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# Super 6G Tech-Sixth Generation on Wireless Networks

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**Abstract:** ***During this revolutionary world, technologies and communications are changing as per human needs. As 5G wireless engineering is being launched, many smart applications will be integrated. However, in a short period of time, 6G will emerge as a next-generation human intelligence. Except for the upcoming generations, 6G is that the shorthand for the sixth generation of wireless networks, the successor to 5G cellular technology.5G specifications merges the necessities of recent emerging technologies. The paper summarizes the latest research work on 6G technologies and applications, and discusses related research challenges.***

**Keywords:** 6G wireless networks; wireless communications; visions; 5G; terahertz; 5G communications; Advantages

## 1. Introduction

Our work, play, and enjoyment have been revolutionized by the wireless industry. Globally, researchers are developing the next generation of wireless communication: 6G. 6G could mean that human intelligence could eventually be sent over the air instantly. Over 6G cell phones, robots, and computing applications with human-like capabilities might be possible. China has finally launched research for its 6G wireless networks Despite being the successor to 5G, 6G should never be referred to as "6G," but rather as 5G Enhanced or 5G Advanced. In telecommunications,6G is the sixth-generation standard currently under development for wireless communications technologies supporting cellular data networks and can likely be significantly faster than 5G.6G mobile communication networks are predicted to be even more heterogeneous than their predecessors, with applications such as virtual and augmented reality (VR/AR) likely to be supported beyond existing mobile use scenarios. There’s a bent to overestimate what is drained in two years but underestimate what is exhausted in ten years. In 10 years or more, many aspects of our daily lives will incorporate ultra-high-speed and ultra-reliable wireless connections, native AI, and advanced sensing technologies. A brand-new communication system is introduced almost every five years, improving the QoS, adding new features, and introducing new technologies.

## 2. Spectacular Speeds and Extreme Connectivity

The term Latency refers to the time between a cause and a sway. Each wireless generation has focused on using different range of radio frequencies to cut back latency and offer more connectivity. Latency is different from generation to generation,4G has the common latency at around 50 milliseconds, but it still not fast enough to accommodate smart environments or devices. In 5G, the commmon latency drops to at least one millisecond, with an occasional latency the IoT may soon become an everyday a part of world.

6G wireless networks have a higher capacity and much lower latency than 5G networks, and can operate at higher frequencies than 5G. 6G is predicted to supply hastens to 1,000 times faster than anything 6G can provide by leveraging the “terahertz (THz) wave” spectrum.

Most speculations expect the speed and data capacity of 6G to revoke connectivity and allowing us to attach more devices with smarter and more precise data. The applications of terahertz waves, the FCC noted that this extreme connectivity would provide “ centimeter-level positioning”. This has direct impact on things like drone fleets, robotics controls**.**

As 5G is being tested around the world and anticipated to be expanded gradually in 2019, studies are already focusing on what 6G may well be in 10 years, and several countries currently have initiatives focusing on researching possible 6G technologies. Using this text, we extend the vision of 5G to more ambitious scenarios in an exceedingly more distant future, and speculate on the technologies that could provide the step changes necessary for 6G to be realized.

## 3. Comprehensive and Reliable Coverage

As The fifth generation (5G) of mobile communication is now available in a number of countries, with a large number of 5G subscribers. It is time for academia and business to focus on the next generation. A review of the current state of the art and a vision of future communications are both necessary at this point. Thus, the goal of this article is to provide a complete overview of the sixth generation (6G) system in terms of drivers, use cases, usage scenarios, needs, key performance indicators (KPIs), and enabling technologies. We begin by addressing the question, "Is there a need for 6G?" by identifying 6G's primary drivers, forecasting explosive growth in mobile traffic through 2030, and anticipating future use cases and usage scenarios. The second step is to compare 6G requirements with 5G ones using KPIs. Third, a summary of current 6G research initiatives and activities from representative institutions and nations is presented, along with a rough roadmap for definition, specification, standardization, and regulation.

Then we choose a dozen prospective technologies and explain their principles, benefits, obstacles, and unsolved research questions. Finally, inferences are drawn in order to create a picture of "What 6G would look like?" This poll is designed to serve as an educational tool to pique people's curiosity and lead to further study and development of 6G communications systems.

