

Transport SDN: Key Drivers & Elements

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The Evolving WAN Landscape

Fiber Capacity

- 100Gb coherent technology
- Optical Super-channels on the horizon
- Bandwidth service needs vary broadly

Transport Convergence

- WDM + OTN + Packet transport = **Flexibility**
- Intelligent traffic management & switching
- Router offload & bypass

Data Center Networking

- Dynamic traffic patterns & profiles
- Demand for adaptive and agile transport
- Integration of Network & IT

How does this impact the Network?

- ▶ Architectural choices for WAN abound – which layers?
 - Layer 3 (IP)
 - Layer 2.5 (MPLS)
 - Layer 2 (Ethernet)
 - Layer 1 (OTN – digital framing, grooming, switching, protection)
 - Layer 0 (WDM - optical level transmission, multiplexing, switching)
- ▶ Network Providers reexamining **total** network economics
 - Lifecycle considerations
 - Traffic types, patterns & growth sensitivity
 - Network trends beyond 100G WDM
 - Minimizing cross-layer traversals (least cost, least power, best perf path)
 - Maximum network resource utilization & efficiency
- ▶ Automation & cloud orchestration are needed
 - Programmability of bandwidth services vs network components
 - Virtualization & abstraction drive simplicity, but how much?

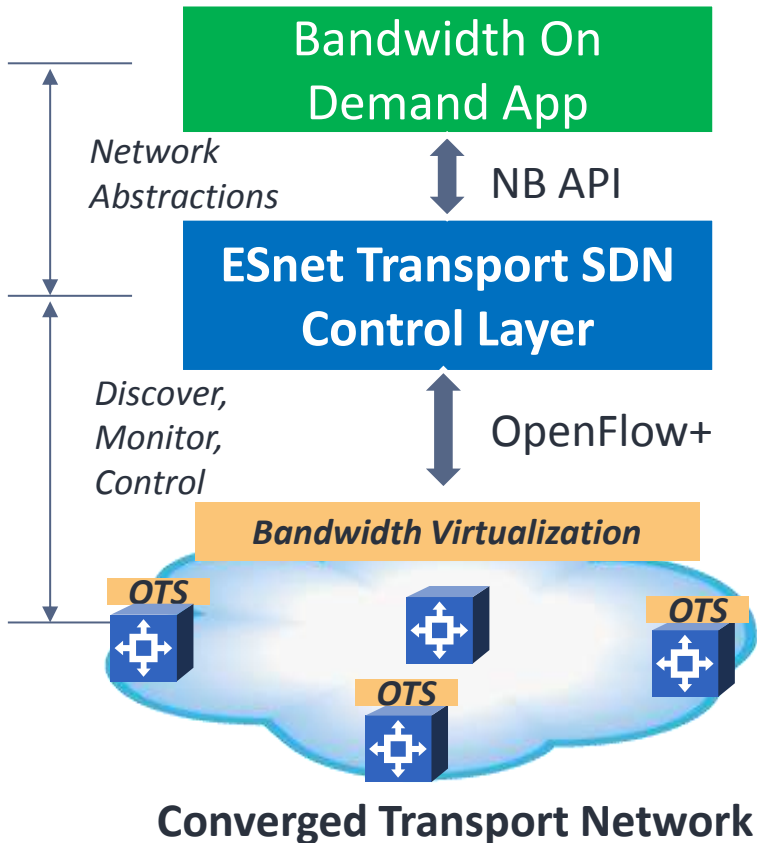
Applications for Transport SDN

Dynamic Virtual Waves

- ▶ **Networking-as-a-Service (NaaS)**
 - Layer 1 Virtual Networks (network slicing for multi-tenancy)
 - Virtual transport switches & virtual bandwidth links
 - Useful as both Internal partitioning & external service capability
- ▶ **Optimized Data Center Interconnect**
 - Right-sized transport capacity (tunnels) for A-Z flow set
 - Multi-layer topology integration & resiliency
- ▶ **Multi-layer orchestration & optimization**
 - Simplified orchestration through uniform API
 - Optimize traffic flows through multi-layer network
 - E.g., minimize packet processing for Big Data at intermediate sites
 - Globalized optimization for lowest-cost & highest network utilization

Transport SDN Demo Collaboration

Key Elements



- ▶ **Integrated WDM/OTN infrastructure**
 - Dynamic, switched real-time circuits
 - Bandwidth Virtualization for abstracting optics
- ▶ **Open Transport Switch (OTS)**
 - Virtual transport switch
 - OpenFlow 1.0 protocol extensions
 - Transport BW src, dst, size, latency, abstraction level, etc.
- ▶ **GMPLS technologies**
 - Key capabilities well suited for SDN framework
 - Topology discovery
 - Robust signaling
 - Route computation can still be centralized!
- ▶ **SDN Controller & App**
 - OSCARS, OpenFlowJ