

Transport SDN: Learnings & Operational Challenges

July 2015

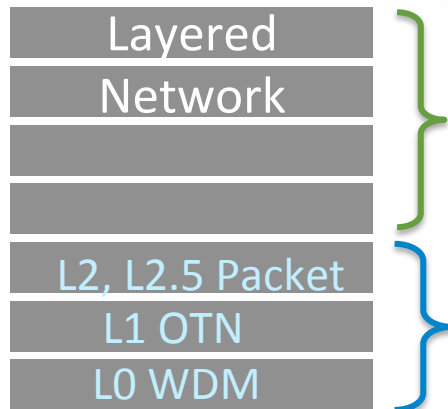
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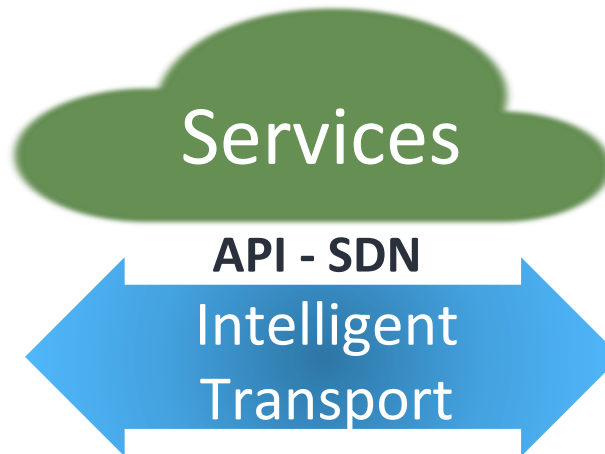


Networking Trends for a Software Driven World

Old Model
(coupled data & control)



New Simplified Model
(logically centralized control)

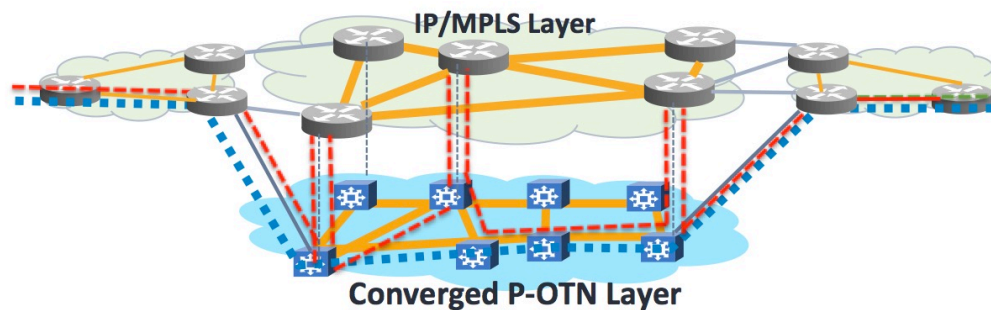


Network Functions
Get Virtualized in the Cloud

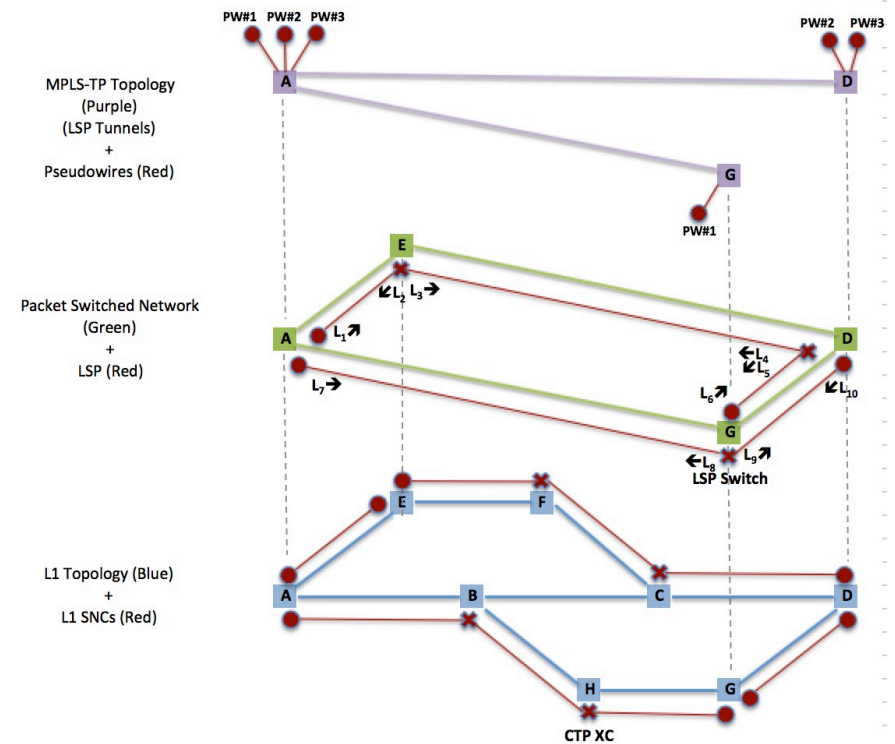
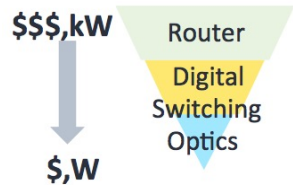
Transport Functions
Converge on a Single Scalable Platform

