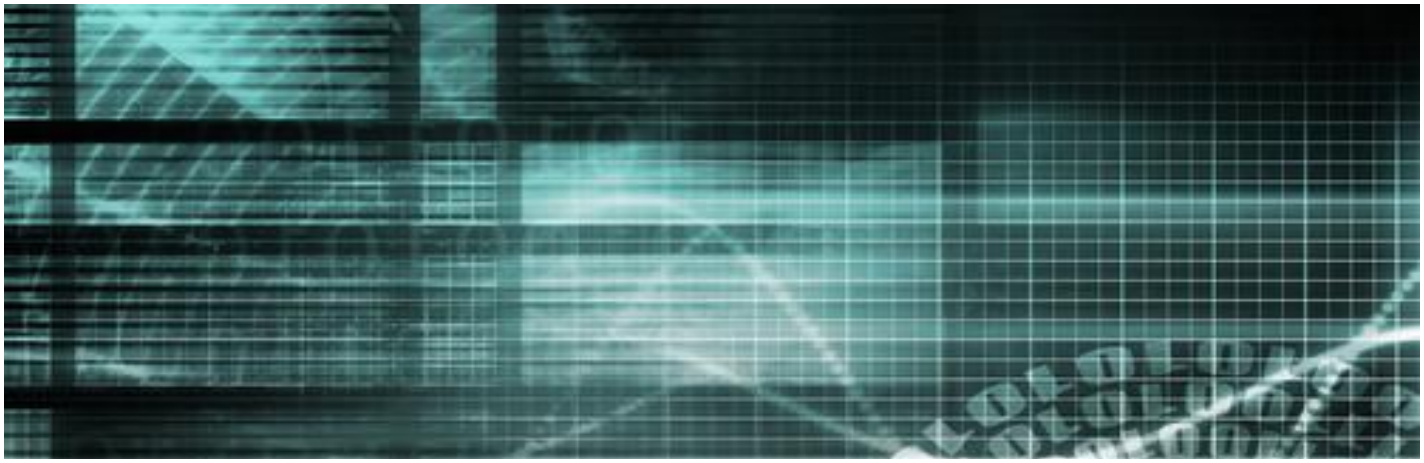
Business Case for Cyan Packet-Optical Hollow Core



Executive Summary

Cloud, virtualization, video and mobility services are driving exponential growth in bandwidth demand. The cost of keeping pace with this growing demand is outpacing the revenue generated, squeezing service providers' margins and threatening their business models. Looking a little deeper, the characteristics of the traffic are also changing. New traffic patterns are creating opportunities to optimize traffic flows, simplify the core network and minimize the need for routing.

Cyan's packet optical hollow core, IP over Connection-Oriented Ethernet (IPoCOE) solution, reduces costly IP core routing by handling transit traffic using low-cost Ethernet, OTN and WDM switching. Cyan's Blue Planet SDN software platform provides virtualized, open, and logically centralized network control that simplifies the development, deployment, and orchestration of scalable network-based services. Blue Planet makes it easy to plan, operate, and validate networks and services in large networks composed of Cyan Z-series and third-party network elements.

ACG Research examined the five-year total cost of ownership (TCO) of Cyan's packet-optical hollow core network solution versus comparable LSR and IP over OTN (IPoOTN) solutions. It found Cyan's TCO is 71 percent lower than the LSR alternative and 48 percent lower than the IP over OTN alternative. The packet optical transport platforms used by Cyan and IPoOTN operate at much lower cost than the router-based technology of the LSR alternative. This accounts for much of the cost savings of the Cyan and IPoOTN alternatives as compared to LSR. The Cyan Blue Planet virtualized and open SDN control plane is significantly more cost efficient than the vendor-specific (or proprietary) embedded GMPLS and MPLS-based control planes used by the IPoOTN and LSR alternatives, respectively. Blue Planet delivers operation expense savings, accelerates business process cycle times, and creates value-added revenue opportunities that extend beyond the network operation.

