Using Network Operations Platform and Orchestrator to Enhance Programmable OpenROADM Optical Networks

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Abstract: Automatic provisioning of server-to-server data transfer over OpenROADM compliant equipment is achieved through the combined use of NOP/PROnet Orchestrator. User's request for datarate is achieved while accounting for the equipment's ability to create wave services.

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1. Overview

The combined use of Network Operations Platform (NOP) and PROnet multi-layer Orchestrator — first shown at OFC'21 [1] — has provided enhanced visibility into the external and internal behavior of open and disaggregated optical networks. The additional insights have included real-time monitoring of metrics such as packet datarate across a multi-node OpenROADM optical network as well as status update events as the TransportPCE controller module provisions (lightpath) wave service across that optical network.

In this new demonstration, we want to show how these received metrics and status information can enable the orchestrator SDN controller to make informed decisions and potentially alter the state of the network as situations change. Additionally, we show these techniques being used against a fully software-emulated OpenROADM network. Even though we have access to a variety of OpenROADM-compliant vendor hardware to test against, software-emulation is the only practical way to test the orchestration in larger metro or wide area transport networks before deployment to the field.

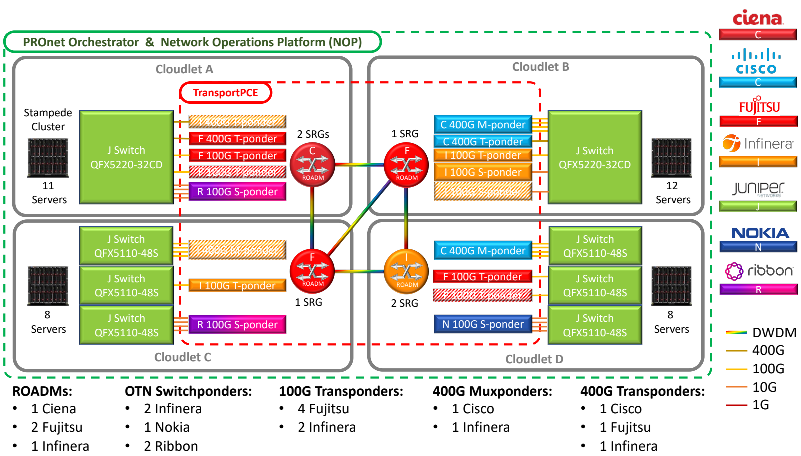

Fig. 1. Logical diagram of NOP, PROnet Orchestrator, compute nodes, and optical network, showing key vendor participation

2. Innovation

Fig. 1 shows the logical diagram of the NOP and the orchestrator on top of the compute infrastructure and optical network. The innovations of this Demo Zone work are as follows.

Control of Programmable Optical Networks – This demonstration builds on the foundation of NOP and PROnet Orchestrator to enhance programability of OpenROADM-based optical networks. We have enabled the PROnet

Orchestrator to provision lightpath service creation, receive real-time feedback, and make decisions based on that feedback. Previously, individual lightpath service creation had to be initiated directly by the user via TransportPCE REST API call without confirmation of successful service provision[1].

