Programmability at Optical Transport Layer

Joint Session of Dante and Infinera: Multi-Layer SDN for Ultimate Flexibility in R&E Networks

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Transport SDN use case for R&E Networks

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Infinera
OTS controlled
MEF L2 Services

MEF L2 Services
Pool of OTN B/W
Pay as you grow B/W
OTS REST API to manage connectivity

Tier1 site
Tier2 site
LHC

Application
SDN controller
OF/REST

Tier1 site
Transport Network-as-a-Service

Network access ports defined per end-customer

Policy & SLA management centralized in Carrier SDN controller

End-customer driven L1/L2 bandwidth services

Customer X
Customer Y
Customer Z
Customer X
Customer Y
Customer Z
Customer X
Customer X
Customer Y
Customer Z
Customer X
Customer Y
Customer Z
Why SDN for Multi-Layer Networking?

Simplify & Speed Provisioning, Enable Optimization

- Bandwidth growth & network costs not aligned
  - Organic cost reductions alone insufficient for minimizing cost/bit
- Network layers operating in isolation, not cooperation
- More cross-layer intelligence needed for optimizing traffic
- Inter-layer/inter-domain control plane lacking
Evolution Towards Intelligent Transport Networking

- **IP/MPLS Routers**
- **Packet-Optical Transport (P-OTN)**

**Intelligent Transport Networking**

- **Scalability**
  - Super-channel Transmission
  - Coherent, Ready for 1TbE

- **Convergence**
  - Multi-layer Switching
  - OTN, WDM, ROADM, MPLS

- **Automation**
  - Open Software Control
  - Programmability, Resiliency

**Intelligent transport networking simplifies total network & enables cost efficiency at Cloud scale.**
Multi-layer Automation for Intelligent Transport

- Need for multi-layer representation, topology computation & provisioning
- SDN approach facilitates orchestration across layers & domains
- **Benefit**: Network carries traffic at the most optimal layer
SDN as good as the Underlying Data Plane

Programmable Optical Transport Networks

The ability to control network resources and properties \textit{at a distance} “No Compromise” for any applications

These characteristics are absent from \textit{traditional optical networks}
Automating Everything

Unified Control Plane
GMPLS + Carrier SDN

Network Efficiency
Digital Automation
Network Reconfigurability
CapEx/OpEX Optimization

Terabit-Scale Multi-Layer Switch
Integrated OTN with WDM
CDC FlexROADM
Optimized Multi-Layer Switching Architecture

Service-level digital switching & grooming (Ethernet/SDH/OTN/SAN)

Digital Switching
- ODU0/flex and packet switching granularity
- Digital grooming maximizes WDM fill -> CapEx savings
- Sub-λ switching & service protection -> OpEx savings

Optical Switching
- Wavelength & super-channel granularity
- Optical express of filled super-channels -> CapEx savings
- Reconfigurable super-channel switching -> OpEx Savings
Digital OTN abstraction of BW delivers optimal fit for SDN

In addition to OTN, SDN-control of ROADMs makes sense

But controlling other analog functions (e.g. power) directly is too complex

“Lots of physics is used to enhance transmission performance. SDN controller will not be able to manage this constant evolution” – Vz
**SDN control of Instant Bandwidth™**

Pay as you grow and Minimize OPEX

- Deploy Service-Ready Bandwidth with Super-channels
- Dynamically control OTN services via Bandwidth virtualization
- Dynamically activate additional line side BW via Instant Bandwidth

100G Era: **500G Pool**

Nx100G Enabled Per Line Module
Software Controlled Modulation
Maximize flexibility, Minimize complexity

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**Application**: Dynamic MPLS tunnel service creation in multi-layer, multi-vendor environment.

**Multi-layer PCE-based controller**: Point and click IP/MPLS services w/automatic router & transport layer provisioned automatically.

**Multiple south-bound protocols**
- REST/JSON
- OpenFlow
- Netconf/YANG
- PCEP
- BGP-LS

**Telefónica Multi-Layer SDN Architecture PoC**

**Network as a Service (NaaS)**

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Multi-layer orchestration with OSCARS-TE

OSCARSTE Multi-Layer SDN Management Modules

Configuration Manager

Topology Exchange

ESNet Circuits Reservation System (OSCARS)

Multi-Layer Topology App

Multi-Layer Path Engine

Multi-Layer Provisioning

Traffic Optimization Engine

SDN Controller

Floodlight

Site A

OpenFlow 1.0

Packet Network

Site B

Optical Transport Network

Hot Interconnect 2014
Summary

- **Intelligent Transport** drives new approach to scaling networks
  - Service-ready capacity, BW delivery @ Internet speed
  - Converged Digital (packet, OTN) and ROADM operations

- **Multi-Layer SDN** has significant benefits
  - Streamline multi-layer, multi-domain operation
  - Rapid application development through standard APIs
  - New dynamic “on-demand” services (e.g., NaaS, BoD)
  - Global view creates opportunity for total network optimization

- **Carriers seeking evolutionary, open approach**
  - Leverage existing robust optical transport control plane functions
  - Open SDN control layer, flexible integration options
Thank You