5G: The Next Generation Mobile Communication Technology: An Introduction

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Abstract **-** Mobile communication technology is evolved as 1G, 2G, 3G, 4G, 5G, 6G and 7G. Every generation developed at about every decade. This paper discusses the next generation mobile communication technology named as "5G" or fifth generation mobile communication in detail. The main features or characteristics of 5G are increased capacity, improved data rate, decreased latency, and better quality of service. Each subsequent "G," or generation, of wireless technology contains higher data transmission speeds and different encoding methods than the one preceding it. The first generation, 1G, started in 1981 and was based on analog cellular technology, followed by 2G in 1992, which was digitally based. In 2001, 3G improved download speeds from 200 kilobits per second (Kbps) to a few megabits per second (Mbps). Our present network, 4G, was launched in 2009 and uses various technologies such as WiMax and Long-Term Evolution (LTE). In addition to faster download speeds, 5G is expected to facilitate the implementation and adoption of the Internet of Things (IoT), D2D and MIMO concept or technology. The new technology 5G is completely wireless and wired internet connections will become a thing of the past except fibre optics used in backhaul traffic. And in resultant telecoms companies expect to save more money in the coming future by not having to create last mile cable access for customers. The paper also presents the effects of being exposed to high frequency electromagnetic radiations of 5G on human body. In nut shell the paper introduces the principle concept, technologies and architectures used for 5G. The paper describes the major differences among wifi and 5G technology as well as the differences between 4G and 5G technology.

Keywords **-** 5G, Architecture, Working Principle, Underlying Technologies, Applications, Challenges

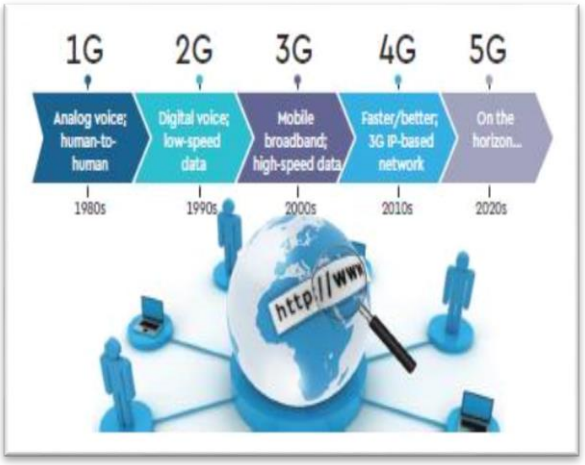
I. INTRODUCTION

This section defines and explains what 5G is, why 5G is important and how it is changing the way the world connects and communicates and how 5G works. 5G is the 5th generation mobile network. It is a new global wireless standard after 1G, 2G, 3G, and 4G networks. 5G enables a new kind of network that is designed to connect virtually everyone and everything together including machines, objects, and devices. 5G will initially operate in conjunction with existing 4G networks before evolving [[1]] to fully standalone networks in subsequent releases and coverage expansions.

Characteristics

First generation 1G is introduced in 1980s and delivered analog voice. Second generation 2G is introduced in early 1990s provided digital voice communication. Third generation 3G is introduced in early 2000 brought mobile data communication. Fourth generation 4G LTE is introduced in 2010 ushered in the era of mobile broadband. 1G, 2G, 3G, and 4G all led to 5G launched early 2019 and is designed to provide more connectivity than was ever available before. 5G is a unified, more capable air interface. It has been designed with an extended capacity to enable next-generation user experiences, empower new deployment models and deliver new services. 5G wireless technology is meant to deliver

- higher multi-Gbps peak data speeds,
- ultra low latency provides faster response time. 3G networks had a typical response time of 100 milliseconds, 4G is around 30 milliseconds and 5G will be as low as 1 millisecond [[2]]
- more reliability,
- massive network capacity,
- increased availability, and
- a more uniform user experience to more users.
- Higher performance and improved efficiency empower new user experiences and connects new industries.
- Battery life will be much longer.
- Whole world will be in *wi fi* zone.
- About 90% reduction in network energy usage.



II. 5G TECHNOLOGIES

A defining capability of 5G is that it is designed for forward compatibility—the ability to flexibly support future services that are unknown today.5G is used across three main [[3]] types of connected services, including

Enhanced mobile broadband provides better smartphones alongwith new immersive experiences such as VR and AR on faster, more uniform data rates, lower latency, and lower cost-per-bit.

Mission-critical communications 5G can enable new services that can transform industries with ultra-reliable, available, low-latency links like remote control of critical infrastructure, vehicles, and medical procedures.

Massive IoT 5G is meant to seamlessly connect a massive number of embedded sensors in virtually everything through the ability to scale down in data rates, power, and mobility—providing extremely lean and low-cost connectivity solutions. 5G will enable instantaneous connectivity to billions of devices, the Internet of Things (IoT) and a truly connected world.

