

Optical Ethernet Demarcation for enhanced service delivery

The demand for Carrier Ethernet is growing quickly with a CAGR in the range of 50% as operators make the shift from legacy services to Carrier Ethernet services as part of their transition to converged multi-service-networks. Infonetics Research Inc. has estimated the worldwide market for Carrier Ethernet services to grow from \$2.5 billion to more than \$22 billion in 2009.

Carrier Ethernet does indeed represent a big opportunity; however, there are two challenges for Service Providers to capitalize on Ethernet services. First, the mainstream enterprise market must be convinced to adopt the services. The solution to this is to provide a complete service that is as good as existing legacy services – only then will the majority of the enterprises be prepared to consider migration to Ethernet. Second, the services must be supplied with a minimum of capital and operational expenses to ensure there is a financial incentive to make the switch to Ethernet, whilst maintaining operator margins.

The scope of this whitepaper is to identify a new breed of device called optical Ethernet Demarcation Unit (optical EDU) as part of the solution to both these challenges for enterprises that have fibre-to-the-premises and for wholesale Ethernet over Optical services. The optical EDU is not only a critical component in the complete solution for Carrier Ethernet services to reach the mainstream enterprise market but also enables very cost-effective network designs in the access-metro network.

This white-paper explains why there is a need for the optical EDU, its main functionality and the benefits that result from deploying it. The paper also identifies a number of applications of the optical EDU - for enterprise demarcation, as a replacement for the first layer metro access aggregation switch and for wholesale Ethernet services.

Drivers for Ethernet Demarcation

There are a number of reasons why Carrier Ethernet services have not yet been generally adopted by the enterprise market in spite of the potential savings that Ethernet can bring. On the demand side, one of the main reasons is the lack of visible service level agreements (SLA) – most enterprises want to have performance guarantees and know that they are getting what they pay for. The explanation for the poor visibility of SLAs is lack of end-to-end service and performance monitoring capabilities in the operator's network and OSS.

There are also a few problems on the supply side. First, Ethernet has inherently had poor OAM capabilities originating from Ethernet as a LAN technology with very different operational requirements than those found in a WAN carrier environment. Second, the lack of end-to-end performance monitoring capabilities has resulted in difficulties in differentiating the services on quality. A clear and visible basis for quality-based service differentiation

with performance guarantees is necessary for value-maximizing marketing strategies.

The consequence of these deficiencies is that mainly early adopters, who prefer the low price of best effort services over verifiable SLAs, have replaced their legacy services with services based on Ethernet in the WAN and that the supply of the services has been limited. There are a number of requirements, originating from both operators and enterprises alike, that must be addressed before Carrier Ethernet can enter the mainstream enterprise market. The requirements from operators are:

- End-to-end performance monitoring – carriers need to monitor the end-to-end path not only within their own network but also potentially across multiple carriers networks.
- End-to-end OAM – carriers need to be able to test and diagnose the entire path across multiple carriers' networks to pin-point where a problem exists. There is also a need for a clear demarcation point between the operator and enterprise to avoid including customer equipment in tests.
- Service-network decoupling – services should be decoupled from access technology. This means that a service should not be tied to a particular type of network equipment.

In addition, there are a number of enterprise specific requirements that must be met before the enterprise market is ready to adopt Carrier Ethernet services on a wide scale:

- Verifiable SLAs – enterprises want to know that they get what they pay for and do not generally accept over-provisioning as a method to ensure SLAs.
- Packaged plug-and-play solutions – as Carrier Ethernet enters the mainstream enterprise market, usually populated by people with IT skills rather than telecommunications skills, there is a need for simple and easy to use devices to be placed at the customer location.
- Support for legacy services and equipment – enterprises want new equipment to be backward compatible to avoid unnecessary disruptions and additional investments.

The Optical Ethernet Demarcation Unit

An EDU is a service controller located at the customer premises, providing a clear demarcation point between two networks. There are EDUs for different access technologies but this paper focuses on operators with fibre-to-the-premises.

An optical EDU is generally located between an enterprise's electrical LAN and the Service Provider's optical Ethernet-based WAN to provide a clear demarcation point between the operator and an enterprise networks.

