

# A REVIEW OF MOBILE NETWORKS: EVOLUTION FROM 5G TO 6G

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## Abstract

The roadmap of 5G and 6G networks represents a significant leap forward in the evolution of mobile communication technology. As the future evolves, the potential of 6G technology to further revolutionize wireless connectivity is an exciting prospect that will continue to drive innovation and research in the field of telecommunications. The vision for 6G networks represents a paradigm shift in wireless communication, aiming to address the evolving demands of the digital era. This paper presents a review of the evolution of the 5G to 6G networks. The review explores the envisioned features, technological advancements, challenges, and future directions of 6G networks. Building upon the foundations of 5G networks, 6G networks are expected to deliver unprecedented data rates, ultra-low latency, seamless connectivity, and intelligent communication. Key technologies shaping the landscape of 6G include terahertz communication, AI-driven networks, quantum communication, and holographic beamforming. However, the deployment of 6G networks is accompanied by various challenges such as spectrum allocation, security, standardization, and regulatory frameworks. By synthesizing current research and industry trends, this review provides insights into the potential trajectory of 6G networks, paving the way for a connected future.

**Keywords:** 6G, 5G, wireless communication, mobile networks, AI-driven networks, MIMO

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## 1.0 Introduction

Understanding the roadmap of 5G and 6G networks is crucial for staying up-to-date with the latest advancements in mobile communication technology (Lin et al., 2021). These networks are expected to revolutionize how we study, work, and live, making it important for organizations to understand and invest in wireless technology (Lin et al., 2021). The demand for high data rate services has significantly increased in recent years due to the explosion of smart devices and data-intensive wireless applications. To meet this demand, the fifth-generation cellular network, or 5G, is currently under intensive research by both industry and academia. According to recent reports, 5G networks are expected to support massive connections with a minimum data rate of 100 Mbps and peak data rates higher than 10 Gbps (Lin et al., 2021). However, achieving these goals requires the implementation of various advanced technologies in 5G systems, such as millimeter-wave communication, massive MIMO (massive multiple-input, multiple-output), and small cell technology. These advancements in 5G technology are aimed at providing high data rates, low latency, and high reliability to support various applications such as cloud services, virtual reality, and augmented reality.

Furthermore, 5G also aims to reduce energy consumption and enhance the end-user quality of experience (Hossain & Hasan, 2015). In addition to the advancements in 5G technology, researchers and industry experts

are already looking toward the future with the development of 6G networks. 6G networks are expected to further push the boundaries of wireless connectivity with even higher data rates, reduced latency, and more efficient energy utilization (Le et al., 2015). The ultimate goal of 6G networks is to enable a fully connected world where devices, machines, and even humans seamlessly interact with each other through ultra-reliable and ultra-fast wireless connections (Chávez-Santiago et al., 2015). In order to understand the roadmap of 5G and 6G networks, it is important to recognize the growing demands for high data rates, low latency, and reliable wireless connections. These demands are driven by the increasing number of connected devices and the need for instant delivery of large volumes of multimedia content. To fulfill the requirements of future wireless networks, several emerging technologies are being considered for inclusion in 5G systems. These include millimeter-wave communication, massive MIMO, and small cell technology (Hossain & Hasan, 2015).

In addition, resource management in 5G systems poses a major research challenge (Chávez-Santiago et al., 2015). Understanding the roadmap of 5G and 6G networks is crucial to meet the increasing demands for high data rates, low latency, and reliable wireless connectivity in the future. The roadmap of 5G and 6G networks is driven by the need for high data rates, low latency, and reliable wireless to move towards the future of wireless communication, the potential of 6G technology is an area of great interest and anticipation. Building upon the foundations laid by 5G networks, 6G technology aims to push the boundaries of wireless connectivity even further. With an emphasis on even higher data rates, reduced latency, and more efficient energy utilization, 6G networks have the potential to revolutionize the way we interact with technology.

