White Paper

Optical Ethernet Services Demarcation

Ethernet in the First Mile Advanced Protocol Requirements

Executive Summary

This white paper discusses the requirements imposed on an Optical Ethernet Services Demarcation solution as demanded by the different deployment architectures, as well as by the protocols exchanged between the different internetworking devices involved in the deployment of Ethernet in the "First Mile".

As Ethernet becomes the predominant access technology for the local loop or First Mile of the telecommunication networks, working groups in both the IEEE and Metro Ethernet Forum (MEF) laid down certain requirements for Optical Ethernet Services Demarcation solutions. These requirements refer to multiple properties and include protocols transparency, E-Line Service rate limiting, and maximum packet size requirements.

Ethernet in the First Mile – Driving Forces and Architectures

The ubiquitous Ethernet, the most widely deployed networking technology, evolved for more than 20 years to be the networking technology of choice for enterprise LAN networks. The question raised in the last decade was: what needs to be done in order to transform the best effort Ethernet, into a "carrier class" protocol able to provide the expected "five nines" of reliability, i.e. 99.999% uptime.

Lacking basic elements like traffic management, SONET signalling and restoration capabilities, and hierarchical scalability confined the Ethernet protocol to enterprise networks. The community, including Ethernet internetworking systems manufacturers and also carriers, saw in the last few years the opportunity to bring the simplicity and economies of Ethernet networking to the First Mile with the desire of reducing operational expenses through low initial investment, scalability and low OAM&P costs.

The challenge of the IEEE 802.3ah Ethernet in the First Mile (EFM) committee was to provide the means of transforming the best effort Ethernet into a highly reliable technology, with the required reliability, and with simple, low cost means of on demand provisioning and easy control of the First Mile link. The resulting 802.3ah IEEE standard lays the principle and rules of interoperability for Ethernet's deployment in the First Mile through three technologies:

- Ethernet over copper lines
- Point to Point (P2P) Optical Ethernet Links including the optical properties for both Fast and Gigabit Ethernet links, as well as the link management protocols
- Point to Multipoint (P2MP) Optical Ethernet Links including the optical properties (PMD) over Gigabit Ethernet, as well as the link management protocols

The enabling EFM concept is FO link or loop (copper) aggregations. This implies that multiple First Mile links are combined into a single physical or virtual link at the carrier's central office (CO) or point of presence (PoP) with bandwidth equal to the sum of the individual link bandwidths. The aggregation transport technology defines the type of Metro Ethernet protocols used beyond the First Mile.

The Metro Area Network (MAN) may be built over a wide variety of technologies and protocols with a single common aspect: the Ethernet based First Mile link. The MAN transport employs:

- Traditional SONET/SDH transport terminated in simple Ethernet ports
- Traditional Switching and Routing
- MPLS/VPLS IP/Ethernet Aggregation

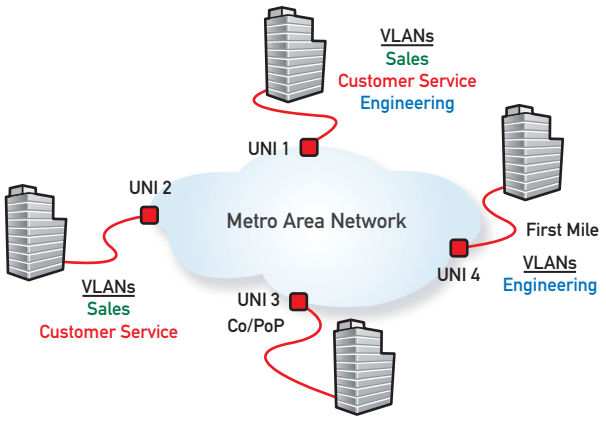
But regardless of the MAN transport, the first mile becomes the turf of Ethernet. The multitude of metro transport technologies and protocols brought a wide range of requirements to Optical Ethernet Service Demarcation solutions.

The community (EFM and MEF) addressed most of these requirements in their standards and documents. Some other requirements are implied by the types of services implemented and by the need for transparent protocol exchanges. Services like Transparent LAN Services (TLS) and Ethernet Private Lines, etc. running over a multitude of Metro Ethernet transport technologies determine specific requirements for maximum Ethernet packet size, certain protocol transparency as well as for minimum levels of QoS mechanisms.

