NTT Communications Transform. Transcend.

NTT Communications' Tech-vision on Softwarization of WAN and Practical Steps

Dai Kashiwa

VP of SDN/NFV technology development,
NTT Communications

Board member of ONF

Wenyu Shen

Manager of technology development,
NTT Communications

TLT member of ONF

Transform your business, transcend expectations with our technologically advanced solutions.
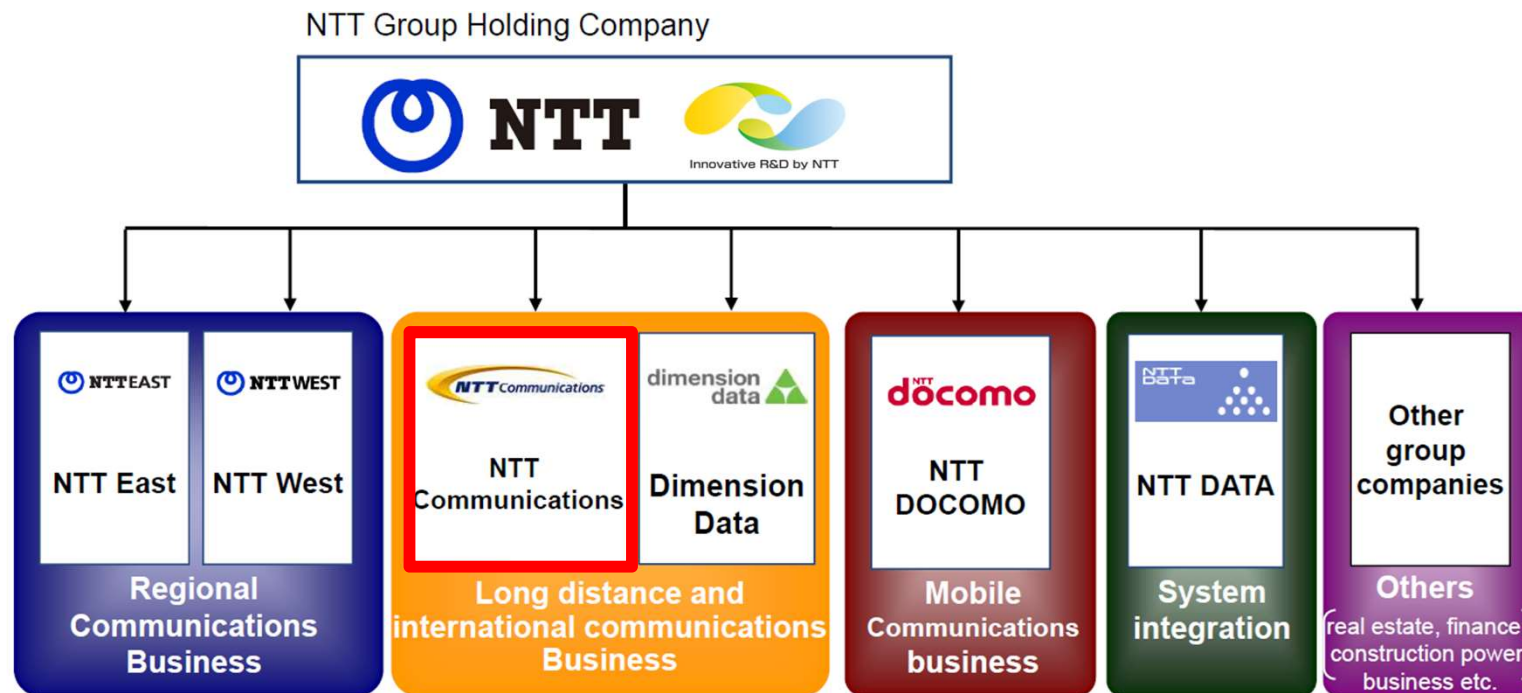
Agenda

● SDN Challenges in NTT Communications

● Tech-vision on Softwarization of WAN

● Dynamic Multi-layer Network Slicing and Transport SDN (Journey towards ODTN)

Agenda
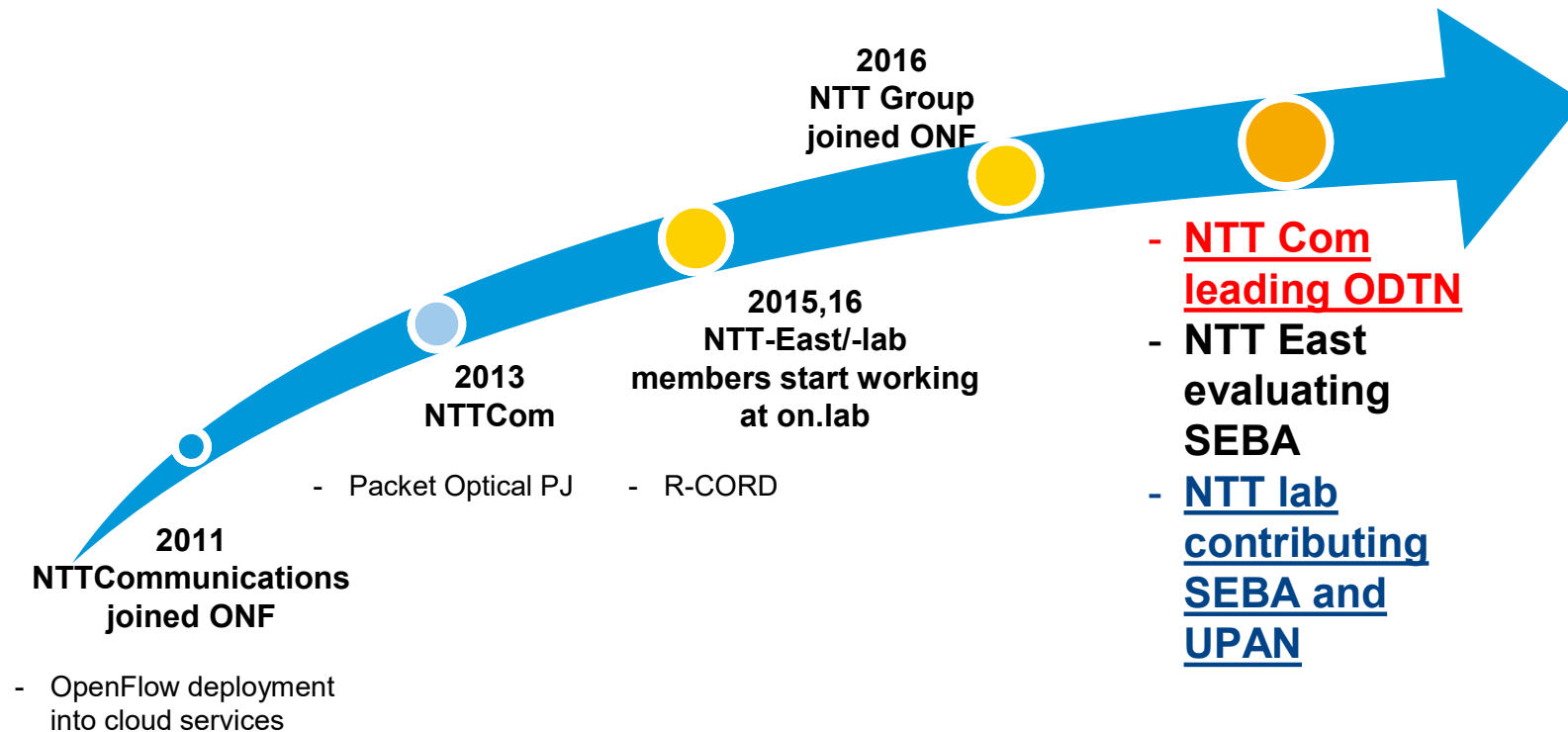
● <u>SDN Challenges in NTT Communications</u>

● Tech-vision on Softwarization of WAN

● Dyamic Multi-layer Network Slicing and Transport SDN (Journey towards ODTN)

NTT Group Business Domains

NTT Groups' Collaborations with ONF

2016
NTT Group
joined ONF

2015,16
NTT-East/-lab
members start working
at on.lab

- **NTT Com leading ODTN**

- **NTT East evaluating SEBA**

- **NTT lab contributing SEBA and UPAN**

2013
NTTCom

- Packet Optical PJ   - R-CORD

2011
NTTCommunications
joined ONF

- OpenFlow deployment
  into cloud services

5

"SDN"-lization Step1: Inside DC(Data Center)

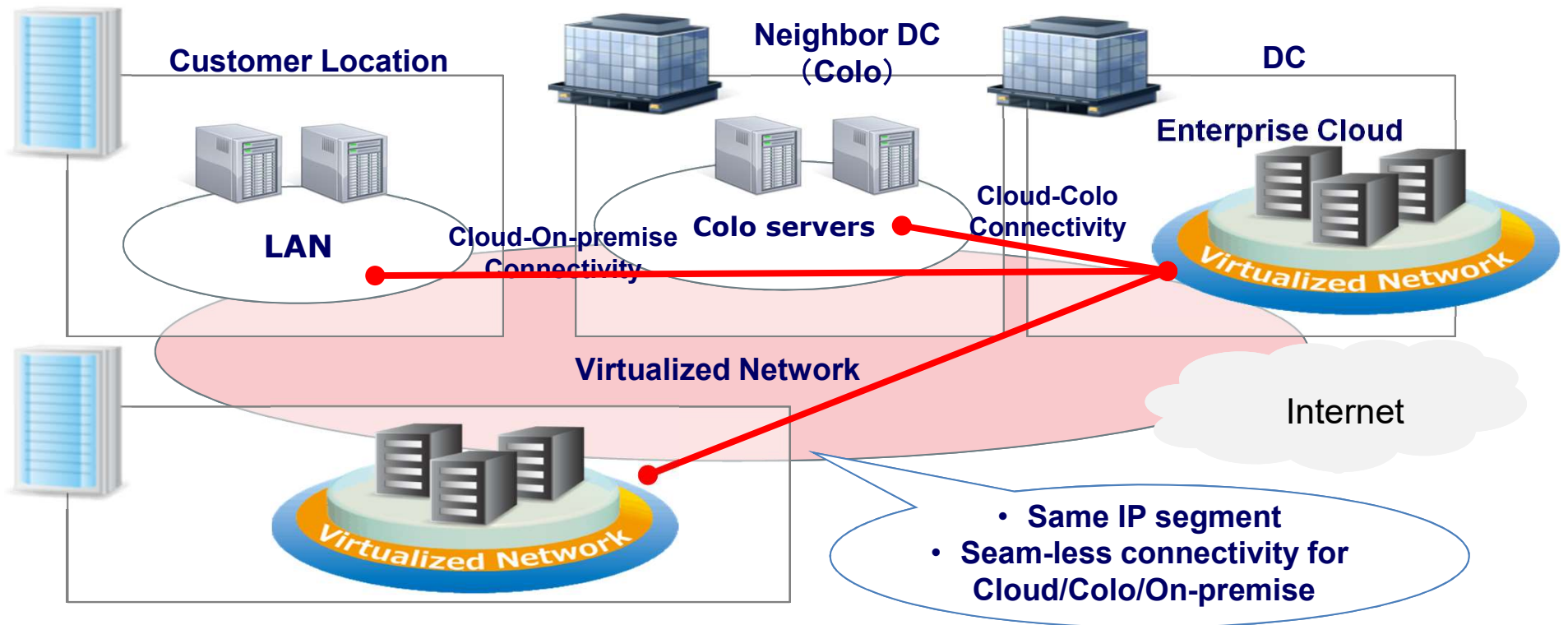✓ **Automation of network configuration**
✓ **Dynamic network management by customer portal**

