The role of SDN/NFV in open optical networks

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tnc18

Intelligent networks, cool edges?

SDN is the solution, but what is the problem?

Copyright 2013 John Klossner www.jklossner.com

Key Driver #1: Operational Efficiency
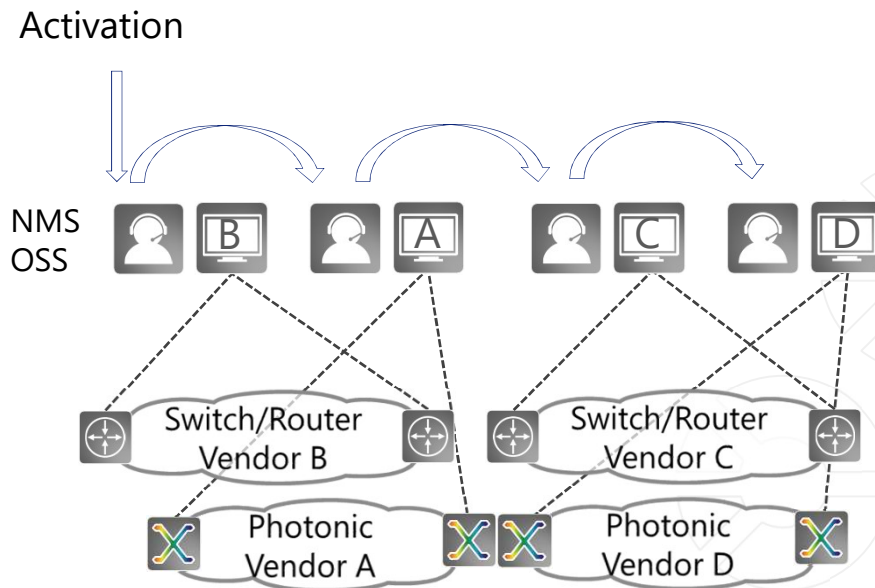
Service Requirements

Cloud-based hosting services require real-time connections

Self-provided bandwidth services

but

NMS islands with manual cross-domain co-ordination

Time-consuming planning, activation and assurance processes

Activation

NMS OSS

Switch/Router Vendor B

Switch/Router Vendor C

Photonic Vendor A

Photonic Vendor D

Multi-domain, multi-layer control featuring open interfaces
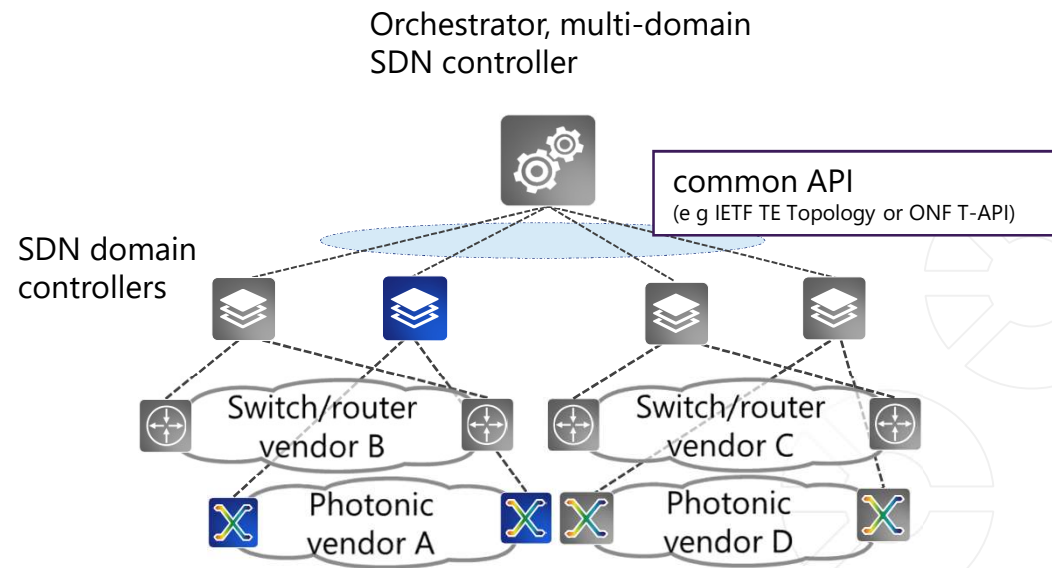
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Key Driver #2: Interoperability

Multi-layer SDN solution

Layered architecture featuring open interfaces and automated control

Technology specific domain controllers and overarching multi-domain orchestration

