



SDN (Software Defined Networking) control of disaggregated optical transport networks

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CELTIC / BMBF and European Commission
Horizon2020 projects SENDATE and MetroHaul

Achim Autenrieth, ADVA Optical Networking
DENOG10, Darmstadt, 22.11.2018



Agenda

1

Introduction – Transport SDN Architectures

2

Optical Network Disaggregation

3

Data Models for Disaggregated Optical Transport Networks

4

Current SDN interops, field trials, and research projects

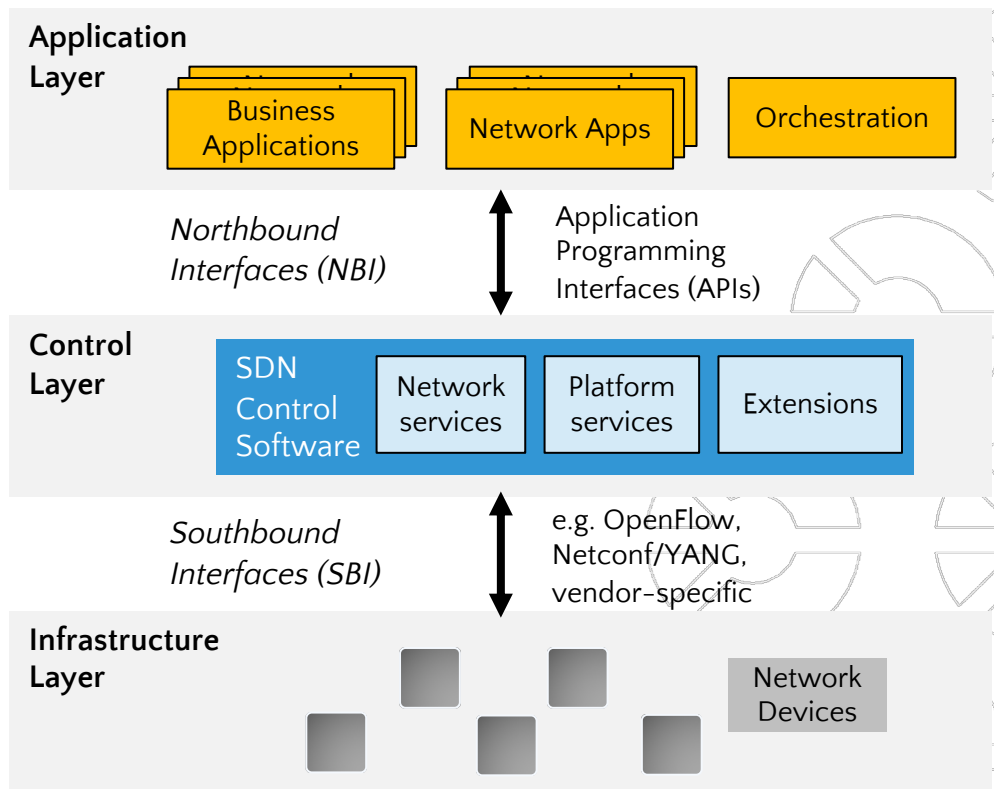
What is Software Defined Networking (SDN)?

Software Defined Networking (SDN) is an emerging network architecture where network control is ...

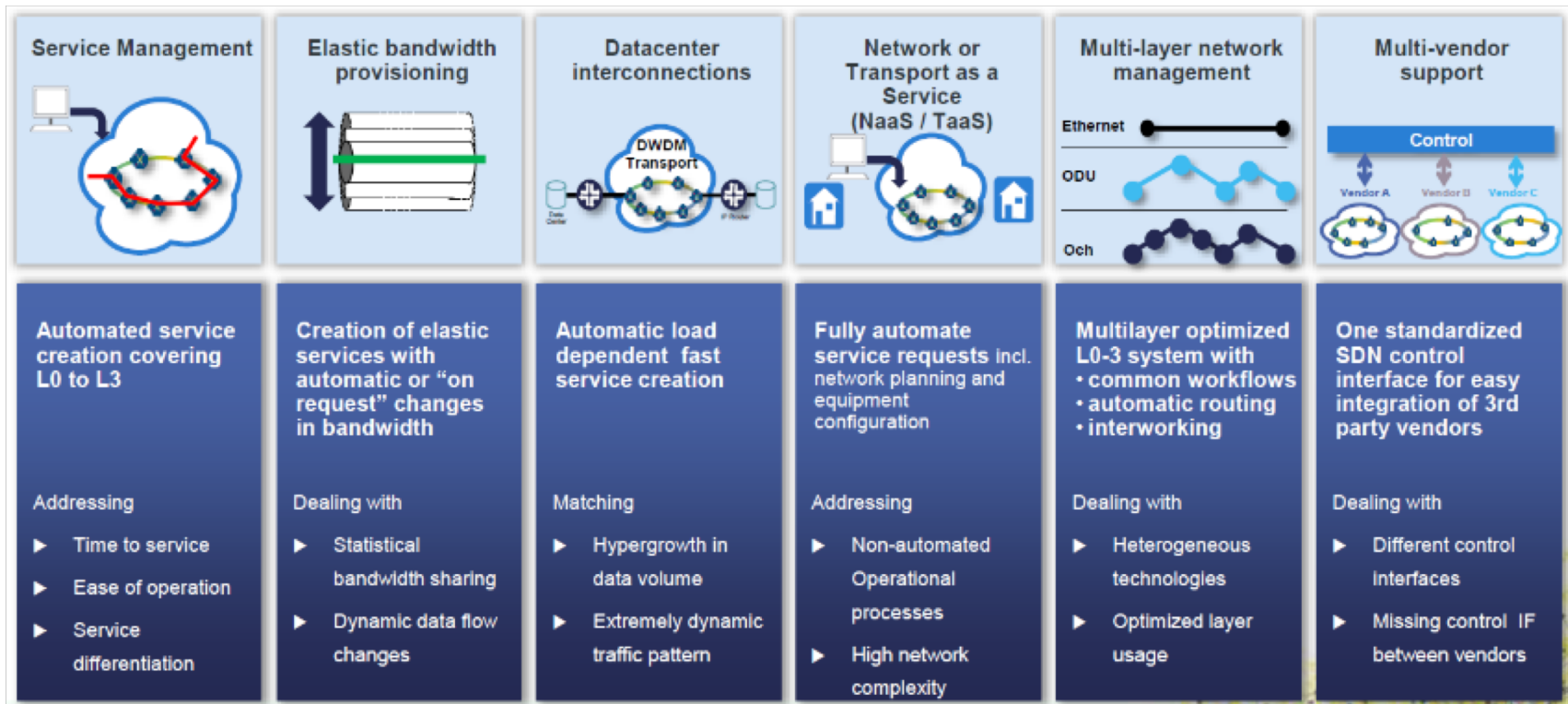
- decoupled from forwarding
- directly programmable
- logically centralized
- abstracted for applications and network services
- based on open standardized APIs



White Paper “Software-Defined Networking: The New Norm for Networks” (2012)



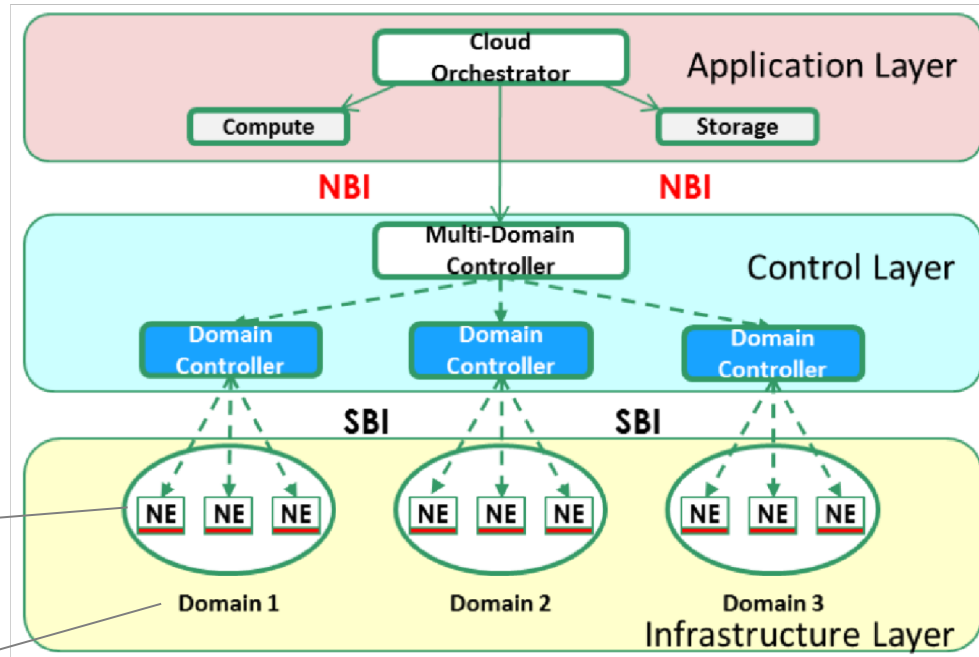
Transport SDN use cases in ONF



[K. Sethuraman, Transport SDN in ONF, ONS 2016]

