

# 5G Wireless Systems: The Future

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**Abstract:** *With the 5G technology so close to its launch we will discuss is this technology really the future of the tech industry. It is supposed to be launched in the market by the end of 2020 and people are still unaware of what this actually is and how will it affect their lives and the industry of almost every sector. What is 5G? 5G is a new wireless network architecture that is expected to replace an existing wireless network architecture. This new architecture is expected to have lower power consumption, lower maintenance costs and offer high quality services. In this paper, we will look at what 5G is and how it will impact various aspects of life once released. We will also look at how 5G will impact the life of the average person and how it will change the world for better or worse. Is the world ready to accept such a dramatic shift in the way things work? Is 5G a dependable replacement? All of these questions and more are addressed in this paper based on in-depth reviews, surveys, and interviews with prominent speakers from various industries.*

**Keywords:** Wireless network architecture, 5G technology

## I. INTRODUCTION

One of the most important factor and characteristic of 5G which is promised by its makers is that the whole network will be wireless. The administrators of 5G which include transmission equipment makers, telecommunications service providers, server manufacturers and antenna manufacturers state that once all the components of 5G are deployed and are operational there will be no need of any sort of wire or cable to operate but all the communication will be done over wireless channels resulting in saving the cost of transmission of data. This will result in solving the 'last mile' which has been a transmission problem in the 4G network system. This means that in order to provide connectivity between the service provider and the consumer there will be no need of any wires but the whole process would be wireless saving up the cost of wires<sup>[1]</sup>.

The story behind all the "G's" is that it was introduced to differentiate between all the systems and technologies of mobile communications. It was made to make the transition process from one network system to another network system easy and differentiable. The transition between each network system has never been easy and it has had a lot of problems. Some of these problems are explained as:

### **Unified carrier offering converged services**

In most of the developed countries such as US an internet provider also provides the services of TV to its consumers. This relationship between the internet provider and TV is under the protection of municipally-regulated authorities that sometimes do not provide fair advantages to the cable and TV service providers. With the introduction of 5G the playing field will be levelled for all the competitors which will result in a healthy competition and as a result of that healthy competition we will get better quality of services.

### **Small cell sites**

The current 4G network consists of cell areas that take up a lot of space. A usual network cell consists of a BTS and a tower. The usual size of the cell of 4G networks range from 400 meters to 2 km and compared to that the area taken up by a 5G network cell is 400 times smaller. This means that the cell of 5G network will take up very small space as compared to the cell of a 4G network. This will result in saving a lot of resources. Another benefit will be that it will be easy to deploy such equipment in urban areas making communication with far stretched areas possible.

### **Global technology shift**

At present, the telecommunications hub of the Scandinavian countries is Finland and Sweden. The headquarters of companies like Ericsson, Nokia, etc. are located in these countries. At present, China has the best technology and innovations in the 5G field. Huawei is one of the leading vendors in China. It has made a lot of progress and is expected to be the first to roll out 5G services. This will lead to a technology shift from Scandinavia to China. <sup>[2]</sup>.

The telecom sector will undergo significant changes with the completion of 5G. It would be reasonable to draw a comparison between this transformation with the discussion of switching from the telegraph to the fax in the 19th century. The fact that 4G technology is becoming unsustainable faster than industry analysts had anticipated is one of the factors making the switch from 4G to 5G inevitable. That is to say, 5G is becoming necessary and is neither a luxury nor a commodity. There are three sets of international standards and four generations, or possibly seven, of mobile networks, according to certain analysts. While "2G" was introduced with both GSM and CDMA technology, there was no established system or well-defined name for 2G, whereas "1G" was never an official phrase. There are two main standards or systems that represent 4G, and the situation for 4G was quite similar to that of 2G. LTE and WiMAX are the names of these systems. They have both been vying for supremacy, but it appears that this war is pointless because 5G will eventually replace them both. Since engineers all have the same objective in mind for 5G, their shared perspectives on the technology have played a significant role in its continual advancement. <sup>[3]</sup>.

When the first mobile systems were introduced in 1991 -- commonly referred to as 2G / GSM -- they were all focused on large-scale mobile device communication, according to Sanjay Koratala, Senior Director of 5G Wireless Strategy and Technology for Ericsson in North America. "All of these networks were primarily aimed at consumers," he said. "Now, however, when we look at the next generation of networks -- 5G -- it's very different from the previous generation. It's a real game-changer from consumer to industry."

