TransportPCE

Full Interworking in Optical Networks

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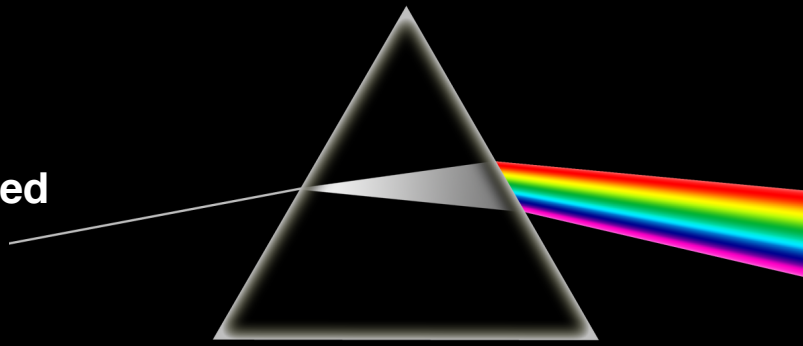
Context: the dark side of the WDM Fiber 1/2

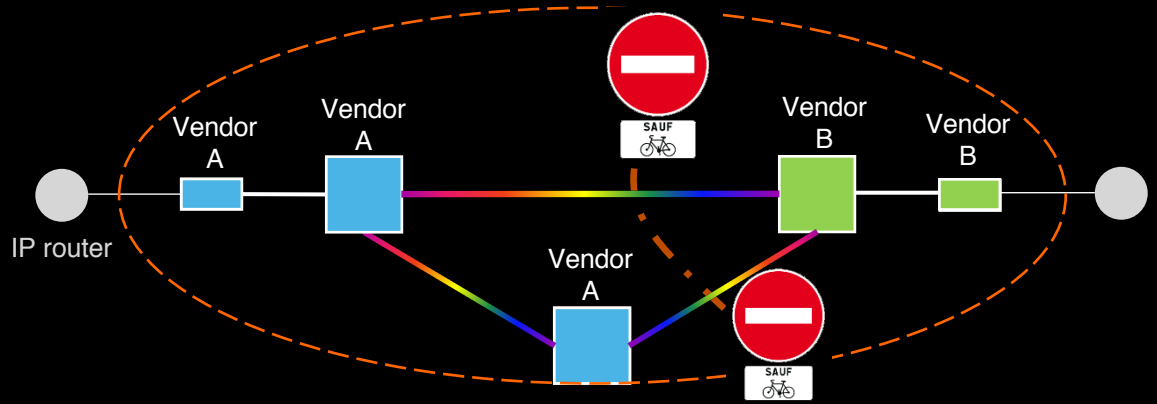


- In the IP domain (similarly for Ethernet)
  - routers have a high level of interoperability
  - equipment of different manufacturers can be mixed easily on the same network.
- At the edge of the optical domain
  - packet-based signals are converted into WDM wavelengths
  - the associated devices are named “Xponders” (transponder or muxponder).
- Then the signal is “routed” to another Xponder by ROADMs (Reconfigurable Optical Add Drop Multiplexer).
- Optical equipment interoperability is very limited
  - when building a new network, equipment from different vendors cannot be mixed
  - a non-exhaustive list of good and bad reasons will follow.

Context: the dark side of the WDM Fiber 2/2

Optical engineering is a complex task. Until now, the end-to-end performance was guaranteed only thanks to a proprietary control of intermediate devices of the optical line, classically centralized with a NMS (network management system)

- **ROADMs are relatively "new" network devices (2002 proof of concept). There is no common modeling among manufacturers.**
- **a same optical basic function can be implemented in many ways.**
- **strong differentiation factors are advocated by manufacturers:**
  - **OSNR (Optical Signal-to-Noise Ratio) must be treated with a global strategy across the network,**
  - **efficient proprietary FECs (Forward Error Correction codes).**