The evolution of mobile networks is a topic of great interest. With the recent deployment of 5G networks, the industry is already looking ahead to the development of 6G technology. The transition from 5G to 6G is expected to bring about significant advancements in terms of network speed, capacity, and latency, paving the way for innovations in various industries. The evolution of wireless communication has been propelled by the continuous advancements in mobile network technologies. As we transition from 5G to 6G networks, there is a growing anticipation for transformative changes that will redefine connectivity and enable innovative applications. This review examines the vision for 6G networks, outlining the anticipated features, technological advancements, challenges, and future directions (Saad et al. (2019)).

One of the key areas of focus for 6G is likely to be the integration of artificial intelligence and machine learning into the network infrastructure. This has the potential to enable autonomous network management and optimization, leading to more efficient use of resources and improved user experiences. Another important aspect of 6G development is the exploration of new frequency bands and antenna technologies to further increase the network's capacity and reduce interference. This could open up opportunities for enhanced connectivity in remote areas and support the growing demand for Internet of Things devices (Jiang et al., 2021). Additionally, 6G is expected to address the issue of network security by implementing stronger encryption protocols and advanced authentication mechanisms (Raddo et al., 2021). Furthermore, 6G networks are likely to incorporate advanced technologies such as free-space optics, Terahertz systems, and photonic integrated circuits (Trommler et al., 2022; You et al., 2020). As 6G technology continues to take shape, it will be crucial for industry stakeholders to collaborate and standardize the technology to ensure seamless global compatibility. Additionally, addressing security and privacy concerns will be paramount to building trust in the new network infrastructure and driving widespread adoption. (Raddo et al., 2021)

The evolution from 5G to 6G networks holds great promise for revolutionizing mobile networks and unlocking new possibilities for connectivity and innovation. It will be exciting to witness how these advancements unfold and shape the future of communication and technology. As technology continues to advance at a rapid pace, the evolution of mobile networks is a topic of great interest (You et al., 2020). With the fast development of smart terminals and emerging new applications, wireless data traffic has drastically increased, and current cellular networks cannot completely match the quickly rising technical requirements. To meet the challenges posed by increasing data traffic and emerging applications, the development of 6G networks is expected to set higher technical standards (Chowdhury et al., 2020)

In this article, we delve deeper into the potential advancements that 6G technology could bring, particularly in the integration of artificial intelligence and machine learning, exploration of new frequency bands and antenna technologies, and the importance of collaboration and standardization among industry stakeholders. We also

address the crucial aspects of security and privacy concerns that need to be considered as 6G technology takes shape (Zhao et al., 2020; Enablers, 2021)

## 1.2 Understanding 5G Technology

As technology continues to advance at a rapid pace, the evolution of mobile networks is a topic of great interest. With the recent deployment of 5G networks, the industry is already looking ahead to the development of 6G technology. To deliver 5G speed at an acceptable cost, service providers are utilizing the microservices-based, cloud-native, containerized architecture that enterprises are currently using. Microservice is a modular method of software development in which a big application is divided and created in smaller chunks, and deployed independently (TO Agboola, 2023). The transition from 5G to 6G is expected to bring about significant advancements in terms of network speed, capacity, and latency, paving the way for innovations in various industries (Giordani et al., 2019; Raddo et al., 2021; Gui et al., 2020).

The development of 6G networks is poised to set higher technical standards to meet the challenges posed by increasing data traffic and emerging applications, and it holds great promise for revolutionizing mobile networks and unlocking new possibilities for connectivity and innovation. It will be exciting to witness how these advancements unfold and shape the future of communication and technology (Ling et al., 2020; You et al., 2020)

## 1.3 The Journey from 1G to 5G

The journey from 1G to 5G marks a remarkable advancement in mobile network technology, with each generation bringing substantial improvements in terms of speed, capacity, and connectivity. The deployment of 5G networks has paved the way for transformative changes in various industries, and the anticipation of 6G technology has sparked a new wave of excitement and potential possibilities (Tomkos et al., 2020; Wikström et al., 2020).

