The Role of Carrier Ethernet in Business Applications

Examining the Choices for your Business Applications

February 2012

MEF Positioning Paper

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1 Introduction

The enterprise Information and Communications Technology ("ICT") landscape is constantly changing. New IP based voice and video services, continue to add pressure on the WAN to deliver increased bandwidth and enhanced performance. Legacy WAN connectivity technologies such as FR and ATM are being grandfathered by many service providers. TDM based connectivity does not provide the operation flexibility expected by the modern enterprise.

As ICT managers look for solutions, MEF defined Carrier Ethernet ("CE") services have emerged as an attractive alternative to provide businesses with a best of breed cost-effective solution. Ethernet standards from the MEF, ITU and IEEE have added (and continue to add) features and functionalities to make Ethernet a WAN capable technology. At the same time an increasing number of service providers are introducing or expanding their MEF-compliant Carrier Ethernet services (hereafter referred to as CE-Services). In many cases, these CE-Services are replacing some of the service providers' legacy technologies (such as FR and ATM) while in other cases they are co-existing alongside more established technologies, such as Layer 3 VPN services – also referred to as IP-VPN services (both Layer 3 VPN and IP-VPN services are hereafter referred to as IP-VPN). Understanding how to integrate and benefit from those CE-Services is an increasing challenge for many ICT managers.

The goal of this MEF positioning paper is to help enterprise ICT decision makers better understand the role CE services can play in a business environment. The first part of the paper highlights and discusses the characteristics and benefits of CE-Services while the second part reviews a number of use cases related to implementation of CE-Services for small, medium and large businesses.

2 Characteristics and Benefits of Carrier Ethernet-services

Carrier Ethernet has five attributes that distinguish it from familiar LAN-based Ethernet. Those attributes are described on the MEF web site [1] and are: standardized services, scalability, reliability, service management and quality of service.
Leveraging those attributes CE-Services offer the following characteristics and benefits which enable implementation of robust and future proof WAN connectivity solutions.

Flexible Service Options - As is the case with layer 2 services based on TDM, frame relay or ATM, CE-Services provide enterprises the ability to self manage their WAN connectivity (i.e. ability to retain control and not share routing tables with the service provider). Alternatively, several service providers now offer managed, CE-Services as a value added option (note that managed services are widely deployed for IP-VPN services).This provides an enterprise or business customer with flexible service choices when migrating to or when implementing a new CE service.

Ethernet OAM (Operations and Maintenance) - The MEF, ITU and IEEE are developing a number of OAM standard features [2],[3],[4] that will provide advanced means to monitor and manage the communication on CE services. As service providers start implementing those Ethernet OAM standards, enterprises implementing CE-Services will have unprecedented visibility into the status and performance of their WAN connections.

Broad Choice of Service Types – While IP-VPN's are mainly deployed for multipoint-to-multipoint connectivity scenarios, CE services offer a broad range of service types [5]. These include point to point E-Line services (EPL/EVPL), multipoint-to-multipoint E-LAN services (EP-

LAN/EVP-LAN) and rooted multipoint E-Tree services (EP-Tree/EVP-Tree). This broad choice of service types enables additional connectivity choices for enterprises.

Choice of CPE Types – IP-VPNs by necessity require IP routers at all customer sites, while CE-Services can use Ethernet switches or IP routers giving business customers more price/ performance choices.

Service Certification – The MEF has developed a number of certification processes and Abstract Test Suites for system vendors and service providers that ensure that their Ethernet offering meets a minimum level of quality and facilitate inter-operability between the different providers of Ethernet services.

Service Level Agreements (SLA) – A larger number of service providers are now backing up their CE-Services with stringent SLAs ensuring the quality and the support of the services.