Data Center

Enterprise Cloud

SDN

Inside Data Center

Virtual Servers

Customer Portal

Automatic Configuration

Network Controller

SDN

OFSW

LB

FW

OFSW

VPN

OFSW: OpenFlow Switch
LB: Load Balancer
FW: Firewall
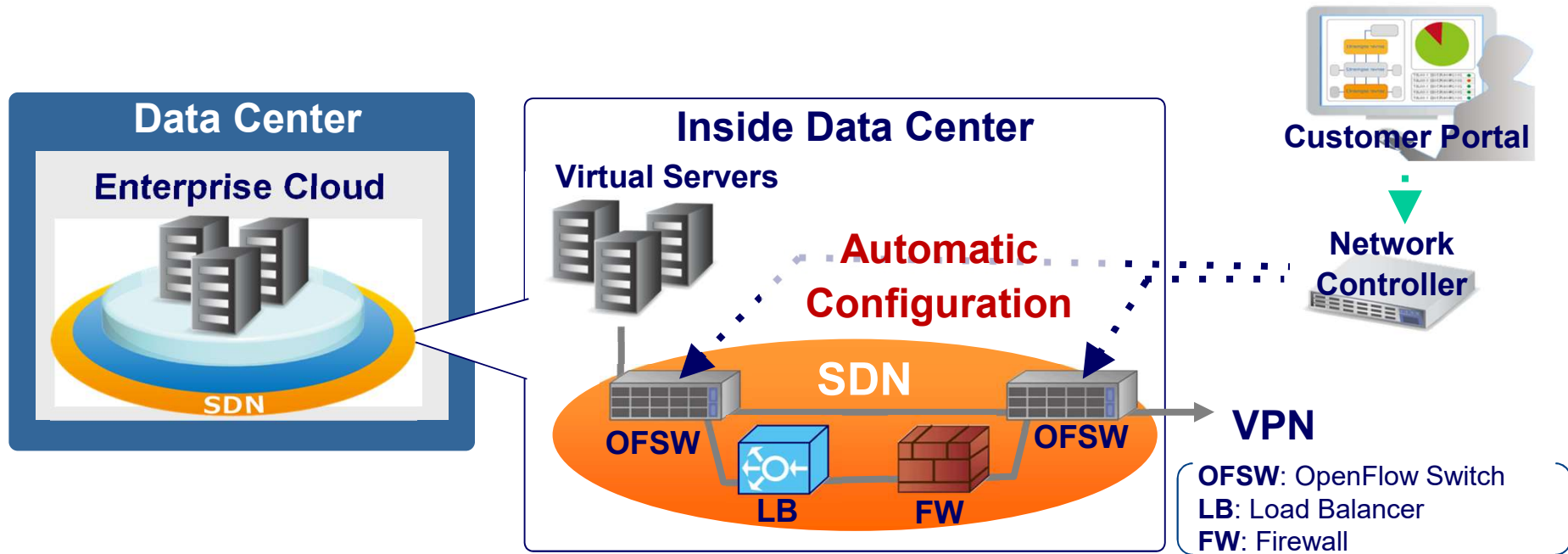
"SDN"-lization Step2: Between DCs

Customer Location

Neighbor DC（Colo）

DC

Enterprise Cloud

Cloud-Colo Connectivity

LAN

Cloud-On-premise Connectivity

Colo servers

Virtualized Network

Virtualized Network

Internet

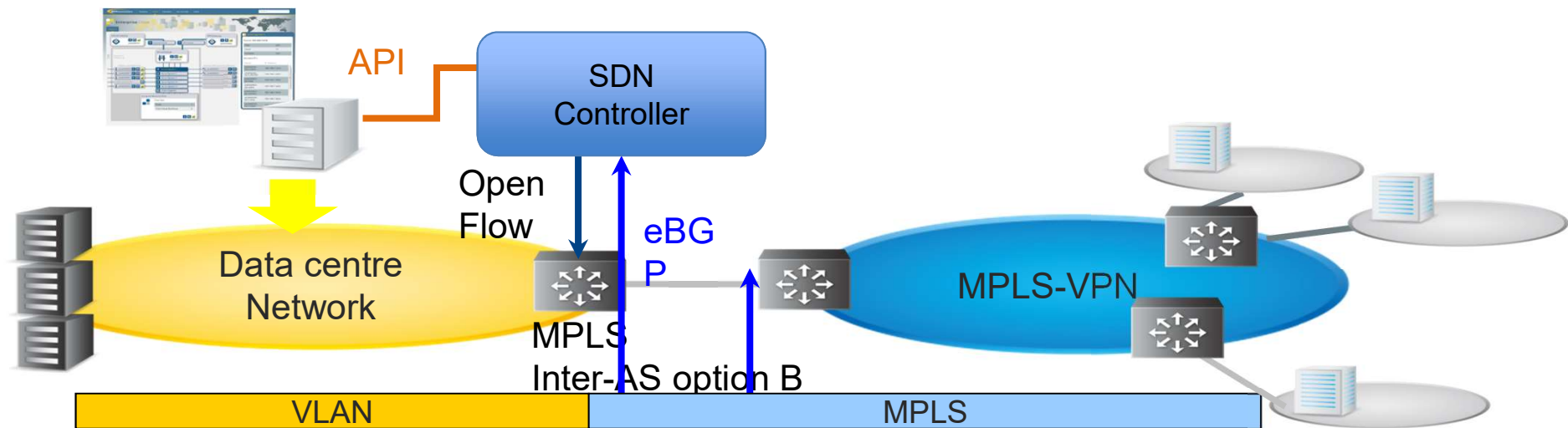Virtualized Network

- Same IP segment
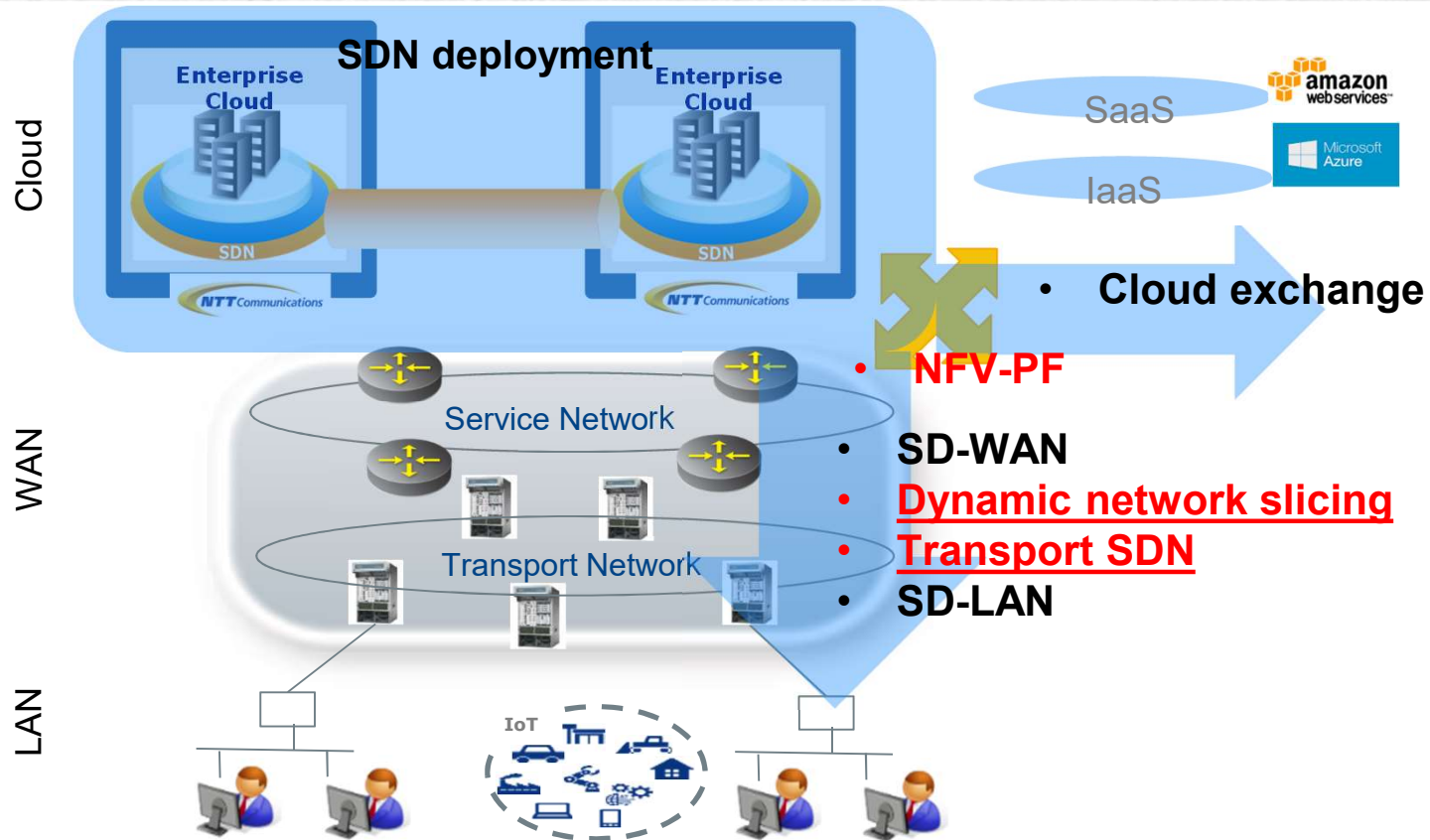- Seam-less connectivity for Cloud/Colo/On-premise

"SDN"-lization Step2: DC～WAN

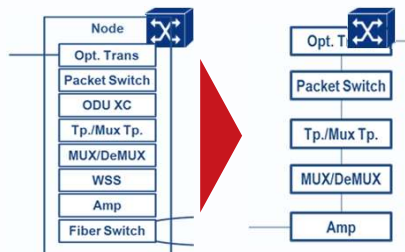✓ **Automated connection settings between our network services (e.g. VPN) with our cloud services**

API

SDN Controller

Open Flow

eBGP

Data centre Network

MPLS Inter-AS option B

MPLS-VPN

VLAN	MPLS

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SDN Deployment Expansion

SDN deployment

Cloud

Enterprise Cloud

SDN

NTT Communications

Enterprise Cloud

SDN

NTT Communications

SaaS

IaaS

amazon web services

Microsoft Azure

- **Cloud exchange**

- **NFV-PF**

WAN

Service Network

Transport Network

- **SD-WAN**
- **Dynamic network slicing**
- **Transport SDN**
- **SD-LAN**

LAN

IoT

Technical Challenges

1 **Disaggregated devices**

- **Speeding up technical innovation**
- **Inventory optimization**

Node	
Opt. Trans	
Packet Switch	
ODU XC	
Tp./Mux Tp.	
MUX/DeMUX	
WSS	
Amp	
Fiber Switch	

Opt. T	
Packet Switch	
Tp./Mux Tp.	
MUX/DeMUX	
Amp	

2 **Open SDN Controller**

- **Customizability**
- **Faster time to market**
- **Interoperability**
- **CAPEX/OPEX reduction**

OPEN SOURCE

3 **Value-added VNFs**

- **Fully and advanced automation & Visualization**
  - **Telemetry**
  - **AI / Deep learning**