ONF Transport SDN Architecture

L3 IP Routers
L2 Ethernet Switches
LO/L1 Optical ROADMs



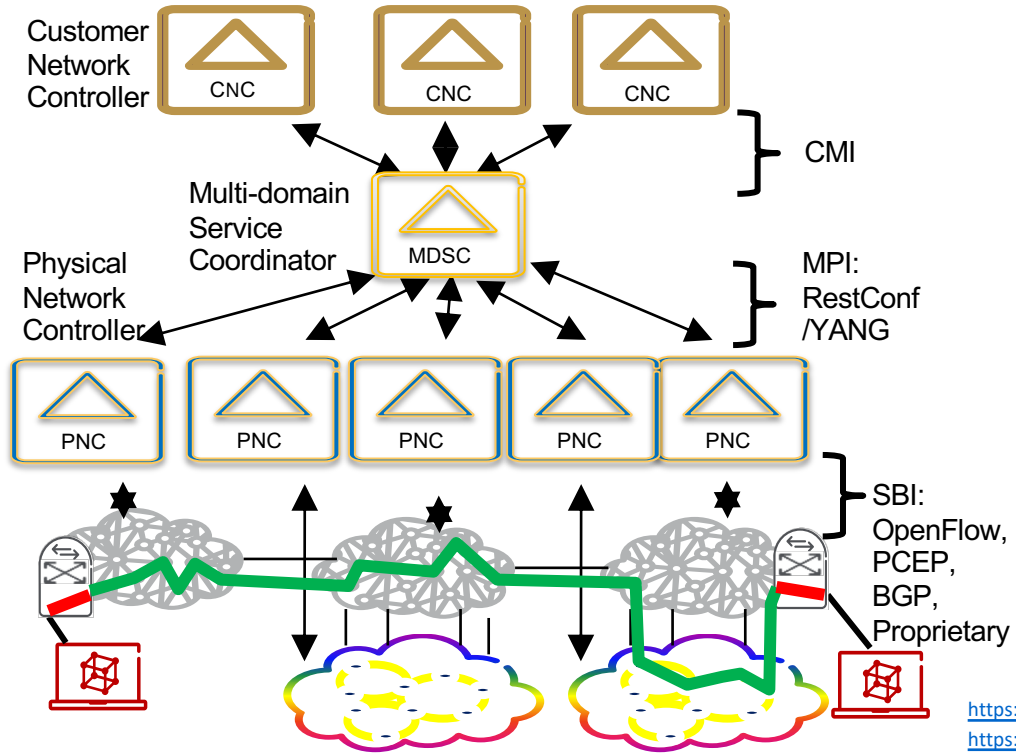
Vendor / Technology Domains

- IP / Ethernet / Optical
- Juniper / Cisco / ADVA / Ciena ...
- Access / Metro / Core

- Operation Applications
- Hierarchy of Controller / Orchestrator
- Open APIs with standardized data models
- Multiple Network / Technology Domains

OIF/ONF Whitepaper, "SDN Transport API Interoperability Demonstration", August 7, 2018

IETF SDN Architecture ACTN – Abstraction and Control of Traffic Engineered Networks



Multi-vendor multi-domain
IP/Transport Network TE SDN
Control

Hierarchical network resource
abstraction and control

Standard IETF Model-based
Northbound Interface

Hybrid legacy and green-field
network deployment

<https://datatracker.ietf.org/doc/draft-ietf-teas-actn-framework/> (ACTN architecture)
<https://datatracker.ietf.org/doc/draft-ietf-teas-yang-te-topo/> (TE topology YANG model)
<https://datatracker.ietf.org/doc/draft-ietf-teas-yang-te/> (TE tunnel YANG models)

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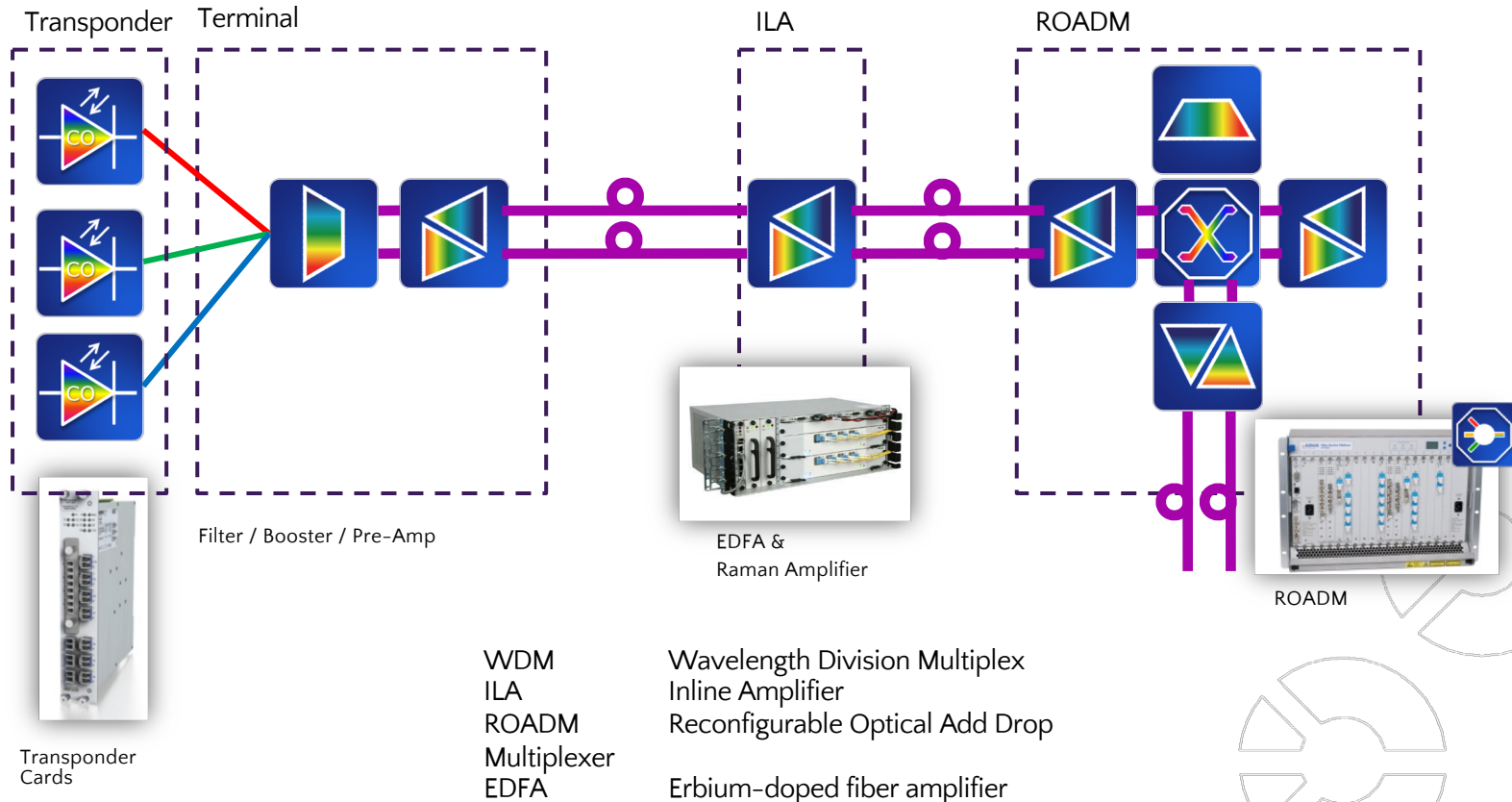
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Data Models for Disaggregated Optical Transport Networks