Resource discovery by topology services, activation by connectivity service
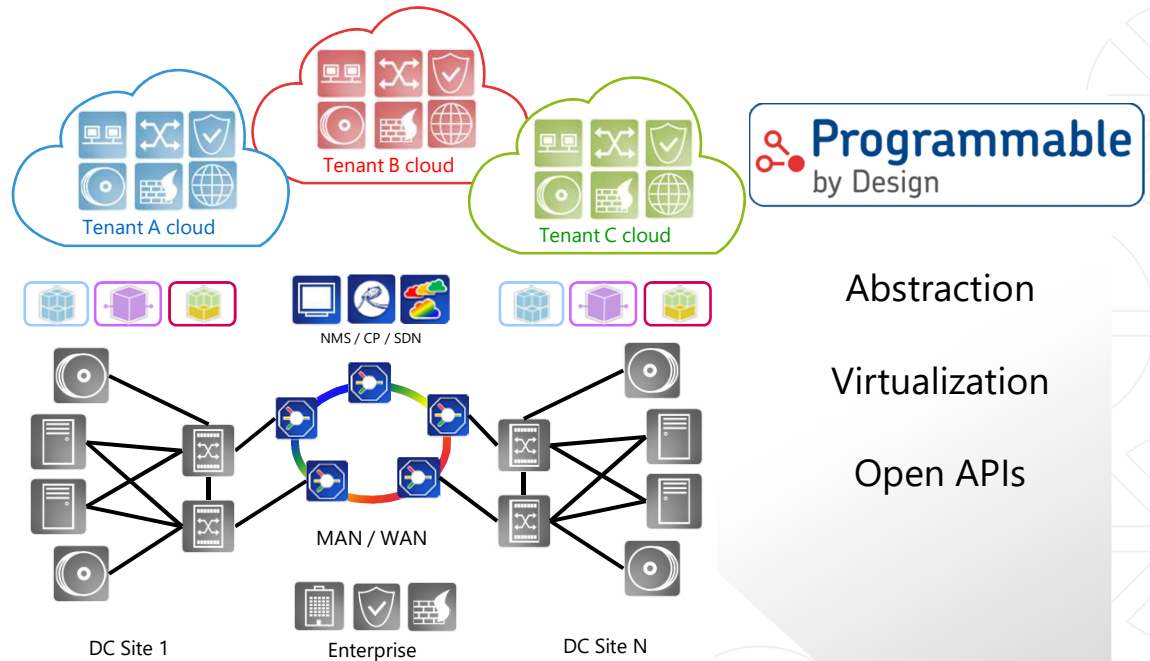
Orchestrator, multi-domain SDN controller

common API
(e g IETF TE Topology or ONF T-API)

SDN domain controllers

Switch/router vendor B

Switch/router vendor C

Photonic vendor A

Photonic vendor D

Multi-domain, multi-layer control featuring open interfaces

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Key Driver #3: New Service Opportunities

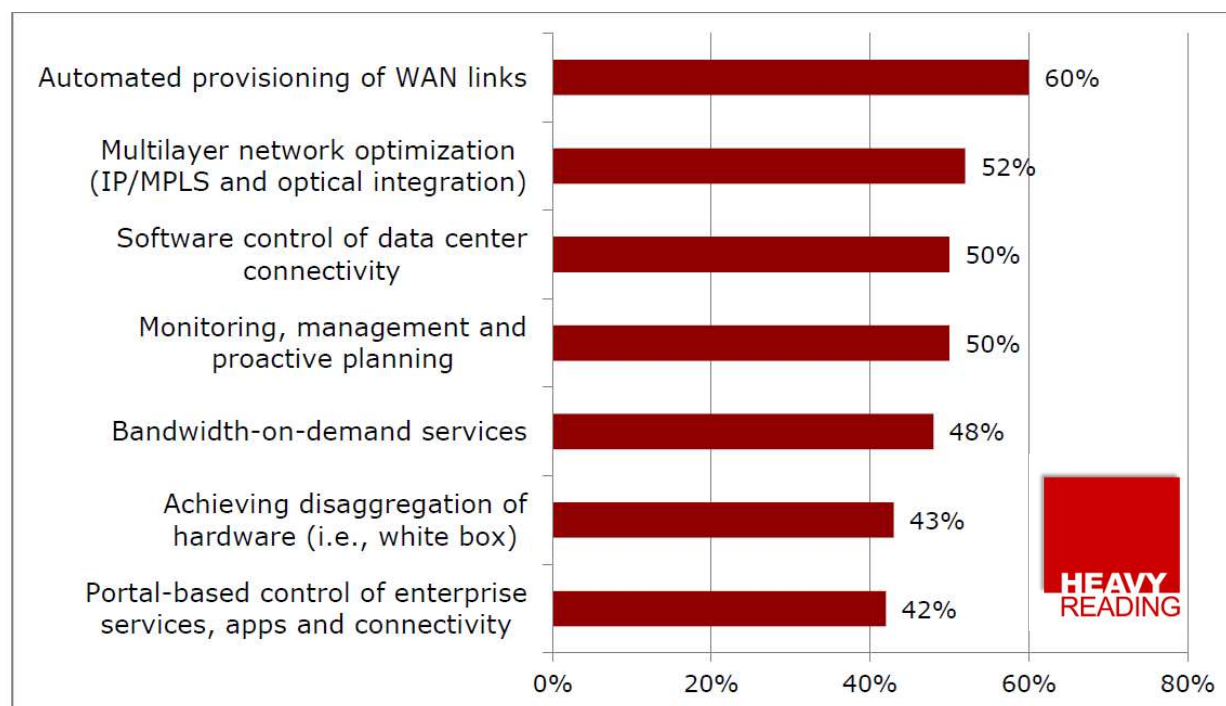## SDN use cases

DC Connectivity

Cloud Bursting

Secure Multi-Tenancy

Multi-Layer Optimization

Optical VPN

Tenant B cloud

Tenant A cloud

Tenant C cloud

Programmable by Design

Abstraction

Virtualization

Open APIs

NMS / CP / SDN

MAN / WAN

DC Site 1

Enterprise

DC Site N

Transport SDN turns the Transport Network into a programmable Resource

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Operator survey: SDN use cases