DEV OPS
CREATE PLAN RELEASE CONFIGURE VERIFY PACKAGE MONITOR
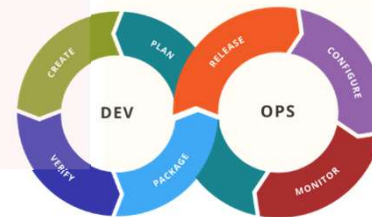
Expectations for Open Source Maturity Level Enhancement
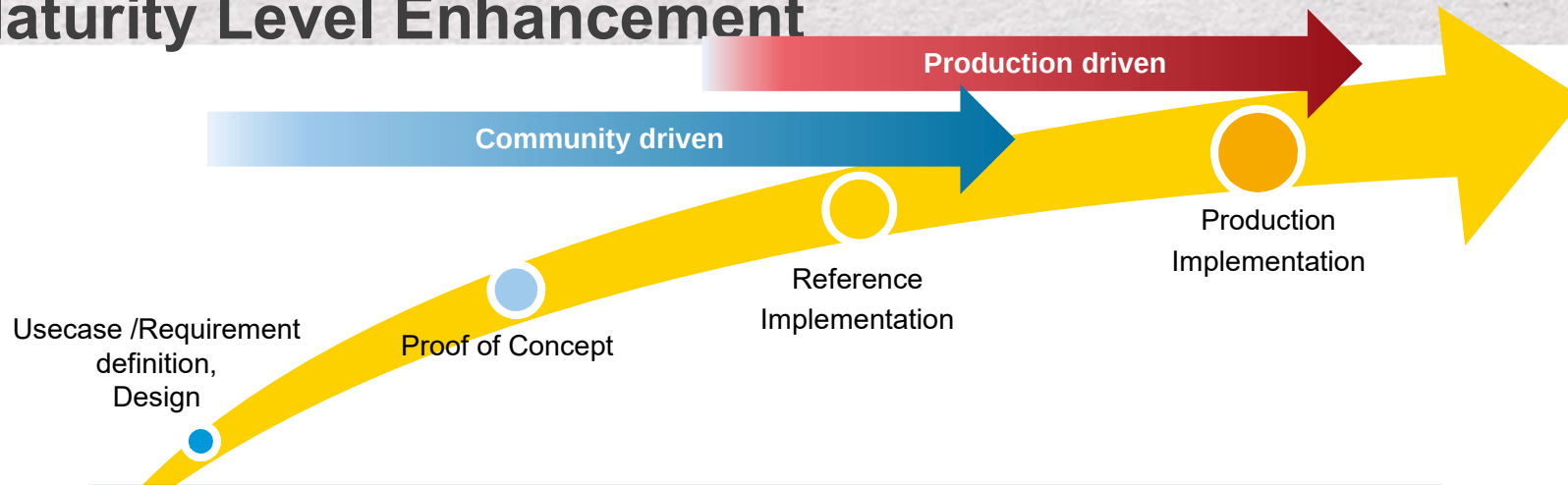
Requirement	PoC	Reference	Production
Easy installment, Documents		👍👍	👍👍👍
Functions	👍👍	👍👍	👍👍👍
Usability/Operability	👍	👍👍	👍👍👍
Performance/Scalability	👍	👍👍	👍👍👍
Quality/Availability	👍	👍	👍👍👍

Excellent	👍👍👍
Sufficient	👍👍
Minimum	👍
N/A	

Agenda

● SDN Challenges in NTT Communications

● Tech-vision on Softwarization of WAN

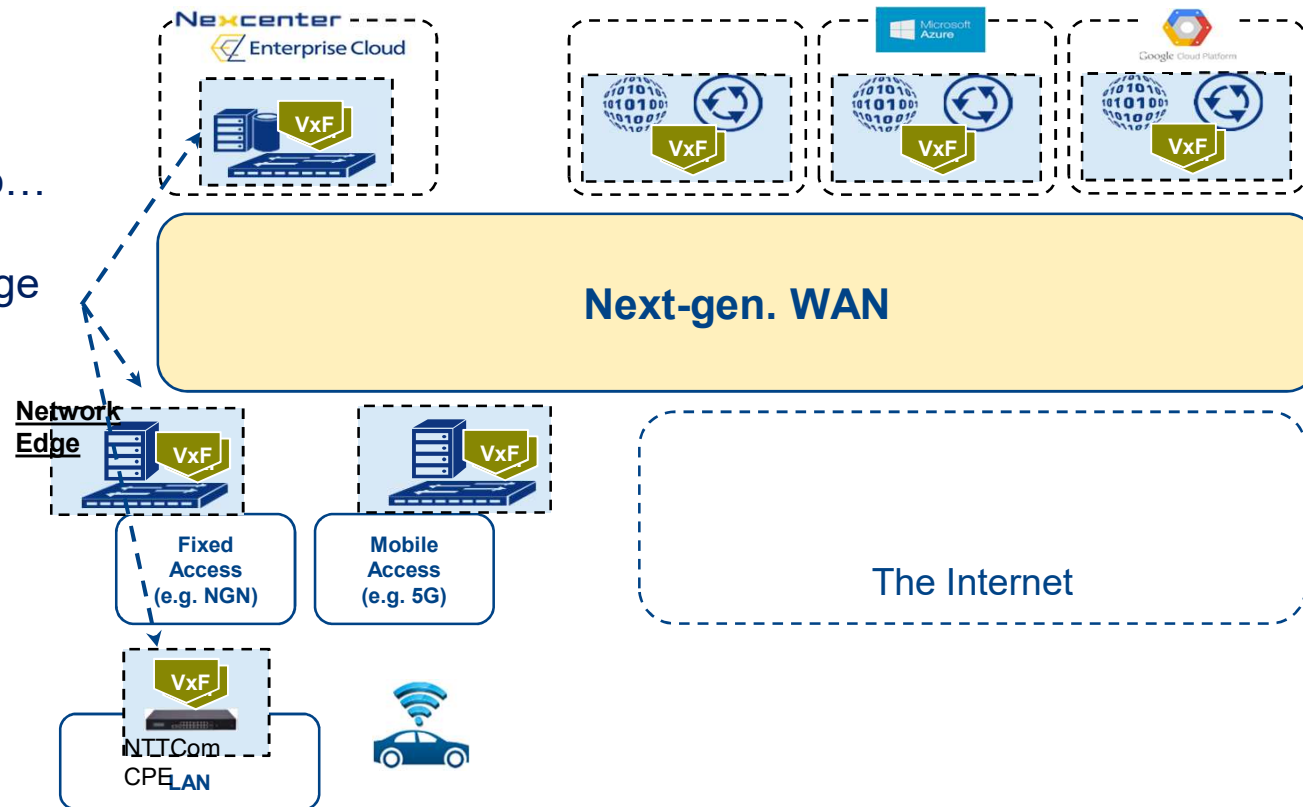● Dyamic Multi-layer Network Slicing and Transport SDN
(Journey towards ODTN)

Network Usage Shift

Traditional WAN | **Today(Hybrid)** | **Next-gen. WAN**

- Flexible and dynamic WAN
- Value-added VxF (x: network, security, IoT, ...)
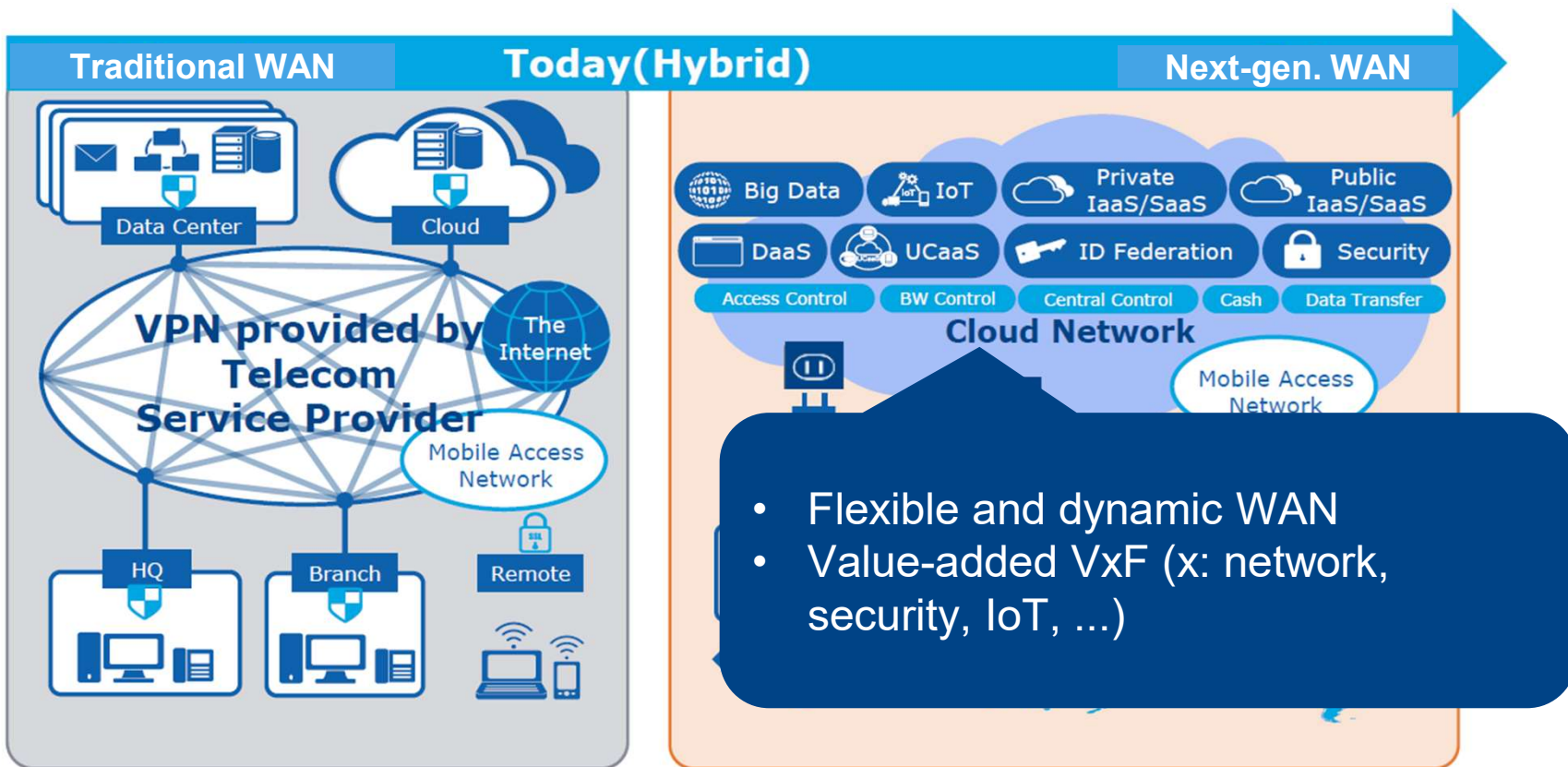
VxF Platform (x: network, security, IoTfunc,…)

Deployment to…
- DC/IaaS
- Network Edge
- CPE

Nexcenter Enterprise Cloud

VxF

Microsoft Azure

Google Cloud Platform

VxF

VxF

VxF

Next-gen. WAN

Network Edge

VxF

VxF

Fixed Access (e.g. NGN)

Mobile Access (e.g. 5G)

