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Shifting Towards 6G from 5G Wireless Networks – Advancements, Opportunities and Challenges

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Abstract*: Radio waves are used in wireless communication to transmit information from one location to another. Beginning in the twenty-first century, the advancement of electronic chips, antenna, and microcontrollers caused radio wave communication to proceed more quickly, which led to the widespread use of wireless voice communication. While 6G communications gained a lot of attention from the business and academic worlds, 5G communications are still being universally adopted. Compared through 5G, 6G will have a wider frequency band, greater transmission speed, spectrum efficiency, higher connection ability, lesser delay, broader exposure, and more strong anti-interference capacity to gratify a range of network necessities. This survey presents an perceptive understanding of 6G wireless communications via introducing necessities, features, serious technologies, challenges, opportunities and applications. 6G is estimated to do better than existing wireless communication systems concerning the transmission speed, latency, global coverage etc. Even though the 5G standard have obtained various advancements, there are still a few limits within it. 6G along will provide the necessities of a entirely related planet and offers ubiquitous wireless connectivity designed for everyone. The analysis of the existing condition of wireless communication in various states, together with the projection of future research potential, are both included in this study.

Keywords: 5G, 6G, Antenna, Data Transmission, UAV, Information Security, Mobile Communication.

1. INTRODUCTION

To come down the installation and maintenance work required for wired information transfer systems, wireless communications were developed. For data communication, the standard information transfer system requires cables, wires, and conducting materials. The installation and upkeep of wired information transmission systems might be simplified with the use of wireless communications. Cables, wires, and other conducting materials are required for data

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exchange in the standard information transfer system. A wirelessly supported tool and a wireless linking medium are essential for the wireless communication method to convey data from one place to another. The kind of hardware component utilized for the purpose determines the choice or remoteness at which information may be sent. A wirelessly supported machine are essential for the wireless communication scheme to transfer data from one place to another. The kind of hardware element utilised for the purpose determines the collection or remoteness at which data may be sent.

In industrialised nations, a small number of towns had 5G network examples installed in order to learn more about how well they performed in actual use. These examples weren't freestanding because they made use of the 4G network infrastructure already in place. Following that, the technologies were revised and improved using the instruction operators acquired from the 5G installations. These updated systems are currently being used all around the world. The beyond 5G network standard will be taken into consideration by the end of 2024. In the past, the primary drivers of the enabling technologies for a expectations of complex systems were either issues brought about (or left unresolved) by the then-dominant standard or shifting promote demands as sustaining mechanism, such cellphone potential, progressed.

Future 6G standards should also predict the possibility of adapting towards and impacting replaces in the culture of corporate manner of working, including one to one, hybrid, and remote performance, as well as the cutting-edge technology that will enable them. Additionally, there are security issues, particularly given the rise of Internet of Things (IoT) frame devices. The Third Generation Partnership Project recommends utilising orthogonal frequency division multiplexing in the uplink and downlink of 5G networks despite its warnings about excessive power consumption.For IoT and some other low-power physical hardware, a 6G execution methodology for OFDM is present. [2]. When comparing the current standards to the past ones, it can be shown that a new network standard should emerge and evolve within a decade on average. By 2030, when the 5G network is anticipated to complete its capacity, several experts have projected that the 6G network will also launch, coincident with the preceding network standards' typical ten-year lifetime. Internet frameworks including the economic network, power web, internet of things, as well as the internet of all must always be simulated, as per conversations currently undergoing on the technological solutions that will support 6G[3]. For obvious sustainability concerns, low-power wide area network technology (LPWAN) will support 6G networks. Future internet will more intelligently utilise the aforementioned internet types for the 6G network standard. In the other words, machine intelligence, intelligent systems, pattern recognition, and machine learning will support and play vital roles in the holographic, information, power, and stuff web of the future. Smart, renewable distributed generation will ultimately replace the existing smart grids. The 6G technology will function with radio transmission in the THz bandwidths, in addition to photonic devices, including light-based Internet of things[4]. The 6G network standard must also identify the supporting technologies that are appropriate, enduring, secure, and affordable for hybrid working. Holographic radio communication technology, for instance, is a significant example.

