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5G Wireless Technology

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Abstract: After the up rise of 4G wireless mobile technology takes place; researchers, mobile operator industries representative, academic institutions have started to look into the advancement (technological) towards 5G communication networks due to some main demands that are meliorated data rates, better capacity, minimized latency and better QoS (Quality of Service). To established the 5G mobile communication technological foundation, various research works or projects entailing main mobile infrastructure manufacturers, academia and international mobile network operators have been introduced recently. Nevertheless, 5G mobile services to be made available for use, their architecture, and their performance have not been evidently explicated. In this paper, we represent thorough overview of 5G the next generation mobile technology. We mainly throws light on 5G network architecture, 5G radio spectrum, ultra-dense radio access networks (UDRAN), traffic offloading of mobile, cognitive radio (CR), software defined radio (SDR), software defined networking (SDN), mixed infrastructure, and 5G network impact on the society.
Keywords: 5G wireless technology, evolution from 4G to 5G

I. INTRODUCTION

The search engine major Google has already confirmed that the smartphone user base has surpassed the desktop userbase. If we go back a few years, the maximum RAM in a smartphone was in a few MBs only but now, even the smartphone configurations are competing with personal computers. It is evident that smartphone usage without the internet is barely minimum. With the increased dependency on IoT, internet speed plays a pivotal role.

The majority of companies think of future needs, innovations, services that could give a better life to mankind. Keeping this in mind, 5G thoughts were rolled a decade back even before the 4G technology was in place. Of course, the 4G has been a base to implement 5G. We will discuss countrywide 5G rollout further in this article.

5G simply refers to the next and newest mobile wireless standard based on the IEEE 802.11ac standard of broadband technology. Rather than faster Internet connection speeds, 5G aims at a higher capacity than current 4G LTE, allowing a higher number of mobile broadband users per area unit, and allowing consumption of data quantities in gigabyte per second. This would make it feasible for a large portion of the population to consume high-quality streaming media many hours per day on their mobile devices, also when out of reach of wifi hotspots. 5G research and development also aim at the improved support of machine to machine communication, also known as the Internet of things, aiming at a lower cost, lower battery consumption, and lower latency and to increase the security and connectivity for a large community.

II. HOW 5G WORKS

Wireless communications systems use radio frequencies (also known as spectrum) to carry information through the air.

5G operates in the same way, but uses higher radio frequencies that are less cluttered. This allows for it to carry more information at a much faster rate. These higher bands are called 'millimeter waves' (mmwaves). They were previously unused but have been opened up for licensing by regulators. They had been largely untouched by the public as the equipment to use them was largely inaccessible and expensive.

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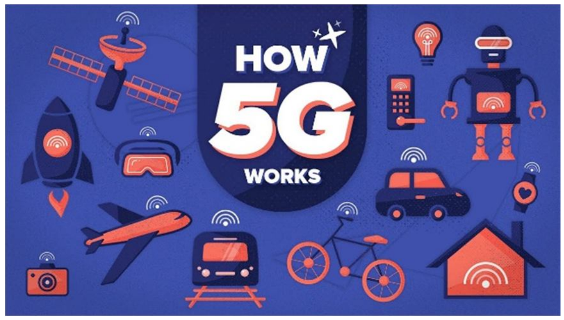


While higher bands are faster at carrying information, there can be problems with sending over large distances. They are easily blocked by physical objects such as trees and buildings. In order to circumvent this challenge, 5G will utilise multiple input and output antennae to boost signals and capacity across the wireless network.

The technology will also use smaller transmitters. Placed on buildings and street furniture, as opposed to using single stand-alone masts. Current estimates say that 5G will be able to support up to 1,000 more devices per metre than 4G.