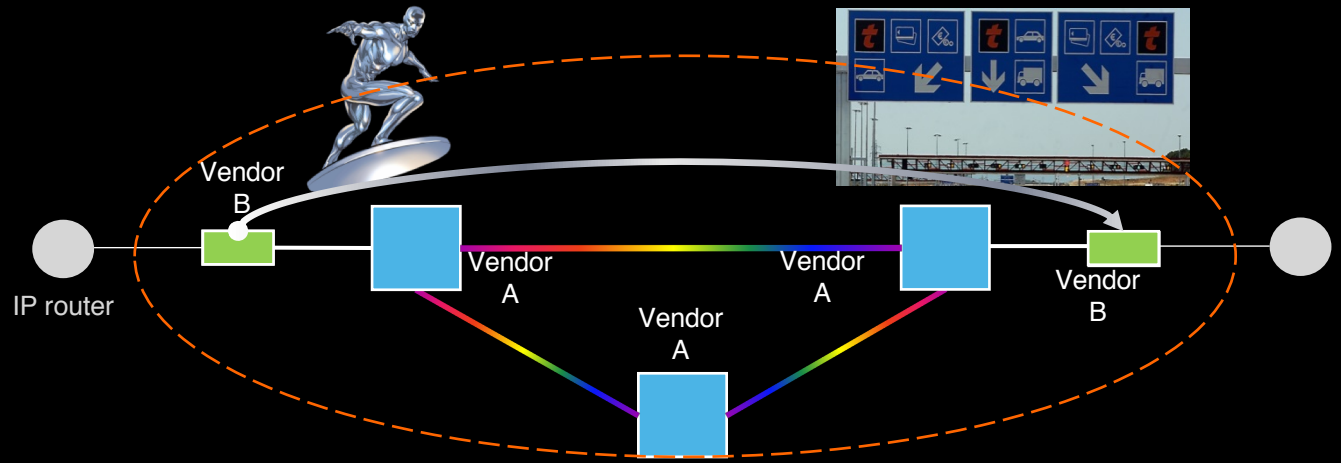


Previous tries to bring more interworking

- Service Providers also triggered various actions in standard development organizations :

  - IETF GMPLS - ITU-T's Staircase FEC - etc

- other attempts mostly limited to end equipment (Xponders) interfacing with client devices. This concept is often named alien wavelengths.
  - Practically, technical implementations requires:
    - additional boards and new Rights To Use (= license fees)
    - huge effort to design and configure Xponders and line consistently.



Obstacles for SDN and interoperability 1/3

No real agreement for a common modeling of the WDM layer

- IETF GMPLS shipped inside protocols (no YANG data model).
  Adoption was very partial.

- IETF topology RFC8345 YANG data models officially released in March 2018.
  - work in progress: augmentations for Traffic-Engineered networks, including optics
    https://tools.ietf.org/html/rfc8345

- ONF T-API YANG set developed from scratch

- OpenROADM YANG set on top of IETF models (first versions based on pre-RFC8345 drafts).
  http://openroadm.org/download.html

Obstacles for SDN and interoperability 2/3

The Network Management System (NMS)

- a completely centralized management software system
- a simple way to guarantee the reliability of transactions
- a part of the OLM Strategy

It wouldn’t be a problem if:

- They could tolerate the presence of other systems / controllers aside.
- not a completely monolithic design.
- not a vendor proprietary data model

Obstacles for SDN and interoperability 3/3

The Optical Line Management Strategy

- OLM guarantees that a reasonable OSNR (Optical Signal-to-Noise Ratio) is maintained across the WDM line.
  - Need to consider non-linear effects.
  - no unique recipe for an optimal solution can be reached.
    Thus a differentiating factor among vendors.

Specific obstacles for interoperability

Today, the obstacles for interoperability are pretty much the same than for SDN / automation.
Both implies to rely on standard communication protocols and common modeling.

In addition some common specifications are needed for interoperability

- Operating ranges (supported wavelength, bandwidth, power level, etc…)
- FEC (Forward Error Correction) is today an unavoidable technique to compensate degradation on a WDM line.
  - But Standardized FEC mechanisms (used to) have limited performances, and most vendors rely upon proprietary FEC.
- etc…

Going further towards automation and interoperability 1/2

IETF

- premier Internet standards organization.
  Standard communications are enabled by adherence to open protocols and procedures defined by Internet Standards. Provides reference protocols, data models,… reused by other initiatives.
  - All major vendors and operators

OpenConfig

- defines simple models for optical systems with the goal of moving networks toward a more dynamic, programmable infrastructure by adopting SDN principles
  - Google, Facebook, AT&T, Level3, BT, DT, Telefonica…

