

## Title: Virtual Network Function Forwarding Graph Embedding in 5G and post 5G Networks

Dealing with new, constrained services, which must be deployed almost instantaneously, is one of the most important challenges facing Infrastructure Providers (InPs) [1]. In order to meet these new requirements, InPs have shifted from hardware solutions known to be rigid to much more agile and scalable software solutions. This vision has been fulfilled with the emergence of network function virtualization, which has made it possible to deploy new services on demand and in near real-time [2]. However, the allocation of these services on an infrastructure remains very complex due to the services' constraints. This complexity is all the more pronounced when the services to be deployed are composite, often in the form of a service graph (i.e. VNF-FGs) [3].

The efficient and automatic placement of network services is certainly one of the most important technological building blocks to move towards a fully automated network (i.e. zero-touch network). Accordingly, researchers from the academic and industrial spheres have stepped up their efforts to solve this crucial issue. Several studies have been carried out, some of them addressing architectural solutions, such as those developed by the European Telecommunications Standards Institute (ETSI), others proposing more algorithmic solutions, on which we focus in this keynote.

Several solutions have already been proposed in the literature [4]. In this Keynote, we will propose an introduction to the research issue in which we will focus on some potential solutions, especially those based on metaheuristics [5] and those using deep reinforcement learning [6].

### References

- [1] "Network Functions Virtualisation (NFV): Architectural framework," *ETSI GS NFV*, vol. 2, no. 2, p. V1, 2013.
- [2] B. Yi, X. Wang, K. Li, S. k. Das, and M. Huang, "A comprehensive survey of network function virtualization," *Computer Networks*, vol. 133, pp. 212 – 262, 2018.
- [3] A. Gupta, B. Jaumard, M. Tornatore, and B. Mukherjee, "A scalable approach for service chain mapping with multiple sc instances in a wide-area network," *IEEE Journal on Selected Areas in Communications*, vol. 36, no. 3, pp. 529–541, March 2018.
- [4] I. Afolabi, T. Taleb, K. Samdanis, A. Ksentini, and H. Flinck, "Network slicing and softwarization: A survey on principles, enabling technologies, and solutions," *IEEE Communications Surveys Tutorials*, vol. 20, no. 3, pp. 2429–2453, thirdquarter 2018.
- [5] Pham Tran Anh Quang, Jean-Michel Sanner, Cédric Morin, and Yassine Hadjadj-Aoul : "Virtual Network Function Forwarding Graph Embedding: A genetic algorithm approach". In Wiley, International Journal of Communication Systems (August 2019)
- [6] Pham Tran Anh Quang, Yassine Hadjadj-Aoul, and Abdelkader Outtagarts : "A deep reinforcement learning approach for VNF Forwarding Graph Embedding". In IEEE, Transactions on Network and Service Management (TNSM) (October 2019)