A. Usage of 5G

Individuals The average consumer is expected to go from being able to consume 2.3 GB of data per month today to close to 11 GB of data per month on their smartphone in 2022. This is driven by explosive growth in video traffic as mobile is increasingly becoming the source of media and entertainment, as well as the massive growth in always-connected cloud computing and experiences.

Business Depending on the industry, some businesses can make full use of 5G capabilities, especially those needing the high speed, low latency, and network capacity that 5G is designed to provide. For example, smart factories could use 5G to run industrial Ethernet to help them increase operational productivity and precision.

Cities Smart cities could use 5G in a variety of ways to transform the lives of people living in them—primarily providing greater efficiencies like more connectivity between people and things, higher data speeds, and lower latency than ever before in areas like automotive safety, infrastructure, VR, and entertainment.

B. Applications of 5G

Application of 5G is very much equivalent to accomplishment of dream. It is integrated with beyond the limit advance features [[4]] in comparison to the previous technologies. Some of the significant applications are −

- It will make unified global standard for all.
- Network availability will be everywhere and will facilitate people to use their computer and such kind of mobile devices anywhere anytime.
- Because of the IPv6 technology, visiting care of mobile IP address will be assigned as per the connected network and geographical position.
- Its application will make world real Wi Fi zone. [[5]]
- Its cognitive radio technology will facilitate different version of radio technologies to share the same spectrum efficiently.
- Its application will facilitate people to avail radio signal at higher altitude as well.

C. 5G in India

Initial 5G services commenced in many countries in 2019 and widespread availability of 5G is expected by 2025.

For Indians to benefit from 5G services, they need access to 5G-enabled phones or other devices, and their network operators need 5G radio spectrum and 5G network equipment. [[6]][[7]]

5G networks were once expected to be launched in India by late 2020 or early 2021, but it's now highly unlikely that this could happen before mid-2021. Even if a date is soon set to auction the spectrum and the telecom companies quickly find the money to buy it, they still need to perform a lot of tests before launching commercial service. Ericsson, a network equipment vendor based in Sweden, has said 5G service is likely to be available in India only from 2022.

Reliance Jio, Airtel, Vodafone Idea is looking ahead for launching 5G, working towards its installation and implementation. [[4]]

D. How 5G works [[6]][[7]][[8]]

5G networks are designed to work in conjunction with 4G networks using a range of macro cells, small cells and dedicated in-building systems. Small cells are mini base stations designed for very localised coverage typically from 10 metres to a few hundred metres providing in-fill for a larger macro network. Small cells are essential for the 5G networks as the mmWave frequencies have a very short connection range.

Most operators will initially integrate 5G networks with existing 4G networks to provide a continuous connection. 5G network architecture illustrating 5G and 4G working together, with central and local servers providing faster content to users and low latency applications.

A mobile network has two main components, the 'Radio Access Network' and the 'Core Network'.

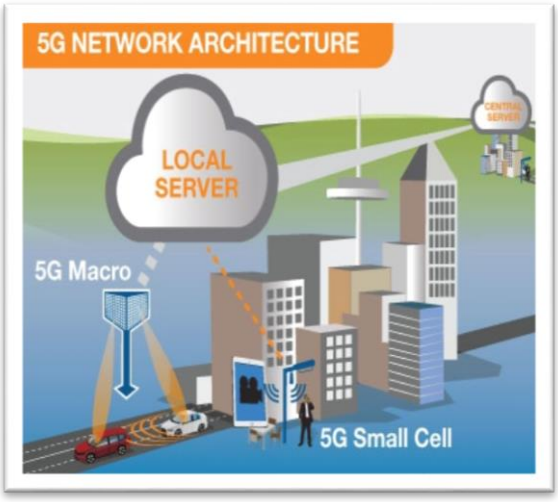
The Radio Access Network - consists of various types of facilities including small cells, towers, masts and dedicated in-building and home systems that connect mobile users and wireless devices to the main core network.

Small cells will be a major feature of 5G networks particularly at the new millimetre wave (mmWave) frequencies where the connection range is very short. To provide a continuous connection, small cells will be distributed in clusters depending on where users require connection which will complement the macro network that provides wide-area coverage.

5G Macro Cells will use MIMO (multiple input, multiple output) antennas that have multiple elements or connections to send and receive more data simultaneously. The benefit to users is that more people can simultaneously connect to the network and maintain high throughput. Where MIMO antennas use very large numbers of antenna elements they are often referred to as 'massive MIMO', however, the physical size is similar to existing 3G and 4G base station antennas.

The Core Network - is the mobile exchange and data network that manages all of the mobile voice, data and internet connections. For 5G, the 'core network' is being redesigned to better integrate with the internet and cloud based services and also includes distributed servers across the network improving response times (reducing latency).

Many of the advanced features of 5G including network function virtualization and network slicing for different applications and services, will be managed in the core. The following illustration shows examples of local cloud servers providing faster content to users (movie streaming) and low latency applications for vehicle collision avoidance systems.