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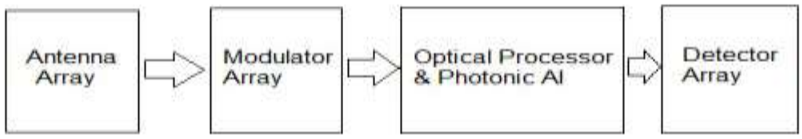

Figure : Holographic Radio System

Current Wireless Communication Systems: Achievements and Limitations

The wireless communication systems are economical since they don't need any extra infrastructure for data transfer. The effort required to deploy communication equipment over walls and other obstructions is further reduced by the use of wireless technology. When demand is low, 6G will start reducing the capacity as well as shut down components to become substantially more energy-efficient. Along with other parameters such as capacity, maximum data rate, congestion, and durability, energy efficiency will be an important design criterion in 6G networks.. In addition, the wireless connection protocol enables remote operation of the modules and equipment. The wireless gadgets may be able to function correctly when moving continuously in some applications. However, ambient interferences and other powerful radio waves passing close by the main device have a profound impact on wireless communication equipment [5]. Similar to this, as data is carried across an open air medium by wireless communication devices, security hazard is one of their key disadvantages. With a cell phone currently, you can enjoy a convenient and simple life, but even more than three billion individuals worldwide are still lacking access to the Internet connection. The high cost of installing base stations and optical fibre cables along with the geographical situation lead to the failure of system design in distant areas. In the 6G era, every edge gadget is anticipated to have a Connection to the internet and often employ AI software. The majority of AI applications are data-driven, which raises questions about how secure and private the data that is gathered is. For instance, gadgets may regularly capture sensitive and private information about a client's health. If the data are made public, the clients' privacy may be at jeopardy [1]. Along with a variety of other security and privacy concerns, the difficulties of edge AI, and the requirement to broaden edge computing and AI-based security techniques, the effectiveness of adversarial attacks against deep learning models is also explored. To achieve the objective of 100% coverage worldwide in the 6G era, the storage integrated network should be established. To establish a space-Earth integration network, base stations should be positioned on platforms inside the high stratosphere and on Satellites, which can fully deliver signal strength to specific distant regions. In general, this technique looks into the possibilities of several new applications. The terahertz frequency band, which covers the range from 100GHz to 10THz, will be utilized during the 6G era. It has a substantial bandwidth but has never been employed. Thus, there are no limitations on how it can be usedTerahertz is anticipated to suffer the same challenges as millimetre wave does today, including poor range, costly installation, an unexplored ecosystem of interfaces, and more, in the 6G era. The global telecommunications industry must seek a solution to these issues. Nowadays, artificial intelligence (AI) is used in many different fields, like machine translation, picture and voice recognition, and many more. As network services evolve, higher standards for network throughput, delay, and customer experience are first and foremost needed. In an effort to get around these challenges, network operators and equipment manufacturers are attempting to embed AI into the network to assist

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network automation and intelligent transformation. The future artificial intelligence service in the 5G and 6G periods must therefore connect AI with networks' crucial resource, radio spectrum [6In the digital era, radio spectrum is an essential transporter of innovation. Dynamic spectrum sharing methods will therefore be investigated for the 6G era. By implementing AI, block chain, and other pertinent technologies, the wireless industry is seeking to govern and distribute the spectrum in a more intelligent and flexible manner. Massive MIMO is developing in the meantime to boost the economy. Low latency, excellent dependability, vast bandwidth, and in particular network security are components of the 5G value today.

Difference between 5G and 6G

A comparison between 5G and 6G communications is shown in this table. We begin by supposing that the electrical potential of 5G was formerly on the edge of occurring due to advancements in massive MIMO, network compression, as well as millimetre wave propagation, for example, as well as a number of classical multiplexed approaches adopted from 5G. [7]. Due to the restricted Shannon constraints, it is unlikely that the signal strength in 6G will grow considerably. On the other hand, modern 6G communications technology need to significantly enhance confidentiality, privacy, and secrecy. The characteristics of 5G and 6G networks are contrasted in Table 1.

