APPLICATION NOTE

Liquid Spectrum: Transforming Static Optical Networks into Dynamic, Responsive Assets

Optical networks are largely deployed as rigid, static networks engineered for worst-case scenarios. These include worst-case predicted A-Z capacity demands, worst-case Service Level Agreements (SLAs), conservative margin allocation based on accuracy of fiber loss data and risk tolerance, and worst-case propagation assumptions such as full-fill, end-of-life conditions. In fact, optical networks are built with a 'one size fits all' mentality, where the 'one size' is engineered using best-guess predictions of worst-case conditions. Operators who overestimate the demand on network capacity overspend on capital and end up with underutilized, stranded equipment. Conversely, higher demand than expected leaves operators unable to satisfy customer requirements and requires them to endure the costly, lengthy process of ordering and deploying additional equipment.

In today's constantly evolving, on-demand world, this mode of operation is no longer sustainable. It is not possible to predict the network impact of applications that have yet to be invented, traffic patterns arising from either augmented and virtual reality applications or the billions of devices that have yet to be connected, nor the full implications of the evolution to 5G. What is certain in today's networks is that bandwidth demand at any location is dynamic and fluid, and will change as new end-user devices and applications enter the market.

Ciena's Liquid Spectrum™ network solution changes the way optical networks are engineered, operated, and monetized to help operators achieve the Adaptive Network™. It enables systems that are both scalable to meet today's significant bandwidth demands, as well as open and programmable to deliver the exact service performance required at any point in time.

What is Liquid Spectrum?

Ciena's Liquid Spectrum network solution combines highly instrumented, programmable hardware with advanced software applications that help operators extract the most value from existing network resources. Value can be quantified as

Benefits

- Uses advanced software applications to extract more value from deployed network resources
- Dramatically simplifies how optical networks are designed, built, and operated
- Increases network efficiency by closely matching Layer 0 channel capacity to available system margin
- Introduces new levels of network visibility enabling optimal system performance

improved efficiency, increased capacity, stronger channel reach, increased service availability, or increased automation for faster time to market.

At its core, Liquid Spectrum fully exploits the ability of Ciena's hardware to closely match the capacity of a Layer 0 channel (or wavelength) to the system margin or specific Signal-to-Noise (SNR) ratio required to traverse a specific path of the network. SNR is often expressed in dB units, so one can think of dBs as a scarce resource whose availability is determined by two factors:

- The physics of the route the channel is propagating through (fiber characteristics, linear and nonlinear noise, etc.)
- Customer-defined policies (such as repair and end-of-life margins and risk tolerance)

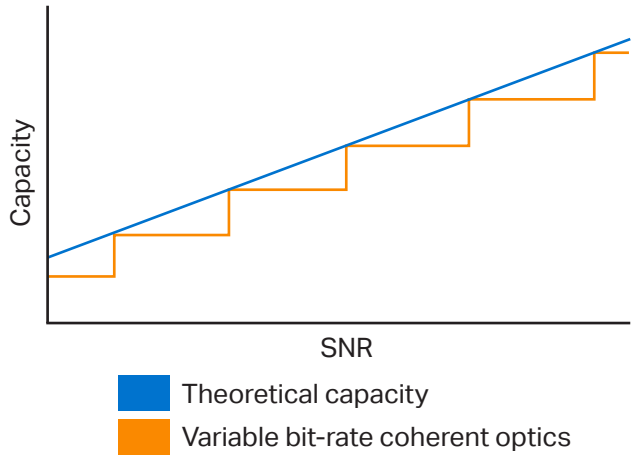

Figure 1. Matching channel capacity to system margin

The 'channel capacity'-to-dB matching can be determined once at the planning phase so capacity remains fixed once the channel is deployed, or performed dynamically over the lifetime of the optical network. The latter takes advantage of the fact that dBs available to the channel can change over time, either due to new network conditions (changing span loss, increased wavelength fill) or new operator-defined policies.

When used in a fixed mode of operation, Liquid Spectrum applications optimize the traditionally valued metrics associated with optical transport: higher network capacity, lower cost per bit, and lower power per bit. Dynamically using Liquid Spectrum applications further improve on the above metrics, enabling exciting new optical network applications and revenue streams for network operators.

Elements of Liquid Spectrum

Ciena's Liquid Spectrum network solution integrates several key elements that can be grouped into two larger categories: programmable hardware and advanced software.