KEY FINDINGS

Cyan provides an IP over Connection-Oriented Ethernet solution for the core network built upon the economics of 100 Gbps technology and Cyan Blue Planet SDN software. The solution when compared to LSR and IP over OTN alternatives has:

- 71% and 48% lower TCO than LSR and IP over OTN, respectively
- 67% and 34% lower CapEx than LSR and IP over OTN, respectively
- Much faster process cycle times and TCO reductions that extend beyond the network operation because of the Blue Planet's virtualized and open SDN control plane that explicitly links the application and network infrastructure

Introduction

Cloud, virtualization, video and mobility services are driving exponential growth in bandwidth demand. Demand for residential and business fixed services and mobile services is growing at a 35 percent compound annual growth rate (CAGR). Costs to support these bandwidth increases, furthermore, are increasing faster than service providers' revenue growth and threatening service providers' business models.

However, the economic efficiencies of cloud computing, video caching and network function virtualization (NFV) are driving (and will continue to drive) proliferation of data centers within the metro area. The result is that additional intra metro area traffic is generated by the cloud computing model as multiple data centers are employed to process individual end-user transactions (east-west traffic flows among data centers). Consequently, metro area traffic is projected to grow at 45 percent CAGR. Conversely, with more traffic originating/terminating in the metro area, backbone traffic growth rates are reduced because more service requests are handled locally (25 percent to 30 percent CAGR). This concentration of traffic originating/terminating at metro data centers also results in a smaller number of aggregate flows transiting the backbone (core) that do not need to be routed in the core. The accelerating growth in the metro and creation of aggregate flows that transit the core create the need for 100 Gbps Ethernet in the metro.

The change in network traffic patterns combined with the attractive economics of 100 Gbps transport technology creates the opportunity to rearchitect the core network to be more scalable and, therefore, improve the viability of service providers' business models.

Cyan's packet optical super core (IPoCOE) solution delivers a low-cost, scalable solution that exploits these new economic opportunities. The Cyan solution matches core networking requirements to the most effective technology. More than half of core network traffic transits the core (does not require routing). The Cyan solution utilizes cost-efficient Ethernet, OTN and WDM to handle this transit traffic and, thus, minimizes high-cost core IP routing. The solution employs Cyan Blue Planet SDN platform, which provides end-to-end network management and control, service automation, agility through open programmable interfaces. This improves service availability by shortening troubleshooting times and enabling dynamic protection schemes. It also simplifies planning, service provisioning and maintenance of the network.

TCO Analysis of Core Network

Five-year TCO of core network switching and routing systems are analyzed to compare the costs of Cyan's IPoCOE approach with LSR and IPoOTN alternatives. Figure 1 summarizes the TCO modeling process.

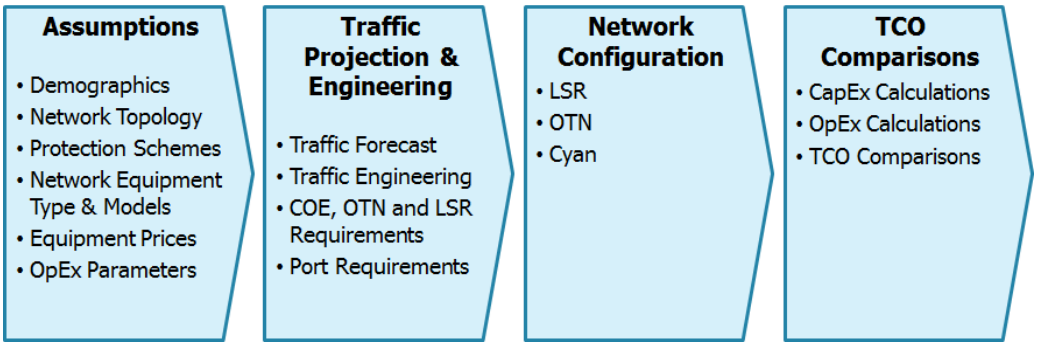


Figure 1 – TCO Modeling Process

The modeling process simulates the buildout of an actual network. Traffic projections are made using input assumptions such as demographics and the network topology. Traffic engineering is performed to assign bandwidth requirements to network nodes and links using the network topology defined in the next section. The results then are used to estimate I/O port requirements. The equipment required for each alternative then is configured and priced out using market pricing.

