INTRODUCTION

Software-defined networking (SDN) and network function virtualization (NFV) are key technologies to address the dramatic growth of IP traffic and the key performance indicators for 5G networks enforce, among other needs, (i) a scalable management framework permitting agile deployment of applications across an advanced programmable network. Moreover, (ii) a reduction of the network management OPEX by at least 20%. Finally, a joint IT-network optimization is imperative to guarantee (iii) the accomplishment of the End-to-End latency less than 1 ms for some of the traffic types. SDN enables OaaS which may provide superior performance in SDN/NFV-based networks, basic to accomplish 5G KPIs.

SCHEMATIC OVERVIEW

This demonstration is based on two major components implemented as Net2Plan specific extensions (plugins):

- **IT Resource Manager (ITRM)** for interfacing multiple OpenStack instances which enables multi-tenant slicing, IT resource visualization and VM migration.
- **Carrier** for representing an operator that deploys a network service.
- **NFV-O.** OSM is in charge of the virtualization infrastructure that manages and deploys VNFs leveraging in VIMs.
- **Virtual Infrastructure Managers (VIMs).** OpenStack instances are responsible for the instantiation and hosting the virtual machines (VMs) of the VNFs.
- **SDN-control.** ONOS controls and configures the metro network via OpenFlow.
- **Emulated Transport** is provided by Mininet with SDN OpenFlow-enabled setup.

TESTBED SETUP

- 1 Personal Laptop: Net2Plan (ITRM)
- 1 Personal Laptop: Net2plan (GUI) + OSM
- 3 Mini PCs: OpenStack (2 VIMs, 3 Compute Nodes)
- 1 Mini PC: ONOS + Mininet

NOVEL FEATURES AND WORKFLOW

1. **Multitenant IT slicing** with the control of the IT infrastructure by different carriers and according to a set of quotas.
2. **IT resource visualization** exploits the REST API to obtain the telemetry service (Gnocchi) the available list of resources (instances, networks, volumes, etc.) that generate metrics and measures.
3. **Intra-cluster VM migration** permits multi-node OpenStack cluster instantiation. Additionally, the IT resource manager plugin launches a terminal console from the GUI assessing the correct instantiation of the VMs.
4. **SC computation, NFV instantiation, and transport flow allocation:**
   a. Topology is loaded in the GUI from ONOS and OSM
   b. Optimization algorithm is executed within the Net2Plan plugin
   c. The network service descriptor is sent to OSM
   d. VMs are instantiated in the OpenStack VIMs
   e. OpenFlow rules are established via ONOS

CONCLUSIONS

This dynamic SDN/NFV demonstration proves (i) an IT resource manager module proves advanced joint control and management of multiple OpenStacks-based data centers in a metropolitan IP-over-WDM network. (ii) Net2Plan implementation for assisting OSM on the multi-site NFV instantiation, and ONOS for the flow allocation.

ACKNOWLEDGEMENT

The research leading to these results has received funding from the European Commission for the H2020-ICT-2016-2 METRO-HAUL Project, (G.A. 761727), H2020-MSCA-IF-2016 INSPIRING-SNI project (G. A. 750611) the Spanish National Project ONOFRE-2 (TEC2017-84423-C3-1-P) and Elastic Networks project (TEC2015-71932-REDT) (G.A.750611).