## 4. 1G to 5G

The cellular wireless Generation(G) usually mention to an alternation in the complexity of framework, speed, technology and frequency. To justify 6G we first provide background network information strategy from 1G to 4G having their own capabilities and limitations and 5G technology status and the research progress toward 6G system.

**1) *1G analog technology(First Generation):***
In the 1980s, the 1G network was introduced. It's designed for voice services. 1G assisted data rates from 1KBps to 2.8 KBps and utilize a circuit switch. It was based on an analog system. 1G used an output technology called Analog Phone Service. It used Frequency Division Multiplexing and it delivers only little quality calls. There are many disadvantages to a 1G system including poor data capacity, unreliable transfer, deprivedsound connection and inability to protect phone conversations.

**2) *2G digital technology(Second Generation):***
In Finland, 2G was launched in 1991. It was the first digital cellular network, which had several benefits over analog networks. The 2G network uses digital modulation techniques including Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA) can support both voice and short messaging services. 2G is depends on the GSM (Global System for Mobile Communications). The objective of GSM is to make the system as secure as a PSTN (Public Switched Telephone Network) (PSTN). Anonymity, authentication, signaling protection, and user data protection are among its security and privacy services.. Despite significant advancements in privacy and security over 1G, 2G still has a number of flaws. One significant security flaw is that authentication is one-way: the network authenticates the user, but users are unable to authenticate the network, resulting in security gaps. Base stations and other illegal devices can impersonate legitimate network members, fooling users and stealing their data.

***3) 3G (Third Generation):***
The 3G system's security is built on 2G technologies. For high-speed data, the third generation of mobile transmission networks provides 144kbps and more. It complies with advancements in previous wireless technologies, such as "high-speed transmission, high multimedia access, and global roaming".3G is a technology that connects mobile phones and headphones to the Internet or other IP networks to provide voice and video calls, download and data, and surf the web. however, the 3G networks, on the other hand, are still subject to dangers posed by IP traffic and encryption keys. In addition, the radio link between the terminal equipment and the service network allows for a variety of attacks. Unauthorized access to data, threats to integrity, Denial of Service (DOS), and unauthorized access to services are all examples of dangers associated with wireless interface attacks. Certain sorts of assaults, such as AKA error messages, are aimed to obliterate user identities as well as confidential or sensitive information, which raises privacy concerns.

***4) 4G(Fourth Generation):***
The fourth generation of wireless technology, or 4G, was launched in 2010. LTE (Long Term Evolution) is a 4G technology that offers downlink data rates of up to 1 Gbit/s and uplink data rates of up to 500 Mbit/s. 4G technology combines current and future communications technology such as "OFDM, MC-CDMA, LAS-CDMA, and Network LMDS" to provide freedom of movement and seamless roaming between technologies. "Long-term evolution" (LTE) and Wi-MAX, or "wireless interoperability for microwave access," are among the 4G technologies being considered.

***5) 5G (Fifth generation):***
5G is the latest generation of cellular mobile communication which was started from late 2010s.The progress of a "World Wide wireless Web (WWWWW), dynamic ad-hoc wireless networks (DAWN), and real wireless communication" is the focus of 5G research. "802.11 wireless networks in local areas (WLAN) and urban areas (WMAN), as well as ad hoc wireless personal area networks (WPAN) and wireless networks for digital communications". The 5G capability gives portable devices AI capabilities.Several challenges, like as throughput, delay, energy efficiency, rollout costs, dependability, and hardware complexity, are linked with 5G technology. The soon-to-be-released 5G communication systems will provide considerable gains over present systems, but they will not be able to meet the demands of future intelligent and automation systems beyond ten years.

## 5. Advantages of 6G over 5G

We begin by assuming that 5G's electrical competence was previously near to the border, with advances in massive MIMO, network compaction, and millimeter-wave transmission, for example, as well as several legacy multiplexes approaches obtained from 4G. Because Shannon's bonds are constrained, it is unlikely that spectral efficiency in 6G will improve on a wide scale. On the contrary, new techniques in 6G communications should considerably improve security, privacy, and confidentiality. Traditional encryption methods based on the basic "Rivest-Shamir-Adleman (RSA)" public crypto-SMS are still employed in 5G networks to assure the security and secrecy of transmissions. RSA crypto-spores are less concerned about the pressures posed by Dig Data and artificial intelligence technologies than privacy protections that were not established in the 5G era.

