

Guest Editorial: Special Issue on Energy Efficiency for Internet of Things

THE NUMBER of IoT devices is increasing at a tremendous rate. It is estimated that there already are about 30 billions IoT devices deployed worldwide (more than 3 per person already!) and this number triplicates in only 10 years. These data are not surprising and clearly explained by the continuous development of new interesting solutions based on IoT. IoT-based applications are countless and being deployed in practically all sectors: for industry and agriculture, for the environment, through monitoring and disaster management, for healthcare and wellbeing, for society and resource management in urban environments.

Energy is often one of the key variables in the design space of these applications and their technological solutions. On the one hand, IoT devices are often relying on little energy storage, if any, and the survivability of nodes or portions of IoT networks is threatened by high levels of energy-consumption. On the other hand, with the number of devices mentioned above, despite being very little the consumption of individual IoT elements, the aggregated energy consumption is huge. In addition, IoT solutions generate traffic that often needs to be transported, stored, elaborated and accessed by users, stressing the overall sustainability concerns for the ICT sector.

Acknowledging the central importance of IoT in the global challenge of ICT sustainability, IEEE TRANSACTIONS ON GREEN COMMUNICATIONS AND NETWORKING (TGCN) is proposing a special issue with a selection of papers that cover some of the key challenges of IoT related to energy and sustainability. The four selected contributions that are included in this special issue focus on different, yet all extremely timely, IoT scenarios: IoT networks that rely on photovoltaic (PV) energy, body area networks, networks assisted by Unmanned Aerial Vehicles (UAVs) and solutions based on simultaneous energy and information transfer through wireless links.

The integration of renewable generation in the communication infrastructure is a promising solution for tackling the issues of high energy-consumption and sustainability. When renewables are considered, however, their intermittent and highly variable generation requires careful prediction of energy production and calls for low computational demanding approaches when predictions are performed at the edge of the network, as in several IoT based scenarios. With this objective, in “A *Lightweight Short-Term Photovoltaic Power Prediction for Edge Computing*”, Xiaomin Chang,

Wei Li and Albert Y. Zomaya propose an accurate PV power output prediction technique that requires limited computation. The solution combines temporal pattern aggregation and weather clustering. Experimental results show that the proposed framework improves both accuracy and efficiency of benchmark solutions that do not rely on weather clustering.

The work “*Energy-Efficient Optimal Admission Control for Body Area Networks*” by Mohammad Nekoui, Lichung Chu, and Ali Eslami focuses on body area networks for enhancing people health and quality of life. The paper proposes an admission control mechanism that takes into account the specific constraints of the scenario, such as limited buffer size and power availability at the nodes, as well as heterogeneous QoS requirements of the traffic flows that, being the traffic typically coming from health monitoring applications, combine in complex ways reliability, delay and priority. Besides considering the possibility to terminate active flows to admit high priority connections, the proposed solution attempts to adjust active flow parameters.

Making use of game theory approaches, the paper “*Matching Game with No-Regret Learning for IoT Energy-Efficient Associations With UAV*” by Safae Lhazmir, Omar Ait Oualhaj, Abdellatif Kobbane and Jalel Ben-Othman formalizes the design and analysis of IoT networks assisted by UAVs, focusing, in particular, on the device association problem. The objective is to provide reliable connections with low communication power and load balance. The locations of UAVs are determined based on urgent data transfer requests and while receiving urgent data, UAVs serve also neighboring IoT devices that have data to transmit. Simulation results show that the proposed approach provides a low average total transmit power, ensures fast data transmission and optimal utilization of the UAVs bandwidth.

In “*Multiuser Full-Duplex IoT Networks With Wireless-Powered Relaying: Performance Analysis and Energy Efficiency Optimization*,” Mahendra Shukla, Ha Nguyen and Om Jee Pandey consider an IoT network scenario in which a multiple-antenna node communicates in full-duplex mode with single-antenna devices through a relay node that employs simultaneous wireless and information transfer technology, so that the received RF signals can be utilized for energy harvesting to keep the energy-constrained devices operational. The authors derive close-form expressions for optimal power allocation and energy-efficiency and simulation results confirm the theoretical findings.

Finally, let me warmly thank the reviewers and the members of the special issue editorial board for helping us in putting

together such a high quality special issue and, above all, let me thank the authors of the papers for sharing their results with us. We hope you will enjoy the special issue that, we believe, contributes to the knowledge growth on the timely and challenging topics of energy-efficiency and sustainability of IoT networks.

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Prof. Meo was an Associate Editor of *ACM/IEEE TRANSACTIONS OF NETWORKING*, Green Series of the *IEEE JOURNAL ON SELECTED AREAS OF COMMUNICATIONS NETWORKING* and *IEEE COMMUNICATION SURVEYS AND TUTORIALS*. She is a Senior Editor of *IEEE TRANSACTIONS ON GREEN COMMUNICATIONS*. In the role of a General or Technical Chair, she has led the organization of several conferences, including ITC, ICC symposia, ISCC. She chairs the International Advisory Council of the International Teletraffic Congress. She was the Deputy Rector of Politecnico di Torino from March 2017 to March 2018.