Advancements in Wireless Network Security and Next-Generation Technologies

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First I would like to express my gratitude to Professor Yi Qian (former EiC and current Director of Magazines) for stepping in as interim EiC of the magazine during my absence of 3-4 months due to unforeseen circumstances that prevented me from providing daily attention to the magazine. I am pleased to be able to resume writing the EiC message. In this issue, we are pleased to present a timely feature topic on "Zero Trust Security Methods for Wireless Networks," organized by guest editors Moayad Aloqaily (lead), Helen Paik, William Tessaro Lunardi, Cihan Tunc, and He Fang. It has attracted numerous submissions. The guest editorial team has done an excellent job in organizing this feature topic and has approved ten quality articles for inclusion after a rigorous selection process. Please refer to the guest editorials and individual articles for more details.

We are also able to include ten articles from the open call, covering a diverse range of topics in the field of wireless communications, which can be grouped into four themes.

The theme of "Innovations in Next-Generation Wireless Infrastructure" encapsulates the first article, "LEO Satellite Access Network (LEO-SAN) Towards 6G: Challenges and Approaches" authored by Z. Xiao *et al.*, the second article, "UAV-Enabled Integrated Sensing and Communication: Opportunities and Challenges" authored by K. Meng *et al.*, the third article "Multiple-Antenna Aided Aeronautical Communications in Air-Ground Integrated Networks: Channel Estimation, Reliable Transmission, and Multiple Access" authored by J. Zhao *et al.*, and the fourth article "Reliable Terabits Feeder Link for Very High-Throughput Satellite Systems with SAG-FSO Transmission" authored by R. Samy *et al.*, which explore groundbreaking advancements in next-generation wireless infrastructure, aiming to revolutionize connectivity in various domains. From the potential of Low Earth Orbit (LEO) satellite networks (LEO-SAN) to enhance sixth-generation (6G) wireless networks to the integration of Unmanned Aerial Vehicles (UAVs) for Integrated Sensing and Communication (ISAC) in 6G wireless networks, these articles delve into the opportunities and challenges presented by cutting-edge technologies.

Furthermore, the theme delves into the complexities of implementing multiple-antenna-aided aeronautical broadband communications (ABC) in air-ground integrated networks, emphasizing the importance of channel estimation, reliable transmission, and multiple access in overcoming obstacles such as spectrum congestion and interference.

Additionally, it discusses the imperative need for reliable terabit/s feeder links in Very High-Throughput Satellite (VHTS) systems, proposing innovative solutions such as combining Free-Space Optical (FSO) transmissions with space-air-ground (SAG) relays to mitigate atmospheric and weather effects.

Overall, this theme showcases the transformative potential of these advancements in reshaping the landscape of wireless communication infrastructure, paving the way for enhanced connectivity, efficiency, and reliability in future wireless networks.

The theme of "Semantic Integration in Wireless Edge Computing," is represented by the fifth article "Multi-Modal and Multi-User Semantic Communications for Channel-level Information Fusion" by X. Luo *et al.*, and the sixth article "A Unified Blockchain-Semantic Framework for Wireless Edge Intelligence Enabled Web 3.0" by Y. Lin *et al.*, revolves around the integration of semantic technologies into wireless edge computing environments, offering innovative solutions to enhance communication, security, and efficiency.

The fifth article discusses the concept of multi-modal and multi-user semantic communications, emphasizing channel-level information fusion to facilitate direct fusion of multimodal data over wireless channels. Semantic precoding techniques are proposed to mitigate the randomness of wireless channels, while a case study on semantic segmentation validates the effectiveness of the approach. Despite its promise, the article also highlights open issues such as signal synchronization and multimodal data transformation, suggesting the convergence of advanced communication technologies with semantic communications.

The sixth article introduces a unified framework for Web 3.0, which leverages blockchain and semantic technologies in wireless edge intelligence. This framework addresses challenges related to data security and efficiency by proposing an Oracle-based proof of semantic mechanism and an adaptive sharding mechanism using Deep Reinforcement Learning. A case study demonstrates the effectiveness of the framework in enhancing wireless edge intelligence.

Overall, this theme emphasizes the importance of semantic integration in wireless edge computing, offering solutions to improve communication reliability, data security, and efficiency in the emerging era of Web 3.0.

