

Metro Ethernet Service over DOCSIS

Introduction

Delivering business Ethernet services is a strategic initiative on which many, if not all, cable operators have placed great focus. Ethernet services provide a flexible alternative to legacy services such as Private Line, Frame Relay, and ATM, which are generally provided by the incumbent local exchange carriers (ILECs). In addition, Ethernet services provide a simpler, more transparent, lower cost, and far more scalable transport option than legacy services. The opportunity is significant and the standards work and marketing efforts led by the Metro Ethernet Forum (MEF) have built a foundation for success. The question is: how do cable operators deploy Ethernet services ubiquitously across their respective footprints in a cost-effective manner?

Private lines (approximately US\$11.2 billion), Frame Relay (approximately \$8.1 billion), and ATM (approximately \$2.4 billion) accounted for a collective approximated \$22 billion (65 percent) of the total U.S business data service revenue of \$34 billion in 2007, according to Vertical Systems Group. Current providers have little incentive to migrate customers from older technologies such as Frame Relay to Ethernet, or to “write down” existing business. As with any business, providers wish to protect their assets for as long as possible to maximize profitability.

According to Vertical Systems Group, 14 percent of Ethernet services will represent new service deployments while 86 percent will come from the replacement of older services. The ILECs have significant business at risk and cable operators have a tremendous opportunity to capture market share in this lucrative space. In order to accomplish this, a competitive and compelling suite of Ethernet services is required.

To that end, Ethernet over DOCSIS® is a solution that enables operators to provide layer 2 services over their existing DOCSIS infrastructure. The solution provides operators the ability to offer Ethernet services to a significantly larger footprint with minimal investment.

Service Requirements

The basic service requirements that any Ethernet service over DOCSIS has to meet are:

- Provide different bandwidth speeds to meet specific customer needs and support the granular speeds of traditional T1 services.
- Target areas that are not currently served or serviceable by fiber.
- Include service-level agreements (SLAs) based on standardized performance-management recommendations such as ITU-T Y.1731
- Comply with MEF standards; MEF 9 certification is required and MEF 14 certification is preferred
- Support endpoint testing capabilities (such as remote loopback, RFC2544-like testing)
- Provide seamless interoperability, functionality, and deployment simplicity

Network-Based and CPE-Based Solutions

Two types of solutions are available to enable Layer 2 VPN (L2VPN) Ethernet service over hybrid fiber coaxial (HFC): a network-based solution where most of the intelligence is in the network and a customer premises equipment (CPE)-based solution where the intelligence resides in the endpoints. Operators can choose their solution depending upon:

- Time to market
- Management and SLA standards compliance
- Ease of deployment
- Targeted average revenue per user (ARPU) and return on investment (ROI)

Network-Based Ethernet-over-DOCSIS Solution: CableLabs Business Services Over DOCSIS

In the CableLabs® Business Services over DOCSIS (BSOD) network-based solution, most of the intelligence resides northbound of the cable modem. It uses a standard cable modem at the customer premises. The cable operator provides the Ethernet service by provisioning the cable modem, configuring the MAC address/SID to VLAN tag association on the cable modem termination system (CMTS), and finally configuring the aggregation device by associating each VLAN tag with the rest of the endpoints through the customer VLAN/Bridge group or Virtual Private LAN Service (VPLS) instance.

The 802.1Q VLAN feature provides the means to create L2VPNs between multiple sites, similar to older services like Frame Relay. It can accommodate all standard topologies outlined by the MEF, such as Ethernet Private Line (EPL), Ethernet Virtual Private Line (EVPL), and Ethernet Private LAN (EPLAN).

This architecture is well suited for:

- Targeted replacement of current Frame Relay services
- Using existing modem inventory and operation processes associated with current Internet and voice deployments
- Deployments that require a low-cost solution
- Operators that want to use their existing provisioning and management tools

This network-based solution can be enabled by the Cisco® uBR10012, uBR7225VXR, and uBR7246VXR CMTSs and the Cisco DPC2100 cable modem with the uBR7600 Series acting as the aggregation router.