Data rates of one terabyte per second are projected to be possible with 6G. Using *orthogonal frequency-division multiple access*, access points will be able to serve numerous customers at the same time. This degree of capacity and latency will improve the performance of 5G applications while also broadening the *range of capabilities* to support breakthrough applications in wireless networking, cognition, sensing, and imaging.Increased frequencies in 6G will enable substantially faster sampling rates, as well as significantly higher throughput and data rates. The use of sub-mm waves (wavelengths less than one millimeter) in combination with frequency selectivity to evaluate relative electromagnetic absorption rates could lead to substantial advancements in wireless sensing technologies.

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## 6. Technologies and Applications

5G was the first generation to introduce artificial intelligence, automation, and smart cities. These technologies, however, were only partially incorporated. 6G is delivering new technology and applications that provide faster data rates, improved reliability, lower latency, and more secure and efficient transmission. The primary applications, trends, and technology presented in 6G are depicted. Some of these 6G technologies and applications are discussed in this section.

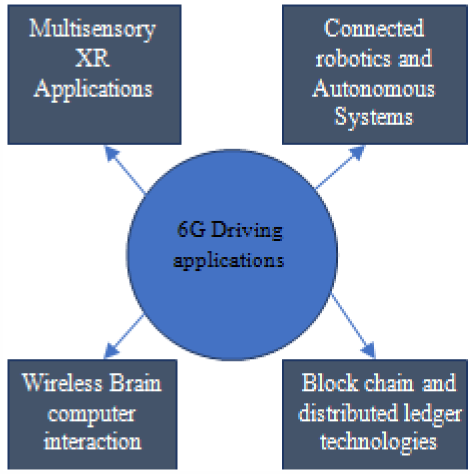


**Figure 1:** 6G main Applications and Technologies[3]

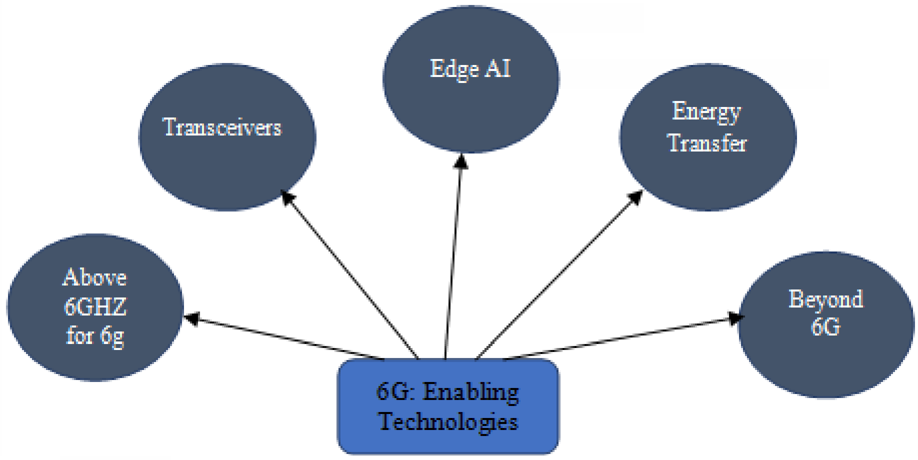


**Figure 2:** Shows the main applications and technologies introduced in 6G.

**1) Cell-Free Communications**

Unmanned Aerial Vehicles (UAVs) were planned for usage in future generations in areas with no infrastructure. This technology, however, will be fully utilized in 6G, allowing for cell-free communication. When the user equipment (UE) switches from one cell to another, the user's call should be transmitted to the other cell. This handover may fail, and in some cases, the user's call may be terminated and the system's QoS would be degraded. The problem of cell coverage will be solved by 6G because the UE will be connected to the entire network rather than a specific cell. Using a UAV allows for the integration of several technologies, allowing the UE to use the technology with the best coverage without requiring any manual setups on the device [].

***2) TeraHertz Communication***

The RF band is nearly filled, and it will be unable to meet the expanding demand for wireless communications technology. The THz spectrum, which ranges from 0.1 to 10 GHz, will be critical in delivering higher bandwidth, capacity, ultra-high data speeds, and secure transmission in 6G. Because technologies using frequency bands below 0.1 THz cannot support Tbps links, 6G will be the first wireless communication system to support Tbps for high-speed communication. The THz band will support the development of minuscule cells in nano-meter to micro-meter dimensions, supplying very high-speed communications within a coverage area of up to 10 m and supporting the Internet of Nano-things.

