Chapter 11
Principles and Enabling Technologies of 5G
Network Slicing

Zoran Bojkovic
University of Belgrade, Serbia

Bojan Bakmaz
University of Belgrade, Serbia

Miodrag Bakmaz
University of Belgrade, Serbia

ABSTRACT
5G mobile systems can be comprehended as highly flexible and programmable E2E networking infrastructures that provide increased performance in terms of capacity, latency, reliability, and energy efficiency while meeting a plethora of diverse requirements from multiple services. Network slicing is emerging as a prospective paradigm to meet these requirements with reduced operating cost and improved time and space functionality. A network slice is the way to provide better resource isolation and increased statistical multiplexing. With dynamic slicing, 5G will operate on flexible zone of the network, permitting varying, adaptable levels or bandwidth and reliability. In this chapter, a comprehensive survey of network slicing is presented from an E2E perspective, detailing its origination and current standardization efforts, principal concepts, enabling technologies, as well as applicable solutions. In particular, it provides specific slicing solutions for each part of the 5G systems, encompassing orchestration and management in the radio access and the core network domains.

INTRODUCTION
Fifth generation (5G) mobile networks are expected to create multitenant ecosystem with extremely increased performance for dedicated use-cases and specific types of services in order to simultaneously satisfy various users’ demands. In such an environment network slicing emerged as one of the key pro-
spective technologies which support different requirements through a common network infrastructure. In this sense, service necessity, isolation and support on a common level of physical infrastructure are assured. It means that on-demand services can be fully supported, while network resources are efficiently allocated according to the users’ requirements. With network slicing, 5G applications will operate on the flexible zone, allowing them to draw adaptable levels of bandwidth and reliability.

Although the network slicing concept is still immature, the potential enabling technologies, such as software defined networking (SDN) and network functions virtualization (NFV), have many feasible researches with practical solutions (Ordonez-Lucena, Ameigeiras, Lopez, Ramos-Munoz, Lorca & Folgueira, 2017). Based on SDN and NFV many user-centric service slicing strategies were proposed. By means of SDN and NFV, operators can provide high degree of flexibility and programmability, allowing legacy functions to be partitioned or migrated in data centers, advancing virtual architectures (Zhang, Liu, Chu, Long, Aghvami, & Leung, 2017).

Currently, network slicing is in the main focus of both, academia and industry, as well as different standardization bodies, e.g., International Telecommunication Union (ITU), 3rd Generation Partnership Project (3GPP), European Telecommunications Standards Institute (ETSI), etc. At the moment, efforts are toward developing 5G mobile systems which are in a position to deploy slicing of different structures and sizes (Katsalis, Nikaein, Schiller, Ksentini, & Braun, 2017).

This chapter aims to provide an updated state of the art in research activities when dealing with the 5G network slicing, together with identified and analyzed opportunities and challenges. To this end, a common framework for bringing together and evaluating various approaches from open literature in concise and holistic manner is presented. The main objective is to analyze current maturity of prospective solutions according architectural segments they target and to identify remaining gaps. This chapter can provide reliable backbone for future standardization and research activities.

The remainder of this chapter is organized as follows. The next section presents service requirements in 5G mobile systems. Following that, a brief overview of network slicing origination and main principles are provided. As enablers of network slicing, different virtualization technologies are introduced. Then, specific slicing approaches for radio access domain and core domain are analyzed. Finally, some open research challenges are elaborated and relevant conclusions are provided.

**SERVICE REQUIREMENTS IN 5G SYSTEMS**

5G mobile systems can drastically change the architecture and nature of communications. Many use cases are emerging with diverse requirements in terms of data rate, latency, connection density, mobility, reliability, spectrum and energy efficiency. These use cases may be broadly categorized in the three generic services (ITU-R, 2015), i.e., enhanced mobile broadband communications (eMBBC), massive machine-type communications (mMTC), sometimes referred as massive Internet of Things (mIoT), and ultra-reliable low-latency communications (uRLLC), a.k.a. mission-critical services, based on corresponding key performance indicators (KPIs), as presented in Figure 1. In this case KPIs can be treated as technical requirements for 5G services. 5G is anticipated to make it possible to efficiently enable diverse services, connecting a pool of varied devices while accessing diverse networks.

At the same time, the 5G Infrastructure Public Private Partnership (5G-PPP), as a joint initiative between the European Commission and industry, brought interest into the requirements of 5G through the