using analog protocols	Designed primarily for voice using the digital standards (GSM/CDMA)	First mobile broadband utilizing IP protocols (WCDMA / CDMA2000)	True mobile broadband on a unified standard (LTE)	'Tactile Internet' with service-aware devices and fiber-like speeds
				?

Figure 1: Evaluation of mobile generation

Zero generation 0G

This is the generation which comes before cell phone mobile technology. They were included before the first generation of cellular telephones, therefore labeled zero generation systems. Such technology include radio telephone mostly used in cars. Mobile radio telephone systems came before modern cellular mobile telephony technology.

First generation 1G

The first generation of wireless cellular technology is used for voice service and based on technology called as Advanced Mobile Phone System(AMPS). The AMPS system was frequency modulated and used frequency channel capacity of 30KHz frequency and band of 824-894 MHZ.As a system expended and neared

capacity, The ability to reduce transmission power allowed new cell to be added, resulting is more , smaller cells and more capacity

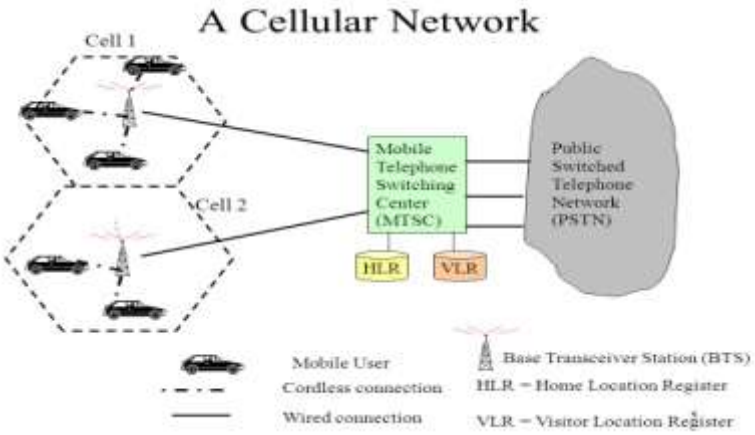

Figure 2: Architecture of 1G technology

Key features of 1G system

- Frequency 800 MHz and 900 MHz
- Bandwidth: 10 MHz (666 duplex channels with bandwidth of 30 KHz)
- Technology: Analogue switching
- Modulation: Frequency Modulation (FM)
- Mode of service: voice only
- Access technique: Frequency Division Multiple Access (FDMA)

Disadvantages of 1G system

- Poor voice quality due to interference.
- Poor battery life.
- Large sized mobile phones (not convenient to carry).
- Less security (calls could be decoded using an FM demodulator).
- Limited number of users and cell coverage.
- Roaming was not possible between similar systems.

Second generation 2G

The second generation 2Gis based on GSM. It is used digital signal for voice transmission. Main focus of this technology was a digital signal and provides service to deliver text and picture message at low speed in (kbps). It used the bandwidth of 30 to 200 KHz .Some benefits of 2G were digital signals require consume less battery power, so it helps to mobile batteries to last long. Digital coding improves the voice clarity and reduce noise in the line. Digital signals are considered environment friendly Digital encryption has provide secrecy and safety to the data and voice calls.