Operation Expense (OpEx) estimates can be grouped as:

- Vendor service contracts: These are recurring charges for vendor support contracts and are estimated as a percentage of the installed network equipment investment.

- Environmental expense: Annual cost of power, cooling, and floor space are all driven by power consumption. Power consumption is calculated for each installed chassis. Price per kilowatt hour (KWH) is applied to the KWH required to power and cool the equipment. Floor space requirements are derived from the power density limit per square foot specified by Network-Equipment Building System standards and the price of floor space for data centers or POPs.

- Training: These costs are estimated as a function of the number of hours of training required for each of three pay grades (hands-on technicians, first-level supervisor or engineer, and second-level supervisor or engineer), and the loaded labor rates. Separate estimates are made for each network equipment chassis type and model.

- Testing & certification operations; engineer, facilities & install; operations, administration and maintenance; and network upgrades and patches: Are all estimated by assigning per chassis hours of year required by each pay grade values for each equipment type and model, computing total chassis under management and then applying the labor rates to the annual estimates of labor hours.

Typical Core Network

Figure 2 shows the topology of a typical core network serving eight large metropolitan areas.

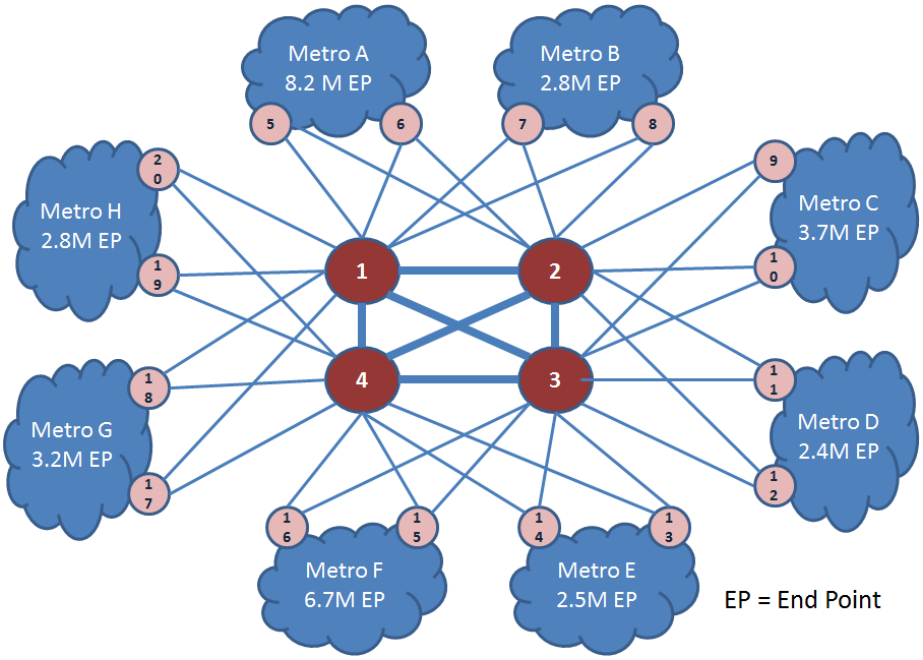


Figure 2 – Typical Core Network

The core network serves eight metro areas with total fixed residential and enterprise, and mobile end points as shown. Core traffic flows are projected as a function of the number of end points. Core traffic has a five-year CAGR of 30 percent. Figure 3 shows the range of traffic volumes across the eight metro areas.

