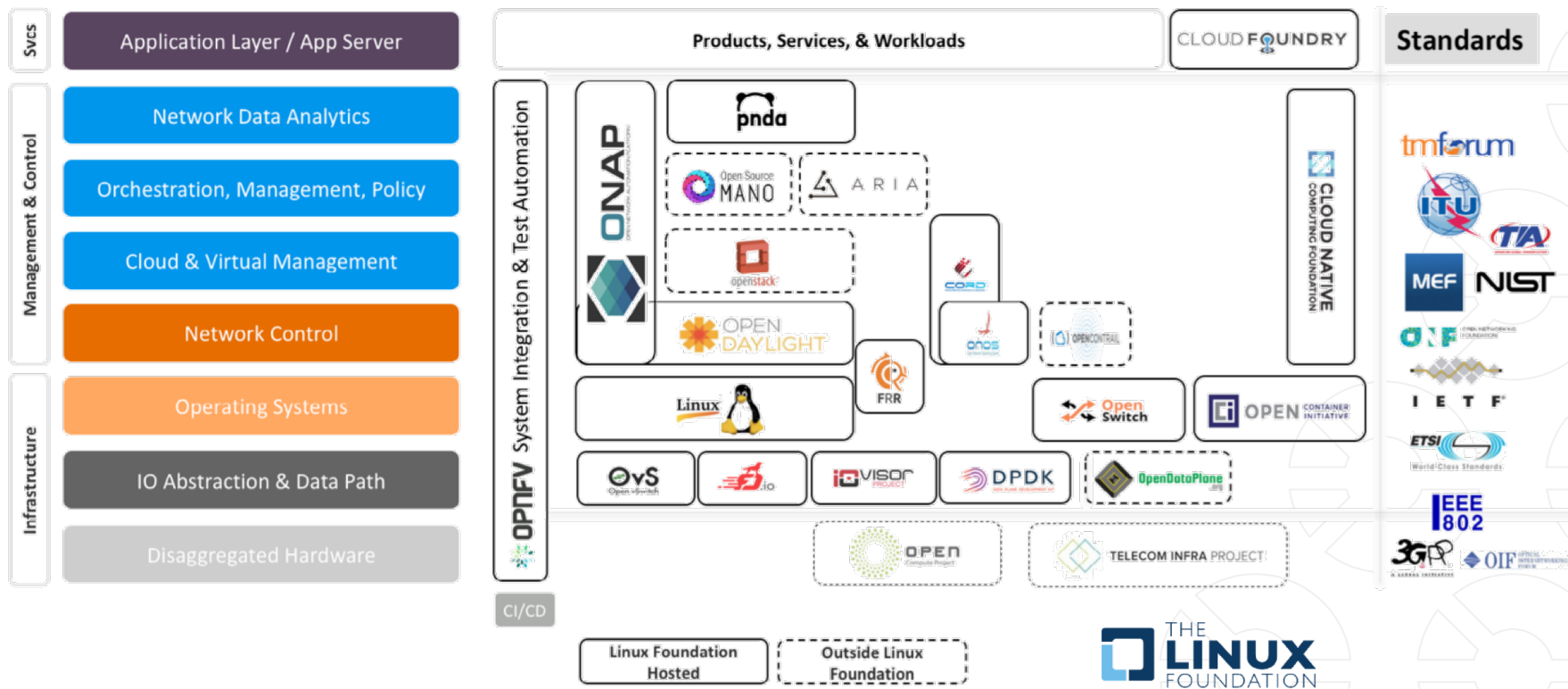# "The nice thing about standards is that you have so many to choose from", Andrew Tannenbaum

YANG data models overview

Standards Defining Organizations (SDOs)

Carrier

MEF OpenLSO Lifecycle Service Orchestration

Transport-API

Topology	Connectivity	Path Computation	Virtual Network	Notification

Core Model

ISPs, IP / Optical

- IETF TE Tunnels
- IETF Network
- IETF Network-Topology
- IETF TE Topology
- IETF Flexi-Grid TED
- IETF Flexi-Grid media channel
- IETF WSON Technology