Use case	Percentage
Automated provisioning of WAN links	60%
Multilayer network optimization (IP/MPLS and optical integration)	52%
Software control of data center connectivity	50%
Monitoring, management and proactive planning	50%
Bandwidth-on-demand services	48%
Achieving disaggregation of hardware (i.e., white box)	43%
Portal-based control of enterprise services, apps and connectivity	42%

HEAVY READING

Provisioning

Multi-layer optimization
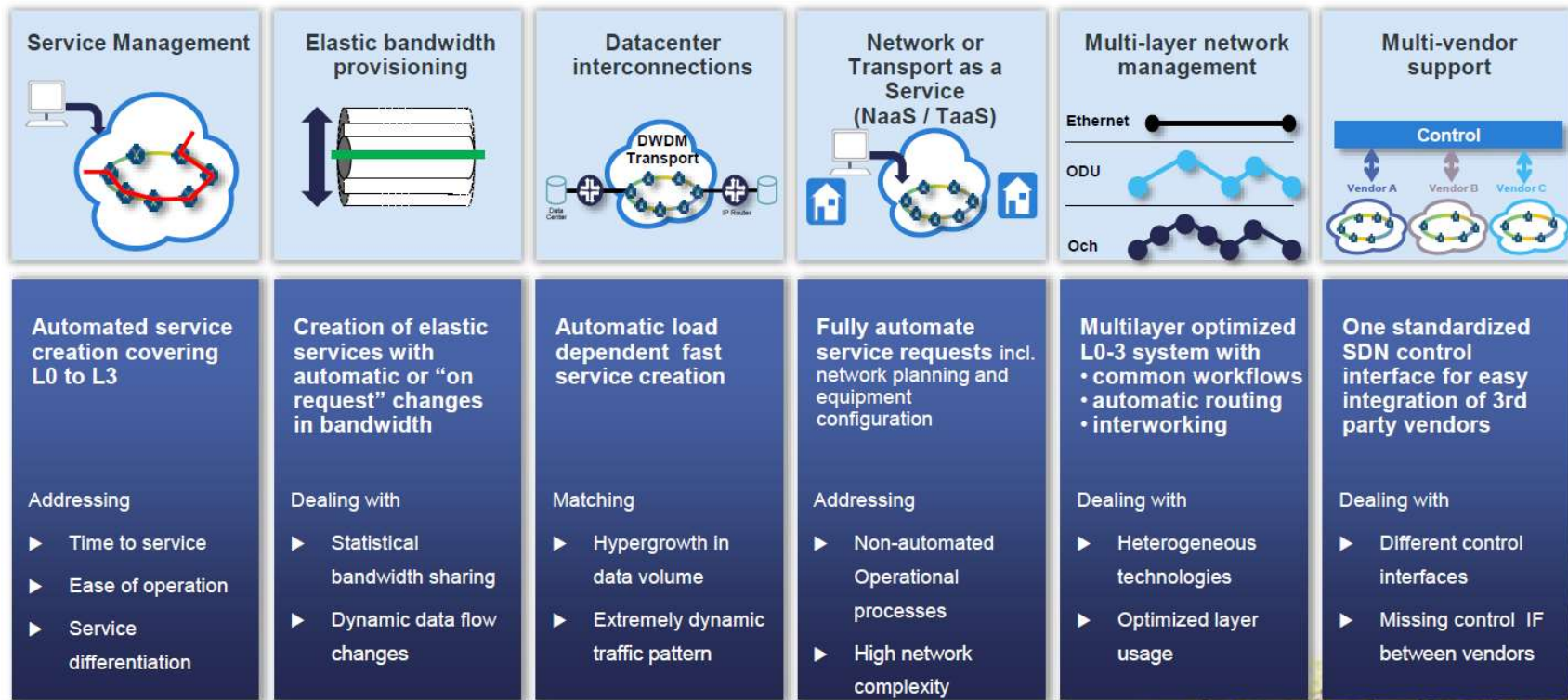
DC connectivity

Monitoring

New services

Disaggregation

Self-service portals

Heavy Reading, Carrier SDN Survey Analysis, February 2018
http://img.lightreading.com/heavyreading/hr20180207_esum.pdf

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Transport SDN use cases in ONF

Service Management	Elastic bandwidth provisioning	Datacenter interconnections	Network or Transport as a Service (NaaS / TaaS)	Multi-layer network management	Multi-vendor support
Automated service creation covering L0 to L3	Creation of elastic services with automatic or "on request" changes in bandwidth	Automatic load dependent fast service creation	Fully automate service requests incl. network planning and equipment configuration	Multilayer optimized L0-3 system with • common workflows • automatic routing • interworking	One standardized SDN control interface for easy integration of 3rd party vendors
Addressing	Dealing with	Matching	Addressing	Dealing with	Dealing with
▶ Time to service	▶ Statistical bandwidth sharing	▶ Hypergrowth in data volume	▶ Non-automated Operational processes	▶ Heterogeneous technologies	▶ Different control interfaces
▶ Ease of operation	▶ Dynamic data flow changes	▶ Extremely dynamic traffic pattern	▶ High network complexity	▶ Optimized layer usage	▶ Missing control IF between vendors
▶ Service differentiation					

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

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Carrier network operators
Multi-domain hierarchical SDN control

