

# 5G Evolution & Innovation with its Applications for Future Wireless Networks

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**Abstract** - This paper gives a summary about 5G-Key Technology & Applications. 5G" is the next generation- of wireless networks. The verge of seeing what a truly "connected world" looks like. It's projected that soon there will be 6 billion people, 30 billion devices and 50 billion machines online. The 5G networks will bring much more than a simple bandwidth or "speed" improvement, higher reliability, low latency, intelligent power consumption, high device density and network slicing make it a breakthrough. The advanced communications of 5G are expected to transform three major use cases: Enhanced Mobile Broadband (eMBB), Ultra-Reliable and Low-Latency Communications (URLLC), and Massive Machine-Type Communications (mMTC) are expecting new services with various requirements, and new applications such as holographic telepresence, instant data transmission, remote surgery, minimized IoT terminals, autonomous transportation system, etc. Wide adaptation of new applications depends on how good they are supported by the network infrastructure. Only by looking ahead to 6G and 7G (take a breath) with space roaming do get a glimpse of what may be possible in the next 10 to 20 years. Also, while 5G has yet to grace us with its presence, Google Trends rates the term "6G" as the 17th most searched word in the search engines

**Key Words:** Future wireless networks, 5G, 6G, and application of 5G.

## 1. INTRODUCTION

The 5G standard promises blazingly fast broadband speeds, exponentially higher efficiencies, massive scalability, significantly lower costs for mobile and mixed networks, and ultra-low latency applications such as connected car and massive M2M and IoT applications. 5G & 6G defines a common network architecture to which all access technologies can adhere. As such, 5G & 6G will dramatically change how satellite is integrated into mainstream, achieving full interoperability within the end-to-end 5G network. We're already working in Industry 4.0. It has been known for a long time that virtual reality and augmented reality can't experience a full-on rollout until 5G catches up to it. The reason is that for AR and VR to feel like—well, reality—they need to operate at the pace of reality. 5G & 6G is the only technology fast enough to allow so many devices to connect at such high speeds that the development of these technologies will be worthwhile. Both the network promises speed. It also promises capacity; cent forecasts communications 100 times faster than current cellular connections and more bandwidth for a greater number of users. It will be more responsive, with less lag time or latency to stall operations. Many cell carriers, including Verizon and AT&T, are working on rolling out 5G applications to customers this year to avoid overloads in the LTE network, says PC Magazine. Both networks will run on three different spectrum bands rather than just one. Digital Trends lists these as low (<1GHz), mid (<6GHz) and high-band (>6GHz), and each brings a different benefit. For example, the mid-band brings greater speeds, at an estimated 1GB per.

Second at peak, with lower latency. High-band 5G, also referred to as mm Wave or millimeter wave technology, will bring speeds up to around 10Gb per second, while Super High Band 6G also referred to as wave.

Faster speed means faster data transfer, and more capacity increases the number of users or services that a network supports. The Institute of Electrical and Electronics Engineers (IEEE) forecasts that 5G will enable "high data-rate instantaneous communications, low latency, and massive connectivity." The new technology will connect massive machine-type communications between mobile-enabled, remote sensors from a variety of devices such as buildings security systems and on-board instruments in unmanned vehicles. In this paper discuss the new architecture of advance networks. The paper is organized as follows & take a look at the problems of future networks, highlighting the most important challenges. Its provide with a forecast of traffic for the next decade. It provides describe emerging new services and applications of future networks. Next, the proposed architecture of advance future network will be discussed finally.