As we explore the potential advancements that 6G technology could bring, it is essential to consider the significant role of artificial intelligence and machine learning in shaping the future of mobile networks. The integration of these technologies holds the promise of enabling autonomous network management and optimization, thereby revolutionizing how resources are utilized and enhancing user experiences (Akyildiz et al., 2016; Jiang et al., 2021; Alsharif et al., 2020; Ling et al., 2020). Moreover, the exploration of new frequency bands and antenna technologies for 6G networks is expected to further enhance the network's capacity and reduce interference. This not only creates opportunities for improved connectivity in remote areas but also caters to the burgeoning demand for Internet of Things devices, laying the foundation for a more interconnected and technologically advanced future (Jiang et al., 2021; Akyildiz et al., 2020; Zhang & Zhu, 2020; Chowdhury et al., 2020)

In addition to technical advancements, the importance of collaboration and standardization among industry stakeholders cannot be overstated. It is crucial to ensure seamless global compatibility of 6G technology, fostering a cohesive and interconnected network infrastructure on a global scale. Equally important is the need to address security and privacy concerns to build trust in the new network infrastructure and drive widespread adoption (Imoize et al., 2021; Raddo et al., 2021; Nayak & Patgiri, 2021). The development of 6G networks holds the potential to revolutionize mobile networks, unlocking new possibilities for connectivity and innovation. It will be fascinating to witness how these advancements unfold and shape the future of communication and technology, ushering in a new era of connectivity and technological evolution (Ray, 2021; Morgado et al., 2018; Wikström et al., 2020). In addition to technical advancements, the importance of collaboration and standardization among industry stakeholders cannot be overstated. It is crucial to ensure seamless global compatibility of 6G technology, fostering a cohesive and interconnected network infrastructure on a global scale. Equally important is the need to address security and privacy concerns to build trust in the new network infrastructure and drive widespread adoption

## **2.0 Key Features of 5G Networks**

### **2.1 The Evolution of Mobile Networks**

The development of 6G networks is poised to set higher technical standards to meet the challenges posed by increasing data traffic and emerging applications, and it holds great promise for revolutionizing mobile networks and unlocking new possibilities for connectivity and innovation. It will be exciting to witness how these advancements unfold and shape the future of communication and technology. With the fast development of smart terminals and emerging new applications, wireless data traffic has drastically increased, and current cellular networks cannot completely match the quickly rising technical requirements. To meet the challenges posed by increasing data traffic and emerging applications, the development of 6G networks is expected to set higher technical standards (Morgado et al., 2018; Chávez-Santiago et al., 2015)

#### **2.1 Challenges Faced in Implementing 5G**

The implementation of any new technology comes with its own set of challenges, and 5G is no exception. The deployment of 6G networks is accompanied by various challenges that need to be addressed (Boccardi, et al., 2014). Cell size and spectrum allocation remains a critical issue, requiring the identification and allocation of suitable frequency bands for terahertz communication and other advanced technologies (Andrews et al. 2014). Security and privacy concerns pose significant challenges, necessitating robust encryption mechanisms and authentication protocols. Standardization efforts, regulatory frameworks, and international collaboration are essential for ensuring interoperability and harmonized deployment of 6G networks (Rappaport, et al., 2013).

Furthermore, the challenges faced in implementing 5G include higher system capacity demands, the need for higher data rates, lower latency requirements, improved security measures, and the need to ensure quality of service compared to the previous 4G system (You et al., 2020). To address these challenges and pave the way for 6G networks, extensive research and development efforts are focused on emerging technologies such as artificial intelligence to optimize network performance, terahertz communications to enable higher data rates, wireless optical technology for lower latency, and quantum communications for improved security (Chowdhury et al., 2020). Additionally, the integration of wireless information and energy transfer, as well as the utilization of unmanned aerial vehicles, will play a crucial role in meeting the increasing user demands for connectivity and improving overall network performance. The future of 6G wireless communication networks lies in addressing fundamental issues such as higher system capacity, higher data rates, lower latency, improved security measures, and enhanced quality of service (You et al., 2020). These challenges will require the development and integration of various technologies, such as artificial intelligence, terahertz communications, wireless optical technology, quantum communications, and unmanned aerial vehicles, among others (Chowdhury et al., 2020). In order to meet the requirements of future wireless communication networks, sixth-generation (6G) technology is being developed and expected to be implemented between 2027 and 2030. The implementation of 6G wireless communication networks is expected to address the challenges faced in implementing 5G, including higher system capacity demands and the need for higher data rates.