Table 1. 5G vs 6G Comparision

Major Factors	**5G**	**6G**
Data Rate	~15 Gb/sec	100 Gb/sec
Traffic Density	10 Tb/sec/km^2	100 Tb/sec/km^2
Latency	5 ms	1 ms
Bandwidth	~ 300 MHz	20 GHz
Mobility	~ 350 km/hr	1000km/hr
Coverage	70%	99%
Reliability	99%	>99.99%
Connection Density	10^6 / km^2	10^8 km^2

Analysis on Present Wireless Networks

The stage of broadband mobile telephony that comes before 5G that supersedes 3G and 4G. The 4G wireless mobile technology was established by the International Telecommunication Union (ITU), which also defines its key components, including transmission methods and data speed. With every generation, wireless cellular technologies has advanced in terms of communication channels and available bandwidth[8]. In contrast to the top speed of 14 Mbps that 3G offered, customers of 4G may enjoy rates of up to 100 Mbps. At 4G download speeds, wireless users can access high-definition audio and video. A fixed, cable connection from an ISP is not necessary for internet access thanks to 4G's ability for wireless broadband services (ISP). A 4G connection provides mobile devices to communicate to wireless services in the simplest form by transmitting over radio transmissions with such an antenna. The reception and transmission features of 4G are made possible by MIMO (Multiple Input Multiple Output)

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and orthogonal frequency division multiplexing (OFDM) technology. MIMO as well as OFDM both provide more bandwidth and throughput as comparable to 3G. The two main 3G technologies, TDMA (Time Division Multiple Access) and CDMA, perform slower than OFDM (Code Division Multiple Access). Compared to 3G, 4G has reduced network congestion since MIMO can accommodate more users[9].

Difference between 4G and 4G LTE?

The key distinctions between 4G and 4G LTE are the marketing approach and evolution of the 4G System communication. LTE was initially developed to assist carriers in the transition from 3G to 4G.

Mobile carriers and equipment were not yet equipped to support 4G's bandwidth and scientific requirements when the ITU first designated it in 2008. While LTE temporarily surpasses 3G in terms of capacity, it falls short of the 100 Mbps full bandwidth network throughput requirement that 4G promises.

Benefits of moving to 5G

5G is the upcoming development in mobile service technology. It promises to give improved speed at peak rates up to 20 Gbps, which is much more than the 100 Mbps required by 4G. Beyond increased bandwidth, switching to 5G has other benefits.

Additional advantages of 5G include:

Reduced latency - 5G allows for faster, more efficient communications. 5G latency is anticipated to be lower than 1 millisecond, as opposed to the 60 to 90 milliseconds that 4G is capable of.

Less congestion - 5G offers less interference problems than 4G provides. The OFDM signal-splitting method is used by both 4G and 5G networks. The 100 to 800 MHz channels of 5G offer better capacity and lower latency than the 20 MHz channels of 4G.

Power consumption - In comparison to 4G, 5G has the ability to use less energy in consumer electronics and smartphones, which could result in longer battery life. Figure 3 illustrates the improvement in data speed from 3G to 5G networks.

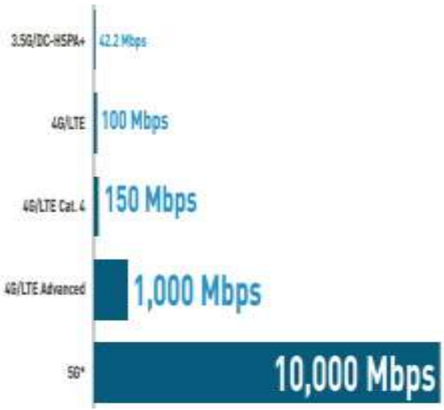

Figure 2 Data speed in 4G and 5G Networks

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6G connectivity vision

The four main ideas that make up the 6G concept are Smart Interconnectivity, Deeper Accessibility, Holographic Communication, and Ubiquitous Connectivity. These four important elements build the 6G general vision of "Wherever you think, everything follows your heart". According to our analysis, the choice to build a 6G network utilizing artificial intelligence technology will be inevitable, and Smarter Linkage will be a key component of this network. Bigger, more connections, a greater range of interfaces and network devices, and more complex and varied business models are some of the issues that 6G networks will face[10]. Smart interconnectivity will concurrently satisfy two requirements: first, all interconnected network devices will be smart, as will the services that sustain them; second, the huge and complex network itself will demand efficient management.The connection concept for 6G networks is depicted in figure.