While an enterprise can benefit significantly from implementing CE-Services, ICT decision makers have to consider the following when implementing CE-Services:

CE-Services require Ethernet access. This includes Ethernet over Fiber, SONET, WDM, TDM, DSL (Copper) as well as a variety of wireless formats. Another consideration, albeit probably a temporary one, is the availability of CE-Services. Because CE-Services are somewhat new, not all service providers offer them. Enterprises expanding in regions where the dominant (and sometimes monopolistic) service provider does not offer CE- services, may find it difficult to procure a CE service. In such cases one alternative may be to mix and match a combination of CE-Services along with an IP-VPN service (which tend to be offered by a greater number of service providers)

3 Carrier Ethernet Business Services - Use Cases

The following subsections discuss a number of generic use cases and highlight some of the benefits of using a CE service.

3.1 Migrating from ATM/FR (to Carrier Ethernet Services)

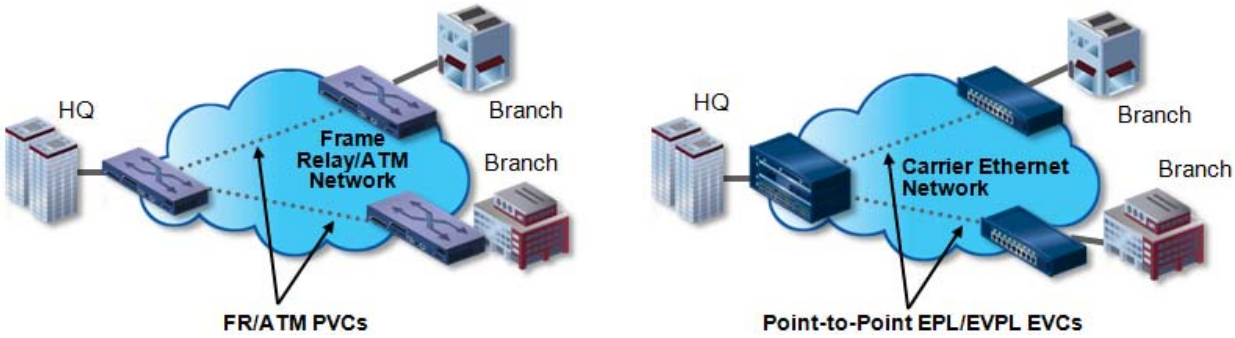

Figure 1a - ATM/FR **Figure 1b - Carrier Ethernet VPN**

Figure 1: Migrating to Carrier Ethernet service

Enterprise drivers

As depicted in figure 1a, many enterprises currently subscribe to a Frame Relay or ATM service for WAN connectivity between their sites. Video, storage and other high bandwidth applications are pushing the limits on ATM or FR based WANs. Enterprises are looking for alternative technologies that can support higher speed connectivity. A CE point-to-point solution (figure 1b), using an E-LINE service (either EPL or EVPL) provides attractive alternatives for migrating from FR/ATM to CE-Services. Alternatively enterprises could consider migrating away from point to point configurations and implement a multi-point solution using an ELAN service (described in section 3.2),

Migration Benefits

With an E-Line based solution, enterprises get point-to-point Ethernet connections over either a switched layer 2 or a private line environment. Those E-Line Ethernet services provide the enterprise with point-to-point services that are similar to the ATM and FR circuits currently in use. As a result, the enterprise will be able to maintain the current network design and operation (assuming this is the desired approach) as only the transport technology has changed. However, this migration presents the enterprise with two additional main benefits. First, a CE service provides a platform that can accommodate the ever increasing demands for bandwidth in the WAN. Moreover, by using Ethernet everywhere, the enterprise will be able to reduce its operational and capital expenses as there are no needs to continue buying, training or supporting ATM and FR technologies or continue working with legacy handoff such as DS1/E1 or OCn/STMn.