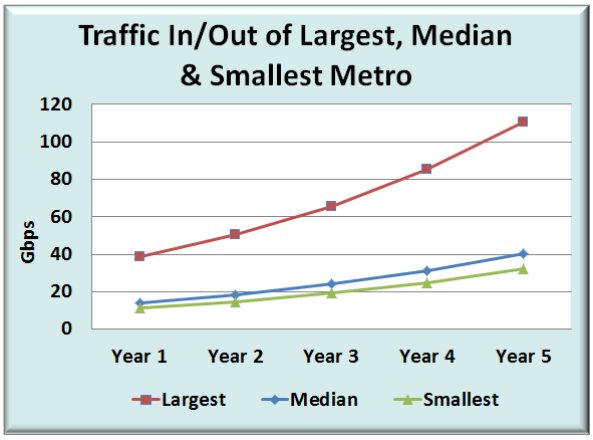


Figure 3 – Range of Traffic Volumes across All Metro Areas

The following common assumptions are used for all three solution alternatives:

- Five-year study
- Capital Expense (CapEx) of Cyan, LSR, and OTN network elements is included in TCO
- OpEx includes all expenses directly related to the Cyan, LSR, and OTN network elements
- TCO of optical transport equipment, IP routers, cable, right-of-way, and outside plant structures is not included

Figure 4 shows the configuration of each core node.

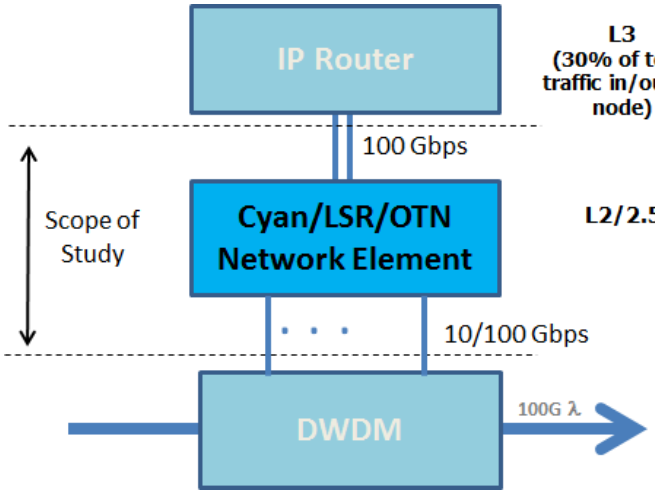


Figure 4 – Core Node Configuration

The cost of the Cyan, LSR or OTN network element is modeled. 10 Gbps ports provide the interface between each metro area and the core nodes. 10 Gbps ports also connect the PE core nodes (nodes 5 through 20) to the P core nodes (nodes 1 through 4). 100 Gbps ports connect the four P core nodes in a full mesh, and 100 Gbps ports are used to connect IP routers located within every core node to the Ethernet, LSR or OTN switch also located within each core node. Neither the cost of the IP router nor the cost of the DWDM equipment is included in the study because these costs are the same for all three solution alternatives.

Cyan IP over Connection-Oriented Ethernet

The Cyan IPoCOE solution is implemented via the Z77 packet optical transport platform. The Z77 is optimized for packet and the transition of TDM to packet. It supports advanced packet switching and transport over Connection-Oriented Ethernet, SDH/SONET, OTN and/or wavelengths.

The Cyan Blue Planet SDN platform provides virtualized network control. It simplifies the development, deployment, and orchestration of scalable network-based services. Blue Planet makes it easy to design, operate, and view networks and services in large networks composed of Cyan Z-series and third-party network elements. The open APIs enable service and application development in a multivendor environment.

Label Switch Routing

Most Label Switch Routing solutions use a vendor-specific (or proprietary) embedded MPLS control plane to switch Layer 2/2.5 traffic flows via Label Switched Paths (LSPs). This approach is less costly than full IP routing; however, its use of an embedded MPLS control plane retains many of the high-cost elements of IP routing as full routing stacks (BGP, ISIS, OSPF) and protocols (LDP, RSVP) are required to establish, signal, and maintain LSPs.