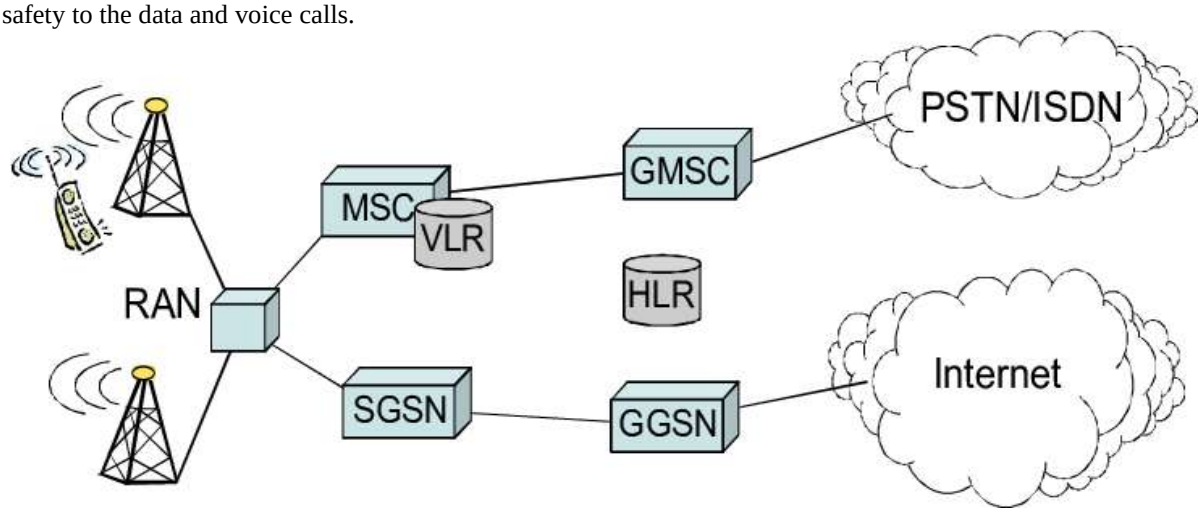

Figure 3: Architecture of 2G technology

Key features of 2G system

- Digital system (switching)
- SMS services is possible
- Roaming is possible
- Enhanced security
- Encrypted voice transmission
- First internet at lower data rate
- Disadvantages of 2G system
- Low data rate
- Limited mobility
- Less features on mobile devices
- Limited number of users and hardware capability

Disadvantages of 2G system

- Powerful digital signal are required to make the mobile phone work.
- There is no proper network coverage in the specified area
- Difficult to handle complex data such as videos ect.

2.5 G

The GSM technology was continuously improved to provide better service which led to development of advanced technology between 2G to 3G. The system uses packet switched and circuit switched domain and provide data rate up to 144 kbps.

Third generation 3G

The third generation 3G is based on GSM. The aim of this technology was to offer high speed data. The technology was improved to allow data up to 14 Mbps and more using packet switching. It is used wide Band Wireless Network which clarity is increased. It is also offers data service access to television/video, New service like global roaming. It operates at a range of 2100MHz and has a bandwidth of 15-20 MHz used for high speed internet service, video chatting.

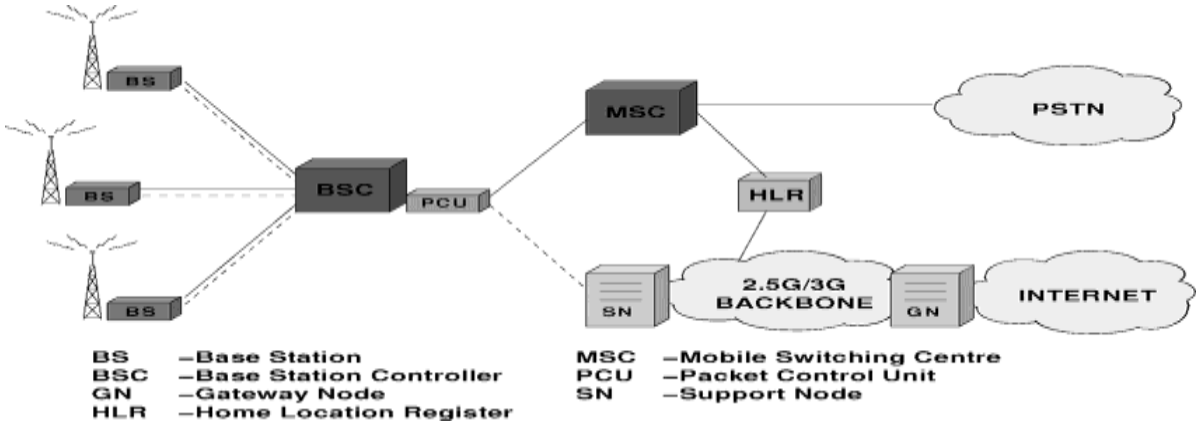

Figure 4: Architecture of 3G technology

Key features of 3G system

- Higher data rate
- Video calling
- Enhanced security, more number of users and coverage
- Mobile app support
- Multimedia message support
- Location tracking and maps
- Better web browsing
- High quality 3D games

