

## EVOLUTION OF 5G TECHNOLOGY

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**Abstract:-** In general, anything that affects us in any way is termed as communication. The sender and the receiver are not always connected via physical media. Such communication which is via the virtue of electromagnetic waves (air) is called "WIRELESS COMMUNICATION". Mind keeps evolving different technologies. As reported in history, society has the tendency to use and adapt new technologies. Level of impact on society differs from technology to technology. Adaptation of internet connectivity in all spheres of life have greatly impacted human society. This paper discusses about communication technology, its present and future impact on society. Technologies are focused to enhance bandwidth, speed, Quality of service (QoS) of existing technologies. In this paper introduction of upcoming fifth generation (5G) is given, technical details and kits comparison with earlier generations is given and impact of 5G on industries.

**Keywords-** 5G, Bandwidth, QoS, Industry 4.0, Future impact

### Introduction

The world is witnessing an enormous amount of changes in the realm of wireless communication. The days are almost gone when we used landline phones and are well taken over by smart phones. Present communication is not confined to voice or visual communication, rather it is communication 'everything' through mobile and wireless internet. These smart phones have everything ranging from smallest size of memory to the largest size of memories, incredibly fast speed compare to the older ones, excellent sound and video quality and finest quality of cameras. Talking about technology, 5G is making a noise all around and it is going to replace 4G very soon in data connectivity. The stream of technology has covered a long path to reach at this point of time. From 1G to 2.5G and from 3G to 5G this world of telecommunications has seen a number of refinements along with an upswing in performance every single time. [3]. The networks and services of 5G are going to be installed in stages over the next few years to accommodate the interdependency on mobile and inter-enabled services. The appearance of 5G in the telecommunication market will bring about a revolution within the tariff plans [1]. It will permute the manner in which the cellular plans are to be extended worldwide. It will induce the totally new experience of communication among people as their experience is going to be enhanced in an affirmative manner. The ultimate aim of this technology is to architect a real wireless world, which should be completely free from hindrances of previous generations.

### Advent of 5G technology

#### 5G

Engineered to immensely increase the speed of responsiveness of wireless communication, the fifth generation or 5G is the latest cellular technology. According to an estimate, with 5G, the data transmission rates over broadband wireless connections could travel at a speed of 20 Gbps. It will also increase the amount of data transmission over wireless systems due to availability of more bandwidth and advanced antenna systems [7]. It will also allow the mobile operators to create multiple virtual networks using a single 5G network.

In India, the first trial on 5G was conducted at Airtel's network experience Centre in Manesar, Gurugram.

Some key features of 5G are: -

- It will provide greater speed (enough to download a movie in few seconds)
- It will definitely possess greater capacity (almost 1,000 times capacity of 4G)
- Reduced Latency (i.e., stop delays)
- It is designed to provide high resolution and larger bandwidth
- It will gather networks on one platform
- Lower battery consumption
- Simultaneous connections can work together
- Provide uninterrupted and consistent connectivity.
- Allow access to parallel multiple services
- Remote place access grant

#### 5G technology requirements: -

In recent years, there have been numerous views regarding what kind of form this latest technology will take. There are two major views of what 5G technology should be:

1.Hyper Connected View: This view of requirements stresses on taking the existing technologies like 2G, 3G, 4G, Wi-Fi and other wireless systems to cover a large geographical area.

2.Next Generation Radio Access Technology: this view of requirements takes the more technology driven view and set specifications for data rates, latency and other key parameters. These requirements for 5G would enable a clear mark off between 4G and the new wireless 5G system.

By reviewing for the majority of the needs, the following 5G requirements are gaining industry acceptance:

- Needed 1-10Gbps connections to end points in the field (i.e. not theoretical maximum)
- It requires 1 millisecond end-to-end round-trip delay - latency
- It has to have 1000x bandwidth per unit area
- It can/should have 10-100x number of connected devices
- It is estimated to have 99.999% availability
- Perception of 100% coverage
- It will have 90% downfall (reduction) in network energy usage
- It has to possess up to ten-year battery life for low power, machine-type devices [9]

These widely varying requirements of 5G are making many people to assume that this new network will be an umbrella which will hold a number of different radio access networks to operate together.

Some applications of 5G will be like:

- It will be used in the form of wearable device with AI capabilities
- It will be a stakeholder for pervasive (Global) networks.
- Media independent handover
- Will be an integral part of radio resource management
- It will develop VoIP (Voice over IP) enabled device. [10]

### Journey of technology before 5G (History of technology)

#### 1G

1G is known as the first generation of the wireless communication technology launched in 1980. In 1G, the land area was divided into many sub sectors, known as cell, and there was a radio network to cover each cell with one transceiver. This generation used analog transmission techniques which were basically for voice signals. Various standards of 1G are as follows:

- Nordic Mobile Telephone (NMT)
- Total Access Communication System (TACS)
- Advance Mobile Phone Service (AMPS)

All these standards use frequency modulation techniques for transmitting voice signals and the handover decisions were taken at the Base stations (BS) [4]. Also, packet switched data was used for the transmission between wire part of connection and PSTN (Packet Switched Telephone network).