IP over OTN

The IPoOTN solution is implemented using a packet optical transport platform. The platform supports a traffic mix that includes TDM, WDM, Ethernet and OTN on a single converged network. The OTN switching function includes OTN mapping, multiplexing, and transport for standards-based management

and networking. A proprietary G-MPLS control plane is employed. This approach has a number of proprietary elements and is high cost compared to a virtualized and open SDN approach. While the control plane has been moved from Layer 3 to Layer 1, the fundamental network performance and economic issues resident in the MPLS model have not been addressed. G-MPLS effectively relocates the problem from Layer 3 to Layer 1.

TCO Results

Figure 5 summarizes the TCO of the three alternatives.

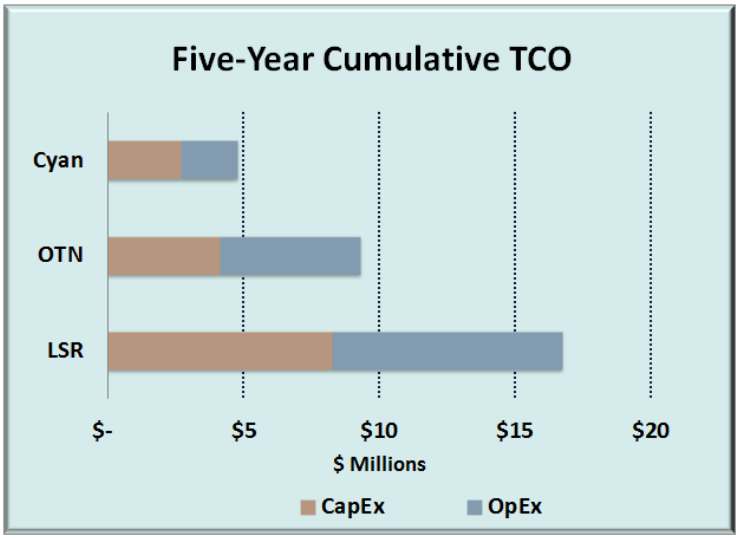


Figure 5 – Five-Year Cumulative TCO Comparison

Cyan's TCO over five years is 71 percent lower than the LSR alternative and 48 percent lower than the IPoOTN alternative. Cyan's CapEx is 67 percent lower than the LSR alternative and 34 percent lower than the IPoOTN alternative. Cyan's OpEx is 75 percent lower and 60 percent lower for the LSR and IPoOTN alternatives, respectively.

The packet optical transport platforms used by Cyan and IPoOTN are much lower cost technologies than the router-based technology used by the LSR alternative. This is the primary source of CapEx savings when either Cyan's platforms or IPoOTN is compared to LSR. Packet optical transport platforms are lower cost than the router-based technology because they can flexibly apply packet, OTN, and WDM technologies to optimally match the lower cost but less granular control capabilities of the lower layer technologies versus the more granular but higher cost Layer 2 and Layer 3 technologies. They also have a cost advantage in that the packet optical transport designs are of more recent vintage than existing LSR designs that are implemented on older IP router designs. Packet optical transport systems also are able to operate at higher capacity utilization levels than LSR solutions because they support integrated planning and operation of the packet and optical transport layers. The LSR solution functionally and organizationally separates the packet and optical transport layers. Separation of the layers forces suboptimization of packet and optical transport capacity because of the longer planning and operational response times required when the layers are planned and operated as separate overlays. A recent ACG Research study found up to a 50 percent TCO savings can be achieved through integration of the planning function alone.

Cyan, in addition, employs an open and virtualized SDN control plane that is more cost efficient than the embedded and proprietary G-MPLS control plane used by IPoOTN or the MPLS control plane used by LSR. The open and virtualized control plane solution is lower cost than either distributed control plane solution because:

- Virtualization of the control plane function reduces compute, storage, and memory costs at each network node, and the open designs carry lower prices than proprietary designs

- The SDN control plane function supports the explicit linkage of the application layer to the network infrastructure that enables:
    - Operation at higher capacity utilization levels
    - Reductions in costly network downtime
    - Higher service velocity that supports creation of value-added services and network operator wide reductions in OpEx

OpEx Savings Sources

Figure 6 compares the five-year cumulative cost of each OpEx category.

