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5G Network: An Insight

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Abstract- As the demands for higher speeds and more data rates are increasing day by day, the demand for some new technologies are also increasing. And to solve such emerging demand that were the lacks of previous technologies, 5G came. In this article we will be discussing the need of 5G, the technologies used in 5G and how 5G differs from its previous technologies. We'll also discuss about some of its features, advantages and the challenges faced by 5G networks.

Keywords: 5G, Beamforming, Small cell, Massive MIMO, New Radio Frequency, Latency.

I. INTRODUCTION

5G stands for "5th Generation" network. As the time passes by, there comes more and more need of more fast speed networks on which we can rely on. And there comes the thought of introducing a new generation of networks named 5G.

As the name suggests, before 5G, there has been 1G, 2G, 3G and 4G and each new generation promises to deliver faster speeds than their predecessor networks. Also, each new generation gives more new functionalities. 1G was the very first generation that introduced mobiles. Then came the 2G that gave us the functionality of texting.

3G introduced services like downloading of video, photos sharing, email access, web browsing, GPS, etc.,. 4G was a very different technology and its main focus was to provide high quality and high speed to users. It also lowered the cost of data services and callings as well as improved the security. 5G is completely reshaping both our professional and personal lives by enabling new use cases like connective vehicles, Augmented Reality and enhanced video and gaming. [1]

II. WHAT IS 5G?

5G technology is said to have major changes over 4G network. It is intended to provide extremely fast speed of data than 4G. It is going to provide lower latency and higher connection density. The aim of 5G is to provide a maximum speed of 35.46 Gbps, which is almost 35 times faster than that of 4G. It can handle thousand times more traffic than what can be handled by other networks available today.

Using 5G, we can download a high definition movie within a second. It will open the gates for virtual reality, internet of things (IoT) on large scales, autonomous driving, and much more that we cannot even imagine today. Around 100 billion devices can be connected at a time. Some technologies enforced in 5G are: Millimeter Waves, Small Cell, Massive MIMO, Beamforming and Full Duplex.

III. TECHNOLOGIES USED IN 5G

1. Massive MIMO:
MIMO stands for Multiple Input and Multiple Output.

2. Massive MIMO increases:
- Capacity density
- Sector throughput

Both of these are increased using the Multi user MIMO and large number of antennas. The base stations used in 4G can support around 12 ports for antennas that handles all of the cellular traffic. Massive MIMO have the capability of supporting 100 such ports and thereby increases the capacity and sector throughput by a large factor.

3. New Radio Frequency:

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3GPP defines air interface for 5G which is termed as New Radio. It subdivides the specification in two frequency bands with some different capabilities.

The bands are:
- **Frequency Range (FR) 1:** It is below 6 GHz
- **Frequency Range (FR) 2:** It is mmWave

4. Beamforming:
It uses the concepts of Interference. It improves the quality of signal provided by the 5G network. It shapes the radio waves so that they point to a specific direction. Antenna releases the signals at various angles.

This technology combines the signals that are at some particular angle and contrastive interference takes place and hence the combined power increases the quality of signal. The other signals that are at different angles experiences the destructive interference.

5. Small Cell:
Higher frequency millimeter waves may or may not pass through obstacles. So if they are encountered with any obstacle, we may lose our signal. And since wireless networks used are dependent on large high powered cell towers to broadcast their signals over long distances, there was a problem of obstacles as mentioned above.

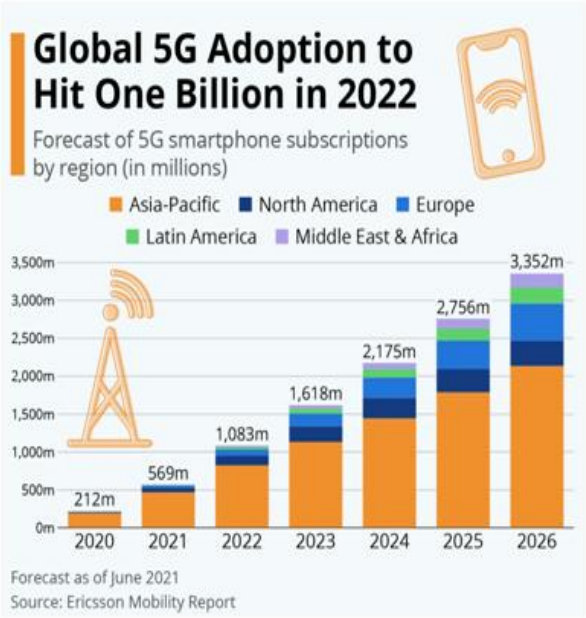

Fig 1. Region wise adaptation statistics of 5G.

To solve this kind of problem, Small Cell technology came into the picture. Each Small Cell is a low cost cellular radio access point. They are transmitters and receivers. They are used to provide network coverage in smaller areas. Small Cell technology uses thousands of low powered mini base stations that are more closer to each other than the traditional towers used to be.

These closer towers then transmits the signals around obstacles and solves the problem where signals could not travel through obstacles. They are mainly useful in cities as there are many obstacles in the form of building, towers, etc.,.

This can help us in case where we are behind any obstacle and our signal becomes very weak, then our mobile (using 5G technology of course) would automatically switch to another base station which has a better range for our device and thereby providing no connection loose.

