Intelligent Communications and Heterogeneous Systems in 5G and 6G: Sensing, Security, Space, Thermodynamics, MultipathTCP, Reflection, and Cell-Free Access

In this issue, we are pleased to present two timely feature topics: a collection of six articles on "Intelligent Ultra-Reliable and Low-Latency Communications in 6G," organized by guest editors C. She, T.Q. Duong, T.Q.S. Quek, H. Viswanathan, and D. Lopez-Perez; and a collection of five articles on "Heterogeneous Robotic Systems in 5G and Beyond Networks," organized by guest editors, H. Lu, B. Khalfi, P.-H. Ho, and C. Verikoukis. Both guest editorial teams did an excellent job in organizing these feature topics via a rigorous selection process. Please refer to the guest editorials and individual articles for more details.

We are able to include seven articles from the open calls–covering a diverse range of topics in the field of wireless communication systems. They include studies on MultipathTCP, reflection, cell-free access, backdoor attacks in federated learning, simultaneous information and power transfer in miniaturized satellites, information thermodynamics, multipath TCP, intelligent reflection enabling technologies, and cell-free fixed wireless access.

The first article, "WISe: Wireless Intelligent Sensing for Human-Centric Applications," by A. Qi et al., proposes a framework for wireless intelligent sensing (WISe) using low-noise electromagnet-wave sensors for human-centric applications, with examples in healthcare and automotive monitoring. WISe has potential for novel applications and business models, driven by intelligent resources.

The second article, "Backdoor Attacks and Defenses in Federated Learning: State-of-the-art, Taxonomy, and Future Directions," by X. Gong et al., discusses backdoor attacks and defenses in the federated learning framework, designed for distributed training without compromising privacy. The authors classify backdoor attacks into two types and defenses into three categories, comparing them through experiments and suggesting potential future directions.

The third article, "Space Simultaneous Information and Power Transfer: An Enhanced Technology for Miniaturized Satellite Systems," by G. Pan et al, presents novel simultaneous-information and power-transfer (SSIPT) schemes to extend the lifetime of miniaturized satellites with limited on-board power. Two types of transceivers and several SSIPT-miniaturized satellite system designs are introduced, with numerical results demonstrating the advantages of SSIPT. Challenges and future directions are also discussed.

The fourth article, "Information Thermodynamics Communications," by Ge and Yan, proposes using information thermodynamics to reduce energy consumption in 6G communication systems, including a thermodynamic entropy balance architecture to optimize energy efficiency. Simulation results show significant energy reduction in parity check circuits.

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The fifth article, "Multipath TCP Meets Reinforcement Learning: A Novel Energy-Efficient Scheduling Approach in Heterogeneous Wireless Networks," by P. Dong et al., proposes a path scheduler for Multipath TCP, referred to as MPTCP-RL, by using reinforcement learning to optimize path usage and improve throughput while reducing energy consumption in wireless networks.

The sixth article, "Intelligent Reflection Enabling Technologies for Integrated and Green Internet-of-Everything Beyond 5G: Communication, Sensing, and Security," by W. Shi et al., discusses how intelligent reflection communication technologies such as reconfigurable intelligent surface and ambient backscatter communication can support IoT applications beyond 5G wireless networks, benefiting green communications, security, and space-air-ground integrated communications.

The seventh article, "Downlink Cell-Free Fixed Wireless Access: Architectures, Physical Realities and Research Opportunities," by Y. Zhang et al, discusses the implementation of cell-free fixed wireless access (FWA) as a complementary solution to fiber-to-the-premise (FTTP), focusing on centralization architectures, channel characteristics, and implications on imperfect CSI performance. The study also presents new research opportunities for cell-free FWA.

I hope you enjoy reading these articles. Also, please remember to read other interesting columns: "Book Reviews," "Scanning the Literature," "Industrial Perspectives," and "Spectrum Policy and Regulatory Issues."

Biography

Nirwan Ansari [S'78, M'83, SM'94, F'09] (nirwan.ansari@njit.edu) is a Distinguished Professor of Electrical and Computer Engineering at the New Jersey Institute of Technology (NJIT), received his Ph.D. from Purdue University, his M.S.E.E. from the University of Michigan, and his B.S.E.E. (summa cum laude with a perfect GPA) from NJIT. He is also a Fellow of the National Academy of Inventors. He has published three books and (co-)authored 700 technical publications, over half published in widely cited journals/magazines. He has guest edited a number of Special Issues covering various emerging topics in communications and networking. He is the Editor-in-Chief of *IEEE Wireless Communications* and has served on the Editorial/Advisory Boards of over 10 journals. His current research focuses on green communications and networking, cloud computing, drone-assisted networking, and various aspects of broadband networks. He was elected to serve on the IEEE Communications Society (ComSoc) Board of Governors as a Member-at-Large, has chaired some ComSoc Technical and Steering Committees, is currently the Director of ComSoc's Educational Services Board. He has served on many committees, such as the IEEE Fellow Committee, and has actively organized numerous IEEE international conferences/symposia/workshops. Some of his recognitions include several excellence in teaching awards, a few best paper awards, the NCE Excellence in Research Award, several ComSoc Technical Committee technical recognition awards, the NJ Inventors Hall of Fame Inventor of the Year Award, the Thomas Alva Edison Patent Award, the Purdue University Outstanding Electrical and Computer Engineering Award, the NCE 100 Medal, the NJIT Excellence in Research Prize and Medal, and designation as a ComSoc Distinguished Lecturer. He has also been granted more than 40 U.S. patents.