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Multi-Layer Performance Based PCE Enhancements to ONOS Controller for SD WAN Packet Optical Integration

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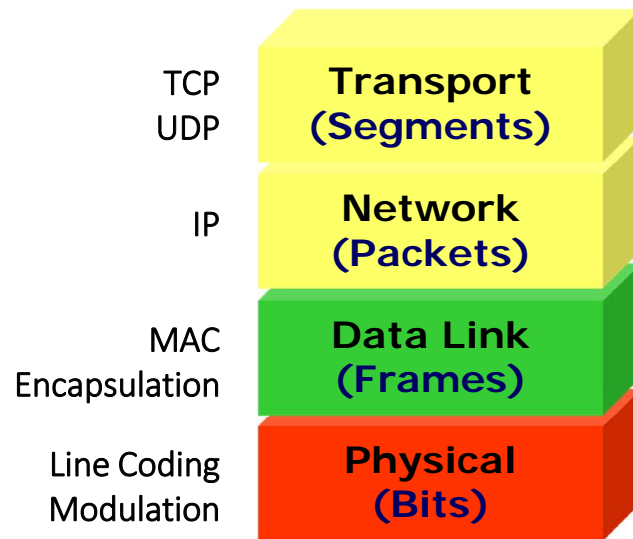


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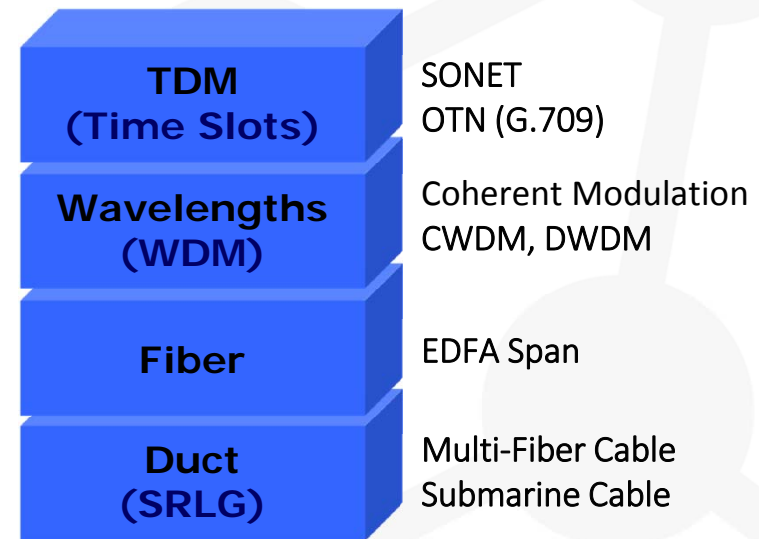
What is Multi-Layer Convergence?

Bringing the physical Layer into the Mix

The OSI
Networking Model



Optical Transport
"Layer 0"



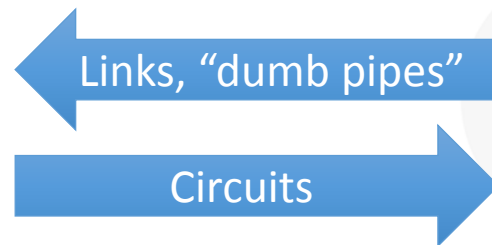


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Why does the divide still exist? *Existing operational and administrative silos*

The Networking World

- **Operations**
 - VPN Services
- **Equipment**
 - Routers
 - Switches
- **Control Plane**
 - MPLS
 - BGP/OSPF



The Transport World

- **Operations**
 - Transport Capacity
 - Circuit Setup
 - Fault Mitigation
- **Equipment**
 - OTN Switches (TSA/TSI)
 - DWDM
- **Control Plane**
 - APS
 - GMPLS





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What's wrong with separate worlds? *The dumb things we still do*

The Networking World

- **Fault Mitigation**
 - MC-LAG
 - FRR
- **Service Creation**
 - Networking parameters
 - Hops
 - Link cost
 - L2/L3 VPN
- **Service Validation**
 - Check Sums



The Transport World

- **Fault Mitigation**
 - Mesh Restoration
 - 1+1
- **Service Creation**
 - Transport Parameters
 - Distance
 - Route cost (\$)
 - Manual
- **Service Validation**
 - BER Thresholds