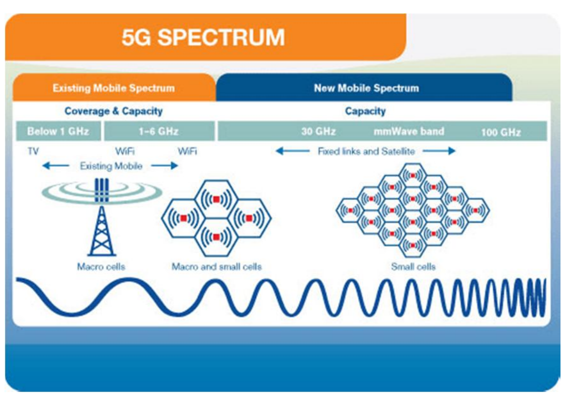
5G technology will also be able to 'slice' a physical network into multiple virtual networks. This means that operators will be able to deliver the right slice of network, depending on how it is being used, and thereby better manage their networks. This means, for example, that an operator will be able use different slice capacities depending on importance. So, a single user streaming a video would use a different slice to a business, while simpler devices could be separated from more complex and demanding applications, such as controlling autonomous vehicles.

There are also plans to allow businesses to rent their own isolated and insulated network slice in order to separate them from competing Internet traffic.

III. NETWORK ARCHITECTURE OF 5G

5G networks will require a change in architecture with respect to current technology. It must be designed to support a higher demand in video transmission, better data transmission speed, greater connectivity, low latency, low power consumption, greater mobility for communications, and of course support all smart devices that will connect to the network, with the Internet of things (IoT), among others. In order to meet these requirements, the current paradigm of communications networks must be changed [1], since current technologies have generated a bottleneck in terms of resources in the current spectrum, making it difficult to improve capacities with limited bandwidth available. There are several changes in technology that are required for this new network. This document will discuss the main technologies that will allow 5G networks to meet their objectives, wireless software-defined network, network function virtualization, milimeter wave spectrum, massive MIMO, hybrid beamforming, device to device communications.

IV. RADIO SPECTRUM FOR FIFTH GENERATION (5G)



5G carries information wirelessly through the electromagnetic spectrum, specifically the radio spectrum. Within the radio spectrum are varying levels of frequency bands, some of which are used for this next-gen technology.

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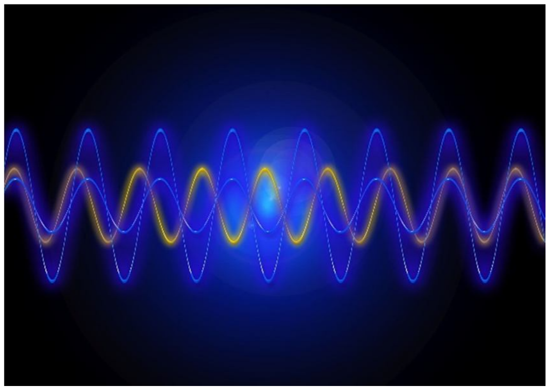
With 5G still in its early stages of implementation and not yet available in every country, you might be hearing about the 5G bandwidth spectrum, spectrum auctions, mmWave 5G, etc.

Don't worry if this is confusing. All you really need to know about 5G frequency bands is that different companies use different parts of the spectrum to transmit data. Using one part of the spectrum over another impacts both the speed of the connection and the distance it can cover.

A. Defining The 5G Spectrum



Radio wave frequencies range anywhere from 3 kilohertz (kHz) up to 300 gigahertz (GHz). Every portion of the spectrum has a range of frequencies, called a band, that go by a specific name.

