Converged SDN Transport: Changing the Economics for Communication Networks

Value Statement
Cisco® Converged SDN Transport is a simplified, trustworthy, programmable network architecture that changes the economics of networks to deliver connected experiences at massive scale.

Overview
Before 2020, the public had a general appreciation for the IP infrastructure of the internet that connects our world together. Over the past 20 years, the internet has scaled to address an insatiable desire for bandwidth to support streaming services, online gaming, cloud-based business applications, and low-latency critical services for healthcare and financial institutions. During the first half of 2020, the impact of the COVID-19 virus turned a general appreciation into a critical dependence on the internet as the collective global community transitioned to remote connectivity for work, shopping, education, and healthcare. Under massive strain from this new demand, the internet did not break and communication service providers (CSPs) became heroes, as their ability to provide connectivity withstood unprecedented growth.

While connectivity did not break, network weaknesses were exposed under this extraordinary demand. Years of adding new technology in support of emerging services on top of existing technologies and services has resulted in a complex topology that is difficult to manage. To scale quickly with demand, CSPs had to add new infrastructure rapidly and without the ability to plan or test the potential impacts. As a result, more complexity was added into the existing network management structure, increasing the potential for errors and failures.

Using a Converged Software-Defined Network Transport (Converged SDN Transport) framework can help CSPs reduce the overall complexity of their network and operations while also allowing them to build the necessary controls into their network to satisfy the stringent performance needs of today’s advanced service offerings.

Benefits
The Converged SDN Transport architecture uses advanced features and technology to help service providers design and migrate to a network that is prepared to scale to meet stringent bandwidth and performance demands.

Implementing the design will allow service providers to realize the following business benefits:

• Reduced operational complexity for network management
• Increased revenue with a service-centric network
• Improved time to market for new services
• Optimized utilization of fiber capacity
• Decreased costs
The need to grow networks quickly but reduce complexity and costs

In the span of a few weeks in early 2020, average internet traffic was up 21 percent at major peering points, and busy-hour traffic spikes hit 2.5 times their normal traffic levels. CSPs must satisfy consumer demand for latency-sensitive streaming content or cloud-hosted services from all network types: mobile, residential, and business networks. This demand increases the need for optimized traffic flows to eliminate congestion for high-priority traffic, and providers must consider a new strategy to minimize costs while maintaining high levels of service.

As CSPs work to integrate new infrastructure and capacity, now is the time to simplify their network operations by reducing the number of moving parts with a flatter design. Reduce the complexity of managing multiple networks for different access types (mobile, business, and residential) by standardizing on one network for all services and use automation to build granular controls in support of dynamic traffic patterns to use all available capacity rather than overbuild with idle capacity.

A Converged SDN Transport architecture allows you to:

- Evolve from unified Multiprotocol Label Switching (MPLS) toward segment routing and Ethernet Virtual Private Networking (EVPN) with an end-to-end IP design
- Converge wireline and wireless network elements for resource-efficient software-defined network slicing with scalable traffic engineering, a simplified protocol stack, and the ability to offer low-latency failover rerouting
- Converge optics and routing with 100G/200G/400G coherent optics directly in the router, helping to reduce Total Cost to Operate (TCO)

Key capabilities

Use convergences to drive out complexity and cost

With the quantum leap in capacity and density available in new routing systems, CSPs can build a single network that will support a convergence of services (residential, cable, mobile, enterprise, or wholesale) on a unified infrastructure. Operating one network that is based on an end-to-end IP design allows CSPs to reduce the number of physical devices needed, simplify their protocol stack with segment routing and EVPN, and reduce operational complexity with a more efficient network design.

Convergence drives the need for more flexibility as the network must accommodate a wide range of requirements driven by new services that do not have the same performance requirements. With the uptake of telco cloud services, the network must be able to support high-demand, high-performance services that are delivered from distributed locations closer to the end users. This creates a strong dependency on the logical systems that will help bind the transport infrastructure and any distributed edge sites as end-to-end services must be built in a seamless fashion with resiliency to minimize the blast radius from outages.

Figure 1. A single IP based network simplifies management operations and improves network flexibility in support of dynamic traffic needs

References:

The move to a converged architecture combined with a cloud-based service delivery approach helps CSPs decrease time-to-market timelines and create “hybrid” service offerings that can leverage any type of access technology (xDSL, FTTH, cable, 4G/5G, Wi-Fi, etc.). In existing networks, these hybrid services would require engineering teams to stitch together new technologies, serving specific purposes, to deliver new services alongside existing ones. Over time, all these different technologies made networks challenging to manage as interoperability issues and troubleshooting complexity arose, and it prohibited innovation as design and testing cycles scaled linearly with complexity.