MRV offers a wide range of Ethernet Services Demarcation solutions, ranging from advanced service gateways with built-in security and L2-L7 features, to multi-service Layer 2 switches with advanced QoS capabilities, and up to the simplest Fiber Driver®-based 802.3ah compliant "raw" Optical Ethernet service channel demarcation solution known as OESD.

Figure 1:

First Mile access solutions that support Transparent LAN Services enable subscribers to connect different physical locations and to create a single virtual enterprise network.



802.3ah Link Management Requirements

The 802.3 AH standard provides mechanisms to monitor the first mile link operation and health, as well as means to detect and improve fault isolation. The standard modifies the Ethernet PMD in order to allow for unidirectional reporting.

802.3ah provides extensive link events and controls that provide:

- Link fault detection
- Dying gasp – signalling the link partner that unrecoverable local faults occurred
- Other critical events
- Link loopback control

The standard also provides the means for link performance monitoring through extensive Ethernet statistics.

MRV's Fiber Driver-based OESD implements the entire standards requirement and through standard enterprise extensions expands its functionality with additional valuable management capabilities.

Table 1: A Comparison Between 802.3ah and Fiber Driver based OESD

	802.3ah	Fiber Driver based OESD
Failure Indication		
- Link Fault	Yes	Yes – user port fault
- Last Gasp	Yes	Yes – power loss
- Critical Event	Yes	Yes – priority notification
- Loopback	Yes	Yes – both local and remote
Link Monitoring		
- Statistics	Yes	Yes – interface and OAM parameters
- Optical Performance Monitoring	**No**	**Yes** – Digital Diagnostics (SFF-8472)
- Errored Symbol Period	Yes	Planned*
- Errored Frame	Yes	Planned*
- Errored Frame Period	Yes	Planned*
- Errored Frame Seconds Summary	Yes	Planned*
Equipment Configuration		
- Bandwidth	**No**	**Yes** – rate limit
- Link Integrity Notification	**No**	**Yes**
- Redundant link	**No**	**Yes**
- Dual-homing	**No**	**Yes**
Equipment Monitoring		
- Temperature	**No**	**Yes**
- Voltage	**No**	**Yes**

* OESD service module is upgradeable via remote download

Protocol Transparency

The emergence of Ethernet Transparent Service posed the requirement of running Layer 2 protocols across the Metro Area Network, and thus across the OESD (Optical Ethernet Services Demarcation) unit. Transparent LAN Services allow the LAN to be extended between geographic locations using the infrastructure of the MAN.

Switched Ethernet environments are today predominant in enterprise networks. These multi-location enterprise networks, interconnected over the MAN, employ switching management protocols that coordinate the functionality of the multiple switching systems. Examples of such protocols are:

- Spanning Tree protocols - 802.1D/Q
- Link Aggregation – 802.1ad
- Port Control – 802.1ab

In general, a Transparent LAN Service over a MAN requires full Layer 2 BPDU transparency in order to allow switches residing in different geographical locations to be managed like a single virtual switched network.

Maximum Packet Size

The maximum size for IEEE standard Ethernet frames is 1522bytes (802.1Q tagged frames). However many Ethernet and IP switch/routers make use of proprietary (or de-facto standard) extensions to the frame that result in a larger maximum frame size. Today these protocols, such as Cisco ISL, VTP, or CDP, run predominantly in the LAN rather than the WAN. The emergence of Ethernet Transparent LAN Service increases the occurrence of these protocols operating across the Metro Area Network.

In may be possible that in the design stage private networks can accommodate restrictions on maximum frame size in particular areas of the network. However, for public network providers any service that they rollout in volume must meet the needs of a wide range of different end-users. Therefore, public service providers are reluctant to deploy a technology that imposes significant limitations on the subscriber.