The Internet

VxF

NTTCom CPE **LAN**

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WAN Role Shift

| Traditional WAN | Today(Hybrid) | Next-gen. WAN |

Traditional WAN

- **Minimal traffic engineering**

- **Simple L2/L3 pipe**

- **Static control**

Next-gen. WAN

- **Fine-grained application – centric slicing and traffic engineering**

- **Simple L2/L3 pipe + Service Functions Chaining**

- **Dynamic control**

Requirements for Next-gen. WAN

➢ **Traffic management**

- **Network slicing** of L2, L3 and L4 flows
- End-to-end traffic management
- **Scalability and Simplicity** for massive traffic flows
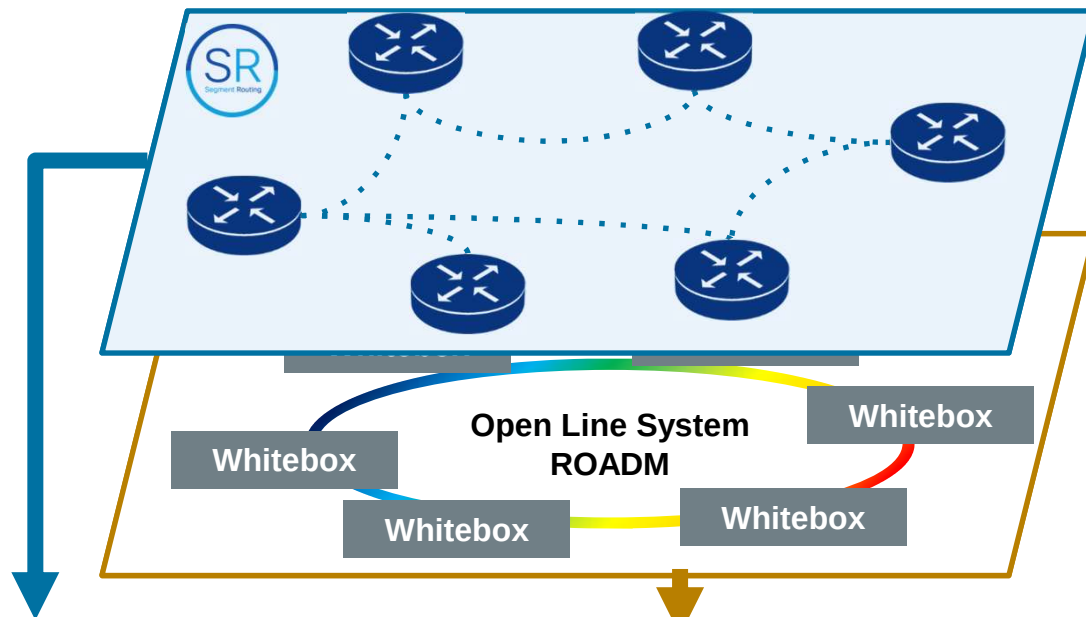
➢ **Flexible traffic isolation**

- **Hard isolation**: entirely decouple traffic by channelization, preemption (e.g. OTN)
- **Soft isolation**: permit interferences between traffic flows for utilization (e.g. QoS)

➢ **Openness**

- Apply the best-suited latest device from markets on time
- **Interoperability** in Data-plane, Control-plane, Management-plane

Architecture of Next-gen. WAN

Standard IF

SR
Segment Routing

Configuration Management

NETCONF / OpenConfig

Traffic Engineering Controller

PCE
P

Orchestrator

Open Line System
ROADM

Whitebox

Whitebox

Whitebox

Whitebox

Intelligent service networks
Slicing, SFC, Distribution
Scalability in traffic flows
Soft-isolation

Simple&fast transport networks
Openness for multi-vendors/whiteboxs
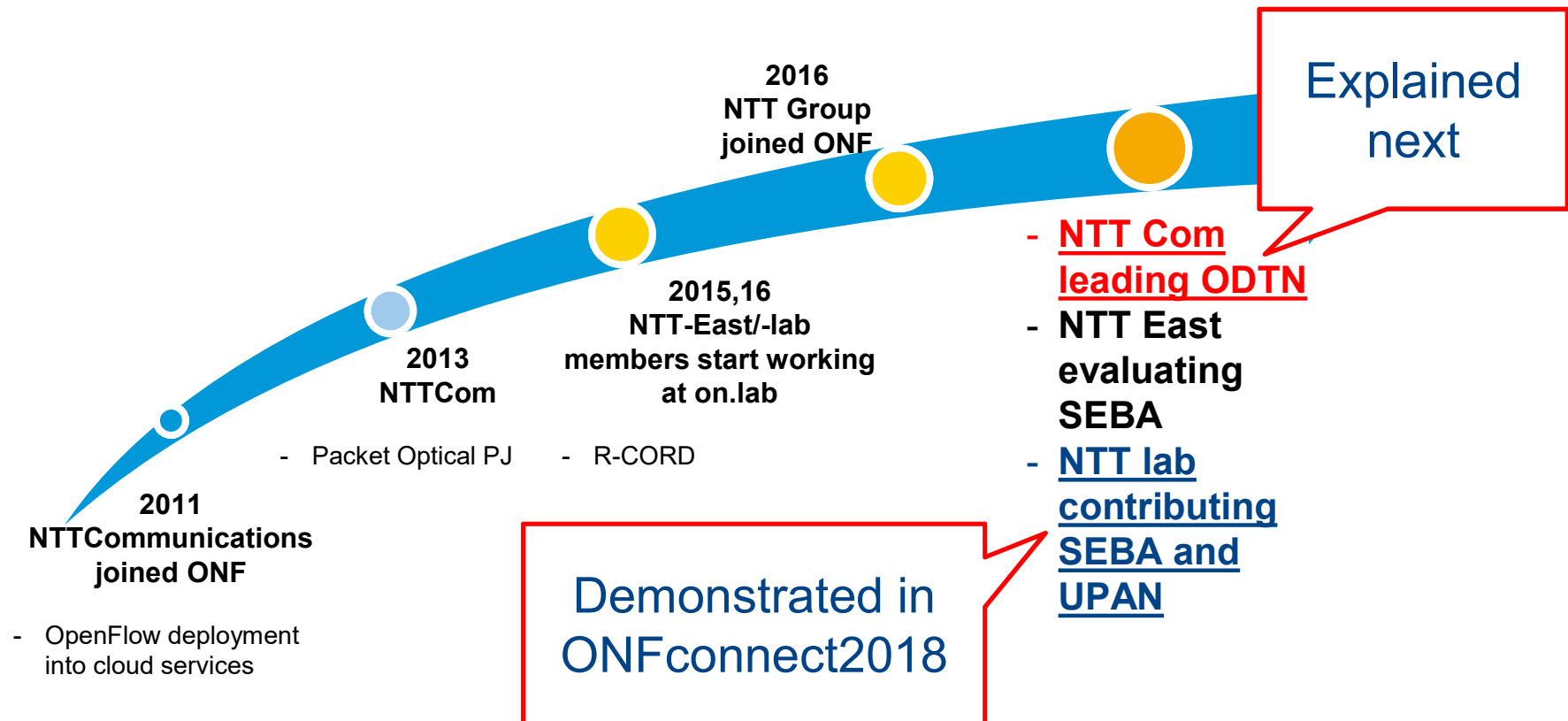Scalability in bandwidth
Hard-isolation
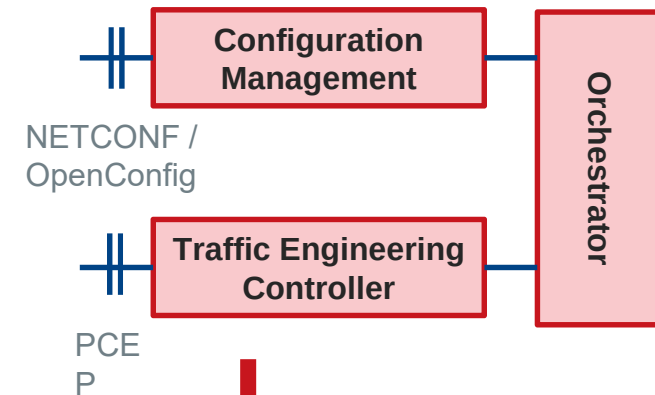
Flexible ctrler/orchestrator
Software-defined approach
Automation, Centralization

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NTT Groups' Collaborations with ONF

2016
NTT Group
joined ONF

Explained next

2015,16
NTT-East/-lab
members start working
at on.lab

- NTT Com leading ODTN

- NTT East evaluating SEBA

- NTT lab contributing SEBA and UPAN

2013
NTTCom

- Packet Optical PJ

- R-CORD

2011
NTTCommunications
joined ONF

- OpenFlow deployment into cloud services

Demonstrated in ONFconnect2018

SEBA Contribution Demo at ONF connect
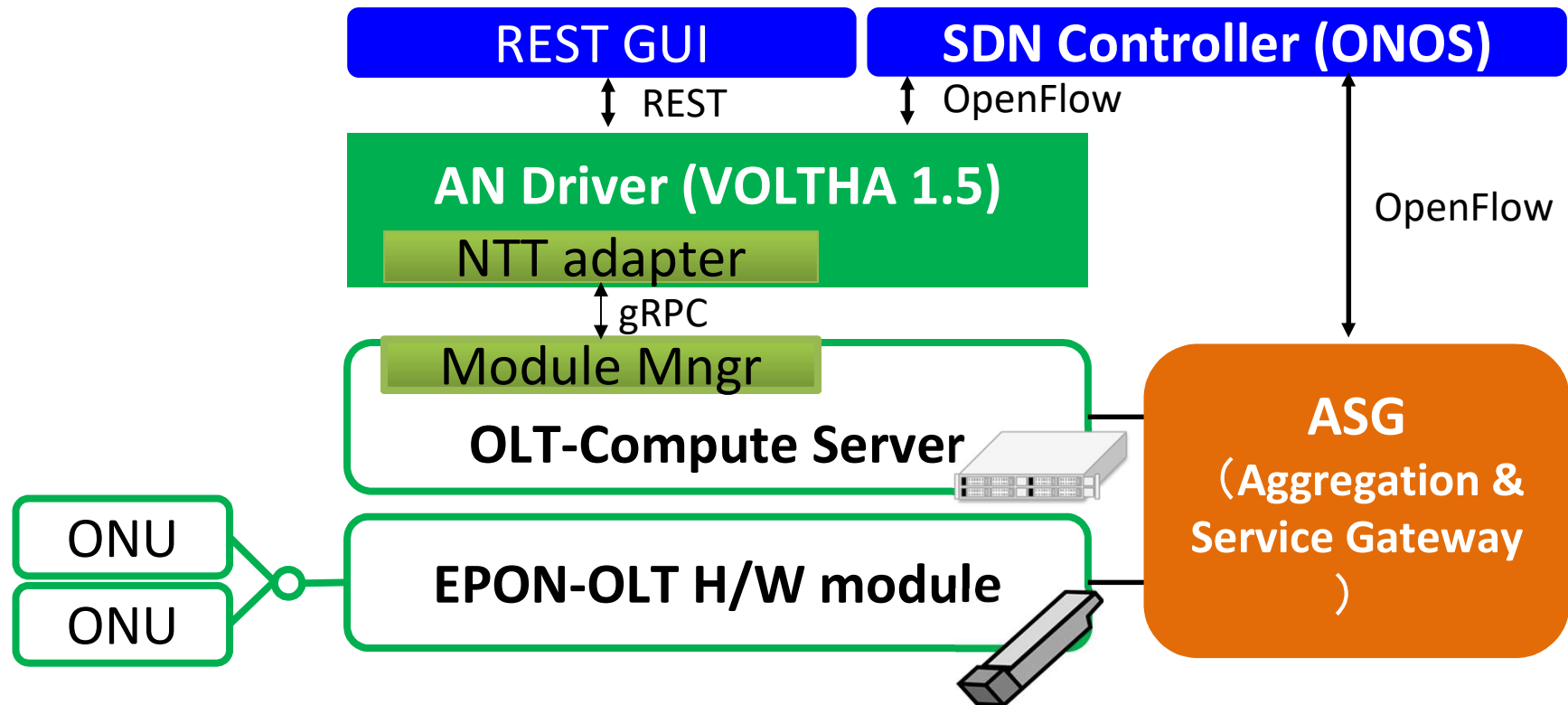
REST GUI

SDN Controller (ONOS)

REST

OpenFlow

AN Driver (VOLTHA 1.5)