3.2 LAN Extension or Transparent LAN Services

Ethernet LAN Service

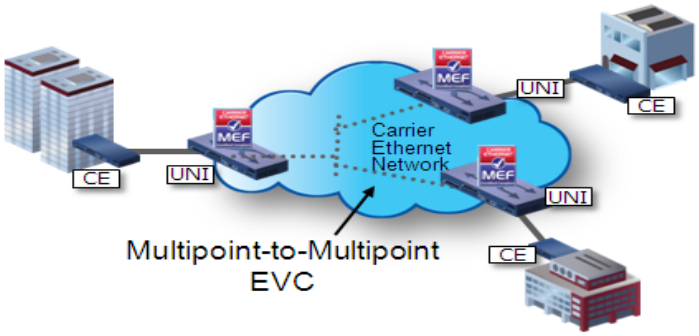

Figure 2: E-LAN Service Type Examples

Enterprise drivers

Small and medium businesses, educational and government agencies are examples of enterprises needing a fairly simple, albeit distributed LAN connectivity. Bandwidth demands are also increasing in this segment as applications like remote video monitoring, distance learning and business continuity/disaster recovery become status quo. A transparent LAN CE service is a service that links together remote Ethernet LAN's in a multipoint-to-multipoint configuration (see Figure 2). The service allows an enterprise WAN connection to appear like an extension of the LAN and is used by enterprises that want to expand their LAN to include remote sites.

As discussed in section 3.1, the E-LAN service may also be implemented by businesses that are migrating from existing FR or ATM based WAN connectivity.

Carrier Ethernet Service Benefits

Transparent LAN based CE-Services offers a simple, yet efficient way to interconnect multiple sites in a LAN type of configuration. There is no need for the enterprise to maintain numerous point-to-point connections or to have to hub all traffic to a single inter-connecting site. With a simple connection to the "LAN cloud", any site will be capable of communicating with any other site in the same domain.
Transparent LAN based CE-Services offer a very simple mechanism to add or remove sites from the network. Similar to the plug-and-play concept, it is sufficient to connect a new site to the "cloud" for that site to be able to communicate with all other sites on that cloud. Similarly, it is enough to disconnect the site from the network to remove it completely from the cloud.
Finally, the capability of a transparent LAN based CE-service to support multiple CoS, allows the enterprise to converge its voice, video and data traffic over the same network.

Those and other benefits simplify the operational and cost challenges that an ICT decision maker faces on a daily bases to keep up with the continuous changing landscape of the enterprise network.

3.3 Data Center Connectivity Using High-Speed Carrier Ethernet Service

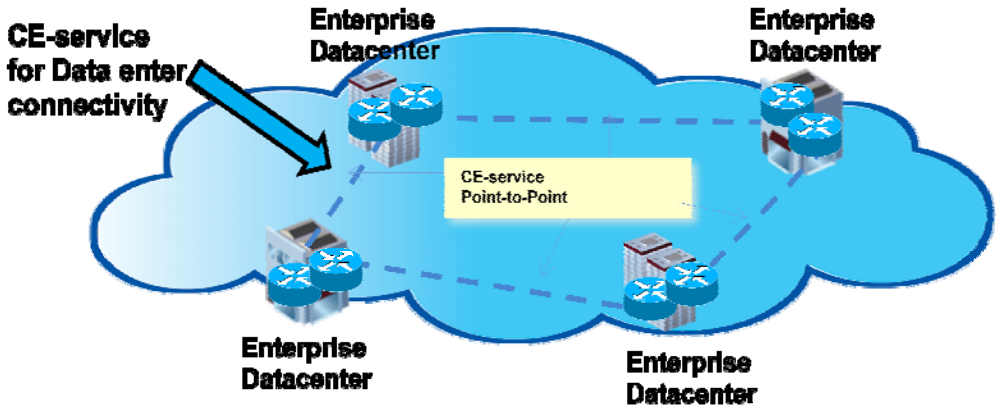

Figure 3: Data Center Connectivity using E-Line CE service

Enterprise Drivers

A large number of enterprises operate datacenter(s) in order to house and distribute massive amounts of data and compute power. Typically an enterprise operates more than one Data Centers (DC), either for redundancy purposes, capacity limitations or to have the DCs closer to their users. A main requirement of multi-DC designs is to have the capabilities to exchange large amount of data amongst them (e.g. for data mirroring, replication or backups). Moreover, the connections need to be reliable, scalable and provide guaranteed traffic parameters (such as delay and delay variation).

High speed point-to-point E-Line Ethernet services provide a very efficient solution to connect two DCs, while E-LAN and E-Tree Ethernet services provide means to create more complex architectures.

