Latency-based Optimization in a Dynamic SDN/NFV Environment Demonstration

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**Abstract** *Your 40 words abstract, which will appear in the conference program, should be an explicit summary of the paper that states the problem, the methods used as well as the major results and conclusions. It should be complementary to rather than a repeat of the title.*

1. **Introduction**

The dramatic forecasted growth of the IP traffic and the incoming 5G era conduct the network management environment to an unforeseen scenario. The Cisco predictions announce an annual increasing of 27% in the IP traffic, mainly due to the popularity of the high-bandwidth video content [1], and the metro network traffic was increased twofold in comparison with backbone traffic in 2017 [2]. Besides, it is worth to consider the 5G key performance indicators, (i) scalable management framework permitting agile deployment of applications, (ii) reduction of the network management OPEX by at least 20% and (iii) the accomplishment of the End-to-End latency less than 1 ms. This picture enables optical networking a new challenging perspective to face in order to satisfy user necessities.

Software-defined networking (SDN) and network function virtualization (NFV) may help to handle the aforementioned scenario. SDN provides a fully-programmable software-based network management uncoupling the control and the data planes whilst NFV reduces the dependency of hardware in network functionalities. This joint dynamicity is key to assess with a wide variety of user traffic requests. The Metro Haul Project [3] suggests scalable, dynamic and efficient metro networks to support 5G access and high-capacity elastic networks. The core of the Metro Haul proposal is the dynamic interconnectivity of two different types of nodes, Access Metro Edge Node (AMEN) and Metro Core Edge Node (MCEN) with computational capabilities to permit SDN/NFV functionalities with the view in placing the Virtual Network Functions (VNFs) close to the requesting users. Some works have pointed out that locating content near to users in an optimal way may partially alleviate the impact in the core/backbone networks [4] putting optimality on the network management table.

In [5], authors demonstrated optimized NVF the use of a specialized open-source planning tool to assist the NFV-orchestrator (NFV-O) in the optimal VNF instantiation, NFV service chain allocation and optimization of the emulated transport network paths jointly. The present work can be seen as an expansion of [5]. In the previous demonstration the control of the data plane was out of the scope. The novelty in the current work is the presence of a SDN controller to manage the data plane in order to allow OpenFlow-based connectivity in an emulated transport network and a modification of the allocation intelligence to be aware of latency requirements without any lack of functionality coming from previous work presented in [5].

1. **Overview**

This work is a demonstration which proofs the use of the planning tool Net2Plan to assist the NFV-O Open-Source MANO (OSM) and the SDN Controller (ONOS) providing optimal VNF instantiation, latency-aware service chain allocation and optimization of transport network in a dynamic SDN/NFV environment using open-source tools only. The agents involved in this demonstration and their main functionalities are presented below and also in Fig. 1:

* Operations Support System (OSS). Represents an operator that deploys an application/service. A GUI has been programmed in Net2Plan to emulate the operator behavior.
* NFV-Orchestrator: Role played by ETSI OSM which is in charge of the virtualization infrastructure that manages and deploys VNFs leveraging in virtual infrastructure managers (VIMs).
* Virtual Infrastructure Managers (VIMs): are responsible for the instantiation and hosting the virtual machines (VMs) of the VNFs. OpenStack provides this actions.
* SDN Controller: represented by ONOS which controls and sets up the devices of the emulated transport network via OpenFlow.



* Emulated Transport. MiniNet provides an emulated transport network for delivering packages in the data plane permitting OpenFlow connectivity.

Fig.2 – Demonstration testbed configuration



Fig.1 – Demonstration Overview schema

* SCCE: a Service Chain Computation Element (SCCE) can be seen as an evolution of the Path Computation Element (PCE) tuned for service chain allocations, where the path is constrained to traverse a sequence of VNFs. Net2plan has the intelligence to achieve such goals.

1. **Testbed configuration**

To test this proof of concept in NFV the hardware used is compound by a personal laptop, three high-performance miniPCs and two regular auto-configured switches. In Fig. 2 a schema of the physical implementation is shown. The planning tool, Net2Plan and OSM (this last one is installed in a virtual machine) are deployed in the personal laptop. Two miniPCs are used as VIMs with two different installations of OpenStack and finally the last miniPC is in charge of the SDN Controller (ONOS) and the emulated transport network created by Mininet.

A management network is configured to for the control plane (Fig.2 in blue), one regular switch is in charge of such purpose. OSM, the two OpenStacks and ONOS are considered as parts of the control plane. Similarly, another network is set up to provide data plane layer 3 connectivity using the other switch, as can be seen in green in Fig. 2. The data plane network has its own interface to communicate the emulated hosts in mininet with the VNF instantiated in the VIMs achieving in this way the packet connectivity needed in a usual SDN/NFV scenario. The VIMs (OpenStack) has been set up with an internal private network to place the VMs of the VNFs. The VMs has external connectivity given by floating IPs of a public network with access to the data plane network.

1. **General assumptions, workflow and results**

In order to proceed with the demonstration in a proper way, a set of assumptions and a structured workflow are considered:

* 1. Firstly, in the load process, Net2plan receives the entire information of the NVF and IT resources via REST/API from OSM and the VIMs and the emulated transport network data from ONOS.
  2. In Fig. 3 a) can be seen how the user defines the service chain request (origin and destination nodes, sorted sequence of VNFs, bandwidth and latency) from the GUI.
  3. Net2plan receives the service chain request, if any of the analyzed k-shortest service-chain-based paths guarantees the latency specifications, the algorithm returns the chosen path in the transport network and the placement of the VNFs in the VIMs. Note that Net2plan is the only one that can accomplish the latency needs providing optimal VNF placement and transport paths.
  4. OSM is noticed about the VNFs placement and starts the instantiation of the VNFs in the corresponding VIMs as indicates Fig.3 b).
  5. Once the VNFs are ready, as it can be seen in Fig 3 c) and d), ONOS creates the OpenFlow rules following the suggestions of the Net2plan algorithm providing real connectivity between the origin and destination nodes through the sorted sequence of VNFs.

1. **Conclusions**

This demonstration offers a proof-of-concept in a dynamic SDN/NFV environment which proves that a fully interconnection between the open-source tools OSM, ONOS, OpenStack, Mininet and the planning tool Net2plan in order to provide optimality, proving that it is not only possible but also necessary to accomplish, among others, the latency requirements of the incoming 5G era.

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