#### **2.2 Applications and Benefits of 5G**

The evolution of 5G networks has brought numerous benefits and applications that have transformed industries and improved user experiences (Giordani et al., 2019). From enhanced mobile broadband capabilities to ultra-low latency and massive machine-type communications, 5G has paved the way for a range of applications such as autonomous driving, virtual and augmented reality, remote surgery, smart cities, and the Internet of Things (Ling et al., 2020). These advancements have allowed for faster and more reliable connections, enabling new levels of productivity, efficiency, and innovation. With the integration of AI and big data technologies, 6G networks will surpass the capabilities of 5G, enabling even faster and more reliable communication, and opening up opportunities for a new range of smart applications. 6G networks will enable faster and further communication to the extent that the boundary between physical and cyber worlds disappears. The fast development of multiband ultrafast seamless networks and super reliable data transmission systems has led to the current cellular network which supports heavy traffic applications such as artificial intelligence, machine learning, deep learning, augmented reality, virtual reality, 3D media, the Internet of Things, and the Internet of Nano-things.

To meet the growing demands and expectations of heavy data users, the sixth generation of mobile technology, 6G, needs to be deeply studied and developed to address the challenges of bandwidth, low latency, channel capacity, energy spectrum efficiency, network connectivity, and data security (Ray, 2021). 6G networks will also incorporate advanced technologies like intelligent computing, wireless massive connectivity, SM-MIMO, and optical computing to further enhance network performance (Giordani et al., 2019). In addition, the deployment of 6G networks will have significant implications and applications in various fields such as industry, automation, healthcare, and transportation (Ling et al., 2020). In today's rapidly changing world, the significance of accurate weather forecasts cannot be overstated. Therefore, the evolution from 5G to 6G networks will not only improve communication capabilities, but also enable the development of advanced technologies and applications that will revolutionize various industries and sectors, ultimately leading to a more connected and efficient society. In conclusion, the evolution from 5G to 6G networks will enable the development of advanced technologies and applications that will revolutionize various industries and sectors, leading to a more connected and efficient society (Giordani et al., 2019).

The development of 6G technology is poised to build upon the foundation laid by 5G networks and revolutionize the way we perceive and utilize mobile networks. Understanding the potential applications and benefits of 6G is crucial as we anticipate the next wave of technological advancements.

### **3.0 Introduction to 6G Technology**

As we embark on the journey from 5G to 6G, it is important to consider the key features that are expected to define the landscape of 6G networks. The transition to 6G technology holds the promise of even faster network speeds, ultra-low latency, and significantly higher capacity, which will not only elevate the user experience but also enable a wide range of emerging technologies such as augmented reality, virtual reality, and holographic communications. (Nayak & Patgiri, 2021; Raj & Ancy, 2021; Insights, 2023)

The integration of artificial intelligence and machine learning algorithms in 6G networks is anticipated to be a game-changer, enabling intelligent network optimization, predictive maintenance, and the seamless integration of heterogeneous technologies. This convergence of AI and wireless communication systems is expected to open up new frontiers in automation and connectivity, paving the way for truly intelligent and adaptive networks. (Giordani et al., 2019; Akyildiz et al., 2020; Ling et al., 2020; Ray, 2021)

Furthermore, the exploration of new frequency bands and antenna technologies for 6G networks is set to transcend the limitations of current spectrum availability and enable the seamless coexistence of diverse wireless applications. This will not only address the need for ubiquitous connectivity but also empower the proliferation of Internet of Things devices and advanced communication services in urban and rural environments alike (Morgado et al., 2018; Strinati et al., 2021)

The journey from 1G to 5G has laid the groundwork for a transformative evolution in mobile network technology, and the transition to 6G is poised to be the next quantum leap in this progression. As industry stakeholders come together to define the technical standards and drive innovation, the future of 6G technology holds the promise of transforming the way we communicate, connect, and interact with the world around us (Tariq et al., 2020)

