

Guest Editorial

Special Issue on Communications and Computing for Green Industrial IoT and Smart Grids

WITH this special issue, the guest editorial team, Drs. Melike Erol-Kantarci, George C. Alexandropoulos, Peter Han Joo Chong, Andrea M. Tonello and Yan Zhang have prepared a selection of excellent articles on novel energy-efficient communication and computing techniques for Industrial IoT (IIoT) and smart grids. The goal of this special issue is to advance and promote significant technological advances in the field. IIoT covers the broad domain of smart grid, smart manufacturing, intelligent transportation and smart cities, and it refers to the combination of IoT technology with big data coming from intelligent processes in those domains. Energy-efficient transmission and processing of this data targets automation, efficiency, and productivity increase. In particular, smart grid can be considered as a typical IIoT example, since it comprises an industrial setting with a large number of IoT devices. Within Green Industrial IoT, smart grid communications, use state-of-the-art communication technologies towards ensuring the reduction of energy consumption, optimal operation of the smart grid, Advanced Metering Infrastructure (AMI), as well as coordination between the different smart grid components from generation to distribution and consumption.

This special issue presents the readers three outstanding invited papers from distinguished researchers. The first article by Arafa *et al.* [A1] provides timely contributions to the area of energy harvesting sensors and considers the critical problems related with age of information. The second invited paper is [A2] by Shahiri *et al.* This article investigates imperfect channel estimation and hardware impairments from a realistic point of view and provides important insights to short packet communications which have unique challenges since their maximum achievable rate cannot be computed by the classic Shannon theory. The third invited paper of this special issue is [A3] authored by Toro *et al.* The paper presents a comprehensive survey on backscatter communications which have recently emerged to enable joint wireless communication and sensing for IIoT.

In addition to the invited papers, the special issue has 8 very interesting papers. In [A4], Wang *et al.* focus on non-intrusive appliance load monitoring and use meta-learning and ensemble learning to improve the training in this important smart grid application. Li *et al.* propose an energy-efficient land mapping scheme for unmanned ground vehicles operating in

unknown environments. In [A5], they use machine learning to fuse a limited number of aerial and terrestrial images. In [A6], Zhu *et al.* propose AI task offloading mechanisms for IoT devices such that energy-efficiency would be achieved. Meanwhile Gu *et al.* [A7] focus on secure and energy efficient image transmission by IoT devices. In [A8], Mensi *et al.* suggest using the gradient ascent algorithm to search for the best combiners and waveforms to maximize the secrecy capacity in smart grid communications. In [A9], Nayak *et al.* presents a survey on resource allocation schemes in VANETs with a focus on security and privacy. The article by Schlichter *et al.* [A10] presents a real-world sensor design and measurement system in an IIoT setting. Finally, in [A11], Dridi *et al.* propose a reinforcement learning approach for energy management in microgrids.

This selection of eleven outstanding papers provide a solid view of the landscape in green IoT and smart grid communications. We would like to thank all the authors for their outstanding contributions to this special issue. We are also grateful to the reviewers for their effort and time in providing insightful opinions and helping to improve the quality of the articles. Finally, we would like to thank the Editor-in-Chief, Dr. Zhisheng Niu, for his diligence and great support.

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APPENDIX: RELATED ARTICLES

- [A1] A. Arafa, J. Yang, S. Ulukus, and H. V. Poor, "Timely status updating over erasure channels using an energy harvesting sensor: Single and multiple sources," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 6–19, Mar. 2022, doi: [10.1109/TGCN.2021.3105881](https://doi.org/10.1109/TGCN.2021.3105881).
- [A2] V. Shahiri, A. Kuhestani, and L. Hanzo, "Short-packet amplify-and-forward relaying for the Internet-of-Things in the face of imperfect channel estimation and hardware impairments," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 20–36, Mar. 2022, doi: [10.1109/TGCN.2021.3092067](https://doi.org/10.1109/TGCN.2021.3092067).
- [A3] U. S. Toro, K. Wu, and V. C. M. Leung, "Backscatter wireless communications and sensing in green Internet of Things," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 37–55, Mar. 2022, doi: [10.1109/TGCN.2021.3095792](https://doi.org/10.1109/TGCN.2021.3095792).
- [A4] L. Wang, S. Mao, B. Wilamowski, and R. M. Nelms, "Pre-trained models for non-intrusive appliance load monitoring," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 56–68, Mar. 2022, doi: [10.1109/TGCN.2021.3087702](https://doi.org/10.1109/TGCN.2021.3087702).
- [A5] J. Li *et al.*, "Energy-efficient ground traversability mapping based on UAV-UGV collaborative system," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 69–78, Mar. 2022, doi: [10.1109/TGCN.2021.3107291](https://doi.org/10.1109/TGCN.2021.3107291).
- [A6] S. Zhu, K. Ota, and M. Dong, "Green AI for IIoT: Energy efficient intelligent edge computing for industrial Internet of Things," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 79–88, Mar. 2022, doi: [10.1109/TGCN.2021.3100622](https://doi.org/10.1109/TGCN.2021.3100622).
- [A7] Z. Gu *et al.*, "IEPSBP: A cost-efficient image encryption algorithm based on parallel chaotic system for green IoT," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 89–106, Mar. 2022, doi: [10.1109/TGCN.2021.3095707](https://doi.org/10.1109/TGCN.2021.3095707).
- [A8] N. Mensi, D. B. Rawat, and E. Balti, "Gradient ascent algorithm for enhancing secrecy rate in wireless communications for smart grid," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 107–116, Mar. 2022, doi: [10.1109/TGCN.2021.3093821](https://doi.org/10.1109/TGCN.2021.3093821).
- [A9] B. P. Nayak, L. Hota, A. Kumar, A. K. Turuk, and P. H. J. Chong, "Autonomous vehicles: Resource allocation, security and data privacy," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 117–131, Mar. 2022, doi: [10.1109/TGCN.2021.3110822](https://doi.org/10.1109/TGCN.2021.3110822).
- [A10] J. Schlichter, M. Vogt, N. Agrawal, L. Wolf, and C. Herrmann, "Enabling energy efficient HVAC operation through IWSNs," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 132–147, Mar. 2022, doi: [10.1109/TGCN.2021.3105370](https://doi.org/10.1109/TGCN.2021.3105370).
- [A11] A. Dridi, H. Afifi, H. Moungra, and J. Badosa, "A novel deep reinforcement approach for IIoT microgrid energy management systems," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 148–159, Mar. 2022, doi: [10.1109/TGCN.2021.3112043](https://doi.org/10.1109/TGCN.2021.3112043).



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