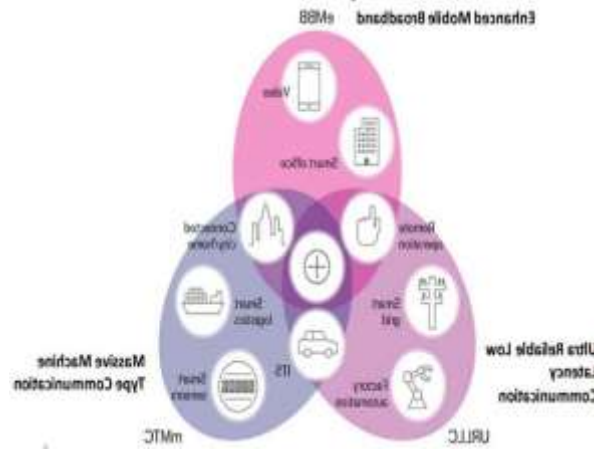


Fig.1:- 5G networks

### 1.1 Core Specification of 5G networks

#### eMBB

At first, 5G will most commonly be used for “enhanced mobile broadband,” specifically higher data bandwidth with improved but not peak latency (faster responsiveness) compared with 4G. 5G bandwidth will eventually get up to 20Gbps, with a guaranteed minimum of 100Mbps, and 5G networks will support 10,000 times the traffic of 4G networks.

#### mMTC

5G is also designed to support Massive Machine Type Communications, a way to bring billions of tiny connected devices and sensors online. The 5G standard supports an insane density of up to 1 million devices in a 0.38 square mile (or one square kilometer) area, with long range, low data rate radio signaling that can deliver 10-year battery life.

#### URLLC

Pushing 5G for purposes beyond 4G, the Ultra Reliable Low Latency Communications specification is designed for specific 5G use cases such as full car automation, factory automation, and remote-controlled surgery where reliability and responsiveness are mandatory. A 5G network will respond to URLLC requests by delivering data so quickly and reliably that responsiveness will be imperceptibly fast — 5ms end-to-end latency — and transmission errors will be lower than 1 packet loss in 100,000 packets. But bandwidth will be limited to under 10Mbps.

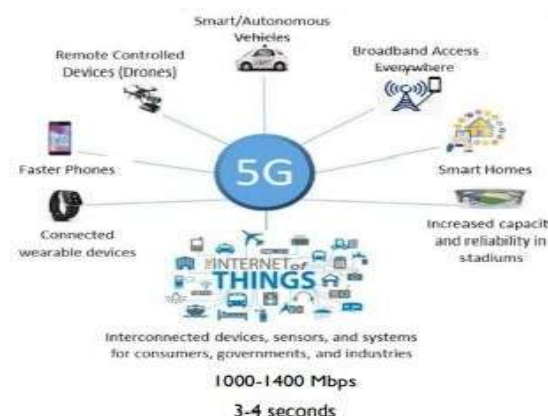


Fig.2:-Set of Specifications for the 5G Core Network

#### What is 5G Architecture consist of?

It's the next (fifth) generation of cellular technology, and it promises to greatly enhance the speed, coverage and responsiveness of wireless networks. How fast are we talking? Verizon's network showed speeds surging past 1 gigabit per

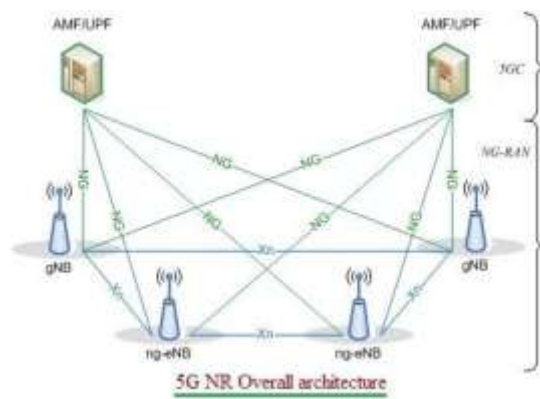
second.

That's 10 to 100 times speedier than your typical cellular connection, and even faster than anything you can get with a physical fiber-optic cable going into your house. 5G system Model explained below.

### About 5G enabling technologies 5G NR

The 5G bit is pretty obvious, but the NR stands for New Radio. 5G refers to fifth generation of wireless technology. With several years of research and testing 5G NR has been introduced recently in April, 2019. It precedes 4G LTE technology and follows same 3GPP roadmap. The specifications have been introduced from 3GPP Release 15 and beyond.

There are different phases under which 5G NR (New Radio) will be deployed as per 3GPP specifications published in the December 2017. There are two main modes viz. Non-Standalone (NSA) and Standalone (SA) based on individual or combined RAT operation in coordination with LTE. In standalone mode, UE works by 5G RAT alone and LTE RAT is not needed. In non-standalone mode, LTE is used for control (C-Plane) functions e.g. call origination, call termination, location registration etc. whereas 5G NR will focus on U-Plane alone. The figure-1 depicts 5G NR architecture.



