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# Guest editorial: Special issue on software defined networking: Trends, challenges, and prospective smart solutions

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## 1 Context

The constraints of currently implemented networks (e.g. vendor dependence, complex and time consuming activities of implementing network wide policies, and adding and moving devices, high risk of service disruption, inability to scale easily) were putting a stasis in meeting the networking requirements and challenges posed by evolving computing trends (such as changing traffic patterns, big data and associated needs, the rise of cloud services, and consumerization of IT and technology trends).

To cope with the challenges, Software Defined Networking/Network Function Virtualization (SDN/NFV) is at the forefront and is becoming the backbone of application economy. SDN, a game changer technology and an important transformational force, is an advanced form of network virtualization. It physically separates the network control plane from the forwarding plane (data plane) to control several devices and to manage the network services through abstraction of low-level functionality. It provides support for the dynamic, scalable computing and storage needs of current complex digital networks and allows adaptive control and operations of networks in a cost-effective manner.

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This article is part of the Topical Collection: *Special Issue on Software Defined Networking: Trends, Challenges, and Prospective Smart Solutions*

Guest Editors: Ahmed E. Kamal, Liangxiu Han, Sohail Jabbar, and Liu Lu

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This special issue is to provide a forum for researchers from both academia and industry to share their latest achievements on Software Defined Networking: Trends, Challenges and Prospective Smart Solutions.

## 2 Submission and selection

The special issue has gone through an open call for papers and rigorous peer-review, where 19 articles from 42 submissions have been selected as representatives of ongoing research and development activities. These 19 articles encompass a wide range of research topics covering dynamic resource provisioning and management, traffic and data engineering, load balancing, security and privacy, efficient topology management, as well as scheduling, forming a comprehensive report of the latest research advances in the context of Software Defined Networking (SDN).

In the first article, “An Improved Network Security Situation Assessment Approach in Software Defined Networks”, Fan et al. presented a security situation awareness approach for assessing and quantifying network status and security situation assessment for SDN.

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The second paper by Yin et al. on “A Hierarchical Mobility Management Scheme based on Software Defined Networking” proposed a mobility management scheme named H-SMM by constructing a hierarchical architecture in control plane to support intra-domain and inter-domain hand-over scenarios at the same time for increased efficiency and reduced communication costs.

The third paper by Bai et al. on “An Optimized Protocol for QoS and Energy Efficiency on Wireless Body Area Networks” proposed a frame structure model of a self-adaptive guard band (SAGB) protocol to reduce the energy consumption of the nodes and extend the lifetime of the network.

The fourth paper by Xu et al. on “Identification and prediction of network attack patterns in software-defined networking” presented methods for detecting and prediction of network attack patterns from time series network traffic data using hierarchical clustering and autoregressive integrated moving average approaches to ensure network security.

The fifth paper by Din et al. on “Energy Efficient Topology Management Scheme based on Clustering technique for software Defined Wireless Sensor Network” proposed a multi-layer clustering architecture for energy efficient topology management including selection of forwarding node, rotation of cluster head, and inter and intra-cluster routing communication.

In the sixth paper “DSCB: Dual Sink approach using Clustering in Body Area Network”, Farhan Ullah et al. proposed a routing protocol -Dual Sink approach to enhances network lifetime by introducing the concept of clustering while using two sink nodes in Body Area Network (DSCB), which is more reliable in terms of network stability, and energy efficient in comparison to its counterparts (such as SIMPLE and DARE).

The seventh paper by Hussain Shah et al. on “Water Rippling Shaped Clustering Strategy for Efficient Performance of Software Define Wireless Sensor Networks” introduced a novel clustering method called Water-Rippling Shaped Clustering (WARIS) with energy efficient clustering head selection technique for network lifetime improvement through energy aware network design.

The eighth paper by Li et al. on “Enhancing Application Performance via DAG-Driven Scheduling in Task Parallelism for Cloud Center” presented function flow- a task parallelism programming framework using work-stealing scheduling algorithm for parallel application programmers to enhance application performance for cloud center.

The ninth paper by Malik on “Enhancing SDN Performance by Enabling Reasoning Abilities in Data

Traffic Control” attempted to provide a methodology for covering data mapping, data transformation, and change control for traffic control. It is resulting in forming a cooperative environment for SDN-based adaptation between system and application, which brings data traffic monitoring at entirely different scales.

The tenth paper by Wang et al. on “SDN and NFV Enabled Service Function Multicast Mechanisms over Hybrid Infrastructure” proposed three efficient heuristics to solve the static dynamic and scalable multicast problem in content of SDN and NFV. NFV enable multicast can be implemented in multiple stages and also adding and removing function for multicast easily.

The eleventh paper by Li et al. on “Joint Routing and Scheduling for Transmission Service in Software-Defined Full-duplex Wireless Networks” addressed the issue of joint routing and link scheduling in software-defined full-duplex wireless network. They worked to maximum the total output of the network. For routing selection sub routine, they proposed the minimum cast routing algorithm.

The twelfth paper by Xiao et al. on “The strategy of path determination and traffic scheduling in private campus networks based on SDN” proposed an improved path determination and traffic scheduling strategy based on software define networking.

The thirteenth paper by Cui et al. on “SCPLBS:A Smart Cooperative Platform for Load Balancing and Security on SDN Distributed Controllers” proposed A smart cooperative platform for load blanching and security on SDN distributed controlees name SCPLBS. It is a secure communication mechanism based on massage authentication code that is adopted between the cooperative platform and the controllers.