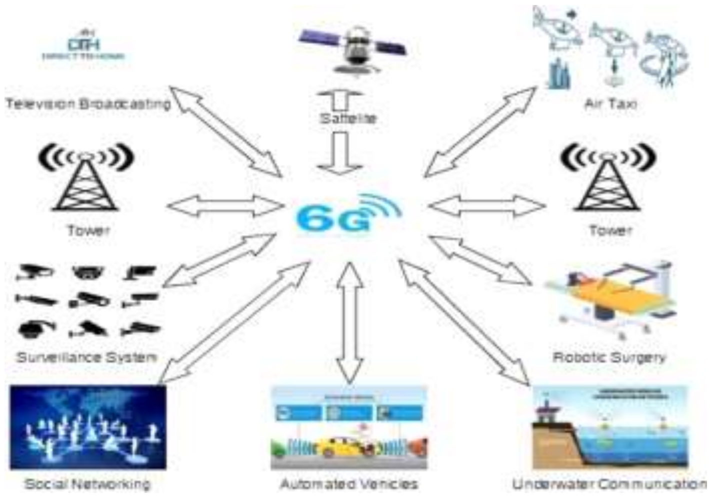

Figure.3 6G Connectivity in Wireless Network

The three other crucial components of the 6G network are profound connection, holographic accessibility, and core networks. Each of these features will have Smart Connectivity at its foundation. The access requirements for 6G networks are anticipated to change from deep coverage to deeper interconnectivity over the next ten years, or around 2030. These qualities can be summed up as follows: The haptic connection, machine learning and cognitive computing, massive data mining, deeper psyche, teleportation, and mental communication are some examples of intense detecting[11]. Directional multimedia will rule broadcast connectivity around 2030, combined with better resolution AR/VR interactions, holographic exchange of information, and wireless true holographic connectivity. Strong AR/VR will be widely available, together with holographic connection and representation that can be accessed whenever and wherever, in order to fulfil the communication aim of so-called holographic connection. This will allow individuals to experience completely immersed holographic interactive experiences. A huge globe will become more and more accessible if the necessity for a connection to be made at any time, anyplace is fulfilled through truly ubiquitous connectivity future 6G scenarios, The 6G platform's infrastructure is made up of the other three qualities, Intense Interconnection, Holographic Internet access, and Internet Of things while

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Smart Accessibility acts as its mind[12]. The future is made up of these four qualities. On the basis of the current 5G, the communication system will be improved and developed further in the future. The network will reduce the distance between everything, the information will overcome the barriers of time and place, and the seamless integration of people and everything else will become a reality.

6G with Satellite Network

The 6G cellular system, which would provide global coverage, will be composed of a synchronised 5G mobile and wireless system and a communications satellite network. These satellite connections include those for telecommunications, transportation, and Global imaging[13]. While the satellite navigation network is used to transmit voice, data, Internet traffic, and video via the telecommunications satellite (GPS), the planet observation satellites connection is used to collect weather and environmental data as shown in figure.

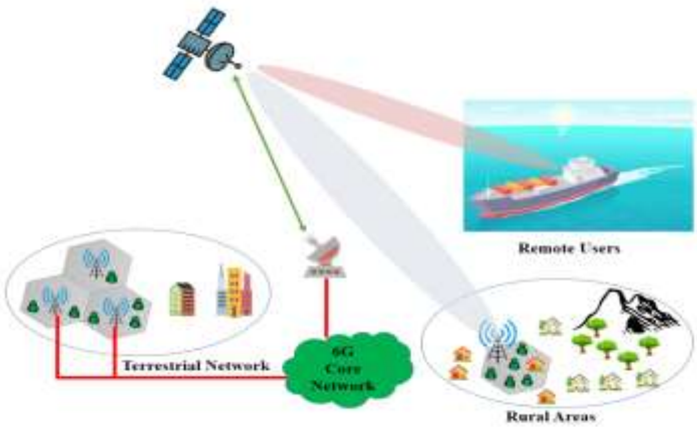

Figure – 4 6G Satellite Network

The major objective of 6G is to offer users of cell devices a variety of services such channel verification in multiple locations, entertainment application, and Web connections for smartphone subscribers with a rate of high data without interfering with the network. Fig. 4 displays the satellite network with 6G.

