Guest Editorial Special Issue on Energy-Efficient Reconfigurable Wireless Communication and Networks

THE NEXT-GENERATION wireless communication and networks are envisioned to become controllable, programmable, and intelligent by leveraging emerging technologies such as Intelligent Reflecting Surface (IRS) and Cognitive Radio. Reconfigurable wireless networks aim to enable "intelligence" into the existing system to perceive and assess the available resources, autonomously learn to adapt to the wireless environment's dynamism and reconfigure its operating mode to maximize the utility of the available resources. Moreover, it needs to be energy efficient to support the technological limitations on energy supply and mitigate the effect of the information and communication technologies. Apart from that, the newly designed solutions need to be energy efficient to accommodate the power consumption of the numerous devices in wireless communication and Networks. This special issue aims to motivate the researchers to design novel schemes and architectures for the energy-efficient reconfigurable wireless communication and networks. This issue has 47 high-quality papers covering several aspects of reconfigurable wireless communication and networks. Among them, 17 papers with significant original contributions were eventually selected for publications in this special issue.

In the first work, Yuan *et al.* [A1] proposed an energy storage-aided reconfigurable renewable energy supply scheme for the 5G base stations. They used deep reinforcement learning to design the scheme on an online battery discharging/charging schedule. The paper by Dev *et al.* [A2] presented an optimal CH selection scheme for optimizing the energy utilization in IoT networks. In the proposed scheme, the authors used the Harris Hawks Optimization algorithm. They analyzed the performance of the proposed scheme while evaluating the metrics such as delay, load, number of alive nodes, residual energy, and temperature. In the third work, Yao *et al.* [A3] designed a multilevel cooperative MPTCP Incast performance evaluation model. They studied the delay performance in MPTCP Incast throughput collapse. Gupta *et al.* [A4] proposed an Adam optimized LSTM-based scheme while ensuring energy harvesting in the downlink transmission of a RIS-enabled wireless communication network. The authors used an LSTM-based deep learning model for training and evaluated the optimal RIS configuration for improved energy harvest in the proposed scheme. In another work, Das *et al.* [A5] studied a multi-hop D2D communication scheme for cellular networks to reduce associated electromagnetic radiation (EMR). They formulated a detailed analytical model while considering the linear and random network topologies. Soleymani *et al.* [A6] also proposed an improper Gaussian signaling (IGS) scheme to improve the spectral and energy efficiency (EE) of a multicell broadcast multiple-input, multiple-output (MIMO) reconfigurable-intelligent-surface (RIS)-assisted channel. To design the proposed scheme, they used minimum-weighted-rate, weighted-sum-rate, minimum weighted-EE, and global-EE maximization. An *et al.* [A7] presented a joint training of the superimposed direct and reflected Links in Reconfigurable Intelligent surface (RIS) for multiuser communication. They addressed the challenging issues of channel estimation and beamforming optimization using a training approach. The work by Li *et al.* [A8] studied a Federated Deep Learning (FDL) based algorithm to maximize the total throughput of multiple Intelligent Reflecting Surfaces (IRSs) assisted multiuser communication system. Xu *et al.* [A9] designed a power allocation intelligent optimization scheme for mobile Internet of Things (IoT) networks. In the proposed scheme, the authors used an improved grey wolf optimization (IGWO) algorithm to design the scheme.

In another work by Li *et al.* [A10] the authors presented an energy-efficient task offloading scheme in a delay-constrained mobile edge computing environment. In the proposed scheme, the authors considered two types of task offloading – binary and partial. The authors solved the aforementioned NP-hard problem using non-convex joint-optimization. Ramasamy *et al.* [A11] proposed an energy-efficient data aggregation by end-to-end security in a 3D reconfigurable wireless sensor network. The proposed scheme used a packet deduplication concept using hashing distance computation algorithm and a cell-by-cell golden sector-based emperor penguin colony for trust-based efficient routing. In the next work, Jia *et al.* [A12] proposed an IRS-based scheme to improve the energy efficiency in a bistatic backscatter network system. Jegadeesan *et al.* [A13] designed a marine traffic management scheme while ensuring anonymous authentication with trajectory privacy. In the proposed scheme, the authors proposed to generate an anonymous certificate, anonymous signature, and verification certificate for resolving the security problems in a resource-limited system.

