ODTN: Open Disaggregated Transport Network. Discovery and control of a disaggregated optical network through open source software and open APIs.

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Abstract: ONOS discovers and manages a topology made of Transponders and a dedicated OLS, using standard protocols (NETCONF/RESTCONF) and models (OpenConfig/TAPI). The demo is a joint collaboration, towards production deployment, between 3 operators and 2 equipment vendors.

OCIS codes: (060.0060) General; (060.4250) Networks

1. Overview

The demo shows the use of ONOS (i.e., Open Network Operating System) controller for the control of a partially disaggregated network. The demo has two phases, first topology discovery and second, point-to-point connectivity setup. The demo scenario, including the optical devices and the Open Line System (OLS) is described in figure 1.

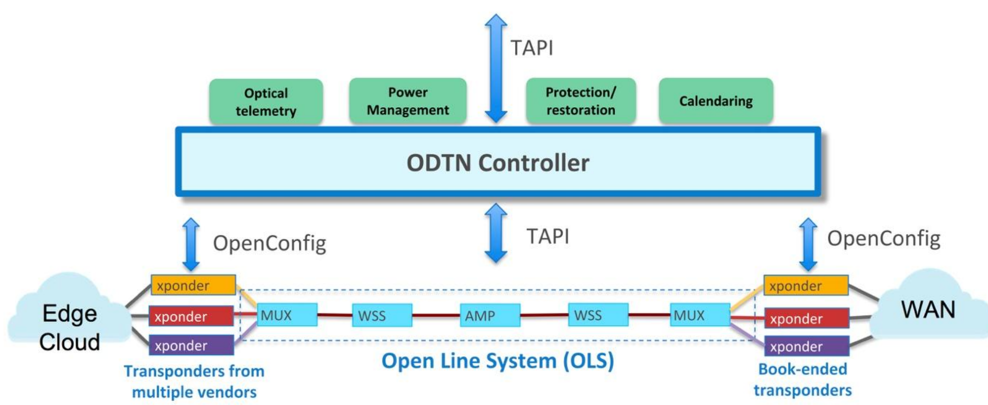

Figure 1, Topology

The underlying infrastructure comprises two disaggregated white box optical transponders considering a partial disaggregation of transponders and Optical Line System (OLS), but considering the transceivers at both ends belonging to the same vendor. The transponders serve as both input and output of the network. Both Transponder client side ports are connected to a virtual host that is capable of generating and receiving L3 traffic. Providing physical connectivity between the two transponders there is an OLS to which both line-side ports of the controller are connected. TAPI Connectivity requests are going to be issued by the operator's BSS or OSS, the system overarching the whole network deployments.

The demo and the ODTN are a collaboration between the Open Networking Foundation (ONF), two of its Service Providers: NTT Communications and Telefonica.

1.1. Main Contributions. Novelty w.r.t State of Art

Although the use of ONOS has been demonstrated for the control of disaggregated networks, in the past, [4], the main novelties of the current demo proposal are:

- The demo is the main result of a joint collaboration amongst 3 operators and 2 equipment vendors, reflecting the use of a model driven development and showcasing interoperability between drivers and devices agents.
- We show the use of a dedicated OLS, as opposed to previous works that directly interact with devices. The use of an OLS is considered a necessary intermediate step, and a realistic scenario for the mid-term, especially since existing open data models do not capture the complex relationships between components within an OLS.
- Extending previous similar demos that rely on a single ONOS instance to control the devices, in this demo, the ONOS controller will be deployed in a 3 nodes cluster, using the latest framework provided by Atomix and integrated into ONOS. Such deployment will highlight resilience to failures in the control plane byshowcasing mastership handover of the topology devices from one ONOS instance to another in the same cluster.
- We demonstrate the use of recursive Transport API [3], both at the ONOS NBI level (since it acts as a network orchestration) as well as at the SBI level, acting as a client of the OLS, along with the use of T-API in two different layers: Ethernet for the provisioning between client ports and a photonic layer between the service interface points mapped to transceivers line ports.

