E2E Transport API demonstration in hierarchical scenarios

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Abstract: We validate the Transport API interoperability with a hierarchical orchestration layer. The demonstration shows the end-to-end provision of connections based on the topology and connectivity services of the ONF Transport API.

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1. Overview

There is an old aim of network operators which is multi-vendor interoperability in transport networks. Interoperability activities help to align the solutions of the vendors, while creating a competitive environment that fosters innovation and leads to new developments and product evolution. The definition of the Transport API (TAPI) within the Open Networking Foundation (ONF) is a pragmatic approach to obtain an end-to-end (E2E) Software Defined Network (SDN) infrastructure for transport networks. It supports network programmability in each optical domain without requiring full data plane interoperability. Currently, network operators deploy optical networks on a regional basis. This means that each vendor uses its technology in a given area and operates it, which is very relevant for production environments. The use of the TAPI as a North-Bound Interface (NBI) of the optical controllers allows the utilization of a common abstraction model to support the optical services. This work is done within the umbrella of the Optical Internetworking Forum (OIF) to coordinate industry in this interworking activity.

The SDN/NFV orchestration architecture is represented in Fig. 1. The application layer contains the cloud orchestrator, which is in charge of providing compute storage and network resources for NFV Virtual Network Functions (VNFs). The VNFs may be located on the same data-center or they can be distributed within the network. In order to provide end-to-end connectivity for data-center interconnection (DCI), set-up of end-to-end service is required across a multi-vendor, multi-domain environment. The control layer is composed by the Network Orchestrator and the controllers. The network orchestrator is defined as a parent controller or a centralized "controller of controllers", which handles the automation of end-to-end connectivity provisioning, working at a higher, abstracted level and covering inter-domain aspects. The controller is defined as an entity which is in charge of the specifics of the underlying technology. The TAPI is the interface for the control layer. It provides a common abstraction model between the controllers and the orchestrator. Finally, the infrastructure layer has the Network Elements (NEs) which is the L1/L0 equipment of the different vendors.

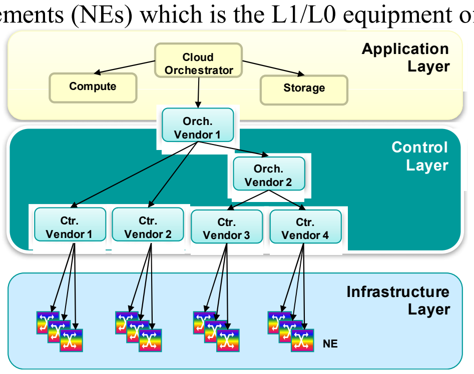

Fig. 1 SDN/NFV orchestration architecture for multi-vendor optical transport networks with hierarchical orchestrators;

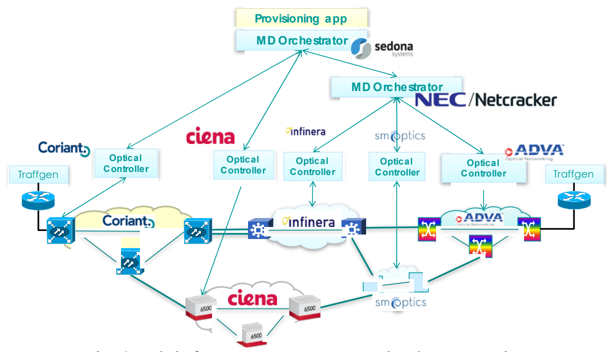

Fig. 2 Lab infrastructure to support the demonstration

2. Innovation

This work demonstrates the use of TAPI to support end-to-end interoperability with a hierarchical orchestration layer through the collaboration of the ONF/OIF. The demonstration shows end-to-end provisioning of connections based on the topology and connectivity services of the TAPI. A first milestone towards this concept was the presentation of the first OIF/ONF interop event Global Transport SDN Prototype Demonstration [1], where a REST interface was proposed for Service Request API. There is also previous work within the research community. The EU-Japan STRAUSS project proposed a multi-domain SDN architecture where the network orchestrator acted as a unified transport network control layer, which enables end-to-end resources orchestration across multiple domains with heterogeneous technologies [2]. The authors in [3] demonstrated a network orchestrator provisioning end-to-end optical services with SDN controllers, but without any common interface. Therefore, the work in [3] lacked a standard interface to operate the optical domains. Based on this need, the authors in [4] proposed the utilization of the Control Orchestration Protocol (COP), which provides a research-oriented multi-technology approach using YANG/RESTconf [5]. This reseach work was taken as a basis to define the functional requirements of the ONF TAPI [6]. The first demonstration of the TAPI within a single domain scenario was done in [7], including the Snowmass Open Source code for a reference implementation in [8].

The main contribution of this work is the experimental demonstration of end-to-end provisioning using an SDN/NFV architecture across multiple control domains using the TAPI to retrieve topology and set-up multi-domain connections. This experiment is done using commercial SDN products from very relevant players in the industry, which are co-authoring this work. It demonstrates that SDN is ready for abstracted control of optical networks, once the deployments of the vendors are moved to a commercial version of implementation. A secondary contribution is the utilization of a hierarchical architecture, which enables other use cases for operators like network slicing or bandwidth on demand. Several abstraction models were discussed during the preparation of this work and a per-domain abstraction model will be used. This model shows the top orchestrator each domain as a single node, reducing the complexity of the top orchestration, but providing enough information to support end-to-end service provisioning.

The demonstration will show how the orchestrators are able to obtain the topology information of the SDN controllers at different levels of abstraction. The top orchestrator will carry out end-to-end provisionining of optical connections to provide services to end customers, which are connected behind an IP router. The set-up is composed of five optical controllers and two orchestrators (Fig. 2). The data plane connectivity will be validated to see how capacity service is set-up across the multiple domains.

3. Relevance

SDN/NFV topics are very relevant for the optical community. The view of the optical network as a static and dumb infrastructure is not acceptable any longer. This demonstration is relevant to see the collaboration of research, standardization fora and industry. This work extends research initiatives, which started within 2014, with innovation from research and industrial institutions.

This work is done with the support of the ONF/OIF. The ONF started a new collaboration model based on Open Source initiatives like the Snowmass project [8]. The utilization of Open Source reduces the time to creation of a testing environment like the one used by OIF. The relevance of this new way to carry out standardization is very attractive. The industry needs specifications to define the requirements of the solutions and develop the products, while, on the other hand, Open Source projects facilitate a dynamic environment, where research institutions, like CTTC in this case, can provide a reference implementation that is then improved on by the industry.

References

[1] OIF/ONF White Paper, Global Transport SDN Prototype Demonstration, October, 2014.
[2] R. Muñoz, et al.: Network Virtualization, Control Plane and Service Orchestration of the ICT STRAUSS Project, in EuCNC, June 2014
[3] V. López, et al.: Demonstration of SDN orchestration in optical multi-vendor scenarios, in OFC, Mar 2015.
[4] R. Vilalta, et al.: The Need for a Control Orchestration Protocol in Research Projects on Optical Networking, in EuCNC, June 2015.
[5] A. Mayoral, et al.: First experimental demonstration of distributed cloud and heterogeneous network orchestration with a common Transport API for E2E services with QoS, in OFC, Mar 2016.
[6] Open Network Foundation, Transport API Functional Requirements, June 2016, TR-527.
[7] V. López, et al.: Transport API: A Solution for SDN in Carriers Networks, in ECOC, Sep 2016.
[8] Snowmass ONF repository, https://github.com/OpenNetworkingFoundation/Snowmass-ONFOpenTransport/