

Different technologies used in 5G

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ABSTRACT

The digital technologies are becoming notable and humans' search for faster ways to achieve things than the current digital status of speed. After 4G LTE-A, Introducing the next generation matrix: the 5th generation cellular network, the latest standard of telecom networks over the current 4G LTE will come across improvements in near future. In particular 5G in this paper, explains the state-of-the-art and the potentials of few enabling technologies extensively used to build the 5G network.

Keywords: 5G, MIMO Technology, Mm-Wave Technology, Small Cell Network, Beam Forming, Full-Duplex

I. INTRODUCTION

The current 4G LTE technology shines with amazing data transfer in speed and increased bandwidth. But after using 4G LTE we expect the network to provide even more reliability, better efficiency, uninterrupted connectivity and higher speed. We need access to network anywhere, anytime in this busy world. The cellular network used earlier had a lot of transformation from texting via SMS(2G), introducing internet(3G), and increase in speed, and bandwidth(4G). Now, as the technology started to stay as an intrinsic part of the humans', we are in an urge to access internet at the easiest way possible. The main idea behind introducing 5G wireless network is to get access to internet on anything anywhere, and anytime within a fraction of seconds. So, various technologies were proposed to fulfil the needs to build the expected speed within seconds. So, remodeling the current network slightly will give better access than now by increasing the connectivity with high-ended speed, and low latency. The telecom networks are working on the next generation matrix to recreate the requirements by introducing the 5G wireless technology, the Fifth- generation wireless cellular network which will see drastic changes in usage of internet. In this paper, we focus on the

concepts of different technologies needed to build the 5G network which when connected to a good cellular network (where transmission of data is over radio waves) works reliably and efficiently with Internet of Things(IoT). These technologies associated with top-notch companies have invested highly by introducing new processors, chips and basebands to carry forward different applications like self-driving cars, smart homes, smart transportations and flying drones by 2020.

II. FOCUS ON 5G

A. *Evolution of 5G:*

In earlier days wired communication was preferred for accessing the devices using cables. This was not applicable for longer distance to connect two ends from one place to another using cables and hence wireless networks were introduced to achieve the drawbacks of wired network. The following are the types of wireless networks used so far:

First Generation Cellular network(1G): These phones were introduced in 1980s and this is the first cellular phones developed with analog signals which helped us to communicate with each other through voice with good quality. They had very low-level security and the speed limit was restricted to 2.4kbps.

Second Generation Cellular network(2G): The major upgrade of cell phones from 1G to 2G was introduced in 1990s where analogue signals are converted to digital signals by introducing the concept of sharing messages, pictures through MMS, SMS and introduced to data services. Later, 2G was upgraded to 2.5G and 2.75G which introduced to slow data connections using GPRS.

Third Generation Cellular network(3G): This technology offered great flexibility than its predecessor 2G by providing more data with faster data transmission speeds of 2Mbps. It was introduced in the year 1998 offering 3G broadband connections to laptops and modems and allows data up to 14Mbps and more.

Fourth Generation Cellular Network(4G): 4G network removed spread spectrum radio technology which was used in 3G and developed higher bit rates with smart antennas. It was introduced in the year 2008 and still in existence providing amazing speed data transfer with increased bandwidth. LTE (Long Term Evolution) acted as a part of this 4G network which delivers fastest internet connection up to 10 times faster than 3G. This technology introduced to an all-IP based technology by providing data rates from 100Mbps to 1Gbps

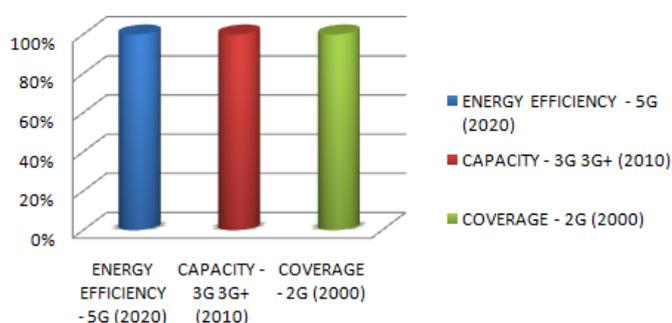


Fig 1: Generation dominance comparison of energy efficiency, capacity and coverage

Remodelling the existing technology is tough and requires a lot of testing, So the telecommunication operators are looking forward for building the next cellular network to fulfil the required features by

introducing the next generation matrix 5G. 5G is still under the testing phase where it requires to increase or produce a different bandwidth application, low latency powered with Internet of Things, and provide high-ended speed for data transfer. 5G has to satisfy these basic goals by providing global connectivity and coverage for any kind of phones, gadgets or devices. So, this cellular technology need to address and achieve this, and it is done using new methods proposed by the researchers where it involves different technologies to overcome drawbacks of previous generations.

B. Growth of fifth generation:

- What is 5G? 5G is the fifth-generation matrix which is built to provide enormous speed and energy efficiency than the existing one. This cellular network mainly focuses on users' performance to enhance the different operations, not only that, it also involves various automated machines to access them easily with great trade-off between higher speed, low latency and low power consumption. It is built upon the currently used LTE network to provide notable profits over the previous system to provide a platform for the telecommunication operators to spend money for 5G technology concept.
- Why 5G? 5G is proposed as a new concept because the previous generation matrix lacked in coverage, dropped calls, low performances at cell edges, consuming lot of data and battery, limitations to certain carriers and regions, lack of network availability, increase in radiations and poor battery life. These drawbacks have to be achieved by the upcoming cellular networks for connecting this new method by using mm-wave-technology, small cell networks, massive MIMO, beamforming, full duplex and green communication networks.