Some key points for 1G are: -

- Developed in 1980s and completed in early 1990s
- Was based on analog system
- Speed up to 2.4 kbps
- Allows user to make voice calls in 1 country.

#### 2G

The telephone technology of second generation is based on Global System for Mobile (GSM) communication. It was commercially launched in Finland on the GSM standard in 1991. It allowed much greater penetration intensity [4]. The salient features of 2G are: -

- Bandwidth use of 30 Hz to 200 Kilo Hertz (KHz)
- Services like text messages and picture messages
- Also, to avail multimedia message (MMS)
- All messages were digitally encrypted
- Helped to establish international roaming
- Uses digital signals for voice transmission
- Provides speed up to 64 kbps

2G technologies could be either of the two, one could be Time Division Multiple Access (TDMA) or Code Division Multiple Access (CDMA) [5]. CDMA is further sub categorized as GSM, PDC, iDEN, and iS-136. CDMA technology is IS-95.

Some key features about 2G are:

- It was flourished in late 1980s and completed in late 1990s
- It is based upon Digital system
- It could have speed up to 64 kbps
- It provided services such as digital voice and SMS with more clarity

It also possessed semi global facility

### 3G

The next generation which has revolutionized the communication industry is 3G i.e. the third generation. It is widely known as International Mobile Telecommunications-2000 (IMT--2000) which are standards stated by International Telecommunication union (ITU). The basic requirement for compiling to IMT-2000 standards is that the technology should provide peak data rates of at least 200Mbit/s for stationary or walking users and 348Kbit/s in a moving vehicle. The spectral efficiency of 3G was way better than 2G. This technology was invented with the purpose to meet the goal of efficient multimedia communication. The concept of IMT came into existence in the mid-1980s at ITU.

It took more than ten years for the approval of standards for the next generation systems. These standards are branded as IMT-2000. [3] Under the technical specifications the spectrum between 400 MHz and 3 GHz was dictated technically suitable for the third generation. IMT-2000 is the result of collaboration of many entities, inside the ITU (ITU-R and ITU-T), and outside the ITU (3GPP, 3GPP2, UWCC and so on). This approval has made possible the full interoperability and interworking of mobile systems [6].

It facilitates five radio interfaces based on three technologies namely FDMA, TDMA and CDMA. The accommodated radio interfaces are: IMT-DS, IMT-MC, IMT-SC, IMT-TC, IMT-FT.

The 3G technology was comprised of basically three technologies, but it was not the reason for its nomenclature as 3G. The technologies are

CDMA2000 - Code Division Multiple Access.

TD-SCDMA - Time-division Synchronous Code-division Multiple Access.

W-CDMA (UMTS) - Wideband Code Division Multiple Access.

Some key points of 3G technology are: -

- Was evolved between late 1990s & early 2000s and is prevalent in use until present day.
- In 2005, 3G was ready to live up to its performance in computer networking (WCDMA, WLAN and Bluetooth) and mobile devices area (cell phone and GPS)
- Transmission speed fluctuated from 125 kbps to 2 Mbps. It possesses superior voice quality
- Good clarity in video conference calls
- Data are sent through packet switching technology
- Voice calls are interpreted using circuit switching

- It enables quicker Communication, Internet, Mobile Television system, E-mail, PDA, information surfing, on-line shopping/ banking, Multi Media Messaging Service (MMS), 3D games, Multi-Gaming etc.

### 4G

It alludes to the fourth generation of the cellular wireless standards that super ceded the third generation. The carriers which use orthogonal frequency-division multiplexing (OFDM) instead of TDMA or CDMA are increasing their services as 4G. Standard 4G or LTE is almost seven times faster than 3G. The theoretical speed of 4G is about 1 Gbps.

Some key points of 4G are: -

- Was flourished in 2010
- It is faster and very reliable
- The speed varies up to 100 Mbps
- It possesses very high performance
- It provides feasible global roaming
- It provides both cellular and multimedia services

Comparison of all the generations on the basis of mobility, bandwidth and services provided. The entire life of humans, including food, transportation, healthcare services and professional services like banking, teaching and reservations are all provided on the internet in the form of apps (like Zomato, Myntra, Netmeds, SBI Anywhere, Indian railways etc.) With the advent and spread of 5g technology, society will be at an ease and services will be provided more efficiently and effectively in terms of speed and quality.[1]

The table below shows a fine line comparison between the 5 head technologies in communication on the basis of their quality of service, speed, bandwidth and applications.