### **3.1 Research and Development**

Research and development play a crucial role in the roadmap of 5G and 6G networks. Researchers are continuously exploring new technologies and techniques to meet the evolving demands of 5G and 6G networks. One of the key areas of focus in the development of 5G and 6G networks is the integration of advanced antenna technologies (Akyildiz et al., 2016). One of the key areas of focus in the development of 5G and 6G networks is the integration of advanced antenna technologies (Alsharif et al., 2020). These technologies, such as massive MIMO and beamforming, can improve network capacity and coverage, leading to higher network performance (Akyildiz et al., 2016). Another important aspect of research and development in 5G and 6G networks is the exploration of new network architectures and protocols. These new architectures and protocols aim to address the limitations of

current systems and enable more efficient and flexible networks. Additionally, the development of new waveform candidates is being explored to overcome the limitations of current waveforms used in 4G systems (Le et al., 2015). Overall, the roadmap for 5G and 6G networks involves addressing the increasing demands for high data rates, low latency, cost-efficient energy consumption and improved connectivity, while also ensuring high network security (Raddo et al., 2021; Xu, 2020). Research and development in the field of 5G and 6G networks are crucial for achieving these objectives (Xu, 2020).

## **3.2 Advancements in Communication Technologies**

In order to meet the increasing demands for high data rates and low latency, significant advancements in communication technologies are essential. The integration of advanced antenna technologies such as massive MIMO and beamforming plays a pivotal role in improving signal coverage and network capacity. These enhancements not only boost network performance but also lay the foundation for seamless connectivity in the 6G era. Furthermore, the exploration of new network architectures and protocols is imperative to efficiently handle the massive scale of connected devices and data traffic. This pursuit leads to more robust and flexible networks that can meet the evolving needs of a fully connected world (Raddo et al., 2021).

### **3.2.1 Deep Dive into Communication Technologies**

The roadmap for 5G and 6G networks is focused on addressing the increasing demands for high data rates, low latency, and efficient energy consumption while ensuring high network security. To delve deeper into achieving these objectives, it is essential to explore the advancements in communication technologies that will shape the future of wireless connectivity.

#### **3.2.2 Evolution of Antenna Technologies**

The integration of advanced antenna technologies such as massive MIMO and beamforming stands as a crucial cornerstone in revolutionizing wireless communication. Massive MIMO, with its ability to employ hundreds of antennas to provide higher capacity and spectral efficiency, promises to reshape the way data is transmitted and received. Similarly, beamforming technology, which allows focusing signal energy in specific directions, greatly enhances signal coverage and network performance, catering to the growing demand for reliable and high-capacity wireless connectivity.

Additionally, the implementation of these advanced antenna technologies not only improves the performance of existing networks but also sets the stage for the seamless integration of emerging technologies, including the Internet of Things devices, autonomous vehicles, virtual reality, and augmented reality.

#### **3.2.3 New Network Architectures and Protocols**

The exploration of new network architectures and protocols is a fundamental aspect of the roadmap for 5G and 6G networks. The aim is to overcome the limitations of current network systems and foster the development of more efficient, flexible, and scalable networks. These advancements are pivotal in addressing the massive scale of connected devices and the ever-increasing data traffic, promising to meet the evolving needs of a fully connected world.

#### **3.2.4 Unveiling New Waveform Candidates**

In line with the need to meet the increasing demands for high data rates, low latency, and reliable wireless connectivity, the development of new waveform candidates has emerged as a critical area of focus. These new waveform candidates aim to overcome the limitations of the current orthogonal frequency-division multiple access waveform used in 4G systems, enabling Gigabit-level communications and ushering in a new era of ultra-fast and reliable wireless connectivity.



Furthermore, the integration of artificial intelligence and machine learning techniques in optimizing network performance, enhancing security, and enabling intelligent decision-making signifies a transformative shift in wireless communication technologies.

More so, the advancements in communication technologies, including advanced antenna technologies, new network architectures and protocols, and the development of new waveform candidates, are pivotal in laying the groundwork for 6G networks. These technological developments not only promise to meet the current demands of wireless connectivity but also herald an era of unprecedented innovation and seamless integration of emerging technologies.