C. Proposed specifications in 5G:

There are various specifications that defines the parameter needed to meet a 5G network. The basic standard parameters suggested include

- i) Network capacity - where it should have capacity 10000 times of the current network
- ii) Peak data rate – Covering a range of 10 Gbps
- iii) Cell edge data rate- Having 100 Mbps
- iv) Latency – Showing Low latency of 10Gbps.

D. Focus to qualify for a 5G:

5G will deliver remarkably faster output, allowing productivity with download speed of 10,000 Mbps, adding greater bandwidth and can run high complex mobile applications. Switching to 5G network is a run-of-the-mill job. There is a qualification proposed by GSMA where it should satisfy at least few points of their criteria. They are:

1. One - 10Gbps connections to end points in the field
2. One millisecond end-to-end round-trip delay
3. 1000x bandwidth per unit area
4. 10 to 100x number of connected devices
5. (Perception of) 99.999 percent availability
6. (Perception of) 100 percent coverage

Secondly, NGMN (Next Generation Mobile Network) alliance, acts as the deciding authority of 5G cellular network where they proposed the connection to be based on ‘user’s experience, system performance, enhanced services, business models and management & operations’.

III. TECHNOLOGIES USED TO ENABLE 5G WIRELESS NETWORK

There are five new brand technologies which helps in developing the next generation network which will be able to handle 1000 times more traffic than today’s network and 10 times faster than the 4G LTE. They are,

A. *Millimeter-Wave technologies*: The smart phones which we use and other devices around us uses very less frequencies on the radio frequency spectrum under 6GHz. The data ranging less than the frequency started to become crowded and the

carrier cannot accept more data into it because it will lead to slow services and drops in connections. The only solution left is to expand the frequencies from the normal range by increasing the bandwidth to 30-300GHz. Researchers are broadly experimenting this technology, and also found that the system do not travel high buildings and gets absorbed by the plants and rains which lead to too much of obstacles when passing through higher frequency. To overcome this problem, another technology is associated to develop the network.

B. *Small cell network*: High power cell towers are used to connect wireless networks nowadays to broadcast signals to long distances. High frequency usage in mm-wave technology leads to obstacles. So, when we use high frequency beyond a limit we tend to lose signals. This can be solved by using 1000s of low power mini base stations which acts as the mediator between the main cell tower and to the device or application acting as a mediator. This helps in automatically switching to less base station when there’s an obstacle in getting the right signal. This can be achieved by keeping the user connected throughout the network usage.

C. *Massive MIMO*: Multiple input Multiple output is used from LTE to Wi-Fi, where antennas are fairly limited. The 4G network uses dozens of ports to control internet traffic but the MIMO ports support 100 ports which could increase the capacity by 22 or more. The extensive of use of this technology will reduce the latency and robustness to interference and intentional jamming. The cellular networks today broadcast information in all direction at once where it leads to serious interference due to cross traffics. This problem can be solved using Beam forming.

Beam forming: Beam forming acts as a traffic signaling system for cellular network signals. It does not send data in all direction and focuses stream of data to one specific user which leads to efficiency and prevents interference. This helps in

incoming and outgoing of data at one time from one access point using multiple antennas to send out the same signal. The throughput of this technology results in coherent data streaming with signal processing algorithms.

- D. *Full duplex*: The data gets transmitted in both the directions to and from on a single carrier at the same time with frequency. The duplex method helps in sending two data showing signals of same frequency without interference or using alternative frequencies at the same time where two data travel at the same time. Researchers have used silicon transistors to build a high-speed switch to allow two data to flow at the same time using signaling method.

These methods are still under the phase of implementation working progress. Other technologies are also used along with the five technologies where combining all of them is a tremendous challenge. If researchers could find the solutions to get all of them together, 5G will be arriving by the year 2020.

IV. ADVANTAGES & DISADVANTAGES IN 5G

- **Advantages:** Notably, 5G will be remarkably faster than its predecessors. This should allow for higher productivity across all capable devices with a theoretical download speed of 10,000 Mbps. "With high resolution and bi-directional large bandwidth in 5G technology which helps to merge all networks into one main platform which leads to more effectiveness and efficiency by removing the difficulties in mobile networks. Possibly to supply a huge broadcasting data (in Gigabit), which will support more than 60,000 connections and therefore, provides steady, uninterrupted, and consistent connectivity across the world. Major advantages is to bring forth easy education, medical treatment and weather detection and enabling parallel multiple services.
- **Disadvantages:** However, 5G will be expensive because of the desire to implement new device replacing the old one which in turn claims to

difficulties. In 5g technology, dependency on devices can be found which is connected to the one main network. With the addition of 5G to the wireless spectrum, this could lead to risk of overcrowding the frequency range. Since the technology is still under process which indeed is in requirement of infrastructure, security and privacy issue.

V. CONCLUSIONS

The technology shift paves way for a better cellular network connection and with just few years left for the 5G network to rule the world, it needs new chipsets, and manufacturers need to spend billions of dollars for its development. The landscape of internet changes after initializing the 5G network to have tremendous speeds in Gbps changes the perspective of digital world. 5G cellular mainly concentrates on providing smart ways to overcome the failures of 4G by providing more data connectivity with high-ended speed and transferring data with low power consumption. This fifth-generation matrix will be drop shipped successfully by relying on different spectrums and sooner it will be starting its journey to connect and widen the networked society.

VI. REFERENCES

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