Industry Alliances

OPENCONFIG

Web 2.0

Lead: Google

Telemetry

Optical Transport

Open ROADM

Disaggregation

Lead: AT&T

Common

- Services
- Network
- Device

Services

Network

Infrastructure
Devices

ADVA Optical Networking

Disaggregation – Operator Concepts & Vision

https://www.youtube.com/watch?v=n9zEiGyvJ-A
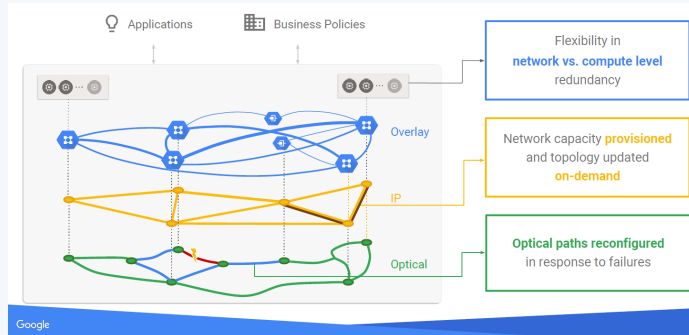
[U. Hölzle, Plenary Talk, OFC 2017]

[M. Filer et al., JOCN,, Vol. 8, No. 7, 2016]
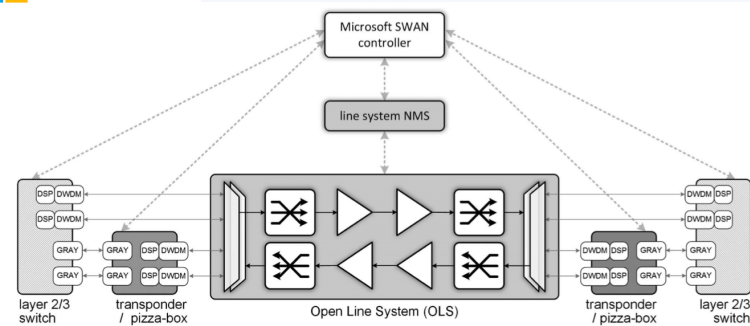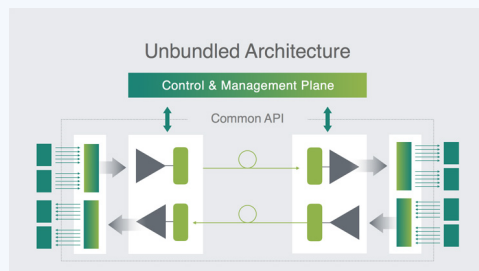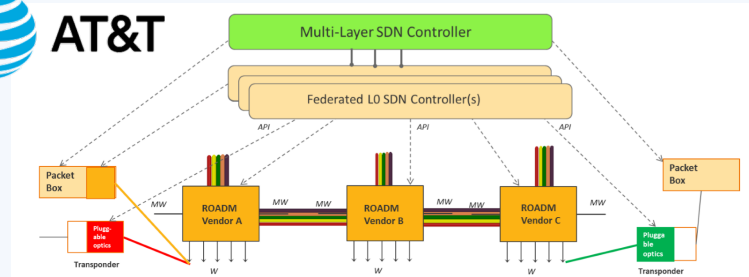
https://0201.nccdn.net/1_2/000/000/098/a85/Open-ROADM-whitepaper-v1-0.pdf

ONF ODTN (01/2018 – 12/2018)

https://wiki.onosproject.org/display/ODTN/ODTN
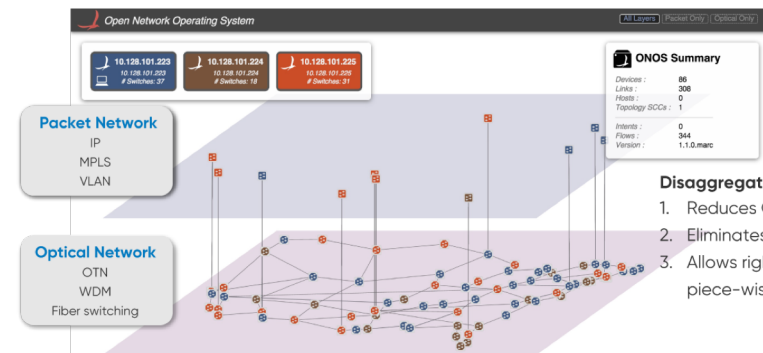
BW Calendaring
SDN-IP
VPLS
Carrier Ethernet 2.0
L3VPN