***3) Artificial Intelligence***

In 4G and preceding generations, artificial intelligence (AI) was not used. It is partially supported by 5G, which is making a difference in the telecoms world and opening the way for new and exciting applications like [8]- [11]. AI, on the other hand, will be fully supported for automation in 6G. It will help with the handover, network selection, and resource allocation, all of which will improve performance, particularly in delay-sensitive applications. The most essential technologies in 6G are artificial intelligence and machine learning [12].

***4) Extended Reality***

The term "extended reality" (XR) encompasses Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality

(MR) (MR). Virtual reality (VR) is a computer-generated reality experience that uses a headset to generate sounds and visuals to create an imaginary environment. AR takes the real world and enhances it with the help of a specific gadget, such as a smartphone. To build an interactive environment, audio, video, and the Global Positioning System (GPS) could be used. The real and virtual worlds collide in MR, creating a complicated experience. All of the actual and virtual environments are merged in XR. Because of its robust connectivity, fast data throughput, high resolution, and low latency, 6G will be particularly handy for this function [14].

***5) Holographic Beam forming (HBF)***

RF impulses from a radio flow into the antenna's rear and scatter across its front, where small elements shape the antenna. The term "holographic" describes the use of a hologram to produce beam steering by an antenna, where the antenna acts as a holographic plate in an optical hologram. RF signals from a radio enter the rear of the antenna and scatter over its front, where small elements change the shape. SDAs are more affordable, smaller in size, lighter, and need less power than conventional phased arrays or MIMO systems [13]. Employing SDAs in HBF will enable flexible and effective transmission and receiving in 6G because C-SWaP (Cost, Size, Weight, and Power) are the primary design constraints for any communication system.

***6) Blockchain technology***

The data in blockchain technology is represented as distributed blocks that are cryptographically encrypted and linked to one another. Blockchain will be utilized to manage and organize vast data, as well as to manage massive connectivity in the 6G network. It will also be utilized in spectrum sharing, allowing users to share the same spectrum, so addressing the issue of large spectrum requirements in 6G, and ensuring secure, low-cost, smart, and efficient spectrum utilization. Integrating blockchain with AI and employing Deep reinforcement learning [15] will increase QoS by allowing smart-resources sharing, establishing an advanced caching scheme, and increasing network flexibility.

***7) Automation***

Automation, robotics, and autonomous systems are currently the focus of research. 6G will assist these technologies by allowing direct communication between them and the server, as well as a direct connection between robots and servers, ie. robot-to-robot and robot-to-server communication. 6G will deliver complete automation, including automated control processes, automated systems, and automated devices. Unmanned Aerial Vehicles (UAV) [16], which will be utilized in wireless communications to provide high data rates instead of traditional base stations, will be supported by 6G. (BS).

***8) Wireless Power Transfer***

In 6G, wireless energy transfer will be used to provide adequate power to batteries in devices like smartphones and sensors [17]. Because Wireless Information and Energy Transport (WIET) employs the same fields and waves as communication systems, the base stations of 6G will be used to transfer power. WIET is a cutting-edge technology that will enable the creation of battery-free smart gadgets, the charging of wireless networks, and the extension of the battery life of other devices.

***9) Wireless Brain-Computer Interface***

Wearable devices have become more popular in recent years, with some of them being brain-computer interface (BCI) applications. Smart wearable headsets, smart embedded devices, and smart body implants are all examples of BCI applications [3]. The brain will be able to interface with external discrete devices using BCI technology, which will be responsible for analyzing and translating brain signals. Affective computing technologies will be used in BCI, in which gadgets will behave differently depending on the user's mood. Because BCI applications require more spectrum resources, a high bit rate, very low latency, and great dependability, they were constrained. However, 6G will support more applications, such as five-sense information transfer, in which data generated by the human's five senses are transferred to allow interaction with the environment.

## 7. 6G Communication Technology

***1) Holographic Communications:***

The transition from standard video conferencing to a virtual in-person meeting is projected to happen at 6G. To do this, a realistic representation of real-time movement must be transferred in a short amount of time, which necessitates the use of holographic communications. One component of the 6G future that will add glitz is holographic communications. A hologram is a three-dimensional image created by manipulating light beams directed at an object and then capturing the resulting interference pattern with a recording device. In fact, broadcasting 3D visuals without a stereo voice is insufficient to convey the features of in-person presence. Reconfigurable stereo audio will drive the creation of a platform for capturing multiple physical presences in each configuration in the 6G future.

