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Optical Networking

Innovative and Open Network Architectures
for research and education networks and automated operation through SDN

Dr. Stephan Neidlinger, Jornadas Tecnicas de RedIRIS

Valencia, November 16, 2016

Abstract

The presentation will discuss innovative and open network architectures for modern research and education networks. The challenges associated with such open network approaches will be analyzed and solutions will be proposed. A particular focus will be on automated operation through software defined networking. Usual listed benefits of SDN include the potential for increasing network agility, functionality, and availability while reducing production cost. However one of the most important drivers for network operators is multi-layer coordination which leads to increased network flexibility especially in open multi-vendor environments.

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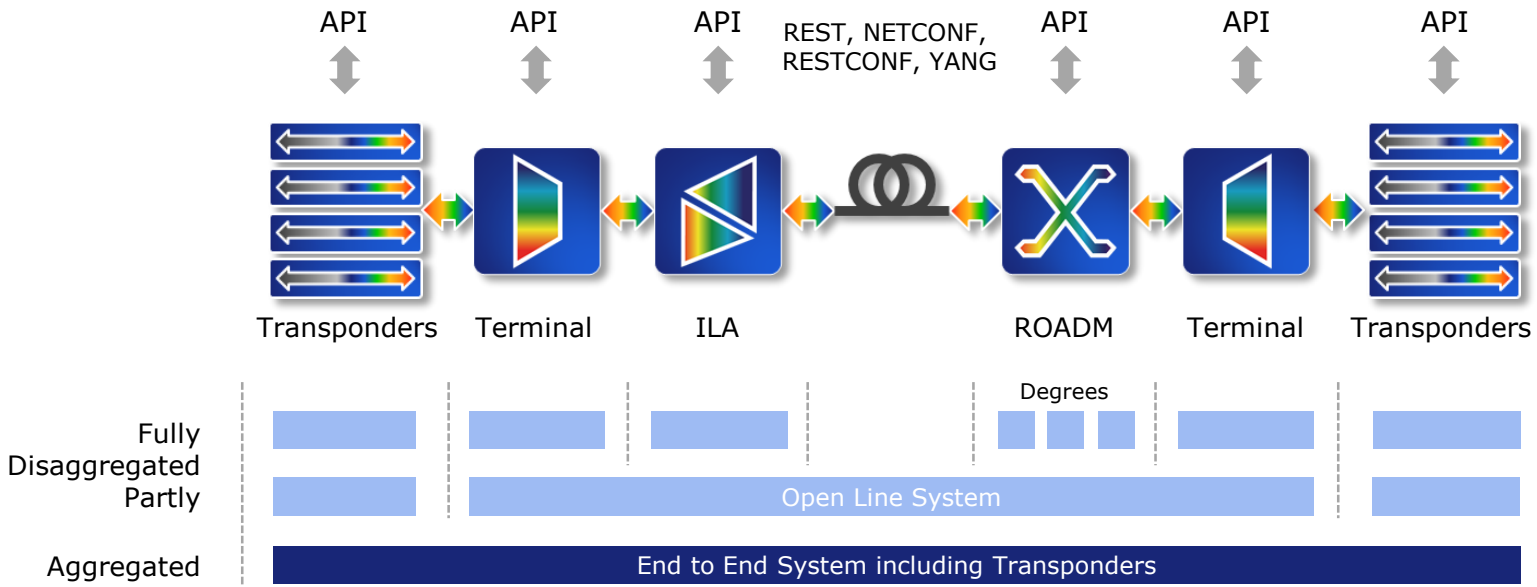
Open Optical Layer System Options

Managing the Network



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Voyager White-Box Solution

- Designed by Facebook; developed by the Telecom Infra Project (TIP); announced at TIP inaugural summit (Menlo Park, CA, USA, November 1 and 2, 2016)

- Voyager is an Open Packet DWDM Transponder platform:
  - 12 x 100Gbit/s QSFP 28 clients
  - 4 x 200Gbit/s 16QAM on the line side
  - 200Gbit/s tested up to 180 km
  - IP/MPLS support for e g oversubscription
  - 1RU device