Control Apps Config Apps Mgmt Apps

ONOS

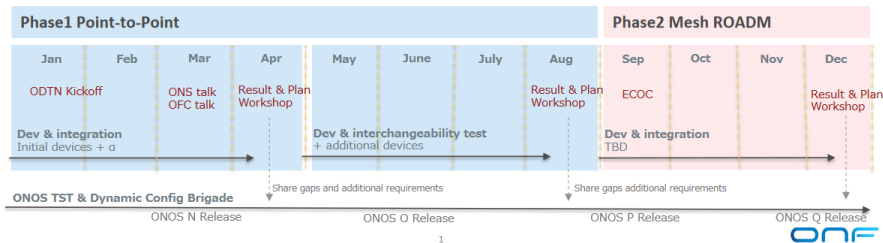**Logically Centralized Control**
1. Optimize resource usage
2. Dynamic traffic provisioning
3. Multi-layer resiliency

Packet Network
IP
MPLS
VLAN

Optical Network
OTN
WDM
Fiber switching

Disaggregated Transport Network
1. Reduces CAPEX & OPEX
2. Eliminates vendor lock-in
3. Allows rightsizing and
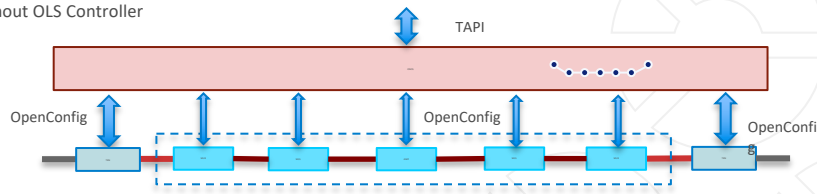   piece-wise upgrades
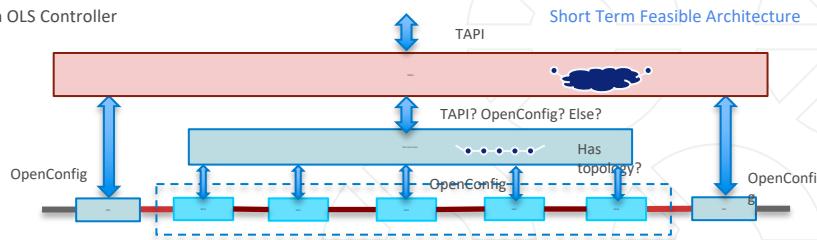
Service Providers

Tier 1 Vendors

Tier 2 Vendors

Without OLS Controller

TAPI

OpenConfig   OpenConfig   OpenConfi
g

With OLS Controller   Short Term Feasible Architecture

TAPI

TAPI? OpenConfig? Else?

Has topology?

OpenConfig   OpenConfig   OpenConfi
g

Phase1 Point-to-Point								Phase2 Mesh ROADM			
Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
ODTN Kickoff		ONS talk OFC talk	Result & Plan Workshop				Result & Plan Workshop	ECOC			Result & Plan Workshop
Dev & integration Initial devices + α				Dev & interchangeability test + additional devices				Dev & integration TBD			