Carrier Ethernet Service Benefits

As depicted in figure 3, Enterprises could use E-Line Ethernet services to design a fully meshed, partially meshed or any other type of configurations to inter-connect their DCs. CE services can be configured with any rate from 1M to 10G (as well as 40G and 100G in the future). This wide range of data rates provide the enterprise with a flexible and granular service that can satisfy their current needs and grow to accommodate their future ones.
Furthermore, E-Line services can be designed to provide connections that are protected and/or restorable and can be configured over diverse geographical routes, thus providing the enterprise with connections that have high availability, a critical component of the inter-DC connectivity.
Finally, the use of Ethernet handoffs provides the enterprise with the benefit of having Ethernet everywhere. Beside the cost benefits of this approach, operational benefits can be achieved as well. As Ethernet is becoming a dominant technology for intra-DC communication as well, using a CE-service for inter-DC communication will result in a common technology (Ethernet) for both intra- and inter-DC communications.

Alternatively, enterprises could use E-LAN based services to connect all (or a subset) of their DCs in a multipoint-to-multipoint type of configurations (see Figure 4). This type of configuration will allow a DC to use one Ethernet connection to communicate with one or more DCs at the same time.

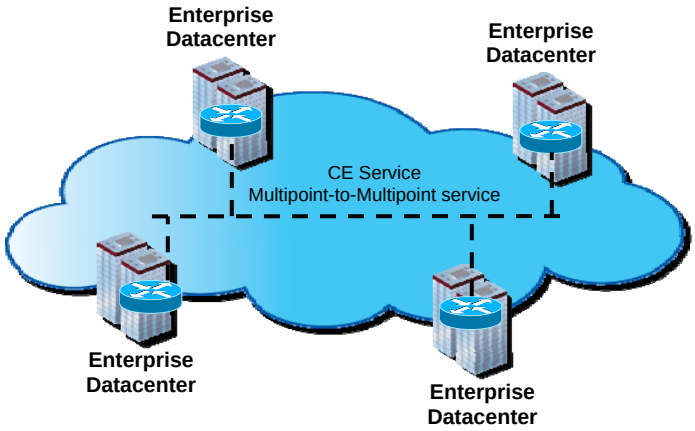

Figure 4 - Data Center Connectivity using an E-LAN CE service

Finally, enterprises can use E-Tree based services where one or more head end (or core) DCs distribute data to a number of remote (or regional) DCs (see Figure 5). The same design characteristics and benefits described for the E-Line approach are applicable as well for the E-LAN and E-Tree approaches.

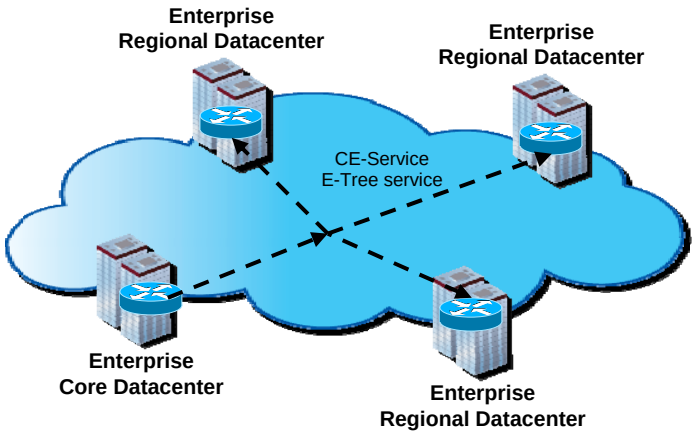

Figure 5 - Data Center Connectivity using an E-Tree CE service

3.4 Remote Site Connectivity to Data Centers

Enterprise Drivers

In addition to data center inter-connection as discussed in Section 3.3, many enterprises also require connectivity from their remote sites to one or more datacenters. The number of remote sites may vary from a few sites to hundreds or thousands of sites. The design is dependent on the number of remote sites and to some degree to the enterprise preferences. In the next section, solutions for a relatively small number of remote sites are first presented then alternative solutions are presented to accommodate situations with a greater number of remote sites.