- ADVA contribution:
  - Sales channel
  - Network management software
  - Network operations center
  - Maintenance services

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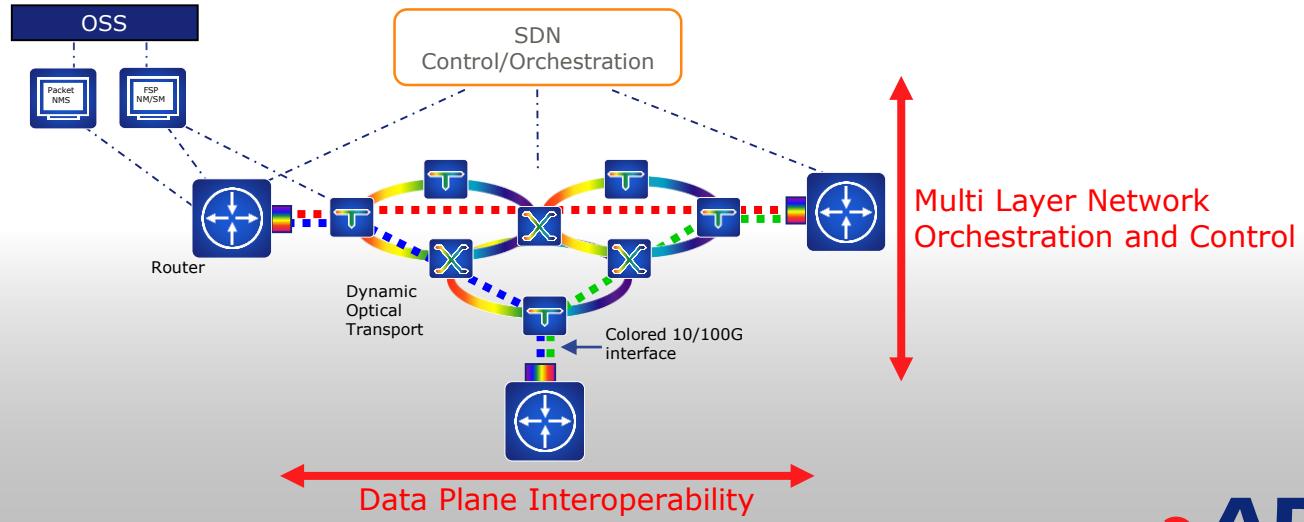
Open Optical Layer System Challenges

- Challenge #1
  - Data Plane Interoperability
- Challenge #2
  - Multi Layer Network Orchestration and Control



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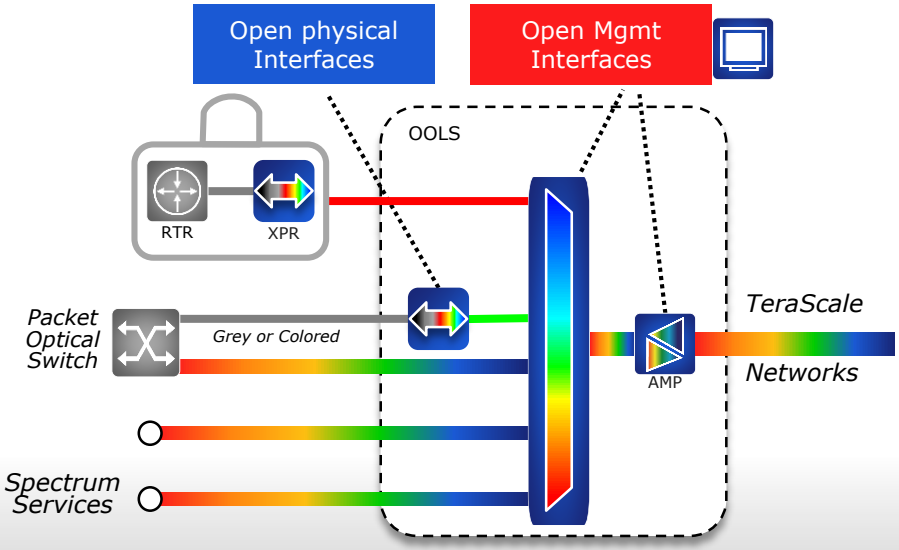
Key Challange #1:
Data Plane Interoperability



- Open Optical Layer Systems have evolved with the emergence of advanced modulation schemes and software-defined management of network infrastructures.
- The separation of the optical layer from the terminals enable operators to introduce terminal equipment innovations much faster.