ONOS TST & Dynamic Config Brigade

Share gaps and additional requirements   Share gaps additional requirements

ONOS N Release   ONOS O Release   ONOS P Release   ONOS Q Release

ADVA Optical Networking

MetroHaul Software Architecture

- Filterless Metro Network Architecture

- Hierarchical SDN control

- **ONF Transport API** for Open Line System via SDN DC

- **OpenConfig** (direct SBI or via Agent) for Transponders
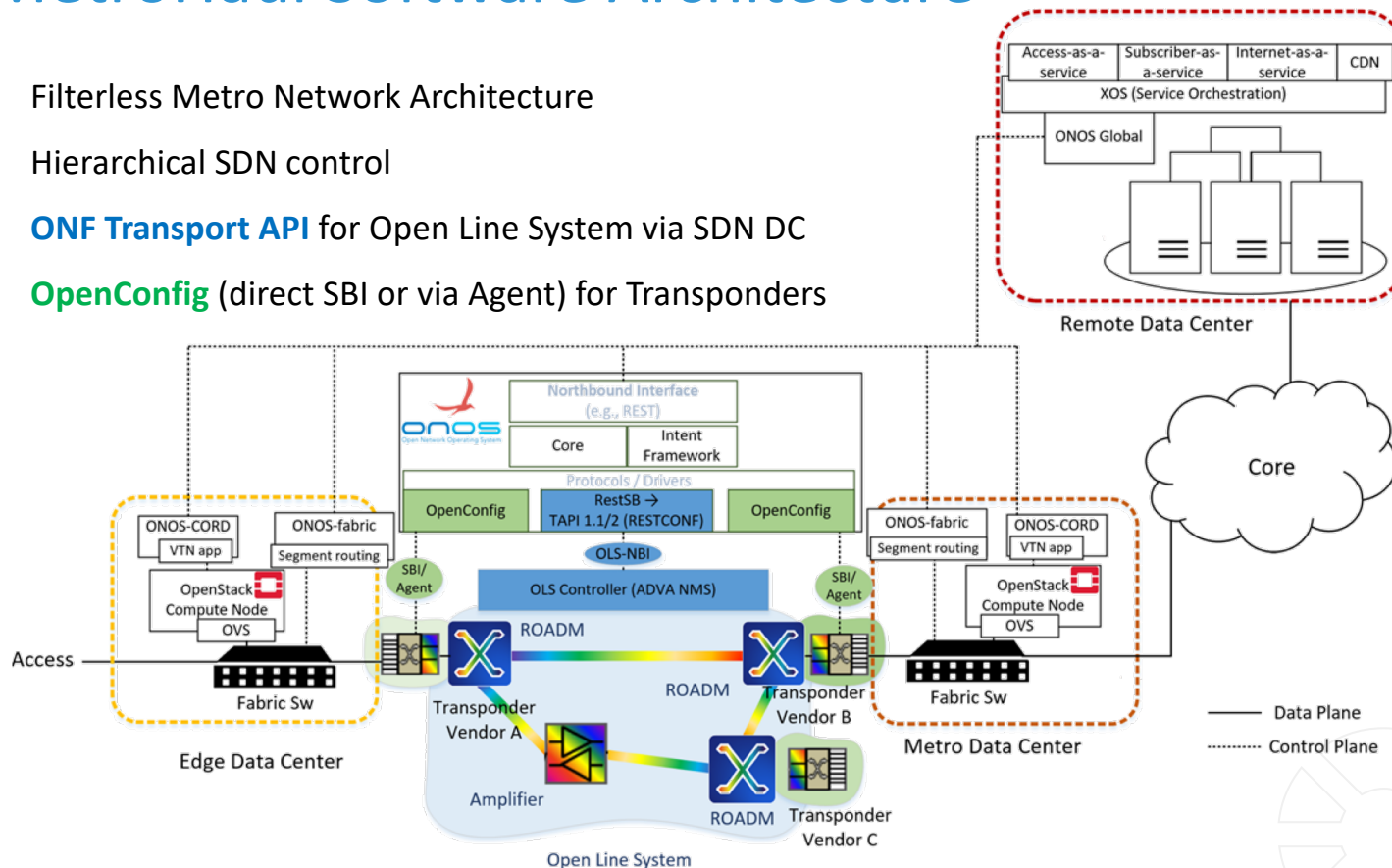
SENDATE Multivendor optical SDN Trial (09/2018)

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 extensions for Optical Performance Planning