A clear demarcation point is imperative for end-to-end SLA monitoring and streamlined OAM. The optical EDU offers:

- A User-Network Interface (UNI) for service policing and definition
- A Network Interface Device (NID) for remote monitoring and testing
- End-to-end performance monitoring through in-service insertion and measurements of tests traffic
- Media conversion between the LAN and optical formats

According to Metro Ethernet Forum, a UNI is a “standard interface that is the point of demarcation between the customer equipment and the Service Provider’s metro Ethernet network”. The UNI provides a number of traffic shaping functions related to the definition of services such as rate-limiting, classification, policing and marking as a basis for the Metro Ethernet Forum service definitions. The UNI is also responsible for VLAN tagging including preservation of customer VLANs (VLAN stacking).

The NID provides functions related to Ethernet OAM (802.3ah, 802.1ag, MEF, ITU) such as remote failure, remote loopback, Ethernet port loopback, service or VLAN loopback, continuity verification and OAM discovery. Both customer and the service provider can initiate loop-back at remote UNIs. See Figure 1.



Figure 1. Both operator and the customer can initiate loop-back to the remote demarcation point to verify the status of the connection.

The EDU insert a small amount of test traffic and measures and calculates the layer 2 performance parameters according to the MEF service profiles. The EDU can report key performance indicators such as packet delay, jitter, packet-loss and service availability to ensure that mission critical applications run as they should.

Finally, the optical EDU performs media conversion between electrical and optical formats to provide all CPE functionality in one device to simplify installation and operations at the customers’ premises. This is hybrid optical plus Ethernet solution is a distinct advantage over separate optical and Ethernet platforms with individual management requirements and multiple boxes to install and maintain.

Services and SLA definitions

The optical EDU provides a point-to-point Ethernet Virtual Connection (EVC) between two UNIs. Metro Ethernet Forum has defined an EVC as “an association of two or more UNIs”. Multiple point-to-point EVCs can be connected to one UNI. MEF also defines a number of bandwidth profiles based on Committed Information Rate (CIR), Committed Burst Size (CBS), Excess Information Rate (EIR) and Excess Burst Size (EBS).

For Metro Ethernet services, SLAs are based on the performance parameters such as service availability, delay, jitter and packet loss between two UNIs. The EDU classifies marks and schedules packets to optimize performance for each service class, for example real-time communication, streaming services or internet-access. The traffic may pass network segments outside the metro Ethernet domain such as IP/MPLS, Ethernet or SDH

networks. This also illustrates the core problem related to QoS – even though there may be enough capacity in the metro Ethernet segments to fulfil the SLA, there is always a risk that intermediate networks may experience congestion with degraded QoS as a result. Naturally, this is a higher risk if more than one operator is involved in providing the end-to-end EVC.

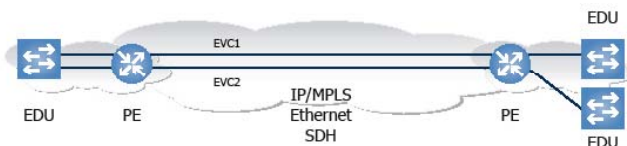


Figure 2. The optical EDU provides an EVC between two UNIs.

The traffic shaping capabilities in the optical EDU, together with end-to-end performance monitoring, enables a wide range of service offerings from symmetrical best effort bandwidth to services according to MEF service profiles with visible SLA guarantees. This allows the carrier to not only differentiate the services based on performance criteria but also prove that these criteria actually are met.

SLA verification

From the operator’s customers perspective it is not enough that the operator meets the SLA – the customer will also want to see that this is the case. To verify SLA fulfilment, the Ethernet Demarcation Unit itself is not sufficient – there is a need for an OSS that collects and analyzes the EDUs’ QoS measurements and reports the degree of SLA fulfilment to the customer. Preferably at least the first step, collection of QoS measurements, should be done in the EDUs’ management system as this data must be correlated with circuit information to create an end-to-end view across the network to provide maximum visibility.

