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IEEE Access Special Section Editorial: Software-Defined Networks for Energy Internet and Smart Grid Communication

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EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL: SOFTWARE-DEFINED NETWORKS FOR ENERGY INTERNET AND SMART GRID COMMUNICATION

A new network paradigm of software-defined networks (SDNs) is being widely adapted to efficiently monitor and manage the communication networks with a global perspective. SDN has a key networking feature that separates control and data plane. Today, due to its inherent benefits, SDN has been widely applied to various networking domains, including data centers, 5G Access and Core network functions, wide area network (WAN), enterprise, optical networks, underwater sensor networks (UWSNs), energy Internet (EI), and smart grid (SG).

EI and SG are two complementary terms. EI refers to the vision of integrating future electricity grid into the web. SG refers to the advancement of current electricity grid with the help of information and communication technologies. The key feature that distinguishes EI from the SG is the tight coupling of EI with the Internet. EI can sometime be seen as an advanced form of SG. Nevertheless, as both EI and SG technologies differ in various ways, especially in terms of implementation and applications, there are fundamental research questions that are yet to be addressed. In a traditional Internet scenario, organizations have local area networks (LANs). These small LANs are from small geographical areas, such as cities, and are connected together to form metropolitan area networks (MANs), which are then inter-connected together to form WANs. Likewise, in an EI scenario, a world-wide energy-WAN (e-WAN) is composed of networked regional small-scale energy-LANs (e-LANs). Similar to a network router in the traditional Internet, we have an e-router in the EI, which is responsible for power delivery and information forwarding.

To realize full functionality of EI and SG, an efficient communication system would be essential, i.e., a networked system and infrastructure with fast reliable information flow capability, and support for good system observability and controllability. Such communication systems would facilitate the EI and SG to achieve secure, reliable, and safe power and information exchange.

Existing conventional energy networks have high-computing operations that result in the overall operations performance degradation. Therefore, SDN has immense potential in playing a significant role in managing the overall network and communication entities for the future EI and SG systems by decoupling the control plane from its data plane.

By adapting the concepts of SDN in the current, as well as to future EI and SG systems, the efficiency and resiliency of the entire system could be significantly improved by further fueling the growth of research and industry methods in EI and SG.

Overall, the goal of this Special Section in IEEE ACCESS is to publish and capture the most recent advances and trends in the promising technologies of EI and SG, particularly from the perspective of SDNs. This Special Section received a total of 48 submissions, of which eight articles were accepted after a rigorous peer-review process.

In the article “Defining a reliable network topology in software-defined power substations,” by Leal and Botero, the authors considered software-defined power substations and proposed a way to generate a reliable network topology considering the IEC 61850 standard. Moreover, the authors also showed how SV (Sample Measure Value) and GOOSE (Generic Object Oriented Substation Event) messages over loop-based topologies cannot work well and how SDN technology can help resolve such issues. Opendaylight SDN controller using Mininet was used for evaluation purposes.

The article “An optimizing and differentially private clustering algorithm for mixed data in SDN-based smart grid,” by Lv *et al.*, proposed a differentially private solution for SDN-based SG. Basically, clustering algorithm K-means was used for preserving the privacy of SDN-based SG users.

In the article “Effective resource management in SDN-enabled data center network based on traffic demand,” by Paliwal and Shrimankar, the authors used few SDN controllers such as Opendaylight, NOX, POX, and Beacon. The goal of this article was to focus on the data center network and analyzed energy aspect by proposing a switch on/off condition.

The article “A Bayesian game-theoretic intrusion detection system for hypervisor-based software-defined networks in smart grids,” by Niazi and Faheem, focused on distributed denial of service (DDoS) attack scenarios in SDN-based SG using a game-theoretic Bayesian Nash equilibrium solution. The proposed solutions facilitate hypervisor in easily detecting DDoS (distributed denial of service) attacks with more efficiency and minimize the costs of monitoring.

