

5G Technology: the Game Changer

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Abstract -- India is the fastest growing country in respect of phone connections, thanks to GSM technology. 5G has brought about a paradigm shift in the technology for communication. It is no less than a revolution in terms of redefining communication. 5G is a unified platform which is much more capable than earlier cellular mobile services featuring lower latency, faster data delivery rate, more capacity besides better spectrum utilization.

For the usage of 5G, 3rd Generation Partnership Project defined Standards. It is a valuable tool to transform industries with low latency, highly reliable communication links. Its higher data speed is going to infuse new meaning into the entertainment industry. Like 4G LTE, 5G uses Orthogonal Frequency Division Multiplexing. Additionally, the new air interface, 5G NR (New Radio) will enhance OFDM and provide better flexibility in data delivery. This tutorial paper highlights basics of 5G technology, terminology, applications and recent controversies.

Keywords : 5G technology, Femto cells, Enhanced mobile broadband, Telemedicine, Autonomous vehicles, Massive machine communication, MIMO, IoT, Disaster management

I. INTRODUCTION

MOBILE Telephony changed the way we work and play. In a period of two decades, the world has undergone a transformation in almost all the fields of human activity catalyzed by mobile connectivity of people. GSM technology has been the main arrow for the development of technology and bandwidth increased over a period of time. The start was from 2G and quickly it changed to 4G. Each generation brought in more convenience and better connectivity. In this scheme of things, arrival of 5G Technology is a complete change in features and usage of applications.

Government constituted '5G India 2020 Forum' with three Secretaries of Departments of Telecom, Meity and DST, besides renowned experts for early deployment and globally competitive product development.

II. VARIOUS GENERATIONS OF GSMA

Mobile technology has undergone many transformations over a period of time. Launched in the 1980s, 1G comprised analog radio signals which supported only voice calls. Subsequent developments and frequency spectrum used are listed in Table 1.

TABLE 1 – GSM EVOLUTION

	Frequency	Launched	Speed
2G	900MHz,1800 MHz	1990s	64 kbps
3G	900MHz, 2100MHz	2000s	1 – 2 Mbps
4G	850MHz,1800MHz, 2300MHz	2010s	100 Mbps – 1 Gbps
5G	700MHz , 3.5GHz	2020s	1-20 Gbps

III. FIFTH GENERATION TECHNOLOGY

5G is based on the basic GSMA Technology, where mobile communication takes place through the dedicated radio system. The basic services are provided by the main switching centre connected by Radio system to the base stations and the cellular domain in which the telephones are connected to radio links and back-haul mechanisms to connect to the switching centre which in turn connects to the called party through a similar network geography.

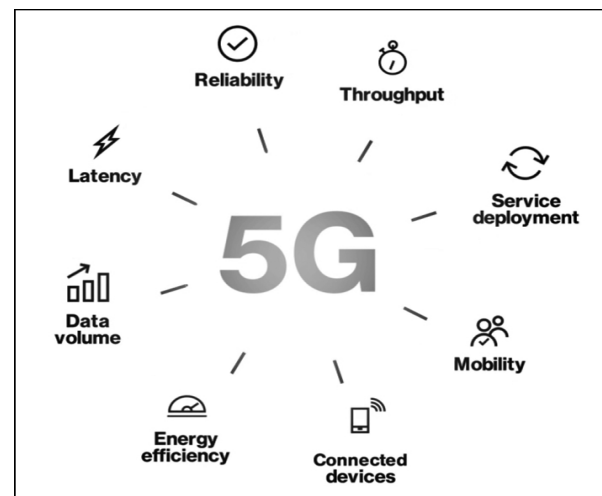


Figure 1. Eight attributes of 5G technology.

GSM technology has redefined the very concept of connecting people in a manner hitherto unheard of in the telecommunication sector. In the land line telephony, a dedicated line was laid to connect people. This required a time consuming process of cable laying and was quite difficult to maintain. GSM technology completely revolutionized the process and was easy

to deploy. This brought about a change in the ease of connecting customers and in scaling up the system easily. It is because of the introduction of this technology that the connection to more than a billion people was achieved in a record time of one decade which was unheard of in India. India was lagging behind in connectivity and the waiting list in getting a telephone connection was more than 15 years in some major cities of India. All that was drastically reduced with the introduction of mobile telephony.