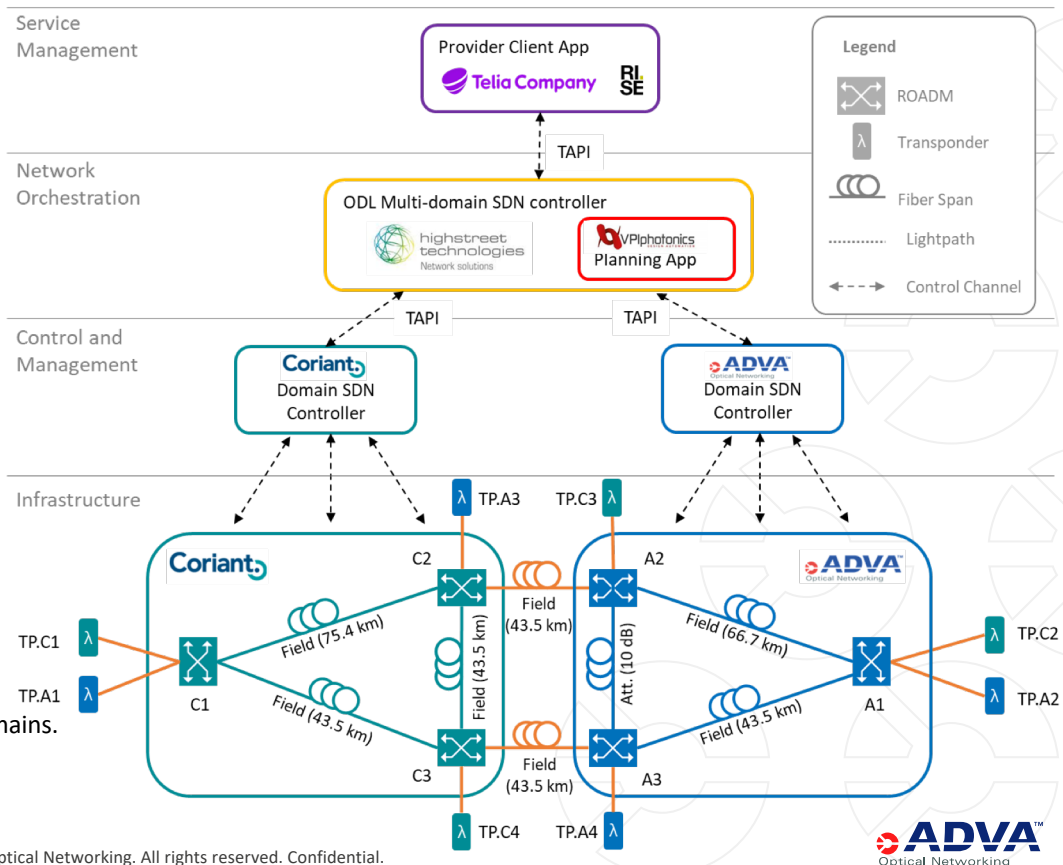**Network Orchestration layer components include:**

- Transport Orchestrator (Highstreet technologies)
- Planning Application (VPIphotonics) (Bundled in Transport Orchestrator)
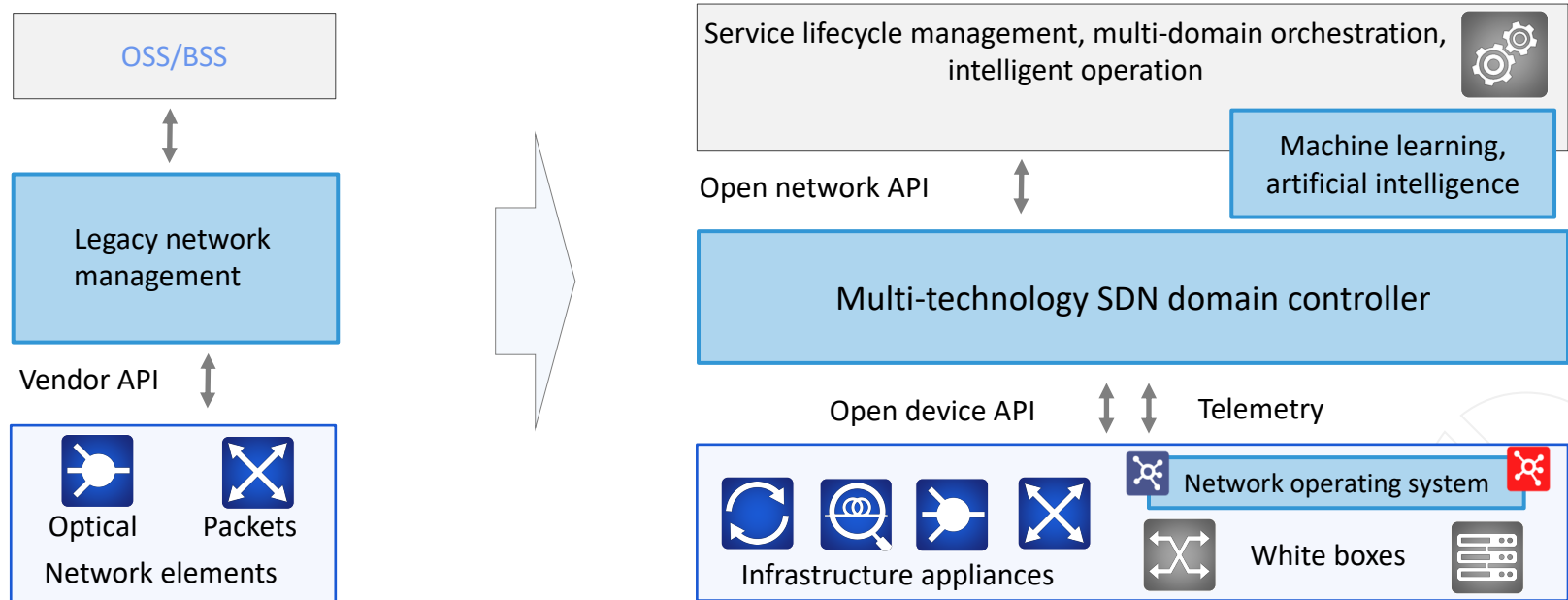
Control and Management layer:

