Intelligent Network Sclicing Management

Gladys Diaz[1] & Abdulhalim Dandoush[2]

[1]Equipe Réseaux du L2TI-USPN, [2]ESME Sudria

Introduction

5G and Cloud technologies enable new business model innovation across all industries. Network slicing will play an essential role in enabling service providers to offer new generation services (critical mission, tele-medicine, IoT services) and develop their existing business model in order to meet a variety of requirements from different type of users [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) [2] and Software Defined Networks (SDN) [3] 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 [1, 4].

End-to-end (E2E) network slicing enables new generation of applications on top of multi-domains (belong to one or many infrastructure operators) and across multi-technology networks (i.e., 5G/RAN, Transport network, Core and Cloud). The design and deployment of an intelligent orchestration cycle to manage E2E slices on a NFV architecture is still an interesting challenge [4, 5, 6]. The SDN/NFV scheme permits to efficiently monitor the network and services elements at different levels and to process of the gathered data to dynamically allocate resources and to be able to scall up or down and to produce the corresponding alert mitigation actions. Network slicing enables operators to minimize the CAPEX via efficient usage and management of the network resources and to radically reduce OPEX through the network automation. The dream of the service operators is to have a zero touch E2E NS management.

Objectives and plan

The objective of this thesis is to explore the key components of network slicing and investigate how the artificial intelligence can help for E2E NS management automation while optimizing allocated resources and ensure fairness between NS. Addressing the security issues related to network slicing management and orchestration is an interesting research challenge that may be investigated as a continuation of this proposed subject.

The candidate should study and how the underlying network resources are abstracted and coordinated and proposed to higher-layer applications and customers. The abstraction should ensure transparency on how these resources are managed or controlled, so that these higher-layer entities can dynamically create, modify, monitor, delete and track virtual networks. The abstraction requires

hierarchy in order to control Multi-domain and multi-tenant virtual network operations as a single virtualized network. This is achieved by presenting the network domain as an abstracted topology to the customers via open and programmable interfaces [4].

Another goal is to investigate how Machine, deep and reinforcement learning can help (e.g., demand and traffic shape prediction, optimum routing algorithm, anomaly detection and recommended actions for correction, etc.) to deploy E2E slicing orchestration where virtual network services and applications meet specific allocation of compute and network resources efficiently with respect to the real customer requirements overtime.

To evaluate the proposed mechanisms and algorithms, the candidate must build a realistic platform as done in [7, 8, 9] based on popular recent opensource software such as:

- OpenAirInterface (OAI) [10] for simulating the radio access network with user traffic.
- Openstack [11] or Kubernete [12] to control the compute infrastructure by virtual machine or docker containers. These compute resources will host all the VNF, the SDN controller and also the orchestrators.
- ONOS [13]: Open Network Operating System by ONF as the SDN controller
- ONAP [14], open Baton [15] or Open Source MANO (OSM) [16] to represent the orchestrator where the AI based management algorithms should run.

The platform can be used to collect datset used in the training phase of machine learning algorithms and to validate the proposed work with several realistic scenarios (e.g., video streaming, tele-medicine or IoT services) that require each a slice of different predefined performance metrics.

Last, evaluating the quality of experience (QoE) perceived by the clients is an interesting issue to be coupled with QoS evaluation seen from the operators point of view.

Supervision :

1) **Université Sorbonne Paris-Nord (Paris 13) – Institut Galilée – Campus de Villetaneuse**
    - Director of thesis: Mme Gladys DIAZ – L2TI – gladys.diaz@univ-paris13.fr

2) **ESME Sudria – Paris-Sud Ivry – Campus Ivry-sur-Seine**
    - Co-supervisor: Mr Abdulhalim Dandoush - abdulhalim.dandoush@esme.fr

Reseach team: Network team, L2TI – Sorbonne Paris Nord University, Villetaneuse, France

References

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

2. SDN : https://opennetworking.org/sdn-definition/

3. NFV : https://www.etsi.org/technologies/nfv

4. 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.

5. [TS23.501] : 5G;System Architecture for the 5G System (3GPP TS 23.501 version 15.2.0 Release 15). https://www.etsi.org/deliver/etsi_ts/123500_123599/123501/15.02.00_60/ts_123501v150200p.pdf

6. [TS23.502] : 5G;Procedures for the 5G System (3GPP TS 23.502 version 15.2.0 Release 15). https://www.etsi.org/deliver/etsi_ts/123500_123599/123502/15.02.00_60/ts_123502v150200p.pdf

7. Slicing for 5G with SDN/NFV: Concepts, Architectures, and Challenges," *IEEE Comm. Magazine*, vol. 55, no. 5, pp. 80–87, 2017.

8. B. Dzogovic, V. T. Do, B. Feng, and T. van Do, "Building virtualized 5G networks using open source software," in *IEEE Sym. on Comp. App. Ind. Elec. (ISCAIE)*, 2018, pp. 360–366.

9. C. Huang, C. Ho, N. Nikaein, and R. Cheng, "Design and Prototype of A Virtualized 5G Infrastructure Supporting Network Slicing," in *IEEE 23rd Int. Conf. on Digital Signal Processing (DSP)*, 2018, pp. 1–5.

10. OpenAirInterface : https://openairinterface.org

11. OpenStack: https://www.openstack.org

12. Kubernetes: https://kubernetes.io/docs/concepts/overview/

13. ONOS: https://opennetworking.org/ONOS/

14. ONAP: https://www.onap.org

15. Open Baton: https://openbaton.github.io

16. Open Source MANO (OSM): https://osm.etsi.org