***2) Tactile communications:***

Holographic communication allows for the transmission of a virtual view of people, events, and settings that are as close to genuine as feasible. Without a tactile Internet that allows for real-time image transmission, the movie experience will be incomplete. Teleportation, cooperative automatic driving, and interpersonal communication are all predicted to benefit from this technology. A haptic touch could be simply built using communication networks for these technologies. Realizing this technology could lead to the demise of the open systems interconnection network model in favour of a cross-layer communication-system design. Another consideration is how to design operations such as buffering, queuing, scheduling, handover, and protocols to satisfy the requirements of 6G networks. Existing wireless communication methods are obviously incapable of meeting these requirements; so, over-the-air fibre communication systems must be investigated. New physical layer (PHY) techniques, for example, must be created to improve signalling system architecture, waveform multiplexing, and so on. When it comes to delay, all sources of delay should be carefully considered, including buffering, queuing, scheduling, handover, and protocol-induced delays. Existing wireless communication technologies are unable to meet these needs, necessitating the use of over-the-air fibre communication networks.

*3) Haptic Communication for VAR*

Haptic communication adds a sensation of "touch" to standard audio-visual communication over the Internet, and it's the key to unlocking VAR's full potential. This will have a significant impact on various economic sectors such as manufacturing, education, healthcare, and smart utilities. Remote users will be able to enjoy haptic experiences through real-time interactive systems, thanks to the proposed 6G wireless communication. This sort of communication is widely employed in a variety of sectors, including AI and robotics sensors, physically challenged persons learning by touch, medical haptic methods in surgery, and gaming virtual conference room and holographic projection. uHLSLLC, mMTC, and uHDD aspects of 6G communication networks can help with the implementation of haptic systems and applications.

*4) Three-dimensional integrated communications(3D-InterCom):*

Device communication heights were insignificant before to the evolution of 6G networks, as evidenced by known propagation empirical models. This circumstance foreshadows a shift in the 6G 3D-InteCom model, which emphasises the necessity for a fundamental shift from two to three dimensions, which includes the heights of communications nodes. Satellite, unmanned aerial vehicle (UAV), and underwater communications are examples of significant technologies that have previously included this dimension. Satellite communications offer acceptable communication services on board, but they are prohibitively expensive, particularly in aircraft cabins.

In order to provide high-quality communication services on board, 6G communications must employ not only new communication technologies, but also novel networking architectures.

*5) Big communications:*

Due to the unconventional technologies adopted by 6G communication systems, such as an extremely large bandwidth (THz waves) and a high AI that will include operational and environmental aspects as well as network services, Big-Com in 6G aims to provide a large coverage of urban and remote areas while maintaining resource balance, allowing subscribers to communicate with one another everywhere with a high data rate speed.

*6) Human-bond communication:*

One of the key drivers of 6G communication is likely to be human-centric communication. Humans should be able to access and/or share physical features or express physical phenomena as they are with this technology. The five human senses will very certainly be involved in this effort. The "communication by breath" initiative, for example, makes it possible to read a human bio-profile using exhaled breath, as well as interact with the human body through inhalation of volatile organic chemicals. As a result, such technology makes disease diagnosis, emotion detection, biological feature gathering, and remote contact with the human body easier.

Interdisciplinary research collaborations are required to design a communication system that can replicate the five human senses. Such research efforts will inevitably lead to hybrid communication technologies capable of extracting diverse physical quantities and then distributing them to the designated receiver across secure channels.

## 8. Advantages of 6G

*1) Dynamic Network Slicing:*

A network operator can utilize dynamic network slicing to enable dedicated virtual networks to facilitate the efficient delivery of any service to a diverse set of consumers, cars, machines, and industries. When numerous users are connected to a large number of heterogeneous networks in 5GB communication systems, it is one of the necessary factors for management. The main enabling approaches for accomplishing dynamic network slicing are software-defined networking and network function virtualization. These have an impact on the cloud computing paradigm in network administration, such that the network has a centralized controller to dynamically steer and manage traffic flow, as well as choreograph network resource allocation for performance improvement.