CPE-Based Ethernet-over-DOCSIS Solution: L2TPv3

Cisco offers a Layer 2 Tunneling Protocol Version 3 (L2TPv3), CPE-based solution to enable transport-independent Ethernet service. The L2TPv3 CPE is a Cisco 1805 Integrated Services Router (ISR) with an embedded DOCSIS 2.0-based cable modem. It offers rich features that operators can use to provide additional services and increase revenue. Some of the advantages of the L2TPv3-based solution are:

- Increased speed to market: Does not require CMTS provisioning
- Transport-independent: Can be used for fiber, HFC, and wireless, as well as connection to off-net endpoints
- Peering between service providers
- Potential additional revenue: The router can be used to provide Layer 3 data, IPsec, and other advanced features

The Cisco ISR 1805 is MEF 9- and MEF 14-certified, making it one of the industry's first Ethernet-over-DOCSIS CPE to be MEF-certified.

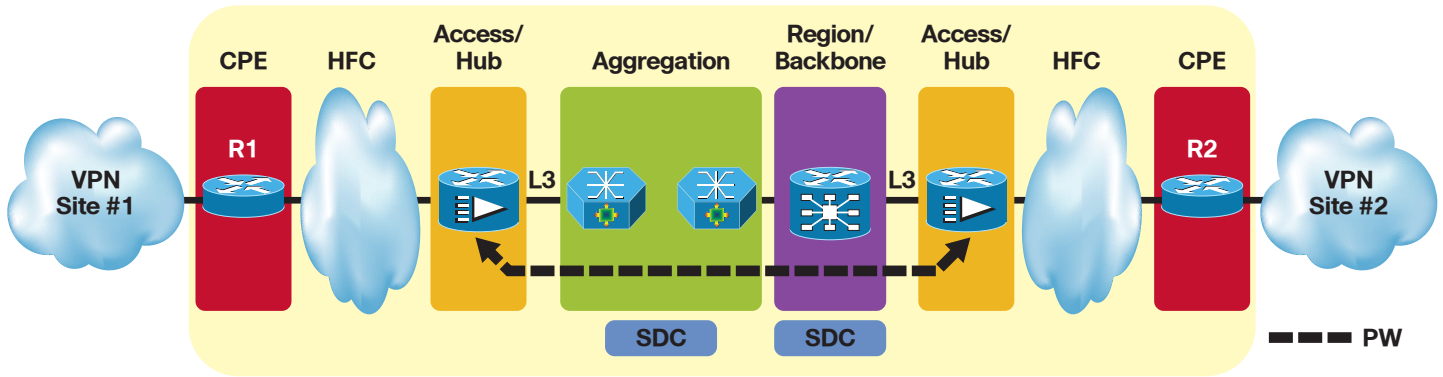


Figure 1. Network-Based Solution

CPE-Based Versus Network-Based Solutions

The CPE-based and network-based Ethernet-over-DOCSIS solutions can coexist in the same Metro Ethernet network along with fiber-based solutions. The solutions differ in the way they are implemented, provisioned, and managed. Service providers must weigh the pros and cons of each approach. While the fact that the L2TPv3 CPE-based solution is CMTS-independent may make it easier to deploy initially, once the CMTS vendors comply with the CableLabs specification, the network-based solution becomes arguably as simple.

While the two solutions provide similar benefits, there are certain features that may make one solution easier to implement than the other. These features are:

- Cross-operator opportunities
- SLA and OAM Implementation
- MEF Standards alignment
- Service provisioning