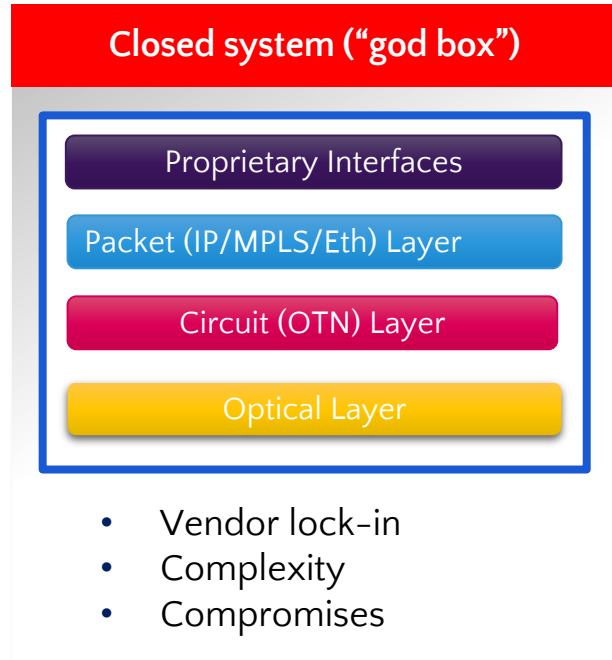
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Current SDN interops, field trials, and research projects