Moreover, Paul and Maity [A14] proposed an energy and spectrum efficient scheme for maximizing the throughput of CRN. In the proposed scheme, they used a support vector machine (SVM)-based primary user (PU) activity (transmit/non-transmit mode) prediction and a Deep

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Q-networks (DQN) based energy and spectrum efficient routing strategy. The work by Bebortta *et al.* [A15] presented a local data reduction (LDR)-based data acquisition scheme for edge Industrial IoT networks. In the proposed scheme, they modeled the proposed scheme as a Markovian birth-death process and evaluated different performance metrics such as average data packets in the system, average data packets in the queue, and the waiting time of data packets in the system and queue. In another work, Zhang and Mao [A16] proposed an energy consumption minimization scheme for the intelligent reflecting surface-based federate learning system in a reconfigurable wireless communication network. In the proposed scheme, the authors designed an iterative resource allocation algorithm while jointly optimizing parameters of the parameters – bandwidth and power resource of the IoT devices. Furthermore, Diamanti *et al.* [A17] presented a dynamic resource management scheme to optimize the end-to-end energy consumption while controlling the phase shifts of the reconfigurable intelligent surface elements in a UAV-assisted Integrated Access and Backhaul network. In the proposed scheme, the authors used single-leader-multiple-followers Stackelberg games for optimizing the phase shifts of the RIS elements, the bandwidth splitting, and the power allocation for the uplink users and UAVs.

We, the Guest Editors, express our gratitude to the authors for submitting their high-quality works. We are also thankful to the reviewers for the painstaking task of providing the timely and insightful reviews that helped maintain the high quality of this special issue at the IEEE TRANSACTIONS ON GREEN COMMUNICATIONS AND NETWORKING (TGCN). We are also highly grateful to Prof. Zhisheng Niu, the Editor-in-Chief of the IEEE TGCN, and associated staff for providing their constant support.

SUDIP MISRA, *Lead Guest Editor*
Department of Computer Science and Engineering
Indian Institute of Technology Kharagpur
Kharagpur 721302, India

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Universita' degli Studi di Milano
20122 Milan, Italy

GUOLIANG XUE, *Guest Editor*
School of Computing, Informatics, and Decision Systems Engineering
Arizona State University
Tempe, AZ 85287 USA

APPENDIX: RELATED ARTICLES

[A1] H. Yuan *et al.*, "BESS aided renewable energy supply using deep reinforcement learning for 5G and beyond," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 669–684, Jun. 2022, doi: 10.1109/TGCN.2021.3136363.

[A2] K. Dev, P. K. R. Maddikunta, T. R. Gadekallu, S. Bhattacharya, P. Hegde, and S. Singh, "Energy optimization for green communication in IoT using Harris Hawks optimization," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 685–694, Jun. 2022, doi: 10.1109/TGCN.2022.3143991.

[A3] J. Yao, S. Pang, J. J. P. C. Rodrigues, Z. Lv, and S. Wang, "Performance evaluation of MPTCP incast based on queuing network," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 695–703, Jun. 2022, doi: 10.1109/TGCN.2021.3125860.

[A4] K. D. Gupta, R. Nigam, D. K. Sharma, and S. K. Dhurandher, "LSTM based energy-efficient wireless communication with reconfigurable intelligent surfaces," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 704–712, Jun. 2022, doi: 10.1109/TGCN.2021.3135437.

[A5] A. Das, N. Das, and A. D. Barman, "Multi-hop D2D communication in cellular networks to minimize EMR," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 713–722, Jun. 2022, doi: 10.1109/TGCN.2021.3139286.

