Series Editorial

"Telecom Software, Network Virtualization, and Software Defined Networks"

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By introducing rapid and innovative network functions, software-based networking and virtualization are fundamentally revamping how the communication infrastructures are designed, programmed and operated. Network slicing, mobile edge computing, new radio access networks, and programmable cloud-native services represent some of key technical components of future network infrastructures, including 5G networks that started being commercialized in 2019. The third issue of "Telecom Software, Network Virtualization, and Software Defined Networks" series features five papers that deal with critical aspects of future networks, such as the adoption of edge computing technologies for mobile networks; the use of network slicing for 5G access and mission-critical services; advanced techniques for virtualized network programmability; automation of virtualized network security services.

The first article, "*LightEdge*: Mapping the Evolution of Multi-access Edge Computing in Cellular Networks" by Estefanía Coronado *et al*., investigates the introduction of Multi-access Edge Computing (MEC) and edge-steering solutions in 4G mobile networks and their evolution into 5G networks. The authors propose *LightEdge*, a lightweight MEC solution for 4G networks that allows us to immediately bring features and capabilities of edge clouds to mobile users. The key feature of LightEdge is its transparency to the existing 4G network infrastructure, allowing a seamless transition to a full 5G architecture. The paper reports on the design, implementation, and assessment of LightEdge in a practical latency-sensitive use case.

The second article, "Toward Operator-to-Waveform 5G Radio Access Network Slicing" by Salvatore D'Oro *et al*., deals with Radio Access (RAN) network slicing in 5G networks. The authors argue that existing cloud-related slicing technologies cannot be applied to the RAN slicing because of mobility, variable interference, and dynamic nature of wireless link capacity that do not allow over-provisioning. They propose a unified framework for operator-to-waveform 5G RAN slicing, which allows mobile network operators to control the selection of base stations, the maximum number of users, down to the scheduling of resource blocks at the waveform level. The framework enables coordination-based 5G communications and reduces inter-slice interference, which eventually results in improved isolation among slices.

The third article, "End-to-end Network Slicing for Flash Crowds" by Simona Marinova *et al*., presents a framework for end-to-end network slicing aiming at satisfying service demands in flash crowd scenarios, especially in emergency situations that may arise due to natural (e.g. earthquakes, floods) or human-generated disasters (e.g. terrorist attacks, industrial accidents, transportation failures). The authors report the *FALCON E2E* network slicing framework that efficiently ensures resource provisioning using the latest technological advancements in network virtualization and thereby enhances state-of-the-art Management and Orchestration (MANO) solutions.

The fourth article, "Libera for Programmable Network Virtualization" by Gyeongsik Yang *et al*., discusses the problems of the existing overlay-based virtual network hypervisors that limit the freedom of tenants to program packet processing, policy handling, and virtual networks. The authors introduce the concept of programmable Network Infrastructure-as-a-Service (p-NIaaS) model, which allows tenants to directly program

virtual infrastructure in datacenters where multi-tenancy is supported. A new network hypervisor called *Libera* is introduced to implement the p-NIaaS model and to ensure scalability, flexibility with different switching platforms, and live migration. The paper presents an open-source prototype developed to validate the proposed model.

The fifth article, "IBCS: Intent-Based Cloud Services for Security Applications" by Jinyong (Tim) Kim *et al.*, proposes IBCS, an intent-based, automated, virtualized security system for service providers. In order to mitigate complex attacks, different types of network security equipment must be deployed and managed together, which requires considerable security knowledge as well as cost and time efforts. To address this challenge, IBCS provides flexible cloud-based security services by combining the IETF Interface to Network Security Function (I2NSF) framework and the ETSI Network Function Virtualization (NFV) architecture. Also, IBCS leverages an intent-based approach to allow both the security service providers and their consumers to interact without any expert-level security knowledge. The paper also describes a proof-of-concept implementation of the proposed services.

The papers in this series are written with application-driven content on the latest advances and technical innovations of research and development, including open-source projects. They are selected after a thorough peer-review process. In our role as Series Editors, we strive to achieve a fast, quality and selective review process for all submissions in order to quickly publish high-quality and cutting-edge papers on relevant topics in this area. We would like to thank all the authors and reviewers who contributed to the series, as well as the IEEE Communications Magazine editors and staff for their continuous support. We hope that you will enjoy this third series issue and find these papers as inspiring and impactful as we do. While we are currently selecting the articles for the next issue, we invite interested authors to submit their work as per the Call for Papers available at http://bit.ly/commag-telcosw.

Biographies

Walter Cerroni [M'01, SM'16] (walter.cerroni@unibo.it) is an Assistant Professor of communication networks at the University of Bologna, Italy. His recent research interests include software-defined networking, network function virtualization, service function chaining in cloud computing platforms, intent-based northbound interfaces for multi-domain/multi-technology virtualized infrastructure management, modeling and design of inter- and intra-data center networks. He co-authored more than 120 articles published in the most renowned international journals, magazines and conference proceedings. He serves/served as Associate Editor for the IEEE Communications Letters and Technical Program Co-Chair for IEEE-sponsored international workshops and conferences. http://bit.ly/commag-telcosw.

Alex Galis is a Professor in Networked and Service Systems at University College London (UCL) - www.ee.ucl.ac.uk/~agalis/. His current interests are on 5G and beyond 5G networking, AI and networking, virtualization and softwarization, network and cloud programmability. He has co-authored more than 250 publications in the future Internet areas and standards including 10 research books. He is a co-editor of IEEE Communications Magazine series on Telecom Software, Network Virtualization, and Software Defined Networks, IEEE JSAC series on Network Softwarization and Enablers, ETRI Journal published by Wiley.

Kohei Shiomoto [M'90, SM'15] (shiomoto@tcu.ac.jp) is a Professor at Tokyo City University, Tokyo Japan. He had been engaged in R&D in the data communication industry for over 25 years since he joined NTT Laboratories in 1989. He has been active in the areas of network virtualization, data-mining for network management, traffic & QoE management since he joined Tokyo City University in 2017. He served as Guest Co-Editor for a series of special issues established in IEEE TNSM on Management of Softwareized Networks. He has served in various roles organizing IEEE ComSoc high profile conferences such as IEEE NOMS, IEEE IM, and IEEENetSoft.

Mohamed Faten Zhani is an Associate Professor at ÉTS Montreal, University of Quebec, Canada. His research interests include network function virtualization, software-defined networking and resource management in large-scale infrastructures. Faten co-authored several research papers published in renowned conferences and journals. He served as the general/technical program chair of several international conferences and workshops. He is co-editor of IEEE Transactions on Network and Service Management and IEEE softwarization newsletter. Faten received the IEEE/IFIP IM 2017 Young Researchers and Professionals Award for outstanding research contribution and leadership in the field of network and service management.