An Overview of 5G Technology

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***Abstract*— Wireless Communication has evolved over the past three to four decades, the evolution brought about major changes in the type of technology been used, the speed of data transfer, capacity latency, and network coverage, amongst several other key factors. Four generations have been established as a result of the constant improvement of Wireless Communication. Fifth Generation (5G) is referred to as the future of mobile wireless communication as it intends to provide a limitless world void of any form of a wired network using the World Wide Wireless Web (WWWW) as its main feature. This study focuses on the significant changes and improvements a succeeding generation has over the preceding generation with more emphasis on the Fifth Generation over the previous generations of wireless communication. 5G has undergone several tests to ensure that it meets its requirement, most recently, some mobile companies in China launched smartphones having 5G technology.**

Keywords—5G, Wireless Communication, generations of communication, technology, speed, latency.

I. INTRODUCTION

The era of mobile wireless communication networks emerged a few decades back which has helped in exchanging information across metropolitan areas, states, countries and even continents. Continuous improvements are being made in wireless communication as it relates to data capacity, speed, frequency, technology, latency. These changes have been categorized into Mobile Wireless Generations, there are four generations in existence.

The Mobile wireless communication's First generation (1G) was based on analog technology with a network speed of about 2.4kbps which was used for public voice service. Its Second-Generation (2G) was a digital-based technology that enabled text messaging. The major differences between 1G and 2G cellular networks according to a survey by Advanced Computer Network Lab are that 1G systems were almost purely analog and didn't have many features while 2G systems were digital that could encrypt communication to avoid eavesdropping, allowed detection and correction of identified errors, provided clear voice reception and also authorized channels that can be simultaneously shared by users. In the third generation (3G) technology, there was a significant increase in speed and capacity for data transmission, and facilities for multimedia support were developed. The fourth-generation (4G) included the internet to its' technology to provide wireless mobile internet, the size of bandwidth was increased while the cost of getting resources was made lesser [3]. Mobile wireless communication's Fifth generation (5G), is expected to be a revolutionary generation that meets all its requirements; blazing-fast connectivity speed, and is believed to be capable of sending the 4G out of vogue for the sweet user experience it will provide.

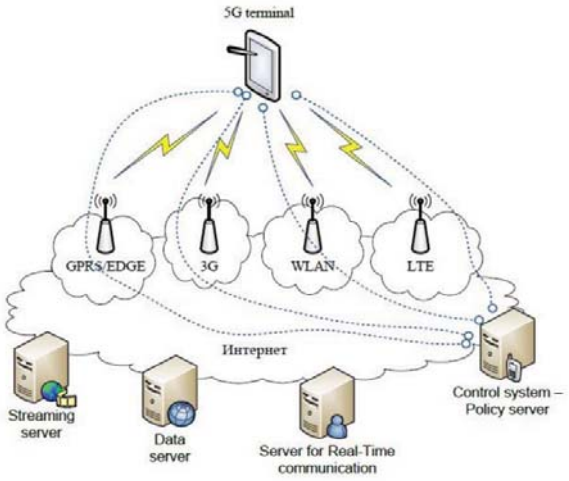
The focus of this paper is to present an overview of 5G technology and the anticipated enormous benefits it can offer in all sectors of the national economy.

II. LITERATURE REVIEW

Wireless communication has evolved over the past three to four decades with each new generation providing an advancement over the previous one(s). Mobile wireless communication started with 1G, gradually evolved into 2G, 3G, 4G, and presently at the fifth-generation (5G).

Mondal et al [10] provided in-depth knowledge on how mobile wireless communication has evolved from one generation to the next which includes improvement a successive generation has over the previous. The first generation (1G) was successful in establishing the basic mobile voice, while the capacity and coverage of communication networks were introduced in 2G technology. 3G was particular about providing increasing the speed at which data is sent which led to having a "mobile broadband" experience, which emerged by 4G. 5G's goal is to provide user terminals that can simultaneously access different wireless technologies. Generations of communication systems that will succeed 5G are presumed to make use of a satellite network. In the case of 6G, there is a presumption that mobile-calls cost will be relatively expensive. Although, in the 7G, low-income users will benefit from the decrease in cost of mobile calls.

Gupta et al [4] compared the 5G network with previous generations of wireless communication technologies and opined that the 5G will be the fastest technology (yet developed), having no access or zone limits. The proposed features and architecture of 5G will increase the quality and capacity of the system within available frequency spectrum, the frequency band is said to be 3 to 300GHz and Data Bandwidth is 1Gbps and probably higher (as demanded) successively.