NTT adapter

OpenFlow

gRPC

Module Mngr

OLT-Compute Server

ASG
（**Aggregation &
Service Gateway**
）

ONU

ONU

EPON-OLT H/W module
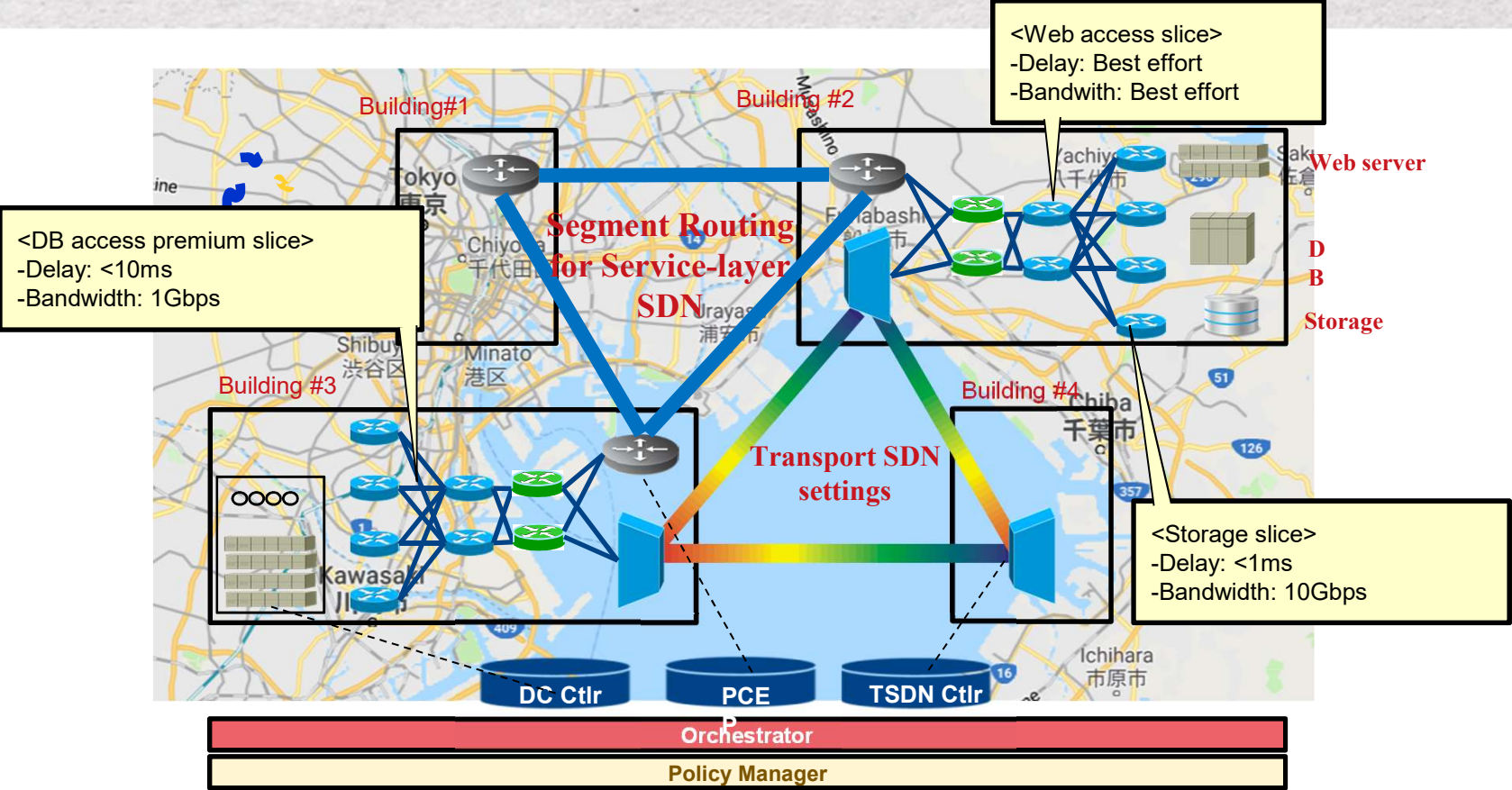
Agenda

● SDN Challenges in NTT Communications

● Tech-vision on Softwarization of WAN

● <u>Dynamic Multi-layer Network Slicing and Transport SDN (Journey towards ODTN)</u>

Dynamic Multi-layer Network Slicing Tech Dev.

Traffic Engineering
Network resource assignment per network slice (e.g., Low latency for storage services, Bandwith guarantee, Burst-tolerant for IoT,…)

Disaggregation
Component level disaggregation, Hardware/Software disaggregation

Slicing
Network isolation aligned with operators/users policy

Data Analysis
Real-time resources condition analysis and dynamic management

Overlay SDN
Service-layer SDN
Transport SDN

DC#3   DC#3   DC#4   DC#1   DC#2

VNF-PF

DC#1   Edge GW   Internet   Edge GW   DC#4   IoT   amazon web services

Search/Analize   Log Collection   Visualize   Machine Learning

Evaluation Environment (Testbed)

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Transport SDN Overview
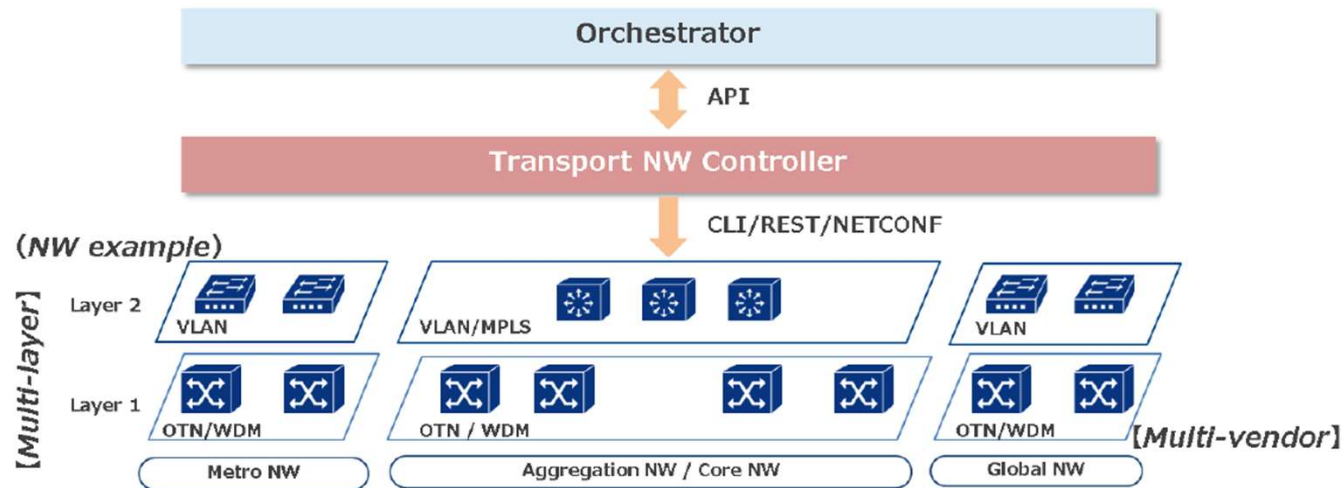
Transport SDN Basic Design