LAN Extension Services are available today in Europe and the Americas at speeds of 10 Mbps, 100 Mbps and 1000 Mbps. In order to allow all the de-facto standard proprietary protocols as well as the new emerging IP/MPLS/Ethernet protocols to run undisturbed between different physical locations, service providers require that access equipment to be able to transmit frame sizes from 64 bytes to a maximum of between 1548-1600 bytes. Examples of protocols with frame tagging formats that exceed the maximum IEEE 802.1Q frame length are:

- VLAN tag stacking (Q in Q)
- MAC address stacking (MAC in MAC)
- MPLS over Ethernet
- Ethernet VLAN over MPLS over Ethernet
- Cisco ISL with EtherChannel – 1548 bytes
- Cisco VTP and CDP protocols
- Cisco UTI/L2TPV3 – 1568 bytes
- Other Cisco proprietary headers related to WAN protocols transport over Extended LANs
- General support of jumbo or at least mini-jumbo frames

It seems that 1,548 bytes is an absolute minimum for the maximum size of Ethernet packets that need to traverse the demarcation interface between the user site and the MAN. However, based on carrier requirements and considering protocols that are currently under development, it appears that a maximum frame size limit below 1,600 bytes will substantially limit the attractiveness of any Optical Ethernet Services Demarcation solution.

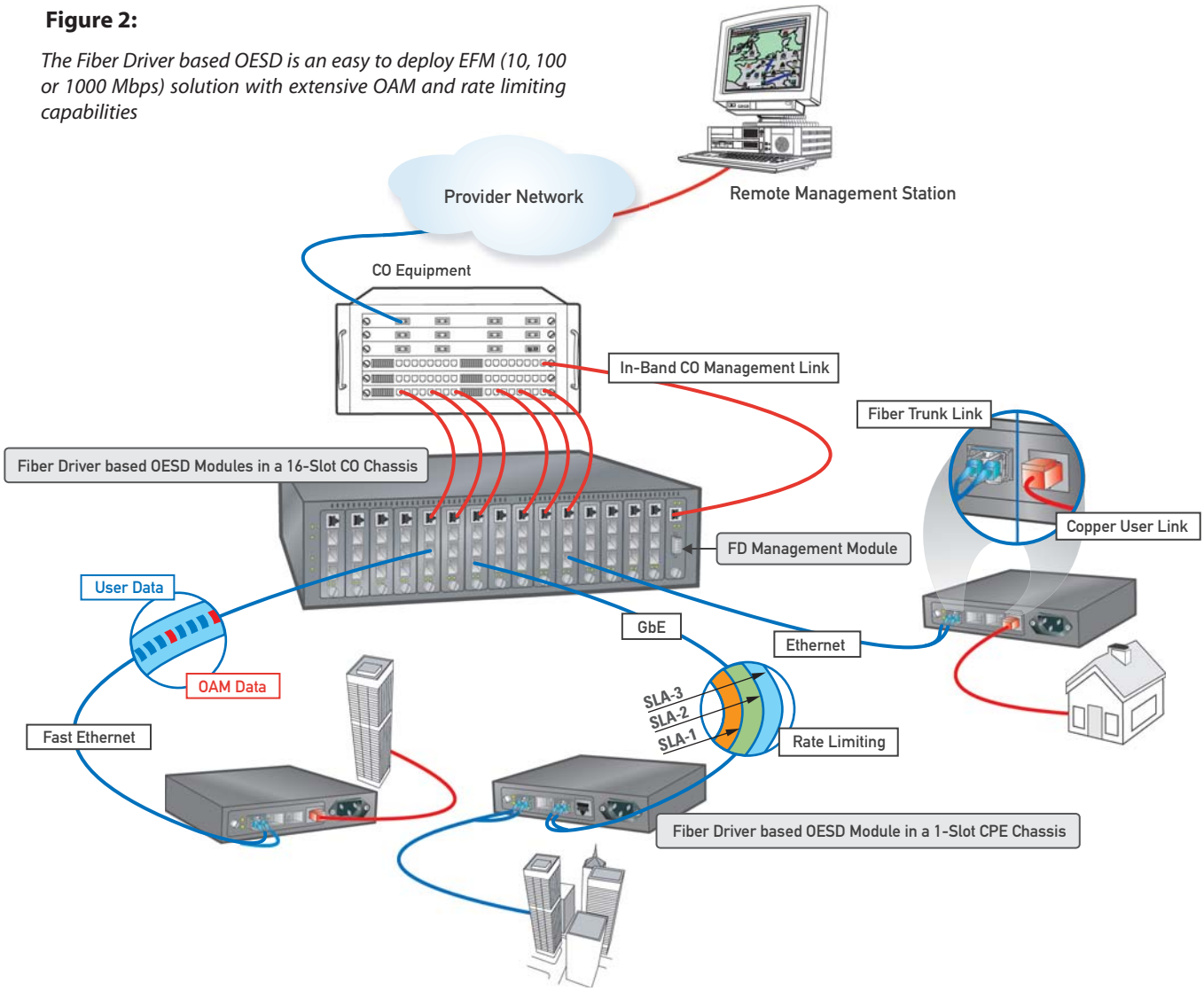
Emerging protocols for Transparent LAN services accept the fact that in full duplex mode Ethernet does not have any practical packet size limit and thus dare to extend it beyond the accepted limit of 1,600 bytes. Emerging services and new protocols request mini-jumbo frames (1,900 bytes) and in the future may request jumbo size packets that extend to 9,000 bytes.

