A Transformative Architecture Challenging Present Modes of Operation

An Executive Brief on Routed Optical Networking: Network Layer Convergence

Introduction

Faced with rising operating costs and flattening revenues, service providers are exploring approaches to meet these changing market conditions. Service providers are looking for a solution that offers investment protection for the massive growth of IP services without requiring linear cost increases in Capital Expenditures (CAPEX) and Operating Expenditures (OPEX). In the past, network operators had to upgrade their networks every 3–5 years since the focal point of the upgrades was usually to deliver a new type of service. This led to dramatic OPEX increases because each upgrade required new ways to deploy, new planning management, and new planning tools.

Additionally, service providers are trying to keep up with the rapidly evolving offerings of today’s content and application providers. Service providers will need to create a more elastic infrastructure to meet the increasing demands of 5G, Internet of Things (IoT), and cloud-based applications. One of the key features of that infrastructure is meeting demands on the scale required for high-value services while maintaining existing revenue offerings. These challenges exist because most networks are layered and siloed into separate technologies and adding a service can now add cost at each layer. Redundant protection at those layers also results in poor network utilization and additional complexity.
New solutions therefore must address the operational aspects of the network. Today, operational costs make up almost 80 percent of network costs. The high-cost pain points lie in the complexity of managing multiple layers, the power and space constraints, and lifecycle management. Services today run over routers, Optical Transport Network (OTN) switches, optical transponders, and Reconfigurable Optical Add-Drop Multiplexers (ROADMs) on a traditionally layered architecture managed by different departments. In the past, IP and optical integration, or IPoWDM, suffered from density tradeoffs and different technological advancement cycles. Organizational boundaries slowed the potential to leverage oncoming advances in automation. With this present mode of operation, it is difficult to properly optimize any network.

There is a transformational architecture causing significant economic disruption in electronics today and leading service providers to consider its adoption when compared to their present operating mode. Network Processing Units (NPUs) in routers can now scale from 10s to 100s of Terabits, and 400G optics are reduced in size and power, thus providing an opportunity to design and architect the network in very different ways than before.

Scaling router platforms was always a challenge, which led to the creation of router bypass and ROADMs. This architecture is a viable option now that massively scalable routers and new optics are on the market. And it provides investment protection for years to come given the scalability of the electronics.

Perhaps most important is the five-year 60 percent OPEX savings from simplifying network management. Although CAPEX savings are relatively small, OPEX savings of 60 percent are quite significant. Even better, Total Cost of Ownership (TCO) for IP aggregation in mobile backhaul applications show savings of up to 50 percent in CAPEX and 70 percent in OPEX.

Rethink your network

Cisco’s vision for a new solution is to leverage the fundamental lifecycle changes happening in the area of routers and optics and utilize those technologies in a different architecture. These technologies – Cisco 8000 routers, 400G ZR/ZR+ coherent optics, simpler DWDM line systems, telemetry software and automation – all lead to a new network paradigm.

That new network is a point-to-point architecture where all wavelengths terminate at all sites. This is also called “Routed Optical Networking.” It will enable operators to maintain their growth and protect their investment over the next 10–15 years. Early models (ACG TCO) have proven over 45 percent (see Figure 1) OPEX savings to date.
Figure 1. Five-Year Cumulative OPEX of IP Transport to Router Bypass (Source: ACG Research 2020)

Figure 2. Routed Optical Networking Architecture
"Cisco is fully committed to the Routed Optical Networking architecture. This is a strategic investment today across our routing, optical, management and automation platforms."

Jonathan Davidson
SVP/GM, Cisco Mass-Scale Infrastructure Group

The Routed Optical Networking solution works by merging IP and private-line services onto a single Internet Protocol/Multiprotocol Label Switching (IP/MPLS) network where all switching is done at Layer 3. Routers are connected hop-by-hop over point-to-point WDM links with standardized optics. Flexible management models are enabled through a single network layer for model-driven programmability that provides automated turnup and provisioning. This simplified architecture enables open data models and standard APIs, allowing a provider to focus on automation initiatives for a simpler network topology (see Figure 2). A multi-phased approach to adopting this architecture will leverage existing infrastructure.

The benefits of the Routed Optical Networking architecture result in simplified planning, design, activation, troubleshooting, and management because it’s a single layer. Reducing devices in the network enhances resiliency and availability, while it also optimizes for fiber capacity since the optical distances are decreased. In short, it simplifies all aspects of maintaining the network.

Cisco has also created a process to provide a comparison between the present mode of operation and a five-year growth plan. Since each operator has unique challenges and specific network designs, Cisco created modeling tools to help compare the present network to a converged architecture network. These modeling tools compare fiber capacity, ROADM scalability, and the IP traffic both on and off the DWDM infrastructure to what it might look like years from now.

For instance, one modeling effort took an operator’s five-year growth plan and increased the traffic at a Compound Annual Growth Rate (CAGR) beyond their estimates, then extended it to a 15-year lifecycle. In this example, the converged architecture proved to be a significantly lower TCO investment. The modeling tools today can take any complex network design and run it quickly without waiting weeks or months for results.

Conclusion

The economics of networking are changing thanks to a new generation of massively scalable routers and 400G optics, enabling the collapsing of layers that will result in simpler topologies and a lower cost per bit.

Ultimately, network optimization will provide efficient network utilization and accelerated time to service. Cisco is leading the way with this disruptive and transformational architecture designed to simplify the network and lower the TCO.

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