In India, the deployment coupled with the regulatory changes for cellular technology was achieved in a record time. Presently, India has become the fastest growing country in respect of telephone connections.

So far the operators were using 2G and 3G technology. These were good in connecting people through voice and low speed data. India is a country where people are used to watching videos and also for talking long durations. These demands were addressed by the Operators through LTE and edge technologies. Operators introduced these technologies in phases. Now a large proportion of customers are using the data services and the average usage of Data in India has gone up significantly. A further change in technology was very much needed.

5G has brought about a paradigm shift in the technology for communication. It is no less than a revolution in terms of redefining communication. The 5G is a tool for industrial upgrade and change. It will take the industry to a new level hitherto unseen.

5G offers connectivity to everyone and can connect devices and machines together. In terms of auto-piloted cars, the same can be managed only through the new technology as the speed of braking and accelerating the car only be managed if it is using 5G technology, without this there will be many accidents and the project will have to be shelved.

The speed of 5G is going to redefine the entertainment industry. In the existing networks, an average size film takes almost 10 minutes to download, in the new 5G tech this time is reduced to only 10 seconds. This speed is much higher than the existing down-load speed of any existing technology. The down-load speed achieved in this technology attains a speed of Gigabit per second.

IV. TERMINOLOGY

5G NR (New Radio) this term was introduced by ITU (International Telecommunication Union) to introduce the new standards of wireless for 5G. The frequency bands are divided into two frequency bands FR1 and FR2. FR1 is the band below 6 GHz, whereas FR2 uses frequency in the band ranging from 24 to 54 GHz.

3GPP (3rd Generation Partnership Project) The 5G standards are being developed in association with industry and ITU and they have defined the new radio requirement in terms of the 5G NR for various connectivity protocols and standards of wireless.

MIMO is the term used for multiple Input and Multiple Output Antenna: Use of efficient antennas is key to the added efficiency of the 5G system.

Millimeter waves: 5G uses high frequency millimeter waves in the GHz frequency range. These frequencies have wavelengths in the millimeter range, therefore due to short wavelengths, the signal is susceptible to absorption in the medium of propagation i.e. air.

This is one area where the 5G technology is at a disadvantage compared to the 3G and 4G technology. Whereas the signal in 4G and 3G can travel long distances upto kilometer in the case of 5G, the signal gets attenuated beyond few 100 meters. Because of this, the 5G will require a new infrastructure of

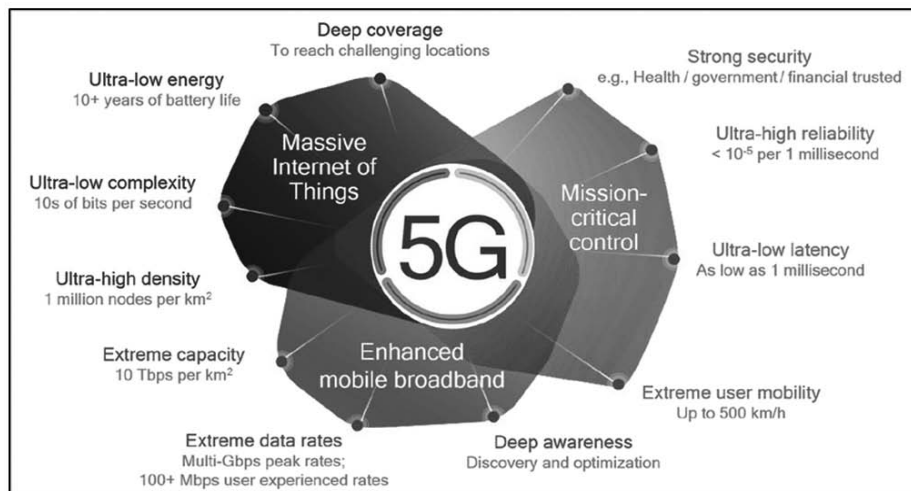


Figure 2. Main features within the target domains of 5G mobile technology [1].

smaller cells. The size of Cell will be reduced to few 100 meters compared to the older versions. These cells are called Femto Cells. For setting up of 5G network, altogether new cells comprising femto cells will be needed. Since 5G can provide comparatively large frequencies and bandwidth, it will be deployed in areas of high density customers. The best example will be in stadia, Malls and high-rise building apartments.

