CARRIER ETHERNET SLAs: TECHNOLOGY ADVANCEMENTS TO IMPROVE OPERATIONAL EFFICIENCY FOR CABLE PROVIDERS

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Abstract

High-capacity, low-latency connectivity is important for the new generation of Ethernet-based retail and wholesale commercial services, including ultra high-bandwidth business Ethernet services and wireless backhaul. As network performance increases in importance to customers, overall characterization of the network and service level agreement (SLA) considerations also become more critical. Network planning, management and verification tools that apply to all layers of a cable provider's packet-optical transport network – starting at the fiber layer and rising up through the wavelength, SONET, connection-oriented Ethernet (COE) and Ethernet services layers – are essential to supporting these requirements.

This paper provides an overview of advanced tools and technologies that allow cable providers to optimize their networks for end-to-end SLA performance across multiple layers, resulting in more intelligent utilization of resources, faster resolution of network issues and improved operational efficiency.

TRANSITIONING TO ETHERNET SERVICES

Ethernet is increasingly being adopted by cable providers as the foundational technology used to deliver the new generation of commercial services. Wireless backhaul, a mainstay wholesale service offering for many cable providers, is transitioning to Ethernet to support the rapidly expanding Long Term Evolution (LTE) network deployments by Tier-1 wireless operators. Unlike prior generation (2/2.5/3G) wireless networks that are supported by TDM or hybrid TDM/Ethernet backhaul networks, LTE mandates that the backhaul architecture be Ethernet/IP-based. A similar transition is taking place with retail business Ethernet services, where cable providers currently hold the Nos. 4 and 7 US market share rankings respectively, in terms of the number of enterprise ports installed*. Here, ultra high-bandwidth switched Ethernet services (GbE and higher) are experiencing the fastest growth, primarily to support the financial, data center, education and state/local government vertical markets.

Recognizing that poor network performance negatively impacts their businesses, end-customers' quality expectations associated with these and other Ethernet-based services are at a high level, and are continuing to rise. As applications across all vertical markets become more cloud- and video-based, higher levels of bandwidth and availability are being demanded, in addition to lower delay, jitter and packet loss. Ethernet, as is well known, does not inherently provide the levels of service availability, reliability and QoS found with traditional TDM/SONET services. So while Ethernet's flexibility and low cost make it attractive to cable providers, profitable delivery of Ethernet-based services on a broad scale is directly related the cable providers' ability to support Ethernet SLAs. Cable providers who are effective in this area will have a competitive advantage.

KEY ETHERNET SLA AND OAM DEVELOPMENTS

The ability to support Ethernet SLAs has improved significantly in recent years as a key focus area for the evolution of Carrier

Ethernet. Concerted efforts by the IEEE, ITU, MEF and other organizations have resulted in a mature set of standards for Ethernet Operations, Administration & Maintenance (OAM) that provide monitoring at the Ethernet link level. as well as end-to-end service-level performance monitoring and connectivity fault management. These key Ethernet OAM standards include IEEE 802.3ah, IEEE 802.1ag and ITU Y.1731 as illustrated in Figure 1.