MRV's OESD Solution

The Fiber Driver-based OESD solution from MRV is 802.3ah compliant and offers the service provider the capability of extending the Metro Network Ethernet port over a fully managed 10/100 Ethernet or Gigabit Ethernet First Mile optical link. It allows the carrier to offer the simplest level of service: a fully managed "raw" Optical Ethernet channel, with pre-allocated bandwidth. This passes full access control to the subscriber where it is their responsibility to manage the Intranet Access Control and security, as well as the QoS needs of their different applications. By providing such a simple but fully managed Optical Ethernet access channel, the service provider is able to minimize their initial investment and OAM&P costs while at the same time limiting their liability. MRV's OESD is the industry best and most flexible all in one solution.

Figure 2:

The Fiber Driver based OESD is an easy to deploy EFM (10, 100 or 1000 Mbps) solution with extensive OAM and rate limiting capabilities



Pluggable SFPs enable the user interface to be either copper (RJ45) or fiber optic. Built-in fast (sub-50ms) optical line restoration (single/dual homing) may be easily enabled when and if the feature is desired by simply adding an optical SFP module into the secondary slot. Optical Interfaces may be customized to any mode (multimode or single mode), optical budget/distance or wavelength (850nm/1310nm/1550nm, CWDM or DWDM).

With its flexible functionality and interface customisation capabilities, MRV's Fiber Driver-based OESD offers the industry's dream inventory solution for Optical Ethernet demarcation: just two modules and a selection of SFPs are all that is need for a complete spare inventory.

MRV's OESD covers all the EFM and MEF requirements:

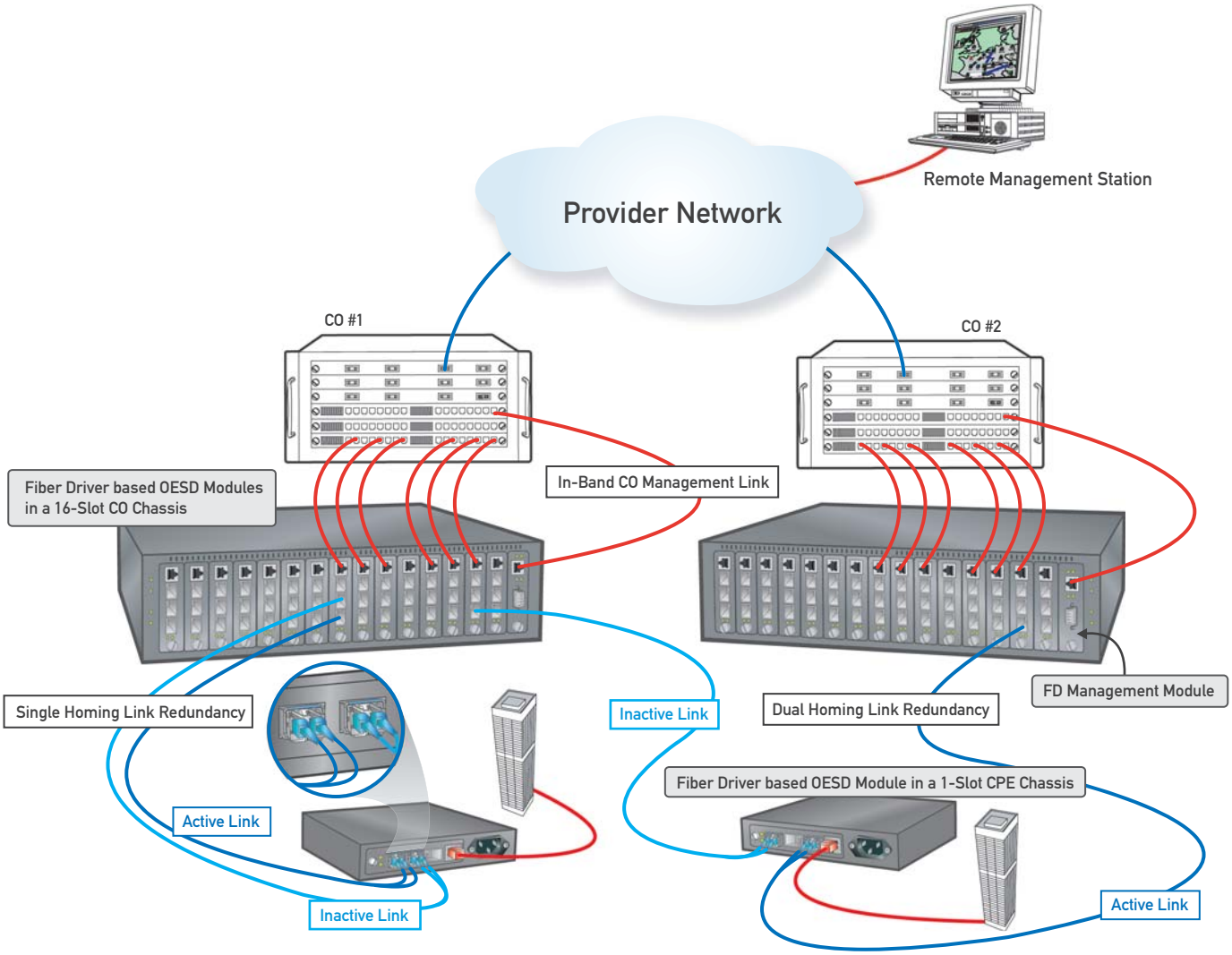
- Transparency for any Layer 2 Switching protocol
- Large packet sizes – 1,900 bytes supporting all the existing and emerging inter-networking protocols
- Advanced optical (SFP Digital Diagnostics as per SFF-8472) and line performance monitoring (Ethernet and RMON statistics)
- Flexible Ethernet channel bandwidth allocation (high granularity rate limiting) that allows the carrier to scale the service with a mouse click, and charge by SLA
- Investment protection – the industry's best in field functionality remote upgrade (for both network processor microcode and firmware) for standards (802.3ah) follow up and feature set enhancement

Metro Area Networks are implemented using a wide range of technologies: ATM and SONET are still predominant, with most of the edge equipment offering Ethernet ports for the first mile. At the same time the emerging IP/MPLS over Ethernet standard is extending its reach over the First Mile optical links.

Significantly, then, MRV's OESD interoperates with any Metro Ethernet Edge solution regardless of its employed core technology. It extends the Ethernet reach into the First Mile for any equipment vendor with standard compliant Ethernet ports.

Figure 3:

The Fiber Driver based OESD provides both single homing and dual homing redundant link capabilities



Summary and Conclusions

The paper has summarized the simple ("raw") E-Line/Optical Ethernet Services Demarcation requirements emerging from the different working groups (IEEE and Metro Ethernet Forum) and also from practical deployment demands that became a de-facto standard.

An Optical Ethernet Services Demarcation solution must:

- Implement 802.3ah event and link controls (link fault, dying gasp, critical events, loopback control)
- Implement 802.3ah link performance monitoring (Ethernet statistics, etc.)
- Provide transparency for switching protocols packets – BPDU packets
- Allow transmission and reception of Ethernet packets up to a minimum of 1,600 bytes and preferably up to 1,900 bytes.

MRV's Fiber Driver-based OESD covers and exceeds all these requirements, offering the industry's most flexible and most advanced EFM solution. It sets an industry standard in performance, functional flexibility and inventory management, and ensures the service provider's investment throughout the evolution of First Mile network technologies and requirements.

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