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Editorial

Green Internet of Things (IoT): Enabling Technologies, Architectures, Performance, and Design Issues

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While research and development in the area of energy-efficient communications are now mature, energy-efficient solutions for emerging Internet of Things (IoT) are far from being explored. IoT systems are envisioned to revolutionize the telecommunication paradigm by allowing direct integration between the physical world and machine-based systems. IoT systems allow everything (household items, vehicles, sensors, and wearables) to be connected, remotely accessed, sensed, and collaboratively communicate over the Internet. All IoT devices are supposed to be equipped with additional sensory and communication add-ons and in turn consume extra energy to sense the world and communicate with each other. As such, new energy harvesting technologies, ambient backscattering, and energy-aware learning and cryptography techniques are of immediate relevance.

After a critical review process, we selected five articles for this special issue that elaborates the performance of some of the aforementioned techniques and in turn contribute to green IoT technology. An interesting contribution "Performance Analysis of RF-Powered Cognitive Radio Networks with Integrated Ambient Backscatter Communications" from L. Xu et al. utilizes backscatter communication for the activation of low power devices. Stochastic geometry tools have been used to evaluate the overall cognitive IoT network performance. Simple energy storage and reusing mechanisms have been designed to improve utilization of harvested energy. Another important contribution by M. Ozturk et al. is "Energy-Aware Smart Connectivity for IoT Networks: Enabling Smart Ports". This work is focused on providing a novel approach for energy-aware and context-aware IoT connectivity that jointly optimizes the energy, security, computational power, and response time of the connection. The proposed scheme employs reinforcement learning and manages to achieve a holistic gain of up to 283.54% compared to deterministic routes.

Another interesting research work "Mobility-Centric Analysis of Communication Offloading for Heterogeneous Internet of Things Devices" presented by D. Kozyrev et al. developed a framework to understand the network connectivity of wearable IoT devices such as smart watches and heart rate monitors. These devices are mobile and are connected via D2D-link to another device, usually a smart phone, which is connected to a base station. An aerial access point is assumed to provide a control link to the D2D pairs located in its coverage area, for offloading the cellular network load, whenever possible. Such an offloading scheme helps in reducing the overall energy consumed by the network.

Cooperative spectrum sensing in cognitive vehicular networks (CVNs) is investigated in the paper titled "Robust and Low-Complexity Cooperative Spectrum Sensing via Low-Rank Matrix Recovery in Cognitive Vehicular Networks" by X. Liu et al. Robust cooperative spectrum sensing using low-rank matrix recovery is proposed to address the uncertainty of the quality of potentially corrupted sensing data. The technique exploits the low-rank and joint-sparse structure of the real spectrum occupancy matrix and corrupted data matrix.

The technique is extended to dense cognitive vehicular networks using weighted low-rank matrix recovery to reduce the complexity. Clearly, reduced complexity of spectrum sensing in cognitive vehicular networks results in energy-efficient architecture and resource management solutions for green IoT.

Another work "Cryptographic Algorithm Invocation Based on Software-Defined Everything in IPsec" by X. Yang et al. proposes a simple and flexible method to add and switch between various cryptographic algorithms in Internet Protocol Security (IPsec) suite in IPv6. This is very important since IoT requires the support of IPv6 to provide enough IP addresses for IoT devices. However, the existing cryptographic algorithms in IPsec suite may not afford enough network security for specific IoT applications, or the default algorithms in IPsec may not be applicable in specific situations. Thus, addition and timely switching of customized algorithms are important in IPsec. Unfortunately, doing this in current IPsec is quite complicated. Thus, this work is important in remedying this situation. Such efficient security methods help to reduce energy consumption of the IoT devices.

This special issue opens new directions for the research on green IoT and highlights the benefits of ambient backscattering, energy-aware learning, energy-efficient spectrum sensing, and computational offloading in emerging IoT networks.

Conflicts of Interest

The author declare that there are no conflicts of interest regarding the publication of this article.

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