In the article “Analysis of artificial neural network architectures for modeling smart lighting systems for energy savings,” by Garcés-Jimenez *et al.*, developed a data model using artificial neural network (ANN) for public lighting scenarios.

The article “Efficient differentiated storage architecture for large-scale flow tables in software-defined wide-area networks,” by Xiong *et al.*, focused on SDN-based WANs and its flow table storage architecture in the context of OpenFlow. The proposed work deals with active flows and considered TCAM capacity for dealing with flow arrivals.

In the article “Latency-optimal network intelligence services in SDN/NFV-based energy Internet cyberinfrastructure,” by Ardiansyah *et al.*, considered EI and proposed a solution for latency minimization using AI, and in this regard, K-means algorithm was optimized so that middle boxes can be placed optimally.

Finally, the article “Blockchain-based distributed energy trading in energy Internet: An SDN approach,” by Lu *et al.*, proposed a blockchain-based energy trading scheme for SDN-based EI. The authors proposed a matching algorithm and ensured privacy for the energy trading users.

In conclusion, all the articles were accepted after a rigorous and extensive peer-review process. The whole GE team would like to thank the authors who submitted their works to this Special Section, as well as the reviewers who provided their in-depth reviews, which ultimately helped the authors enhance the quality of their work. The GE team is also thankful to the Editor-in-Chief and Editorial Office Staff of IEEE ACCESS for their guidance and help during the whole process of this Special Section. They hope you enjoy reading this Special Section.

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Editor of the IEEE COMMUNICATIONS SURVEYS AND TUTORIALS for the year 2015, from the IEEE Communications Society. He received the Best Paper Award from the IEEE ComSoc Technical Committee on Communications Systems Integration and Modeling (CSIM), in IEEE ICC 2017. He consecutively received the Research Productivity Award, in 2016 and 2017, and also ranked # 1 in all Engineering disciplines from the Pakistan Council for Science and Technology (PCST), Government of Pakistan. He received the Best Paper Award from the Higher Education Commission (HEC), Government of Pakistan, in 2017. He was a recipient of the Best Paper Award from *Journal of Network and Computer Applications* (Elsevier), in 2018. He has been selected for inclusion on the annual Highly Cited Researchers 2020 list from Clarivate. His performance in this context features in the top 1% in the field of computer science. The highly anticipated annual list identifies researchers, who demonstrated significant influence in their chosen field, or fields, through the publication of multiple highly cited papers during the last decade. Their names are drawn from the publications that rank in the top 1% by

citations for field and publication year in the Web of Science citation index. He has served for three years (from 2015 to 2017) as an Associate Editor for the IEEE COMMUNICATIONS SURVEYS AND TUTORIALS. He has been serving as a Column Editor for Book Reviews in *IEEE Communications Magazine*. He was appointed as an Associate Editor of IEEE TRANSACTIONS ON GREEN COMMUNICATIONS AND NETWORKING. He serves as an Associate Editor for *IEEE Communications Magazine*, *Journal of Network and Computer Applications (JNCA)* (Elsevier), and the *Journal of Communications and Networks (JCN)*. He has been serving as a Guest Editor for *Ad Hoc Networks* journal (Elsevier), *Future Generation Computer Systems* journal (Elsevier), the IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, and *Pervasive and Mobile Computing* journal (Elsevier). He is an Area Editor of the IEEE COMMUNICATIONS SURVEYS AND TUTORIALS.



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to the IETF standardization for ten years. She has more than 80 publications in international conferences and journals, including IEEE and ACM. She has coauthored books published by the CRC Press. She is a regular guest editor of several journals, and she is an active member in TPCs for IEEE and ACM conferences. She is also the regular co-chair of several IEEE workshops and conference symposiums. She has been involved in several European projects with a technical lead role and served as a Consultant for the European Commission (EU) from 2008 to 2012 and contributed to defining the research agenda for "Future Internet and Media Networks" published in EU white papers.



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