To meet the unique Service Level Agreement (SLA) performance standards for different service offerings, CSPs need end-to-end granular control to route traffic into different performance slices. This requires routers and network intelligence that identifies the end-user application wherever it resides and computes the proper network transport path to ensure performance. Segment routing acts as the foundation by providing the ability to label traffic packets by the performance needs of the service and offer varied Quality of Service (QoS) on any path segments. Segment routing dynamically routes traffic based upon service SLA requirements and uses computation elements to provide automatic rerouting to maintain performance during congestion, maintenance, or outage events.

Likewise, EVPN provides an optimal user experience by using SLA-based forwarding to minimize latency and maximize bandwidth. It extends from the data center to the metro/access level bridging the WAN, further simplifying the networking stack. From a management and operations perspective, EVPN not only speeds up service recovery and restoration, but also reduces day-to-day configuration and operations overhead, allowing CSPs to fast track the provisioning and delivery of L2 and L3 VPN services.

Lastly, existing networks rely upon IP and optical network layers that are commonly operated in siloes. Despite several attempts to implement multilayer optimization solutions, CSPs are still grappling with OpEx increases and inefficient use of CapEx. But the situation is changing rapidly as functions traditionally delivered in separate chassis-based transponder solutions can now be delivered in a pluggable form factor. As coherent optics technology becomes available in pluggable form factors supporting up to 400G over long distance (400G ZR/ZR+), CSPs can consider architectural shifts to collapse layers and reduce operational complexity. Eventually the IP and optical networks could be combined into a single, simple layer.

A phased approach will facilitate an existing networks’ evolution to start tactically rolling out digital coherent optics that can directly plug into routers to save on transponders. Later on, operators can migrate legacy TDM and wavelength services to a full-IP infrastructure with Private Line Emulation (PLE) solutions resulting in less of a need for OTN switches. Finally, operators can fully collapse IP and optical networks by entirely removing ROADM and have routers connected hop by hop over point-to-point simplified WDM links. This overall simplification reduces the number of moving parts, removes management complexity, and serves to drive costs out of the network.

Maintain control and improve response times with automation

Migrating to a simplified, converged framework enables CSPs to improve operations by integrating automation tools into their network that can support scaling for traffic growth. With an end-to-end IP network, telemetry data can be consumed from anywhere, allowing the automation to detect and respond to congestion or other network events before they become a major issue. The network can be designed to automatically alter the traffic flow around events based on SLA parameters and alert engineers for faster remediation while ensuring that client expectations are satisfied.

Using automation to help manage your network architecture has inherent operational cost benefits:

- Automatic rerouting to multiple alternate paths during outage events offers improved network resiliency.
- Congestion management offers threshold controls to shift loads during peak usage times or maintenance and outage events.
- Use segment routing to build network slices for differentiated service levels to clients and facilitate new revenue streams.
- Network maintenance is simplified because nodes can be programmed in or out of service without disrupting traffic.
- Cloud-based test environments allow engineers to stress-test new infrastructure nodes or software and configuration designs before deployments.

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Models and options

Because service offerings can be supported from anywhere in the network or out in a cloud server, performance standards and controls must span the entire network: from access to core. The Converged SDN Transport architecture is built upon robust infrastructure elements that are optimized to support scalability and functionality in each area.

Cisco 8000

The Cisco 8000 Series routers are available in fixed or modular form factors, and range in performance from 10.8 to 260 Tbps within single-unit deployments to upwards of 2 petabits when arranged in a fabric together. As a carrier-class router, the 8000 Series provides tens of milliseconds of buffering, large forwarding tables, and flexible packet operations. It offers enhanced programmability and is suitable for deployments in power- and space-constrained facilities such as small central office locations (COLOs) or in large core data center sites where fabric systems could be utilized.

Fixed platforms:
- Cisco 8201 router: up to 12.8 Tbps total system capacity in a 1 RU fixed configuration
- Cisco 8202 router: up to 12.8 Tbps total system capacity in a 2 RU fixed configuration

Modular platforms:
- Cisco 8804 router: 4-slot, 10 RU chassis delivering up to 57.6 Tbps
- Cisco 8808 router: an 8-slot, 16 RU chassis initially delivering up to 115.2 Tbps
- Cisco 8812 router: a 12-slot, 21 RU chassis delivering up to 172.8 Tbps
- Cisco 8818 router: an 18-slot, 33 RU chassis delivering up to 259.2 Tbps

NCS 5500 and NCS 5700

The NCS 5500 and NCS 5700 platforms offer a rich choice of 100GbE and 400G optimized fixed and modular platforms that have evolved to become some of the most flexible workhorse platforms for peering and aggregation use cases. Although designed for scalability and low power consumption needed in data centers and WAN aggregation environments, it maintains operational simplicity to meet the needs of large enterprises, web-scale providers, and other communication service providers.