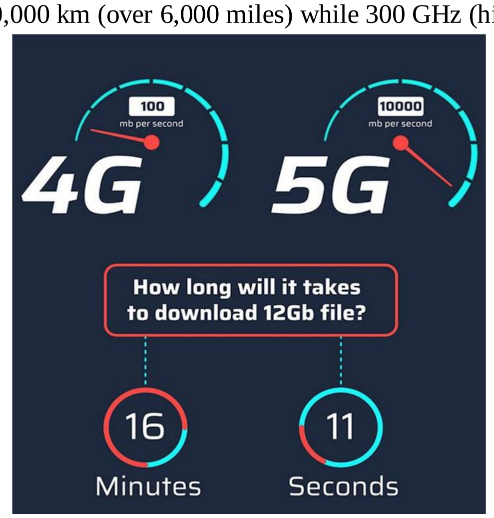
Some examples of radio spectrum bands include extremely low frequency (ELF), ultra low frequency (ULF), low frequency (LF), medium frequency (MF), ultra high frequency (UHF), and extremely high frequency (EHF).

One part of the radio spectrum has a high frequency range between 30 GHz and 300 GHz (part of the EHF band), and is often called the millimeter band (because its wavelengths range from 1-10 mm). Wavelengths in and around this band are therefore called millimeter waves (mmWaves). mmWaves are a popular choice for 5G but also has application in areas like radio astronomy, telecommunications, and radar guns.

Another part of the radio spectrum that's being used for 5G, is UHF, which is lower on the spectrum than EHF. The UHF band has a frequency range of 300 MHz to 3 GHz, and is used for everything from TV broadcasting and GPS to Wi-Fi, cordless phones, and Bluetooth.

B. Frequency Determines 5G Speed & Power

All radio waves travel at the speed of light, but not all waves react with the environment in the same way or behave the same as other waves. It's the wavelength of a particular frequency used by a 5G tower that directly impacts the speed and distance of its transmissions. Wavelength is inversely proportional to frequency (i.e., high frequencies have shorter wavelengths). For example, 30 Hz (low frequency) has a wavelength of 10,000 km (over 6,000 miles) while 300 GHz (high frequency) is just 1 mm.



When a wavelength is really short (such as the frequencies at the higher end of the spectrum), the waveform is so tiny that it can become easily distorted. This is why really high frequencies can't travel as far as lower ones.

Speed is another factor. Bandwidth is measured by the difference between the highest and lowest frequency of the signal. When you move up on the radio spectrum to reach higher bands, the range of frequencies is higher, and therefore throughput increases (i.e., you get faster download speeds).