Programmable hardware:

- A flexible grid, reconfigurable photonic layer provides the ability to reroute channels of variable spectral occupancy across any path, and across any optical spectrum in the network. Ciena's WaveLogic Photonics is a highly instrumented, flexible grid photonic layer that supports any combination of colorless, directionless, and contentionless flexibility.
- Variable bit-rate, software-configurable coherent optics can match optimal channel capacity to available system margin for a specific network path. With Ciena's WaveLogic Ai and WaveLogic 5 Extreme coherent optics, operators can tune capacity from 100G to 400G and 200G to 800G—in 50G increments—and take advantage of the higher baud-rate engine to maximize capacity across a wide range of applications, from metro to long-haul to subsea.
- To fully exploit the benefits of tunable coherent transponders, the ability to efficiently map a flexible number of client signals to the variable line capacity is needed. A centralized Optical Transport Network (OTN) or packet switching architecture (such as Ciena's 6500 Packet-Optical Platform) is efficient for this purpose, as it is designed for 'any-client-to-any-line' flexibility. A high-density muxponder solution (such as Waveserver® Ai) is another viable option. In the future, operators could also leverage flexible clients such as Flex Ethernet for Liquid Spectrum applications.

Optical reimagined for an on-demand world **Learn more**

New software capabilities:

- Advanced software applications abstract complexity associated with advanced flexible technologies, enabling operators to fully operationalize and realize benefits associated with the modernized network. The applications are intended to run 'off-box' in the cloud and take advantage of typical cloud computing and scale properties.
  - Ciena's Manage, Control, and Plan (MCP) is a lifecycle operations system that unifies network and service management with granular resource control and online network planning, within a single rich user interface.

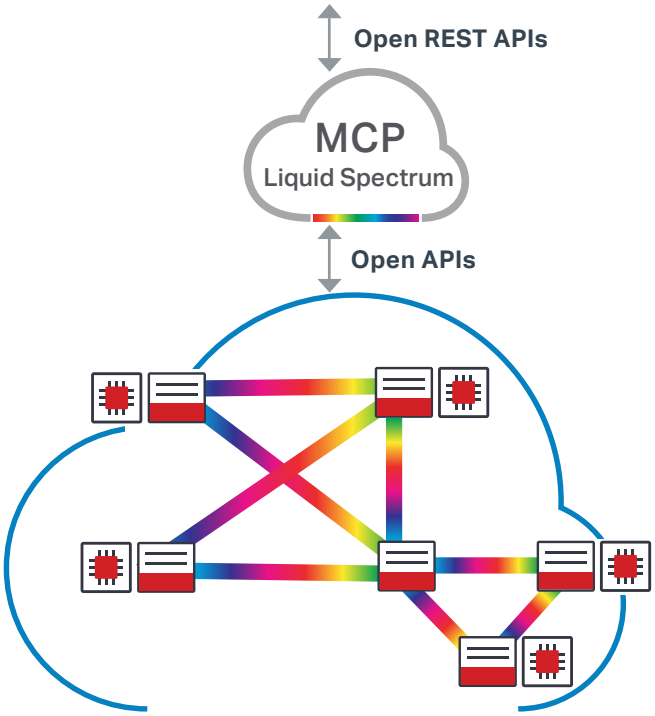

Figure 2. Liquid Spectrum implementation example, using a fully integrated Ciena solution

MCP marks a strategic shift from legacy network management software, enabling the transformation to open, scalable software control that easily integrates into network operators' business processes.

- Liquid Spectrum software applications allow operators to monitor, control, and extract the maximum value from their existing network assets. As an example, operators can mine available network margin and convert it to capacity as needed, allowing them to instantly dial bandwidth up or down, or improve service availability during a disaster recovery situation.

- Modern, normalized data models and APIs are required for high-performance telemetry used to measure and predict, at any time and for various scenarios, the 'scarce' dBs that can be 'spent' and reallocated in the network. Ciena has implemented open interfaces at both the software and hardware levels, giving operators more choice in their architecture implementation.

Liquid Spectrum is designed with an open and disaggregated software architecture to allow customers to reap the benefits of the solution across the spectrum of technology consumption models, from fully integrated solutions to largely disaggregated configurations where customers can select the functions from Ciena they most value.

