Paving the Path to Multi-Layer Networking via SDN

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Key Drivers for Transport SDN

Service Innovation
- Accelerate development of new services
- Multi-tenancy, Transport Network Virtualization
- Customer-driven networking & services (NaaS)

Operations Automation
- Unified control plane
- Simplify multi-layer, multi-vendor provisioning
- Standard, open API’s

Network Optimization
- Increase network efficiency through optimal resource utilization
- Globally optimize traffic
- Coordinate multi-layer restoration
An Intro to Key SDN Concepts

- Decouple data & control planes
  - For transport, not necessarily all CP functions

- Logically centralize networking intelligence
  - Globalized view
  - Central orchestration

- Open APIs
  - Programmability
  - Standardized information models
  - Abstraction is key

- SDN ≠ OpenFlow
Application Use Case 1: Multi-layer Optimization 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
Application Use Case 2: Elastic Data Center Interconnect (EDCI)

- Dynamic orchestration of flexible inter-DC bandwidth
  - Cloud bursting, Bandwidth on demand (L2, L1, L0), Disaster recovery, VM migration
- Unified coordination of packet flows & transport
  - Cross-layer coordination of packet QoS, L1 bandwidth, latency, resiliency & diversity
  - Reconfigurable & adaptive to traffic/performance demands (L1 & L2)
Relevant Standards & Technologies

Transport SDN

- Standards efforts
  - ONF Optical Transport Working Group (OTWG)
    - Architecture, information modeling (nodal & network)
    - OpenFlow protocol extensions
  - OIF
    - Carrier SDN requirements & use-cases
  - IETF
    - PCE, ABNO (controller arch), abstract topology
    - YANG modeling, protocols
- Open source initiatives
  - OpenDaylight consortium
  - ON.Lab Open Network OS
Infinera Approach to Transport SDN

- **Software Enabled Platforms**
  - Modular, multi-layer transport solutions (L0 – L2.5)
  - Deployable independent network layers or integrated converged solutions

- **Open and Easy to Integrate**
  - Open, lightweight approach
  - Integration with any provider’s SDN controller

- **Open Transport Switch (OTS) Innovation**
  - Transport service layer focus
  - Multi-tiered abstractions & resource virtualization
  - Standards-based information modeling w/ multiple control APIs
  - Multiple operational modes & levels of control plane centralization

- **From concept to first product**
  - Multiple OTS collaboration PoCs → production integration w/ OTSv
  - Multi-vendor/multi-layer applications in ideation
Virtualizing Transport Systems
Open Transport Switch (OTS) Concept

- Multi-layer (L0 - L2.5) transport abstraction
- Multi-protocol control interfaces
- Programmatic APIs for configuration, discovery, & management
- Architected to run anywhere
- Interworks with SSON/GMPLS

OTS enables open interface & network virtualization for SDN
Multi-Layer Provisioning & Optimization PoC
ESnet, Brocade Collaboration

PoC Scenarios
1. Multi-layer provisioning
2. Dynamic Router offload
3. Dynamic Site bypass
Telefónica Multi-Layer SDN Architecture PoC
IP Link Automation & MPLS NaaS

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

Intelligent Transport Abstraction

Open Transport Switch (OTS)
Bandwidth Virtualization
Digital Switching
DWDM
Super-Channels
End-to-end Multi-Layer, Multi-Domain PoC
APAC Tier 1 Service Provider

Multi-controller, multi-technology PoC
- Network: OTN/WDM, MPLS-TP, Ethernet
- Key SDN components:
  - Infinera Open Transport Switch
  - OVS
  - NEC OdenOS & Ryu
  - Hitachi SDTN Controller

Multi-layer, Multi-domain Orchestration
- Network & resource virtualization
- Multi-tenancy virtual networks (slicing)
- Single-pane E2E provisioning across layers
- Multi-layer failure monitoring

Multi-protocol southbound APIs
- OpenFlow, REST, SNMP, TL1
OTSv – Transport Abstraction & Programmability
From Concept to Product

- Multi-Layer Transport Control API (L0-L2)
  - Technology agnostic network model
  - Layer specific provisioning model

- Inventory & discovery
  - Topology resources
    - Network, SubNetworks, NEs, Links
  - NE, Port, Switch Inventory
    - Information, availability, state

- Provisioning & protection
  - SNC: Network level, NE level
  - Traffic engineering, route query

- Realtime monitoring
  - Create/Delete/Update notif.
  - Problems/Alarms
  - Performance stats

- Server & VM hosted

Security
- Basic, Oauth
- https/REST/JSON

Adaptation Function
- Inventory, Provisioning, Monitoring
- https/REST/JSON

Inventory
- SubNetwork, NE, Port
- NE Communication Layer (ssh, xml)

Provisioning
- SNC
- Port Monitoring
  - State, Fault, Config

Notifications – Pub/Sub
- Websockets/JSON/STOMP

Request/Response
- https/REST/JSON

Secure communications

Converged Transport Solutions
- L0/L1/L2, L0/L2, L0, L1
Summary

- **Intelligent optical transport** driving new approach to scaling core
  - Service-ready capacity facilitates BW delivery @ Internet speed
  - Unparalleled flexibility with Digital (packet, OTN) and optical (ROADM) switching

- **Multi-Layer SDN** has significant benefits
  - APIs driven automation & operations
  - Rapid application & service innovation
  - Globalized view facilitates optimization of traffic & network

- **GMPLS** facilitates **evolutionary, open** approach
  - Open SDN control layer, flexible integration options
  - Leverage existing robust control plane functions
Thank You
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