CE-Service Designs and Benefits

An initial and simple design would be to use an E-Line service to create a point-to-point connection between each remote site and the data centers it needs to communicate with. An E-Line approach allows a design where each remote site has its own bandwidth and a traffic profile that fits its particular needs.
While an E-Line approach is the optimal design in some scenarios, it presents two main challenges: the first, a separate point-to-point connection is needed between the remote site and each DC it needs to communicate with, creating a cumbersome design at each remote site. The second is that as the number of sites grows, the total number of point-to-point connections could increase to an unmanageable level.

The first challenge could be improved on by creating an EVP-LAN that connects in a multipoint to multipoint configuration each remote site to all the DCs it needs to communicate with. This approach will reduce the number of connections at each remote site to potentially one, simplifying significantly the operation aspect at the remote sites. Furthermore this design continues to provide each remote site with its own connection that can be configured to meet the remote site specific needs. Finally the design also allows a remote site to switch between a number of DCs (based on needs and availability) without changes to the underlying network infrastructure.

However, this approach does not address the second challenge, i.e., as the number of sites grows, the number of EVP-LAN connections to manage can still grow to an unmanageable level. So it is an efficient design when the number of remote sites is relatively small

Ultimately, the CE-service design could be extended to use a single multipoint-to-multipoint E-LAN EVC where all the remote sites and the DCs are connected to a single domain, allowing any remote site to communicate with any of the DCs. This design approach has the benefit of being the simpler to design and manage (using the Transparent LAN design discussed previously in this paper) and could be the design of choice for a large number of small and medium businesses with a limited number of remote sites.

The design issue to keep in mind with the E-LAN approach is that an E-LAN CE-service creates broadcast domains that inter-connect the enterprise sites. A single E-LAN domain may be impractical from a performance perspective for large businesses requiring connectivity for a large number of sites. Best design guidelines recommend limiting the number of nodes in a single domain to 50 nodes or so, although this is a recommendation and not a hard limit and the performance of the domain will depend mostly on the traffic patterns.

Enterprises with a large number of remote sites can address their challenge in different manners. One of those would be to create a design that integrates multiple E-LAN domains in a hierarchical manner. For example, regional E-LAN domains could be used for regional operation and then have one or more core domains that inter-connect the regional ones. Alternatively, the enterprise could use “functional” domains, where each domain has a specific function (e.g., one dedicated to R&D, one to production, one to sales, etc.). Here again, one or more core domains could be used to interconnect between those “functional” domains.

This hierarchical approach to a CE service design would allow the enterprise to continue using a CE-service design for their network and integrate a very large number of sites.

Another alternative for connecting a large number of remote sites could be to opt for a hybrid IP-VPN and CE services design. With this type of design, an IP-VPN design is used to aggregate the traffic from the numerous remote sites to a number of regional hubs (see Figure 6). Then the regional hubs are connected using a CE-service design. This approach has the advantage of using the better of the two worlds, where IP-VPN is used with the remote site where Ethernet access might be challenging and regional availability and offering might have to be accommodated and then use high speed CE-Services to inter-connect those regional networks.

