



Editorial

Editorial for the Special Issue on 6G Requirements, Vision, and Enabling Technologies



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As the commercialization process of the fifth-generation (5G) communication systems accelerates, research on the sixth generation (6G) is being placed on the agenda in academic and industrial communities all over the world. 6G systems are expected to further enhance the performance of 5G systems and continue to penetrate into all aspects of society, promoting the technological integration of communications with other disciplines, such as artificial intelligence, materials science, and biology. Therefore, a special issue on the development of the future 6G is both timely and valuable. This special issue contains eight papers detailing recent cutting-edge research achievements from the perspectives of 6G requirements, visions, and enabling technologies.

The first paper, entitled “6G: Ubiquitously extending to the vast underwater world of the oceans” by Yuanliang Ma et al., extends current communications to underwater scenarios. The practical needs, bottleneck constraints, physical discoveries, scientific and technological breakthroughs, and cross-disciplinary integration of wireless communication in oceans are analyzed and discussed. To combine the merits of radio and acoustic communications, a new concept of building data bridges between the ocean and atmosphere is proposed, and several feasible approaches for data bridges are presented. It is shown that unified air–surface–under-sea networks are feasible via these bridges.

The second paper, entitled “Industrial wireless control networks: From WIA to the future” by Haibin Yu et al., studies the current status and future prospects of the wireless networks for industrial automation (WIA) technology family. Critical communication requirements and development challenges of

industrial wireless control networks (IWCNs) in the 6G era are analyzed. Key techniques, performance, and applications of WIA are summarized, and a heterogeneous hierarchical architecture for future IWCNs is proposed to meet the requirements of 6G.

The third paper, entitled “Federated learning for 6G: Applications, challenges, and opportunities” by Zhaohui Yang et al., provides a comprehensive overview of the applications of federated learning (FL) for the future 6G wireless networks. The essential requirements, promising applications, main problems, and challenges of FL are addressed, and a comprehensive treatment of FL implementation for wireless communications is discussed.

The fourth paper, entitled “The SOLIDS 6G mobile network architecture: Driving forces, features, and functional topology” by Guanyi Liu et al., presents a logical function architecture named SOLIDS for 6G. The proposed architecture integrates the features of soft, on-demand fulfillment, lite networking, native intelligence, digital twins, and native security. Functions such as self-generation, self-healing, self-evolution, and self-immunity are supported by SOLIDS without human involvement.

The fifth paper, entitled “Toward wisdom-evolutionary and primitive-concise 6G: A new paradigm of semantic communication networks” by Ping Zhang et al., proposes a new route to boost network capabilities toward a wisdom-evolutionary and primitive-concise network (WePCN) vision for the Ubiquitous-X 6G network. An intelligent and efficient semantic communication (IE-SC) network architecture is established, which integrates artificial intelligence and network technologies to enable intelligent interactions among various communication objects in 6G. A brief review of recent advances in semantic communications is presented, and potential use cases for 6G—complemented by a range of open challenges—are highlighted.

The sixth paper, entitled “Blockchain for transparent data management toward 6G” by Xuemin (Sherman) Shen et al., presents blockchain solutions to achieve decentralized data management (DM) while addressing challenges due to the increasing data volume and stringent data privacy-preservation requirements in 6G. The authentication and authorization requirements for DM stakeholders are investigated, DM privacy requirements are categorized, and blockchain-based mechanisms for collaborative data processing are studied. Research issues and potential solutions for blockchain-based DM toward 6G are presented.

<https://doi.org/10.1016/j.eng.2021.12.001>

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The seventh paper, entitled “Joint modulations of electromagnetic waves and digital signals on a single metasurface platform to reach programmable wireless communications” by Xiang Wan et al., proposes a mechanism to fuse the modulation of digital signals and the manipulation of electromagnetic (EM) radiation on a single programmable metasurface (PM). By designing digital coding sequences in the spatial and temporal domains, the digital information and far-field patterns of the PM can be simultaneously and instantly programmed in desired ways. A programmable wireless communication system is presented that can realize digital information transmission in both single-channel and multichannel modes. This work provides excellent prospects for applications in 5G and 6G wireless communications and modern intelligent platforms for unmanned aircrafts and vehicles.

The eighth paper, entitled “MEC-empowered non-terrestrial network for 6G wide-area time-sensitive Internet of Things” by Chengxiao Liu et al., proposes a process-oriented framework to

design communication and mobile edge computing (MEC) systems in a time-division manner in order to balance the time-sensitive requirements and uneven distribution of Internet of Things (IoT) devices. Large-scale channel state information (CSI) is used to characterize the complex propagation environment at an affordable cost. A nonconvex latency minimization problem is formulated, decomposed, and solved to confirm the advantages of non-terrestrial network (NTN) and MEC integration.

In closing, we would like to thank all the authors who submitted their research papers to this special issue. We would also like to acknowledge the contributions of many experts in the field who participated in the review process and provided valuable suggestions to improve the content and presentation of these papers. Finally, we would like to extend our sincere thanks to the editorial team of *Engineering* for their support and help in bringing forward this special issue. We hope you will enjoy reading the papers in this collection and gain inspiration on the future development of 6G.