
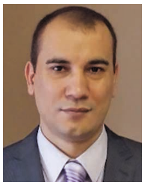

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6G Networks: Is This an Evolution or a Revolution?

The lessons learned from the third industrial revolution taught us that the transformation from mechanical and analog technology to digital electronics have changed the world once and forever. While computers and communication networks have become the new oil that defines the wealth of countries, research and industrial communities have been the driving forces that have made this transition possible. In the future, the same communities and stakeholders are required to enable the transition to net-zero communication networks. With reference to mobile communications, 5G is an evolution from all previous networks with the adoption of new radio access technologies, multisliced architecture, cloud-native and automation, and so on. By definition, 5G is a network that adapts to user needs and dynamic changes in traffic, designed to serve a new class of users: "machines." Therefore, latency has become a critical metric in 5G. Looking forward, 6G shall employ cell-less access networks, integrated nonterrestrial networks, joint sensing and communications, new spectrums such as terahertz (THz) communications, switching from traditional channel-based design paradigms to designing channels through novel technologies such as intelligent reconfigurable surfaces, open interfaces that interconnect all network functions, end-to-end orchestrators, and, most noticeably, artificial intelligence (AI) machines that govern all functional modules and operational services. The various network functions generate traces of various operations that are ingested into databases; then AI will leverage this data for optimized decisions that are reflected into network status transitions, resource utilization, service enhancement, and ultimately lead to self-synthesizing networks. Built upon commercial clouds, 6G will have the flexibility to scale and restructure for more resilient response to traffic fluctuations and user requirements. To this end, cybersecurity features will become an embedded part of network functions to shield the network services not only from external threats but also from hosting domains. From an air interface perspective, 6G will integrate nonterrestrial (space, air, drone, and ocean) communications technologies to connect and route new users such as drones and coastal trading vessels. Furthermore, future wireless networks need to make use of a spectrum that extends into the optical spectrum and includes the THz range. The channel becomes a critical component due to the impact of blockages and random orientations at these frequencies. Active and passive intelligent reflecting surfaces (IRSs) will become a new wireless system element that will help overcome new challenges related to coverage and the propagation channel.

Digital Object Identifier 10.1109/MVT.2021.3116995
Date of current version: 2 December 2021

The evolution of mobile networks could be defined by the continuous improvement and integration of new services or users. However, if 6G became an intelligent network that identified requirements, adapted to situations, and applied self-configuration for sophisticated actions without human intervention, would this be considered an evolution of new network infrastructure? In fact, this is a revolution! The question that we should ask is, "Is such a network vision achievable in five to 10 years from now?" The answer is simple: "It is possible." Considering the massive investment and attention to AI, the migration of networks to the cloud, the adoption of new service and integral components, and most importantly the new visions for a network-over-the-cloud, all of those enablers will allow a new network generation that connect humans through smart machines to be built. A smart 6G network will open the space for groundbreaking advancements in technology and service management. 6G will provide connectivity to new verticals and management to life-supporting facilities at reduced power consumption rates. Therefore, it is the time to think about standards for such networks, composed elements, key-performance indicators, and changes that may be brought to social and economic domains. It seems that this is not the time to think about evolution; it is time to be bold and consider revolutionary steps to adapt to the rapidly changing user demands.

This is the fourth special issue of *IEEE Vehicular Technology Magazine* dedicated to 6G technologies, and the third issue in the 6G series with the IEEE Future Networks Initiative. The special issues will cover different technical areas to help research and industrial communities have a better understanding of the state of the art for 6G communications. This special issue has six articles that address various network segments and technologies.

The first article, "Slicing-Based Artificial Intelligence Service Provisioning on the Network Edge," by Li et al., addresses the AI service provisioning to support 6G edge network intelligence. The authors specify the features and requirements for AI as well as the customized slicing for such services. The article also provides a trace-driven case study to demonstrate the AI service performance requirements via flexibly choosing resource pooling policies.

In the second article, "Key Technologies in 6G Terahertz Wireless Communication Systems: A Survey," Wang et al. study the interesting THz technologies and their potential in future 6G wireless communication systems. The authors conducted a survey for key technologies in 6G THz wireless communication systems, focusing on THz channel modeling, THz multibeam antenna design, THz front-end chip design, THz baseband signal processing, and THz resource management. The article presents various performance analyses.

In the third article, "Cooperative Multiterminal Radar and Communication: A New Paradigm for 6G Mobile Networks," Leyva et al. explore the new hitherto separate radar and communication systems toward their amalgam known as a joint radar and communication system. The article proposes to integrate a radio sensing component into 6G considering an ultradense network scenario. The authors show that building such a system is feasible with current technologies and will support high-resolution applications for next-generation networks.

In the fourth article, "Intelligent Reflecting Surface-Aided Vehicular Networks Toward 6G: Vision, Proposal, and Future Directions," Zhu et al. analyze IRS, considering the significant improvement in the power of needed signals at the receivers, especially that IRS has no energy cost and easy deployment. The authors show how the IRS can improve the signal transmissions between vehicles and roadside units. The article provides interesting analysis and also open the discussion for more complex scenarios that could be studied in the future, such as the utilization of IRS resource in vehicular communication systems.

In the fifth article, "Multicarrier-Division Duplex: A Duplexing Technique for the Shift to 6G Wireless Communications," Li et al. show the advantages of multicarrier-division duplex (MDD) over the in-band full-duplex (IBFD) mode and the conventional half-duplex modes of frequency-division duplex and time-division duplex from several essential aspects, including self-interference cancellation (SIC) techniques capability, resource integration, and the support for high-mobility communications. This article provides many numerical results that show that MDD outperforms IBFD in terms of energy efficiency and SIC. The article also discusses some implementation challenges for MDD systems.

The last article, "Directional Terahertz Communication Systems for 6G: Fact Check: A Quantitative Look," by Boulogeorgos et al., derives realistic values for the needed directivity to establish ultrabroadband communication links at THz frequencies both in backhaul and fronthaul scenarios. The authors also study the impact of misalignment on practical link distances, incorporating reconfigurable intelligent surfaces as a solution to overcome blockage, and explored the implications on the physical layer security of THz networks. The findings of this article are supported by a detailed analysis for performance.

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