Orchestrator

REST API

Metro Ring Service App

Leased Line Service App

Transport NW Controller

Metro Device Driver

Aggregation Device Driver

Core Device Driver

Global Device Driver

Abstraction

In-house production

Common Platform

CLI / NETCONF

Layer 2

Metro

Aggregation

Layer 1

DCI

Core / Backhaul

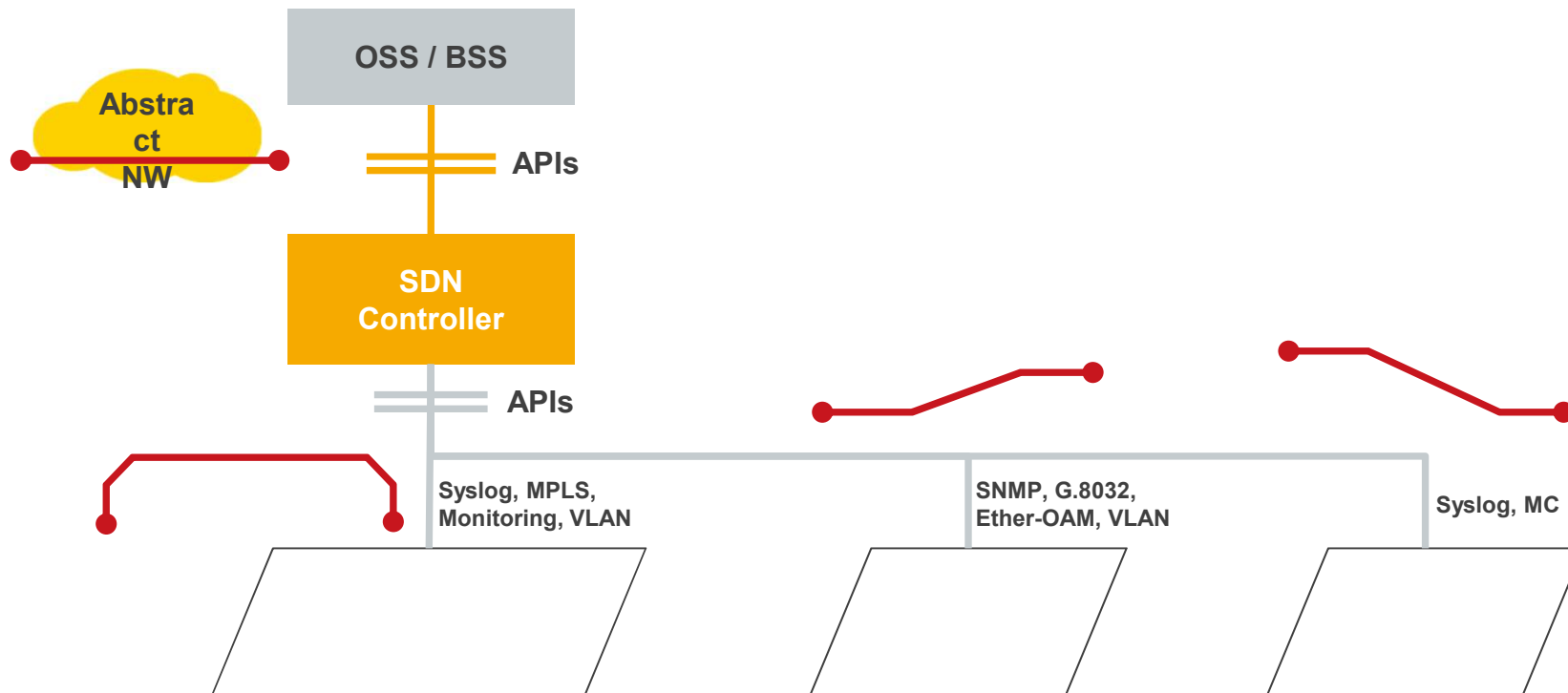Global
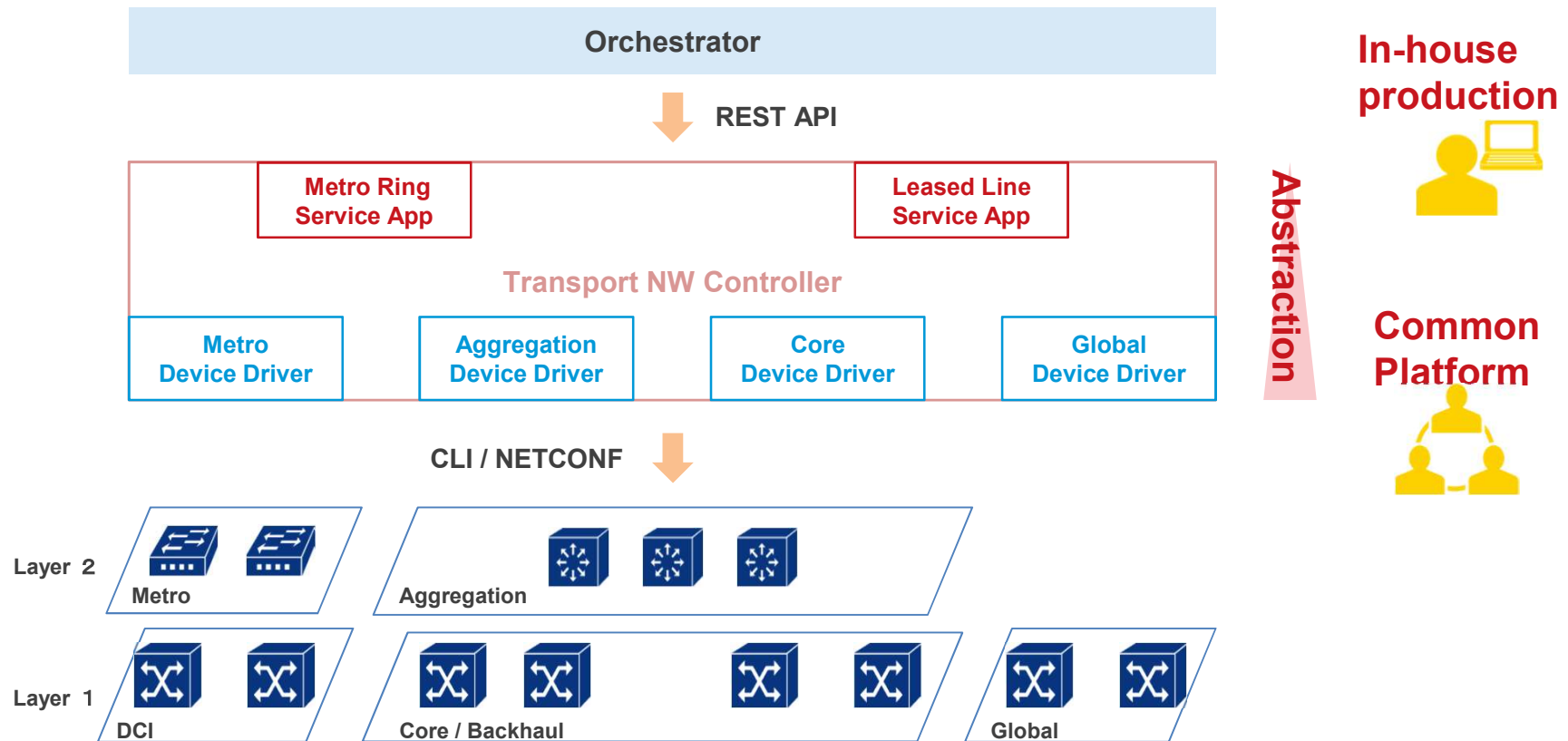
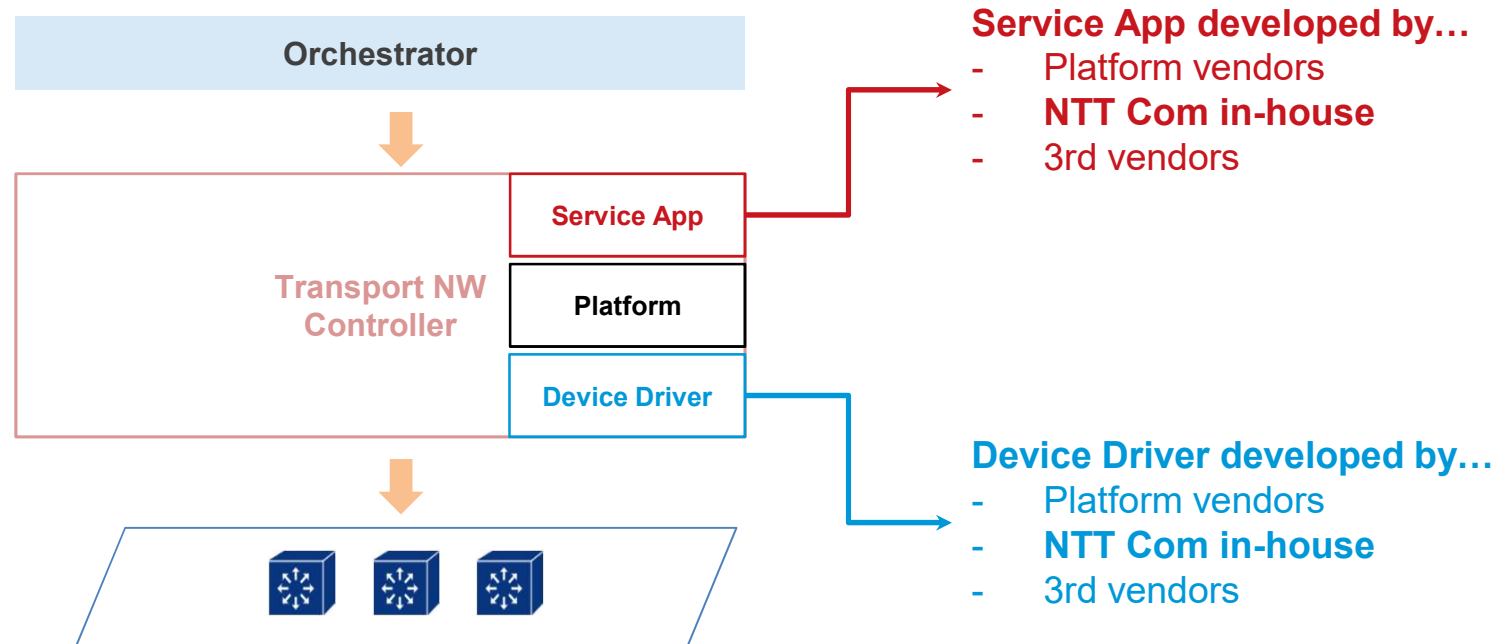# Abstraction

Integrated and seamless operation among multi-domain networks by abstracting device configuration

OSS / BSS

Abstract NW

APIs

SDN Controller

APIs

Syslog, MPLS,
Monitoring, VLAN

SNMP, G.8032,
Ether-OAM, VLAN

Syslog, MC

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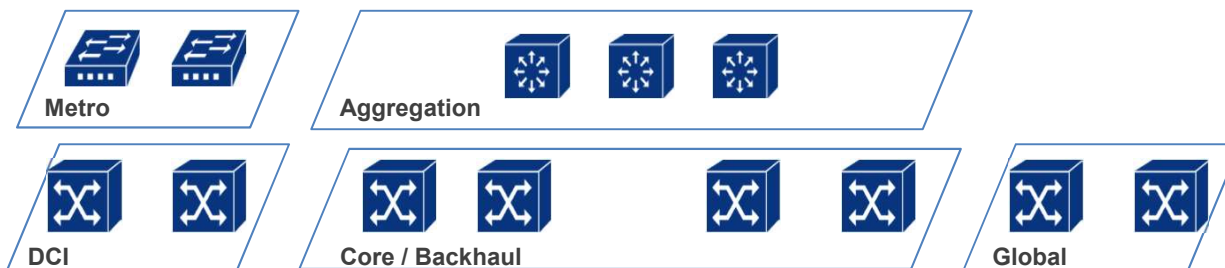# In-house Production

Agile and in-house software development to shorten development term and enhance productivity

Orchestrator

Transport NW Controller

Service App

Platform

Device Driver

Service App developed by…
- Platform vendors
- **NTT Com in-house**
- 3rd vendors

Device Driver developed by…
- Platform vendors
- **NTT Com in-house**
- 3rd vendors

Common Platform

Platform integration among multiple development projects to enhance productivity and keep sustainability of developer resources
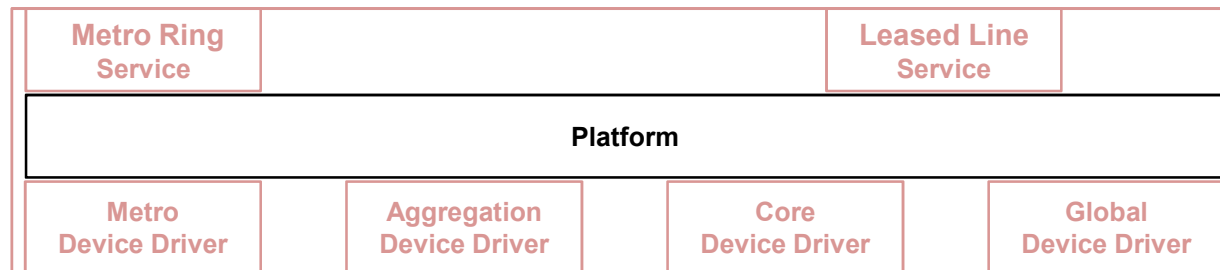
Peripheral Eco-systems of Transport SDN

OSS/BSS

Orchestrator

NW1 Ctrl

NW2 Ctrl

Transport NW Ctrl

ONOS
Open Network Operating System

Platform

Analysis

Streaming Telemetry

DC NW Ctrl

Cloud Ctrl

NETCONF

NW1

NW2

MPLS

Disaggregated Network

Opt. Trans

Packet Switch

Tp./Mux Tp.

MUX/DeMUX

Amp

OTN / WDM

VLAN/OTN

User Site

Access Domain

Packet & Optical Transport Domain

Technical Challenges

1 **Disaggregated devices**

- **Speeding up technical innovation**
- **Inventory optimization**

Node
Opt. Trans
Packet Switch
ODU XC
Tp./Mux Tp.
MUX/DeMUX
WSS
Amp
Fiber Switch

Opt. T
Packet Switch
Tp./Mux Tp.
MUX/DeMUX
Amp

2 **Open SDN Controller**

- **Customizability**
- **Faster time to market**
- **Interoperability**
- **CAPEX/OPEX reduction**

OPEN SOURCE

3 **Value-added VNFs**

- **Fully and advanced automation & Visualization**
  - **Telemetry**
  - **AI / Deep learning**

CREATE
PLAN
RELEASE
CONFIGURE
DE
OPS
VERIFY
PACKAGE
MONITOR

Disaggregated Transport Networks

Vendor Proprietary Network Controller

Open Source Network Controller

- Proprietary and closed API
- Vendor-specific data model

- Open and standard API
- Common data models

- Vertically integrated
- Single vendor

- Multi vendor
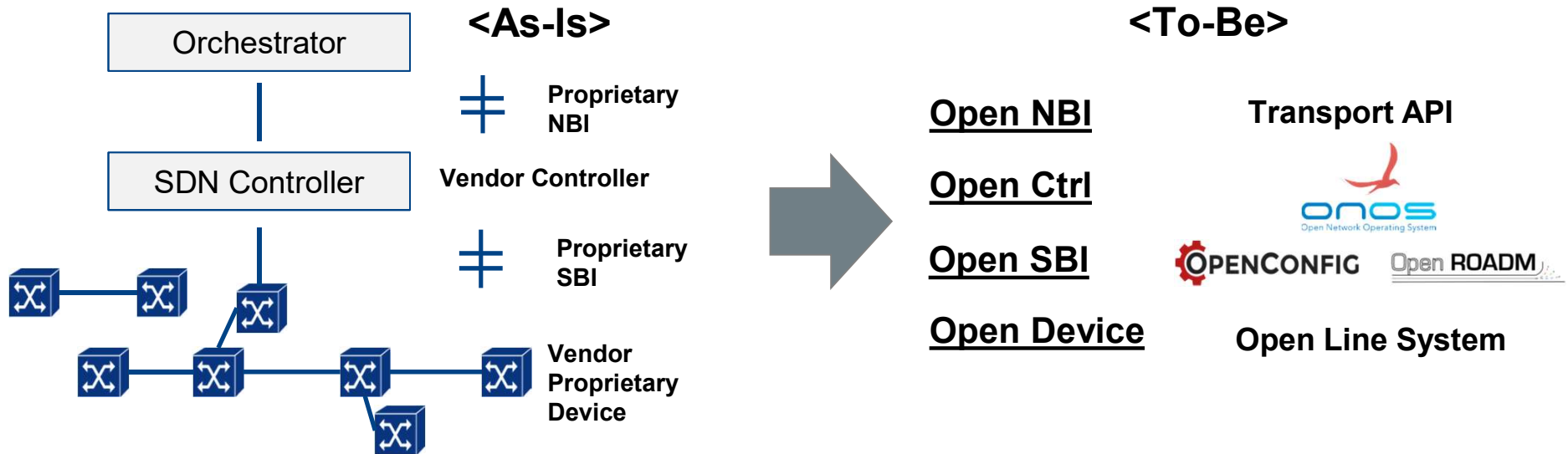- Disaggregated

Towards Full Open Architecture

- Existing communities are focused on each specific target
- No "Integrated Solution" in open source community