Open Networking Foundation approach

- defines a standard northbound interface (T-API) for SDN controllers inside ONOS (with a set of per-vendor drivers)
- ODTN working group: NTT, Telefonica China unicom, ADVA, Ciena, Coriant, Nokia, infinera, ZTE, …

Going further towards automation and interoperability 2/2

OpenROADM : network layer disaggregation approach

- defines “interoperability specifications for ROADM, including ROADM switch, transponders and pluggable optics”.
  - AT&T, Orange, SK Telecom, RosTelecom, SaudiTelecom, Telecom Italia, Deutsche Telecom, KDDI, Ciena, Fujitsu, Nokia, Cisco, Coriant, Juniper

Telecom Infra project

- hosts several initiatives (GNPy, hardware disaggregation approach, …)
- defines “DWDM open packet transport architecture that triggers a new pace of technology innovation and flexibility, and avoids implementation lock-in”.
  - Facebook, Orange, BT, DT, Telefonica …

Playing the opensource card
to implement standard specifications

IETF protocols specs and international code point registry

- OTN/WDM topology is conveyed in OSPF-TE (possibly fed into BGP-LS)
- Connections are triggered & learnt using PCEP (+ RSVP-TE signaling)
- Allows to reuse proven tools and implementations from IP/MPLS (e.g. OpenDaylight)

IETF Yang models

- Specification of both NETCONF protocol and Yang modeling language
- Detailed data models in Yang, for various management purposes
- OTN/WDM topology is specified
- Supports connections provisioning
- Includes high level service models

Playing the opensource card
to deal with performance evaluation

GNPy

Opensource community initiated by TIP to deal with the line performance evaluation, a problematic close to the OLM strategy.

It provides a tool written in Python to evaluate the feasibility of a WDM service :

- **topology**
- **devices modeling (amplifier, ROADM, xponders, fiber, …)**
- **physical parameters (amplifier & non-linear noises, OSNR)**
- **SPF (Djikstra)**
  https://gnpy.readthedocs.io/en/master/

Playing the opensource card
to deal with hardware interoperability

FEC

- Acacia oFEC & staircase FEC adopted in Open ROADM

TIP voyager

Voyager is the code name of an open hardware implementation « whitebox » of a Xponder pushed by Facebook.
mostly addresses DC issues
currently, only supported by one vendor.
https://telecominfraproject.com/vodafone-deploys-tips-voyager-in-a-live-network-trial-to-transform-optical-networks/

Playing the opensource card
to deal with North and Southbound API

OpenConfig

an informal working group
only addresses how to manage devices with Netconf (and telemetry)
does not specify any common operating range => no guarantee for interoperability

ONF T-API

A Standard Northbound interface for Transport SDN controller (ONOS).
Implementations are often shipped with OpenConfig or per-vendor drivers.

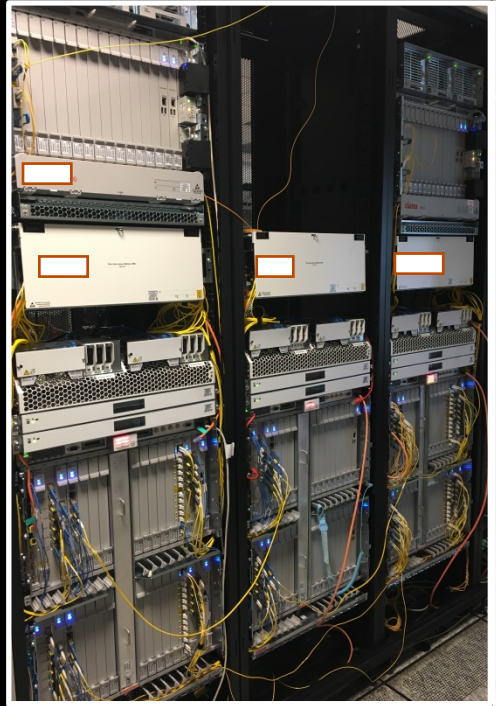
Playing the opensource card to manage interworking issues: the North and Southbound API