### **Overcoming Limitations in Waveform**

The development of new waveform candidates is a critical aspect of research and development in 5G and 6G networks. Overcoming the limitations of current waveforms used in 4G systems is essential to enable Gigabit communications. By exploring new waveform candidates, the network can achieve improved efficiency and higher data transfer rates, addressing the increasing demand for faster and more reliable communication.

### **Integration of Artificial Intelligence and Machine Learning**

The incorporation of artificial intelligence and machine learning techniques is another pivotal area of focus in the roadmap for 5G and 6G networks. These techniques play a vital role in optimizing network performance, enhancing security, and enabling intelligent decision-making. By leveraging the power of AI and machine learning, the network can adapt to dynamic conditions, optimize resource allocation, and provide a secure and reliable communication environment for a wide array of applications and services.

## **3.3 Envisioning 6G: The Next Frontier in Wireless Communication**

Envisioning the future of 6G wireless communication technology involves addressing the limitations and challenges faced in implementing 5G. The vision for 6G revolves around achieving higher system capacity, higher data rates, lower latency, improved security measures, and enhanced quality of service compared to the previous generations. This will require the development and integration of emerging technologies such as artificial intelligence, terahertz communications, wireless optical technology, quantum communications, and unmanned aerial vehicles. These technologies will optimize network performance, enable higher data rates, lower latency, improve security measures, and enhance the overall quality of service. By implementing these technologies, 6G wireless communication networks aim to meet the increasing demands for connectivity and provide seamless, high-speed, and reliable communication (Tariq et al., 2020; Ji et al., 2021) Furthermore, the integration of wireless information and energy transfer will contribute to the sustainability and efficiency of 6G networks (Chowdhury et al., 2020). The future of 6G wireless communication networks aims to address the limitations of previous generations and meet the growing demands for connectivity (You et al., 2020).

### **3.3.1 Vision for 6G Networks**

To understand the roadmap of 6G networks, it is important to envision its potential and the goals that it aims to achieve. The ultimate goal of 6G networks is to create a fully connected world where devices, machines, and even humans seamlessly interact with each other through ultra-reliable and ultra-fast wireless connections. This level of connectivity will enable various advancements such as autonomous vehicles, remote healthcare, smart cities, and immersive virtual reality experiences. To realize this vision, 6G networks will need to overcome several challenges and introduce new technological innovations (Le et al., 2015). Some of the key areas of focus for 6G networks include: (1) Integration of artificial intelligence and machine learning algorithms to enhance network efficiency, security, and resource allocation; (2) Development of new spectrum and waveform technologies to support even higher data rates and capacity (Chávez-Santiago et al., 2015); (3) Exploration of new frequency bands, such as Terahertz frequencies, to enable faster and more reliable wireless communications (Le et al., 2015); (4) Integration of advanced antenna technologies, such as massive MIMO and beamforming, to improve signal coverage and capacity (Choudhury, 2015); (5) Exploration of new network architectures and

protocols that can efficiently handle the massive scale of connected devices and data traffic (Chávez-Santiago et al., 2015).

To meet the increasing demands for high data rates, low latency, and reliable wireless connectivity in the future, the roadmap of 5G and 6G networks is centered around the development and implementation of innovative technologies and solutions. These technologies include massive MIMO, millimeter wave communication, software-defined networking, virtualization, cloud computing, and small cell networks (Le et al., 2015). These technologies, along with advancements in artificial intelligence and machine learning, will pave the way for the seamless integration of various applications and services on a global scale, ultimately leading to the realization of a fully connected and intelligent world facilitated by 6G networks (Chávez-Santiago et al., 2015).

Furthermore, in order to understand the roadmap of 5G and 6G networks, it is important to consider the goals and potential advancements that these networks aim to achieve (Le et al., 2015). These networks are aimed at providing higher data rates, lower latency, greater reliability, and increased capacity to support a wide range of applications and services. The roadmap of 5G and 6G networks is driven by the need to meet the increasing demand for high data rates, low latency, and reliable wireless connectivity in order to support the growing number of devices and applications that require wireless connectivity (Chávez-Santiago et al., 2015). These networks need to address challenges such as network densification, utilization of millimeter wave spectrum, implementation of massive MIMO, and the integration of advanced networking technologies like software-defined networking and virtualization.

