INFOBRIEF

IP Over Optical Transport—Delivering Optimal Resiliency

There exists a practical implementation of IP over optical convergence—proper shared risk management and alarm correlation to achieve optimal network utilization and resiliency in real network failure scenarios. The compelling benefit of a policy-driven automation solution is highlighted in the context of a common service provider use case: an optical failure that reduces the available bandwidth to transport IP traffic.

Ciena's Manage, Control and Plan (MCP) domain controller is inherently multi-layer and multi-vendor and provides intelligent, automated, multi-layer network operations for Dense Wavelength Division Multiplexing (DWDM), Optical Transport Network (OTN), Ethernet, and IP network layers. Through its user interface—Graphical User Interface (GUI) or Application Program Interface (API)—MCP provides integrated planning, provisioning, and assurance for service lifecycle operations. Moreover, MCP's integrated advanced analytics bring network operations to a new level of intelligent network control—enabling operational workflows to be optimized, accelerated, and automated. The MCP platform is cloud-native, is built on a micro-services architecture for modular extensibility, and offers open APIs to simplify Operations Support System (OSS) integration and workflow automation. In short, MCP is ready to take on the challenge that has been discussed for many years but never successfully implemented: optimizing IP over optical transport.

Key questions for optimizing IP over optical transport

There are many, many questions about an 'optimal' IP over optical transport solution. The fundamental questions are:

1. How is the IP traffic moved across the network? What is the complete infrastructure risk view?
2. What resiliency or protection is available at the lower layers for IP links (including optical control plane, where used) and how can it be used to support IP traffic?

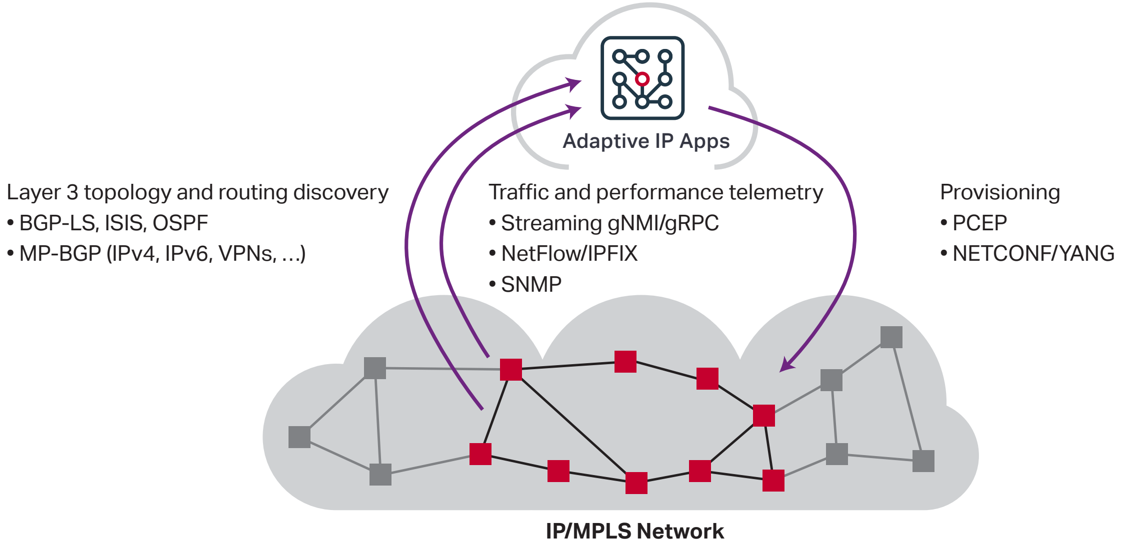

Figure 1. Adaptive IP Apps leverage open interfaces for real-time analytics

Understanding the key properties of how traffic flows, what risks it has, and the optical resiliency strategy is essential to building an 'optimal' solution that can persist across multiple failure modes and is future-proof for network growth and evolution.

How is the IP traffic moved across the network?

MCP includes integrated real-time analytics for IP traffic, including service-level views for Layer 2/Layer 3 (L2/L3) VPNs as well as multicast. These Adaptive IP™ Apps provide performance monitoring and correlation of services to traffic flows, as well as monitoring of latency, discards, and jitter, through advanced visualization. In addition, Adaptive IP Apps enable anomaly recognition and alerting.