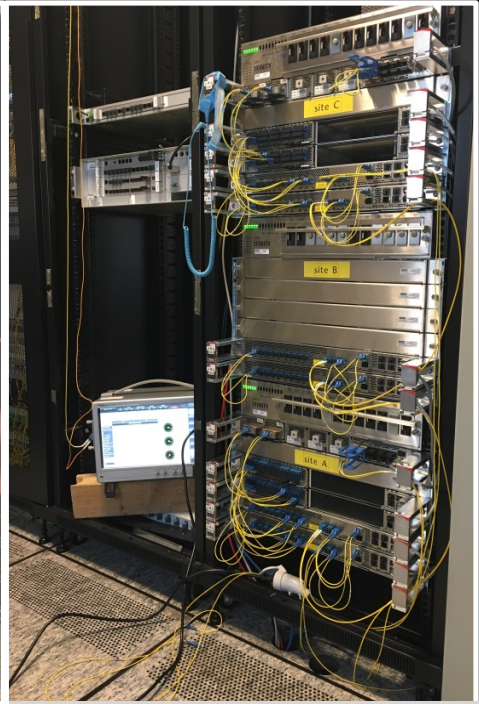
Open ROADM

Opensource community initiated by operators to reach interoperability between optical equipment

- Common open Data Model specifications for network, services & devices (with a node disaggregation)
  - ROADM, Xponder, Optical pluggable
- Relies on Netconf / YANG but provides specifications for interoperability.
- Becomes, de facto, a reference architecture for the design of future optical nodes

http://www.openroadm.org/
https://github.com/OpenROADM/OpenROADM_MSA_Public





Open ROADM

Yang models for device control, service management and network topology

Members

ATT, Acacia, Cesnet, Ciena, Coriant/Infinera, DT , ECI Telecom, Fujitsu , KDDI, Juniper, Nokia-USA , Orange , Rostelecom, Cisco, Saudi Telecom, , SK Telecom, Telecom Italia , Surfnet, ViewQwest

Playing the opensource card to manage interworking issues: North,South and East/West API

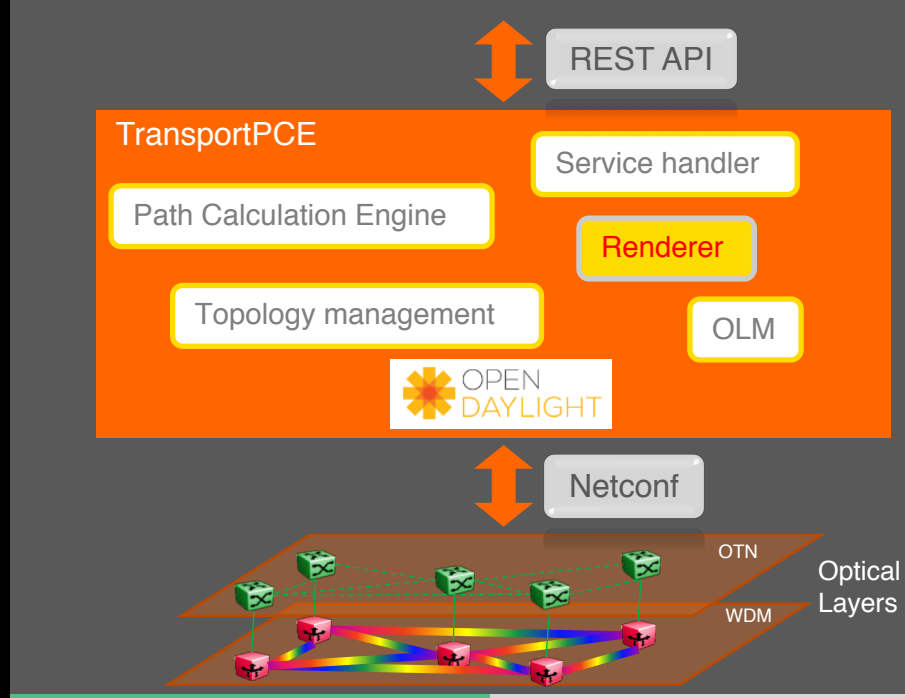
TransportPCE

Opensource project developed inside the OpenDaylight framework to provide the community with the first open implementation of main optical node management functions.