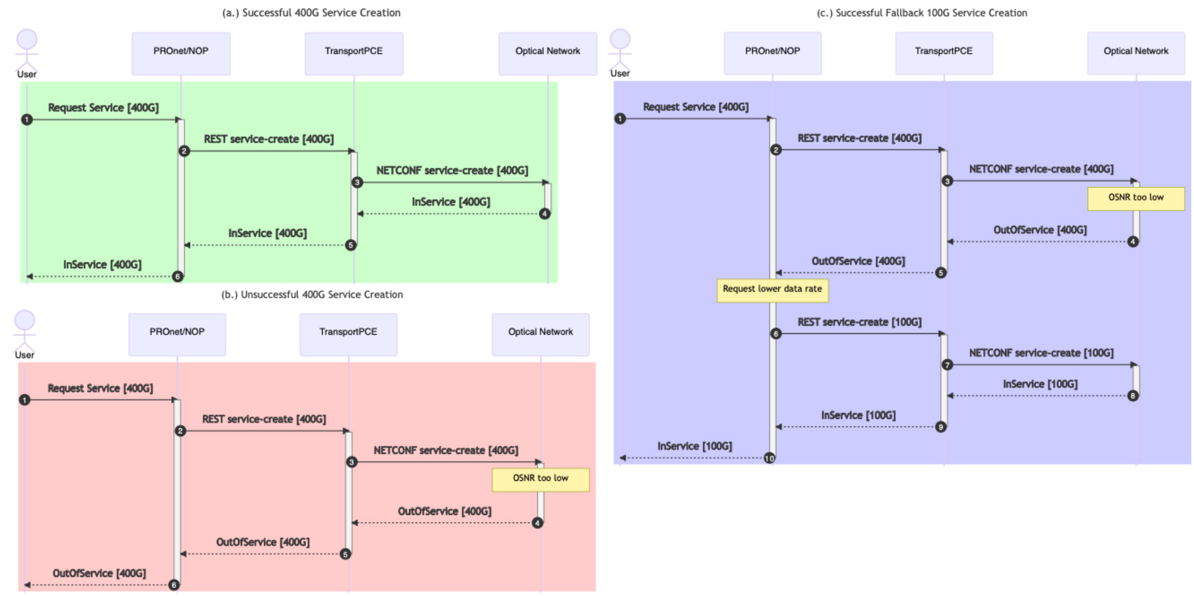

Fig. 2. PROnet Orchestrator/NOP sequence diagrams *(a.)* Successful 400G service creation. *(b.)* Unsuccessful 400G service creation due to low OSNR. *(c.)* Successful 100G service creation after initial 400G failure.

There are many possible scenarios where the behavior of an optical network could be altered programmatically. One we will consider is shown in Fig. 2. Sequence *(a.)*, in green, shows a successful 400G service creation, in which the user provides appropriate details and asks PROnet Orchestrator to establish the lightpath (Step 1). The orchestrator marshals the correct attributes and makes a REST API call to TransportPCE (Step 2). Then TransportPCE performs its path and power level calculations and makes the correct NETCONF API calls to the physical optical equipment (Step 3). Finally, if all goes well, the lightpath is established and set to “InService” status. However, if TransportPCE is unable to provision the lightpath, say due to OSNR being too low for the requested datarate, *(b.)*, in red, shows the steps of an unsuccessful service creation.

However, rather than returning this failure to the requesting user, the orchestrator can take some alternate actions. For example, if the user is agreeable to a lower datarate, the orchestrator can automatically make a lightpath service creation request at a lower datarate (e.g. 100G, or 200G if hardware supports it) as shown in *(c.)*.

Other programmable scenarios could be considered in the future, as anticipated by the OpenROADM MSA [2] [3]. For example, since the PROnet Orchestrator has control of associated L2 network switches in addition to the optical network, it could take actions to provision and combine multiple lower datarate wave services to fully or at least partially fulfill the original datarate request. Additionally, since NOP has a time-data series store of key metrics (including L2 network metrics like errors and utilization and compute/container metrics such as CPU/memory/disk performance) many decisions can be taken by the orchestrator by utilizing ML-type algorithms on the past and current metric data.

Control of Software-emulated Optical Networks – While we are fortunate to have significant hardware for testing, it is not feasible to do any experiments at a typical metro or wide area scale. Therefore, we have expanded our NOP and orchestrator to also interact with software-emulated optical network devices. The combination of FD.io HC2VPP-based Honeynode NETCONF Docker container [4] on top of the newly-available Optical Network Emulator (ONE) Engine [5] running in a Kubernetes multi-node compute environment allows us to test orchestration scenarios on much larger optical networks. In this demonstration we show NOP and PROnet Orchestrator interacting with a medium-sized metro optical OpenROADM network, including lightpath service creation and monitoring of operational status.

