

## SHORT TERM SCIENTIFIC MISSION (STSM) SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

**Action number: 15127**

**STSM title: Availability-driven NFV Orchestration**

**STSM start and end date: 18/12/2018 to 02/01/2019**

**Grantee name: Stefano Secci**

### PURPOSE OF THE STSM:

The motivation for this STSM is to work on novel orchestration algorithms for NFV environments able to take into consideration infrastructure availability targets in the VNF orchestration decision. Relevant amount of work has been done by the networking teams at Politecnico di Milano and Cnam. The purpose is to conceive novel availability-driven Network Function Virtualization (NFV) orchestration algorithms, taking into account multiple types of failures and network misconfiguration in the placement of individual VNF, with or without protection, as well as Virtual Network Functions (VNF) chains, and their integration in an OpenStack-NFV testbed.

### DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

In the forthcoming network infrastructures, virtualization will become the basic technology to execute and orchestrate virtual network functions, indeed adding the orchestration dimension to legacy network management practices. Finding acceptable strategies to protect VNFs, and that can be integrated at a low computational effort possibly allowing on-line execution is a major research challenges to which S. Secci and M. Tornatore have been working on recently [1-3]. VNF protection strategies allow, on the one hand, the cope with different types of failure and configuration issues (at operating system, VNF, hypervisor/container management system, physical system and link failures) and, on the other hand, to ensure that a higher availability performance can be contractualized and agreed for network services.

During the STSM, multiple meetings took place during which S. Secci presented to the local team the work in [1], highlighting the open research work related to (i) the computation of exact availability targets using bayesian networks [5], (ii) its usage for the orchestration of VNFs with shared backup protection [4], (iii) the modeling of VNF switching and recovery in case of shared backup protection and (iv) the inclusion of chaining to extend the current placement approach, and that while maintaining polynomial complexity and good availability target reachability performance.

Multiple Q&A sessions took place during the visit which allowed clarifying the different facets of the reliability aspect in NFV architecture.

[1] M Casazza, P Foulhoux, S Secci, M Bouet, "Securing Virtual Network Function Placement with High Availability Guarantees", Proc. of IFIP Networking 2017, June 12-16, 2017, Stockholm, Sweden.

[2] A Hmaity, M Savi, F Musumeci, M Tornatore, A Pattavina, Protection strategies for virtual network functions placement and service chains provisioning, Networks 70 (4), 373-387, 2017.

[3] High Availability Network Functions Virtualization (HA-NFV) software project: <https://ha-nfv.roc.cnam.fr>

[4] Tornatore, M., Lucerna, D., Mukherjee, B., & Pattavina, A. (2012). Multilayer protection with availability guarantees in optical WDM networks. *Journal of Network and Systems Management*, 20(1), 34-55.

[5] S. Ktari, S. Secci, D. Lavaux, "Bayesian Diagnosis and Reliability Analysis in Private Mobile Radio Networks", Proc. of 22nd IEEE Symposium on Computers and Communication (ISCC), July 3-6, 2017, Heraklion, Greece.

#### **DESCRIPTION OF THE MAIN RESULTS OBTAINED**

Agreement was reached toward the precise definition of the open tasks (i)-(iv) mentioned above. The lack of sufficient human resources at the time being led to kick-off the work for task (i) first. Time was spent in the exploration of previous studies at the state of the art. Our attention was rooted on previous works [4] and [5] from M. Tornatore and S. Secci. In [4], different availability computation models for shared path protection in optical networks were compared; our conclusion is that most of the models therein can be applied to the VNF shared protection case with some algorithmic adjustments that were tentatively identified. Furthermore, the usage of Bayesian networks in [5] to compute availability accordingly to CEI standards was discussed as a possible approach, while identifying the time and spatial complexity limits of the approaches. A master internship topic to perform preliminary simulations and work on the finalization of task (i) toward tasks (ii) and (iii) was prepared and will be announced closely to master students in Milan and Paris, with the goal to ideally be able to address (iv) in 2019/2020.

#### **FUTURE COLLABORATIONS (if applicable)**

The collaboration between the two research teams will continue, with further visits planned for next years, including possible joint submissions of the results of the research activities.