The goals are multiple:

- **to provide the community with feedbacks and a proof-of-concept of Openroadm specifications**
- **to standardize with yang models the API between the various components in an optical controller , not only the northbound API.**
- **to propose tests and code for a reference implementation that can be reused in third-parties derived products**
- **a complete functional tests suite and a simulator based on FD.io honeycomb is shipped with the code**

https://wiki.opendaylight.org/view/TransportPCE:Main
https://git.opendaylight.org/gerrit/#/q/project:transportpce



OPEN DAYLIGHT

Contribute to renderer development

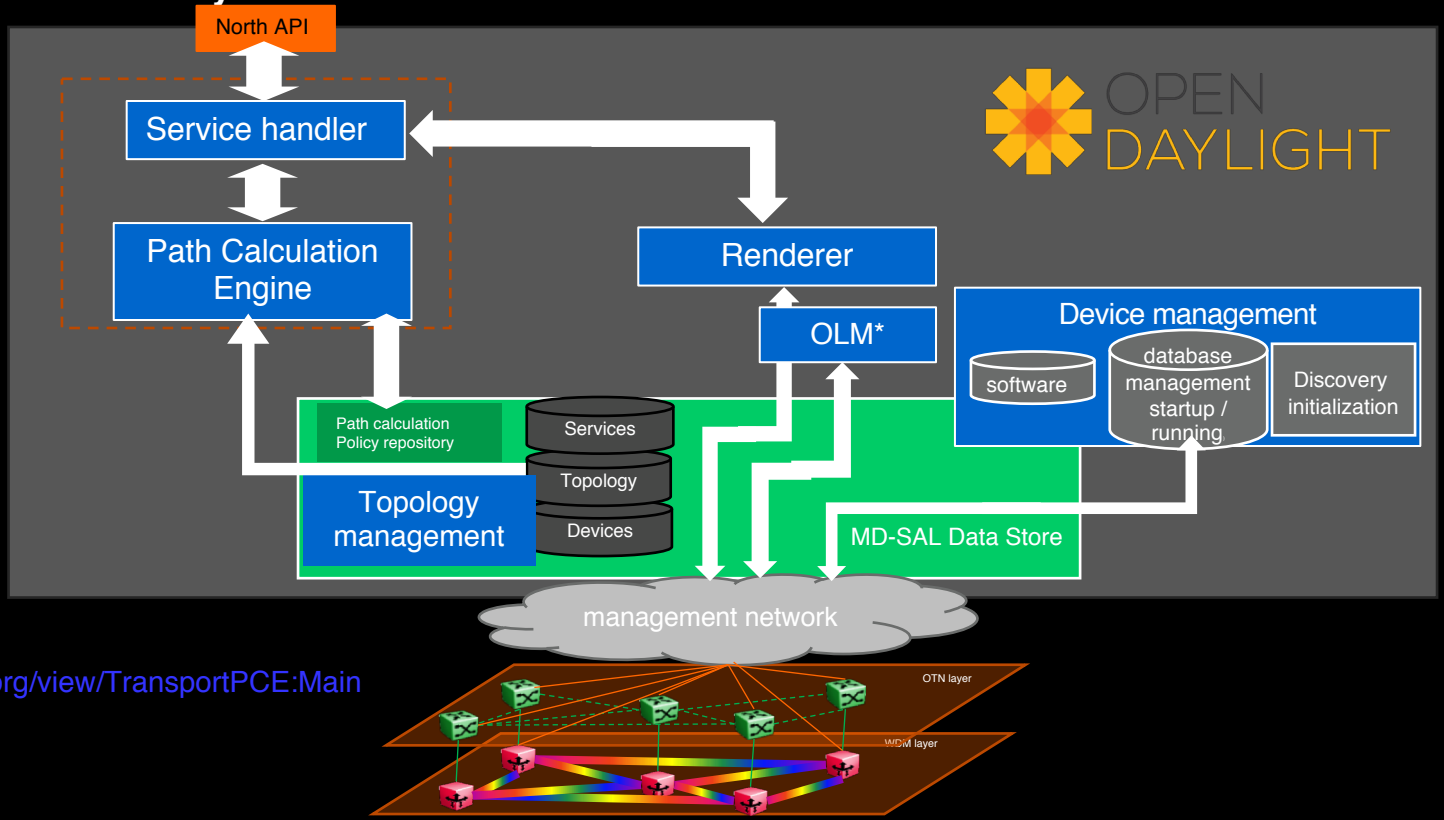
Lead service-handler and OLM development