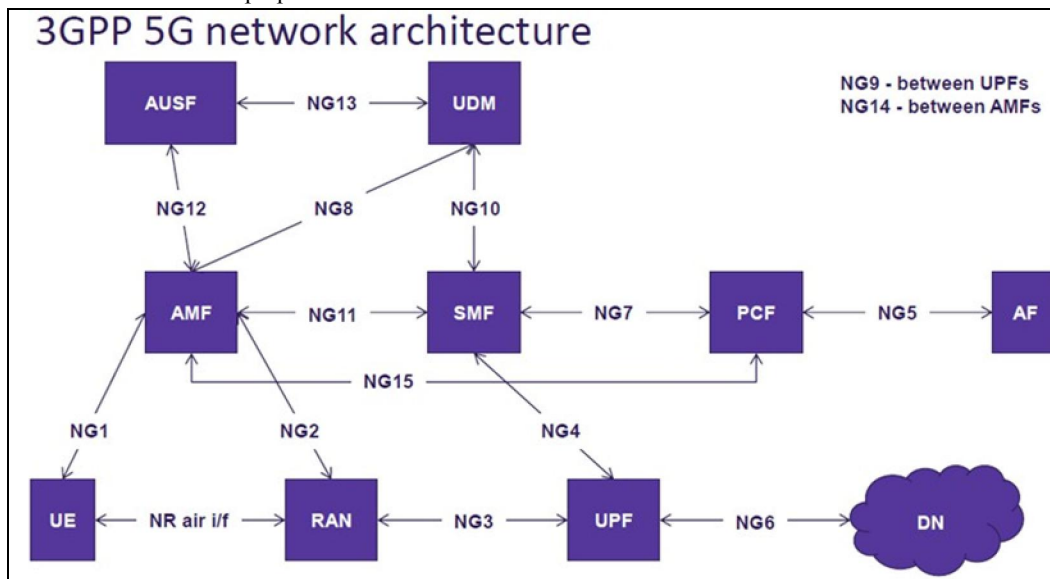
The technology behind 5G has been defined by the 3GPP, including "Release 15", "Release 16" and "Release 17". The work on Release 15 and Release 16 has been completed but the work on Release 17 has just started. 3GPP is basically an organization that has all the standard bodies of the telecommunication industry and they all have agreed to share the definition of 3G and to improve on it. Right now 3GPP consists of all technology that is specific to 5G wireless. 5G wireless standard has to be global and achieving that is a very tough task. The participating countries would want to retain their own rights and would like to have their own definition of 5G. In November 2018, the US Federal Communications Commission started a closeout for selective sections of range in the 28 GHz band, destined to be trailed by offers in the 24 GHz band, for elite use by the triumphant bidders. The next month, the FCC collectively endorsed an arrangement to make more range in the 37 GHz, 39 GHz, and 47 GHz groups accessible for the most astounding velocity interchanges level for 5G remote, called millimeter-wave (mmWave). In any case, a major component of the 5G roadmap includes many synchronous reception capabilities, some of which utilize spectrum that telcos agree to share (e.g., 3.5 GHz in the US) as well as unlicensed spectrum that controllers, such as the FCC, maintain open for everyone (regions from 5 GHz to 7 GHz, and from 57 GHz to 7much the way 802.11ac Wi-Fi gadgets do now <sup>[4]</sup>.

## **II. HOW DOES 5G WORK?**

Like the previous cellular networks 5G network uses a system based on cell sites that helps map large territory into small sectors and then send encoded data with the help of radio waves. These cell sites are interconnected and each cell site should be connected to the backbone of the network. This connection can either be wired or wireless. The encoding used by 5G networks is known as OFDM and it is sort of similar to the techniques that were used in 4G networks. The difference will be in the air interference, meaning that it will have low latency and more flexibility than LTE systems. One of the major differences of 5G from 4G is that 5G has a system that is designed to work on larger channels having more bandwidth so that they can maintain high speeds. In 5G, channels can contain 100MHz with up to 800MHz at a time, while in 4G, 20MHz channels are bonded together into up to 160MHz. This implies that in comparison to 4G, 5G will have larger transition channels [5].

5G is considered to be a more intelligent network than 4G because it has to handle many more calls than 4G, and it has to be more intelligent than previous systems because it has to manage many more calls, and its cell size is significantly smaller than previous networks. Current macro cell technology cannot support the load of 5G, and they need to increase

their capacity by around 4x to meet the demands of 5G. They can do this by using wider bandwidths, and by using advanced antenna technology. The goal of 5G is to achieve faster data processing, higher capacity per sector, and much less latency than 4G. Standard bodies and experts aim to achieve a 20Gbps speed and a latency of 1ms. 5G is based on two different types of air waves: above 6GHz and lower 6GHz. Existing Wi-Fi networks use low frequency 5G and below 6GHz. Low frequency 5G networks i.e. below 6GHz are used by existing Wi-Fi and cellular bands. This gives them the advantage of flexible encoding and massive channel sizes which provide 25 to 50 percent better and faster results than LTE. Those networks can cover the same distances as existing cellular networks and generally won't need additional cell sites. Sprint, for example, is setting up all of its new 4G cell sites as 5G ready, and it'll just flip the switch when the rest of its network is prepared.