[A6] M. Soleymani, I. Santamaria, and P. J. Schreier, "Improper signaling for multicell MIMO RIS-assisted broadcast channels with I/Q imbalance," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 723–738, Jun. 2022, doi: 10.1109/TGCN.2021.3140150.

[A7] J. An, C. Xu, L. Wang, Y. Liu, G. Lu, and L. Hanzo, "Joint training of the superimposed direct and reflected links in reconfigurable intelligent surface assisted multiuser communications," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 739–754, Jun. 2022, doi: 10.1109/TGCN.2022.3143226.

[A8] L. Li, D. Ma, H. Ren, P. Wang, W. Lin, and Z. Han, "Towards energy-efficient multiple IRSs: Federated learning based configuration optimization," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 755–765, Jun. 2022, doi: 10.1109/TGCN.2021.3136306.

[A9] L. Xu, X. Zhou, Y. Li, F. Cai, X. Yu, and N. Kumar, "Intelligent power allocation algorithm for energy-efficient mobile Internet of Things (IoT) networks," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 766–775, Jun. 2022, doi: 10.1109/TGCN.2022.3144532.

[A10] Z. Li, N. Zhu, D. Wu, H. Wang, and R. Wang, "Energy-efficient mobile edge computing under delay constraints," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 776–786, Jun. 2022, doi: 10.1109/TGCN.2021.3138729.

[A11] K. Ramasamy, M. H. Anisi, and A. Jindal, "E2DA: Energy efficient data aggregation and end-to-end security in 3D reconfigurable WSN," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 787–798, Jun. 2022, doi: 10.1109/TGCN.2021.3126786.

[A12] X. Jia, X. Zhou, D. Niyato, and J. Zhao, "Intelligent reflecting surface-assisted bistatic backscatter networks: Joint beamforming and reflection design," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 799–814, Jun. 2022, doi: 10.1109/TGCN.2021.3127190.

[A13] S. Jegadeesan, M. S. Obaidat, P. Vijayakumar, and M. Azees, "SEAT: Secure and energy efficient anonymous authentication with trajectory privacy-preserving scheme for marine traffic management," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 815–824, Jun. 2022, doi: 10.1109/TGCN.2021.3126618.

[A14] A. Paul and S. P. Maity, "Machine learning for spectrum information and routing in multi-hop green cognitive radio networks," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 825–835, Jun. 2022, doi: 10.1109/TGCN.2021.3127308.

[A15] S. Bebortta, D. Senapati, C. Panigrahi, and B. Pati, "An adaptive modeling and performance evaluation framework for edge-enabled green IoT systems," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 836–844, Jun. 2022, doi: 10.1109/TGCN.2021.3127487.

[A16] T. Zhang and S. Mao, "Energy-efficient federated learning with intelligent reflecting surface," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 845–858, Jun. 2022, doi: 10.1109/TGCN.2021.3126795.

[A17] M. Diamanti, P. Charatsaris, E. E. Tsiropoulou, and S. Papavassiliou, "The prospect of reconfigurable intelligent surfaces in integrated access and backhaul networks," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 2, pp. 859–872, Jun. 2022, doi: 10.1109/TGCN.2021.3126784.

Sudip Misra (Fellow, IEEE) received the Ph.D. degree from Carleton University, Ottawa, Canada. He is a Professor with the Indian Institute of Technology Kharagpur. He is the author of over 350 scholarly research papers. He has 11 books published by Springer, Wiley, and World Scientific. He has won several national and international awards, including the IEEE ComSoc Asia–Pacific Young Researcher Award during IEEE GLOBECOM 2012. He was also the recipient of several academic awards and fellowships, such as the INSA NASI Fellow Award (National Academy of Sciences, India), the Young Scientist Award (National Academy of Sciences, India), the Young Systems Scientist Award (Systems Society of India), and the Young Engineers Award (Institution of Engineers, India). He has also been serving as the Associate Editor for IEEE TRANSACTIONS ON MOBILE COMPUTING, IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, IEEE TRANSACTIONS ON SUSTAINABLE COMPUTING, IEEE SYSTEMS JOURNAL, and the *International Journal of Communication Systems* (Wiley). He is a Guest Editor of the *IEEE Network Magazine*. He is also an Editor/Editorial Board Member/Editorial Review Board Member of the *IET Networks* and the *IET Wireless Sensor Systems*. He was invited to chair several international conference/workshop programs and sessions. He was also invited to deliver keynote/invited lectures in over 30 international conferences in the USA, Canada, Europe, Asia, and Africa. For more details, please visit http://cse.iitkgp.ac.in/∼smisra.

