SD-DCI: Converged Packet and Optical Transport

Whitepaper | CALIENT Solution Brief

The economic benefits of converging network layers are powerful. Estimates suggest potential 35% to 50% savings in core router network CAPEX by allowing layer 3 to drive the optimization of optical transport networks. Converging network layers also offers up a new range of services and revenue opportunities, allowing end users and service providers to dynamically setup optimal paths based on traffic patterns, quality of service level commitments, and time of day effects.

By deploying Optical Circuit Switches (OCS) at the edges of networks and between network and vendor domain boundaries, Service Providers and Data Center Operators can optimize all the disparate new and legacy resources in their optical transport networks, providing a pool of network resources that can be used, and in some cases reconfigured on demand.

The Drivers for Multi-Layer Network Optimization

As demand for network capacity and cloud services continues to expand, service providers are facing increased pressure to deliver more capacity and network performance at lower price. Service providers can no longer support network architectures consisting of separate layers configured and managed independently. Network optimization must take a holistic approach across all the constituent elements end to end.

- Service providers can truly offer dynamic services on demand – resources can be allocated and removed with a speed and flexibility previously unavailable
- Service Providers and Data Center Operators can optimize network resource allocation and delivery routes, thus increasing efficiencies and QoS of existing network infrastructure
- The topology blockages of separate vendor islands or domains of equipment which don't interoperate may be circumvented by providing transparent connectivity at the Optical Layer

The Challenges to Optimization

Physical layer optimization requires switching at the optical layer. Historically, this function has been provided by OTN and ROADM technology. As services are aggregated to speeds approaching transport wavelengths, sub rate OTN switching is no longer cost effective. Optical layer ROADM technology is widely deployed in carrier networks. However, carrier class ROADM nodes are too expensive for deploying

commodity bandwidth.

Moreover, optical layer switching is often deployed as an underlay for the revenue generating IP services. Until now, convergence to multilayer network orchestration has typically required support of and validation to open interfaces, protocols, and APIs across all network platforms.

In order to express the full potential of true, dynamic Multi-Layer Network Optimization, two key pieces need to be in place:

1. Control Plane visibility and interoperability must exist across all network layers to allow packet and routing engines to drive the optical topology.
2. All network layers must be able to flexibly reconfigure topology and capacity to support traffic patterns in the most optimal way.

Multi-layer optimization hasn't seen much deployment to date. Recent advances in Software Defined Networking (SDN) are enabling control plane visibility across the network layers, but the missing link is a truly ubiquitous flexible optical network layer that can respond to the control plane.

The CALIENT S320 and Edge|640 Optimization Solution

CALIENT Technologies using the S320 and Edge|640 Optical Circuit Switches has solved this challenge by providing flexible optical layer on-off ramps between different equipment and network domains. As shown in Figure 1, adding Optical Circuit Switches (OCS) at the edges of metro and wide area networks allows the multi-layer control plane to access and select resources from any domain or vendor, including a legacy network.

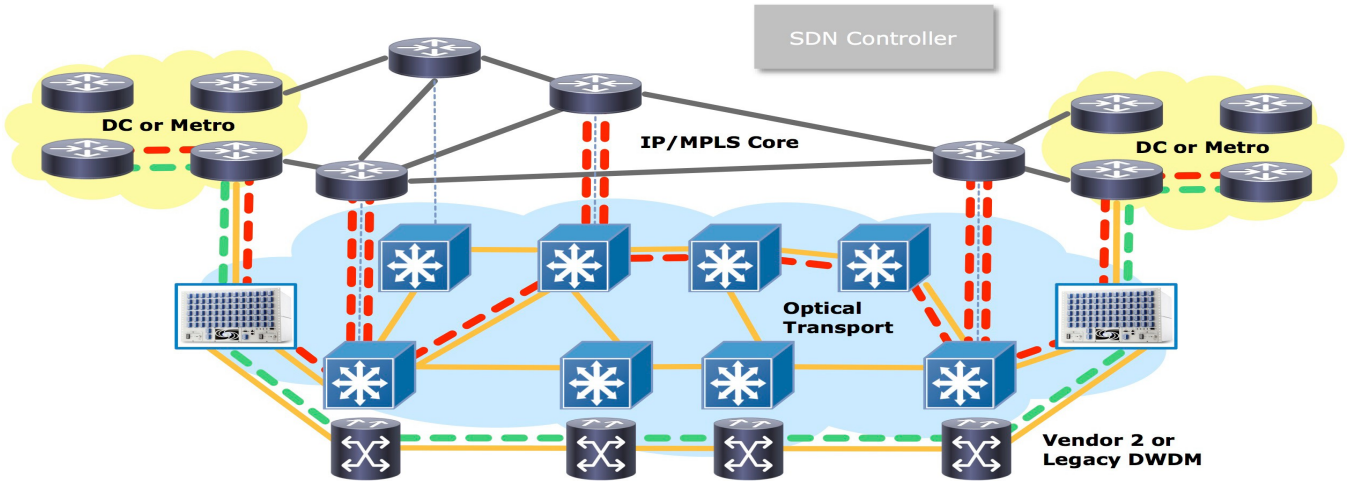

Figure 1: Optical Circuit Switching provides Flexible On-Off Ramps

The optical network capacity now becomes a pool of resources – It doesn't matter which vendor's equipment is in use, or whether it's a new CDC system or a legacy system. The OCS at the network edge allows any client-side resource to be connected to any network resource and supports network-wide SDN control of the optical layer.

With everything under SDN control, CALIENT has essentially taken the entire transport network including all vendor and geographical domains and virtualized it as a giant optical switch. Any router port can request an optical connection to any other router port in the network, now realizing the myriad economic and performance benefits of Multi-Layer Network Optimization.

CALIENT Core Technology

CALIENT's Optical Circuit Switch is a large port count all-optical (OOO) switch that establishes, monitors and switches physical layer connections between single-mode optical fibers using Micro-Electro-Mechanical Systems (MEMS) based optical switching. Connections are made between fibers carrying signals with any data rate or protocol. Any input fiber on the S-Series OCS can be connected to any output fiber making a fully non-blocking switch fabric.

Light is directed from the input fibers to the output fibers using arrays of tiny silicon mirrors that are fabricated using the proven CALIENT MEMS process. An optical signal transmitted through the OCS passes through three sections of the switch core: the input collimator array, which directs the light from each input fiber to its input mirror; the mirror matrix, an array of MEMS input mirrors and an array of MEMS output mirrors; and the output collimator array, which couples light from each output mirror back into its output fiber. High-quality mirrors and collimators and precise electrostatic control of the position of each mirror, enable typical switch times of less than 50ms and optical loss that is less than 3.0 dB for CALIENTs complete line of optical circuit switches.