DT's SDN Implementation Strategy in the IP Core
Matthias Gunkel, ECOC 2016

TRANSPORT SDN FOR MULTI-LAYER NETWORKS
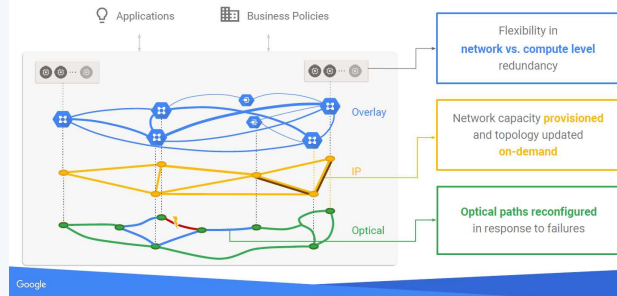Hierarchical Control Architecture
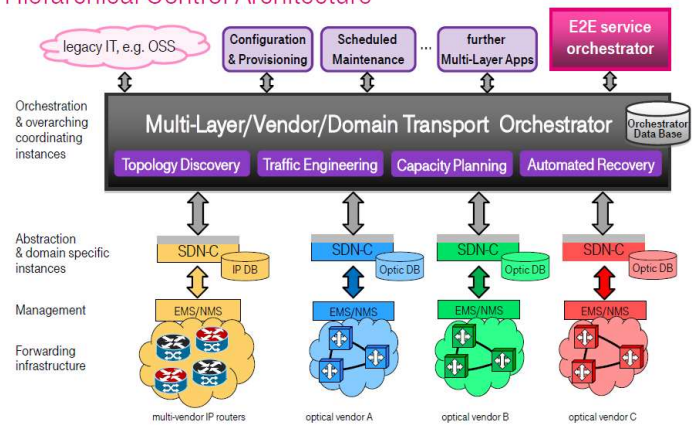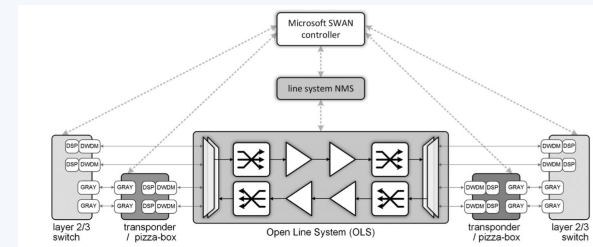
Verizon SDN-NFV Reference Architecture

Figure 9-5: WAN SDN Controller Plus Domain-Specific Controllers
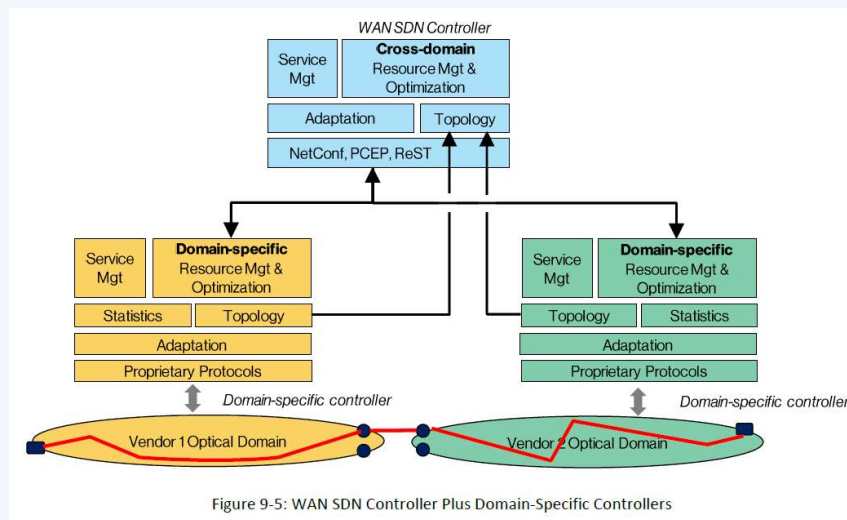
Web 2.0 Operators

Google – SDN-based NetOps

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

Microsoft – Open Line System (OLS)

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

Facebook – Whitebox Transponder & OLS
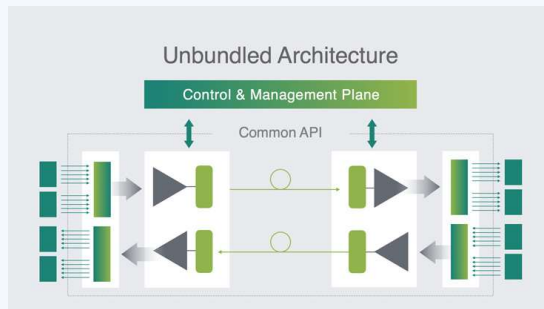
AT&T – Full Disaggregation
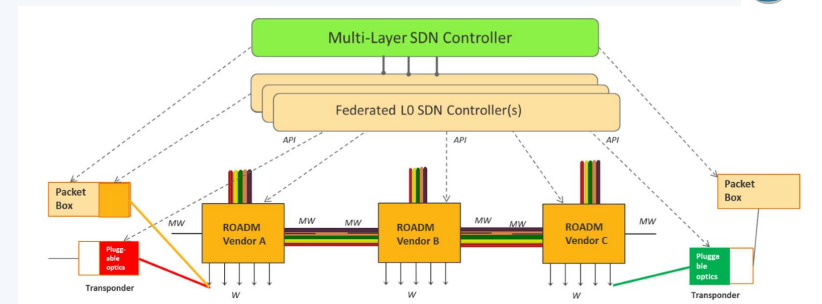
https://0201.nccdn.net/1_2/000/000/098/a85/Open-ROADM-whitepaper-v1-0.pdf

Vision: The software-defined operator

Digital Customer Experience

Programmable Infrastructure

Self-Service Portals

Simplified point-and-click service ordering

Automated, fully interconnected, virtualized network infrastructure

Intuitive customer-facing interfaces that simplify service management and monitoring

DevOps

Intent-based Operation

Streaming Telemetry & AI-based Analytics

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SDN definition & architectural principles

Software Defined Networking (SDN) is an emerging network architecture where network control is decoupled from forwarding and is directly programmable. This migration of control, formerly tightly bound in individual network devices, into accessible computing devices enables the underlying infrastructure to be abstracted for applications and network services, which can treat the network as a logical or virtual entity.