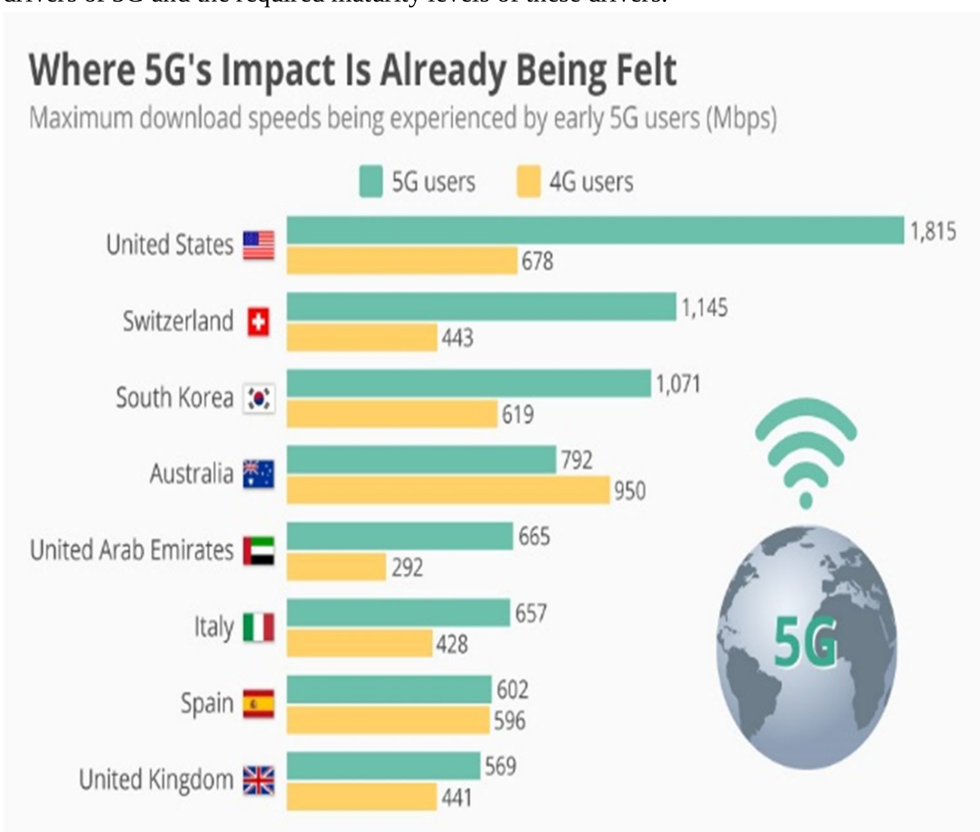
V. ULTRA-DENSE RAN

A new conception anticipated in the state of affairs of fifth generation (5G) is UDRANETs (Ultra-Dense Radio Access Networks) . Ultra-Dense Radio 1869 Access Networks are envisioned as less power access nodes a few meters apart for within door regions. The prime aim of UDRANETs will be to offer an immensely high traffic capability over highly dependable low-range knots. Ultra-Dense Radio Access Networks will probably function in the frequency range of 10-100 GHz, which has continued virtually unutilized for mercantile cell-phone networks notwithstanding its prospective to give bandwidths of hundreds of megahertz. Modern communication & access technologies have to be flourished & systemized for this sort of systems, needing spectrum apportionment studies in millimeter waves.

A. 5G Impact on Society

The positive impact of the Fourth Industrial Revolution and its related emerging technologies will be fully realized through the wide-scale deployment of 5G communication networks in combination with other connectivity solutions.

The key functional drivers of 5G will unlock a broad range of opportunities, including the optimization of service delivery, decision-making, and end-user experience. This will result in $13.2 trillion in global economic value by 2035, generating 22.3 million jobs in the 5G global value chain alone. To better understand how to realize this large estimated economic output potential, this report proposes a bottom-up approach analyzing 40 use cases that identified key industrial advances and social impact areas in addition to the main functional drivers of 5G and the required maturity levels of these drivers.



Additionally, it maps the 5G ecosystem to identify its components, its stakeholders and interdependencies, and the actions needed to accelerate 5G deployment and fully realize the potential.