How Liquid Spectrum is redefining optical networks

To illustrate the value that Liquid Spectrum can bring to optical networks, this document describes several advanced software applications and compares the benefits of the new operating model to the Present Mode of Operation (PMO).

Planning Tool Calibrator

In networks today, optical hardware deployment decisions are made based on upfront link engineering, which is often determined using inaccurate fiber characterization data. Lack of network visibility and little hardware flexibility limit network efficiency, forcing operators to operate at suboptimal capacity and resort to unnecessary overbuilds. Limited visibility into the stability of system margin also means operators are often unaware of system performance degradation until there is a service impact.

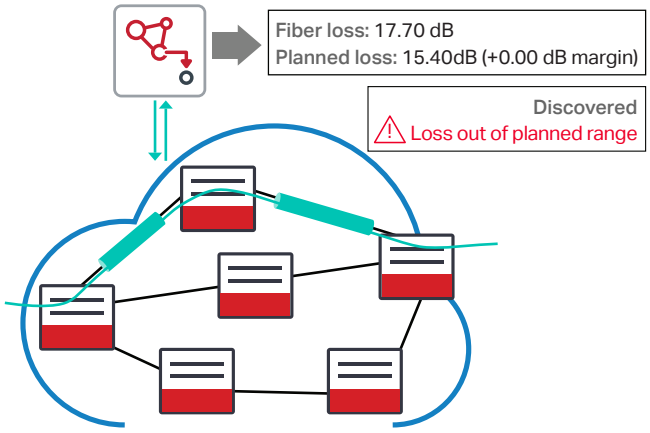

Figure 3: Planning Tool Calibrator

Planning Tool Calibrator accesses actual fiber characterization data for deployed services, including fiber span loss, using real-time data from the network. This accurate fiber characterization information feeds into planning tools to ensure optimal network designs, without all the manual link engineering and spreadsheet checking processes currently in use today. Now operators can quickly compare real-time data against reference data and update planning data for future services, significantly optimizing capacity planning, and providing the ability take action in case of fluctuations. With this information, users have access to real-time, accurate data for both the existing services and new planned services and can proactively ensure optimal performance.

Bandwidth Optimizer

Today, when operators need to deploy a certain amount of capacity between two points, they manually select the type of wavelength they expect to deploy and perform a link engineering exercise that results in a 'Pass' or 'Fail' outcome. Expert users run the exercise for all available wavelength capacities. Once the link engineering is complete, users manually determine the maximum channel capacity that can be deployed with acceptable margin for the path in question. Typically, all modems are set to the same capacity for the same route. This process becomes increasingly complex as a multitude of settings (such as baud and capacity rates) become available with next-generation coherent technology.

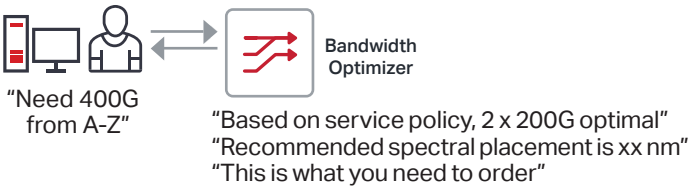

Figure 4. Bandwidth Optimizer

Bandwidth Optimizer greatly simplifies this process. An operator simply inputs the total capacity requirements for points A to Z, and Bandwidth Optimizer outputs the optimal solution for the network. It provides the optimum configuration (with associated Bill of Materials) and channel placement based on customer-definable margin policies.

Bandwidth Optimizer becomes even more powerful when used dynamically on installed equipment. In situations where new unplanned services need to be turned up quickly, new service policies can be put into effect (for example, end of life and repair margin can be reduced), and Bandwidth Optimizer can recalculate the new hardware provisioning and capacity for the new policies. Operators now can quickly respond to new service demands using existing network resources.