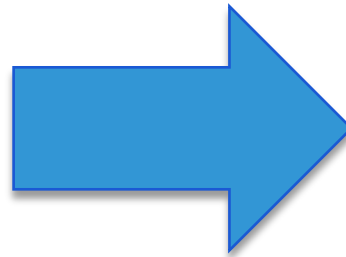
Basic WDM System Architecture



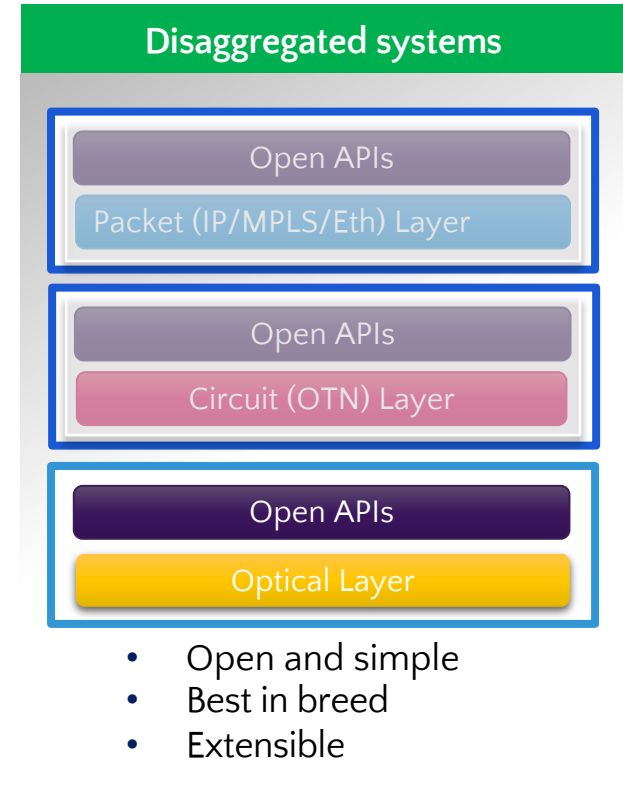
Disaggregation – Vertical direction



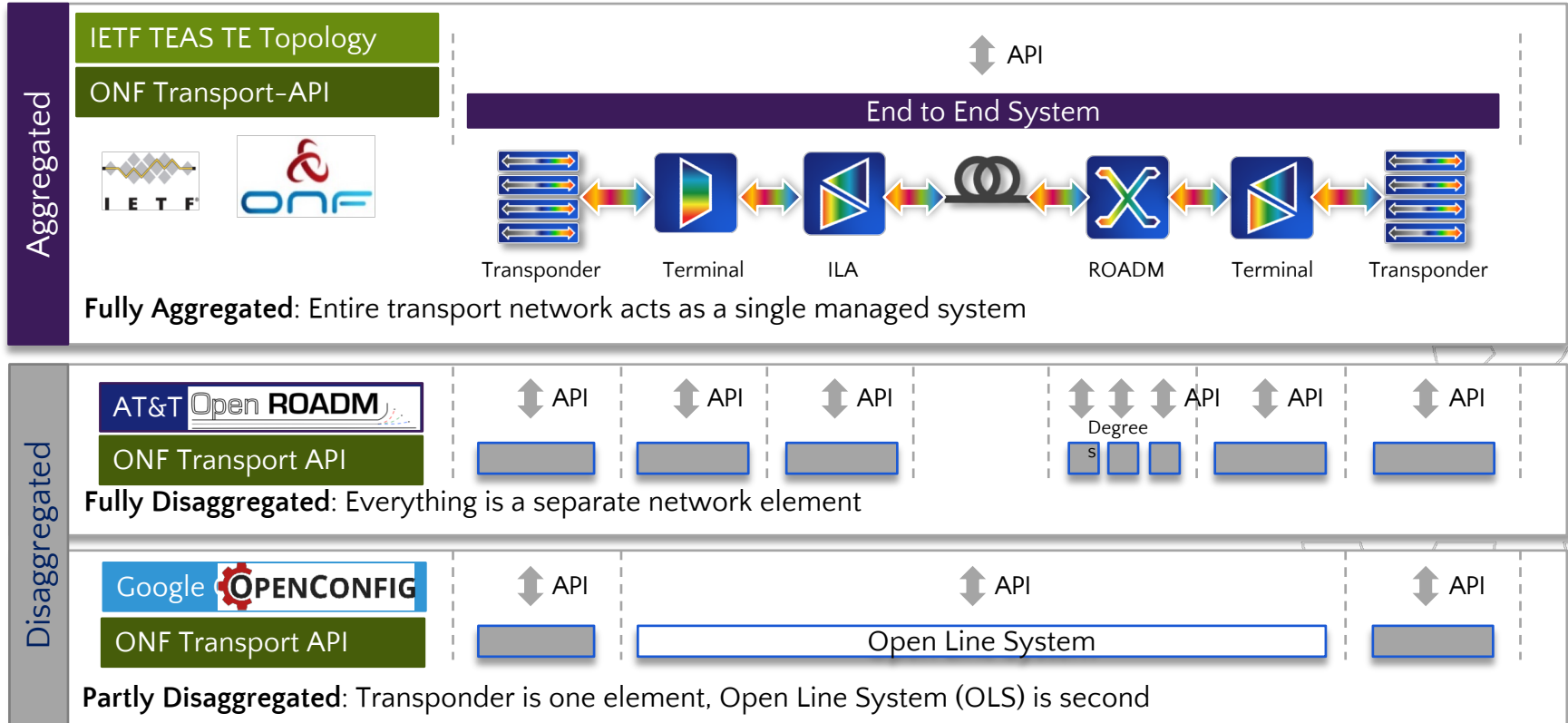
From
Old Style



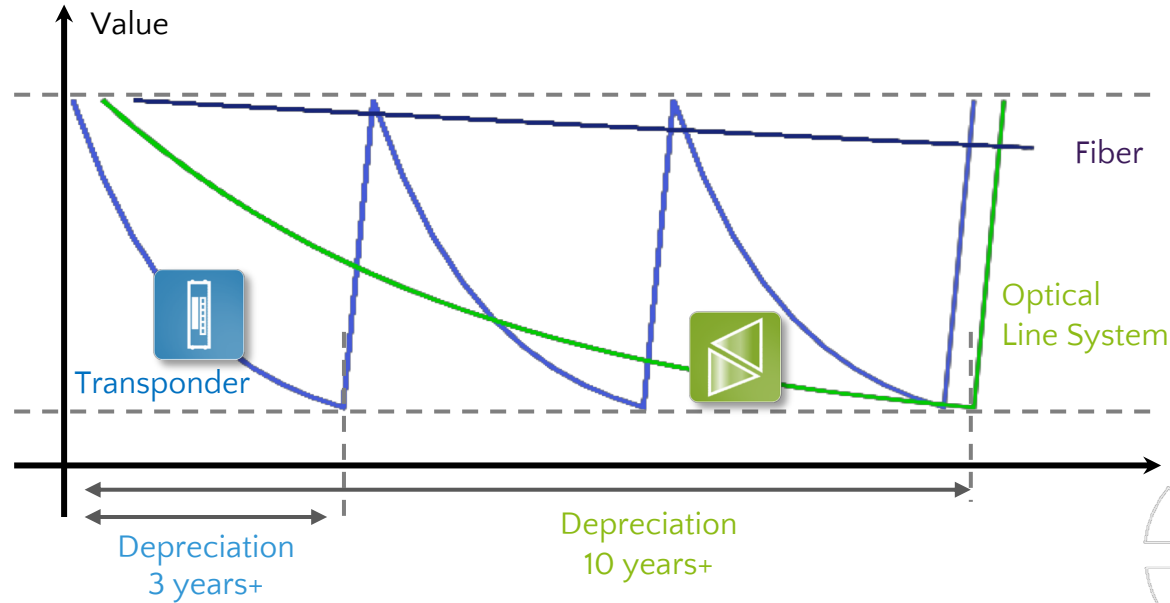
To
New Style



Disaggregation – Horizontal direction



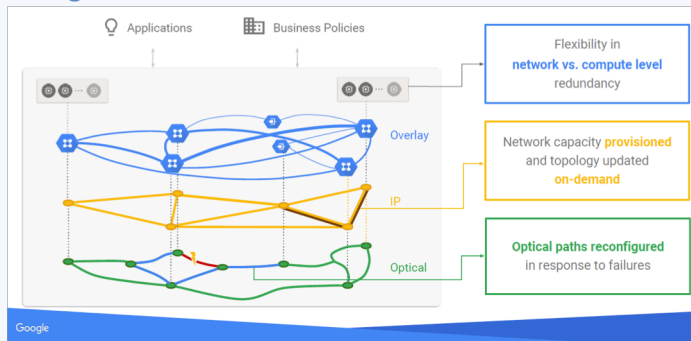
Investment and depreciation



Disaggregation flexibility: Different lifecycles for line systems and terminals

Disaggregation – Operator Concepts & Vision

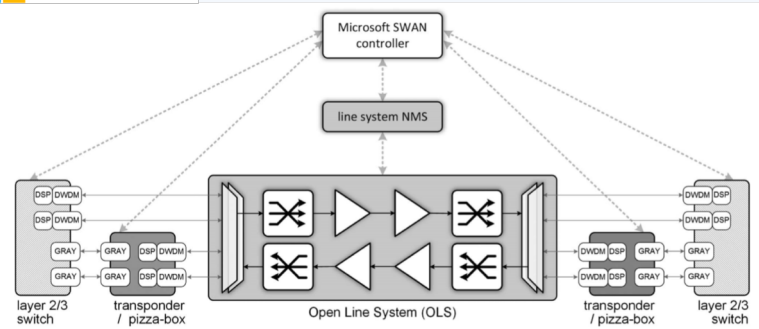
Google <https://www.youtube.com/watch?v=n9zEiGyvJ-A>



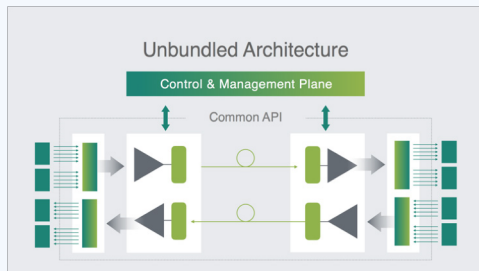
[U. Hölzle, Plenary Talk, OFC 2017]



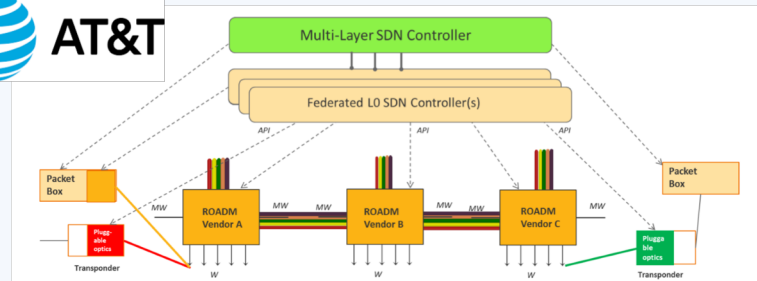
[M. Filer et al., JOCN,, Vol. 8, No. 7, 2016]



facebook



TELECOM INFRA PROJECT



https://O201.nccdn.net/1_2/000/000/098/a85/Open-ROADM-whitepaper-v1-0.pdf

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Data Models for Disaggregated Transport Networks