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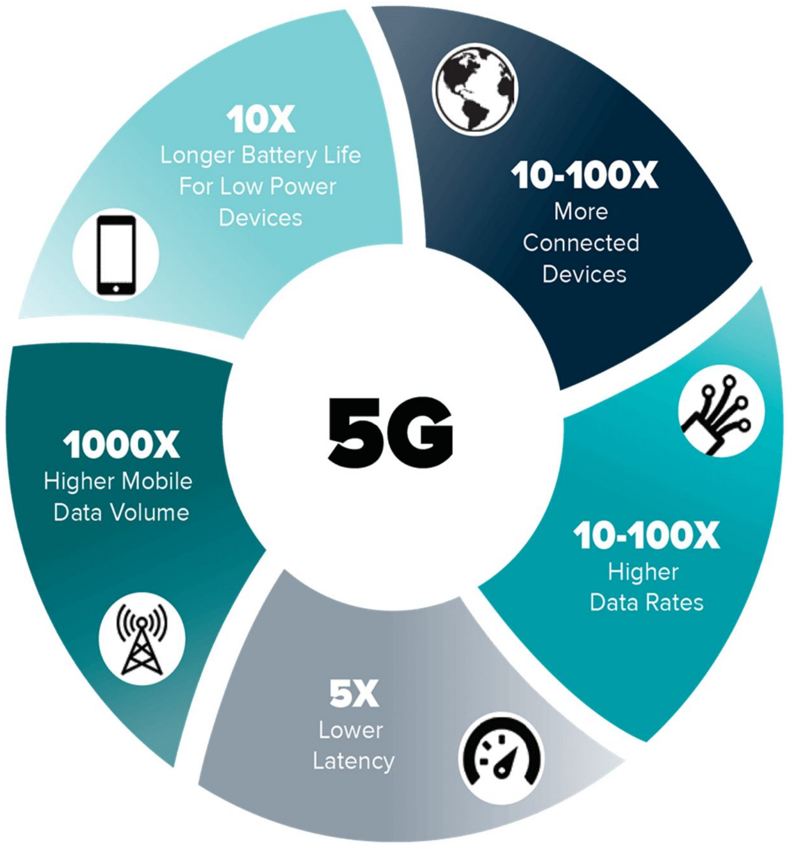
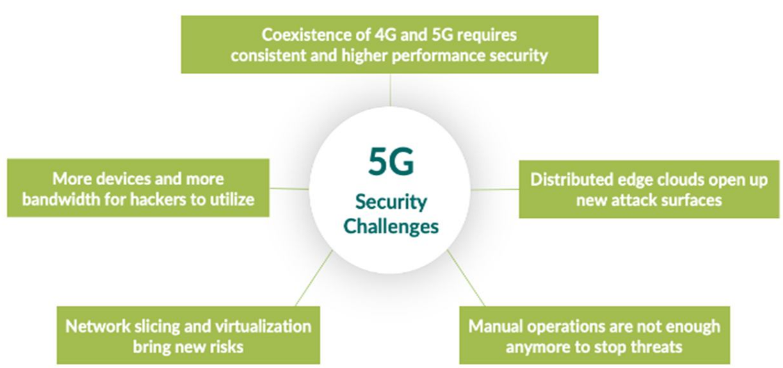
VI. CHALLENGES



Challenges The transition from 4G to 5G presents several transformational challenges which must be tackled to fully realize the 5G vision. There are challenges faced with the new technologies enabling 5G. There are also challenges with the integration of this technology to provide services in different application scenarios. Some have criticized 5G for its high projected cost and that it is incompatible with the previous generations. 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 4G/LTE service.



To address these challenges, we need a drastic change in the design of cellular architecture. We also need to meet 5G system performance requirements such Mfentocells, stringent latency, network scalability, very long battery life, and green communications. It is a challenge to satisfy these requirements and minimize costs at the same time.

VII. CONCLUSION

Over the past two decades, the world has witnessed a rapid evolution of cellular communication technologies from the Global 2G Mobile System (GSM) to the Advanced Long Term Evolution System (LTE-A) 4G. The main motivation has been the need for more bandwidth and less latency. While performance is the actual data transfer rate, latency depends largely on the processing speed of each node data flow through. Along with performance-related performance improvements, some related parameters, such as instability, interference between Channels, connectivity, scalability, energy efficiency and compatibility with legacy networks are also taken into account when developing a new mobile technology. When technology advanced from 2G GSM to the 3G universal mobile telecommunications system (UMTS), a higher network speed and faster download speed allowed real-time video calls The data rate has improved from 64 kbps in 2G to 2 Mbps in 3G and 50–100 Mbps in 4G. 5G is expected to improve not only the data transfer speed of mobile networks, but also the scalability, connectivity and energy efficiency of the network. It is assumed that by 2020, 50 billion devices will be connected to the global IP network, which seems to present a challenge. Remote operation of critical commercial equipment and machines in a reliable 5G network will be possible without delay. Real-time control of machines using mobile devices will be possible, making Internet of things (IoT) more available to everyone. Finally, but not least, network nodes that consume less energy will be needed to achieve a greener world. Therefore, the following are the most important elements in the description of 5G: high performance, low latency, high reliability, greater scalability and mobile communication technology of low consumption.