To meet the increasing demands for high data rates, low latency, and reliable wireless connectivity in the future, the roadmap of 5G and 6G networks will focus on several key areas. One area is the integration of advanced antenna technologies, such as massive MIMO and beamforming, to improve signal coverage and capacity. Also, exploration of new network architectures and protocols that can efficiently handle the massive scale of connected devices and data traffic (Akyildiz et al., 2016). Another area is development of new waveform candidates that can overcome the limitations of the current orthogonal frequency multiple access waveform used in 4G systems and enable Gigabit communications (Alsharif et al., 2020). In addition, an important area is the integration of artificial intelligence and machine learning techniques to optimize network performance, enhance security, and enable intelligent decision-making. Incorporating these advancements will not only improve the performance and efficiency of the network, but also enable the integration of emerging technologies such as IoT devices, autonomous vehicles, virtual reality, and augmented reality (Akyildiz et al., 2016). Overall, the roadmap of 5G and 6G networks involves addressing the increasing demands for high data rates, low latency, and reliable wireless connectivity in order to support the seamless integration of various emerging technologies and applications.

### **3.4 Potential Capabilities of 6G Technology**

Potential capabilities of 6G technology include higher system capacity, enabling more devices to connect simultaneously and handle increasing data traffic. This will be achieved through innovations in spectrum allocation, advanced antenna technologies, and network optimization techniques (Chowdhury et al., 2020). Additionally, 6G technology aims to provide significantly higher data rates compared to previous generations, enabling faster and more efficient communication. Moreover, 6G will focus on reducing latency to support real-time applications and services, ensuring a more seamless and responsive user experience.

Furthermore, 6G technology will prioritize security to mitigate potential risks and vulnerabilities. This will involve the integration of advanced encryption algorithms, secure authentication protocols, and enhanced privacy measures. Additionally, the implementation of artificial intelligence will enable intelligent network management and optimization, making the network more efficient and adaptable to changing conditions. The network architecture of 6G wireless communication will also incorporate emerging technologies such as terahertz communications, wireless optical technology, quantum communications, unmanned aerial vehicles, and blockchain. These technologies will work together to create a robust and flexible network infrastructure. Some other key capabilities of 6G technology include the use of integrated sensing and communication, which will enable a more seamless and efficient exchange of information between devices (You et al., 2020). Overall, 6G wireless communication networks will strive to provide higher system capacity, higher data rates, lower latency,



enhanced security, improved quality of service, and increased energy efficiency. In conclusion, the evolution of mobile networks from 5G to 6G aims to address the limitations of previous generations and meet the growing demands for connectivity in today's rapidly changing world.

### **3.5 6G and the Future of Connectivity**

#### **3.5.1 The Future of Connectivity**

The future of connectivity lies in the development and implementation of 6G technology. This next generation of wireless communication will revolutionize how we connect and interact with the digital world (Chowdhury et al., 2020). With its higher system capacity, faster data rates, lower latency, improved security, and enhanced quality of service, 6G technology will pave the way for a new era of connectivity and digital transformation (Giordani et al., 2019; Chowdhury et al., 2020). By exploring the full spectrum of available frequencies, including sub-6 GHz, millimeter wave, terahertz, and optical bands, 6G technology will be able to support a higher density of connections and significantly increase data rates. Additionally, 6G will not be limited to terrestrial communication networks but will extend to include non-terrestrial networks such as satellites and unmanned aerial vehicles (You et al., 2020). This will enable the creation of a space-air-ground-sea integrated communication network, providing global coverage and connectivity (Giordani et al., 2019; Ling et al., 2020)

#### **3.5.2 Future Directions and Opportunities**

Despite the challenges, the vision for 6G networks presents numerous opportunities for innovation and advancement. Emerging technologies such as terahertz communication, AI-driven networks, quantum communication, and holographic beamforming are poised to revolutionize wireless communication and enable transformative applications across various domains. By embracing these opportunities and overcoming obstacles, we can unlock the full potential of 6G networks and usher in a future where connectivity empowers individuals, organizations, and societies to thrive in the digital age.