It has traditionally been a manual process to determine the optical service paths over which IP links are running and to determine the true Shared Risk Link Group (SRLG) values of IP links, including the inherited optical SRLG. In optical networks enabled with Link Layer Discovery Protocol (LLDP) snooping—for example, Ciena's WaveLogic™ Ai or WaveLogic 5 DWDM transponders—the IP to optical traffic matrix can be derived deterministically and, in networks where this is not available, it is derived using algorithmic modeling. In either case, the traffic matrix over the optical transport is known and the SRLG inherited from the optical layer is understood at the IP layer. This enables Adaptive IP Apps to deliver alarm correlation, fault modeling, and full multi-vendor support for mapping, monitoring, and controlling (via Traffic Engineering [TE] tunnels) the network.

In addition to monitoring the network traffic flows, setting up L2/L3 services and TE tunnels, Adaptive IP Apps also display IP network physical layer parameters including device, interface, and link availability. Real-time analytics are available (gathered via traffic and performance telemetry) to provide DVR-like playback of routing events and paths to enable operations teams to understand both how traffic was flowing before a fault, and how it was rerouted.

In short, Adaptive IP Apps provide the operator with complete visualization and control over the IP traffic routed across a multi-vendor network. As described in the next section, combining this control capability with an understanding of optical resiliency models provides a complete multi-layer solution.

Adaptive IP Apps
Optimize IP network performance
Learn how

What resiliency or protection is available at the lower layers for IP?

Understanding and optimizing at the IP/Multi-Protocol Label Switching (MPLS) layer alone is not always sufficient. Optical layer resiliency strategies are often invaluable in delivering IP traffic. Optical transport resiliency can (and, in the case of Ciena, does) include full-capacity or partial-capacity restoration after fiber cuts, the ability to increase capacity of optical service paths, and the ability to signal new optical service paths around bandwidth choke points. Fundamentally, any change at the optical layer requires coordination at the IP layer.

Integrated within Ciena's MCP are Liquid Spectrum™ analytics, which mine and use available optical system margin—a changing variable over the life of the network—to gain optical capacity, improve reach for a specific channel, or increase service availability. In particular, the Liquid Restoration app increases service availability by allowing restoration to occur on available routes with reduced data rates, when full data rate restoration is not possible. In contrast, conventional methods require restoration paths always satisfy the full data rate of the home path.

Use case: Leveraging IP resiliency plus optical resiliency to optimally restore IP traffic

Figure 2 illustrates multiple scenarios for transporting IP traffic over optical networks with different resiliency models:

Baseline: 480 Gb/s of IP traffic is utilizing 60 percent of two 400 Gb/s optical links (a typical IP utilization number) split 50/50 across each optical link, so each carries 240 Gb/s of IP traffic.

Model 1: IP layer resiliency only – A failure has occurred on one of the optical links with no optical resiliency; the IP traffic is rerouted onto the remaining 400G link, but 80 Gb/s of the traffic is dropped.

Model 2: Optical resiliency only – A failure on one of the optical links has been restored, but the restoration bandwidth is only 100 Gb/s, and therefore 140 Gb/s of the traffic is dropped.

Model 3: Combined IP plus optical resiliency – As in Model 2, the restored optical link is operating at 100 Gb/s; however, in this case the IP layer has intelligently adjusted the traffic management to route 20 percent of the 480 Gb/s IP traffic (96 Gb/s) over the 100 Gb/s link, and the remaining 384 Gb/s over the available 400 Gb/s link; therefore, 100 percent of the IP demand is successfully transported.