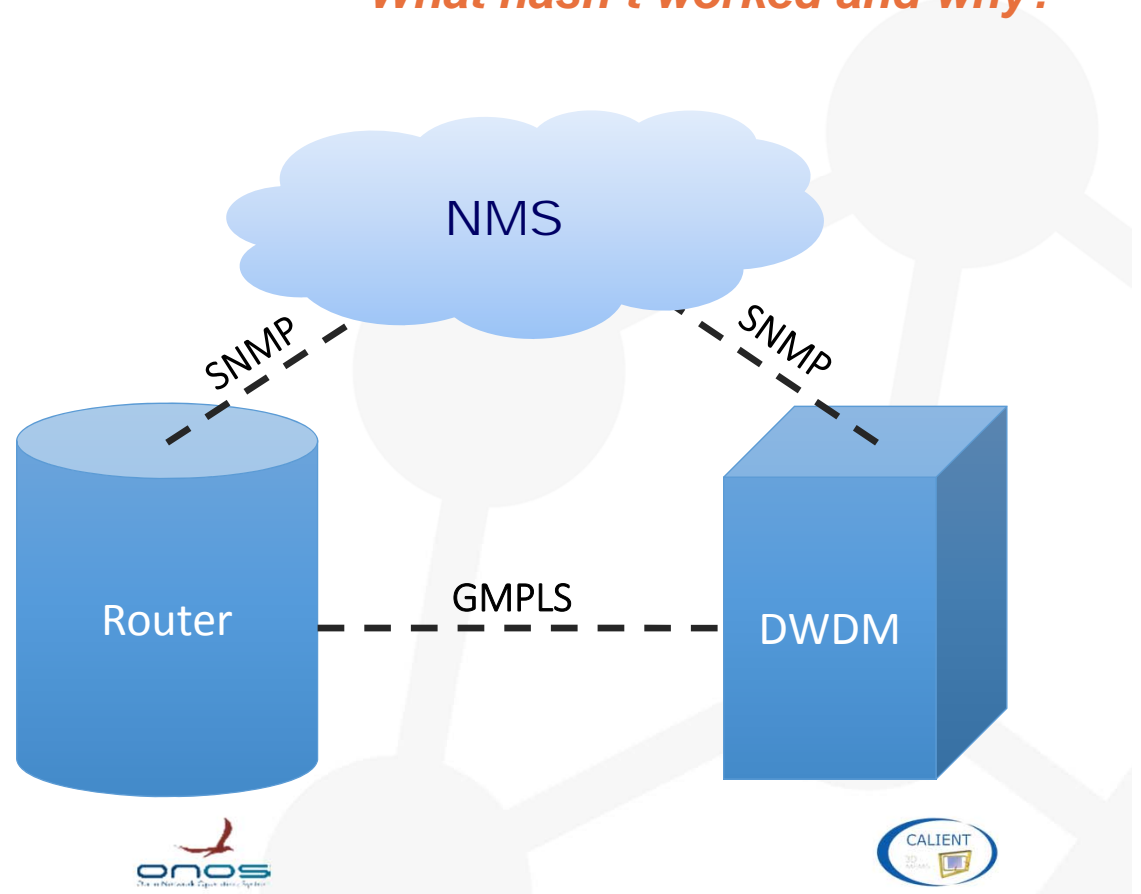




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It isn't that we haven't tried
What hasn't worked and why?

- **e.g., SNMP**
 - Common NB Interface
 - Syntax only; provisioning of every device by parameters doesn't scale.
- **GMPLS**
 - Common Control Plane
 - Multi-Layer, Multi-vendor interoperability not practical





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A practical implementation of SDN Packet Optical Integration

Harmonization of Hardware and Software





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Practical and scalable unified interface *Thanks to OpenFlow*

- **OpenFlow 1.3/1.4/1.5**
 - Optical extensions
- **Netconf**
- **Extensions using OpenFlow Experimenter messages**
 - Events
- **Foundation for ADARA's SKY Controller and ONOS Controller**
- **Supports both in-band or out-of-band management**





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Multi-Layer Path Computation Engine

Consider performance metrics every layer

- **Multilayer Coordination and Optimization: Packet and Optical**
 - Converts all layers properties (L0-L7) into normalized attributes
 - Example: Path computation based on Hops at packet and optical layer
- **Based on ADARA's Dynamic Link State Protocol (DLSP)**
 - Artificial Intelligent Neural Network Performance based rather than static configuration
- **Extensible configuration knobs**
 - Extensible Path Computation Algorithm





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Multi-Layer Path Computation Engine

Consider performance metrics every layer

- Virtual (VxLAN, DWDM) and Physical / Packet and Optical
- MultiPath *All / Multiple* Communication Mediums; Ethernet, Optical Fiber, etc.
- QoS and Admission Controls
- *Can always control actual physical spectrum or capacity*
- *Optimizes the network after restoration/capacity changes*

SD-WAN for Free!