To streamline back-office integration, many operators have invested in a higher order performance management systems. These systems are not only integrated with vendor specific OSS but also with web portals so that customer can see whether the operator complies with his SLAs. The primary role of the EDUs’ OSS then becomes that of a mediator with ability to correlate performance and topology data and feed it through the north-bound interface. See Figure 3.

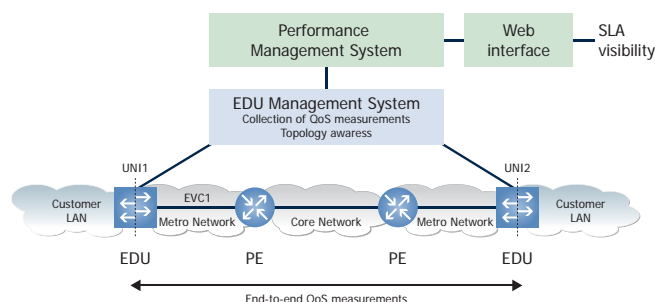


Figure 3. The complete solution for SLA verification including the EDU, its management system and higher order

Application cases

Application 1:

EDU for enterprise communication

The optical EDUs are placed at the customer's location and it provides a clear demarcation point between the customer's LAN and the operator's WAN. Multiple customer sites can be connected with multiple point-to-point EVSs. The EDUs measure the end-to-end QoS between the sites and allow for remote testing and network operations without need for truck-rolls.

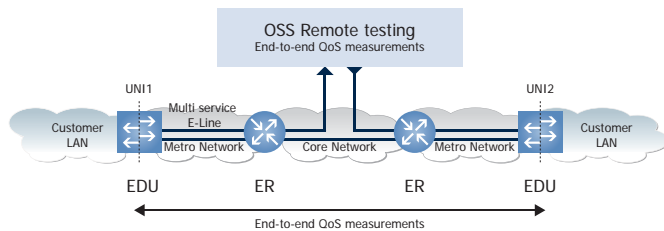


Figure 4. EDU for Enterprise demarcation

The EDU allows:

- Remote service provisioning, for instance upgrade of bandwidth or insertion of new service classes
- Remote testing and diagnosis from a centralized OSS through the capabilities in the NID
- End-to-end performance monitoring through insertion and analysis of in-service traffic
- Plug and Play functionality with full integration into the WDM based optical platform

Application 2:

EDU as replacement for metro access aggregation switch

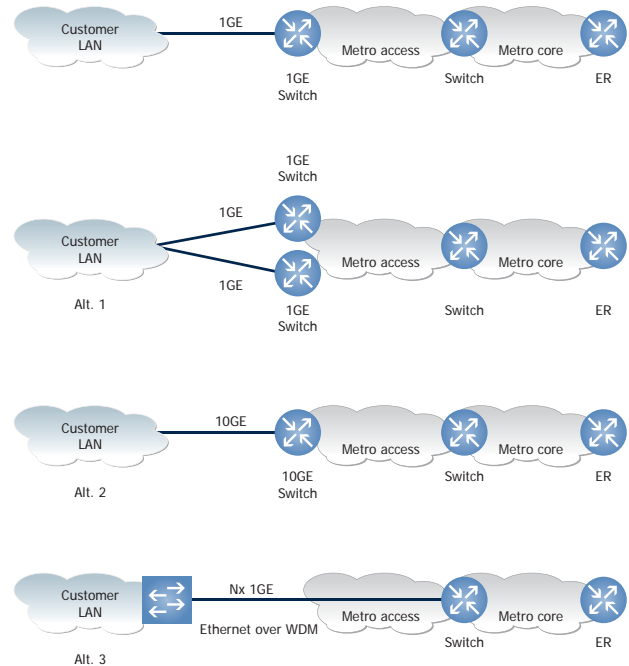
Problem: To expand the bandwidth to an existing enterprise customer requires an upgrade of the metro access aggregation switch. There are two solutions if the existing switch architecture is to be maintained:

- Incrementally add more 1GE switch
- Replace the existing Ethernet switch with a 10GE switch

However, both these solutions are very expensive. A cheaper solution is to replace the existing aggregation switch with an optical Ethernet Demarcation Unit at the customer premises and run Ethernet over WDM directly to the metro Ethernet.