Example of a local server in a 5G network providing faster connection and lower response times

Network Slicing – enables a smart way to segment the network for a particular industry, business or application. For example emergency services could operate on a network slice independently from other users.

Network Function Virtualization (NVF) - is the ability to instantiate network functions in real time at any desired location within the operator's cloud platform. Network functions that used to run on dedicated hardware for example a firewall and encryption at business premises can now operate on software on a virtual machine. NVF is crucial to enable the speed efficiency and agility to support new business applications and is an important technology for a 5G ready core. When a 5G connection is established, the User Equipment (or device) will connect to both the 4G network to provide the control signalling and to the 5G network to help provide the fast data connection by adding to the existing 4G capacity.

Where there is limited 5G coverage, the data is carried on the 4G network providing the continuous connection. Essentially with this design, the 5G network is complementing the existing 4G network.

E. Challenges of 5G [[9]][[10]][[11]]

- **Multiple Services** − Unlike other radio signal services, 5G would have a huge task to offer services to heterogeneous networks, technologies, and devices operating in different geographic regions. So, the challenge is of standardization to provide dynamic, universal, user-centric, and data-rich wireless services to fulfil the high expectation of people. **Infrastructure** − Researchers are facing technological challenges of standardization and application of 5G services.
- **Communication, Navigation, & Sensing** − These services largely depend upon the availability of radio spectrum, through which signals are transmitted. Though 5G technology has strong computational power to process the huge volume of data coming from different and distinct sources, but it needs larger infrastructure support.
- **Security and Privacy** − This is one of the most important challenges that 5G needs to ensure the protection of personal data. 5G will have to define the uncertainties related to security threats including trust, privacy, cybersecurity, which are growing across the globe.
- **Legislation of Cyberlaw** − Cybercrime and other fraud may also increase with the high speed and ubiquitous 5G technology. Therefore, legislation of the Cyberlaw is also an imperative issue, which largely is governmental and political (national as well as international issue) in nature.

III. CONCLUSION

5th generation technology is designed to provide incredible and remarkable data capabilities, unhindered call volumes, and immeasurable data broadcast within the latest mobile operating system. Hence, it is more intelligent technology, which will interconnect the entire world without limits. Likewise, our world would have universal and uninterrupted access to information, communication, and entertainment that will open a new dimension to our lives and will change

our life style meaningfully. Several researches and discussions are going on across the world among technologists, researchers, academicians, vendors, operators, and governments about the innovations, implementation, viability, and security concerns of 5G.

Moreover, governments and regulators can use this technology as an opportunity for the good governance and can create healthier environments, which will definitely encourage continuing investment in 5G, the next generation technology.

IV. REFERENCES

[1]. Aleksandar Tudzarov, Toni Janevski, " Design for 5G Mobile Network Architecture", (IJCNIS) International Journal of Communication Networks and Information Security, Vol. 3, No. 2, August 2011, Pg 112-123

[2]. Konstantinos Samdanis ,Steven Wright ,Albert Banchs AntonioCapone, MehmetUlema ,, Kazuaki Obana,"5G Network Slicing - Part 1: Concepts, Principles, and Architectures", IEEE Communications, Volume 55 , Issue 5 , May 2017

[3]. Marcin Dryjanski, "5G Core Network– Architecture, Network Functions, and Interworking", rfglobalnet, July 2019

[4]. www.qualcomm.com/

[5]. Meer Zafarullah Noohani, Kaleem Ullah Magsi,"A Review Of 5G Technology: Architecture, Security and wide Applications", International Research Journal of Engineering and Technology (IRJET), Volume 07 Issue 5, May 2020 p-ISSN: 2395-0072, e-ISSN 2395-0056

[6]. Pekka Pirinen, "A Brief Overview of 5G Research Activities", Conference Paper · November 2014

[7]. "5G: a technology vision," White Paper, Huawei, Nov. 2013. [Online]. Available: http://www.huawei.com/5gwhitepaper

[8]. M. Nader Tehrani, M. Uysal, and H. Yanikomeroglu, "Device-to-device communication in 5G cellular networks: challenges, solutions, and future directions," IEEE Commun. Mag., vol. 52, pp. 86–92, May 2014

[9]. Asvin Gohil, Hardik Modi, Shobhit K Patel, "5G technology of mobile communication: A survey", International Conference on Intelligent Systems and Signal Processing (ISSP), March 2013

[10]. Amit Kr. Jain, Rupesh Acharya, Saroj Jakhar and Tarun Mishra, "Fifth generation (5G) Wireless Technology: Revolution in Telecommunication", International Conference on Inventive Communication and Computational Technologies (ICICCT) Coimbatore, September 2018

[11]. Kelechi G. Eze, Matthew, N. O. Sadiku, Sarhan M. Musa , "5G Wireless Technology: A Primer", International Journal of Scientific Engineering and Technology ISSN 2277-1581 Volume No. 7, Issue 7, July 2018, PP 62-64