**Fig.3:-5NR (New radio packets)**

### Millimeter wave

All cellular networks use airwaves to ferry data over the air, with standard networks using spectrum in lower-frequency bands like 700 megahertz. Generally, the higher the band or frequency, the higher the speed you can achieve. The consequence of higher frequency, however, is shorter range. To achieve those crazy-high 5G speeds, you need really, really high frequency spectrum. The millimeter wave range falls between 24 gigahertz and 100 gigahertz.

The problem with super-high-frequency spectrum, besides the short range, is it's pretty finicky -- a leaf blows the wrong way and you get interference. Forget about obstacles like walls. Companies like Verizon are working on using software and broadcasting tricks to get around these problems and ensure stable connections.

### Small cell

Traditional cellular coverage typically stems from gigantic towers littered with different radios and antennas. Those antennas are able to broadcast signals at a great distance, so you don't need a lot of them. Small cells are the opposite: backpack-size radios can be hung up on street lamps, poles, rooftops or other areas. They can broadcast a 5G signal only at a short range, so the idea is to have a large number of them in a densely packed network. Some cities have this kind of dense network in place, but if you go outside the metro area, that's where small cells become more of a challenge.

### Sub-6GHz

Given how troublesome really high-band spectrum can be (see the "millimeter wave" section above), there's a movement to embrace spectrum at a much lower frequency, or anything lower than 6GHz. The additional benefit is that carriers can use spectrum they already own to get going on 5G networks. T-Mobile, for instance, has a swath of 600MHz spectrum it plans to use to power its 5G deployment. Prior to sub-6GHz, that would've been impossible. That's why you're seeing more carriers embrace lower-frequency spectrum.

But lower-frequency spectrum has the opposite problem: While it reaches great distances, it doesn't have the same speed and capacity as millimeter wave spectrum. The ideal down the line will be for carriers to use a blend of the two.

### Gigabit LTE

You're hearing more about Gigabit LTE as a precursor to 5G. Ultimately it's about much higher speeds on the existing LTE network. But the work going toward building a Gigabit LTE network provides the foundation for 5G.

### MIMO

Multiple-input, multiple-output antenna systems coordinate two or four antennas at a time to simultaneously send data over the same radio channel, increasing data speeds. A phone might have a 4x2 MIMO system with 4 receiving (downloading) antennas and 2 transmitting (uploading) antennas, with up to an 8x8 array for 5G. To address multiple customers at once, new cell towers will include "massive" 128-antenna arrays with 64 receiving and 64 transmitting antennas.

### Carrier aggregation

Think of the FM radio in a car, and a single channel like "88.1." If your radio tunes the channel perfectly, it can pick up a single, clear audio signal — let's say it's just a voice, singing a song. Carrier aggregation enables a radio to simultaneously tune the equivalent of 88.1, 88.2, and 88.3 at once, overlapping the voice channel with a guitar channel and a drum channel in something known as "channel bonding." 5G supports aggregation of up to 16 channels at once, including mixes of separate 4G and 5G frequencies.

### QAM

Though the phrase "Quadrature Amplitude Modulation" doesn't roll off the tongue, QAM is a technology that packs additional data signals into radio waves, enabling each wave to send multiple blocks of data simultaneously. Rather than dividing each radio wave into 16 data points (16-QAM), 5G starts by packing even more data into the same wave using 64-QAM or 256-QAM. Even higher QAMs are already possible.

### Beam forming

This is a way to direct 5G signals in a specific direction, potentially giving you your own specific connection. Verizon has been using beam forming for millimeter wave spectrum, getting around obstructions like walls or trees.