Optical layer system needs to be able
to route & provision External Wavelength Service

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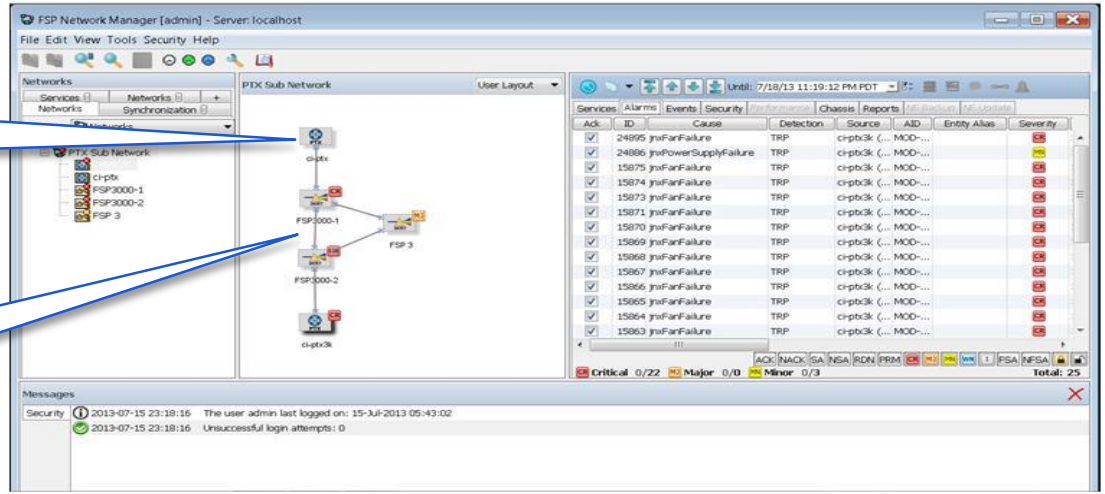
NETWORK MANAGEMENT SUPPORT OF EXTERNAL WAVELENGTH SERVICE

Client Layer:
Router

Server Layer:
Open Optical
Layer System



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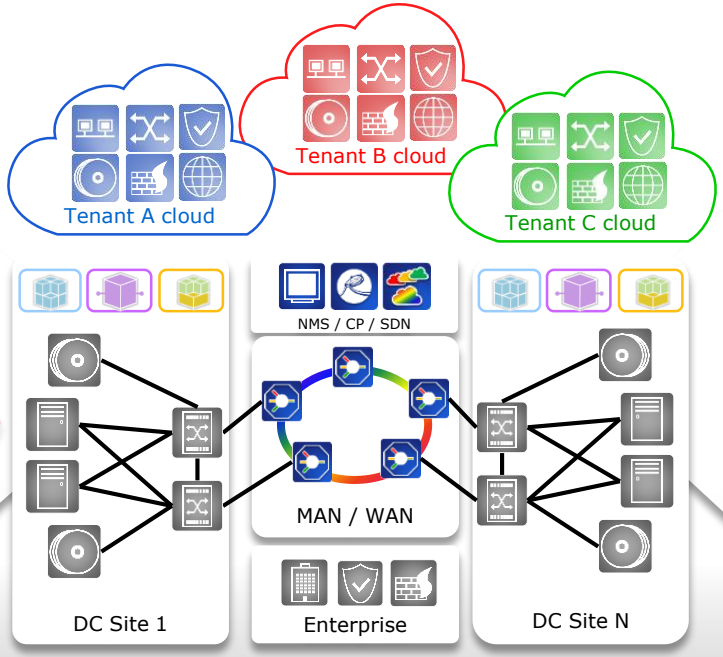
Challenge #2
Multi Layer Network Orchestration and Control

