Intelligent dynamic Network Slicing Management

Gladys Diaz (Director) and Abdulhalim Dandoush (co-supervisor)

Email: gladys.diaz@univ-paris13.fr, abdulhalim.dandoush@esme.fr

Network Team at L2TI-USPN

Scientific context

Network and telecommunication protocols address continuously numerous challenges driven by new critical marketplace such as transportation and remote surgery in addition to an exponential increase of traffic volume. To cope with the new needs, network and service operators use traditional modeling, simulation and emulation techniques to evaluate the performance of network functions and protocols. Based on performance indicators and political/commercial strategies, operational research and data science approaches can be used in a second stage in order to optimize the whole system based on an objective function to be minimized (e.g., cost, or delay). Currently, 5G/6G and cloud technologies enable new business model innovation across all industries. Network slicing coupled with data science techniques (i.e., Machine and reinforcement Learning) will play an essential role in enabling service providers to offer new generation services (e.g., critical mission, tele-medicine, and IoT services for green planet) [**1**]. A network slice (NS) is nothing but a set of logical or virtual networks on top of a shared physical infrastructure based on the network function virtualization (NFV) and Software Defined Networks (SDN) technologies. Each logical network is combined of one or many virtual network functions (VNF) designed to handle a particular goal and that consume some compute and/or network resources (e.g., cpu, memory, bandwidth capacity, and radio frequency), configured and connected end-to-end [**2**].

Objectives and plan

Network providers need to perform intelligent and efficient resource management to offer slices that meet the quality of service and quality of experience requirements of 5G/6G use cases. The management aspects cover 4 main phases (i) admission control (accept/delay/reject multitenant network slice requests), (ii) resource allocation of accepted slices (e.g., CPU, Memory, Bandwidth), (iii), resource scheduling (the timely planning of the allocated resources), and (V) the whole resource orchestration (instantiate and manage the life cycle of slices) [**3**]. The dream of the service operators is to have a zero touch E2E NS management [**4**]. Thus, proposing novel approach combining operational research (i.e., optimization theory) based methods with Machine and deep reinforcement learning (DRL) techniques becomes an interesting research issue and may improve the performance of resource allocation in a dynamic scenario of novel applications requiring specific Quality of Service (QoS) and/or quality of Experience perceived by end users.

The objective of this thesis is to explore the key components of network slicing and investigate how the operational research and artificial intelligence can help for E2E NS management at each phase of the 4 main phases mentioned above while optimizing allocated resources and ensuring fairness between NSs. We need to investigate if machine, deep and reinforcement learning may outperform the traditional optimization techniques (i.e., operational research and heuristics approaches) that are used usually for managing functions and optimizing resources used for network slices provisioning. In fact, the optimum solution is often not applicable for the new generation of real time solutions. Last, the proposed solutions may run at several levels (e.g., virtual infrastructure and orchestration level) and my span multi administrative domains. Usually, the orchestration is logically centralized but physically distributed for scalability and reliability.

References:

[**1**] Ericsson, Network slicing accelerates 5G for business, https://www.ericsson.com/en/network-slicing

[**2**] M. Chahbar, G. Diaz, A. Dandoush, C. Cérin and K. Ghoumid, "A Comprehensive Survey on the E2E 5G Network Slicing Model," in IEEE Transactions on Network and Service Management, doi: 10.1109/TNSM.2020.3044626.

[**3**] A. Kammoun, N. Tabbane, G. Diaz, A. Dandoush and N. Achir, "End-to-End Efficient Heuristic Algorithm for 5G Network Slicing," *2018 IEEE 32nd International Conference on Advanced Information Networking and Applications (AINA)*, 2018, pp. 386-392, doi: 10.1109/AINA.2018.00065.

[**4**] Kammoun, A., Tabbane, N., Diaz, G., Achir, N., Dandoush, A. (2020). Proactive Network Slices Management Algorithm Based on Fuzzy Logic System and Support Vector Regression Model. In: Barolli, L., Hellinckx, P., Enokido, T. (eds) Advances on Broad-Band Wireless Computing, Communication and Applications. BWCCA 2019. Lecture Notes in Networks and Systems, vol 97. Springer, Cham. https://doi.org/10.1007/978-3-030-33506-9_34

Directrice de thèse : Mme Gladys DIAZ – MdC (HDR) – Institut Galilée, USPN – **Email :** gladys.diaz@univ-paris13.fr
Adresse : USPN, L2TI (Laboratoire de Traitement et Transport de l'Information) - 99 Av J-B Clément – 93430 Villetaneuse