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

1. Decoupling of traffic forwarding & processing from control
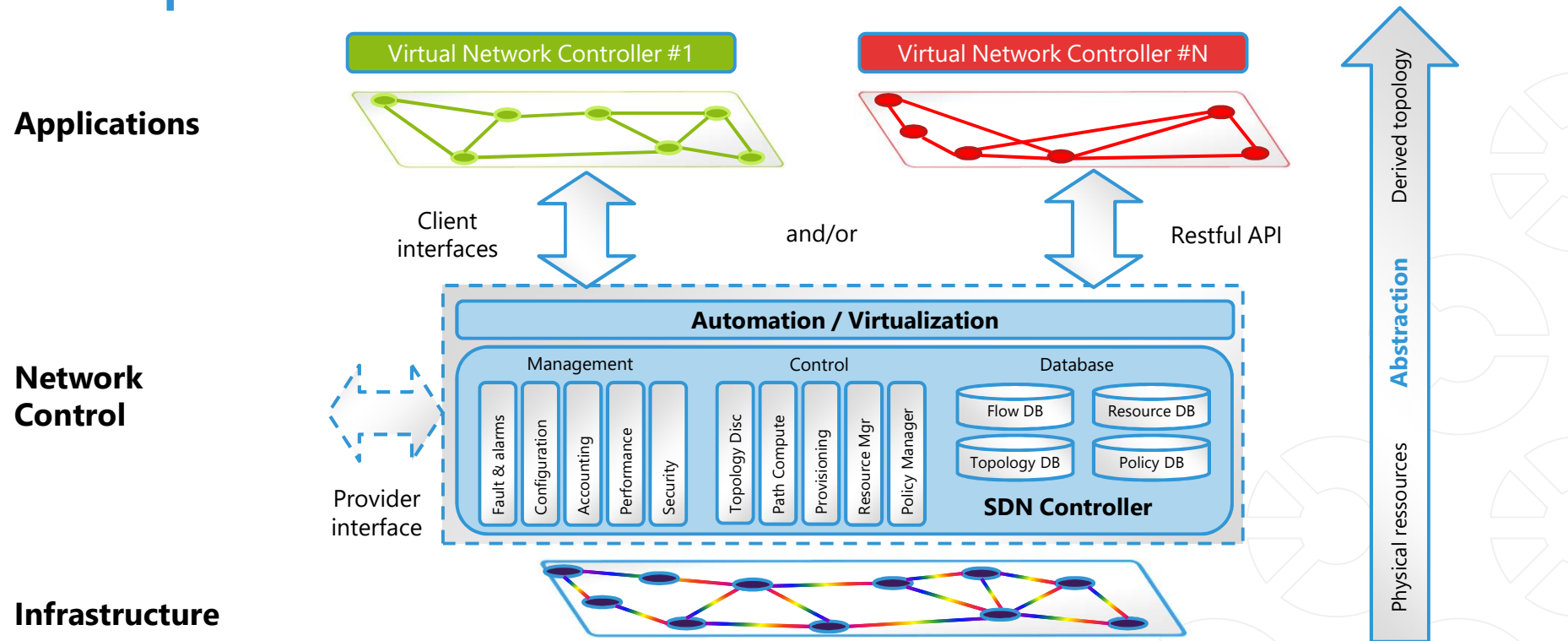
2. Logically centralized control
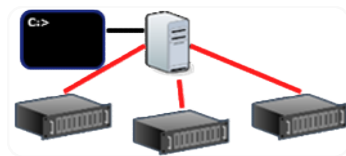
3. Programmability of network services

Software defined networking (SDN)