SDN

- DC Connectivity
- Cloud Bursting
- Secure Multi-Tenancy
- Multi-Layer Optimization
- Optical VPN

BigData Transport



- Abstraction
- Virtualization
- Open APIs

1TB Data Transfer

Speed	Duration
10G	15 min
1G	2.5h
100M	1 day

Transport SDN turns the Transport Network into a programmable Resource

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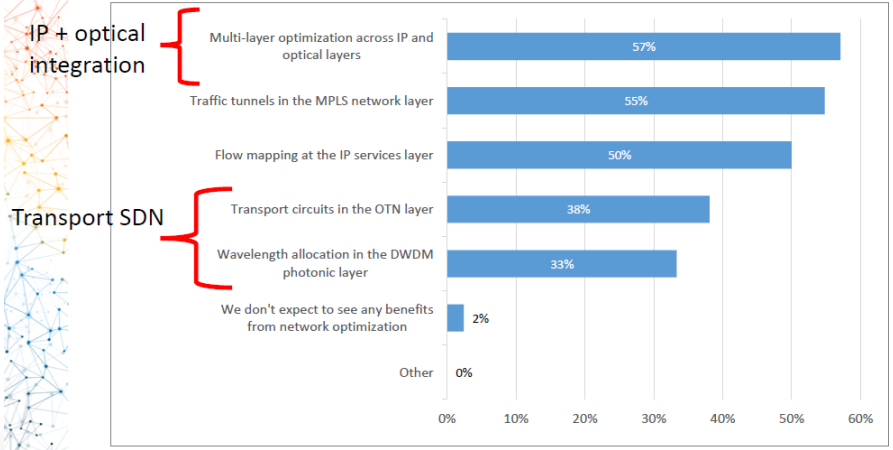
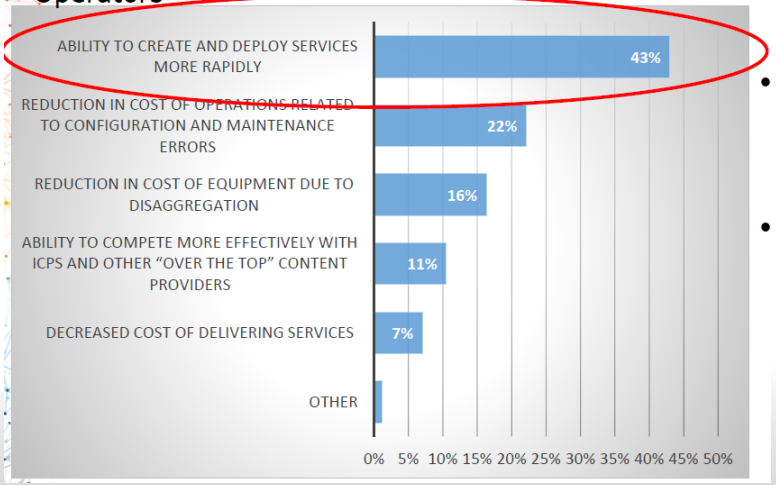
Heavy Reading's Carrier SDN Service Provider Perspectives

Q: Where does your company expect to see the biggest benefits from network optimization over the next three years?