Low-band 5G networks have great range from towers so it is best to use them for rural networks as there are less number of users in a wide spread area. In order to achieve high multi-gigabit speed carriers are using a much higher frequencies known as millimeter wave. In the existing cellular bands the spectrum is heavily used as it has a lot of traffic. Having said all that the spectrum between 28GHz and 39GHz there is a potential to create bands that can cater for big channels and very high speed transmissions. These bands have been used previously in the case of a backhaul in which their job was to connect base stations to remote internet links, but they have never been used for consumer's devices as the previous antennas and handheld processing power of the devices wasn't enough. Millimeter wave signals also drop off faster with distance than lower frequency signals do, and the massive amount of data they transfer will require more connections to landline internet. The base stations required by the cellular providers will be small and use less power as compared to using powerful macro-cells so that they are able to offer multi-gigabit speeds that have been promised to the customers. Usually the macro-cells use about 20-40W but these small stations will use 2-10W [7]. During the 4G era, these small cells that are required for rapid communication and transmission were already installed to increase the capacity of the cells. This is a fortunate thing as there will be needed to deploy new cells, which will save the deployment cost. In order to make that site a 5G compatible site they just have to add a radio. In suburban areas the carriers are having difficulty convincing the towns to add these small sites that are essential for the working of 5G. These towns caused similar problems at the times of implementation of 2G and 4G. It is easier to explain to them that this network uses sites that use less power as compared to the macro-cells that have already been working there. 2 W compared to 20W is very less. There is another type of band that is currently being used by some countries. It is known as the mid-band and it lies between the frequencies of 3.5GHz to 7GHz. This is marginally above the current band used for cellular services. This band is also being used by the satellite companies and the Navy so it is not easy to use or utilize this bandwidth but some efforts are made to use this band. The benefit of using mid-band is that it does not require as many cell sites as other bands do [8].

**III. USES OF 5G**

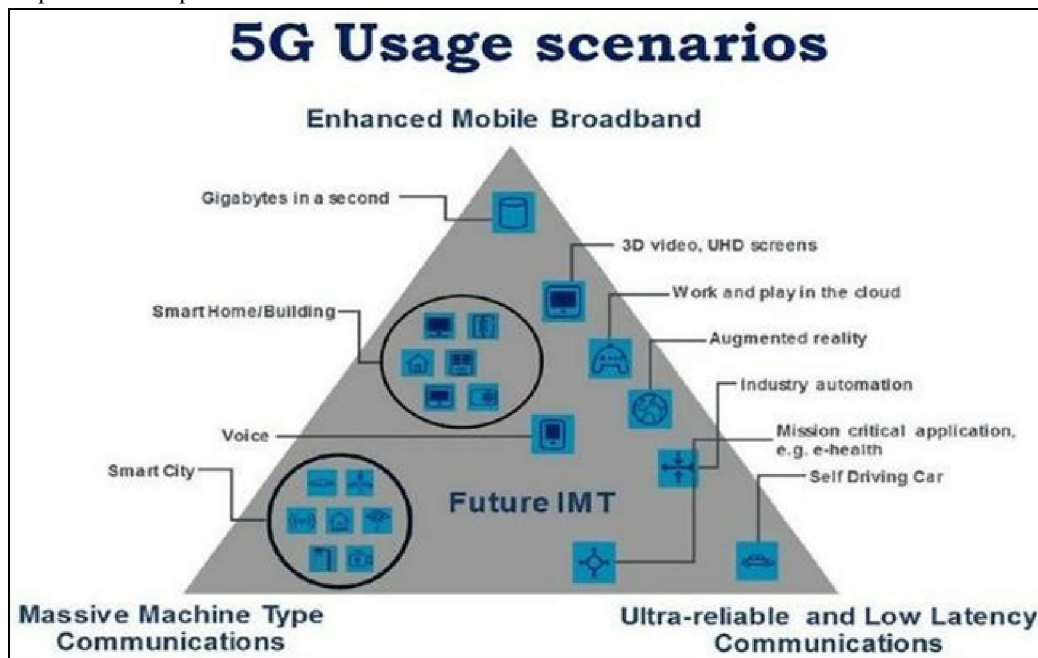
5G as a whole has a lot of advantages both in communication and data center architecture. All these advantages ultimately benefit the telecom industry and their consumers. The majority of the technical advancements made in this field are related to these three categories:

- **Spectral efficiency:** Using frequencies more efficiently such that greater bandwidths are achieved which can travel across larger distances from base stations which is the main goal of all the generations.
- **Energy efficiency:** To reduce the costs of cooling and achieving that by designing efficient technology for transmitters and servers.
- **Utilization:** In order to finance this massive change in the infrastructure for implementation of 5G the telecom industry has to come up with more ways to generate revenue and provide services such as edge computing, hosting mobile apps and add them on public cloud providers for competition<sup>[9]</sup>.

During the implementation of 4G the telecom industry realized that they need to have different classes of services that are according to the needs of their customers. This option was included in the 5G network. It offers three types of services which are according to the business model of the clients:

**1. Enhanced mobile broadband (eMBB)**

This service is mostly used in densely populated areas. Metropolitan and populated areas are provided this service in which indoors the speed is 1Gbps and outdoors the speed is 300Mbps. This can be achieved by installing high frequency antennas that cater for millimeter-wave (mmWave). These antennas are the size of a baseball so in order to cover a densely populated area we would need hundreds and thousands of them. So to cater for this they would be placed on lampposts, towers, top of buildings and even on public busses. EMBB will act as a replacement for current LTE systems that belong to 4G. It will provide omnidirectional antennas which use less power and provide us with a downlink speed of 50Mbps<sup>[10]</sup>.



**Fig 2:** Uses of 5G

**2. Massive machine type communications (MMTC)**

This service caters for machine-to-machine (M2M) and internet of things (IoT) related services. Experts in the M2M and logistics fields state that the 2G generation was best for narrow service bands and other advancements have actually made this service worse. MMTC would help cater for this problem and will do this by adding a compartmentalized

service tier that will cater for downlink bandwidth which can be as low as 100kbps and the latency will be almost 10 milliseconds.

### **3. Ultra reliable and low latency communications (URLLC)**

This service is for consumers that demand more speed and do not care much about the bandwidth especially end-to-end latency of 1ms or less. This service is mostly used by the industry that deals with autonomous vehicles where they need high speeds and ability to take decisions in no time. URLLC could also be used by the satellite industry as they can also be an application of 5G and they would most likely work on geolocation which is a replacement of GPS<sup>[11]</sup>.

Up till now we have discussed in what fields can 5G work and the technical services that it can provide. Now we will discuss the application of 5G and how it assists different industries.

#### **1. Autonomous cars**

The industry of autonomous car depends upon 5G. Basically these vehicles are self-driving cars that follow precise maps, avoid obstacles, interact with smart signs and communicate with each other. In order for these cars to work properly we need to process huge amount of data in real time and only 5G has the capacity to provide such speed, low latency levels and security. The benefits of these cars is that they help in reducing pollution but also improve driver's security. Their introduction in the market has opened up an entirely new dimension in car industry. It also save up time of the drivers as they can do other tasks while the car drives itself. Intel predicts that this industry can be worth \$7 trillion by 2050.

#### **2. Smart cities**

In future the cities will be automated and to achieve that we have to use 5G. Various new ways of transport can emerge too such as smart busses and flying drone taxi's and they all will require next-generation advanced technology which can be provided by 5G. The building will be smart meaning that they will be energy efficient and the businesses will be more automated such as smart billboards that can target the desired consumers. The data collected from smart cities can be used by the experts to see how resources are used and this can help them make decisions based on this data. 5G based cities will offer a lot of opportunities for improvement in the current systems and enable forward thinking in businesses<sup>[12]</sup>.

#### **3. IoT technology**

The Internet of Things (or IoT) will benefit a lot from the introduction of 5G as it will allow it to get billions of more connections to the internet. This will result in increase in the number of IoT devices which is an opportunity for the hardware manufacturers but the real potential lies in industrial IoT. IoT will bring revolutionary changes in the field of manufacturing, agriculture and healthcare. With the help of 5G we can perform remote surgery with the help of a robot. We can also allot personalized medicine on the basis of vitals of the patient that can be tracked with the health of wearable trackers. This ability to monitor the vitals of the patient can also help the insurance industry and they can give insurances on the basis of their lifestyles<sup>[13]</sup>.

#### **4. Immersive entertainment**

Thanks to the data capacity, speed and low latency offered by 5G we will be able to experience a new form of interactive entertainment. Such technology has also been used in sports recently such as VR which is helping making referees make the right decisions. They are also helping in improving the experience of the fans with games having Augmented Reality (AR)<sup>[14]</sup>.