Yue Gao (Senior Member, IEEE) received the Ph.D. degree from the Queen Mary University of London, U.K., in 2007. He is a Professor and the Chair of Wireless Communications with the Institute for Communication Systems, School of Computer Science and Electronic Engineering, University of Surrey, U.K. He currently leads the Antennas and Signal Processing Lab developing fundamental research into practice in the interdisciplinary area of smart antennas, signal processing, spectrum sharing, millimeter-wave, and Internet of Things technologies in mobile and satellite systems. He has published over 200 peer-reviewed journal and conference papers, one book, and five book chapters. He was a co-recipient of the EU Horizon Prize Award on Collaborative Spectrum Sharing in 2016 and elected as an Engineering and Physical Sciences Research Council Fellow in 2017. He is a member of the Board of Governors and a Distinguished Lecturer of the IEEE Vehicular Technology Society (VTS), the Vice-Chair of the IEEE ComSoc Wireless Communications Technical Committee, and the Past Chair of the IEEE ComSoc Technical Committee on Cognitive Networks. He has been an editor of several IEEE transactions and journals, and the symposia chair, track chair, and other roles in the organizing committee of several IEEE ComSoC, VTS, and other conferences.

Nitin Gupta (Senior Member, IEEE) received the Ph.D. degree from NSIT, University of Delhi under the supervision of Prof. S. K. Dhurandher. He has been serving as an Assistant Professor with the Department of Computer Science and Engineering, National Institute of Technology Hamirpur, Hamirpur, India, since 2007. His research interest includes efficient resource allocation in next-generation wireless networks, especially cognitive radio networks. He has published various research papers in high-impact reputed international journals, such as IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, IEEE TRANSACTIONS ON NETWORK SCIENCE AND ENGINEERING, and IEEE SYSTEMS JOURNAL and conferences of repute, such as IEEE ICC, GLOBECOM, and INFOCOM. He has served as an Associate Editor for *International Journal of Sensor Networks* (Inderscience) and a Guest Editor for IEEE TRANSACTIONS ON GREEN COMMUNICATIONS AND NETWORKING, *Transactions on Emerging Telecommunications Technologies* (Wiley), and *Sustainable Computing: Informatics and Systems* (Elsevier). Along with organizing various short-term courses and conferences, he was also a member of technical program committees of various IEEE/ACM/Springer/Scopus conferences. He is a reviewer of various reputed journals, such as IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS, IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, IEEE SYSTEMS JOURNAL, and *International Journal of Communication Systems* (Wiley). He is a member of the IEEE Communication Society and ACM. He is also a member of the Executive Committee of the IEEE Communication Society-Delhi Chapter.

Falko Dressler (Fellow, IEEE) received the M.Sc. and Ph.D. degrees from the Department of Computer Science, University of Erlangen in 1998 and 2003, respectively. He is a Full Professor and the Chair for Telecommunication Networks with the School of Electrical Engineering and Computer Science, TU Berlin. He authored the textbooks *Self-Organization in Sensor and Actor Networks* (Wiley) and *Vehicular Networking* (Cambridge University Press). His research objectives include adaptive wireless networking (sub-6 GHz, mmWave, visible light, and molecular communication) and wireless-based sensing with applications in ad hoc and sensor networks, the Internet of Things, and cyber–physical Systems. He has been an Associate Editor-in-Chief of IEEE TRANSACTIONS ON MOBILE COMPUTING and *Computer Communications* (Elsevier) as well as an Editor for journals, such as IEEE/ACM TRANSACTIONS ON NETWORKING, IEEE TRANSACTIONS ON NETWORK SCIENCE AND ENGINEERING, *Ad Hoc Networks* (Elsevier), and *Nano Communication Networks* (Elsevier). He has been chairing conferences, such as IEEE INFOCOM, ACM MobiSys, ACM MobiHoc, IEEE VNC, and IEEE GLOBECOM. He has been an IEEE Distinguished Lecturer as well as an ACM Distinguished Speaker. He is an ACM Distinguished Member. He is a member of the German National Academy of Science and Engineering (acatech). He has been serving on the IEEE COMSOC Conference Council and the ACM SIGMOBILE Executive Committee.

