Extending SDN into the Transport Network

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Why is the Industry Interested in SDN?

Integration of Network with IT

- CapEx savings via virtualization & sharing
- Accelerate introduction of new services across whole network
- Automate workflow processes to reduce OpEx & scale operations
- Optimize resource consumption via global view of resources
Network Programmability - The Transport World is Different

Packet World

- Connectionless
- Enterprise origins
- Dynamic flows
- Innate control plane (EMS/NMS independent)
- Numerous distributed CP solutions
- Monolithic, closed systems

Transport World

- Connection (circuit) oriented
- Service provider origins
- Static pipes
- EMS/NMS + Cross-connect paradigm
- Nascent CP (GMPLS)
- Open, programmable systems

Historically, transport networks have been programmable.
Motivations for Extending SDN to Transport

Network Virtualization & Programmability

Applications see simple, flat virtual network

Centralized SDN controller

- Multi-layer integration & Optimization
- Application-driven bandwidth
- Multi-vendor
- Simplify & automate workflow operations
- Inter-domain connection management
Transport SDN

*Open & Programmable Networking*

- P-OTN convergence enables flexibility & agility
- SDN unifies control over multi-layer, multi-vendor network
- Abstraction simplifies network representation
- Benefits:
  - Rapid & Flexible Bandwidth
  - Simplify/Automate Operations
  - Global resource optimization
  - Speed New Service Deployment
ONF Optical Transport Use Cases

Enterprise Networks

SDN Controller

Network Virtualization & SP Data Center Interconnection

Client Controller

Packet-Optical Integration

Provider Network

Network Provider Controller* Optimized
- Packet Network Controller
- Transport Network Controller

*May one or multiple systems
Open Transport Switch
Abstract & Simplify

SDN Controller

Monitoring  
Discovery & Configuration  
Provisioning (OpenFlow)

OTS-Mgmt Agent  
OTS-Control Agent  
OTS-Data Agent

Control Plane

Data Forwarding Plane

Physical Interfaces

• Lightweight virtual switch representation
• Capabilities exposed depends on NE
• Discovery, Configure, Provision, Monitor
• Runs on NE or in the cloud
• Embeds open control onto the platform

Common interface, user request mediation, network virtualization
Transport SDN Control Plane Models

Explicit (Direct) Model
- Centralization of all network control
- Individually controlled NE’s
- Hop-by-hop provisioning

Implicit (Indirect) Model
- Network abstraction per domain
- Multi-domain orchestration
- Leverage existing control plane

Hybridized network control model combines best of both worlds
Transport SDN

Data Center Related Applications

- Dynamically configurable transport network
- Customer managed Bandwidth on Demand
- Same approach can be used for other applications
  - Network-as-a-Service (NaaS)
  - Increased L3/L2 VPN capacity
  - Reconfiguring transport network after router failure
Transport SDN Demo at Esnet

*OpenFlow-enabled optical virtual switch for big-data application*

**ESnet**

- 40 DOE research sites
- Connect to 140 research and commercial networks
- US National Laboratory system & supercomputing facilities
- 7 to 10 petabytes monthly
- Traffic growth: 1000% every 4 years

**Network Problem**

- Bursty, short-lived flows of typical business applications
- Trampled by massive, long-lived scientific data flows
ESnet Transport SDN Demo Configuration

- SDN Controller communicating with transport network via OpenFlow extensions
- Bandwidth on Demand application for Big Data RDMA transport
- 3 physical transport path options (with varying latencies)
- Implicit & explicit provisioning of 10GbE/40GbE services demonstrated
ESnet SDN Controller

Setup an Edge-to-Edge Connection

On-demand Secure Circuits and Advance Reservation System

The OSCARS service is provided by ESnet, the Energy Sciences Network. OSCARS software developed by ESnet, in collaboration with Internet2 and GlEast.

Circuit Active

On-demand Secure Circuits and Advance Reservation System

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Reservations list

The reservations returned by a search can be constrained by their status, text in their description, times that they end or start before, and topology identifiers that they contain in their path. Times given are in the time zone of the reservation. Click on REFRESH again to get the latest information on the reservations chosen.
Summary

*Extending SDN to Transport has significant benefits*

- Lowers opex via open multi-layer, multi-vendor, multi-domain orchestration
- Lowers capex by optimizing flows across layers
- Speeds service delivery for internal Data Center customers
- Makes transport resources dynamic & visible to applications
- Creates the ability to easily slice the network