Fig,1 5G Architecture [2]

Fig.1 shows the proposed all IP-based design model of the 5G mobile network architecture and its mobile networks interoperability. The model comprises of several independent, autonomous radio access technologies, and a user terminal which is a major key factor in 5G architecture.

There must be significant differences between the generations before 5G and 5G itself other than an increase in throughput, such as better coverage, Lower battery consumption and high data rates available at unit area (that is, high system spectral efficiency). 5G is expected to provide a data rate of around 1Gbps in mobility, cheaper traffic fees due to low infrastructure deployment causing an increase in peak bit rate and better cognitive radio security. Also, it is expected to provide a high capacity that allows more devices to connect concurrently, a larger number of supporting devices, better connectivity irrespective of the geographic region, and higher reliability of the communications [11].

5G has been assigned a new spectrum in mmWave bands that helps to increase its throughput, while its network capacity will significantly expand using Multiple Input Multiple Output (MIMO). The increase in demand for faster access to media services and the rapid growth of IOTs prompted the move for the development of 5G wireless communication.

This development is being led by communications companies such as Intel, Qualcomm, Nokia, Ericsson, BT, Verizon, AT&T, and Samsung [7].

The mobile wireless communication journey is an ever-evolving one and recent research on future generations distinguished the distinct improvements that 5G, 6G, and 7G will provide. According to [3], the goal of 5G technology is to have a world void of any wired networks. The hybridization of 5G and Satellite networks will lead to 6G technology but roaming or handoff will be a challenge as a result of variable technologies and standards. Hence, this challenge will lead to the development of 7G with the sole purpose of providing space roaming.

5G technology is intended for mobile users to enjoy a World Wide Wireless Web (WWWW) which is network access management-based as against using IPv6 which based on-location management. A survey report by Advanced Computer Network Lab on the generations of the wireless network indicates that it will cause resource waste of 5G wireless networks and difficult for the IPv6 to work on the WWWW. To solve this drawback, the bandwidth optimization control protocol (BOCP) and the mix-bandwidth data path were then proposed for 5G technology. The BOCP is executed after the MAC layer and comes before the TCP/IP layer, to provide the mix-bandwidth.

Some advantages of 5G over 4G include enabling applications and use cases that 4G cannot provide such as Streaming 4K video surveillant, TV services, and telemedicine., HD maps can be downloaded at a high speed to a large number connected vehicles in a city simultaneously. Also, 5G technology can sustain 4devices/m^2 with each device having a throughput of 30Mbps. For highly dense environments, 5G can support up to 200,000 devices/km^2 with 300 Mbps and 60 Mbps per device as download and upload speed respectively, as well as 1 million devices/ km2, this capacity property of 5G is referred to as massive IoT (mIoT) or massive Machine-Type Communications (mMTC). Furthermore, 5G has a latency target of under 4ms for enhanced mobile broadband (eMBB) and 0.5ms for mission-critical applications which has multiple components and interpretations. Achieving this target enables 5G to support highly delay-sensitive applications such as telemedicine and public safety, these applications are known as Ultra-Reliable, Low-Latency Communications (URLLC) applications [9].

III. ENABLER OF 5G TECHNOLOGY

Several existing techniques serve as building blocks for 5G technology. They include [6]:

1. Evolution of Existing Radio Access Technologies (RATs): 5G is a collection of RATs, rather than a distinct RAT, it is an evolution of existing RATs having unique revolutionary designs.
2. Developing Hyperdense Small-Cell: This innovative solution is called HetNet, as it can help enhance the area spectral efficiency (b/s/Hz/m^2). Also, it meets the 1000x capacity crunch, at the same time, provides extra Energy Efficiency (EE) to the system.
3. Self-Organizing Network (SON) capability: An increase in the number of small cells In 5G increases the momentum of the SON.
4. Machine Type Communication (MTC): In this kind of communication, machines are required for connectivity by one or both users.
5. Development of Millimetre-Wave RATs: Research on centimeter and millimeter waves for mobile communications is ongoing as there is increasing congestion of the sub-3 GHz spectrum and existing RATs are reaching the limit of Shannon's capacity.
6. Backhaul Links Redesign: 5G is expected to redesign the backline hauls to expand its capacity for user traffic generated while simultaneously developing on the radio access networks (RAN).
7. Energy Efficiency (EE): In the development of 5G, it is of a significant importance that the improve the design of energy-efficient approaches for RAN, User Equipment (UE) as well as backhaul links.
8. New Spectrum Allocation: This is necessary as enhancing spectral efficiency or hyper-densification cannot properly manage the 1000x traffic surge of wireless communications in the next few years.