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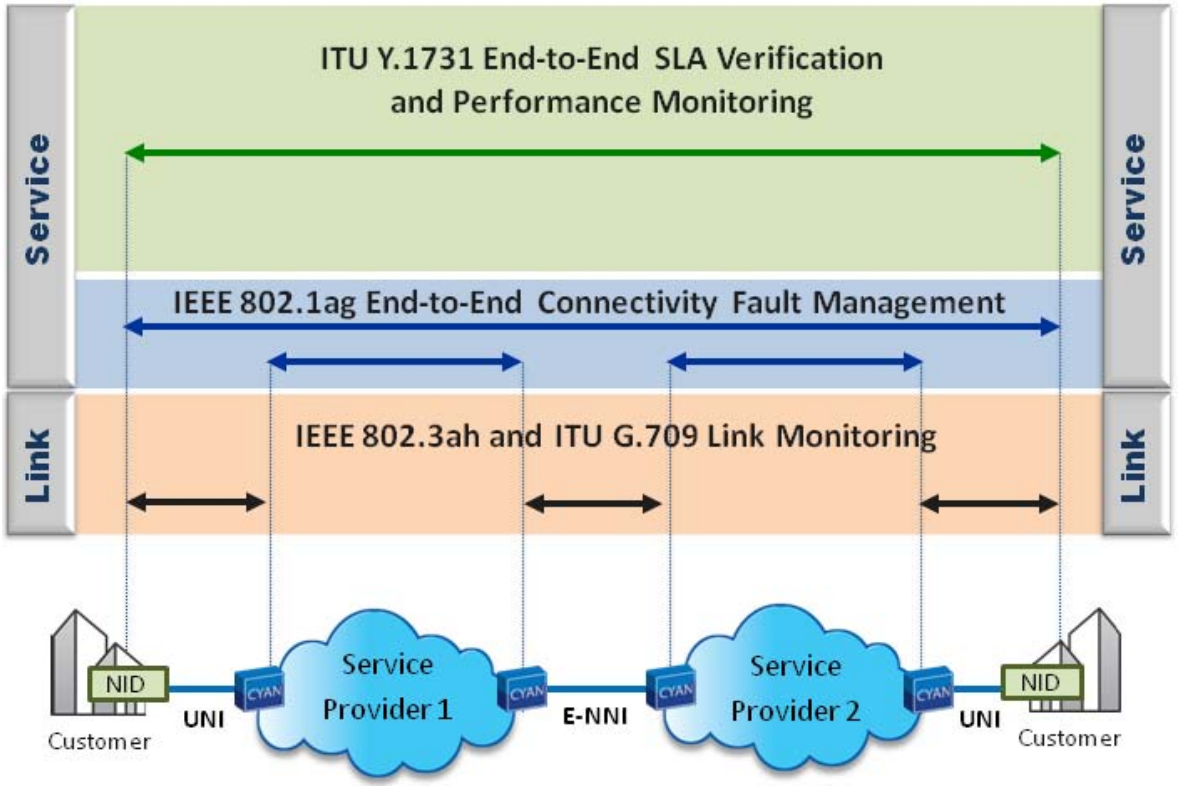

Figure 1: Ethernet OAM Standards

802.3ah Link OAM

The IEEE 802.3ah OAM standard enables cable providers to monitor and troubleshoot at the physical Ethernet link level. 802.3ah is particularly valuable in the "last-mile" connection to the Ethernet access or customer demarc network interface device (NID), where the majority of link events occur. Link OAM allows the cable provider to monitor a link for critical issues, and then if necessary, perform a "loopback" with the remote device in order to test the Ethernet link.

802.1ag Service OAM

The IEEE 802.1ag Connectivity Fault Management standard allows cable providers to manage individual customer connections at the service-level. A customer service instance, also defined by the MEF as an Ethernet Virtual Connection (EVC), is the service that is sold to a customer and is typically designated by a Service-VLAN tag on the User-to-Network Interface (UNI). 802.1ag enables the cable provider to know if a service instance/EVC has failed, and if so, provides

the utilities to rapidly isolate the failure within the overall network management framework.

Y.1731 Service OAM

The ITU Y.1731 standard builds on the concept of 802.1ag by allowing cable providers to monitor the performance of individual customer connections at the service-level. Y.1731 provides real-time and historical EVC monitoring including measurements of Ethernet frame delay, frame delay variation, frame loss and throughput. This data is collected from network devices to support end-to-end SLA verification and assurance. *(continue reading to the right)*

MULTI-LAYER, SERVICE-LEVEL AWARE NETWORKS

Service OAM enables performance monitoring and fault management at the Ethernet services layer, but network performance is not determined by this layer alone. Cable providers' networks consist of multiple, independent network layers, each of which plays a role in delivering services from end-to-end, as well as in determining network performance. Depending on the provider, the network can include a physical fiber layer and rise up through the DWDM, Optical Transport Network (OTN), TDM/SONET, connection-oriented Ethernet (COE) transport and Ethernet service layers, as shown in Figure 2.