Channel Margin Gauge

Channel Margin Gauge provides instant real-time visibility into network efficiency, with the ability to turn up capacity on demand. Channel Margin Gauge grants users access, for the first time, to real-time SNR operating margin for services that are deployed in the network. Using this real-time data from the network, operators have access to performance SNR for a single channel, all channels on a path, or all channels in the network. This application becomes even more valuable with variable bit-rate coherent optics, as the user is better able to match optimal capacity to available margin

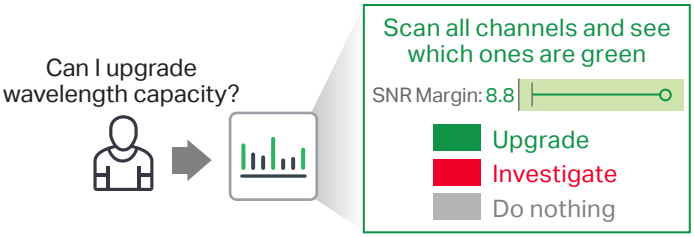

Figure 5: Channel Margin Gauge

across the network. For each photonic service, the SNR margin data is displayed in an easy to read, color-coded horizontal bar graph that will be highlighted in green if the signal can be upgraded based on the analysis of data collected over several days. This tool can also operate with Blue Planet Analytics to provide historical trending analysis that operators can use to take proactive action and ensure stable system performance before services are affected.

Bandwidth Optimizer and Channel Margin Gauge are foundational Liquid Spectrum applications that will enable a whole series of new, value-added applications for customers.

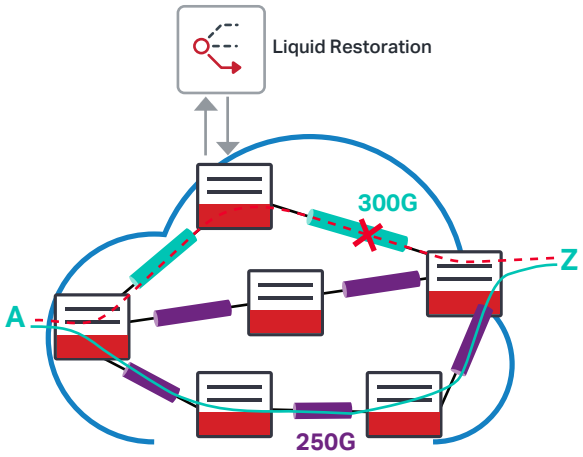

Figure 6. Liquid Restoration

Liquid Restoration

Today, optical restoration of wavelengths is limited in its capabilities. Restoration can only be completed successfully if: a) the restoration path is viable for the full capacity to be restored, often resulting in the need to pre-deploy regen equipment; and b) the exact amount of spectrum used in the working path is available on the restoration path.

Liquid Restoration uses Bandwidth Optimizer and Channel Margin Gauge, and user-defined service policies alongside flexible photonic resources to increase service availability versus the PMO. In contrast to today's networks, where

services would have been dropped or additional hardware would have needed to be deployed, Liquid Restoration flexibly adjusts the transport capacity of deployed coherent optics as needed for operation across any available path in the network.

Wave-Line Synchronizer

In today's PMO, when an operator wants to deploy transponders from Vendor X and a photonic line system from Vendor Y, there are numerous manual provisioning steps and potential for errors because the equipment uses two different software systems.

Wave-Line Synchronizer synchronizes the settings of the modems and photonic lines to which they are connected, accelerating service provisioning, reducing manual provisioning steps, and eliminating associated human errors for multi-vendor optical deployments.

The new 'on-demand'

The ability to deliver service and bandwidth on demand is something that has been discussed in the industry for years. In today's PMO, the requirement for bandwidth on demand is largely addressed in Layers 2 and 3 of telecom networks. The optical network does not participate in bandwidth reconfiguration and, in fact, must be engineered (with additional hardware pre-deployed) to handle the maximum peak capacity expected at any specific time, in any specific location.

Liquid Spectrum Chalk Talk
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Liquid Spectrum completely changes the operating model. With Liquid Spectrum, the dBs available in the optical network now can be mined and borrowed to temporarily increase network capacity via software and flexibly move capacity where it is needed using existing network assets. Link budget studies show that, depending on network conditions (start-of-life vs end-of-life, percent wavelength fill, etc), a 30 to 100 percent capacity increase can be obtained from existing deployed hardware by temporarily borrowing and re-arranging dBs of margin. With Liquid Spectrum, operators have access to new revenue streams and can more fully monetize existing assets.

New rules for a new world

Ciena's Liquid Spectrum delivers agility through a fully programmable and instrumented infrastructure, operational simplicity through sophisticated applications, and choice in architecture implementation through open APIs and a building block approach. With Liquid Spectrum, Ciena is redefining how optical networks are built, with a blueprint for a software-defined architecture that is more agile, dynamic, software-driven, and open—to help operators realize the benefits of Ciena's Adaptive Network.

Was this content useful? Yes No