Enabling 5G Verticals and Services through Network Softwarization and Slicing


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5G networks are expected to facilitate a business ecosystem enabling innovative services and networking capabilities for new industry stakeholders such as verticals focusing on various commercial industries including energy, transport, healthcare, manufacturing, and entertainment to mention a few. 5G will enable the wide adoption of the Internet of Things (IoT), promoting tactile Internet and an enhanced broadband experience in the crowd and on the move. These diverse services introduce a broad range of often conflicting performance requirements, making it impossible for network operators to enable the desired level of performance on top of the same network infrastructure. Hence, 5G networks should be more flexible and programmable to support all these different use cases, also facilitating the appropriate level of security and privacy across a heterogeneous architecture with unified control.

To accomplish this, 5G networks will rely more on software for flexibly deploying network functions and value added services, as well as on programmable control that unifies networking, computing, and storage resources. In addition, 5G networks will rely on virtualization technologies for enabling isolated logical networks on top of a common physical infrastructure, allowing network customization considering the service requirements. Logical networks may operate under the paradigm of micro-operators, which enables network deployment either independently or in collaboration with the macro network operators to provision tailored 5G services.

Ensuring the appropriate interoperability between vendors, operators, service providers, and verticals is key for the success of 5G. Service abstraction models, interfaces, slice templates, service chaining, slice orchestration and life cycle management, and fixed mobile convergence are a few areas among many on which standardization efforts currently concentrate. Several standardization bodies currently study and specify the concept and realization of network softwarization and slicing including the Next Generation Mobile Network Alliance (NGMN), Third Generation Partnership Project (3GPP), GSM Association (GSMA), European Telecommunications Standards Institute (ETSI), Internet Engineering Task Force (IETF), Open Networking Foundation (ONF), International Telecommunication Union — Telecommunication Standardization Sector (ITU-T), Broadband Forum (BBF), Metro Ethernet Forum (MEF), IEEE, and so on.

This Feature Topic includes seven outstanding articles that focus on softwarization and network slicing considering 5G services. These articles provide an insight on the different standardization activities considering service orchestration, security, operational aspects, and applications, pointing out key enabling technologies for ensuring the desired customization and performance.

The first article, "Virtual Cells for 5G V2X Communications," by T. Sahin, M. Klugel, C. Zhou, and W. Kellerer, introduces the concept of virtual cells, which combines a number of transmission points with an association pattern that is created for, and moves with, every user in the network, and explores its adoption for vehicle-to-everything (V2X) broadcast groups.

The second article, "LAA as a Key Enabler in Slice-Aware 5G RAN: Challenges and Opportunities," by E. Pateromichelakis, Ö. Bulakci, C. Peng, J. Zhang, and Y. Xia, proposes an licesed assisted access (LAA)-as-a-service framework, which aims to offer different LAA configurations allowing opportunistic service-oriented usage of unlicensed spectrum when allocating a network slice to enhance latency and reliability, especially for 5G ultra-dense networks with unplanned small cells.

The third article, "Overview of 5G Security Challenges and Solutions," by I. Ahmad, T. Kumar, M. Liyanage, J. Okwuibe, M. Ylianttila, and A. Gurtov, analyzes the security aspects and user privacy issues focusing on cloud, software defined network (SDN), and network functions virtualization (NFV) technologies, which are the fundamental components of 5G network slicing, also summarizing the related standardization activities.

In the following article, "High-Speed Train Communications Standardization in 3GPP 5G NR," F. Hasegawa, A. Taira, G. Noh, B. Hui, and H. Nishimoto elaborate flexible network slicing architectures focusing on both higher layer and physical layer technologies across the radio access and

core networks for improving the service quality of various train applications.

The next article, "Point-to-Multipoint Communication Enablers for the Fifth Generation of Wireless Systems," by D. Gomez-Barquero, D. Navratil, S. Appleby, and M. Stagg, brings light onto network slicing for 5G multimedia broadcasting, exploiting network customization for various services including critical communications, while keeping backward compatibility with LTE.

The following article, "A Survey and an Analysis of Network Slicing in 5G Networks," by A. Kaloxylos, elaborates the notion of network slicing, summarizing 3GPP standardization activities also considering solutions across the access, transport, and core as well as network management, for enabling resource flexibility to support verticals with diverse performance requirements.

The last article, "Network Slicing Technology in 5G Wearable Network," by Y. Hao, D. Tian, G. Fortino, J. Zhang, and I. Humar, introduces data-driven network slice management for fulfilling the latency requirements of different wearable device services, considering networking, storage, and computation resources in a 5G ultra-dense environment.

We hope that these seven articles provide an overview to the readers with a representative taste of standards related mechanisms and technologies for enabling 5G services via the means of softwarization and network slicing.

Biographies

Konstantinos Samdanis (konstantinos.samdanis@huawei.com) is a principal researcher at Huawei for 5G carrier networks. He is involved in research for 5G SDN/NFV architectures and network slicing, also being active in BBF in wireless-wired converged networks and the 5G Public Private Partnership (5GPPP). Previously he worked for NEC Europe, Germany, as a senior researcher and a broadband standardization specialist, involved in numerous EU projects and 3GPP. He received his Ph.D. and M.Sc. degrees from Kings College London.

Athul Prasad (athul.prasad@nokia.com) obtained his M.Sc. (Tech) and D.Sc. (Tech) degrees from Aalto University, Finland, and is currently pursuing the one-year Executive Education (LEAD) Program on Corporate Innovation from Stanford University's Graduate School of Business. In the past, he worked with Huawei and NEC as a researcher and standardization delegate. Since 2014 he has been with Nokia, currently as a senior radio research specialist. He has contributed toward 80+ international publications, patent applications (including granted patents), technical reports, and standards contributions.

Min Chen [SM'09] (minchen2012@hust.edu.cn) has been a full professor in the School of Computer Science and Technology at Huazhong University of Science and Technology since February 2012. He was an assistant professor in Sthe chool of Computer Science and Engineering at Seoul National University. He worked as a postdoctoral fellow in the Department of Electrical and Computer Engineering at the University of British Columbia for three years. His Google Scholars Citations reached 11,200+ with an h-index of 53. His top paper was cited 1100+ times. He received the IEEE Communications Society Fred W. Ellersick Prize in 2017.

Kai Hwang [LF] (kaihwang@usc.edu) is a world-renowned scholar in computer science and high-performance computing. Presently, he is a professor of electrical engineering and computer science at the University of Southern California. He has made fundamental contributions to the field of parallel, distributed, and cloud computing systems. As a Life Fellow of the IEEE Computer Society, he is still working actively in frontier research. In particular, his work has helped the design and upgrade of today's supercomputers, massive data centers, and cloud platforms.