Chapter 2
Relevant Technologies to 6G

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ABSTRACT

From the first generation to the third generation (3G), data communications such as "i-mode" and multimedia information such as photos, music, and video could be communicated using mobile devices. From the fourth generation (4G), smart phones have been explosively popularized by high-speed communication technology exceeding 100 Mbps using the long-term evolution (LTE), and multimedia communication services have appeared. 4G technology continues to evolve in the form of LTE-Advanced and has now reached a maximum communication speed close to 1 Gbps. 5G is expected to provide new value as a basic technology supporting future industry and society, along with artificial intelligence (AI) and the internet of things (IoT). 5G is expected to evolve, and the sixth generation (6G) technology will support industry and society in the 2030s. The objectives of 6G technology include simultaneous achievement of several requirements such as ultra-high-speed, high-capacity, and low-latency connectivity.

INTRODUCTION

We are moving toward a society of fully automated and remote management systems. The very rapid development of various emerging applications, such as Artificial Intelligence (AI), Virtual Reality (VR), three-dimensional

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(3D) media, and the Internet of Everything (IoE), has led to a massive volume of traffic (Mumtaz, 2017). This statistics clearly depicts the importance of the improvement of communication systems. Autonomous systems are becoming popular in every sector of society, such as industry, health, roads, oceans, and space. To provide a smart life and automated systems, millions of sensors will be embedded into cities, vehicles, homes, industries, foods, toys, and other environments. Hence, a high-data-rate with reliable connectivity will be required to support these applications. In certain parts of the world, fifth-generation (5G) wireless networks have already been deployed. By 2020, it is expected that 5G will be fully deployed worldwide.

5G networks will not have the capacity to deliver a completely automated and intelligent network that provides everything as a service and a completely immersive experience (Nawaz S, 2019). Although, the 5G communication systems that are going to be released very soon will offer significant improvements over the existing systems, they will not be able to fulfill the demands of future emerging intelligent and automation systems after 10 years (Giordani, 2020). The 5G network will provide new features and provide better Quality of Service (QoS) as compared with fourth-generation (4G) communications (Shafi, 2017; Zhang, 2016; Jaber, 2016; Andrews, 2014). The 5G technology will include several new additional techniques, such as new frequency bands (e.g., the millimeter wave (mmWave) and the optical spectra), advanced spectrum usage and management, and the integration of licensed and unlicensed bands (Giordani, 2020). Nevertheless, the fast growth of data-centric and automated systems may exceed the capabilities of 5G wireless systems. Certain devices, such as Virtual Reality (VR) devices need to go beyond 5G (B5G) because they require a minimum of 10 Gbps data rate (Mumtaz, 2017). Hence, with 5G reaching its limits in 2030, the design goals for its next step are already being explored in literature. To overcome the constraints of 5G for supporting new challenges, a sixth-generation (6G) wireless system will need to be developed with new attractive features.

The key drivers of 6G will be the convergence of all the past features, such as network densification, high throughput, high reliability, low energy consumption, and massive connectivity. The 6G system would also continue the trends of the previous generations, which included new services with the addition of new technologies. The new services include AI, smart wearables, implants, autonomous vehicles, computing reality devices, sensing, and 3D mapping (Saad.W). The most important requirement for 6G wireless networks is the capability of handling massive volumes of data and very high-data-rate connectivity per device (Mumtaz, 2017).

The 6G system will increase performance and maximize user QoS several folds more than 5G along with some exciting features. It will protect the system and secure the user data. It will provide comfortable services. The 6G communication system is expected to be a global communication facility. It is envisioned that the per-user bit rate in 6G will be approximately 1 Tb/s in many cases (Mumtaz, 2017; David, 2018). The 6G system is expected to provide simultaneous wireless connectivity that is 1000 times higher than 5G. Moreover, ultra-long-range communication with less than 1-ms latency is also expected (F. Tariq). The most exciting feature of 6G is the inclusion of fully supported AI for driving autonomous systems. Video-type traffic is likely to be dominant among various data traffic systems in 6G communications. The most important technologies that will be the driving force for 6G are the terahertz (THz) band, AI, optical wireless communication (OWC), 3D networking, unmanned aerial vehicles (UAV), and wireless power transfer.

In this section we describe how 6G communication systems can be developed; we also describe the expected 6G technologies, and the research issues required to address the needs of future smart networks. Section A presents the 6G enabled technologies. The possible network architectures with the applications of future 6G communication systems is presented in Section B. The expected service requirements

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