- SDN Domain Controllers (ADVA and Coriant)

Infrastructure layer:

- ROADMs and transponders (ADVA and Coriant)
- Transparent OMS back-to-back ROADM interconnect
- Alien wavelength interconnection passing both vendors optical domains.

Rearchitected network control… towards Autonomy

OSS/BSS

Legacy network management

Vendor API

Optical   Packets

Network elements

Service lifecycle management, multi-domain orchestration, intelligent operation

Machine learning, artificial intelligence

Open network API

Multi-technology SDN domain controller

Open device API   Telemetry

Infrastructure appliances

Network operating system

White boxes

ADVA
Optical Networking

AI/ML example : capacity optimization

- o Neural networks
- o 9 input features, 1 output feature (OSNR)
- o 2 hidden layers (120x100 neurons)
- o ReLu activation function

MAE	0.039 dB
Max Error (+)	+0.57 dB
Max Error (-)	-0.57 dB
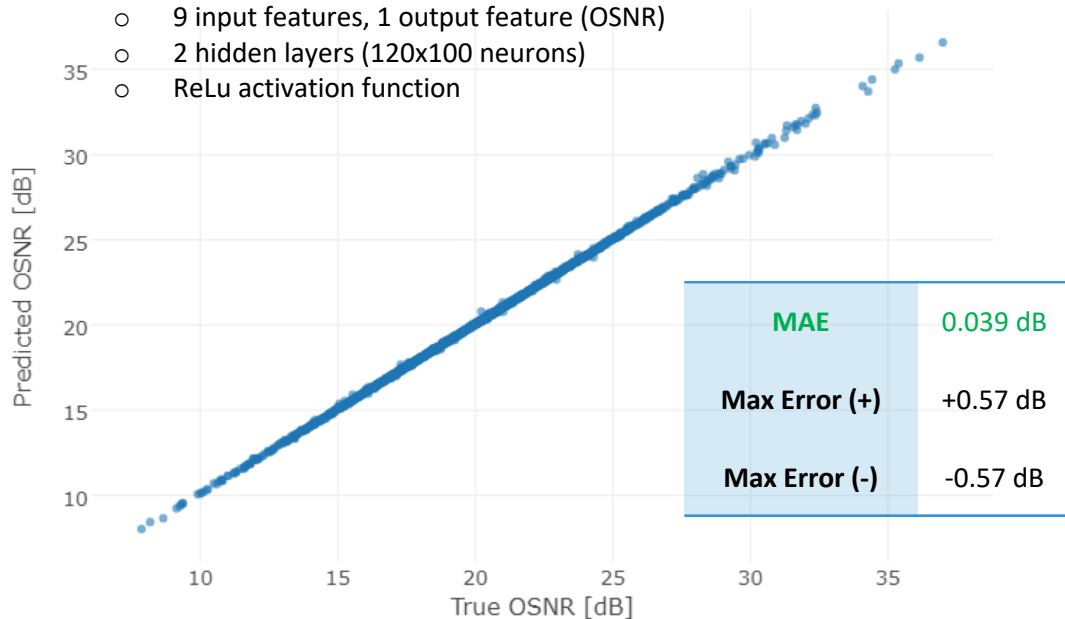
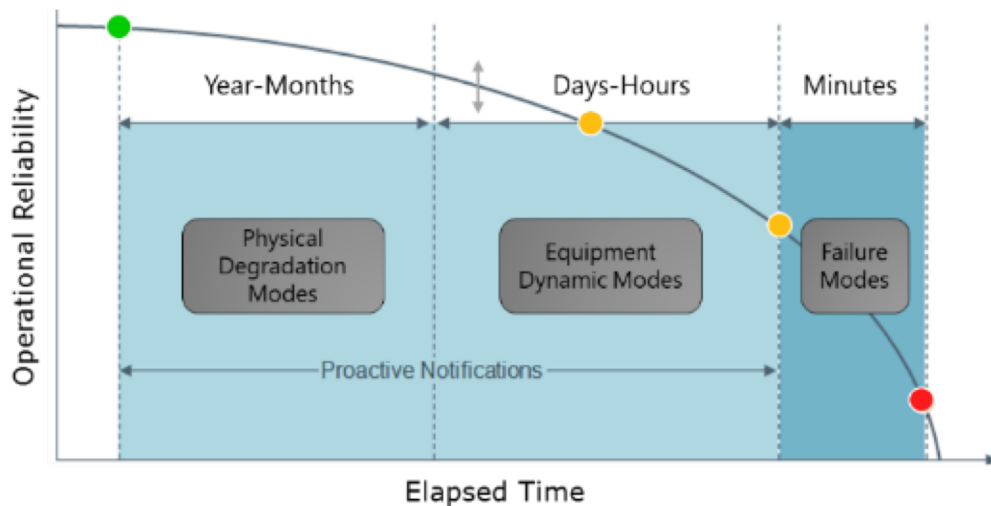Split entire dataset

Build ML model using train/validate

Get test data, and remove **true** OSNR values

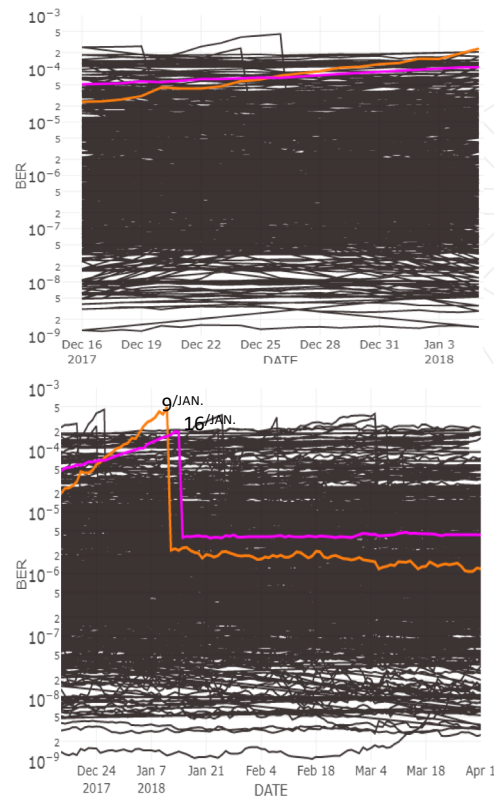Apply ML model (Get **predicted** OSNR values)

Compare True OSNR vs. Predicted OSNR

Prediction of OSNR with ~0.04dB mean accuracy

ADVA
Optical Networking

AI/ML example: predictive maintenance

Colored lines detected by ML (Jan 6th)

Precise prediction verified

Improving availability and faster repair cycles by predicting device outages

ADVA
Optical Networking