Dynamic Bandwidth **Intelligent Automation**
Network Efficiency **Application Driven Performance**
DevOps Innovation

Multi-layer Network View



Multi-layer - High Level View



Multi-layer - Detailed View

Key Drivers for Transport SDN

Service Innovation

- Bandwidth on Demand
- Multi-Tenant Virtual Networks
- Network as a Service (NaaS)
- Intelligent SLA Management



Automate Operations

- Unified Control & Provisioning
- Multi-Layer & Multi-Vendor
- Open API's

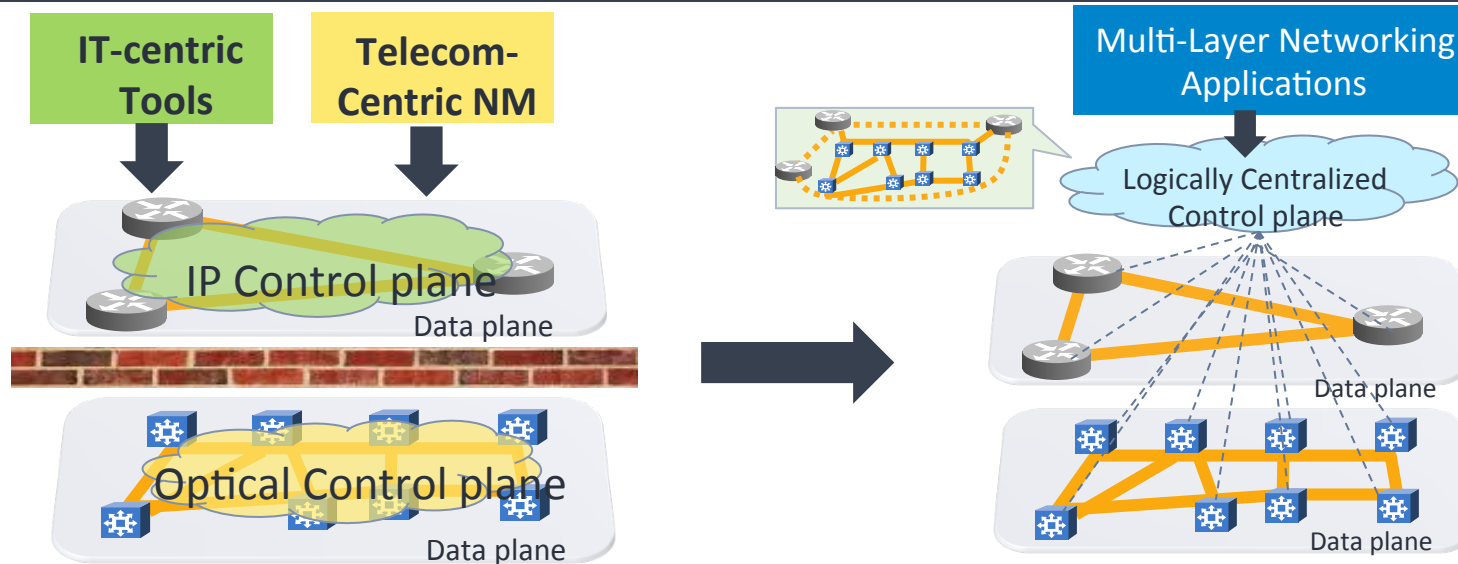


Network Optimization

- Multi-Layer Restoration
- Traffic (Re-)Optimization
- Resource Optimization



Promise of SDN-based Network Control & Programmability



Independent Control Planes

- Isolated over-provisioned network layers
- Disjoint network management
- Distributed, un-coordinated intelligence

Multi-Layer SDN Architecture

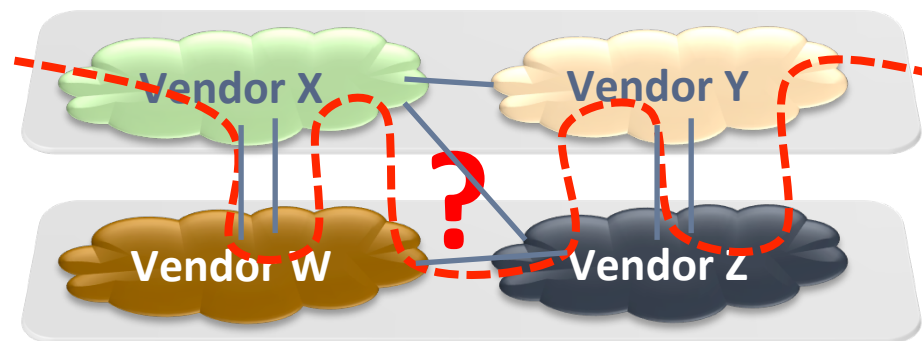
- Next-gen unified network control
- Multi-layer orchestration & optimization
- Network agility with DevOps model