Disadvantages of 3G systems

- Expensive spectrum licenses
- Costly infrastructure, equipments and implementation
- Higher bandwidth requirements to support higher data rate
- Costly mobile devices
- Compatibility with older generation 2G system and frequency bands

Fourth Generation 4G

The fourth generation 4G offers a downloading speed of 100 Mbps. 4G provides same feature as 3G and additional services like multi-media Newspapers, To watch T.V programs with more clarity and send data much faster than previous generation. LTE (Long Term Evolution) is consider as 4G technology. 4G is being developed to forthcoming applications like wireless broadband access, Multimedia messaging service (MMS), Video chat, mobile TV, HDTV, Digital video Broadcasting, Minimal service like voice and data and other services.

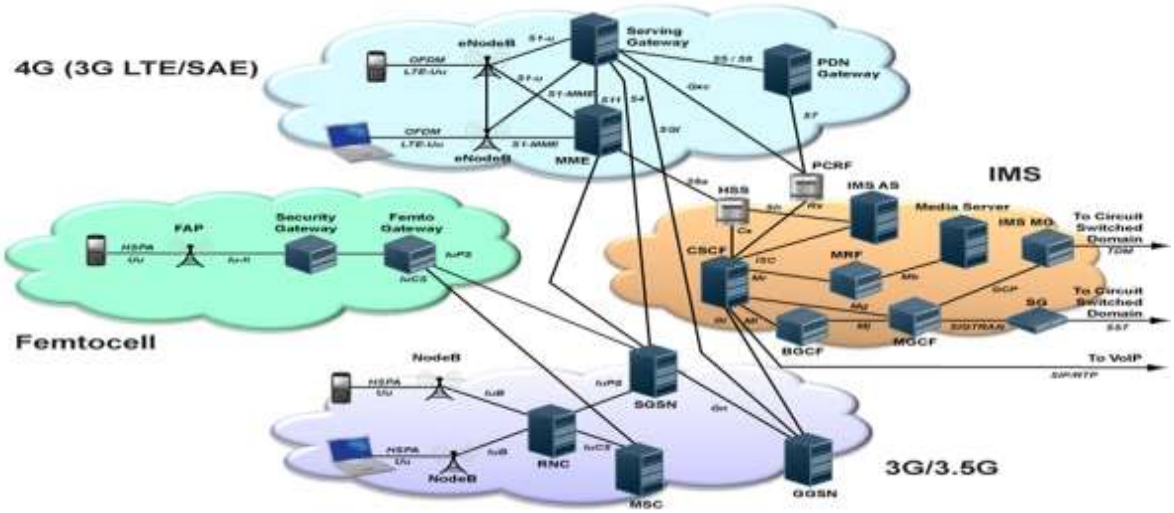

Figure 5: Architecture of 4G technology

Key features of 4G system

- Much higher data rate up to 1Gbps
- Enhanced security and mobility
- Reduced latency for mission critical applications
- High definition video streaming and gaming
- Voice over LTE network VoLTE (use IP packets for voice)

Disadvantages of 4G system

- Expensive hardware and infrastructure
- Costly spectrum (most countries, frequency bands are is too expensive)
- High end mobile devices compatible with 4G technology required, which is costly
- Wide deployment and upgrade is time consuming

Fifth Generation 5G

The 5G refers Fifth generation which was started from 2010s. Facilities that might be seen with 5G technology includes far better levels of connectivity and coverage. The main focus of 5G will be Wireless World Wide Web (WWWW).

