NFV Management and Orchestration in the Age of 5G

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Tutorial duration: 4 hours

Outline

NFV is a potential candidate for deploying and managing future networks. Indeed by turing network functions into software modules and by deploying them on top of general purpose computing and networking infrastructure NFV can make networks cheaper to deploy and to manage. However, in order to achieve its full potential, NFV needs to extend its reach also to the radio access segment. Here Mobile Virtual Network Operators shall be allowed to request radio access VNFs with custom resource allocation solutions. Such requirement raises several challenges in terms of performance isolation and resource provisioning.

This tutorial will provide an overview on NFV management and orchestration of in wired, wireless, and converged networks. The NFV fundamentals, such as network/computing virtualization and software defined networking will be presented and discussed. The different aspects of NFV orchestration, such as network service composition, lifecycle management, and network service scaling will also be introduced. Different NFV architectures and proposals will be discussed and their impact on the orchestration task will be presented. An emphasis on 5G mobile networks and a short introduction on converged optical/wireless systems will be given.

Biography of the Instructor

Dr. Roberto Riggio is currently Senior Researcher staff member in the Future Networks team at CREATE-NET, Italy, and Guest Lecturer at the University of Trento, Italy. He received a PhD in Communications Engineering from University of Trento, Italy, in 2008. His research interests include performance isolation in multi-tenant data-centers and mobile networks; software defined mobile networking and deep programmable mobile networks. He was, or is, involved in several European Projects including three 5G-PPP projects (COHERENT, SESAME, X-Haul) and has directly generated more than 1 M€ in competitive funding. Dr. Riggio has 2 granted patents on network virtualization and has published more than 60 papers in internationally refereed journals and conferences. He serves in the TPC of leading conferences in the networking field, including IEEE NOMS 2016, IEEE NoF, IEEE IM, IEEE NFV-SDN, IEEE NetSoft, IEEE QCMAN, IEEE ManSDN/NFV, EWSDN, and IEEE ManFI. He is associate editor for the Wiley International Journal of Network Management and Editor for the Spring Wireless Networks journal. He is the co-founder of the IEEE workshop on Software Defined 5G Networks (Soft5G) and of the IEEE Workshop on Management of 5G Networks (5GMan). He is a member of the ACM and of IEEE.

Importance and timeliness of the Tutorial

Among all the aspects currently being investigated by researchers and practitioners in the field of NFV, orchestration is one of the most challenging. This is due to the sheer complexity of future softwarized networks as well as to the resiliency and performance requirements these systems are called to satisfy. Moreover, upcoming 5G technological enablers such as Mobile Edge Computing, flexible functional split of small cells, and heterogeneous and dense deployments will require the NFV paradigm to be extended in order to account for network resources and orchestration challenges that go beyond what can already be found in the current NFV landscape.

In order to cope with the diverse range of requirements that sprout for such use cases, future wireless and mobile networks will further rely on virtualized resources and on dynamic service orchestration. Although a rich body of literature exists on VNF placement [1], virtual network embedding [2], and component placement [3], most of these works focus on the problem of mapping an input virtual network request (often in the form of a VNF Forwarding Graph) onto a physical virtualized network substrate (often offering computational as well as networking resources). However, these works implicitly assume that once a VNF is mapped on a node, the virtualization layer (i.e. the hypervisor) will take care of scheduling the various VNFs ensuring both logical isolation and an efficient use of the substrate resources [4]. Such an assumption does not hold anymore if radio nodes are added to the set of virtualized resources available in the substrate network (alongside computational and networking resources). In this case, in fact, the amount of resources available at each substrate radio node is a stochastic quantity depending on both channel fluctuations and end–users distribution.

The scenario described above calls for a dramatic revision on how orchestration is performed in converged networks, from the way radio resource are virtualized and exposed to the tenants, to the onboarding of new network services. The speaker is currently 5G System Architect at CREATE-NET where he is leading the design of 5G NFV/SDN systems across 4 EU-funded projects with the final objective of building a platform that can span multiple technological domains including: satellite-terrestrial convergence (H2020 Vital), converged optical/wireless (H202-5G Crosshaul), edge computing (H2020-SESAME), and radio access (H2020-COHERENT).

Finally, the tutorial will include an hands-on session where the open-source OpenBaton platform will be used in order to demonstrate how to orchestrate the deployment of VNF over multiple OpenStack instances. Remote access to an OpenStack deployment at CREATE-NET premises will be considered in order to allow the audience to directly experiment with the technology discussed during the tutorial.

Previous lecture and tutorial experience of the tutorial speaker

- **2013 - Present,** guest Lecturer at the University of Trento, Wireless Networks Course, M.S. in telecommunication engineering and computer science. Reference: Prof. Imrich Chlamtac.
- **15/5/2015, University of Waterloo, IEEE Seminar/Lecture,** “Where is the SDK for my Software-Defined Wireless Networks”, sponsored by the IEEE Communication Society. Reference: Prof. Raouf Boutaba.

References

[1] H. Moens and F. De Turck, “VNF-P: A model for efficient placement of virtualized network functions,” in Proc. of IEEE CNSM, Rio de Janeiro, Brasil, 2014.

[2] A. Fischer, J. Botero, M. Till Beck, H. de Meer, and X. Hesselbach, “Virtual network embedding: A survey,” Communications Surveys Tutorials, IEEE, vol. 15, no. 4, pp. 1888–1906, April 2013.

[3] B. Jennings and R. Stadler, “Resource management in clouds: Survey and research challenges,” J. Netw. Syst. Manage., vol. 23, no. 3, pp. 567–619, Jul. 2015.

[4] M. Ghaznavi, A. Khan, N. Shahriar, K. Alsubhi, R. Ahmed, and R. Boutaba, “Elastic Virtual Network Function Placement,” in Proc. of IEEE CloudNet, Niagara Falls, Canada, 2014.