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Everything is open
Best of breed technology

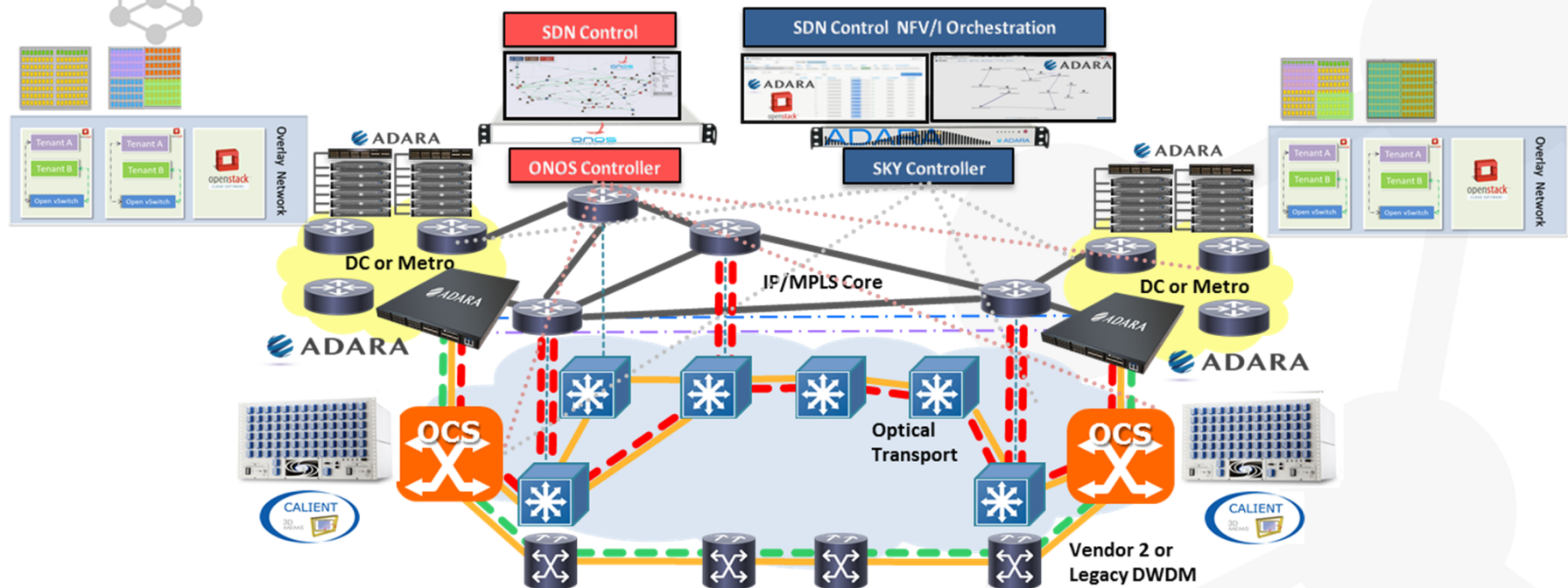
- **ONOS Controller**
- **OpenStack based choreography and orchestration**
- **Uses ONIE boot loader**
- **Runs on Industry standard Broadcom ASICs**
 - Uses OFDPA 2.0
- **Any Linux distribution**
- **OpenVSwitch 2.3.2**
 - Integrated with OFDPA 2.0
- **Uses OVSDb for configuration**



ONS

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Ubiquitous physical layer switch fabric *Trivial with OCS*



PCE leverages OCS cross connects to create dynamic L2 links based on the current state of network and policies

ADARA

ONOS
The network Open Flow System

CALIENT



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Put your \$\$\$ to work
Optimized usage of resources

- **De-risk SDN Roll-Out with Incremental deployment**
- **Green Field**
 - Works on any white boxes available
- **Brown Field**
 - Can co-exist with existing switches/Routers
 - Uses RouteFlow
 - Supports incremental deployment
 - Can be overlayed with existing infrastructure using Calient OCS

- **For Service Provider**
 - Higher utilization rate
 - Faster response times
 - Higher availability
 - Lower CAPEX/OPEX
- **For Data Center/Large Enterprises**
 - Provides flexibility (vPod)
 - Supports disparate resources
 - Optimizes elephant flows using optical express paths
 - Orchestration and Service Choreography

Deploy Anywhere. Deploy Now





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Thank You