III. WHAT IS 5G?

5G technology stands for 5^{th} generation mobile technology. 5G mobile technology has changed the means to use cell phones within very high bandwidth. User never experienced ever before such a high value technology. 5G performance targets high data rates, reduced latency, energy saving, cost reduction, higher system capacity, and massive device connectivity. The first phase of 5G specification release-15 will be completed by April 2019 to accommodated the early commercial department. The second phase in releases-16 is

due to completed by April 2020 for the submission to the International Telecommunication Union as a candidate of IMT-2020 technology.

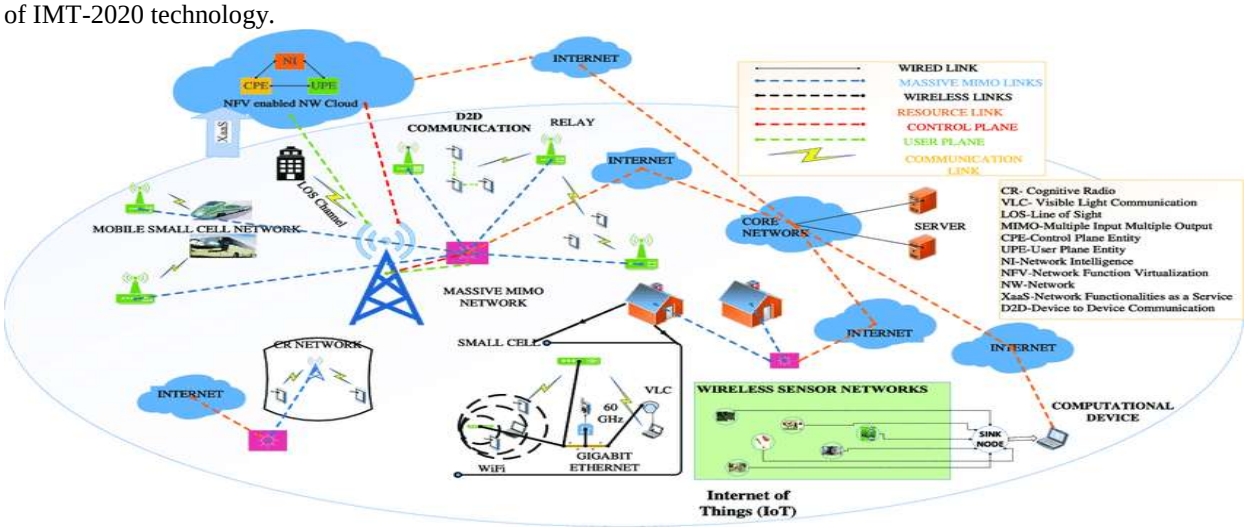

Figure 6: Architecture of 5G technology

The future 5G technology provides a cell phone which like a PDA and then the whole office will be in our figure tips in our phone. In a few years we may be able to download a full length HD movie in six seconds, While 4G require seven minutes and 3G require more than an hour to download the same. 5G is a packet switched wireless system with wide area coverage and high throughput. 5G wireless OFDM

IV. Technologys In 5G

New radio frequency

The air interface defined by 3GPP for 5G is known as New radio (NR), and the specification is subdivided into two frequency bands, FR1 (below 6 GHz) and FR2 (mmWave) each with different capabilities.

Frequency range 1 (< 6 GHz)

The maximum channel bandwidth defined for FR1 is 100 MHz. Note the beginning with Release 10, LTE supports 100 MHz aggregation (five *20 MHz channels). FR1 supports a maximum modulation of 64-QAM , meaning 5G achieves significant throughput improvements relative to LTE-advanced already used 256-QAM ,eliminating the advantage of 5G FR1.

Frequency Range 2 (24-86 GHz)

The maximum channel bandwidth defined for FR2 is 400 MHz, with two- channel aggregation supported in 3GPP release 15. The maximum physical layer rate potentially supported by this configuration is approximately 40 Gbit/s. In Europe,24.25 – 27.5 GHz is the proposed frequencies range.