Industry Alliances

SDOs



MEF



Carrier

ISPs, IP over Optical

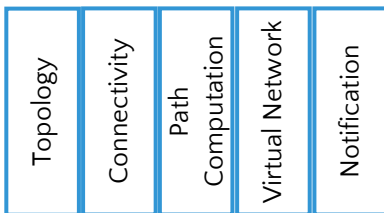
Web 2.0

Disaggregation

Services



Transport-API



Core Model



IETF TE Tunnels

IETF Network

IETF Network-
Topology

IETF TE Topology

IETF Flexi-Grid TED

IETF Flexi-Grid
media channel

IETF WSON
Technology



Telemetry

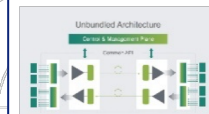


Services

Common

Network

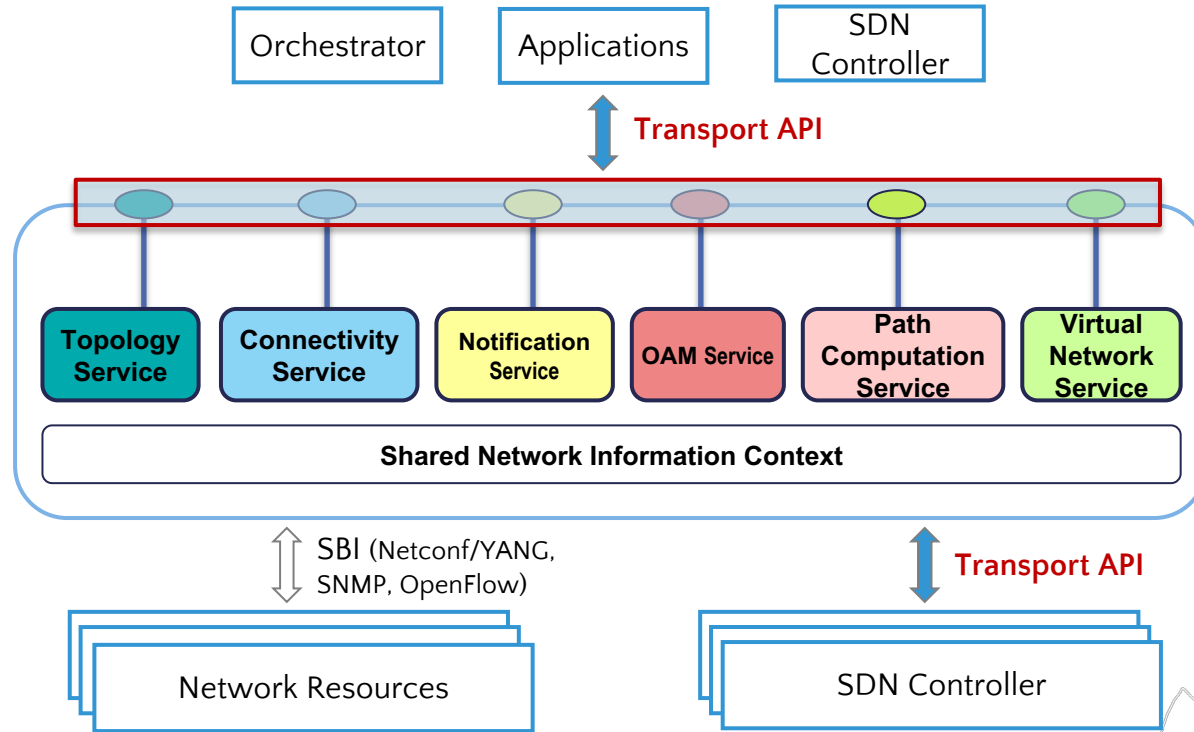
Device



Infrastructure

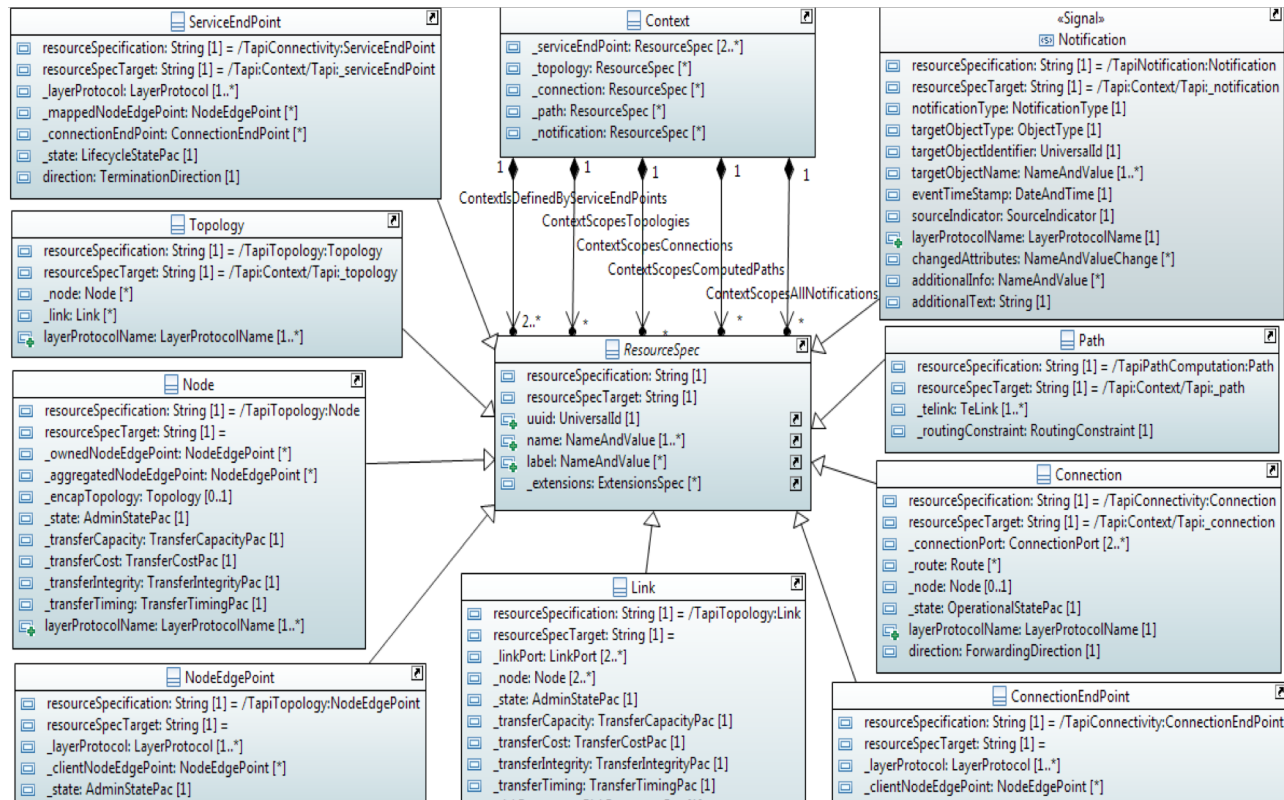
Device

ONF Transport-API functional architecture



ONF TAPI

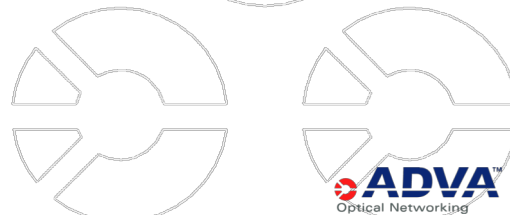
- ServiceEndPoint
- Topology
- Node
- NodeEdgePoint
- Link
- ConnectionEndPoint
- Connection
- Path
- Notification



[1] "Transport API (TAPI) 2.0 Overview", Aug 2017
https://github.com/OpenNetworkingFoundation/Snowmass-ONFOpenTransport/blob/develop/DOCS/TAPI%20%20WVP_Final.docx

[2] <https://github.com/OpenNetworkingFoundation/Snowmass-ONFOpenTransport/tree/develop/YANG>

[3] https://github.com/OpenNetworkingFoundation/TAPI/DOCS/presentations/onf2016.307_TAPI_SDK.01.pptx



OpenConfig

Generic, module level API

Focus on Terminal Equipment

YANG models

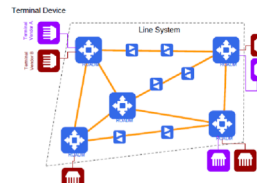
- openconfig-transport-types.yang
- openconfig-terminal-device.yang

Main elements

- physical client port, physical client channel, logical channel, optical channel, physical line port
- Directionality: client to line
- Physical layout: not modeled

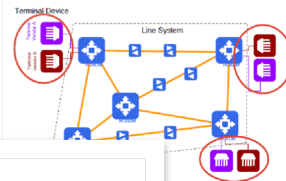
Members: Google, A&T, British Telecom, Microsoft, Facebook, Comcast, Verizon, Level3, Cox Communications, Yahoo!, Apple, Jive Communications, Deutsche Telekom / TeraStream, Bell Canada

Optical transport partitions



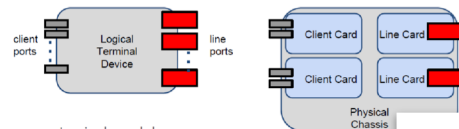
- Terminal device
 - muxponder/Transponder
 - DWDM port of IPoDWDM
- Line system
 - wavelength router
 - Mux/Demux
 - ROADM
 - WSS
 - optical amplifier
- Coherent optics makes it easier to vendors
 - book

Initial focus: terminal optics device



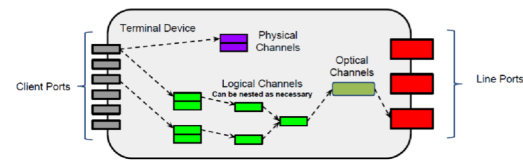
- Less coordination necessary between devices
- More likely to be multi-vendor
- Models for configuration and telemetry (incl. PMS)

