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5G Networks: An Overview

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***Abstract* - There couldn't have been a better time than today to be in the world of technology that we live in, as this era looks forward to, "What is the next big thing we can see." In this era of evolution of Networks, it is expected to revolutionize mobile networking and pave the way for new economic opportunities. One such highest evolvement of Networks introduces us to 5G Networks. Till now, we have been experiencing fast internet services and networks like 3G, 4G whereas 5G is significantly better than these networks. 5G stands for Fifth Generation wireless technology and is the latest iteration of cellular technology. With 5G, people will experience a level of call volume, and data transmission never experienced before. Also, it can connect a lot more devices simultaneously. A commercial wireless 5G will deploy by next year. This paper will brief you about the features and characteristics of the most awaited technology that is 5G networks.**

Keywords: 5G, Networks, Cellular, Technology.

I. INTRODUCTION

Communication is the primary means by which people obtain and exchange information, and it can be through speech, wired, or wireless connection, etc. Today we are in the modern generation of communication that is "Wireless Communication. "Wireless communication technology has grown and advanced significantly over the years through research and innovations. Cellular telephone and wireless networks have made drastic growth over the last several years. The time has come when we can connect various wireless technologies, systems, and applications simultaneously. This latest technology is called 5G, which is the next generation of cellular networks to replace 4G technology. 5G moves us beyond network design for mobile devices alone towards systems that connect different types of machines operating at different speeds. 5G is expected to connect people, things, data, applications, transport systems, and cities in smart networked communication environments. It is to be faster and more efficient than 4G, and it is believed that with the help of 5G, congestion will is eliminated. 5G technology can tie together unrestricted call volumes and unlimited data broadcast within the latest mobile operating systems. The router and switch technology used in 5G provides high connectivity. With all these exciting features, 5G is believed to set the trend in the generations of networks.

Key features of 5G- High throughput, improved spectrum efficiency, reduced latency, better mobility support, and high connection density.

II. EVOLUTION FROM 1G TO 5G

1G, 2G, 3G, 4G, and 5G are the generations of wireless telecom connectivity. 1G, it is the first generation of mobile technology. The antecedent to 1G is the cellular radiotelephone. 1G used analog radio signals and FDMA techniques; however, call made from the 1G network had a poor quality, which led to the evolution of 2G and 3G networks.2G second-generation wireless telephone technology used GSM techniques that enable various services such as text messages, MMS, etc. Since 2G uses digital signals, there were more issues of network coverage in specific areas. To overcome this, 3G and 4G networks came into light. 3G allows for advanced technology, multimedia services, and extensive network capacity, and it allows a cell phone to operate on the net, 3G became the first telecom technology to provide broadband-speed internet connection on mobiles. 4G, which is also known as "beyond 3G," which will provide internet up to the speed of 1GBPS. It is said to be able to overcome the problems of weak network strength and should give a much more comprehensive network, making sure that the users get high-speed connectivity anytime and anywhere. Whereas 5G is expected to provide the fastest communication over all the other technologies by its extraordinary features.

III. WORKING OF 5G

Like the other generations of cellular network, 5G networks also consist of cells divided into sectors and send data through radio waves. Each cell is connected to a network backbone through a wired or wireless connection. With the tremendous increase in devices connecting to the internet, 5G aims to have far higher speeds available, at higher capacity per sector, and far lower latency than 4G. This generation promises a smarter, faster, and efficient network that can be achieved using various vital technologies such as millimeter waves, small cells, beam forming, MIMO, full-duplex connections, and so on.

Existing mobile networks that use lower frequency are not compatible with 5G since the bandwidth is crowded. To manage the drastic increase in devices connecting to the

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internet, communication without cross-talk and delay becomes a considerable challenge. Hence the use of millimeter waves. Opening an unused frequency area for communication enables not only smooth communication between the present set of devices but also manage any significant increase of devices due to various applications such as IoT.

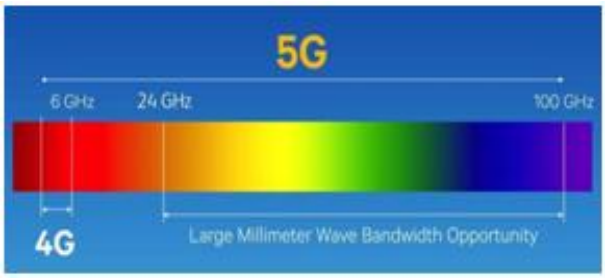

Figure 1: 5G network

In order to increase the network efficiency, the cells are subdivided to micro and picocells called small cells. Also, higher-frequency radio-waves do not provide the same coverage as their lower-frequency counterparts. Still, they do have the advantage of much higher bandwidth is available, and so support the delivery of increased capacity. Millimeter waves do not have the luxury of being able to penetrate through objects, and thus small cells are not only to improve efficiency but rather a necessity.