Vincenzo Piuri (Fellow, IEEE) received the Ph.D. degree in computer engineering from the Politecnico di Milano, Italy, in 1989.

He has been a Full Professor of Computer Engineering with the Universitá degli Studi di Milano, Italy, since 2000. He has also been an Associate Professor with the Politecnico di Milano, a Visiting Professor with The University of Texas at Austin, USA, and a Visiting Researcher with George Mason University, USA. He is an Honorary Professor with Obuda University, Hungary; Guangdong University of Petrochemical Technology, China; Northeastern University, China; Muroran Institute of Technology, Japan; Amity University, India; and Galgotias University, India. Original results have been published in more than 400 articles in international journals, proceedings of international conferences, books, and book chapters. His research interests include artificial intelligence, computational intelligence, intelligent systems, machine learning, pattern analysis and recognition, signal and image processing, biometrics, intelligent measurement systems, industrial applications, digital processing architectures, fault tolerance, dependability, and cloud computing infrastructures.

Prof. Piuri received the IEEE Instrumentation and Measurement Society Technical Award in 2002 and the IEEE TAB Hall of Honor in 2019. He is a Distinguished Scientist of ACM and a Senior Member of INNS. He is an IEEE Region 8 Director-Elect in 2021–2022. He has been the IEEE Vice President for Technical Activities in 2015, the IEEE Director, the President of the IEEE Systems Council and the IEEE Computational Intelligence Society, the Vice President for Education of the IEEE Biometrics Council, the Vice President for Publications of the IEEE Instrumentation and Measurement Society and the IEEE Systems Council, and the Vice President for Membership of the IEEE Computational Intelligence Society. He is an Associate Editor of IEEE TRANSACTIONS ON CLOUD COMPUTING. He was the Editor-in-Chief of IEEE SYSTEMS JOURNAL from 2013 to 2019 and has been an Associate Editor of IEEE TRANSACTIONS ON COMPUTERS, IEEE TRANSACTIONS ON NEURAL NETWORKS, IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT, and IEEE ACCESS.

Guoliang (Larry) Xue (Fellow, IEEE) received the B.S. degree in mathematics and the M.S. degree in operations research from Qufu Normal University in 1981 and 1984, respectively, and the Ph.D. degree in computer science from the University of Minnesota in 1991. He is a Professor of Computer Science and Engineering with Arizona State University. His research interests include resource allocation in computer networks, security and survivability issues in networks, and machine-learning-enabled crowdsourcing. He received several best paper awards, including the 2019 William R. Bennett Prize from the IEEE Communications Society. He was an Area Editor of IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS for the Wireless Networking Area overseeing 12 editors. He is an Associate Editor of IEEE TRANSACTIONS ON MOBILE COMPUTING. He is a Past Editor of IEEE/ACM TRANSACTIONS ON NETWORKING and *Computer Networks*. He was a TPC Co-Chair of IEEE INFOCOM2010 and a Co-General Chair of IEEE CNS2014. He was a Keynote Speaker at IEEE LCN2011, IEEE ICNC2014, and IEEE ICT-DM'2018. He served as the VP-Conferences of the IEEE Communications Society in 2016 and 2017. He is the Steering Committee Chair of IEEE INFOCOM.