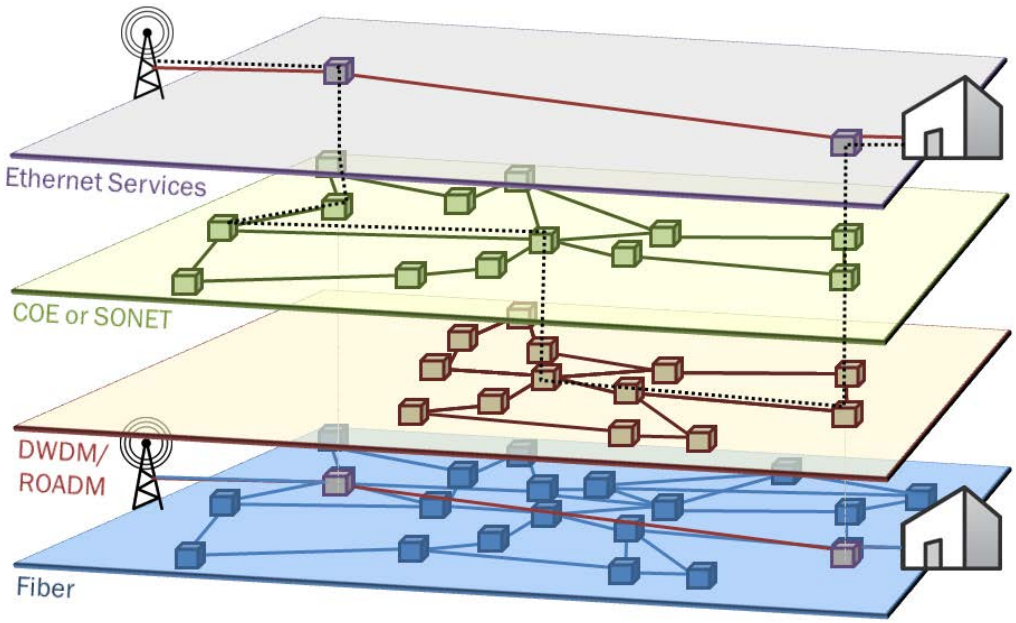

Figure 2: An End-to-End Service Traversing Multiple Network Layers

Historically, each of these layers has been managed and operated independently, without awareness of adjacent layers or services. This inefficient method of operation makes it difficult for cable providers to optimize their networks for end-to-end Ethernet SLA performance. "Service-level aware" tools and technologies that concurrently extend across multiple layers are required to meet these challenges. Key multi-layer, service-level aware building blocks that have recently been introduced to the market include the following:

Multi-Layer Network Planning Software

Advancements in cloud-based network planning software enable cable providers to quickly and cost-effectively design multi-layer networks that are optimized for SLA performance. Advanced algorithms are utilized to ensure the most efficient and economical network design for any given traffic requirement. In addition, the software auto-generates a complete bill of materials that includes equipment configuration and installation checklists to accelerate the planning and deployment process.

Multi-Layer Network Management Software

Innovations in multi-layer management simplify the process of implementing, monitoring, maintaining and operating networks to improve SLA performance for cable providers. Multi-layer network management incorporates object-based intelligence, which provides the software with an awareness of network resources such as switching/transport nodes, connections, and network layers, as well as their inter-dependencies, to optimize the efficiency of network planning and operations. Multi-layer network management also provides advanced 3-D visualization that delivers intuitive, graphical views of the network and network resources, as shown in Figure 3.