Opportunities for Wireless Networks Research

One of the key requirements for every wireless network is energy conservation. Due to the implementation of several access points in various places with varying user counts, MWN's (Multimedia Wireless Networks) energy consumption levels are not constant. As a result, MWN uses an approach to provide higher performance with less power usage. The MWN users were categorised using a two-tier classification tree technique to improve connection. It is defined by looking at how a user uses the network and why they are utilising the facility. As a result, the MWN can operate more safely and effectively. The machine was equipped with a variety of MIMO transceivers. The medium access control sublayer is very important for WLAN performance under different circumstances. The performance of the WLAN is closely correlated with the number of receiving stations linked to it. Based on the traffic ratio priority observed on the MAC layer, a technique was created to assess WLAN performance. WLAN approaches must, among other things, be able to connect users at a variety of speeds to various access points. A two step decimation filter was developed in order to more efficiently boost frequency conversion. To enhance communication in WLAN, numerous strategies have been devised [14]. Dual band antenna design is essential for facilitating network connection at several frequencies. For WPANs (Wireless Personal Area Network), the dual band antenna designs are also often employed. The goal of this concept is to simultaneously offer a low-speed internet connection and a GPS signal. To improve the energy consumption of the low power WPANs, a technique based on Lamport's algorithm was created. In addition, by solving the shortcomings of the collision avoidance strategy, this decreases the latency on the MAC layer. The WPANs are used in healthcare applications to monitor a person's heart rate, blood oxygen level, and blood pressure. The technique uses a Bluetooth network to send detected information to an Android mobile device. However, a number of methods are being developed using multi objective optimization models to enhance the battery performance of WPAN. The study analyses the event patterns seen on WSNs to control the power flow in the circuit. In order to deploy WWAN models in the agriculture sector, a long-range subterranean sensor connection is used. The mission uses a MAC layer format to convey the signal through an underground connection for a remoteness of several kilometres. The WWAN systems were in addition necessary to utilize IoT associations to observe engine vibrations. For the reason of facilitating signal connection, the effort uses multichannel IOT. The instance slotted channel hopping method is used in the effort to facilitate multi-hop communication[15]. For high speed applications, the investigational effort provides advanced throughput, and for lesser rate models, it improves battery existence.

2. CONCLUSION AND FUTURE TRENDS OF 6G WIRELESS NETWORKS

Just before a decade has passed, real-time WSN apps have begun to gain popularity. In this document, we have discussed both the current and upcoming generations of communication systems. In this article, we provide a detailed summary of the innovations that will be used in 6G networks. 6G networks will make use of new frequency bands and feature advancements in every aspect of the network, including device and antennas structure, network infrastructure, interfaces, and intelligent systems. Finally, we discuss a few problems with 6G communication systems in the hopes that they will help guide future research. We saw that 6G networks are thought of as flexible and versatile, and that their conceptual design is well organised. The research opportunities and trends for communication networks in the coming decade are examined in this study, which also presents a comprehensive top-down description of 6G systems. A full analysis of the ensuing technology use cases, which include greater holographic connectivity, haptic reality, physical Internet, and even beyond 6G, follows the section on the problems of 5G and imparts a vision for 6G. This article also discusses the adoption of modern network design for the 6G core network. The research can draw the conclusion that there might be an exciting future ahead after a thorough evaluation that dissects numerous system components and investigates workable solutions. Although there are many impediments in the way of addressing the issues, we offer enough information to start study in potential paths. Due to the simplicity of IoT integration with Android devices, academics interest in the field is

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growing. Many industries do not use such IoT apps because of their inconsistent data transfer and security measures . The MWN and MWLAN models struggle to give the customer an effective data transmission. The research to enhance the capabilities of WSN is currently ongoing, and it is put into practise by changing how traditional systems handle routing. In a similar vein, research is being done to increase the security of data sent through WSNs. However, because to a research restriction on simulations, MWN research is not progressing as quickly as WLAN and WPAN research. Similar to this, WWAN research is progressing extremely slowly. The next-generation WSN system might feature a constant connection with effective energy routing and a secure network across all applications [16]. In order to solve the immediate problems with frequency, bit rate, connectivity, ultra-low delays, and the capability to support IOT Network edge devices security concerns now also indicated in the 5G and other earlier wireless generation standards, and this so Above 5G network, which is the 6th generation of wireless communications standard, was created. Study groups have also been established by the ITU and 3GPP to define acceptable enabling technologies for 2030 and far beyond, with collaboration from a variety of educational research projects. The 6G wireless communication standard will indeed definitely be operational in less than ten years.

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