Most Important Potential Business Benefit of SDN for Operators



Automated Multi Layer SDN for faster Service Deployment

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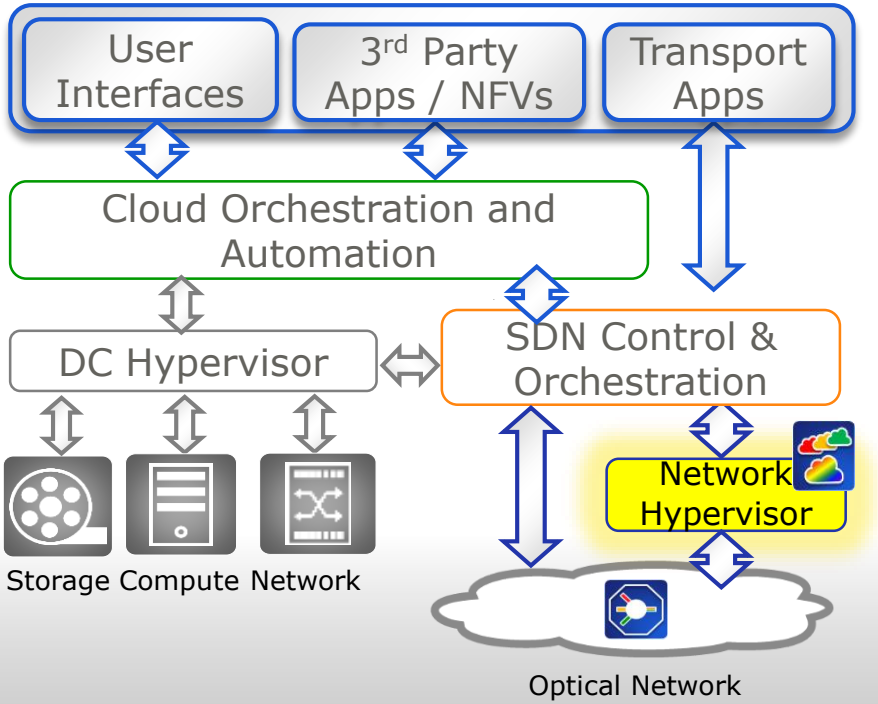
SDN Network Architecture



Virtualized Apps and NVF Network Functions

- Network appliances e.g. Firewall, virtual Router, Intrusion Detection et.al

Cloud Orchestration and Automation

- Open Software for orchestration of storage, processing and networking resources
- Automates cloud management
- Manages virtual functions and connectivity

SDN Control and Orchestration

- Allows automation and programming of physical network resources
- Supports virtualization of network resources

Optical Network Programmability and Automation

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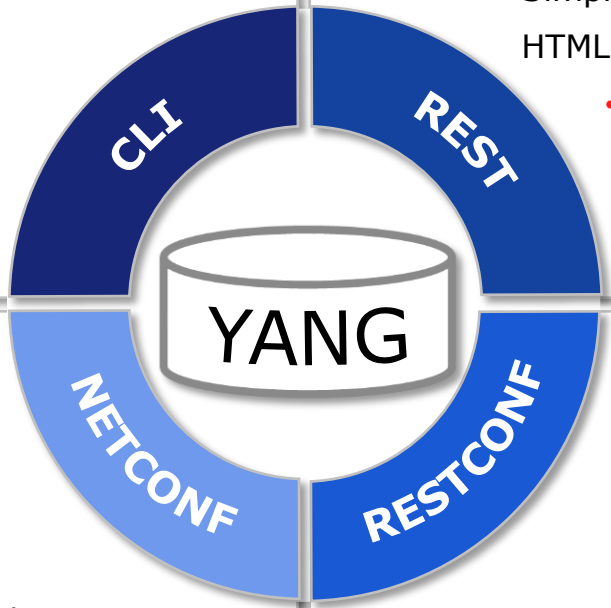
Application Programming Interfaces

- Command Line Interface
- Preferred for scripting
- L2/L3 vendor's look and feel

- Simple, web-based protocol

  HTML Create/Read/Update/Delete
  - Stateless/idempotent



- Network Configuration Protocol
- Successor to SNMP
- Multiple configuration data stores (candidate, running, startup)
- Network-wide transactions & telemetry

- REST-based access to NETCONF datastores candidate/active/startup)

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YANG Data Models

ONF Transport-API

- Focus on Transport Networks
- Services
  - Topology discovery
  - Connectivity management
  - Path computation
  - Virtual networks
  - Notifications
- Interface between hierarchical controllers

IETF TEAS TE Topology

- Focus on IP / Optical Interworking
- Representation for path computation
- Generic topology (TE topology)
- Has to be augmented for specific devices
  - WSON
  - Flexi-grid
- Supports overlays (virtual networks) and SRLGs

Google OpenConfig

- Device configuration oriented
- Models for a variety of technologies
- Optical model rather new and empty
- No topology view
- Good performance monitoring capabilities
- Strong consortium of operators and service providers