→ **Build a reference implementation by using those communities outputs**

\<As-Is\>

Orchestrator

Proprietary NBI

SDN Controller — Vendor Controller

Proprietary SBI

Vendor Proprietary Device

\<To-Be\>

Open NBI — Transport API

Open Ctrl

Open SBI — OPENCONFIG Open ROADM

Open Device — Open Line System

ONOS Open Network Operating System

Expectations for ODTN

Component **Reference Architecture**

Open
Source
Controller

Common
Data
Model

Data
Model
Language

YANG

Open
Protocol

NETCONF/
gNMI

Innovative
Device

OLS / Disaggregation

■ **Make ONOS production-ready**

- ◆ OpenConfig, TAPI, NETCONF/YANG support
- ◆ DRY supportive platform (transcation, sync-db)
- ◆ Easy for service providers to add apps

■ **Create eco-system around disaggregated transport network**

- ◆ Based on TAPI & OpenConfig models
- ◆ Data plane interoperability is optional
- ◆ Applicable to both metro and backbone cases

ODTN Members

- 5 operators

- 12 vendors

Transport SDN Schedule

IP-Optical PoC

Disaggregated ROADM PoC

Activities to launch ODTN

LAB

ODTN(1.0 ->1.5 ->2.0…)

2016

2017

Requirements

2018

Disaggregated ROADM Trial

LAB

LAB

Disaggregation Trial

Field

LAB

LAB

Transport SDN ctrler

1st Production Deployment
(with Proprietary controller)

▲ **Production**

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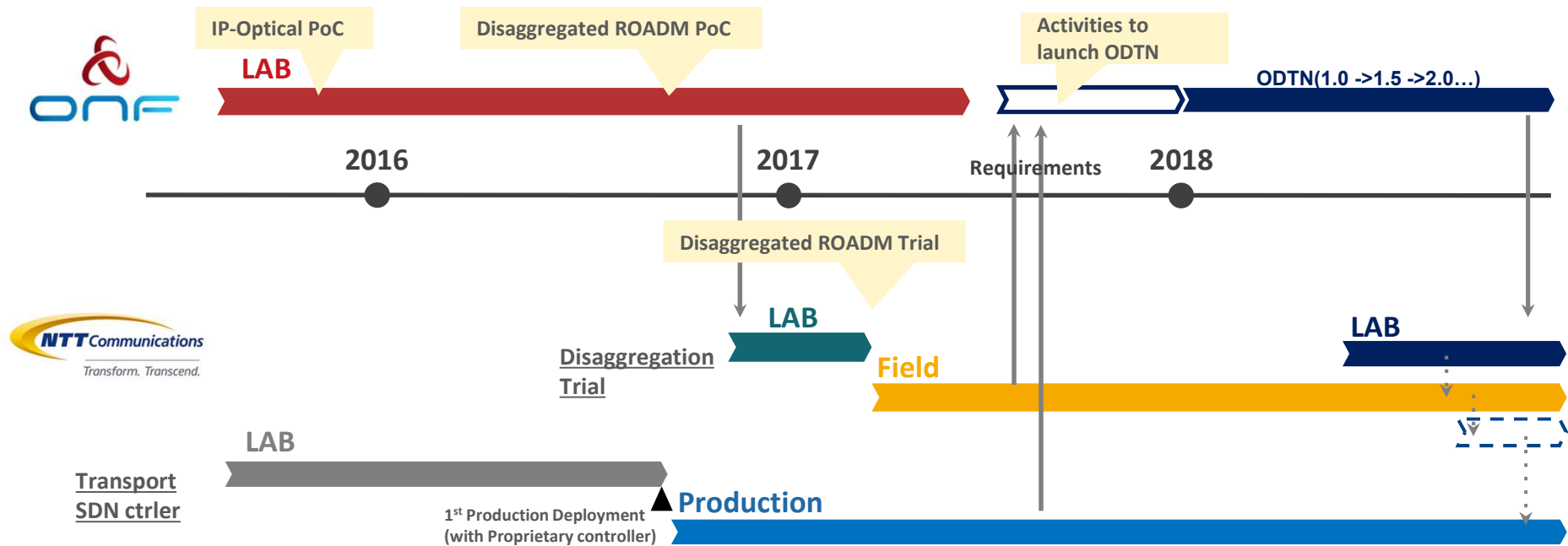
ODTN
An Open Controller for the
Disaggregated Optical Network

Andrea Campanella
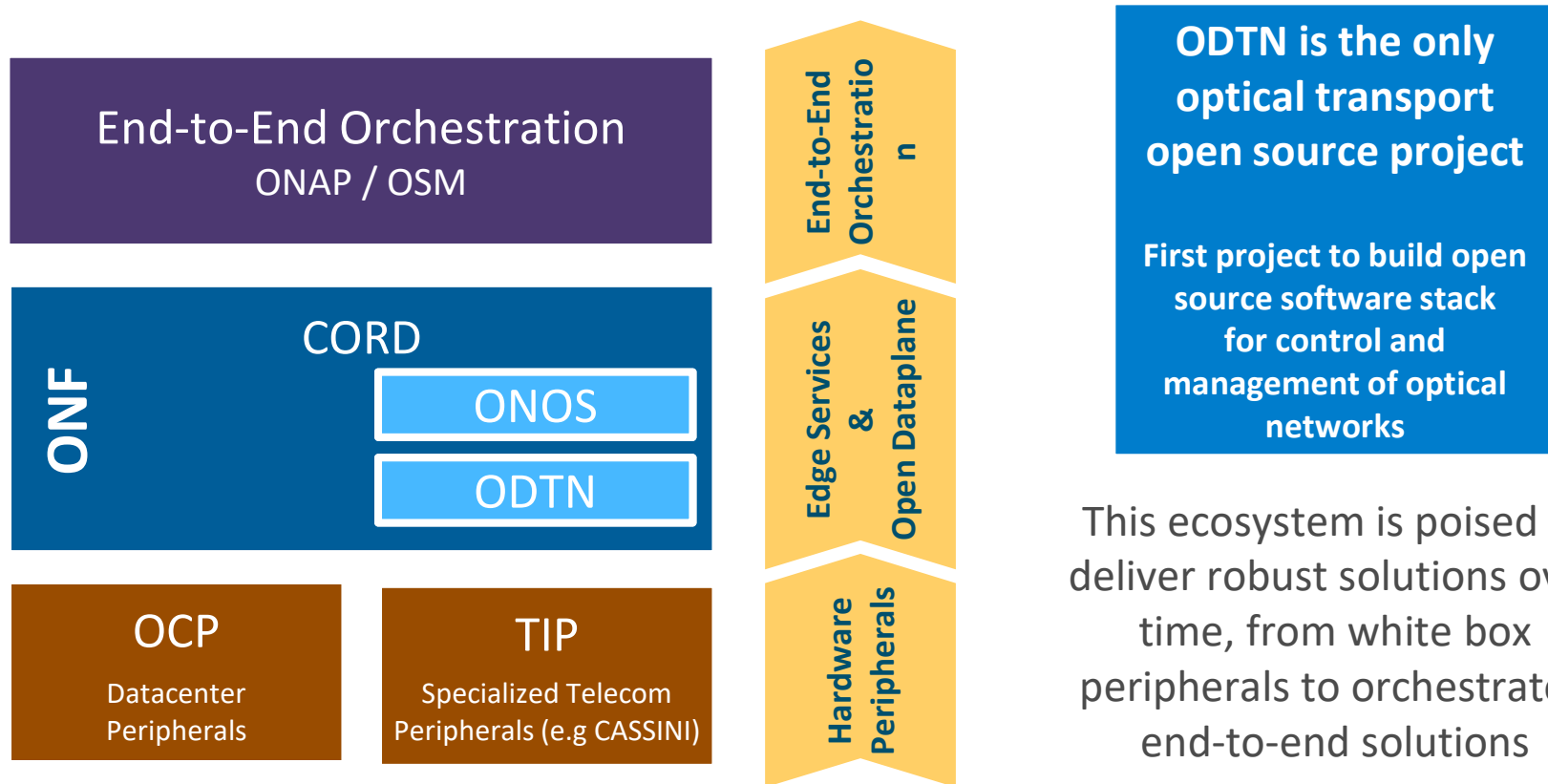andrea@opennetworking.org

An Operator Led Consortium

ODTN Open Disaggregated Transport Network

- Identified industry traction
  - Open and common data models for both devices and services
  - Driving disaggregation of optical networks

- Bring eco-system together
  - Build reference implementation using open source and open standards
  - Do lab and field trials
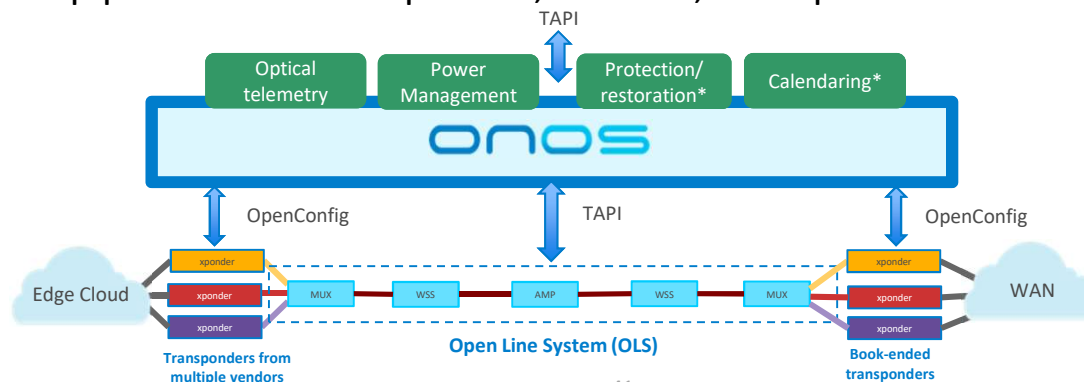
- Plan consisting of phases

ONF

Where ODTN Fits into Open Source Ecosystem

End-to-End Orchestration
ONAP / OSM

CORD

ONF

ONOS

ODTN

OCP
Datacenter Peripherals

TIP
Specialized Telecom Peripherals (e.g CASSINI)

End-to-End Orchestration

Edge Services & Open Dataplane

Hardware Peripherals

ODTN is the only optical transport open source project

First project to build open source software stack for control and management of optical networks

This ecosystem is poised to deliver robust solutions over time, from white box peripherals to orchestrated end-to-end solutions