Members

Orange, ATT, Telia

Opendaylight transportPCE

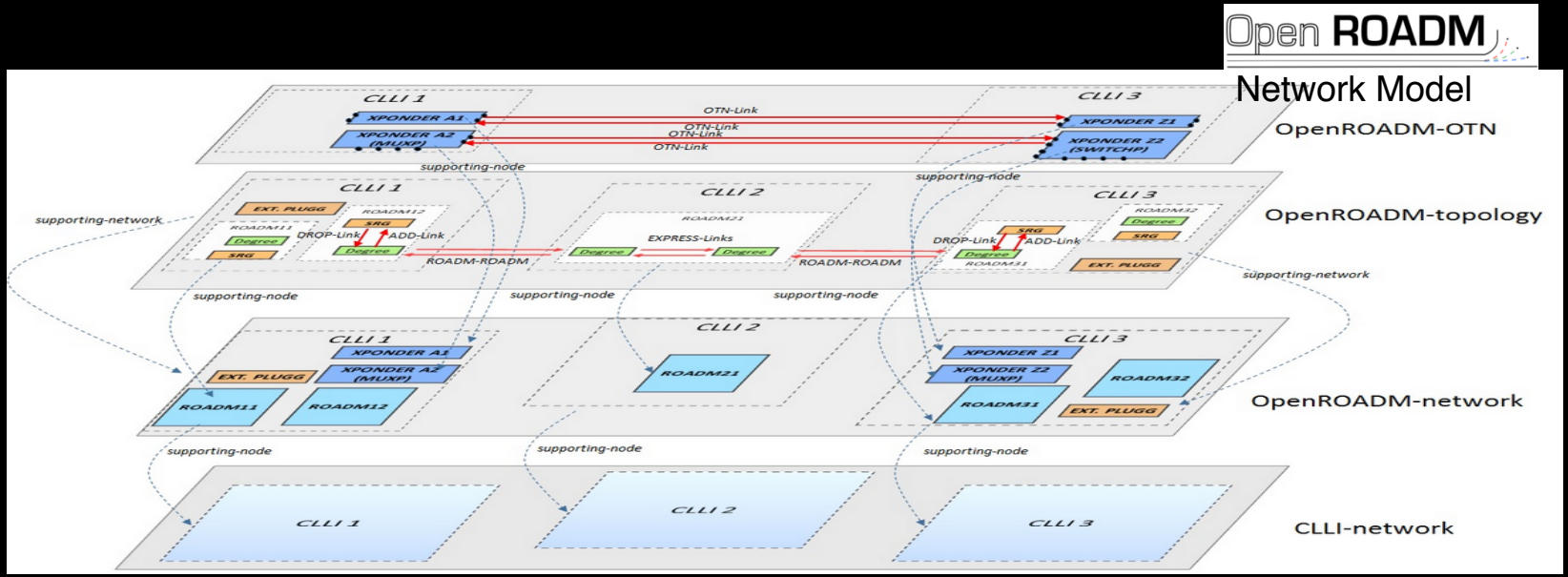
transportPCE primary functions are to create, modify or delete paths according to service requirements on OTN/WDM transmission networks. The modular approach allows more flexibility than classical NMS system for SDN automation. The idea is not to replace NMS function but to allow interaction with such systems thanks to East /West or SouthBound API.



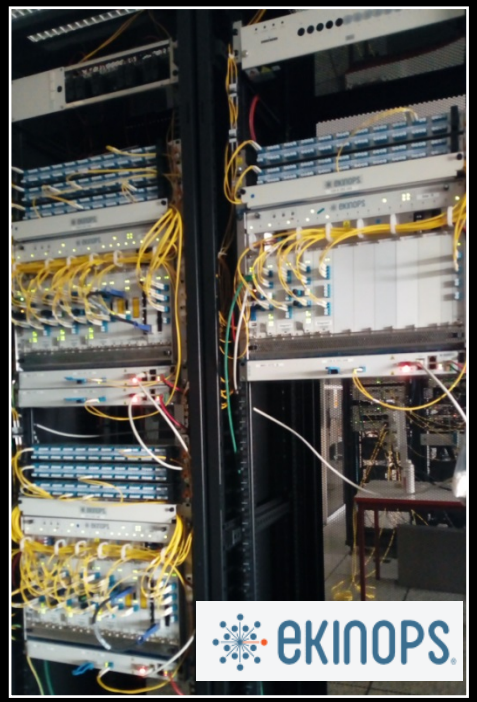
https://wiki.opendaylight.org/view/TransportPCE:Main