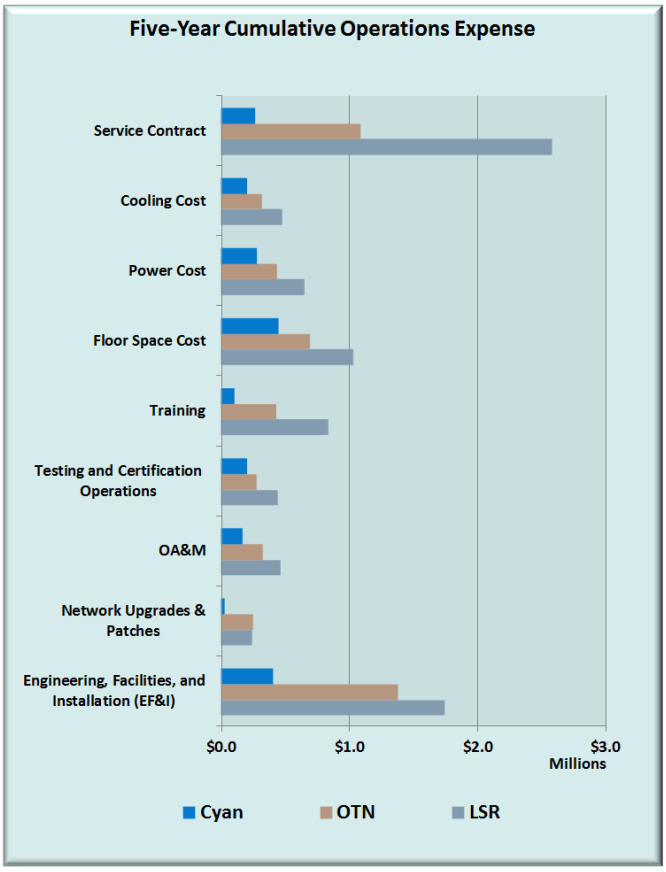


Figure 6 – Five-Year Cumulative OpEx Comparison (IP Routers Excluded)

The service contract, Engineering, Facilities and Installation (EF&I), and environmental OpEx categories produce the largest savings for Cyan when compared to the other alternatives. Service contracts (vendor annual service fees) are closely tied to equipment cost; consequently, the source of those savings is the same as those affecting CapEx savings. Cyan Blue Planet software includes a Planet Design module that

provides network planning and design services. This is the source of Cyan's EF&I savings. The benefits of Planet Design are discussed in the next section. The packet optical transport designs of the Cyan and IPoOTN alternatives are much more energy efficient than the router-based design of the LSR alternative. This drives their lower environmental expenses (floor space, power and cooling) as compared to the LSR. Also, Cyan's centralized SDN control plane employs fewer total resources than the other alternatives. They distribute control resources to all network elements. This provides a further environmental expense reduction for Cyan compared to the alternatives.

The extensive use of virtualization, abstraction and orchestration by Blue Planet simplifies all operations activities: operations, administration and management; network upgrades and patches; and testing and certification operations. This consolidates and/or eliminates many manual tasks, resulting in fewer labor hours, which is the largest cost item. Cyan produces significant labor savings compared to LSR and IPoOTN. The labor and time savings benefits of Blue Planet go beyond the direct impact on core network element OpEx and are discussed in the next section.

Additional Benefits of Cyan's Open SDN Architecture

The preceding TCO analysis, which is directly related to the Layer 2 and Layer 3 core network elements, quantified the CapEx and OpEx savings of Cyan's IP over Ethernet solution. However, the benefits of Blue Planet extend well beyond network equipment TCO to other business processes, including service delivery, supply chain, customer management, and service creation (See Figure 7). SDN affects these other categories. For example, SDN reduces COGS by decreasing server expenses by supporting software running in the cloud and reduces SG&A by enabling streamlined business processes, which decreases staffing requirements.