ONF

Disaggregating Transponders from OLS
Business Benefits

- Rapid adoption of innovations in terminal equipment

  - Enable vendors to innovate: speed, reach, QoT, …

  - Let operators reap benefits through simple bookending

- Rapid introduction of new services in production network

  - Realize DevOps model through SDN-enabled optical network

  - Build CI/CD pipeline between operator, vendors, and open source software stack

TAPI

| Optical telemetry | Power Management | Protection/ restoration* | Calendaring* |

onos

OpenConfig   TAPI   OpenConfig

Edge Cloud

xponder
xponder
xponder

MUX — WSS — AMP — WSS — MUX

xponder
xponder
xponder

WAN

Transponders from multiple vendors

Open Line System (OLS)

Book-ended transponders

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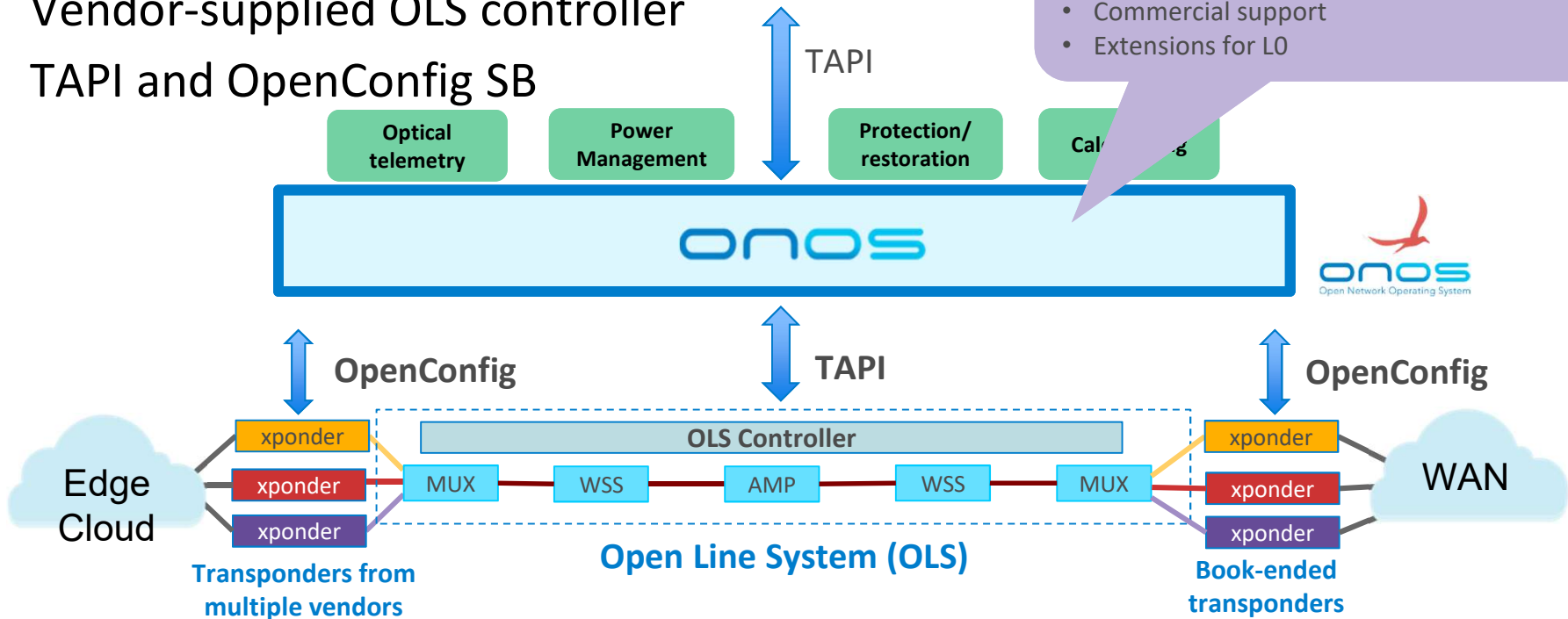* Post phase 1

ONF

Phase 1.0 with OLS control

Point to point network

Bookended Transponders

Vendor-supplied OLS controller

TAPI and OpenConfig SB

OLS control model
- Represent as single device

**TAPI 2.1 for OLS control**
- Commercial support
- Extensions for L0

TAPI

Optical telemetry	Power Management	Protection/ restoration	Cal... ...g

onos

onos
Open Network Operating System

OpenConfig   TAPI   OpenConfig

Edge Cloud

| xponder |
| xponder |
| xponder |

OLS Controller

| MUX | WSS | AMP | WSS | MUX |

| xponder |
| xponder |
| xponder |

WAN

Transponders from multiple vendors

Open Line System (OLS)

Book-ended transponders

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ODTN current progress

- **Phase 1.0**

  - Only Transponders (P2P, with OLS controlled out of band)

    - Use case: Done

    - Implementation: Done (but PoC quality)

  - Transponders with OLS (P2P, control both Transponder and OLS)

    - Use case: On going, both NTT and Telefonica Leading

    - Implementation: In progress

- **Phase 2.0** (Mesh network with Roadms)

    - Use case: On going, TIM/Metro-Haul is leading

    - API Definition: In progress

    - Implementation: In progress

Lab Trials

Transponders

Open Line System   **TBD: ADVA, INFINERA, OTHERS ?**
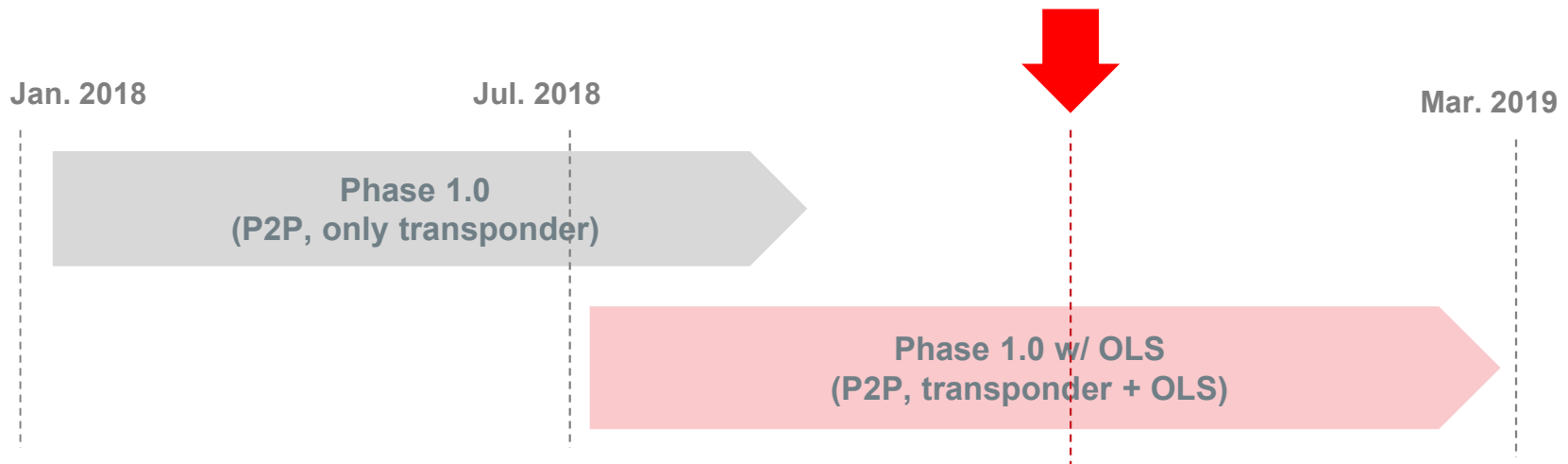
Relationship to Other Standards & Optical Organizations

- ONF Transport API

  - Wide industry support and growing acceptance

  - ODTN using TAPI for service provisioning, topology, …

- OpenConfig

  - Develops common **data models for network management**

  - ODTN using OpenConfig models for transponders, MUX, WSS, AMP

- OpenROADM MSA

  - Develops open models for optical devices, networks and services

  - Focus on transponder compatibility (eliminating need for bookending)

  - Models may be incorporated if ODTN community puts focus on data plane interoperability

ODTN is the only optical transport open source project

First project to build open source software stack for control and management of optical networks

ONF

CANDI (launched at TIP summit 18)

CONVERGED ARCHITECTURES FOR NETWORK DISAGGREGATION & INTEGRATION
NTT & Telefonica

PURPOSE
- Define **operator use cases** in open converged packet and optical networks.
- Prove that use cases can be met with **architectures based on open technologies**
- Leverage the opportunity provided by TIP to involve different players to **accelerate technical developments** and help operators in real-world scenarios.

The target areas expand from the edge of the network up to the VNF or Datacenter platform going through the backbone network
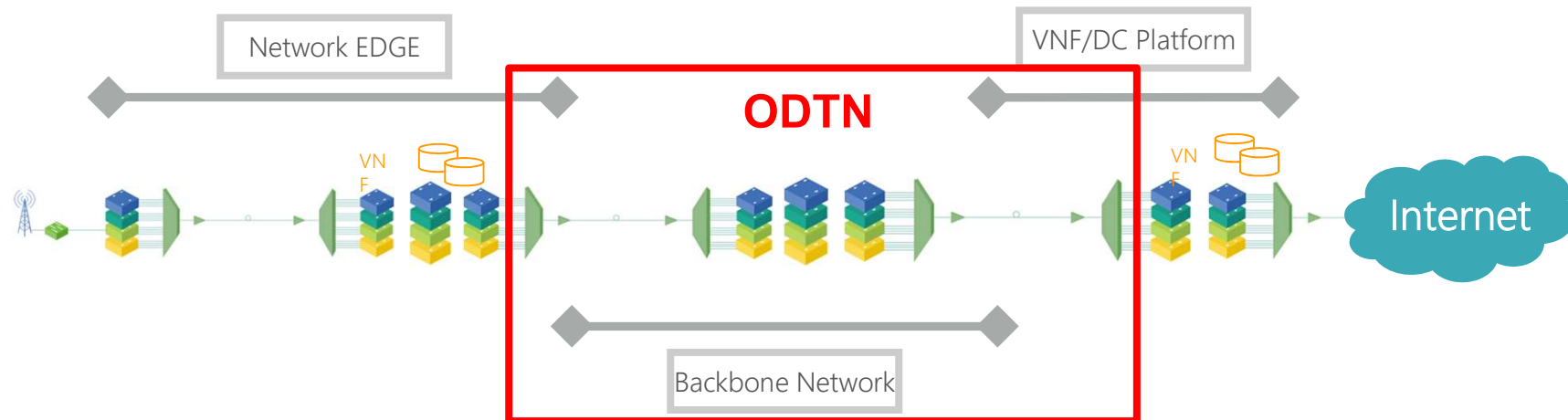
Benefits of Collaboration

Benefits of collaboration between OOPT and ODTN

- **Standard and open APIS**

- **No duplicated effort**

- **Share** knowledge, resources, findings and development

- **Achieve a stronger industry consensus** and **stronger impact**

- **Common test labs**

- **Accelerate trials and production deployments**

Takeaways

- **First (and only) open source software stack for optical networks**

- **Standard and open APIS**

- **Wide variety of vendors**

- **Incremental approach**

- **Lab trials → feedback loop**

- **Path to production**

- **Collaboration** with other open source initiatives

Takeaways

Great Community, Thank you!

Still lots to do, come and join us!
odtn@opennetworking.org

Useful Info

ODTN Wiki: https://wiki.onosproject.org/display/ODTN/ODTN

ODTN Session

Today, starting at 2 PM, Salon 3

ODTN Demo

ONOS + Cassini at ODTN Booth

Questions ?

andrea@opennetworking.org

ONF

https://www.opennetworking.org