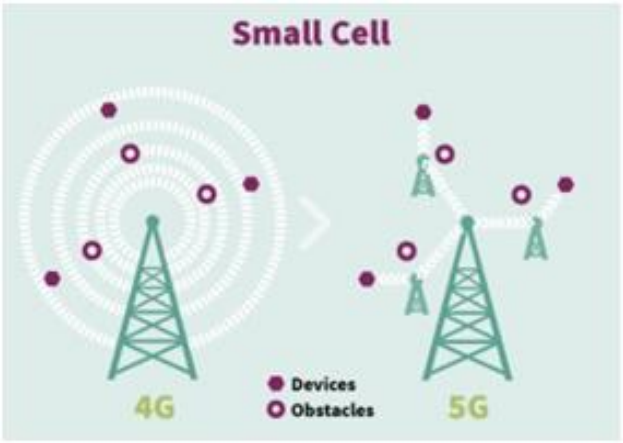

Figure 2: Small cells implementation in 5G

While using MIMO technology (Multiple Input Multiple Output) for transmission, the data stream is transmitted using multiple transmitting and receiving antennas. This, while improving the received signal, extends the possible distance, and also increases data throughput in general. Since 5G consumes more power, several hundred antennas are frequently used at a station in the case of millimeter waves. The stations are usually referred to as receiver-transmitter stations. This multiple antenna technology or sometimes referred to as Massive MIMO increases the capacity of the cellular network. Traditional antennas are used to radiate signals in all directions uniformly. If signals overlap with those from other transmitters, interference can arise to the significant damage of the signal transmission.

The Massive MIMO multiple antenna technology resolves this problem in combination with beamforming: by sending the same signal at staggered intervals using several antennas, the transmitter targets the approximate location of the user and aligns its transmission power accordingly – thus creating a signal beam or beamforming. This means that a beamforming transmitter can send individual signals to individual recipients in different directions. Therefore, there is an increase in the coverage by ensuring a more stable connection as well as higher transmission rates and radio interference.

Figure 3: Massive MIMO

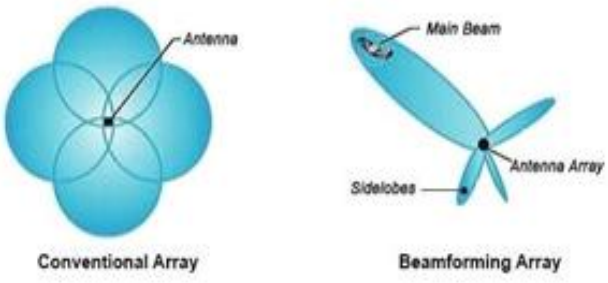

Figure 4: Signals transmission with Conventional antennas vs Beamforming

In recent days, base stations and cell phones rely on transceivers that take turns in transmitting and receiving information over the same frequency or different frequencies when transmission and receiving happen at the same time. With the help of 5G, a transceiver will be able to transmit and receive data at the same time, on the same frequency. This technology is called full-duplex and can double the capacity of wireless networks at their most fundamental layer, that is, the physical layer. This can be achieved using Silicon transistors that allow smooth travel of traffic, as shown in figure 5.

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Figure 5: Full duplex in 5G

But, there is a significant drawback to full-duplex, where it creates more signal interference, through a pesky echo. This happens when a transmitter emits a signal, and that signal is much closer to the device's antenna and, therefore, more potent than any signal it receives. Only with the help of unique echo-canceling technology, we can expect an antenna to both speak and listen at the same time.

IV. ADVANCEMENTS

Engineers aim to deliver the unimaginable with full-duplex and the various other 5G technologies. One of the few aspects that require further development includes a wireless network that future smartphone users, VR gamers, and autonomous cars will rely on every day. Already, some of the researchers and companies have set high expectations for 5G by promising ultra-low latency and record-breaking data speeds for consumers. Regardless, as the 5G future takes shape, one can see that the technology is much more than just enabling faster connections for smartphones. 5G quite literally has the potential to transform not only internet broadband service, but it will also enable new applications and use cases, from connected smart devices in the IoT to autonomous vehicles, smart cities, and connected factories; the list goes on.

V. CHALLENGES

Despite 5G offering, a significant increase in speed and bandwidth, its more limited range will require further infrastructure. The problem is those 5G antennas while being able to handle more users and data, beam out over shorter distances. Even with antennas and base stations getting smaller in this scenario, more of them would likely have to be installed on buildings or homes. Cities will probably need to install extra repeaters to spread out the waves for extended range, while also maintaining consistent speeds in denser population areas. Spreading out access to rural areas will be as much of a challenge as it was with LTE. Just as 2G phones could not connect to 3G or 4G networks, 3G and 4G phones will not connect to a 5G network. One is forced to buy a new phone, which is likely to be more expensive than the 4G/LTE service. To address these challenges, we need a drastic change in the design of cellular architecture.

VI. CONCLUSION

In this paper, we have briefly surveyed 5G technology for Mobile Communication, the transitions from the previous generations to 5G, which triggered its existence, and how it is superior to the existing Generations. Fifth-generation is an intelligent technology that interconnects the entire world without limits. It offers tremendous data capabilities and unrestricted call volumes and unlimited data broadcast together within the latest mobile operating system. Fifth-generation makes an essential difference by adding more services and benefits to the world over 4G. This generation is expected to be released around 2020. The world of universal, uninterrupted access to information, entertainment, and communication will open new dimensions to our lives and change our lifestyle significantly!

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