What is the OIF?

• Since 1998 OIF has brought together industry groups from the data and optical worlds

• Mission: To foster the development and deployment of interoperable products and services for data switching and routing using optical networking technologies

• Our 100+ member companies represent the entire industry ecosystem:
  • Carriers and network users
  • Component and systems vendors
  • Testing and software companies
Where We Fit
Trends

• Carrier environment has evolved and changed
  • Network standardization environment has changed and there is increasing emphasis on
    • Virtualized environment
    • Standard (COTS) hardware
    • Software implementation of network functions
• New forums have been started – ONF, NFV, OpenDaylight, ...
• Stepping forward towards new areas
  • PLL: Operationalizing 100G, towards 400G/1T
  • SDN: What does this mean to (non-packet) optical transport networks
• OIF projects and work plan
  • Complementary and in sync with industry direction
SDN Architecture – Vision of NFV

Classical Network Appliance Approach

- Non-commodity hardware.
- Physical install per appliance per site.
- Hardware development large barrier to entry for new vendors, constraining innovation & competition.

Network Virtualisation Approach

- Independent Software Vendors
- Orchestrated, automatic & remote install.
- Standard High Volume Servers
- Standard High Volume Storage
- Standard High Volume Ethernet Switches
- P-OTN

Orchestration - One main Aspect of SDN

- Processing
- Storage
- Transport
Optical Networks in SDN Architectures

What does SDN mean for the optical transport network?
SDN Architecture - Standardization

Mature
ITU-T, IETF, OIF
ASON / GMPLS
(G.8080 / G.771x,...)

ONF
OpenFlow Switch Spec. 1.3.1
OF Config. & Mgt Protocol 1.1

MP – EMS/NMS

Control Plane

L1/L2 Transport NEs

MP – CLI/GUI

OF – Controller

OF Packet Switches
SDN Reference Architecture

Orchestration

Controller → Mgt

Data Center

Transport

Application Layer

Control/Mgt Layer

Transport Layer
SDN Architecture - Virtualization & Slicing

- Application Layer
- Control/Mgt Layer
- Transport Layer

- Service
- Service
- Service

- Orchestration

- Hypervisor

- Controller → Mgt

- Virtual Machines

- Data Center

- Flexible L1/2/3
- VPN

- OIF Optical Internetworking Forum
The Vision – Seamless Interworking

- On-demand services are provisioned, based on ASON/GMPLS control plane functions
  - Multi-domain
  - Multi-layer
  - Multi-technology

→ OIF control plane follows ASON multi-domain architecture and allows UNI, E-NNI protocol separate from domain operation
→ Interworking with SDN domains is ensured

Domains can use Network Management, SDN or distributed control plane internally

Domains can use different technologies internally
Interworking SDN and Control Plane

- **Why look at this?**
  - Interwork with deployed equipment
  - Introduce SDN capabilities more rapidly

- **What can be leveraged from existing work?**
  - Core control plane functions
    - Automated discovery
    - Automated connection provisioning and recovery
  - PCE
    - Centralization of topology, path computation, global view
    - Central trigger for connection setup
Stateless to Stateful PCE

- OIF PCE IA defines usage of stateless PCE
- PCE maintains network topology
- Multiple PCEs can work together to calculate a full end-to-end, multi-domain route
- In Stateful PCE, the PCE initiates connections
PCE and Carrier SDN

1) PCCreate
2) E-NNI 2.0 Signalling
3) PCRpt
OIF Carrier WG

- Requirements on Transport Networks in SDN Architectures - Transport SDN
  - Document will be based on contributions of major carriers worldwide
  - Work in progress
  - Will comprise requirements on
    - Orchestration layer (transport network relevant)
    - Control and mgt. layer
    - Transport layer
  - Will be communicated to other SDO and forums
General Requirements

• Requirements are not aimed at a particular (set) of protocols, HW and SW implementations
  • Packet & circuit switching
  • Centralized & distributed control instances
  • Allow multiple protocols
  • Modular SW and HW (COTS)
  • Decoupling of network layers
• Increase high level of interoperability among different vendor implementations, carrier network domains, data center functions, …
  • Well defined interfaces
SDN Reference Architecture

- Service
- Service
- Service

Orchestration

Hypervisor

Controller → Mgmt

Data Center

- Application Layer
- Control/Mgt Layer
- Transport Layer
Requirements on Orchestration Layer

- Coordinate data center and transport network actions
  - Provide translation function for communication between data center and transport network instances and vice versa
  - Provide computational resources to deliver timely solutions for problem statements, alarms, notifications
  - Coordinate virtualization on both data center and transport network sides
- Structured, extensible, flexible, well defined interfaces to
  - Application layer (northbound API) to support customer service requests
  - Transport network control and management layer, as well as hypervisor (southbound)
SDN Reference Architecture

- **Application Layer**
- **Control/Mgt Layer**
- **Transport Layer**

- **Orchestration**
- **Controller**
- **Mgt**
- **Data Center**
- **Hypervisor**
- **Service**

- **Service**
Requirements on Control/Mgt Layer

• Northbound interface to the orchestration layer
• Provide dedicated network element functions, e.g. higher layer awareness
• Provide routing and signaling functions
  • Distributed or centralized as needed
• Provide boundaries and interfaces to customers and neighboring transport network domains
• Resource / topology discovery
• Monitoring and OAM functions
• Traffic engineering
  • Connection management: path computation & connection setup, modification, monitoring, teardown based on provided parameters
  • BoD
• Mesh restoration functions
SDN Reference Architecture

- **Application Layer**
- **Control/Mgt Layer**
- **Transport Layer**

- **Service**
- **Orchestration**
- **Hypervisor**
- **Controller**
- **Data Center**
- **Transport**

- **OIF** Optical Internetworking Forum
Requirements on Transport Layer

- Northbound interface to different control plane instances to support network slicing, ...
- Support of L1-L3 VPNs
- Support different client data formats
- Meet the client bandwidth requirements in term of volume and granularity
- Support on-demand network (re)configuration
- Provide various resilience mechanisms
  - Protection, restoration, combination of both
- Provide differentiated service parameters (latency, delay variation, jitter, jitter wander, security)
- Support carrier grade OAM functions
Many Opportunities for Collaboration

- **IETF**
  - Protocol extensions
  - ...

- **ITU-T**
  - Extensions to ASON architecture
  - ...

- **ONF**
  - Inter-domain model using control plane signaling
  - OpenFlow protocol extensions for transport
  - ...
**Summary**

- Carriers have just started SDN requirements work
  - E.g. on Transport SDN
- Analysis have been started to evaluate interworking of SDN architectures with existing transport network control plane functions and specification
  - Gap analysis
  - Most likely some architecture and protocol extensions needed
- Quite certain – this is just the beginning of the hard work and an exciting time!
Thank you

for your kind attention!