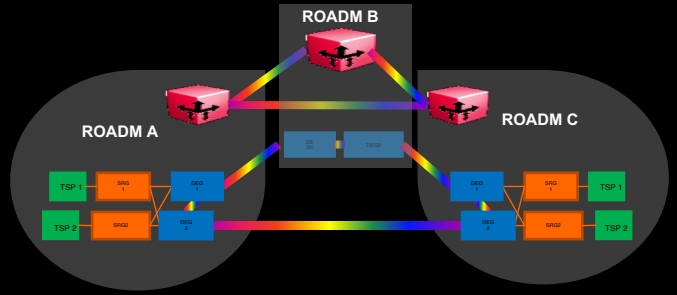
Initial implementation : the Open ROADM choice

- Open ROADM Multi-Service Agreement (MSA) provides comprehensive and coherent Yang models, not only for device control, but also for network topology & service management.
- It also defines specifications for the optical layer (real interoperability).
- The disaggregation of ROADM & Xponders building blocks, provides a high level of interoperability
- Turn out to be the most natural choice for first implementation of transportPCE



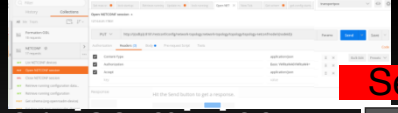
2018
Proof of Concept platform

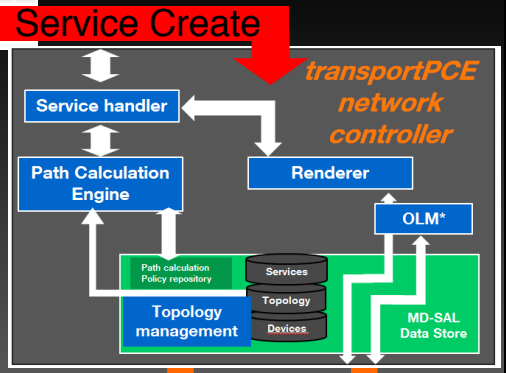




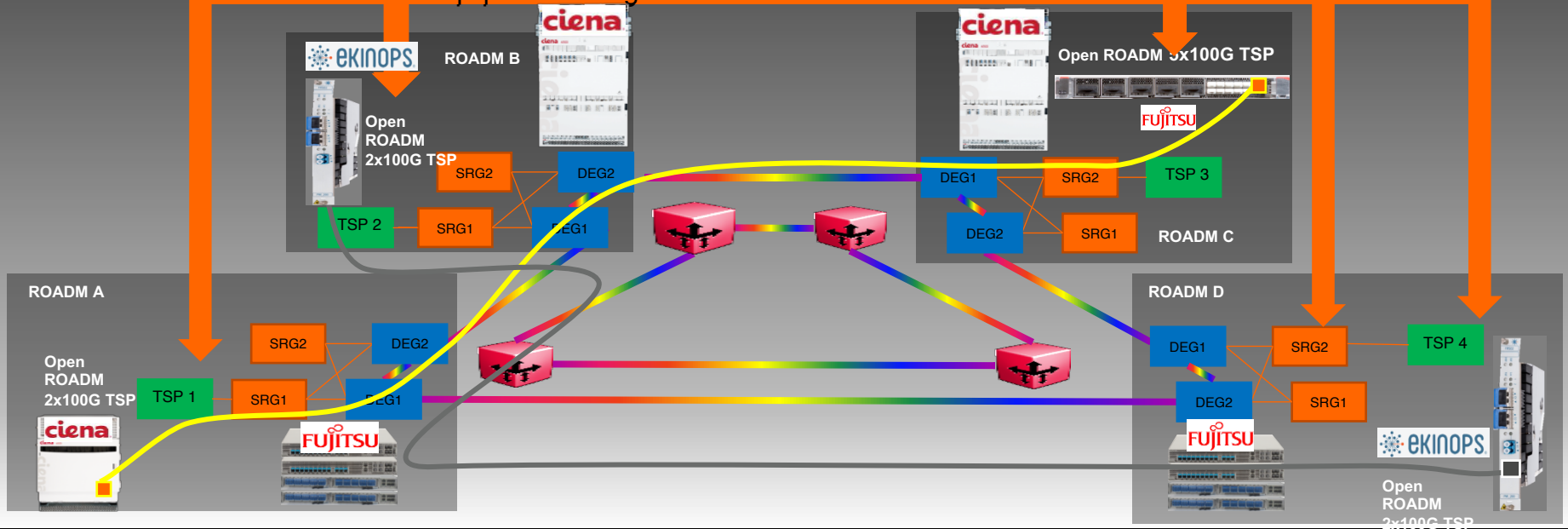
PoC

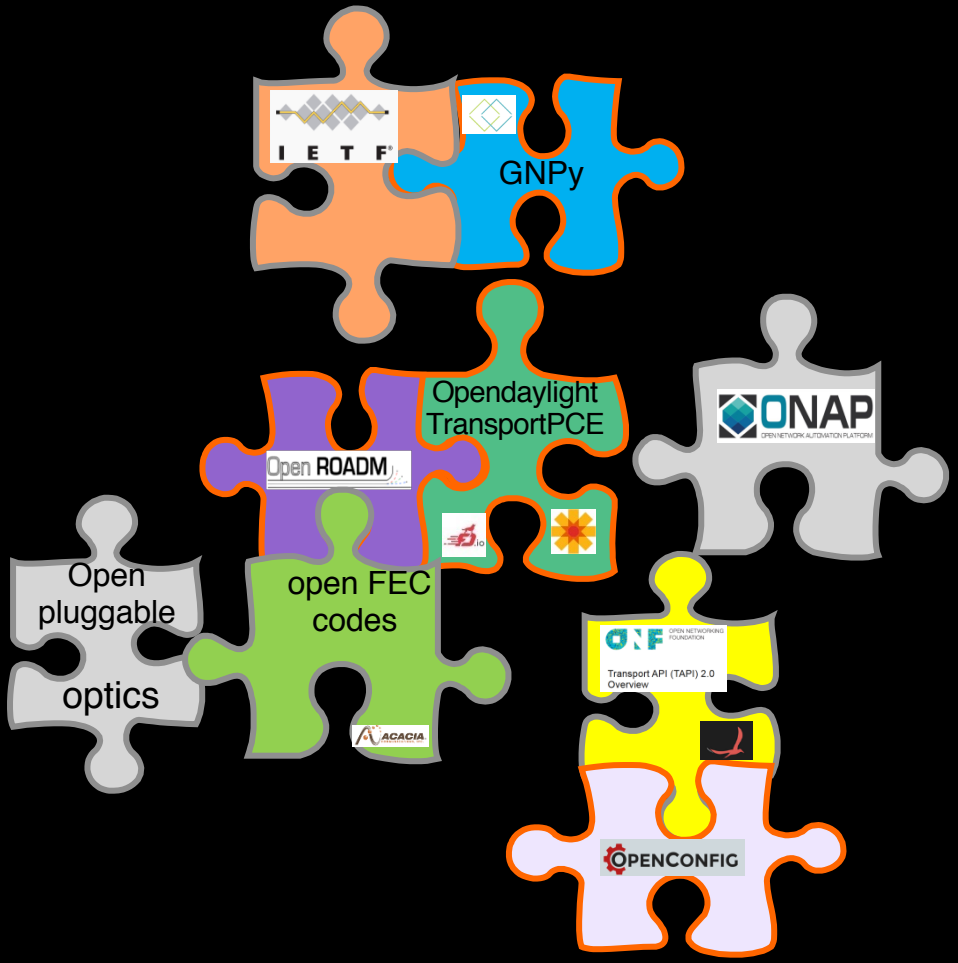
- We use TransportPCE Controller to create a service mixing Open ROADM transponders and ROADM from different suppliers
  - Create/delete service from Transponder A (Ciena) /ROADM A (Fujitsu) to Transponder C (Fujitsu) / ROADM C (Ciena) using staircase FEC
  - Create/delete service from Transponder B (Ekinops) /ROADM B (Ciena) to Transponder D (Ekinops) / ROADM D (Fujitsu) using SD FEC





Equipment configuration via Netconf connector





Take-Away

It will take time before ROADMs reach the degree of interoperability of IP routers.

Many open initiatives more or less advanced exist. They have not the same level of integration between each others.

Some of them do not guarantee interoperability even if they allow a better level of automation.

Publishing opensource software reference implementations helps gathering all the good will to bring more interoperability to the ecosystem.

Thank You