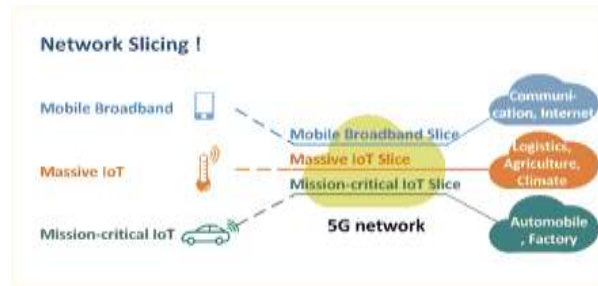
Fig.4: - Beam forming

### Unlicensed spectrum

Cellular networks all rely on what's known as licensed spectrum, which they own and purchased from the government. But the move to 5G comes with the recognition that there just isn't enough spectrum when it comes to maintaining wide coverage. So the carriers are moving to unlicensed spectrum, similar to the kind of free airwaves that our Wi-Fi networks ride on.

### Network slicing

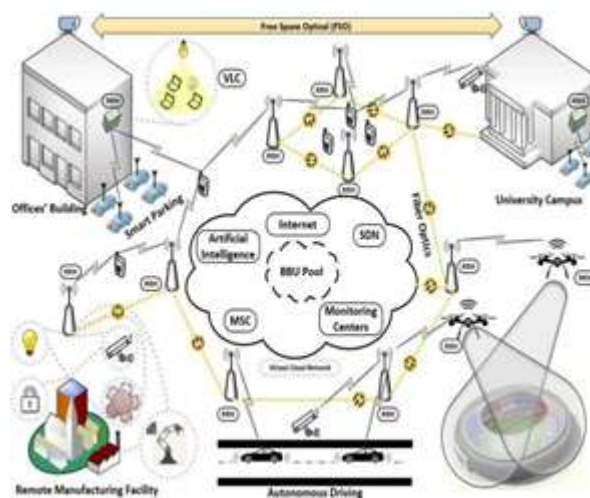
This is the ability to carve out individual slivers of spectrum to offer specific devices the kind of connection they need. For instance, the same cellular tower can offer a lower-power, slower connection to a sensor for a connected water meter in your home while at the same time offering a faster, lower- latency connection to a self-driving car that's navigating in real time.



**Fig.5: - Network Slicing**

### Future application:-

There are multiple different types of 5G technology that will be deployed by the various carriers, but in short, the technology is all about much larger slices of available spectrum and massive scale in capacity. The FCC defines 5G spectrum in four primary bands, Low-band between 600–900MHz, Mid-band between 2.5–4.2GHz also known as Sub-6, frequencies above 24GHz, otherwise known as millimeter Wave or mm Wave, and finally what it calls unlicensed spectrum, that can be accessed for a variety of dedicated uses including 5G.



**Fig.5: - 5G Application**

#### a) 5G & 6G could enable smart city infrastructure and truly autonomous driving

It will also help enable technology innovation that will require ultra-high capacity, low latency networks to be fully realized, for example smart city applications and autonomous vehicles. When you think of the city of the future, with a significant number of autonomous cars driving around, there are a number of wireless solutions that will need to be deployed to allow this futuristic vision to become a reality.

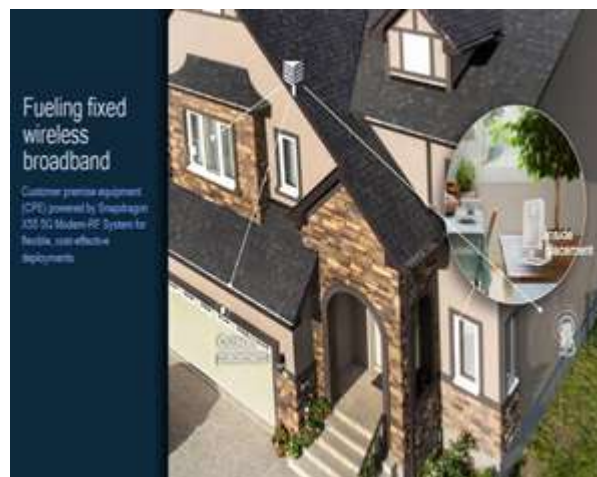


**Fig 6: - 5G for Smart Transportation**

Beyond just AI on edge devices for machine vision and machine learning, a myriad of IoT device technologies can all be integrated via 5G connectivity to enable safer, more efficient smart transportation services. Traffic signals that communicate with vehicles and vehicles that not only communicate with each other but to “everything” around them or (C-V2X, as Qualcomm likes to strap acronyms around everything), will allow safer autonomous vehicles and could, in theory at least, alleviate traffic congestion and minimize the possibility of an accident.