9. Sharing of Spectrum: This process is of critical importance to avoid the time-consumption of overseeing new spectrum allocation. New modes for allocating spectrum can thus be embraced excluding traditionally-licensed or unlicensed allocation.
10. Network Virtualization of RAN: This process is also very important as it permits wireless infrastructure sharing among several operators, jointly manages both wired and wireless networks from a central orchestration unit, and improves network efficiency.

IV. BENEFITS OF 5G IN SECTORS OF NATION ECONOMY

5G technology is expected to offer innovative features over the 3GPP Long Term Evolution (LTE) solutions, providing ubiquitous, ultra-reliable, and low-latency connectivity "anywhere" and "anytime". Low latency and high-reliability wireless communication technologies are expected to become major features of wireless industrial communication systems [1].
mmWave communications, Network slicing, eV2X communications and Multi-access edge computing (MEC) are major enabling technologies expected from 5G. Network slices are virtual functions graphs implemented by required resources. The characteristics of network slices include ease of configuration, reusability for network services and security [5].
MEC concept is implemented by Network slicing to guarantee high resilience, reduced delays, energy consumption, and bandwidth consumption. These are key features in Medical Care and Automotive Services [5].
Automotive industry is expected to experience the multiple revolutionary services of 5G technology which support out-of-coverage conditions and provide new security mechanisms for authorization, authentication, and privacy. These services are presumed to support vehicle platooning, which involves dynamic grouping of vehicles to drive together at proximity; advanced driving features include sensor data, driving intentions sharing, and videos gathered from network servers, other vehicles, onboard cameras with roadside infrastructure and pedestrians[5].
The quantity of networked applications usied in the healthcare sector has rapidly incrteased with varying data of distinct types, as such, demands of convulated types are made on the network which have effect on the speed of data, latency and bandwidth.
For high-tech healthcare, the network slicing feature of 5G is expected ensure privacy and security of patient data while handling vital statistics from millions of connected devices. Also it expected offer end-to-end for condition analysis, remote medical examination, active monitoring, smart surgery and data transmission [8]
Large hospitals are experirncing rapid increase in quantity of sensor-enabled devices and machines requiring connectivity, 5G is expected to provide 10 Gbps and beyond. The sensored devices will run on technologies such as Bluetooth, Tactile Internet, Wi-Fi, and energy-efficient systems hence promote Massive-Machine Type Communication (mMTC), Low Latency Communications (URLLC) and Critical Machine Type Communication (cMTC) or Ultra Reliability for advanced robotics. High-frequency bands can be used for communication between hospitals while lower frequency-bands can be used in sub 6 GHz range for remote healthcare could accommodate coverage needs [8].
Other application areas of 5G are Mobile security Wireless cloud-based office/multiple-person videoconferencing, Smart gird, Blockchain, 3D and Ultra HD videos, and Unified global standard for all [7].

V. CONCLUSION

The mobile wireless communication network has evolved over the past four decades, ushering new eras (or generations) of wireless communication technology that attempt to meet the high-rising requirements and demands of mobile telecommunication users. Wireless mobile communication first generation (1G) technology emerged in the early 1980s, it was an analog technology with a speedup of 2 to 4kbps that provides public voice services. The second-generation (2G), came into existence in the late 1980s, having digital technology and network infrastructure supporting both digitally encrypted voice services and text messaging, its data rate was about 144kbps. The third-generation wireless system (3G), introduced around the year 2000, used Wide Brand Wireless Network and transferred data through Packet Switching, providing higher data rates for wide and local coverage areas with guaranteed internet services. The fourth-generation wireless technologies (4G) were LTE (Long Term Evolution) and WiMAX (Wireless Interoperability for Microwave Access), it supports the Quality of Service (QoS) amongst other services and provides its speed up was about 10Mbps to1Gbps. The core of 4G is integration, it integrates cellular networks and Wireless LAN with fixed internet networks. The Fifth Generation (5G) of wireless technology is designed to be a multipurpose wireless network (World-Wireless World Wide Web) that can be used for mobile, enterprise and fixed wireless applications with advanced facilities that have far better levels of connectivity and coverage. 5G has undergone several tests implementation, some mobile companies in China recently launched smartphones having 5G technology, such as Huawei (Mate X), Samsung (Galaxy S10), ZTE (Axon 10 Pro), OPPO (Reno 5G), OnePlus (7 or 7T), Xiaomi (Mi Mix 3). 5G is anticipated to be widely commercialized across several continents by the year 2020.

VI. ACKNOWLEDGMENT

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