The seventh article "Codebook-Based Solutions for Reconfigurable Intelligent Surfaces and Their Open Challenges" by J. An *et al.* and the eighth article "Model-Free Configuration of Intelligent Reflecting Surfaces: Towards Pervasive Adaptability and Enhanced Robustness" by W. Wang *et al.* constitute the theme of "Innovative Approaches in Intelligent Surface Configuration for Enhanced Wireless Communications," which explores cutting-edge methodologies in configuring Intelligent Surfaces (IS) to optimize wireless communication networks. The seventh article introduces a codebook-based framework for Reconfigurable Intelligent Surfaces (RIS), revolutionizing channel estimation and passive beamforming methods to streamline network complexity. It emphasizes adaptability to diverse quality-of-service requirements, setting a new standard in wireless network optimization. Complementing this, the eighth article delves into model-free configuration techniques for Intelligent Reflecting Surfaces (IRS), circumventing challenges posed by imprecise reflection control and channel uncertainty. By employing methodologies such as Majority Voting and Deep Reinforcement Learning, it enhances IS robustness and adaptability, paving the way for pervasive deployment in future wireless networks. Together, these articles epitomize the forefront of intelligent surface configuration, promising enhanced performance and efficiency in wireless communication systems.

Finally, the ninth article "Task-Efficiency Oriented V2X Communications: Digital Twin Meets Mobile Edge Computing" by G. Cai *et al.* and the tenth article "Federated Learning for Digital Twin-Based Vehicular Networks: Architecture and Challenges" by L. U. Khan *et al.* establish the theme of "Empowering Vehicular Networks: Integrating Digital Twins and Federated Learning,"

which delves into the synergy between Digital Twin (DT) technology and Federated Learning (FL) to enhance efficiency and intelligence in Vehicular-to-Everything (V2X) communications. The ninth article explores the integration of DTs with V2X networks, emphasizing task-oriented approaches to maximize benefits such as improved human-machine interaction and traffic safety. It addresses challenges like algorithm complexity and data privacy, paving the way for practical implementations. Complementing this, the tenth article focuses on FL in DT-based vehicular networks, offering a privacy-preserving distributed learning framework. It tackles issues of convergence time and resource optimization while showcasing FL's potential in analytics and caching. Together, these two articles highlight the transformative potential of DTs and FL in revolutionizing vehicular networks, emphasizing their crucial role in shaping future mobility solutions.

While I strive to provide readers with a concise overview of the articles mentioned above, I acknowledge that they may not fully capture the depth and complexity of each piece. I apologize for any oversight or omission that may have occurred in my summary. I encourage readers to explore the full articles for a comprehensive understanding of the topics discussed. Additionally, I recommend checking out the informative write-up on "The National Spectrum Strategy and Implementation Plan" featured in the Spectrum Policy and Regulatory Issues column for further insights into spectrum management.

Biography

NIRWAN ANSARI [S'78, M'83, SM'94, F'09] (nirwan.ansari@njit.edu), a Distinguished Professor of Electrical and Computer Engineering at the New Jersey Institute of Technology (NJIT), holds a Ph.D. from Purdue University, an MSEE from the University of Michigan, and a BSEE (summa cum laude with a perfect GPA) from NJIT. He is a Life Fellow of the Institute of Electrical and Electronics Engineers (IEEE) and a Fellow of the National Academy of Inventors (NAI). He authored Green Mobile Networks: A Networking Perspective (Wiley-IEEE, 2017) with T. Han, and co-authored two other books. He has also (co-)authored over 700 technical publications, with more than half of them published in widely cited journals and magazines. He has served as a guest editor for numerous special issues on various emerging topics in communications and networking. Currently, he serves as the Editor-in-Chief of *IEEE Wireless Communications* and has been on the editorial/advisory board of over ten journals. His current research focuses on green communications and networking, edge 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. He has served as the Director of the ComSoc Educational Services Board, has chaired various technical and steering committees within ComSoc, and has served on many committees such as the IEEE Fellow Committee. He has actively participated in organizing numerous IEEE International Conferences/Symposia/Workshops. Among his many recognitions are several excellences in teaching awards, multiple best paper awards, the NCE Excellence in Research Award, several ComSoc TC 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.