#### **5. Communication and collaboration**

The basic use of 5G was to provide a stable mobile network. So in addition with providing infrastructure to other businesses it will help provide streamline communication and improve data transmission speed. 5G will help support remote working and also makes working on cloud based platforms easy and in real-time<sup>[15]</sup>

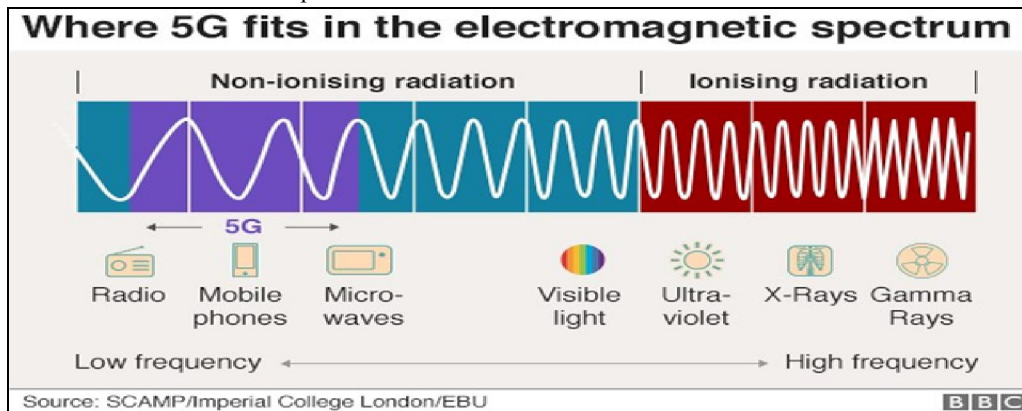


**IV. HAZARDS OF 5G**

5G networks use radio waves to carry their signals and these radio waves are a part of the electromagnetic spectrum and are transmitted between the antenna and consumer’s device. 5G devices use higher frequency as compared to the previous devices and this allows them to handle more devices and provide them internet along with higher speed levels. The 5G network requires its transmitters to be placed close to the consumers meaning that they will be close to the ground level and this results the radiations being closer to the masses and this has lead a concern among the masses that it will increase the risk of certain types of illnesses including cancer.

In 2014, the WHO stated that “no evidence has been found that mobile phone use causes adverse health effects” [16]. However, the WHO, along with the IARC, has classified all radiofrequency radiation (including mobile signals) as “potentially carcinogenic”. This is because “there is evidence that does not prove conclusively that exposure can cause cancer in humans” [17]. According to a US department of health report, when rats are exposed to high doses of radio radiations, they develop cancerous tumors in their hearts. The rats were exposed to 9 hours of mobile phone every day for 2 years.

A similar study was conducted on mice, but no tumors were found. A respected scientist noted that these studies are not comparable to humans because the exposures are



**Fig 3:** Electromagnetic spectrum

"There is some statistical evidence that heavy users of mobile phones may be at an increased risk of developing cancer," says Dr. Frank de Vocht who helps advise the government on cell phone safety. "However, the evidence for a causal relationship is not strong enough to suggest that precautionary measures should be taken."

5G radio waves aren't ionizing, meaning they don't have enough energy to break down DNA, which means they can't cause negative cell damage. This is according to research conducted by physicist and carcinologist David Robert Grimes.

According to Dr. Grimes people consider the waves of sun to be a cause of cancer, but they should know that the radio waves used by the 5G network are far less energetic as compared to the light and radiations that come from the sun. He also says that there is no evidence that mobile phones and their radiations are the cause of cancer or other health problems in humans. As we know that the 5G network antennas work on lower power levels as compared of that of 4G network so it means that they will be an improvement from the current networks. The radio frequency levels of base station are many times less than the guideline levels set by the UK government making it safe to deploy base stations [18].

**V. CONCLUSION**

5G technology is a very fast and efficient technology that cannot be considered as a luxury, but it is becoming the need of the hour as the currently existing 4G network system is failing to do its job at a very alarming rate. The future sure does belong to the 5G technology because of its high speed data transmission rates and its ability to cater for the huge amount of data in one go. This makes this system suitable for today’s world as the users on the networks are increasing day by day and we need greater bandwidths and processing speed to provide them with the services that have been

promised to them. 5G can also be used to set up new industries such as autonomous cars which, according to many experts is the next big thing. It also provides the option of smart cities that use integrated networks to make life easier. The introduction of IoT also signifies the importance of 5G and its need.

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