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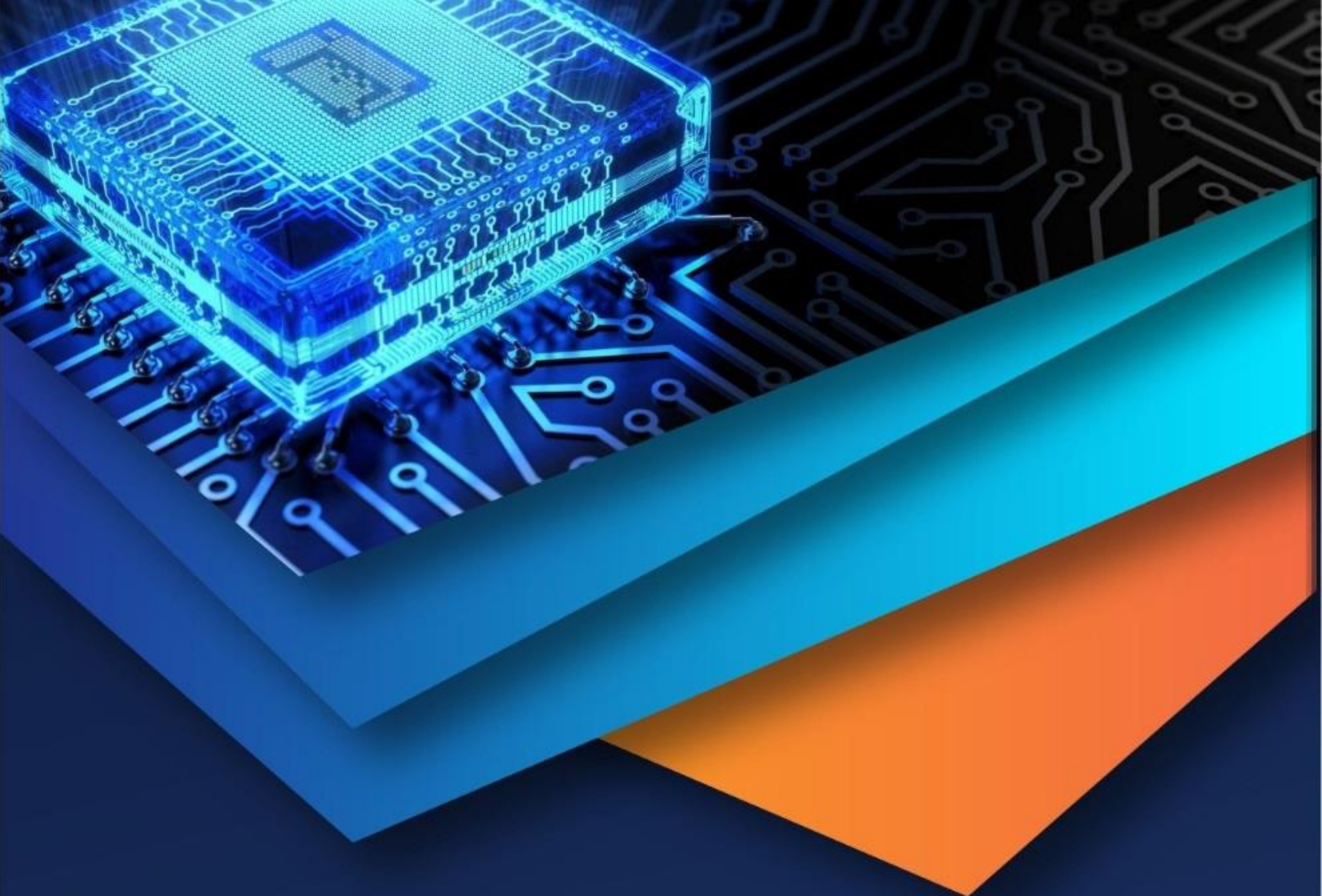

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