### **3.6 Implications of 6G for Society and Industry**

#### **3.6.1 Consequences for Society and Industry**

The deployment of 6G wireless communication networks will have significant implications for both society and industry (Akhtar et al., 2020; Jiang et al., 2021; Chowdhury et al., 2020). These networks will enable the development of new and advanced technologies that will enhance various aspects of our lives. For society, 6G technology will enable the proliferation of smart applications and services, making cities smarter and more efficient. For industry, 6G will open up new opportunities for innovation and transformation in sectors such as manufacturing, healthcare, transportation, and agriculture (Akhtar et al., 2020; Zhao et al., 2020; Ray, 2021). It will enable the implementation of technologies such as artificial intelligence, terahertz communication, wireless optical technology, blockchain, quantum communication, cell-free communication, and integrated sensing and communication (You et al., 2020). The integration of these technologies will drive advancements in automation, data analytics, and connectivity, leading to increased productivity, improved decision-making, and enhanced user experiences, as well as the potential for new business models and revenue streams.

Furthermore, 6G networks will also address the increasing demand for high-quality and reliable connectivity in remote and underserved areas. Overall, the evolution of mobile networks from 5G to 6G will bring about a new era of connectivity and digital transformation (Ling et al., 2020). The deployment of 6G wireless communication networks will have significant implications for both society and industry (You et al., 2020). The deployment of 6G wireless communication networks will have significant implications for both society and industry. The deployment of 6G wireless communication networks will have significant implications for both society and industry. The deployment of 6G wireless communication networks will have significant implications for both society and industry.

## 4.0 Conclusion

In conclusion, the roadmap of 5G and 6G networks involves addressing the requirements for high data rates, low latency, cost-efficient energy consumption, improved connectivity, and high network security. To achieve these goals, several key areas of focus have been identified for the development of 5G and 6G networks (Le et al., 2015). As we look towards the future, the potential of 6G technology to further revolutionize wireless connectivity is an exciting prospect that will continue to drive innovation and research in the field of telecommunications. The evolution of mobile networks from 5G to 6G is poised to revolutionize connectivity and digital transformation. With its focus on higher system capacity, faster data rates, lower latency, enhanced security, and improved quality of service, 6G technology will bring about a new era of seamless, high-speed, and reliable communication. The integration of emerging technologies such as artificial intelligence, terahertz communications, wireless optical technology, quantum communications, and unmanned aerial vehicles will further optimize network performance and enable new levels of efficiency.

The potential capabilities of 6G technology, including higher system capacity, advanced data rates, reduced latency, and enhanced security, will pave the way for the proliferation of smart applications and services in cities, as well as drive innovation and transformation across various industries. Moreover, the deployment of 6G wireless communication networks will not only meet the increasing demands for connectivity but also address the need for high-quality and reliable connectivity in remote and underserved areas. Overall, 6G technology will have far-reaching implications for society and industry, driving advancements in automation, data analytics, and connectivity, while also presenting new opportunities for business models and revenue streams. Its potential to create a space-air-ground-sea integrated communication network with global coverage will further solidify its impact on the future of connectivity.

As we anticipate the deployment of 6G wireless communication networks, we can expect to witness significant progress in the realm of connectivity and digital transformation, ultimately shaping the way we interact with the digital world. The deployment of 6G wireless communication networks will have wide-ranging impacts on society and industry. Significantly, the vision for 6G networks holds immense promise for transforming the landscape of wireless communication. By delivering unprecedented speed, reliability, and intelligence, 6G networks have the potential to enable transformative applications and empower a connected future. However, addressing challenges such as spectrum allocation, security, and standardization will be crucial in realizing the full potential of 6G networks. By leveraging emerging technologies and fostering collaboration across industry and academia, we can pave the way for a seamless transition to the era of 6G connectivity.

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