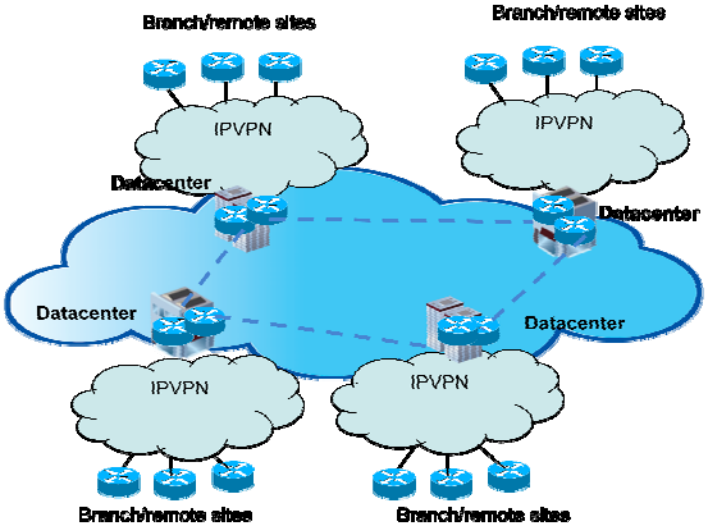

Figure 6: IP VPN for remote site to datacenter connection

3.5 Data and Video Distribution:

Enterprise Drivers

In a number of situations, an enterprise would like to distribute data from one or multiple sources (or roots) to a large number of destinations (or leaves). Examples of such designs are multimedia companies distributing video streams to affiliated stations, financial institutions distributing market data to their clients or organizations using live video remote training or presentations. The main characteristics of these designs are the almost uni-directionality of the data stream (from the root to the leaves), the relatively limited amount of data from the leaves back to the root, and the lack of communication between the leaves.

In order to address this type of request, an E-Tree set of services were defined as a CE service.

Carrier Ethernet Service Benefits

With E-Tree, the service provides a configuration where an EVC connects a number of sites in a "tree" format, with one or more roots transmitting data to a number of leaves. The CE service E-Tree design offers enterprises an alternative approach with a number of benefits. First, the Root-to-Leaf communication is provided intrinsically by the network. The enterprise will be also able to define the number of roots and leaves as well as the bandwidth assigned to each. Finally numerous and independent streams can be configured between the same set of sites (if there is a need to segregate the traffic sent to the different leaves). These benefits are in addition to the generic CE service benefits discussed in the previous sections of this document which make an E-Tree CE service solution an optimal choice for this type of network configurations.

4 Summary and Conclusions

Enterprise disaster recovery, data replication and video based applications, will continue to push the bandwidth requirements in the WAN. In addition, the growth of mobile and telecommuting applications, cloud based services and changing organization structures within enterprises will drive the consolidation of services and data centers, thus requiring high speed WAN connectivity between remote sites and headquarter sites.

As described in this paper there are several connectivity scenarios in which MEF-compliant Carrier Ethernet Services may be implemented. CE-Services support the WAN connectivity requirements of small and medium businesses (SMBs), as well as medium and large enterprises.

CE-services are complementary to existing IP-VPN services and therefore allow an enterprise to implement CE-Services to meet the increased bandwidth and performance requirements while retaining existing IP-VPN connectivity.

Carrier Ethernet provides a wide variety of low cost access options with business class attributes. Carrier Ethernet supports higher bandwidth and low latency, particularly where demand for high performance mission critical applications is accompanied by the need to closely control and manage performance.

In summary, businesses of all sizes can benefit from the higher bandwidth and high performance attributes of CE-Services to support their current and evolving WAN connectivity requirements.

5 Glossary and Terms

A glossary of terms used in this document can be found online at www.metroethernetforum.org/glossary.

Other Abbreviations used in this document

Term	Description
CE-service	Carrier Ethernet service. In this document CE service refers to a Carrier Ethernet service for business services.
ICT	Information and Communications Technology
IP-VPN	IP or Layer 3 Virtual Private Network
SMB	Small and medium business
WAN	Wide Area Network.

6 References

[1] MEF web site http://www.metroethernetforum.org
[2] MEF Technical Specifications
[3] ITU-T
[4] IEEE
[5] MEF E-Line, E-LAN and E-Tree service Types are defined in MEF 6.1 & MEF 10.2, etc
[6] IETF RFC 4364

7 About the MEF

The MEF is a global industry alliance comprising more than 190 leading organizations including telecommunications service providers, cable MSOs, network equipment and semiconductor manufacturers, software and testing organizations. The MEF's mission is to accelerate the worldwide adoption of Carrier-class Ethernet networks and services. The MEF develops Carrier Ethernet technical specifications and implementation agreements to promote interoperability and deployment of Carrier Ethernet worldwide. http://MetroEthernetForum.org.

8 Acknowledgements

Editors: Anthony Peres, Alcatel-Lucent; Ghassan Semaan, Verizon Business
Contributors: John Hawkins, Ciena; Umesh Kukreja, Alcatel-Lucent