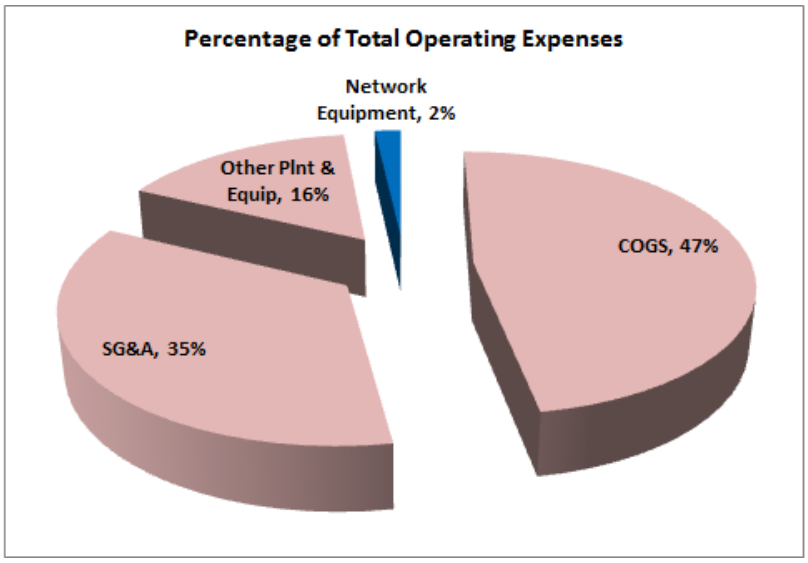


Figure 7 – Decomposition of Total Service Provider Operating Expense[1]

[1] Network equipment and other plant and equipment depreciation and amortization expense (depreciation and amortization is used by accountants to represent CapEx items commensurately with other operating expense items); cost of goods and services; sales, general, and administrative expense.

Blue Planet software includes the following capabilities whose benefits reach across multiple service providers' business processes.

End-to-end Provisioning

Planet Operate is a multilayer management solution that provides conventional FCAPS functionality in addition to more advanced three-dimensional (3D) visualization and multivendor support. End-to-end (A-to-Z) provisioning enables interactive creation of optical and packet transport tunnels. Import tools allow bulk service creation and enable rapid, low-risk turn-up. Multilayer visualization under a common management framework allows operations staff to better understand interfunctional relationships, which improves communication and coordination even in organizations that separate functional teams based on the network layer.

Service providers using Planet Operate have service turn-up time intervals reduced from 30 to 45 days down to a few minutes. OpEx also is reduced by a 7:1 factor.[2] This is achieved through orchestration and virtualization processes that span the network from access to core and across layers, including WDM, OTN and Ethernet. The result is that, multiple touch-points that required manual CLI interactions are replaced by a unified and automated process.

Troubleshooting

Trail View provides Network Operations Center (NOC) personnel an end-to-end view of a path across multiple layers, including Ethernet, OTN and wavelengths on a single screen. It includes color-coding and 3D to improve visibility. Multivendor support eliminates the need by NOC staff to reference many screens displaying multiple element management system statistics. This speeds fault detection and resolution processes that improve quality and reduce OpEx by minimizing NOC staffing requirements.

Service Level Agreement (SLA) Assurance

Planet View provides performance monitoring and SLA assurance service. It can be made available as a cloud-based portal for use by the service provider's operations staff or by individual end-customers. Dynamic bandwidth controls can be extended through Planet View and automatically linked to usage-based billing software to create high-margin, value-added services or as a bundled component of a premium service offering. Also, service offerings can be differentiated by offering low-latency path or low-cost service options.

