Physical-Layer Awareness: GNPy and ONOS for End-to-End Circuits in Disaggregated Networks

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Physical-Layer Awareness: GNPy and ONOS for End-to-End Circuits in Disaggregated Networks

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Abstract: This demo shows the automatic end-to-end path provisioning over a multi-vendor fully disaggregated Open Line System by Czech Light using the GNPy QoT estimator and Cassini transceiver by the Telecom Infra Project integrated with ONOS.

1. Introduction

With the dramatic increase in data traffic envisioned for the next years, optical networks will be requested to sustain a large amount of data traffic. Network operators are trying to maximize returns on infrastructures by automating the management and by maximizing capacity in existing networks. Thanks to the coherent optical technologies, such a goal is obtained by a multi-layer abstraction of networks down to the physical WDM layer [1, 2].

The Telecom Infra Project (TIP) Open Optical Packet Transport – Physical Simulation Environment (OOPT-PSE) [3] group is defining and developing a common, open source and vendor-neutral set of algorithms able to assess the optical impairments in an open optical line system.

The core software developed by the OOPT-PSE Team is called Gaussian noise simulation in Python (GNPy) [4] and relies on a quality-of-transmission estimator (QoT-E) that abstracts the optical transmission by evaluating the accumulation of the amplified spontaneous emission (ASE) noise generated by the amplifiers and of the nonlinear interference (NLI) introduced by nonlinear fiber propagation. So, the QoT-E of GNPy, given the network status, calculates the Generalized Signal to Noise Ratio (GSNR) [1, 5] over a described network route with validated excellent accuracy [6] and quick computational time

The Open Network Operating System (ONOS) [7] is an open source SDN network controller targeted specifically to Service Providers and mission critical networks. It is developed to provide the high availability, scale-out, and performance in network demanding. Furthermore, ONOS includes Northbound abstractions and APIs that ease application developments.

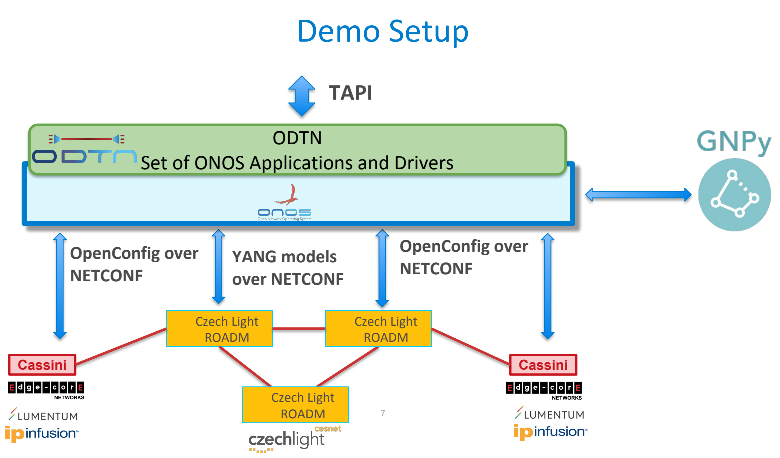

Fig. 1: Demo schema

Fig. 2: Hardware setup at the TIP Summit

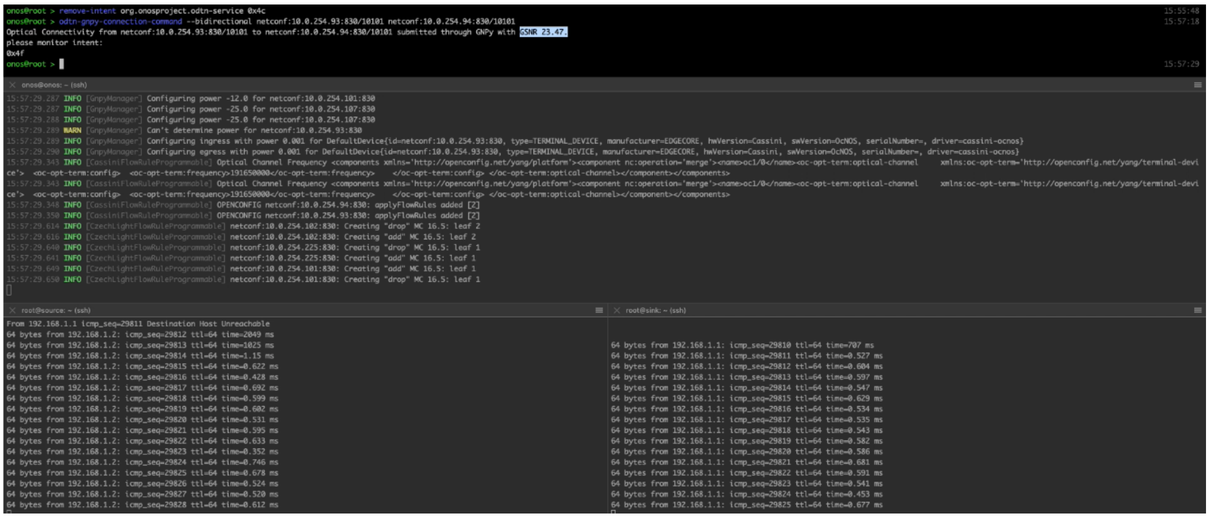

Fig. 3: Provisioning an end-to-end path with ONOS: GNPy interaction, console log, and the resulting traffic

2. Demo Description

The demo consists of four main parts as shown in Figure 1: (1) the *ONOS SDN controller* for device management and service orchestration, (2) a pair of *Cassini transponders* as an example of disaggregated optical hardware (EdgeCore) with third-party software (IP Infusion), (3) *GNPy* for Path Computation Engine (PCE) and QoT estimation, and (4) Czech Light ROADMs as a *fully disaggregated Open Line System*.