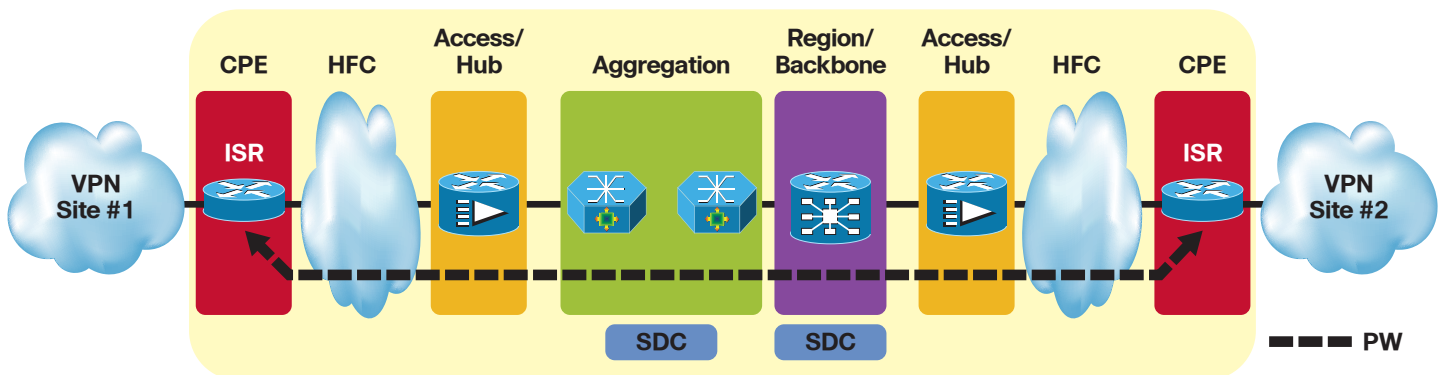


Figure 2. CPE-Based Solution

Cross-Operator Opportunities

In most regions, due to the non-contiguous footprint of many cable companies, there are multiple cable operators serving an area. To entice customers to select Ethernet over DOCSIS, it must be available throughout the entire region, which requires cross-operator peering of Ethernet-over-DOCSIS service to facilitate greater adoption. Be aware that cross-operator networking creates some challenges in the CableLabs network-based Ethernet-over-DOCSIS solution, particularly with coordination of VLAN tags among customers. The CPE-based solution will make the cross-operator peering much simpler.

SLA and OAM Implementation

When deploying Ethernet-over-DOCSIS Services, some guarantees have to be made for throughput, latency, packet loss, and jitter of the Layer 2 network. The DOCSIS network's design provides access to DOCSIS-layer statistics, such as QoS, throughput, and dropped and delayed packets, from the CMTS' IP detail records. But service-levels agreements based on MEF standards are the preferred way to provide SLA statistics.

Adding the OAM functionality to Ethernet-over-DOCSIS CPE negates the cost and operational efficiencies associated with a cable-modem-based service. For services that require more stringent SLA and OAM functionalities, a CPE-based approach becomes more compelling since the device will have the power and flexibility to provide these types of service management enhancements. There is work being done at Cablelabs to examine how OAM standard for performance management such as ITU-T Y.1731 can be accomplished within the cable modem to make the Network based solution OAM standards compliant.

MEF Standards Alignment

The Metro Ethernet Forum, the standards organization for Ethernet service providers and equipment vendors interested in standardization and certification, has ratified two Technical Specifications. MEF 9 and MEF 14 define the requirements and corresponding test procedures that determine the readiness of a Metro Ethernet Network to deliver various Ethernet services, such as Ethernet Line (E-Line) and Ethernet LAN (E-LAN) services. The Cisco 1805 ISR is MEF 9- and 14-certified, making the CPE-based solution from Cisco MEF-compliant. CableLabs is working to ensure that the network-based solutions will also become MEF-certified and Cisco will incorporate MEF certification as soon as it becomes available.

Service Provisioning

Another difference between the two solutions is service provisioning. In the Network-based solution, Service provisioning includes cable modem provisioning, CMTS provisioning and aggregation device provisioning. The Network based solution leverages the Cable modem configuration file to provision the CMTS but the aggregation router will be manually configured. Cisco is developing an MPLS based Pseudowire that will automate the aggregation router provisioning .

In the CPE-based solution, the service provisioning includes the configuration of the L2TPv3 tunnel at each end point and Cisco provides tools to provision the tunnel. If the solution is not point-to-point, an aggregation router will also have to be provisioned just like the network based solution.

Conclusion

Both the CableLabs network-based solutions and the CPE-based solutions are scalable, capable solutions for providing Ethernet-over-DOCSIS service. As vendors start integrating more features such as OAM and testing capabilities into CPE devices, the devices will become more expensive and the service will migrate from standard cable modems to more expensive CPE. Next-generation CPE should support service providers interested in either a CPE-based or a network-based approach. OAM and testing capabilities will be critical in successfully scaling the provider's business.

An operator can select the best approach by determining the state of provisioning, service management, and support infrastructure as well as the services that customers require in addition to the Ethernet service. Service providers will likely find use for both options given the disparity of networks and back offices. Cisco is leading the way to make improvements and enhancements to minimize the service provisioning and management challenges that operators are facing.

Technical Specifications

MEF: http://metroethernetforum.org/page_loader.php?p_id=29

CableLabs: <http://www.cablelabs.com/specifications/CM-SP-L2VPN-I08-080522.pdf>

RFC 2544: <http://www.faqs.org/rfcs/rfc2544.html>

ITU-T Y.1731: <http://www.itu.int/rec/T-REC-Y.1731/en>

IEEE 802.1ag: <http://www.ieee802.org/1/pages/802.1ag.html>



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