AT&T OpenROADM

- Focusing on ROADMs
- Very close to the structure of a ROADM node
- Topology modeled
- Capable of path computation and wavelength assignment
- Flexi-grid currently not supported
- Vendor-driven consortium

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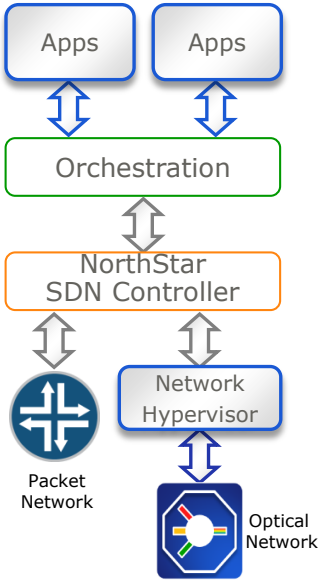
IEFT INTEROP EXAMPLE: JUNIPER NETWORKS

DEMONSTRATION AT SDN OPENFLOW WORLD CONGRESS, DUESSELDORF, GERMANY, OCTOBER 12-16, 2015



- **Juniper's and ADVA's integrated SDN architecture enables multi-layer coordination which delivers benefits like:**
  - Reduced time-to-market
  - Automated network operations
  - Decreased operational efforts
  - Increased overall network availability
- **Use/show cases:**
  - Multilayer Visualization on NorthStar
  - NorthStar configures Diverse Shared Risk Link Group Label Switched Path Pair
  - Service recovery after fiber cut

Multi-layer integration leads to
SDN enabled top-down network performance optimization

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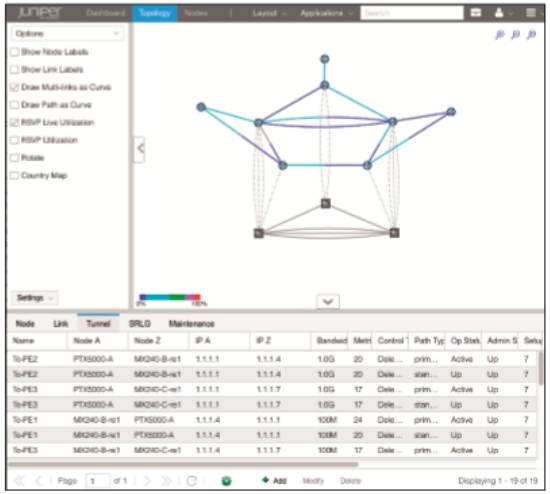
SOFTWARE DEFINED PACKET-OPTICAL NETWORKING

DEMONSTRATION AT SDN OPENFLOW WORLD CONGRESS, DUESSELDORF, GERMANY, OCTOBER 12-16, 2015

SDN OpenFlow WORLD CONGRESS

Use Cases

Juniper Networks and ADVA Optical Networking is showcasing its Packet-Optical SDN Architecture at the SDN OpenFlow World Congress 2015. The demonstration focuses on three use cases.



Use Case 1: Multi-Layer Visualization

- NorthStar connects to Network Hypervisor
- Network Hypervisor pushes abstract optical topology, including Shared Risk Link Group information, to NorthStar
- NorthStar displays topology of both IP and transport layers

Use Case 2: Diverse Shared Risk Link Group Label Switched Path Pair

- NorthStar provisions two SRLG diverse LSPs with abstract optical topology information from Network Hypervisor

Use Case 3: Fiber Cut

- Simulate fiber cut in optical network (and failure of associated IP links)
- Optical Network GUI visually shows failure
- Network Hypervisor pushes abstract topology update to NorthStar
- NorthStar visually shows failed optical link
- NorthStar visually shows new LSP path