Terminal device model overview

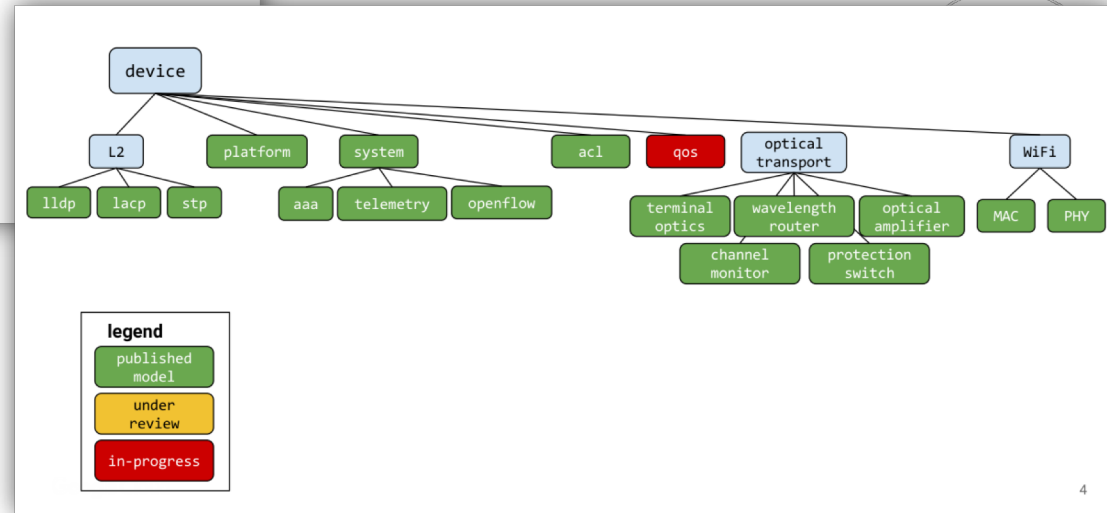
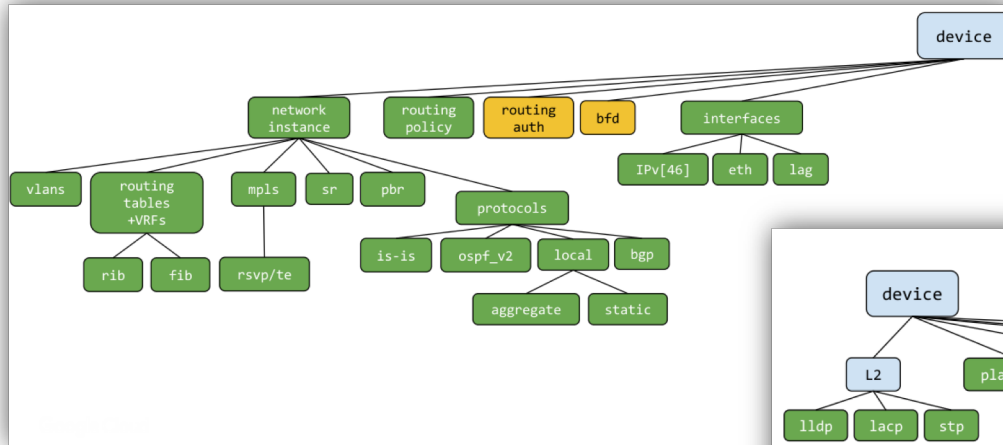


- Logical model
 - pool of client and line ports
 - traffic grooming and mapping between client and line ports
- Physical portion of model
 - reflects device chassis, slot, port structure
 - logical "ports" reference the physical port

Logical terminal device details



OpenConfig Data Models



Google Cloud

OpenConfig - progress toward vendor-neutral network management

Anees Shaikh
on behalf of Google network operations and OpenConfig group

OPENCONFIG
www.openconfig.net

OpenROADM Multi-Source Agreement (MSA)



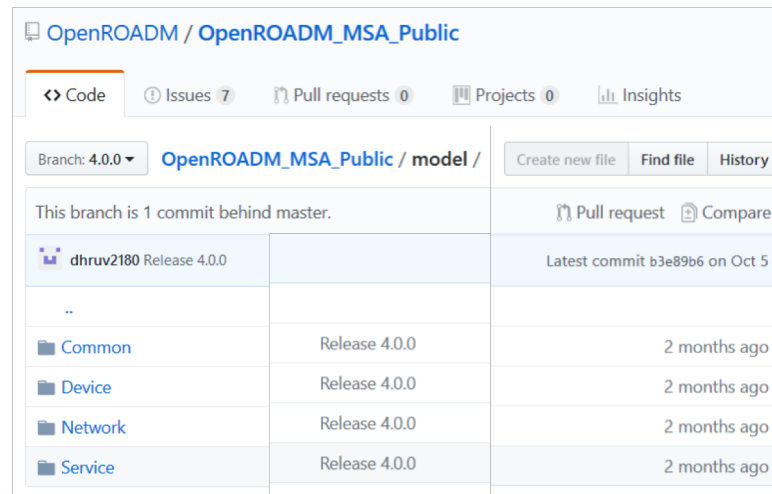
Interoperability specifications for Reconfigurable Optical Add/Drop Multiplexers (ROADM).

ROADM switch

transponders

pluggable optics.

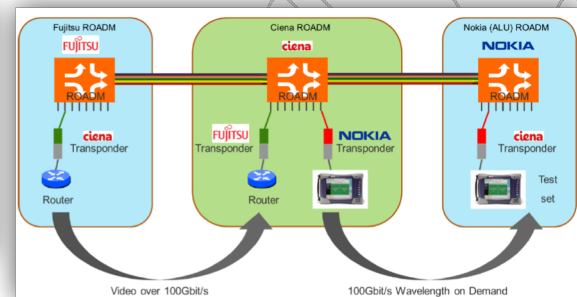
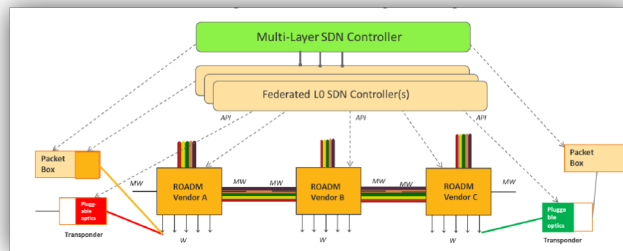
Specifications consist of both optical interoperability as well as YANG data models.



<http://openroadm.org/>

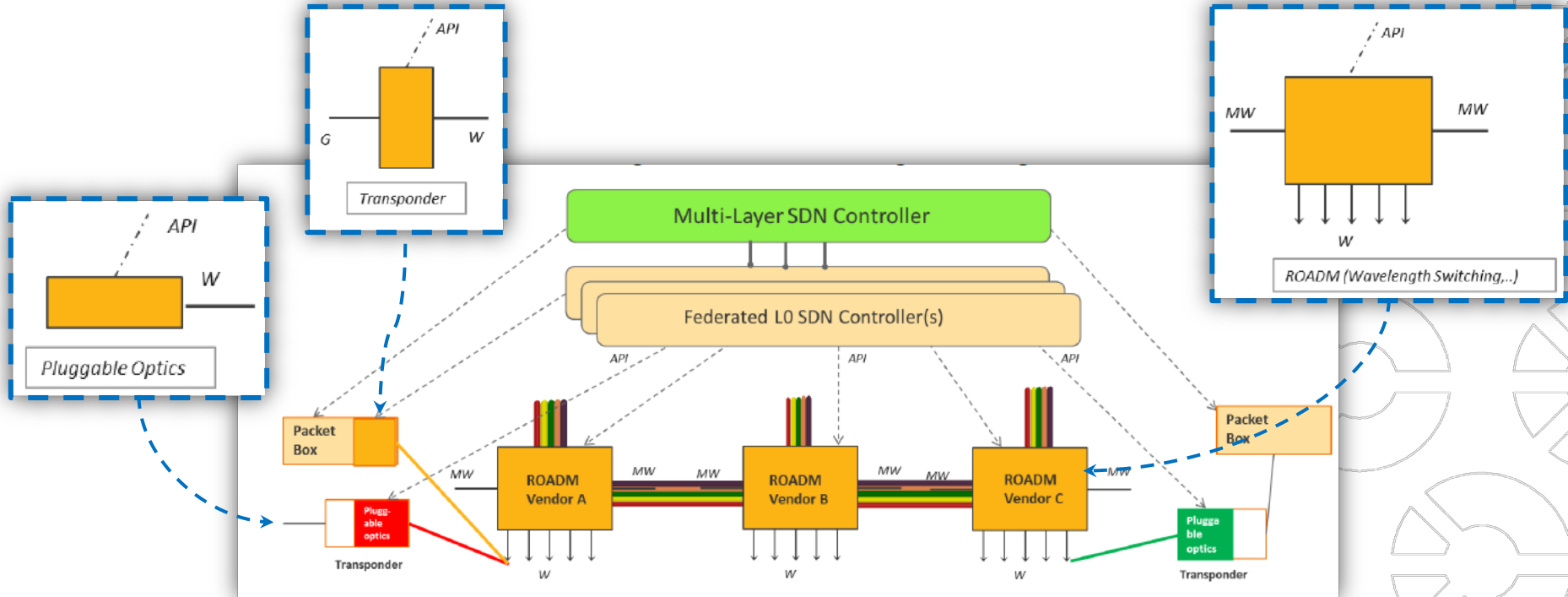
Open ROADM GitHub:

https://github.com/OpenROADM/OpenROADM_MSA_Public



OpenROADM Network Model and Main Objects

https://github.com/OpenROADM/OpenROADM_MSA_Public/tree/master/mod



Challenges

- Optical network consists of many in-homogeneous network elements
 - Amplifier, WSS, Wavelength Blocker, ...
- ROADMs have different levels of flexibility and internal constraints
 - Colorless, direction-less, contentionless add drop, ...
- Especially in cost-sensitive metro network environments constrained technologies are often used (filterless / fixed filters ROADMs, non-colorless, ...)
- Data models must be **abstract** to allow future technology advances
- Number of data models should be **limited** to allow interoperability testing