Applications

| User I/Fs | Network Apps | Orchestration |

Applications & derived network services

↕ *Open APIs (e.g. RESTful)*

Open Northbound Interfaces

Network Control

| Network services | Platform services | Extensions |

SDN Controller Platform

↕ *e.g. OpenFlow, Netconf/YANG, vendor-specific*

Southbound Interfaces

Infrastructure

Network Elements
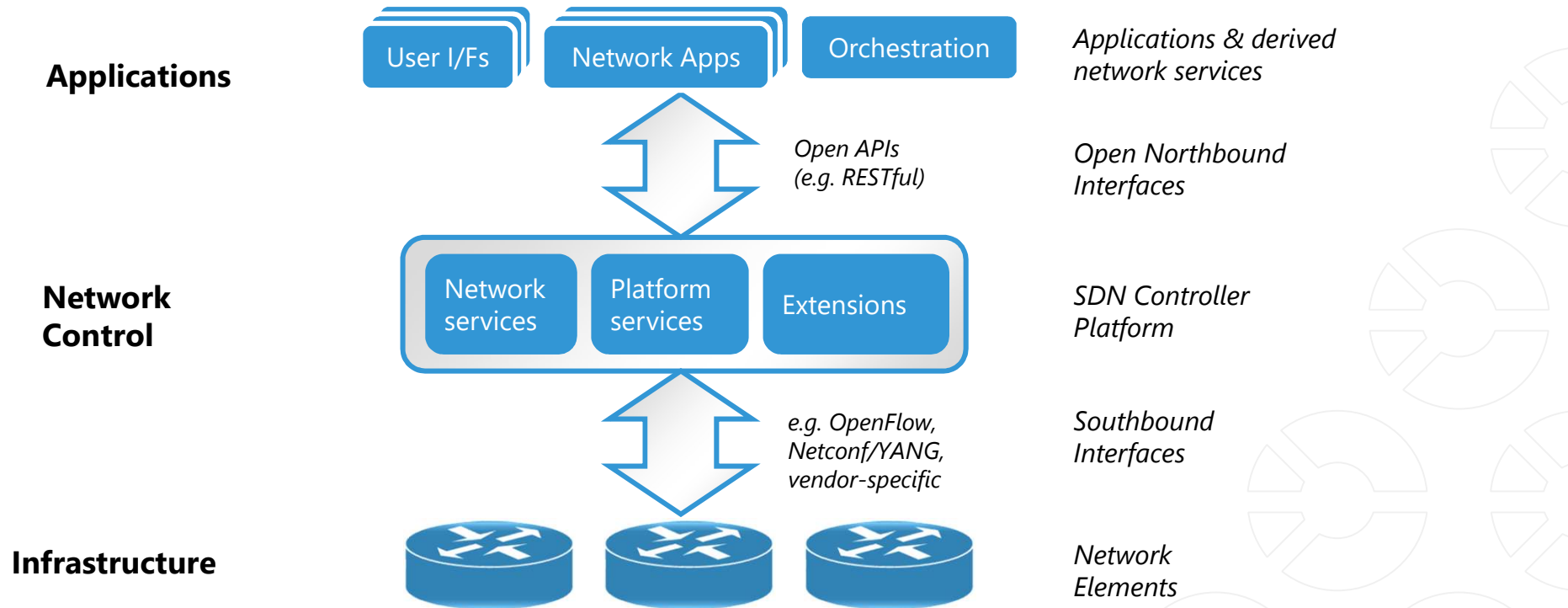
Turning the network into a programmable resource under central control

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Transport SDN Automation and Virtualization

Applications

Virtual Network Controller #1

Virtual Network Controller #N

Client interfaces

and/or

Restful API

Network Control

Automation / Virtualization

Management | Control | Database

Fault & alarms | Configuration | Accounting | Performance | Security | Topology Disc | Path Compute | Provisioning | Resource Mgr | Policy Manager

Flow DB | Resource DB

Topology DB | Policy DB

SDN Controller

Provider interface

Infrastructure

Derived topology

Abstraction

Physical ressources

Applying SDN to multi-layer, multi-domain transport networks.

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SDN protocols and data models

YANG modeling language as common basis for all APIs

Support of various APIs: CLI, REST, **NETCONF**, RESTCONF

Multiple data encodings: XML, JSON, …

Supports data retrieval as well as services via Remote Procedure Calls (RPCs)

Topology Service	Path Calculation Service	Provisioning Service	Telemetry Service
• Network structure • SRLGs	• SLAs • Disjointness	• Terminal Equipment • Network Service	
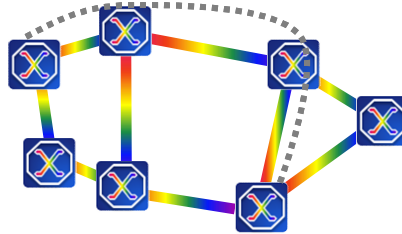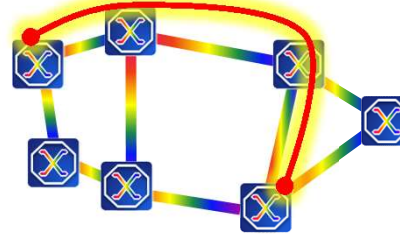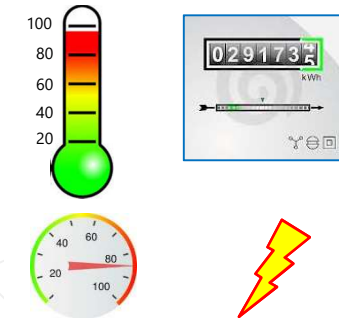
YANG data models overview

Standards Defining Organizations (SDOs)