IV. AVAILABILITY OF 5G

Till 2021, the number of cities having 5G technology available in following countries are:
- Sweden: 21
- Thailand: 24
- France: 24
- Italy: 35
- Saudi Arabia: 37
- Australia: 37
- Canada: 49
- Spain: 53
- United Kingdom: 54
- South Korea: 85
- United States: 279
- China: 34

V. LOW LATENCY OF 5G

Latency is described as the measure of delay. It is widely used in networks and determines the efficiency of network. It is the time taken for data to reach its destination across the network. Latency rate is the delay of time between sending and receiving of the data.

5G has very low latency rate. It is around 1 millisecond (for 4G, it is 200 milliseconds). This extremely low latency rate makes transmission of data across the network very fast.

VI. FEATURES OF 5G

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- Many networks can be automated.
- Broadband speed of 10Gbps can be reached.
- Will result in less traffic.
- Open the gates for virtual markets.
- Bandwidth will become large and Bi - directional.
- Lower cost for service delivery.
- Transfer of high resolutions at very fast data rate.
- Will unite wireline, wireless and satellite services under one common structure.

VII. IMPACT OF 5G IN VARIOUS FIELDS

1. Health Care:
Facility of diagnosing patients remotely and also possibilities of remote surgeries.

2. Smart Cities:
5G increases the era of IoT to a large extent and it will help in monitoring and collecting data of possibly everything like quality of air, usage of energy, traffic patterns, etc.,.

3. Cloud Computing:
5G wireless offers the potential for distributing cloud computing services much closer to users than most of Amazon's, Google's, or Microsoft's hyperscale data centers [2].

4. Smart Buildings:
With the rise of IoT in 5G, we can automate the building control like security, fire, on/off energy savers, lighting, etc.,.

5. Agriculture:
The connected devices can transform the data on crop health, chemical levels, moisture, plant health, etc., that can affect the waste reduction, cost management.

6. Manufacturing:
Manufacturing operations can become more efficient and flexible. It'll also improve the safety. Maintenance costs can also be reduced.

7. Retail:
As per the reports of 2018, after the rise of 4G LTE, above 100 million Americans purchased things using their smartphone. It is because of the ease of use and high speed network. With 5G, speed will be extremely high to the extent that it may invite virtual reality dressing rooms and thereby increasing retails.

8. Entertainment:
With 5G technology, there will be more opportunities in TV, mobile advertising, mobile media and gaming.

9. Public Safety:
Mission-critical push-to-talk (MCPTT) and mission-critical video and data are expected to be furthered in 5G. [3]

VIII. ADVANTAGES OF 5G

- Artificial Intelligence (AI) can be incorporated in our day to day lives using 5G.
- Ecosystem will be facilitated for Internet of Things.
- Because of high speed provided by 5G, cloud systems might stream the music, software updates and navigation data.
- It can help in country's digital growth and thereby raising the GDP.
- It may generate more employments in country.

IX. CHALLENGES FOR 5G

- 5G needs a frequency which should be have higher bandwidth. Building such brand new infrastructures is very costly.
- Since wavelength is inversely proportional to frequency, because of higher frequencies in 5G, it does not have power to even cross a wall. So a lot of resources are required for 5G to work properly.
- 5G has higher frequencies that may be harmful for human bodies (though not proven yet).
- Connecting to 5G network is difficult because of the type of spectrum that 5G uses.
- It may be harmful for environment because of exposure to its very high electromagnetic fields.
- Radio frequency radiation of 5G networks can have huge impact on humans as well as children (as per the findings of professor in Örebro University).
- Some companies are planning to provide 5G networks from space in lower and higher orbit of Earth. There will many such satellites for providing 5G which means more and more radiations. It can result in climate changes.
- Testing of 5G while integrating with other networks is one of the biggest issue because of the complex architecture of 5G.
- As the technology advances, there are more chances of cyber crimes.
- The frequency spectrum used by 5G is similar to other remote sensing devices. So, there's possibility that 5G waves may interfere with the

satellites that are used by weather forecasters and hinder their functioning.

- With the increase of 5G usage (mainly because of its high speed and low latency), people will rely more on internet connections. Use of IoT will also increase. In this way we will be on the path of becoming more vulnerable to cyber attacks as more data will be floating and stored in the cloud servers.
- It'll hence increase the chances for hackers to steal our data

X. 4G VS 5G

- 5G is around 100 times faster than 4G.
- Bandwidth of 5G is greater than 1 Gbps and of 4G is 200 mbps.
- Due to high latency in 4G (as compared to 5G), self driven cars using 4G are more prone to accidents. Since latency in 5G is extremely low, car can sense it's nearby object and obstacles quickly. It can also send and receive signals much quicker which will result in taking appropriate actions faster and prevent the accidents.
- With 4G, we have to face many problems in live streaming for long hours and also buffering problems in high definitions videos ex: 4K. But that will not be the case when using 5G.
- 5G has more capacity than 4G. 4G can support 10K - 100K devices per square kilometer. While in 5G, number of devices that can be connected are 1 million per square kilometer.
- Imagine a highly populated area such as a sports stadium where there are many devices. This can result in slowing down of data rates up to a very large extent. In such case, 4G cannot provide high speed to each device. But 5G solves this problem. Because of low latency and high speed of 5G, it can handle 1000 times volume of data than that could have been handled by a 4G network. We expect by gathering real data and analyzing it, some useful results can be produced [4].

XI. CONCLUSION

5G Technology is very different from its predecessors in terms of new features through very high data rates. The most significant feature of 5G that makes it best among all other networking technologies till date is its low latency.

There are still fews challenges for 5G but community is working hard to overcome those challenges and make best use of what 5G can offer.

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