Use of Non Proprietary Software – This demonstration continues to leverage non-proprietary open source software packages, as discussed in our earlier work [1], including Prometheus, Grafana, Kafka, Elasticsearch, Logstash, Kibana, and Docker. We have added the Honeynode NETCONF server (based on FD.io HC2VPP project) and also

[1]TransportPCE does not acknowledge successful completion of service creation.

make significant use of Kubernetes.

Utilization of Current OpenROADM-compliant Hardware – This demonstration makes use of the latest OpenROADM equipment from a number of vendors, including ROADMs, switchponders, muxponders, and 400G pluggable transponder modules. We fully utilize the lightpath wave service bandwidth with multiple parallel iPerf2 server/client pairs. Fig. 3 shows some of the equipment that is expected to be connected to the NOP and PROnet Orchestrator demo during OFC'22.

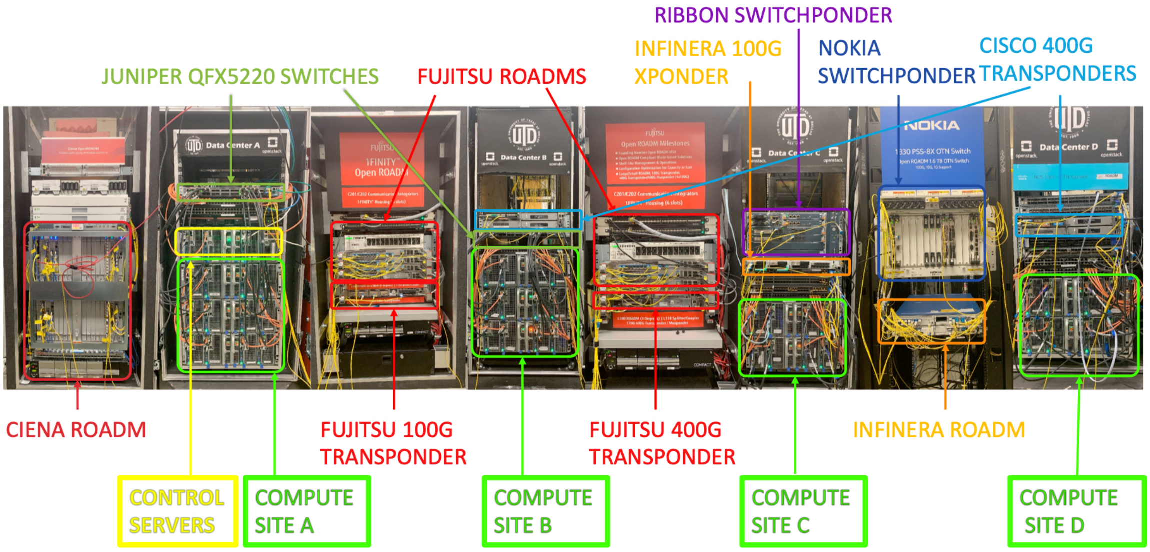

Fig. 3. OpenROADM environment (as first demonstrated during OFC'21 [1]) showing location of control servers (in yellow) in relation to Compute Sites A, B, C, and D with packet-optical multi-vendor OpenROADM network components in between

3. OFC Relevance

This submission directly responds to the OFC Demo Zone call for demonstrations of programmable networks, with NOP-based control and monitoring of programmable optical hardware. In addition, the demonstration focuses on the disaggregated OpenROADM latest technologies and makes use of predominantly open-source software packages for ease of independent replication by other researchers.

4. Demo Zone Content and Implementation

The objective of this demo is to showcase the new functionalities that we have added to NOP and PROnet Orchestrator. The configuration of the demo is much like that shown in Fig. 3 with hardware compute nodes communicating across a diverse multi-vendor optical network. Our NOP display is web-based and can be shown on a large monitor attached to a laptop which will be connected to our demonstration test bed on the conference showcase floor or via VPN to the UTD lab if conditions do not allow shipping of the equipment.

The demonstration itself consists of some introductory slides followed by live presentation of features discussed above, along with any late-breaking functional additions. The Demo Zone attendees can ask questions after the demonstration and additional functions or scenarios can be presented, if needed.

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