Carrier

MEF OpenLSO — Lifecycle Service Orchestration

ONF

Transport-API

| Topology | Connectivity | Path Computation | Virtual Network | Notification |

ONF | ITU

Core Model

ISPs, IP / Optical

IETF

- 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
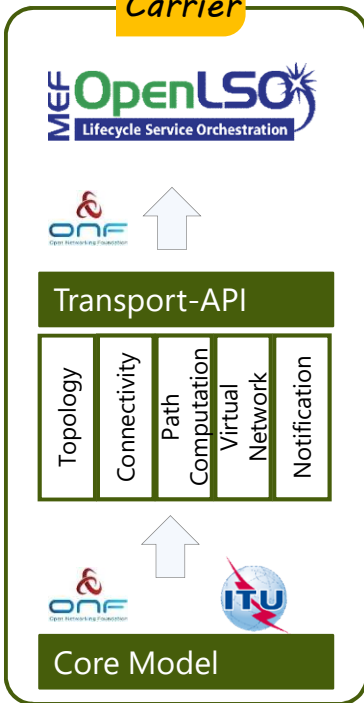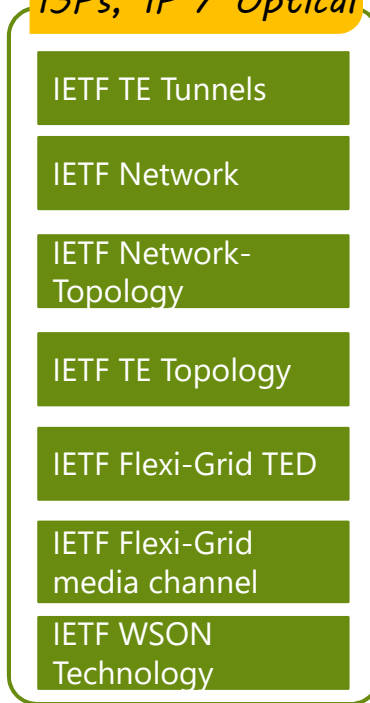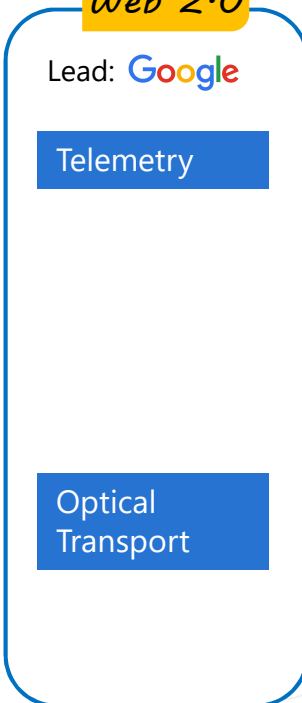
Disaggregation

Lead: AT&T

Common

- Services
- Network
- Device

Services

Network

Infrastructure
Devices

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ONF Transport–API functional architecture
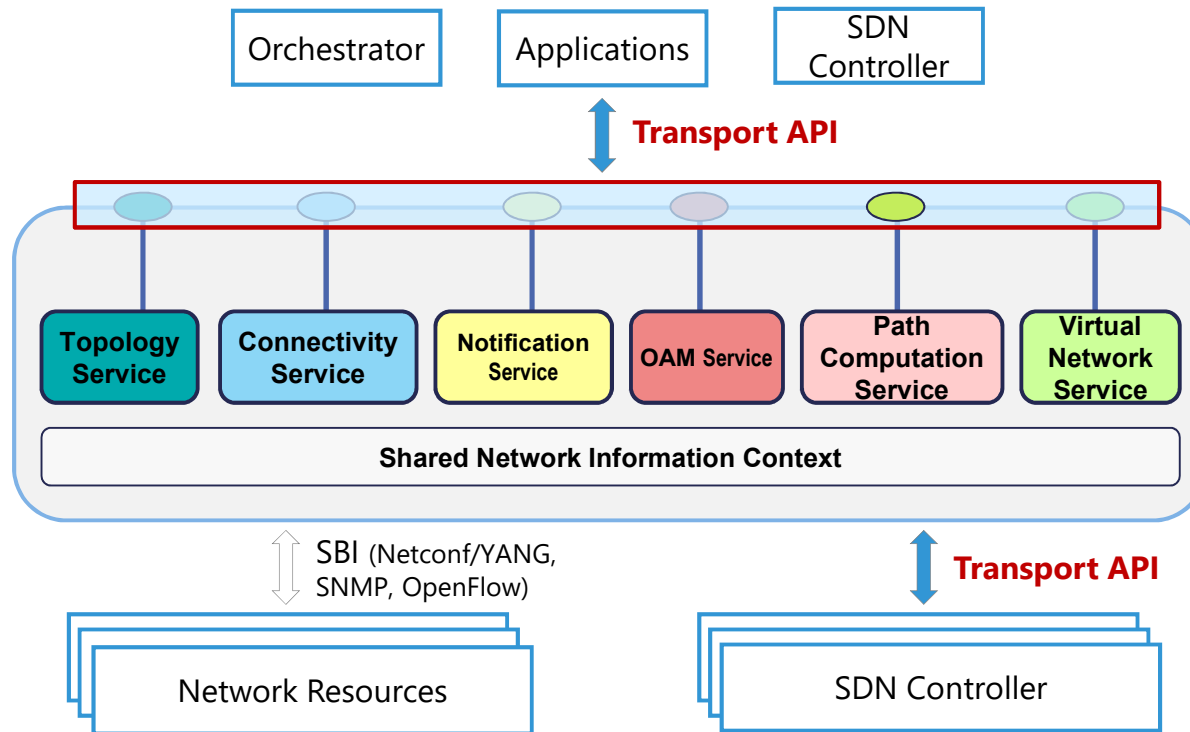
Topology Service
- Retrieve Topology, Node, Link & Edge-Point details (Across layers)

Connectivity Service
- Retrieve & Request P2P, P2MP, MP2MP connectivity (Across layers)

Notification Service
- Subscription and filtering / Autonomous event notification

OAM Service
- Creation and Activation of Monitoring Points/Sessions

Path Computation Service
- Request for Computation & Optimization of paths

Virtual Network Service
- Create, Update, Delete Virtual Network topologies

Summary

SDN is essential to enabling truly open optical networks

Use cases well understood and value driven

Carriers, enterprises and Web 2.0 operators all pursuing solutions

Architecture well understood and great progress being made in API definitions

Market faced with multiple 'solution' options... maybe too many?

