5G NETWORK SLICING – PART 2: ALGORITHMS AND PRACTICE


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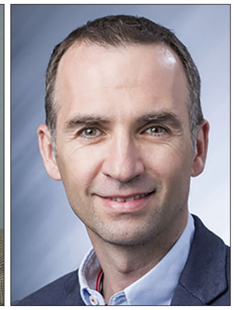
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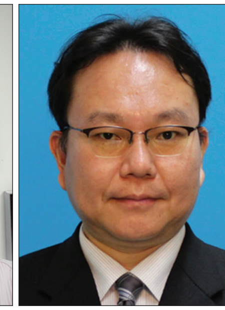
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The emerging fifth generation (5G) networks are expected to support a plethora of different services and applications with diverse and often conflicting performance requirements. Network slicing enables network operators to allocate logical self-contained networks toward service providers, virtual operators, and vertical segments, with specific service-oriented functionality over a common physical network infrastructure providing the means of supporting efficiently diverse services.

By means of software defined networks (SDNs) and network functions virtualization (NFV), operators can deliver automation, flexibility, and programmability, allowing legacy functions to be partitioned or migrated in data center environments, advancing virtual network architectures. However, certain network slicing attributes, including function customization, performance and security requirements, management operations, and control, can be supported in a number of different ways by combining different types of cloud and network resources that influence in a distinct way the associated capital and operational expenses.

To ensure that network slicing can deliver the desired benefits, operators need to rely on service and network intelligence, user context awareness, and machine learning, which can empower slicing algorithms to perform admission control, slice selection, policing, and closed-loop performance maintenance. Common resource abstraction, service representations, and flexible service chaining are also key technology attributes related to such slicing algorithms, facilitating service exposure and programmability as well as a joint optimization of virtual network functions and service allocation. In mobile environments service continuity is also significant, and hence network slicing algorithms and operations should consider not only user mobility but also service mobility and even new mobility mechanisms related to particular types of slices.

Network slicing also has practical attributes and limitations with respect to slice instantiation, resource virtualization, and certain slice operations. For ensuring scalability and rapid slice instantiation, the use of slice templates is a valuable asset, which needs to be designed carefully in advance considering performance requirements and the desired service flexibility. Although network slices are self-contained networks, certain types of resources cannot be isolated but must be shared, for instance, spectrum , due to its highly dynamic nature. Network slicing algorithms should take such practicalities into account, introducing tactics and mechanisms to deal with resource sharing, particularly for highly dynamic resources.

This Feature Topic includes five outstanding articles that focus on the 5G network slicing algorithms and practice considering the resource allocation mechanisms, service provision, and performance assurance in different segments of the network, such as the radio, transport, and core. These articles provide an insight on the service orchestration and slice operational aspects, pointing out key enabling technologies for ensuring the desired customization and performance.

The first article, "The Algorithmic Aspects of Network Slicing," by S. Vassilaras, L. Gkatzikis, N. Liakopoulos, I. N. Stiakogiannakis, M. Qi, L. Shi, L. Liu, M. Debbah, and G.S. Paschos, focuses on resource allocation and control algorithms related to real-time management of network slicing considering orchestration as an instance of virtual network embedding, while taking into account the dynamic nature of contemporary networks.

In the second article, "A Cloud Native Approach to 5G Network Slicing," S. Sharma, R. Miller, and A. Francini elaborate a service-oriented concept of 5G slicing analyzing the paradigm shift from a network of entities to a network of capabilities with respect to the entire life cycle of network slicing considering the design, instantiation, and orchestration. The article also presents a proof-of-concept implementation demonstrating service customization.

The following article in this series, "5G-Crosshaul Network Slicing: Enabling Multi-Tenancy in Mobile Transport Networks," by X. Li, R. Casellas, G. Landi, A. de la Oliva, X. Costa-Perez, A. Garcia-Saavedra, T. Deiß, L. Cominardi, and R. Vilalta, brings light to the next generation of transport networks integrating backhaul and fronthaul segments considering the coexistence of distributed and cloud RAN architectures. The article elaborates the design of a control plane for enabling multi-tenancy that allows flexible and efficient allocation of transport and cloud resources.

The next article, "Network Slicing Based 5G Networks: Mobility, Resource Management and Challenges," by H. Zhang, N. Liu, X. Chu, K. Long, A.H. Aghvami, and V. C. M. Leung, analyzes mechanisms for efficient resource management considering joint power and sub-channel allocation in spectrum sharing taking into account co-tier and cross-tier interference, while proposing a new mobility scheme to enhance 5G network flexibility based on network slicing.

The last article, "Network Slices toward 5G Communications: Slicing and LTE Networks," by K. Katsalis, N. Nikaein, E. Schiller, A. Ksentini, and T. Braun, elaborates the notion of service-oriented network slicing concentrating on an eMBB deployment prototype. The article emphasizes service control and programmability based on the Open Air Interface and the Juju framework.

We hope that these five articles provide an overview to the readers with a representative taste of 5G network slicing algorithms and practice.

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 slice OS, also being active at BBF in wireless-wired converged networks and the 5GPPP Architecture WG. 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.

Steven A. Wright (s.wright@ieee.org), M.B.A., Ph.D., J.D., has been involved in the communications industry in research, development, program management, product management, university faculty, and board roles, resulting in 50+ patents and a number of diverse publications. He has presented his research at international conferences in Europe, Asia, Australia, and the United States, and founded the IEEE NFV SDN conference.

Albert Banchs (banchs@it.uc3m.es) is a professor with the University Carlos III of Madrid (UC3M) and has a double affiliation as deputy director of the IMDEA Networks institute. Before joining UC3M, he was at ICSI Berkeley, Telefonica I+D, and NEC Europe Ltd., respectively. He has authored more than 100 peer-reviewed publications, as well as several patents and standardization proposals. A current major focus is on the 5G architecture work within the 5G NORMA European project.

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Mehmet Ulema (mehmet.ulema@manhattan.edu) is a professor at Manhattan College, New York. Previously, he was with AT&T Bell Laboratories and Bellcore. He also serves as Director of Standards Development in ComSoc. He has had leadership roles for many major IEEE conferences. He is on the Editorial Boards of the *IEEE Journal of IoT* and the *Journal of Network and Services Management*. He received his Ph.D. from Polytechnic University, Brooklyn, New York, and his B.S. and M.S. from Istanbul Technical University.

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