The fourteenth paper by Hu et al. “EASM: Efficiency-Aware Switch Migration for Balancing Controller Loads in Software-Defined Networking” proposed an Efficiency-Aware Switch Migration (EASM) to balance the controllers’ loads and improve Migration efficiency. It introduces a load difference matrix and trigger factor to measure load balancing on controllers.

The fifteenth paper by Xing et al. on “Estimating SDN Traffic Matrix based on Online Adaptive Information Gain Maximization Method” proposed the Online Information Gain Maximization based SDN traffic matrix Estimation method (IGME). It uses the information gain metric to determine which flows are most informative, and then constructs the measurement flow set iteratively until the accuracy requirement is satisfied or the measurement resource constraint is reached.

The sixteenth paper by Zhang et al. on “Virtual network embedding based on modified genetic algorithm” examined and better understand the effects of virtual network embedding algorithm based on modified genetic algorithm. It improves the classical genetic algorithm from three aspects such that population initialization strategy, improved mutation operation and improvement operation.

The seventeenth paper by Chilamkurti et al. “Survey on SDN based Network Intrusion Detection System using Machine Learning Approaches” described the various recent works on machine learning methods that leverage SDN to implement NIDS. More specifically, they evaluated the techniques of deep learning in developing SDN-based NIDS.

The eighteenth paper by Zhang et al. on “Behavior Reconstruction Models for Large-scale Network Service Systems” designed a model to examine the behavior reconstruction for largescale network service systems integrated with Petri net reconstruction methodology. It is for the purpose of achieving load balancing in the system under increasing number of users.

The nineteenth paper by Tayyaba et al. On “Resource Allocation in SDN based 5G Cellular Networks” presented a comprehensive survey on state of the art on the 5G integration with the SDN. They surveyed different integrated architectures of 5G cellular network based on SDN and NFV. Moreover, Different architectural integration of other wireless technologies such as 3G/4G, LTE, WiMAX etc. are highlighted in term of SDN and network virtualization.

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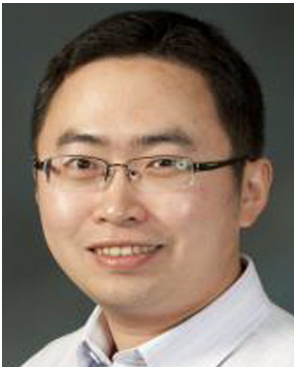
**AHMED E. KAMAL**, IEEE Fellow, Senior Member ACM, is currently serving as a Professor at Department of Electrical & Computer Engineering, Iowa State University. He has more than 250 research publications in renowned journals (e.g., IEEE Wireless Communications, IEEE Communication Magazine, Computer Networks, IEEE/ACM TON, ACM Computing Survey, WCMA, IEEE TOC, Computer Communications) and conferences (e.g., GLOBECOM, High Performance Switching and Routing, INFOCOM, Optical Networking and Communications, ICC, IEEE WCNC). He has been editor of the books “Resilient Wireless Sensor Networks: The Case of Network Coding”, and “Traffic Grooming for Optical Networks: Foundations

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ment of novel intelligent architectures that facilitate big data analytics (e.g., parallel and distributed computing, Cloud/Service-oriented computing/data intensive computing) as well as applications in different domains using various large datasets (biomedical images, environmental sensors, network traffic data, web documents, etc.). Having worked in both industry and academia, Prof. Han has over 14 years of research and practical experience in developing intelligent ICT-enabled software solutions in different application domains (e.g., health, smart cities, bioscience, cyber security, energy, etc.). As a Principal Investigator (PI) or Co-PI, Han has been conducting research in relation to large-scale data processing, big data analysis and mining, cloud computing, software architecture (funded by EPSRC, BBSRC, Innovate UK, Horizon 2020, Royal Society, British Council, Industry, Charity, etc.). Prof. Han has published over 86 peer reviewed international journals and book chapters. Prof. Han is a member of EPSRC Peer Review College, an independent expert for Horizon 2020 proposal evaluation/review and British Council Peer Review Panel. She has also served as a guest editor for a number of reputable international journals (e.g. IEEE Access, PPNA, Journal of Medical Systems, etc.) and a chair (or Co-Chair) of a number of international conferences/workshops in the field. She has been invited to give a number of keynotes and talks on different occasions (including international conferences and national and international institutions).



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Research Awards of the Year, Research Productivity Award, BK-21 Plus Post Doc. Fellowship are few. He received the Research Productivity Award from CIIT in 2014 and 2015. He has been engaged in many National and International Level Projects. He has authored 2 Book Chapters, and 70+ research papers. His research work is published in various renowned journals and magazines of IEEE, Springer, Elsevier, MDPI, and Old City Publication, and conference proceedings of IEEE, ACM, and IAENG. He has been the reviewer for leading journals and conferences. Sohail is currently engaged as TPC member/chair in many conferences. He is guest editor of *Sis in Concurrency and Computation Practice and Experience*, (Wiley), *Future Generation Computer Systems* (Elsevier), *Peer-to-Peer Networking and Applications* (Springer), *Journal of Information and Processing System* (KIPS), and *Cyber Physical System* (Taylor & Francis). Sohail is on collaborative research with renowned research centers and institutes around the globe on various issues in the domains of Internet of Things, Wireless Sensor Networks and Big Data.



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