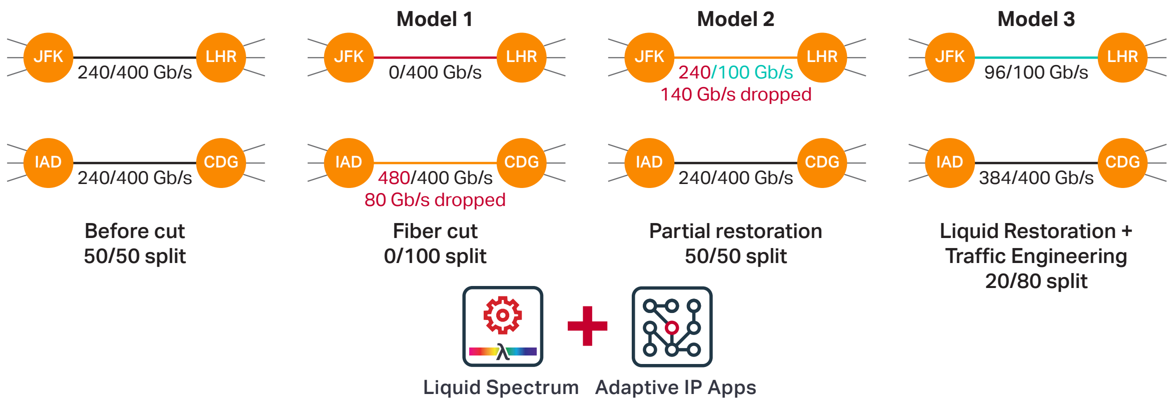

Figure 2. Closed-loop multi-layer traffic engineering

Ciena MCP Applications
Level up to intelligent network control
Learn how

The information flow that informs the IP layer of the capacity at the optical layer, and enables it to derive the optimal solution, is shown in Figure 3. This requires:

- Understanding of the IP over optical topology and traffic matrix
- Network policies to drive deterministic behavior based on network events
- IP-layer TE analysis engines to add, delete, merge, and split segment routing policies to reroute traffic
- Programmable interfaces into the network to drive the required changes to network elements
- Feedback verification to ensure the changes executed delivered the required results

Intelligent network control for IP over optical resiliency

Ciena's MCP domain controller provides an integrated set of applications for controlling, managing, and monitoring both IP and optical multi-vendor networks and network elements. The combined traffic matrix at both layers is modeled within MCP to ensure core functionality, including alarm and fault correlation. SRLG inheritance can be used as inputs to MCP's policy engine to drive automated network resiliency. Optical resiliency strategies include the Liquid Restoration app, which may be used to restore wavelengths in the event of failure and then advertise the available bandwidth to Adaptive IP Apps for policy analysis at the IP layer, and delivery of an optimal comprehensive network resiliency solution. Ultimately, such strategies result in a more adaptable network that end-customers can rely on for their essential digital services.

Was this content useful? Yes No

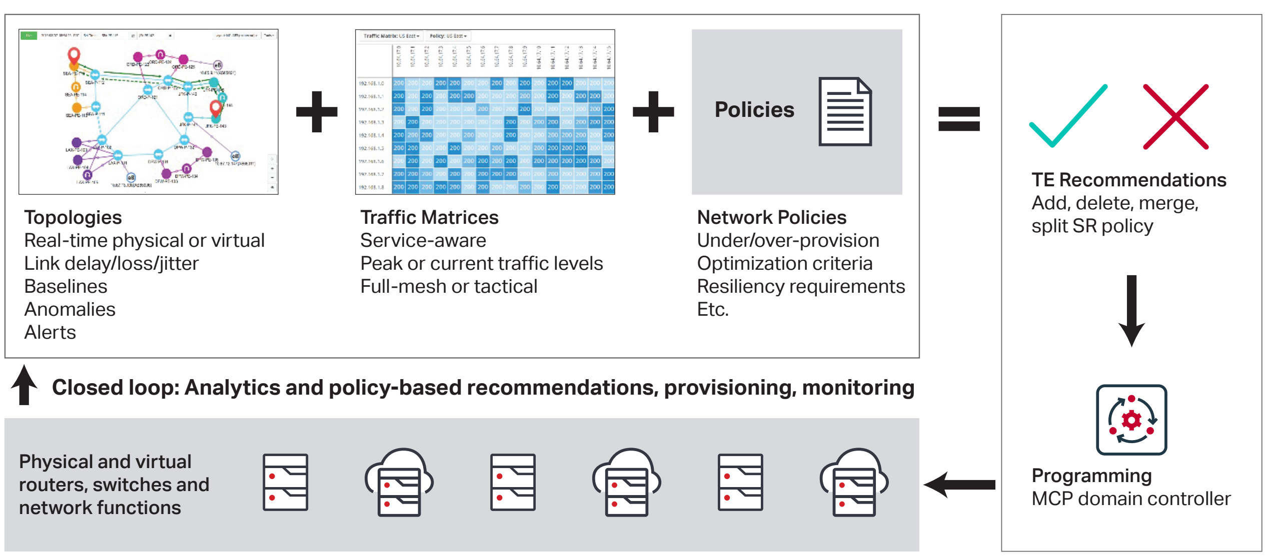

Figure 3. Closed-loop multi-layer traffic engineering

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