Thank you

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The open source networking landscape

http://passionateaboutoss.com/how-onap-will-merge-ecomp-and-open-o/
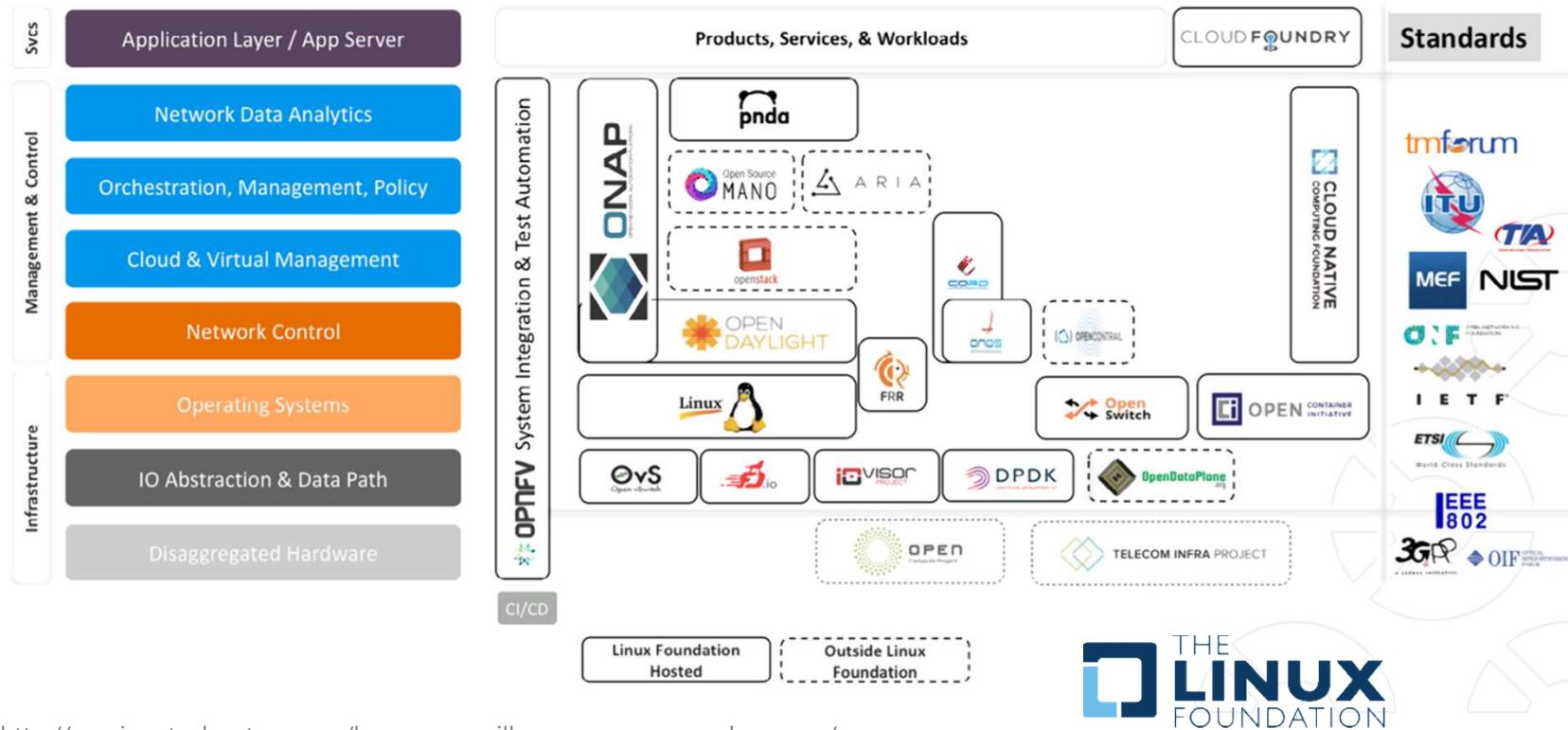
ADVA supported YANG Data Models

Network Scope

IETF TEAS TE Topology

- Focus on IP over Optical
- Released FSP 3000 AgileConnect product feature
- Existing customers
- Partner integration: Cisco NSO/WAE, Juniper/NorthStar

ONF Transport-API

- Focus on Carrier Transport Networks
- Several customer RFIs
- Ongoing Interops and Demos
    - ONF T-API Interop 2018
    - ONF ODTN (Open Disaggregated Transport Networks)
- Partner intergration: Ciena Blue Planet, NEC/Netcracker, Sedona
- Planned product feature FSP NM 11.1

MEF LSO Presto

- Based on ONF Core Model
- Uses ONF Transport API
- Adds Service API for Ethernet & OTN
- Product release on ProVision

Decive Scope

Google OpenConfig

- IP / Ethernet / Streaming telemetry device level configuration
- Direct device API
- Used by many DCI / Web 2.0 providers
- (Partially) supported by FSP 3000CC

AT&T Open ROADM

- Full disaggregation
- Small community (current AT&T vendors)

ONF Core Model

- Focus on Device Scope
- Large SDO support ITU-T G.874.1/G.8052, BBF, MEF, IEEE, IETF
- Few contributors for Optical / Ethernet

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