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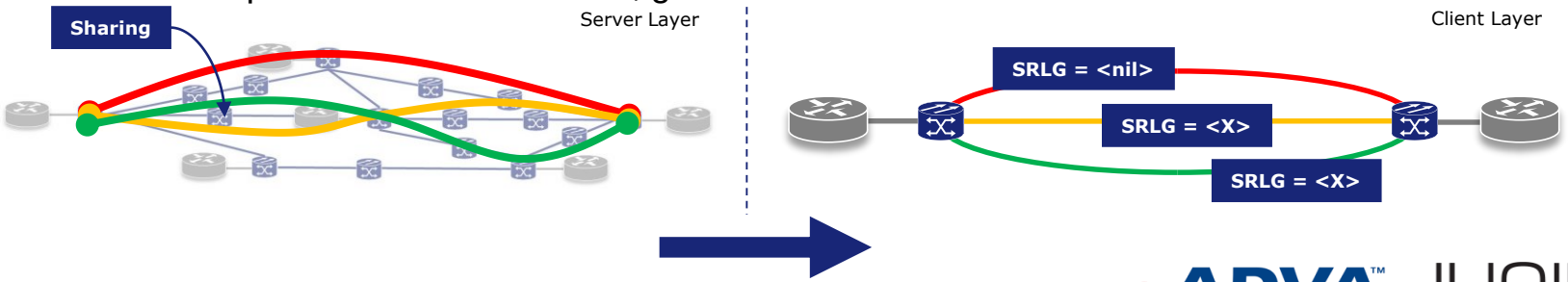
Benefit Example: Diversity Control

- Abstract Links reflect diversity of server network
  - Server network connections may share fate
    - Multiple wavelengths which share the same fiber
  - Path computations in client network may require diversity
    - Abstract links must expose fate sharing of server network connections
- Shared Risk Link Groups (SRLGs)
  - Integer annotations to TE links, identifying fate-sharing groups
    - SRLGs are per-layer/domain, must be coordinated
  - Path computation considers annotations as constraints
    - If paths are SRLG-diverse, guaranteed to not share fate



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First Demonstration of an Automatic Multilayer Intent-Based Secure Service Creation by an Open Source SDN Orchestrator

ACINO Application-centric IP network optimization **adapt the network to the needs of the apps**

ECOC2016 DÜSSELDORF

Intent-based Networking → App-centric Optimization → Network Orchestration

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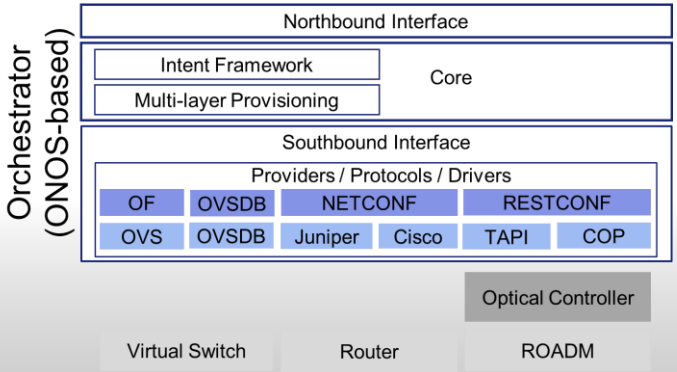
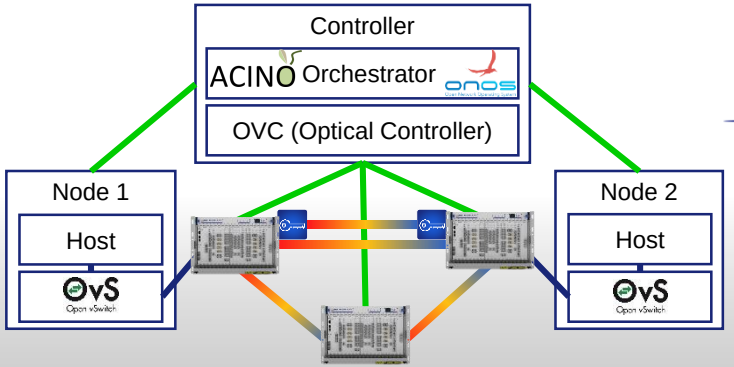
CREATE-NET

Telefónica





Thomas Szyrkowiec, Michele Santuari, Mohit Chamania, Domenico Siracusa, Achim Autenrieth, Victor Lopez, "First Demonstration of an Automatic Multilayer Intent-Based Secure Service Creation by an Open Source SDN Orchestrator", ECOC 2016 PDP

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