Operational Reality: Multi-Layer Networking

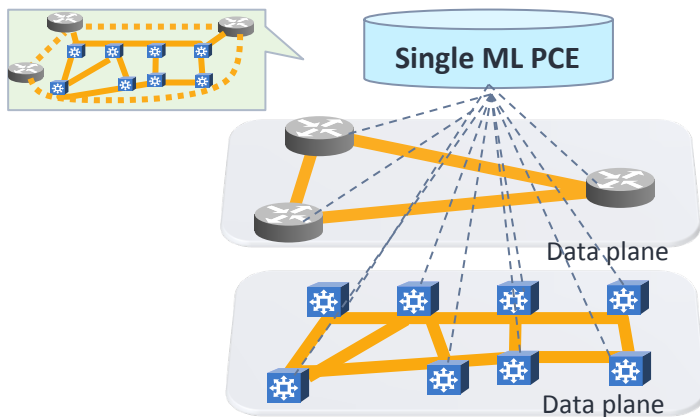
- **Real-time:** On-demand network services and Bandwidth growth require more efficient networking
- **Optimization:** Network layers operating in isolation, not cooperation
 - Little cross-layer awareness & intelligence
 - Different departments at carriers for IP/MPLS and Transport (IP/MPLS networks typically over-provisioned by >50%)
 - Local optimization $\neq$ Global optimization
- **Proprietary:** Optical impairment calculations for WDM are proprietary for each vendor
- **Interoperability:** Common management abstractions & protocols lacking
 - Closed, proprietary multi-layer solutions limit evolution & innovation
- **Deployments:** Multi-Layer, Multi-Vendor, Multi-Domain, Multi-Region, Multi-criteria

IP/MPLS
Network Layer

Transport
Network Layer

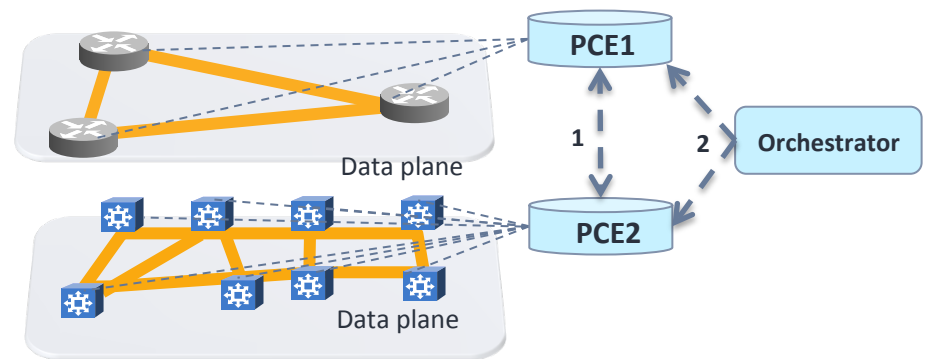


Operational Models: Multi-Layer PCE



Single Multi-Layer PCE

- Complete Multi-Layer topology information
- Multi-layer orchestration & optimization (improves network performance and utilization)
- Multi-layer restoration



Multiple PCEs

- Each network layer has its own PCE
 - [1] PCEs communicate to set up E2E path
 - [2] Orchestrator communicates with PCEs to set up E2E path
- Sub-optimal paths since full topology is unknown
- More expensive restoration

Operational Challenges: Multi-Layer PCE

- ▶ **Single PCE is generally not applicable to carrier networks**
 - Organizational separation of IP/MPLS and transport network.
 - Multi-vendor environment with PCE from each vendor.
 - Vendor PCE can be for multiple layers. For e.g., transport PCE can do path computation for WDM, OTN, and MPLS-TP.
- ▶ **Inter-layer Topology Discovery**
 - How to build a complete view of the network, including inter-layer interconnects?
 - Proprietary solutions exist to determine these interconnects.
 - In many cases inter-layer interconnects need to be set up manually.
- ▶ **Multi-layer Policy enforcement**
 - Each network layer could have different policy – Lack of common “normalized” policies.
 - Inter-layer interconnects could have different policies.
 - E2E inter-layer traffic engineering to be executed without violating multiple policies.
- ▶ **Multi-layer tools**
 - Multi-layer simulation tools.
 - Troubleshooting tools – E2E Multi-Layer path tracing.
 - Use case simulation and testing tools, e.g. simulate network failures, understand different recovery schemes under different policies and constraints.
- ▶ **Support for legacy equipment and legacy southbound protocols.**
- ▶ **Periodic re-optimization of the multi-layer network.**

Summary

- ▶ **Transport SDNs are being deployed**
 - SDN deployments started in data centers.
 - Carriers are now deploying Transport SDN.
 - ONF active in defining use-cases and support for transport SDN.
- ▶ **Multi-Layer SDN driven by E2E Automation & intelligence need**
 - API is the key to automation & operations.
 - Rapid application & service innovation.
 - Globalized view facilitates optimization of traffic & network.
- ▶ **Carriers and vendors working together**
 - Providing new services based on Transport SDN.
 - Reducing OPEX and CAPEX using network automation and optimization.

Thank You