The hardware side of the demo (Fig. 2) comprises three fully disaggregated ROADM nodes [8]: Amsterdam ("A"), Bremen ("B") and Cologne ("C"). At the A and B sites, the ROADMs were configured with two line degrees and a single Add/Drop module for transponder connection. In the C site, the demo showed no direct need for an Add/Drop stage nor transponders, and the C therefore consisted of a pair of Line Degree nodes.

Figure 3 shows a typical service request and its handling within ONOS. At the top, the user input in form of *intent* is communicated to ONOS via the `odtn-gnpy-connection-command`. ONOS delegates path computation to GNPy, and GNPy replies to ONOS with the calculated GSNR value. Depending on a service request, this computation might have resulted in one or more possible optical paths, each with a matching GSNR as a final QoT metric. GNPy supports full suite of PCE options, including path disjointness and additional constraints.

ONOS chooses the path with the highest GSNR (best quality) and provisions it on the transponders and ROADMs (middle window). At the bottom, traffic is shown to have just started flowing in form of simple ping requests.

As a debugging and troubleshooting tool, the ROADMs export live optical spectrum data over a built-in web interface. An example is shown in Figure 4. The direct line A-B (top row) carries a single DWDM channel, while the A-B (middle left) and B-C (bottom right) segments are dark, and the graphs show just the noise floor. Two physically different Add/Drop boxes are used in the demo (one with Alien Wavelength support, the other optimized for coherent detection), and only the Bremen Add/Drop contains hardware capable of optical spectrum monitoring (middle right).

3. OFC Relevance and Conclusion

The proposed demo showcases the current state of development in open source and open hardware related to open optical networks. The demo was created in response to an often raised feedback highlighting operation complexities of disaggregated optical networks [9–11].

As implemented, it presents results of collaboration of three organizations, the Telecom Infra Project for the GNPy simulation software, the Open Networking Foundation for the SDN controller, and CESNET for open designs of ROADMs, including hardware and software. Together, the presented solution can act as a step on the road towards bringing full disaggregation to real networks.

This demo verified feasibility of integrating the GNPy feature set and PCE capabilities into an SDN controller. The integration is, however, limited – both ONOS' and GNPy's PCE currently require full knowledge of the network topology, which is therefore duplicated. The integration was also implemented on top of an experimental interface, mainly due to the work-in-progress nature of the corresponding IETF draft [12].

Going forward, we are looking forward to a standardized API for service requests (likely IETF TE or TAPI), and GNPy's API stability in this regard. An interesting opportunities on their own are performing alert correlation

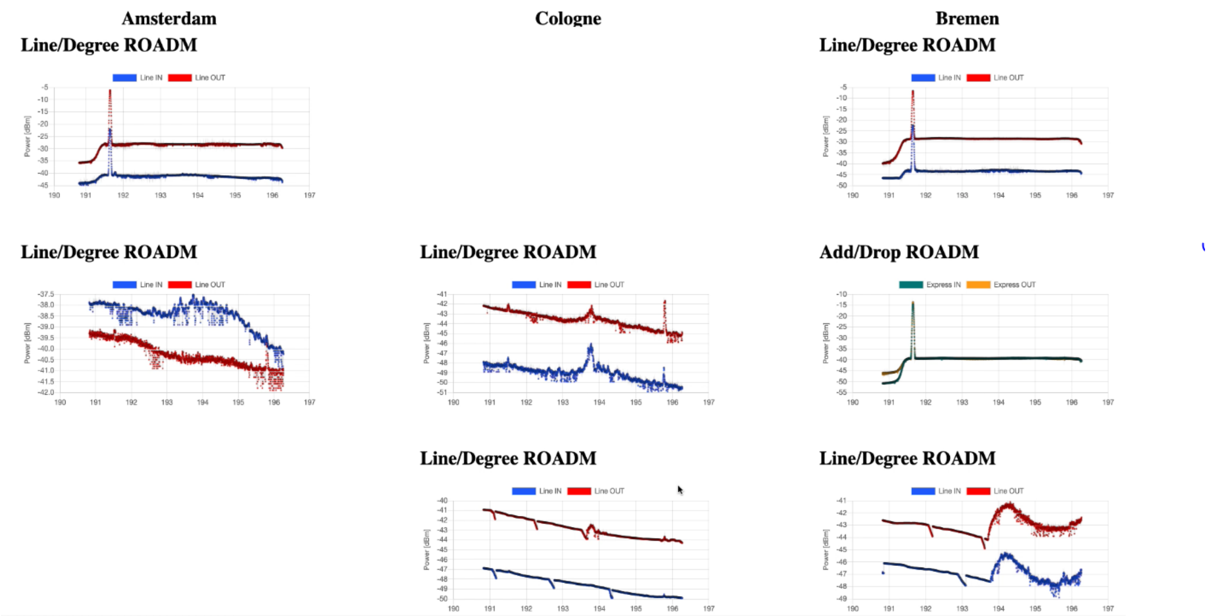

Fig. 4: Optical spectrum traces of different fiber lines as caputred by ROADM devices

for root cause analysis and distributing the power control loop. GNPy's optimization features [13] can be used for iterative performance improvements on a per-media-channel basis as well.

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