1.2 Topology Discover

The demo first demonstrates the automated optical network topology discovery through ONOS [1]. After an initial step by which ONOS is given the IP addresses and credentials of the transponder devices (more concretely, of the Netconf server part of the device agent software) and the OLS, ONOS opens a Netconf session over SSH to the terminal devices. Once the session has been established, the transponder's capabilities are discovered, querying the device capabilities such as components, ports and interfaces, as well as supported Optical Channels, according to the OpenConfig models [2]. On the other hand, ONOS relies on the RESTConf interfaces exported by the OLS, which exports several models as defined by the Transport API [3]. In the selected partial disaggregation configuration, the OLS abstract from ONOS the discovery of underlying optical components such as WSS, muxponders and amplifiers.

The result of this first demo part is the discovery of the underlying network. Topology discover highlights how though open source software ONOS can interact with different type of devices, network components, leveraging different protocols and models in a seamless way. Such result is achieved using ONOS modular architecture on the southbound and specific drivers that were implemented to deal with both transponders (based on OpenConfig models) and OLS specifics.

1.3 Connectivity setup

The second part of the demo showcases the setup of an end to end connectivity between the two hosts attached to the client side ports of the transponders.

Setup of such connectivity will be triggered from a request coming to ONOS Northbound RESTCONF interface of a T-API connectivity service.

The first request, OTSi specific, will contain parameters for the OLS and the line side ports of the transponders. This request will be broken down by ONOS to a rest call containing a connectivity-service object from TAPI to the OLS and two requests modifying port state, power and frequency on the transponder line side. This was a very specific design choice to allow pre-provision of the photonic layer and, at a later stage, the ethernet layer. After this first connectivity-service request has been processed ONOS will receive a second connectivity service request, describing the mapping between the Line side and client side in each transponder and enabling end to end connectivity in the network.

For both requests the Transponder will be configured though OpenConfig defined messages exchanged on top of the previously established Netconf SSH session. After the setup of end to end connectivity traffic will be shown flowing between two end hosts attached to the transponders.

The result will be an end to end connectivity that is reported by ONOS to OSS/BSS when queried with the json shown in figure 2.

```
{
  "tapi-connectivity:output": {
    "service": {
      "uuid": "20b8de56-f2c3-46dc-a605-4c36e4482987",
      "end-point": [
        {
          "local-id": "234184e5-b5af-45dd-a27e-6818e96aad87",
          "service-interface-point": {
            "service-interface-point-id": "7b4385cf-8f4a-4161-bf90-d084acb1015f"
          }
        },
        {
          "local-id": "343b8d8a-384f-4af8-9672-fa2eac4d2f7f",
          "service-interface-point": {
            "service-interface-point-id": "fcc00b2d-ae2c-4add-94c6-5109bf62c9ce"
          }
        }
      ],
      "connection": [
        {
          "connection-id": "31733d3a-2527-4473-93df-ae654c93b687"
        }
      ]
    }
  }
}
```


Figure 2, TAPI Connectivity

2. Innovation Section

Today's optical transport market is served by vertically integrated network solutions. Operators select a vendor for their network, and then all transponders, ROADMs, line systems and optical design tools are provided by this same vendor. As a result, operator choice becomes limited once the initial vendor selection is made.

ODTN's solution has three key pillars: open source software, Open APIs and device disaggregation. The optical network can use a different brand of transponder for each end to end link, and these transponders can run over an open line system from yet another supplier. Through disaggregation and opening of the optical systems and by using open APIs ODTN brings several benefits to the optical space. Open APIs and modularity to the Southbound also ensure the project and it's deployment will be vendor neutral and modular, thus enabling future network changes.

3. OFC Relevance

Being OFC the largest conference for optical communications it has the perfect audience for a demo of ODTN. ODTN pushes the boundary of softwarization, disaggregation and programmability of current optical networks. Such concepts are key to the future of optical networks. Through the demo the audience will learn about the different components, software and APIs that are the building blocks for future optical network. The ODTN demo offers the audience also an insight in specific requirements and path to production of new, software based, optical solutions from different Service Providers.

4. References

[1] ONF, ONOS Whitepaper, http://onosproject.org/wp-content/uploads/2014/11/Whitepaper-ONOS-final.pdf, 2014

[2] OpenConfig, https://github.com/openconfig/public/tree/master/release/models/optical-transport, 2018.

[3] Transport API, *https://github.com/OpenNetworkingFoundation/TAPI , 2018*

[4] A. Sgambelluri, et al., "Fully Disaggregated ROADM White Box with NETCONF/YANG Control, Telemetry, and Machine Learning-based Monitoring", in Proc. OFC, Mar. 2018.