Massive MIMO

Massive MIMO (multiple input band multiple output) antennae increase sector throughput and capacity density using large number of antennae and Multi-user MIMO (MU-MIMO). Each antenna is individually-controlled and may embed radio transceiver components.

Edge computing

Edge computing is a method of optimizing cloud computing systems by taking the control of computing applications, data and service away from some central nodes. In a 5G network it would promote faster speeds and low-latency data transfer edge devices.

Radio convergence

One expected benefit of the transition to 5G is the convergence of multiple networking functions to achieve cost, power and complexity reductions. LTE has targeted convergence with Wi-Fi via various efforts, such as License Assisted Access (LAA) and LTE-WLAN Aggregation (LWA), but the differing capabilities of cellular and Wi-Fi have limited the scope of convergence. However, significant improvement in cellular performance specifications in 5G, combined with migration from Distributed Radio Access Network (D-RAN) to Cloud- or Centralized-RAN (C-RAN) and rollout of cellular small cells can potentially narrow the gap

between Wi-Fi and cellular networks in dense and indoor deployments. Radio convergence could result in sharing ranging from the aggregation of cellular and Wi-Fi channels to the use of a single silicon device for multiple radio access technologies.

Channel coding

The channel coding techniques for 5G NR have changed from turbo in 4G to polar for the control channel and LDPC for the data channel. Operation in unlicensed spectrum Like LTE in unlicensed spectrum, 5G NR will also support operation in unlicensed spectrum (NR-U). In addition to License Assisted Access (LAA) from LTE that enable carriers to use those unlicensed spectrum to boost their operational performance for users, in 5G NR it will support standalone NR-U unlicensed operation which will allow new 5G NR networks to be established in different environments without acquiring operational license in licensed spectrum, for instance for localized private network or lower the entry barrier for providing 5G internet services to the public.

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V. Features Of 5G

- 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.

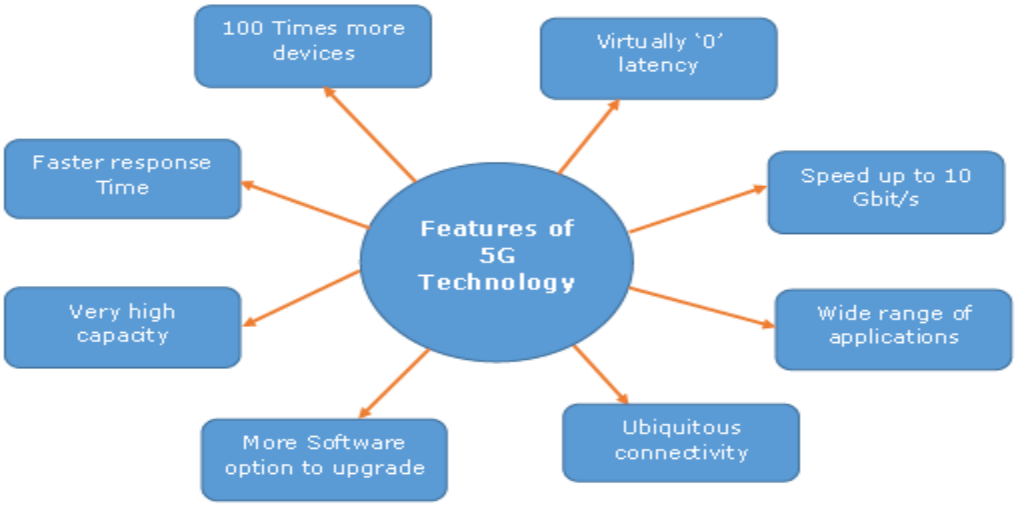

Figure 7: Features of 5G technology

VI. Challenges Facing 5G

Integration of various standards: One of the big challenges facing 5G is standardization. There are already multiple group working to come up with standards around interoperability, back ward compatibility with order technologies (4G,3G), and making will be future proof.