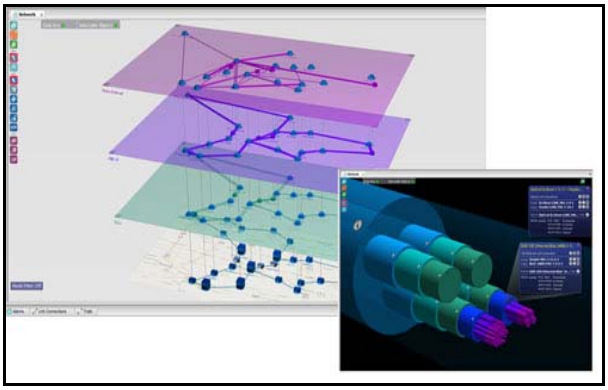

Figure 3: Multi-layer Network Management -- Network View and Cable/Connection View

In addition, multi-layer network management supports "virtualized" network views based on customer, service type, region or responsibility, allowing cable providers to partition network visibility in a manner that is consistent with their operational procedures – accelerating the introduction of new services and lowering costs.

Multi-Layer SLA Verification Software

Developments in cloud-based performance monitoring software allow cable providers to make network performance data available via customer-specific web portals for SLA verification purposes. Each customer-specific SLA verification portal provides real-time and historical reporting of Ethernet network performance data for parameters such as availability, delay, jitter, throughput and packet loss that is collected from network devices based on Y.1731 or other standards-based protocols. The cable provider maintains full administrative control over the level of SLA/network performance visibility provided to individual customers via secure, partitioned network views, as illustrated in Figure 4.

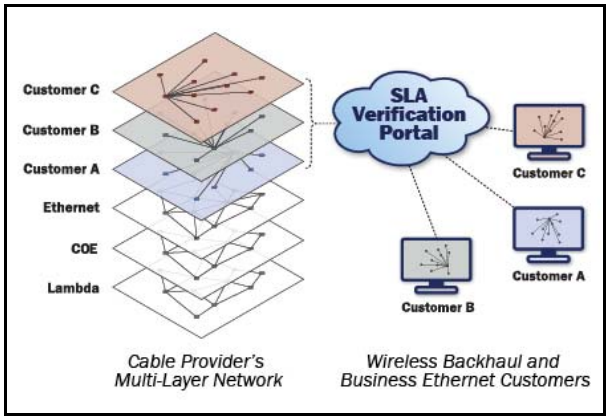

Figure 4: SLA Verification Portals Partitioned to Individual Ethernet Customers

Packet-Optical Transport Hardware

Evolutions in equipment design have led to the development of the packet-optical transport platform (P-OTP). P-OTPs integrate service- and link-layer OAM-enabled 1/10

Gigabit Ethernet switching and connection-oriented Ethernet transport to deliver deterministic bandwidth with carrier-class protection switching (50 ms or less), and support stringent SLA requirements associated with availability, resiliency, throughput and low-latency. Further, the P-OTP integrates SONET and DWDM switching and transport, and is capable of supporting future 100 GbE services as well as 40G and 100G optical transport, allowing cable providers to scale their multi-layer networks with improved operational and capital efficiency.

CONCLUSION

The new generation of Ethernet-based commercial services mandate predictable performance. As a result, Carrier Ethernet SLAs are increasingly required to ensure that these services can be delivered profitably on a broad scale. While important SLA and OAM monitoring standards have matured, cable provider's networks are multi-layer in nature. "Service-level aware" tools and technologies have recently been introduced that allow cable providers to optimize their networks for end-to-end SLA performance concurrently across multiple layers. These advancements include scalable packet-optical transport platforms and powerful software tools that enable management of the entire network life cycle, from service-level aware planning to management/operation and verification. For cable providers, these new tools and technologies result in more intelligent utilization of network resources, faster resolution of issues and improved operational efficiency.

* Vertical Systems Group's 2010 U.S. Business Ethernet Leaderboard