COMPARISON OF 1G TO 5G TECHNOLOGIES					
Technology	1G	2G/3G	3G	4G	5G
Deployment	1970/1984	1980/1999	1990/2002	2000/2010	2014/2015
Bandwidth	2kbps	14-64kbps	2mbps	200mbps	>1gbps
Technology	Analog cellular	Digital cellular	Broadband/wcdma/tp technology	Unlicensed spectrum in LAA/WiMAX/5G NR	4G+WWW
Service	Mobile telephony	Digital voice,short messaging	Integrated high quality audio, video & data	Dynamic information access, variable devices	Dynamic information access, variable devices with AI capabilities
Multiplexing	FDMA	TDMA/CDMA	CDMA	CDMA	CDMA
Switching	Circuit	Circuit-switched for access network-air interface	Packet except for air interface	All packet	All packet
Core network	PSTN	PSTN	Packet network	Internet	Internet
Handoff	Horizontal	Horizontal	Horizontal	Horizontal&Vertical	Horizontal&Vertical

Fig. 1 (comparison of 1G to 5G)

## Industry and Technology

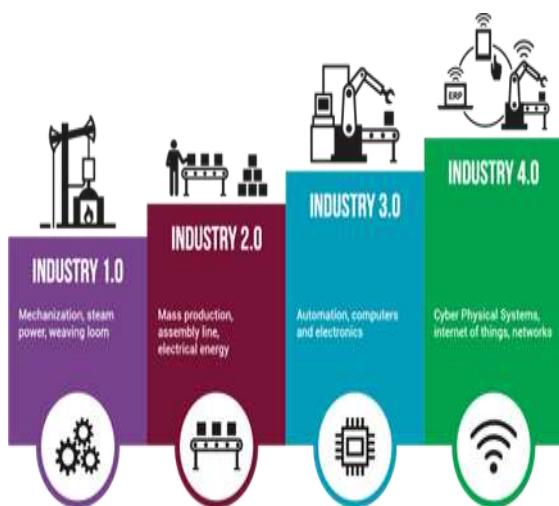


Fig. 2 (industrial revolution)

The picture above, depicts the industrial revolution from Industry 1.0 (where water and steam powered machines were developed to fuel the industries) to Industry 4.0 (where new business models, customer service, faster and efficient networks and advanced technologies are implemented).

With the introduction of 5G technology, we can think about turning goals into reality. The faster communication and reliable networking with high mobility and higher bandwidth will enable the Industry 4.0 to meet its goals efficaciously.

### Scope of 5G in India

The technologists, researchers, academicians and governments around the whole world are doing discussions and researches regarding the innovations, implementation and security concerns of 5G. Society as well as industries will be affected largely by the introduction of 5G.

Already, digital transformation has made a transition in the services and has brought about a shift in the economic models. New economic models will evolve. Life, business and services will be drastically affected, as it has happened every time a new technology paved its way in existence.

For countries like India, a big question arises that what will be the future and scope of 5G technology when still previous technologies like 3G and 4G are under process and are yet to inaugurate in many parts of the country.

It's true that still 4G is not fully flourished in India but the concept of 5G is related with IoT i.e. internet of things. India plans to roll out state of the art 5G technology in around 2020. But it is expected that the complete roll out will be near about 2022.

Additionally, for the testing of 5G, Indian government has approved a financial grant for a project to set up indigenous

5G test bed by Indian Institutes of Technology (IIT's) and Indian Institute of Science (IISc).

Some of the capabilities of 5G network will be-

1. The ability to download a full-length HD movie in seconds.
2. The quick reaction time (low latency) to enable remote robotics
3. The ability to spin up virtual networks on-demand with network slicing.
4. Battery lifetimes beyond 10 years for remote cellular devices [8]

Impact of 5G on social life-

- Automobile industry is going to be totally revolutionized by this latest technology.
- There will be more advanced health care approaches as the whole data can be clouded easily on mutual network. The combination of timely medical-grade connectivity and data integration across the care continuum will lead to radically transformed, predictive care.
- The concept of Internet of Things (IoT) will be implemented efficiently using such high speed of transmission.
- This technology is also going to help in traffic system as cars will automatically detect the ETA and will take the optimal route based on traffic data collected from other cars and roadways.

It will also generate a huge amount of revenue for the industry related to this field.

### CONCLUSION

Fifth generation communication would provide better connectivity on the vital parameters of speed, bandwidth and Quality of Services. More Indian population would get on to the digital global platform. Paper studied that it would affect our economic models. People would be able to converse better and hence would be exposed to more information. Service industry including health services, take benefit out of this seamless connectivity. These all aspects would be a big stride towards Industry 4.0. This indefectible connectivity would hit social traditions, cultures and human living largely. The paper observed that the change would be more than exponential in all the dimensions of our society which includes business, education, medical care and Industries. The paper keeps further discussion open on the real impact of 5G on all these issues.

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