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Fixed platforms:
- 5501 and 5501-SE router: able to provide from 800 Gbps up to 3.6 Tbps of total system throughput in a 1 RU system (“SE” denotes an available external TCAM to improve scalability)
- 5502 and 5502-SE router: able to provide from 800 Gbps up to 4.8 Tbps of total system throughput in a 2 RU system (“SE” denotes an available external TCAM to improve scalability)
- 5700 Fixed: Up to 4.8 Tbps total capacity with 24x 100G ports and 6x400G ports (QSFP-DD). Support for ZR/ZR+ optics, Class C timing and MACSec.
- 57C3-MOD: Up to 4 Tbps of total capacity with 48 x 1/10/25G ports and 8 x 100G ports. Available modular ports of 2 x 800G or 1 x 400G and support for ZR/ZR+ optics, Class C timing and MACSec.

Modular platforms:
- 5504 router: capable of a total system throughput of 14.4 Tbps in a 7 RU, 4-slot system
- 5508 router: capable of a total system throughput of 76.8 Tbps in a 13 RU, 8-slot system
- 5516 router: capable of a total system throughput of 153.6 Tbps in a 21 RU, 16-slot system

ASR 9000
The ASR 9000 has enabled service providers to evolve from 1G through 10G and up to 100G connectivity on the same platform. With newly expanded support for 400Gbe ports on ASR 9000, customers can have the peace of mind to keep on investing in ASR 9000 platforms with an easy migration path to 400G connectivity.

The recent expansion on the ASR 9000 platform brings additional line cards with:
- A 4 Tbps line card with up to 10 x 400G ports with MACSec supported on all ports
- A line card supporting 32 100GbE ports delivering up to 3.2T of total capacity
- A line card supporting both 5 QSFP-DD ports (400/200/100 GbE ports) and 15 ports of QSFP 28 delivering up to 2T of total capacity
- A line card supporting both 2 QSFP-DD ports (400/200/100 GbE ports) and 6 ports of QSFP 28 delivering up to 0.8T of total capacity

All these line cards are edge ready from day one and deliver significant power consumption efficiency compared to previous line card generations.

NCS 500 Series
The NCS 500 Series is a secure and highly available access routing platform for service providers. Both fixed and modular form factors support advanced automation and programmability to provide 5G, remote PHY, carrier Ethernet, and FTTx. With support for advanced timing, ultra-low latency, segment routing, and YANG data models, providers can intelligently converge network services onto a single platform to build an application-aware, 5G-ready network.
- NCS 540: fronthaul routers designed to support 5G with CPRI, eCPRI, and radio over Ethernet in 1 RU with support for up to 900 Gbps
- NCS 560: a full-featured modular aggregation platform designed for the delivery of converged services in either a 4 RU or 7 RU system capable of up to 800 Gbps

Figure 4. The ASR 9000 Series; the most popular Cisco router family for Service Providers

Figure 5. The NCS 500 Family of Routers: the 520, 540, and 560
Gain flexibility with modernized software

To keep up with today’s more flexible networks, network infrastructure operating systems need to modernize as well. The improved operational structure of Cisco IOS® XR creates a modern operating system that is designed to help engineers by:

- Providing a single operating system paradigm across the network: edge, aggregation, and core
- Reducing OpEx with custom loads of Cisco IOS XR based on the features you need
- Using a Linux design for easier provisioning and deployment
- Improving operational efficiencies with management API integration to provide near real-time, actionable telemetry data
- Allowing for automation to drive smoother implementations and remote configuration updates

Having a single operating system reduces the management complexity for a team of engineers and improves the operational efficiency of the network. With Cisco IOS XR, you can load and operate only the features you need for a specific use case, whether it’s a full version load on a multipetabit core router or a scaled-back version that runs on a multigigabit access router.

With Cisco IOS XR, service providers build powerful automation into their network that takes advantage of the reporting tools and structure they already have in place. By integrating open APIs that access the software stack at all levels, Cisco IOS XR provides the custom access that service providers need to efficiently build and operate a network. For example, with the service layer APIs integrated into Cisco IOS XR, service providers use the same controller agent and telemetry data collection tools that have been used in the past. By combining these service layer APIs with the open forwarding abstraction (OFA) API, engineers can make near real-time changes to the network routes.

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