V. USAGES

5G technology is going to redefine the communication sector in a big way. Various uses where it can be used more effectively are:

Telemedicine: Long distance surgery will be achieved by the instant connectivity. Using 5G, surgeon will be able to perform online operations as if he is present inside the operation theatre, whereas in reality, he may be sitting in another continent.

IOT: Internet of things is a major technology which is going to change the production and supply-chain sector. The 3D printing will be improved due to the fast speed of the 5G technology. It will be possible to produce a War tank at the battle field in a comparatively shorter time.

Massive Machine type communication (mMTC), where a large number of machines will be communicating simultaneously for real time data response. This will be most effective in disaster management and connecting a number of rescue operation devices.

Enhanced Mobile Broadband (eMBB): due to large bandwidth and higher speeds, the 5G technology will provide high speed data when a large number of users are present at one place. 5G provides high-resolution and higher dynamic-range video-streaming without interruption via 120 frames per second.

Autonomous Cars: Evolution of driverless cars, where the vehicle is driven by the on-board computers and traffic signals, need to analyze and use the data in an online real-time situation. In this case, it was observed that the vehicles require high speed data for safe driving. It was found that for braking, response time of few milliseconds is required, for which 5G will prove crucial advantage.

Smart cities: Applications like emergency response, smart lighting of street, energy management, instant weather update, traffic management, local area broadcasting, smart power grid, water resource management, crowd management.

Smart farming: Smart sensors will be used for irrigation control, access control and energy management. Using smart RFID sensors and GPS technology, farmers can track the location of livestock.

VI. DISADVANTAGES AND CONTROVERSIES

A lot of debate and controversies are going on in relation to

the deployment of the technology. It has been pointed out that 5G will prove a major threat to the Health and will give rise to many diseases due to its high frequency usage. These issues were raised earlier also and it has been pointed out by a number of studies conducted on the subject that these fears are unfounded and since the radio waves are non-ionization radiation unlike X-Rays and gamma Rays.

Recently, a number of flights to US were suspended when the 5G was started in many cities of America. The Airline Pilots were afraid that the system will interfere with the altimeter system of the plane which uses the same frequency. The frequencies used in the Altimeter are in the range of 4.2 - 4.4 GHz. The spectrum used in US 5G lies in the C band with frequencies ranging from 3.7 GHz to 3.98 GHz. Though this is not the same as that of the frequency used in an altimeter, but it has been observed that some emission from 5G, at times is in the same frequency of 4.44 GHz. They were afraid that the altimeter may give a wrong altitude reading while landing and take-off. This has however been resolved. New guidelines have been issued to the pilot to avoid automatic landing systems and rely on visual landing while operating in US.

VII. CONCLUSION

Humanity is on the verge of the next stage of the Internet revolution, with 5G being at the core. More than 60% of the world's population will be online by 2025, with video consumption accounting for over 75% of the Internet usage. 5G technology is much more than being an advanced version of 4G: It's a global platform capable of ushering cutting-edge technologies and concepts that include ultra-fast, MIMO-based new radio, edge computing, network slicing, and virtualization.

5G will make possible functioning of smart cities via realization of the full potential of Internet of Things. Being up to 99.99% reliable, 5G is a necessity in sectors that engage with time-sensitive data such as defense and healthcare. Owing to less power consumption, it will be a blessing for low power IoT devices achieving enhancement of battery life.

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S.D. Saxena FIETE worked in the Indian Civil Service and was former Director finance of BSNL. He was also involved in setting up of C-DoT as the core team member. He is the author of the book *Connecting India*.