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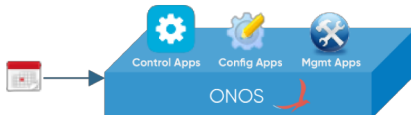
4

Current SDN interops, field trials, and research projects

ONF Open Disaggregated Transport Network (ODTN) (01/2018 – 12/2018)

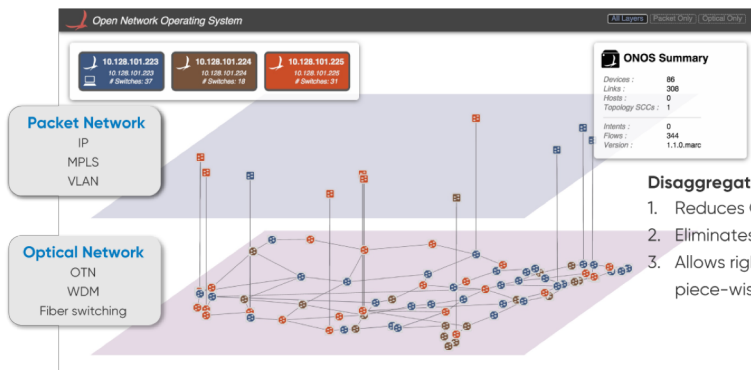
<https://wiki.onosproject.org/display/ODTN/ODTN>

BW Calendaring
SDN-IP
VPLS
Carrier Ethernet 2.0
L3VPN



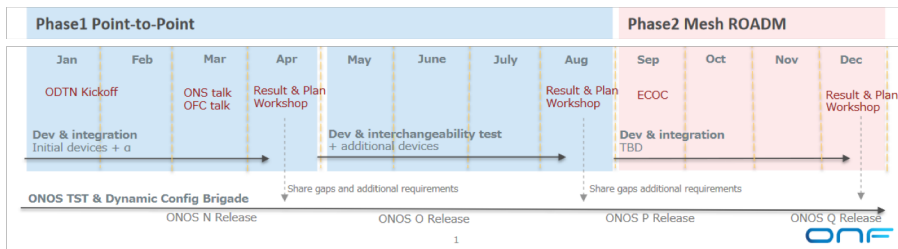
Logically Centralized Control

1. Optimize resource usage
2. Dynamic traffic provisioning
3. Multi-layer resiliency



Disaggregated Transport Network

1. Reduces CAPEX & OPEX
2. Eliminates vendor lock-in
3. Allows rightsizing and piece-wise upgrades



Service Providers



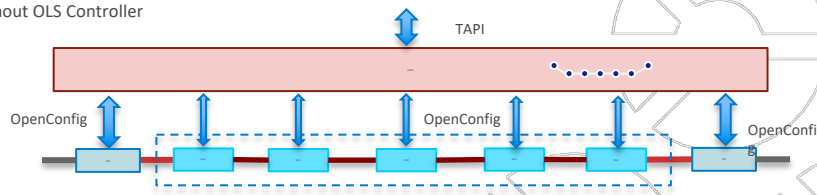
Tier 1 Vendors



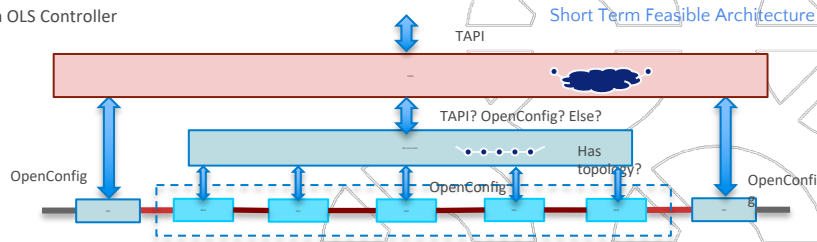
Tier 2 Vendors



Without OLS Controller

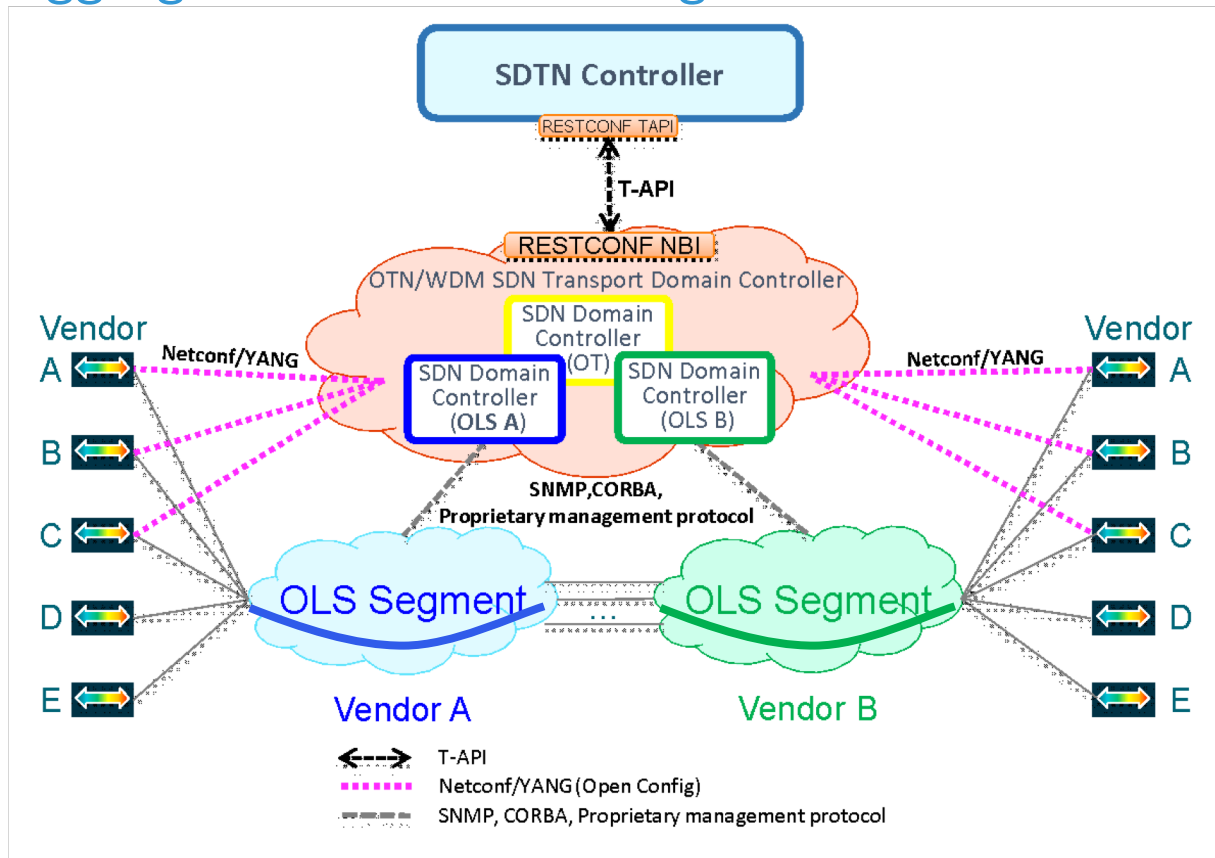


With OLS Controller



23

Multidomain SDN architecture for partially disaggregated network management



SENDATE Multivendor optical SDN Trial (09/2018)



Open Disaggregated SDN Control Architecture

- Multivendor trial including Network orchestration layer, Control and management layer and Infrastructure layer.
- Layered approach based on **ONF Transport API 2.0** with **Physical Media extensions for Optical Performance Planning**