*2) Physical-Layer Security:*

Human-centric communications are the most significant among many 6G applications, hence 6G networks are human-centric. As a result, 6G networks should prioritize security, secrecy, and privacy. 5G systems face a number of security difficulties, including decentralization, openness, data interoperability, and network privacy flaws. The present techniques of regulation and processes of privacy and security in 6G are insufficient to preserve the network's physical safety.

*3) Planning of Economic Prospects:*

The economic outlook is also critical for the adoption of 6G communication. A new 6G installation will incur significant network infrastructure costs. However, by converting the 5G system to a 6G system and preparing ahead of time, the cost can be reduced. As a result, the possibilities for infrastructure, data, and spectrum sharing must be thoroughly researched in order to make the 6G network cost-effective.

*4) OAM Communication:*

It has been proved that very large-capacity wireless communication systems can be designed to work across a few meters using polarisation diversity and OAM mode multiplexing. Several separate data streams can be configured to transmit over the same spatial wireless channel, increasing the area of spectral efficiency many fold. The performance is especially promising over a short distance, which could be useful for industrial automation. A mm-Wave OAM system it was reported to have attained a rate of more than 2.5Tbps with a tremendous spectral efficiency of 95.7bps/Hz. This might be a profitable technology for Industry 4.0, which is one of the primary 6G use cases.

***5) Metamaterials-based Programmable Radio Environment:***

Despite their immense success over the previous decades, traditional antenna design techniques appear to have reached their limits, with any additional attempts projected to yield only minor incremental gains. Nonetheless, while metamaterials-based antennas have been studied for nearly two decades, they have been unable to make an impact in prior generations of mobile communications. This will change in 6G, when metamaterials-based antennas will become the standard for UEs, allowing massive MIMO technology to be used in mobile phones as well. Because of the maturity of Metamaterials-based antennas, small-sized extremely efficient wideband antennas will be achievable, providing the hardware flexibility required by 6G radios.

***6) Cell-Free Networks:***

One hot issue in the late stages of 5G research is the UAV wireless network, which proposes to use flying base stations to provide mobile coverage in situations where infrastructures do not exist or are severely compromised due to disasters and reconnaissance activities. The entire potential of UAV wireless networks or drone cells will be realized in 6G, and their application will be widely extended to mobilize network resources in order to establish cell-free networks with arbitrarily low latency. To fully exploit the fluid cells generated by UAVs, resource allocation (including radio, energy, and computer resources), trajectory, content caching, and user association will be optimized collaboratively. Furthermore, in 6G, UAVs will not only function as flying base stations for radio coverage but also as content providers and computer servers. There will be a lot of cross-pollination with other new technologies. For example, AI will use network usage statistics to learn and dynamically discover the optimum paths for UAVs while also optimizing their other characteristics. This will unavoidably result in dynamic network topology reconfigurations. Furthermore, UAVs will benefit immensely from WPT technologies that can keep them moving at all times, and UAVs will also aid in the development of service-based network slicing.

***7) Radar-Enabled Contextual Communications:***

Intelligence is only visible if there is enough data to examine. Radar technologies improve ambient awareness for mobile UEs and IoT devices, enabling context-aware communications to a previously unattainable level. This will provide ambient awareness to 6G radios, allowing AI to be enabled at the device level. UEs will be able to identify and localize potential eavesdroppers or adversaries by combining radar observations with AI and adjust their communications for greater protection using physical layer security techniques by combining radar observations with AI.

## 9. Conclusion

With each iteration of the communication system, new and fascinating features are introduced. The 5G communication technology, which will be formally implemented globally in 2020, has a lot of fascinating capabilities. However, 5G will be unable to meet the increasing demand for wireless connectivity in 2030. As a result, 6G will need to be deployed. 6G research is currently in its infancy and in the research phase. This study considers the prospects and methods for achieving the aim of 6G communication.

In this paper, we discussed the detailed version of 6G,its uses, advantages, communication technology, network ,etc. Finally, 6G will have some fantastic features that will provide some amazing key potential in wireless technology in order to connect the entire world.

**Abbreviations**

The following abbreviations and symbols are used in this manuscript

| | |
|---|---|
| 1G | First Generation |
| 2G | Second Generation |
| 3G | Third Generation |
| 4G | Fourth Generation |
| 5G | Fifth Generation |
| 6G | Six Generation |
| Big-Com | Big Communication |
| UAV | unmanned aerial vehicle |
| eMB | Benhanced Mobile Broad-Band |
| THz | Terahertz |
| MIMO | Multiple-Input and Multiple-output |

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