**b) 5G fixed wireless will reshape the broadband ISP and services landscape**

Another industry, beyond just faster smartphones, that 5G NR technologies will reshape will be residential and commercial broadband internet services. Especially in under-served areas that have issues with last mile connectivity and legacy cable/fiber internet operators, 5G technologies will enable wireless gigabit and multi-gigabit internet services in your home or office, without the need for WiFi, or in-conjunction with WiFi-6, and always-connected. 5G fixed wireless access is one of my favorite burgeoning areas of the new technology, as it will enable new levels of competition between carriers and ISPs, as well as new services with much lower latency, high speed connections for cloud computing, gaming and more. Gaming services like Google Stadia, Microsoft xCloud and NVIDIA GeForce NOW will thrive when 5G fixed wireless access becomes a reality.



**Figure: - wireless Broadband**

**c) 5G & 6G: Healthcare the future is now**

**1. Quickly transmitting large imaging files**

MRIs and other image machines are typically very large files, and often must be sent to a specialist for review. When the network is low on bandwidth, the transmission can take a long time or not send successfully. This means the patient waits even longer for treatment and providers can see fewer patients in the same amount of time.

## 2. Expanding telemedicine

According to a study by Market Research Future, the telemedicine market is expected to grow at a compound annual growth rate of 16.5% from 2017 to 2023. The study determined that the reason for the predicted increase is demand in rural areas for healthcare, as well as a rise in government initiatives. Telemedicine requires a network that can support real-time high-quality video, which often means wired networks. With 5G, healthcare systems can enable mobile networks to handle telemedicine appointments, which can greatly increase the reach of the program.

## 3. Improving AR, VR and spatial computing

While augmented reality (AR), virtual reality (VR) and spatial computing are already being used in healthcare on a limited basis, 5G may eventually further enhance a doctor's ability to deliver innovative, less invasive treatments. Among 5G's many ultimate potential applications, some of the most exciting involve its role in simulating complex medical scenarios and enabling alternative treatments for the critically ill.

AT&T is working at the forefront of this exciting field, exploring opportunities to apply 5G to medical challenges. The goal is to reduce pain and anxiety for terminally ill patients in hospice by providing calming, distracting content via 5G-enabled AR and VR.

## 4. Reliable, real-time remote monitoring

By using IoT devices, healthcare providers can monitor patients and gather data that can be used to improve personalized and preventive care. With 5G technology, which has lower latency and higher capacity, healthcare systems can offer remote monitoring for more patients. Providers can then be confident that they will receive the data they need in real time and can provide the care their patients need and expect.

## 5. Artificial intelligence

Many key healthcare functions are beginning to use artificial intelligence (AI) to determine potential diagnoses and decide on the best treatment plan for a specific patient. Additionally, AI can help predict which patients are more likely to have post-operative complications, allowing healthcare systems to provide early interventions when necessary.

The large amounts of data needed for real-time rapid learning require ultra-reliable and high-bandwidth networks.

Additionally, providers often need to access data from their mobile devices. By moving to 5G networks, healthcare organizations can use the AI tools they need to provide the best care possible – from wherever they are in the hospital or clinic.

## 2. CONCLUSION

5G technology promises to be revolutionary. Larger bandwidth and low latency times will allow the development of new services and the improvement of existing ones. Many big countries are investing huge amount of money on this project as it was having high demand in the future. It will altogether manufacture flexibility, limit, degree, comparability and meeting. Thusly, it will satisfy the growing solicitations of rising big data, cloud, machine-to-machine, and diverse applications. Our world would have universal and uninterrupted access to information, communication, and entertainment that will open a new dimension to our lives and will change our lifestyle meaningfully. The throughput of 5G gives us idea to implement the different application like IOT, Health, 3D video, remote control car driving, hologram technology images etc. The goal of 6G technology is to fulfill vision of 5G technology and in addition to meet Wisdom connection, Deep connectivity, Holographic connectivity and Ubiquitous connectivity. 5G accommodates different types of networks whereas 6G aggregates them dynamically.

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## BIOGRAPHIES



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