Network Orchestration layer

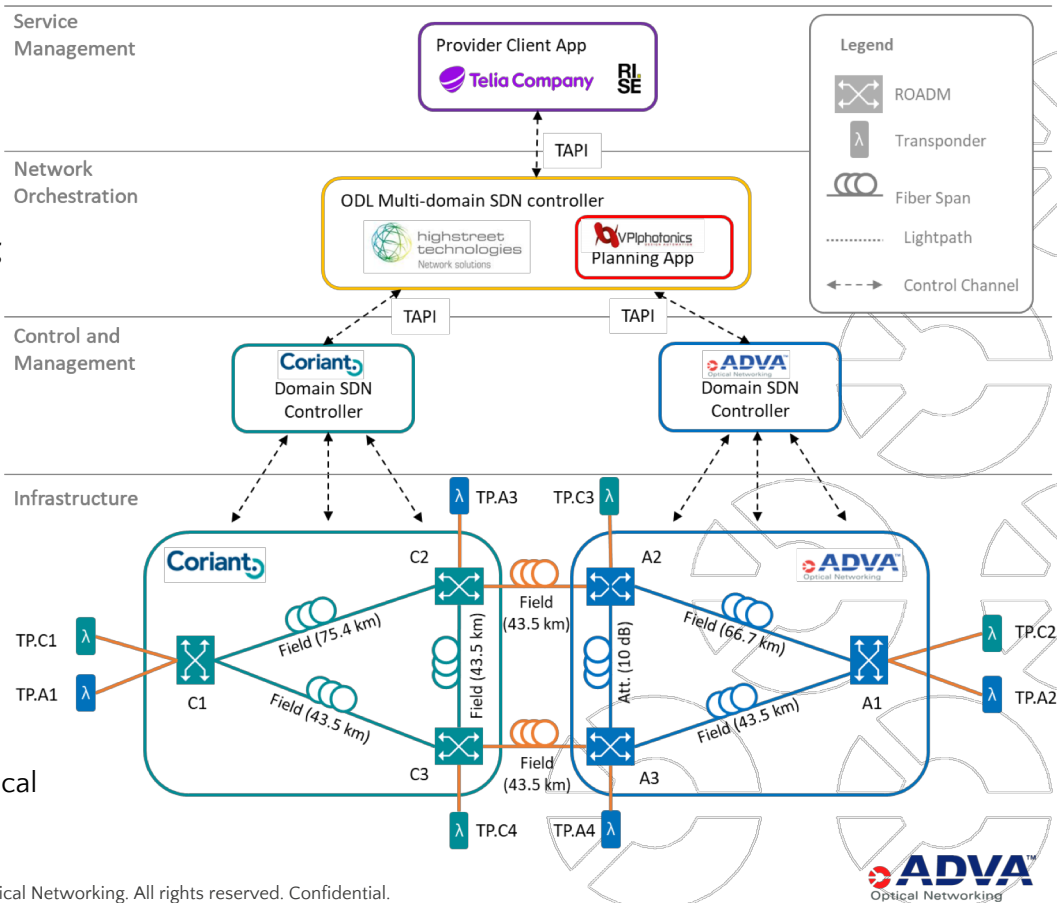
- Transport Orchestrator (highstreet technologies)
- Planning Application (VPIphotonics)
(Bundled in Transport Orchestrator)

Control and Management layer

- SDN Domain Controllers (ADVA and Coriant)

Infrastructure layer

- ROADMs and transponders (ADVA and Coriant)
- Transparent ROADM line port interconnect
- Alien wavelength interconnection passing both vendors optical domains

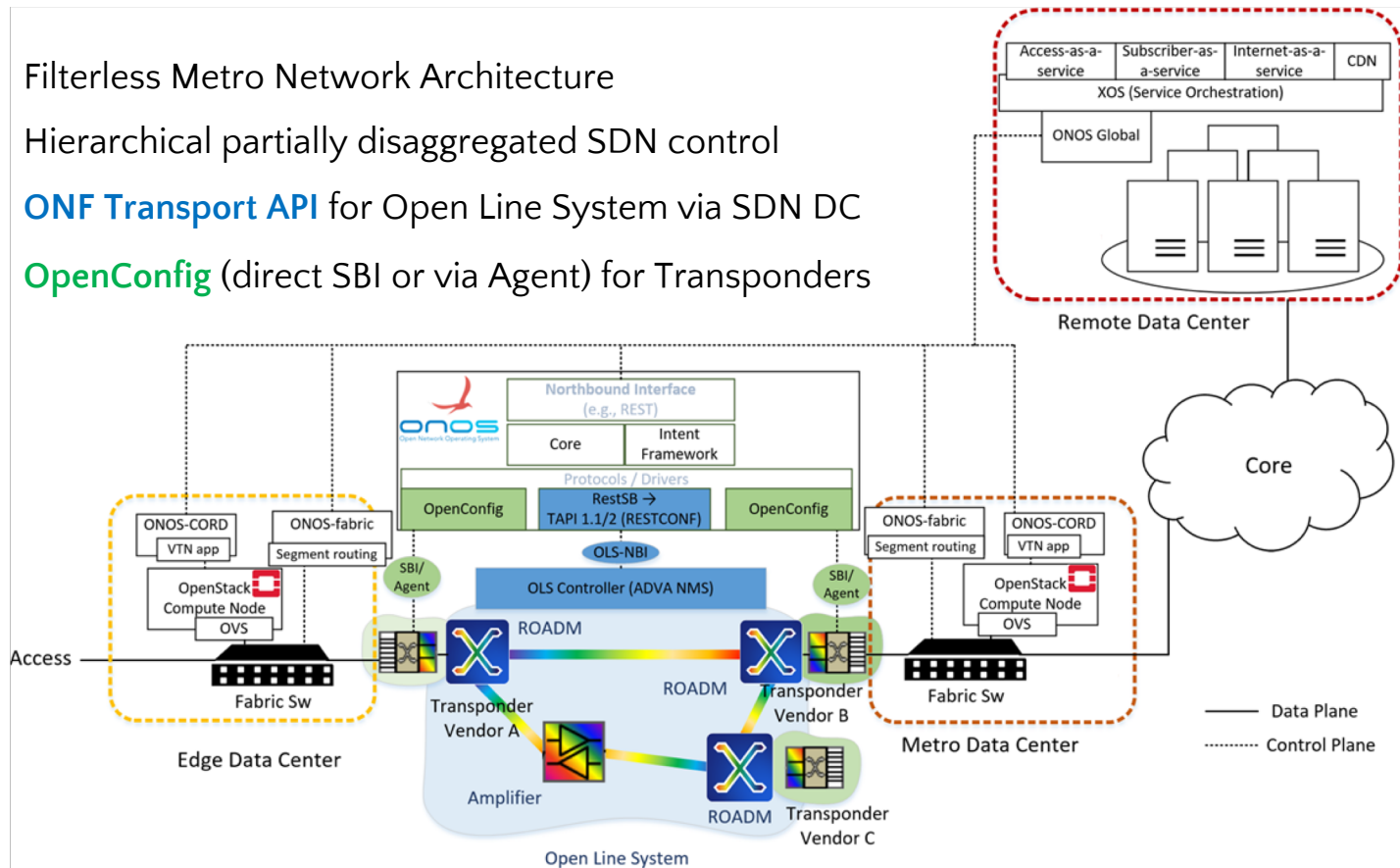


MetroHaul Architecture (.. 2019)



<https://metro-haul.eu>

- Filterless Metro Network Architecture
- Hierarchical partially disaggregated SDN control
- **ONF Transport API** for Open Line System via SDN DC
- **OpenConfig** (direct SBI or via Agent) for Transponders



Current status

- Commercial Transport SDN and NFV orchestration solutions with open platforms are available and being deployed
- Practical implementations and successful interop demos for (partially) disaggregated networks supporting distributed datacenters / edge clouds in metro networks
- Ongoing research activities with field trial and demonstrators (MetroHaul, SENDATE)
- Ongoing standardization effort on YANG models for (partial) disaggregation
 - ONF WTP PoC 5.0 → ONF T-API Extensions with Photonic Media (OTSi)
 - ONF ODTN (Open Disaggregated Transport Networks)
 - Telecom Infra Project (TIP)
 - OpenROADM

Conclusions

- **Partial disaggregation** and OLS with per-device data monitoring allows a visibility down to the devices level but simplifies operation of the network
- Recent demonstrations have proven that partial disaggregation is a working approach for metro networks and data center connectivity
- High number of evolving data models delay implementation and testing and limit interoperability
- Industry (including operators) should decide on a **common data model**
- Full disaggregation of the optical layer will slow down technological progress and result in more complex (and cost-intensive) network operation



Thank you



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