The value of Planet View is enhanced through third-party support for 20 vendors and 50 equipment types. This saves OpEx by accelerating internal service management and monitoring processes and increases customers' value perceptions (and loyalty) by broadening customers' ability to monitor and control their services. Differentiated services and increases in perceived value enhance revenue and profit margins.

[2] ACG Research studies: See business cases at http://www.acgresearch.net/UserFiles/File/Brocade/Brocade%20SDN%20Business%20Case%20Whitepaper_%20ACG%20Research_2013.pdf.

Network Planning and Design

Planet Design is cloud-based SDN planning software that enables service providers to design multilayer networks quickly and cost effectively. It integrates planning through the wavelength, OTN, and packet transport layers to create a cost-optimized design. Also, it provides the capability to create an end-to-end minimum latency design across multiple layers by taking into account the distances between nodes and the type of processing occurring along planned routes. Once planning is done Planet Design auto-generates a complete network BOM that includes equipment configurations and installation checklists. It also links to Planet Operate management applications to aid operational planning and to Google Maps to assist sales initiatives within the footprint of the new network.

This shortens the planning, design, and implementation cycle from 18 months to less than two months. This much shorter cycle dramatically reduces planning, design, and implementation costs by automating many manual tasks. The much shorter cycle eliminates the need to project capacity requirements far in advance. Capacity projection error variation declines exponentially as planning cycle time is reduced. Consequently, both the risk of providing too little capacity, which impairs service quality, and the risk of providing excess capacity, which increases CapEx, are dramatically reduced. For example, a recent ACG Research study[3] showed that elimination of an over capacity error of 10 percent in planning the capacity of a protected optical wavelength produced a 50 percent TCO savings over five years.

NOC Services

Cyan offers turnkey NOC outsourcing service. Service offerings range from augmenting and supporting existing service providers' NOCs to providing a fully customized turnkey NOC service. Service providers have found these services to be valuable in providing comprehensive coverage from the turn-up of the Cyan solution and as a means of minimizing the learning curve for their internal NOC personnel. This improves services agility, simplifies new products and technology integration, and accelerates operational efficiency.

Conclusion

Cloud, virtualization, video and mobility services are driving exponential growth in bandwidth demand and, in turn, network cost. Service providers' revenue growth is not keeping pace with the rising cost. This is squeezing service providers' margins and threatening their business models.

The new service offerings, however, are changing metro traffic patterns, which are concentrating traffic at metro hubs. Consequently, packet aggregation in the metro results in aggregated traffic flows that transit the core network without the need for routing.

These changes in traffic patterns combined with the attractive economics of 100 Gbps transport technology create the opportunity to build a more scalable and cost-effective core network.

[3] See business case studies at http://www.acgresearch.net/UserFiles/File/Cisco%20Documents/Cisco%20nLight%20Economics%20Whitepaper_ACG.pdf.

Cyan provides an IP over Connection-Oriented Ethernet solution for the core network that exploits the economics of 100 Gbps transport technology and the capabilities of Blue Planet, its SDN software.

ACG Research compared the five-year TCO of Cyan's core network solution with LSR and IPoOTN solutions. It found Cyan's TCO is 71 percent lower than the LSR alternative and 48 percent lower than the IPoOTN alternative. The packet optical transport platforms used by Cyan and IPoOTN operate at much lower cost than the router-based technology of the LSR alternative. This accounts for much of the cost savings of Cyan's platform and IPoOTN as compared to LSR. Cyan, in addition, employs an open and virtualized SDN control plane that is more cost efficient than the proprietary and embedded G-MPLS distributed control plane used by IPoOTN. This accounts for the remaining CapEx savings produced by Cyan as compared to IPoOTN.

Cyan's packet-optical core approach and its open SDN architecture also produce TCO reductions that were not explicitly analyzed. These include SDN contributions to streamlined businesses processes such as service delivery, supply chain, customer management and service creation. Also, though not discussed in this analysis, the packet-optical core approach may ultimately eliminate the need for some core routers. This will produce an even more dramatic TCO reduction.