Common Platform: There is no common architecture for interconnecting various engineering practices. One common governing body is required, which creates a common platform for all engineering practices to regularize the interconnectivity issues as well as knowledge sharing.

Building the infrastructure: It is a huge task, with issue around spectrum and installing new antennas. 5G is likely going to rely, at least in part, on higher-frequency bands. There is more space in those airwaves available, but at such frequencies, signals can't travel nearly as far as they can over the frequencies used for 4G, resulting in a poor connection.

Obstacles: Like buildings, trees and even bad weather can also cause interference. To offset that, carriers will need to install more base station to ensure better coverage, and use antenna technologies like MIMO.

Application Of 5G

Applications of 5G are beyond our imagination. User never experienced before such high value technology which includes all type of advanced features. Some of the applications of 5G is mentioned below.

- High speed mobile networks.
- Entertainment and multimedia.
- Internet of things-Connecting everything.
- Smart home.
- We can vote from mobile phone.
- Our mobile rings according to our mood.

5G Specifications

Although the standards bodies have not yet defined the parameters needed to meet a 5G performance level yet, other organizations have not set their own aims that eventually influence the final specifications. Typical parameters for a 5G standard may include.

PARAMETER	PEFORMANCE
Network capacity	10000 times current network
Peak data rate	10 Gbps
Cell edge data rate	100 Mbps
Latency	<1 Mbps

VII. 5G Hardware And Software

5G HARDWARE

Ultra wide band network: It is already known that WI-Fi, Wi-Max and cellular wide area communications are long-range radio technologies. But system like WPAN need short-range radio technology, which helps in achieving higher bandwidth (around 4000 Mbps) but at low energy levels (UWB network) for relaying data from host devices to device in the immediate vicinity, i.e., distance around 10 meters or so. This higher bandwidth (4000 Mbps) level is almost 400 times faster than today's wireless network. Each network will be responsible for handling user-mobility while user terminal will make the final choice among different wireless/mobile access network providers a given service.

Smart antenna:

Switched beam antenna: This type of antenna supports radio positioning via angle of arrival (AOA). Information is collected from nearby devices.

Adoptive array antenna: Such antennae promise to improve the capacity of wireless system by providing improved safety through position-location capabilities. This technique rejects interference through spatial – altering-position location through direction-ending measurement and developing improved channel models through angle –of-arrival channel sounding measurement.

CDMA(code division multiple access) technique: This technique converted audio analogue input signals into digital signal (ADC) in combination with spread spectrum technology. This signal is transmitted using modulation according to some predefined code, and is demodulated using the same pattern there can be billions of code patterns which can provide privacy and sufficient security.

5G Software

5G will be a single unified IP standards of different wireless networks and a seamless combination of broadband, including wireless technologies, such as IEEE802.11, LAN, WAN, PAN, and WWWW. 5G will enable software-defined radio, packet layers, implementation of packets, encryption flexibility, ect.

Key Concept Of 5G

- Ultra fast mobile internet up to 10Gbps
- Low latency in milliseconds (significant for mission critical applications)

- Total cost deduction for data
- Higher security and reliable network
- Uses technologies like small cells, beam forming to improve efficiency
- Forward compatibility network offers further enhancements in future
- Cloud based infrastructure offers power efficiency, easy maintenance and upgrade of hardware

VIII. Conclusion

The world of mobile wireless communication is rapidly developing. The last few years have experienced a remarkable growth in wireless industry. 5G technology going to be a new mobile revolution in mobile market. There are many new techniques and technologies that will be used in the new 5G cellular or mobile telecommunications system. These new 5G technologies are still being developed and the overall standards have not yet be defined. However as the required technologies develop, they will be incorporated into the new system which will be defined by the standards bodies over the coming years. Attempts are being made to reduce the number of technologies to a single global standard resulting in 5G. Trials have already started on 5G which may lead to its commercial availability around 2020. The world is trying to become completely wireless, demanding uninterrupted access to information anytime and anywhere with better quality, high speed, increased bandwidth and reduction in cost.

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