The benefit of using the EDU includes:

- No need to upgrade the access aggregation switch – substantial CAPEX (GE switches expensive) and OPEX (install and operate switch) savings
- End-to-end view for performance monitoring and testing



Application 3:

Carrier carrier Wholesale Gigabit Ethernet Services

With the rapid growth of high capacity broadband and Triple Play residential services and business Ethernet services in the market operators are always looking for ways to differentiate their services on quality and cost. Residential services in particular are often limited in that very few operators have access to fibre in the right places to build out a suitable network of their own. They are therefore forced to use the backhaul services from the incumbent operator. The price of these backhaul links are often regulated and therefore offer limited opportunity to differentiate on cost in this part of the network. However in some countries and regions alternative operators do have fibre access close to suitable residential locations, often cable TV operators. Some of these operators are now starting to offer wholesale Ethernet services to other carriers for Local Loop Unbundled services such as DSL and Triple Play.

In these cases the operator needs to offer a suitable alternative to SDH or SONET networks that may have been considered in the past for this scenario. The service needs to have a guaranteed QoS, throughput and performance. Therefore for Ethernet to be considered as an alternative, the Ethernet demarcation functionality is required. The optical EDU is an ideal candidate for this as it can be integrated into the optical layer deployed by the carrier. This gives layer 2 capabilities to his optical network, removing the need for external demarcation devices or Ethernet switches.

This could be viewed as a further example of both scenarios 1 and 2 above. In the first case the enterprise user is now replaced by a second carrier but the goal is still the same, to offer a manageable Ethernet service with a measurable QoS at the minimum cost, smallest footprint and simplest implementation. However, there is one distinct difference and that is capacity. Whereas an enterprise user may deal in multiples of 50 Megabits of capacity, carrier customers will require multiples of Gigabits of capacity or even 10 Gigabits of capacity. Therefore the optical EDU must scale to meet this higher capacity.

Also, the pre-EDU alternative would be to deploy either a simpler standalone demarcation unit with possibly less functionality or a full Ethernet switch, with more, unused, functionality. For this application a standalone switch is overkill for the necessary demarcation function and is too expensive. This is especially the case when multiple Gigabit Ethernet or 10 Gigabit Ethernet services are being deployed to a DSLAM site for LLU backhaul to a central office. Again, the EDU is the ideal fit for this application with the right level of functionality and full integration into the optical layer.

Summary

The optical Ethernet Demarcation Unit is a critical component in a FTTP networks when expanding the enterprise market for Carrier Ethernet services as it allows operators to offer revenue generating Carrier Ethernet services with verifiable SLAs in a cost effective way. It is also critical for carriers wishing to offer high capacity Ethernet services to other carriers or very large enterprises.

The capabilities in the EDU, together with end-to-end performance monitoring, enables a wide range of service offerings from best effort bandwidth to services according to MEF service profiles. This allows the carrier to not only differentiate the services based on performance criteria but also to prove that these criteria are met to ensure that mission critical applications run as they should.

For operators, the optical EDU packaged with an OSS provides an attractive and cost effective solution for Ethernet demarcation. For enterprises, Carrier Ethernet services based on the optical EDU are an attractive alternative to TDM based services as they come with visible SLAs, remote management capabilities, a simple to install plug-and-play Customer Premises Equipment including media conversion, optical interfaces and RJ 45 interfaces on the enterprise side.

Abbreviations

CBS – Committed Burst Size

CRI – Committed Information Rate

CPE –

EBS – Excess Burst Size

EDU – Ethernet Demarcation Unit

ER – Ethernet Router

ERI – Excess Information Rate

EVC – Ethernet Virtual Connection

LAN – Local area network

NID – Network Interface Device

OSS – Operations Support System

OAM – Operations, Administration and Maintenance

PE – Provider Edge router

QoS – Quality of Service

SLA – Service level agreements

UNI – User Network Interface

WAN – Wide Area Network