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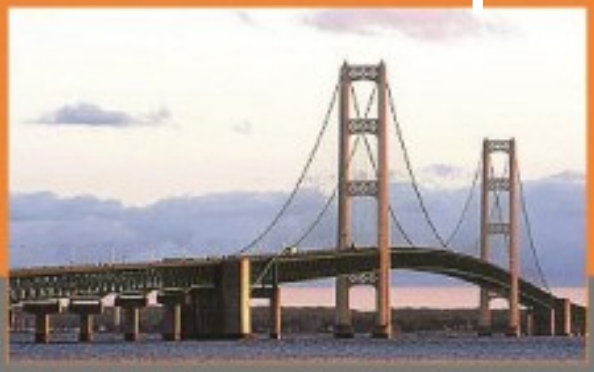
Synchronize the Ethernet

Carrier Ethernet White-Paper



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White-Paper

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Document Contents

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I. History

Rev.	Date	Author(s)	Remarks
1.0	01.11.16	SZE	Initial version of the document.

1 Introduction to Carrier Ethernet

Ethernet has become ubiquitous. Ethernet networks scale from

- small home computer networks with less than 10 connected devices up to large campus or company installations with tens of thousands of connected devices,
- slow 10 Mbit/s up to ultra-fast 40/100 Gbit/s.

Its popularity stems not only from scalability, but also from cheap and easy installation and its ease of use.

One of the disadvantages of Ethernet is that it is constrained to Local Area Networks (LAN). It is not easily extended across Metro Area Networks (MAN) or even Wide Area Networks (WAN). This can only partly be attributed to the variety of transport technologies used by MAN/WAN Network Operators, which is not always Ethernet-compatible. It is also the scope of a LAN (e.g. the Broadcast Domain) that cannot be extended across a MAN/WAN at will. Establishing Ethernet connectivity between different locations therefore requires the use of additional tunnelling protocols like IP/VPN, which add additional layers of configuration and management, or the installation and operation of dedicated, private Ethernet lines between all locations.

Carrier Ethernet was designed to overcome this limitation. Instead of needing to install private Ethernet lines, it allows existing MAN/WAN infrastructure to be used to provide virtualized private Ethernet lines as a service. The goal is to deliver end-to-end Ethernet services, where

- data is carried in Ethernet frames,
- frames are transported across one or more carrier networks, independent of the transport technologies used by the carriers, and
- Ethernet frames are delivered largely unaltered.

The Metro Ethernet Forum (MEF) is the driving force behind Carrier Ethernet. It develops and releases the standard specifications, run certification programs and operates equipment test centres.

1.1 Key Attributes of Carrier Ethernet

In contrast to LAN-based Ethernet, Carrier Ethernet is a carrier-class service defined by five key attributes.

1.1.1 Standardized Services

In Carrier Ethernet, a small set of standardized service types is specified. The specification restricts itself to describing how an Ethernet service operates and the configurable properties (attributes) of the Ethernet service, including a wide range of bandwidth, CoS and QoS options. This explains the success of Carrier Ethernet:

- It allows Ethernet Services to be defined for any purpose.
- It allows standardized equipment to be used (that understands the service attributes).
- It is independent of the transport infrastructure and can be implemented in many existing Metro / Wide Area Networks.
- It converges data, voice, video, … over a unified transport.

1.1.2 Scalability

Carrier Ethernet is scalable in almost every aspect:

- It allows the delivery of huge numbers of Ethernet services across Carrier Networks.
- It may span large geographical distances.
- It allows transport via a variety of infrastructure.
- It allows expansion over different access technologies.
- Service bandwidth can smoothly be scaled from a few kbit/s up to full link capacity.

1.1.3 Quality of Service

Carrier Ethernet defines a means for the definition and monitoring of Service Level Agreements (SLA). The SLA is a specification of required performance measures of the service.

Among the performance measures that are standardized by the MEF are: frame delay, inter-frame delay variation, frame loss ratio and service availability. MEF compatible equipment is able to continuously monitor these performance measures and can detect and notify violations of the SLA.

1.1.4 Reliability

Carrier Ethernet cares about the reliability of Ethernet services. The declared goal is a service resiliency similar to or better than SONET/SDH and which provides an end-to-end service-level protection.

MEF combines tools for the fast detection of various faults (link failures, path errors, service isolation faults, …) with fault notification and redundancy or recovery mechanisms.

1.1.5 Service Management

One of the most important challenges is the capability to effectively manage the service delivery infrastructure. This challenge is addressed by Carrier Ethernet through two measures.

The first one is the definition of a standardized service behaviour and set of service attributes. It provides for a unified, vendor-independent capability to manage network equipment and allows a centrally-managed, rapid provisioning of Ethernet Services.

The second one is a carrier-class Operation, Administration and Maintenance (OAM) helping to monitor and troubleshoot provisioned services.

2 MEF Service Model

One of the declared goals of Carrier Ethernet is to provide standardized Ethernet services over existing Carrier network infrastructure, including different access technologies, MAN and WAN network operators. A typical situation might look like in the following picture. In this example, four customer sites are connected to different carrier networks.

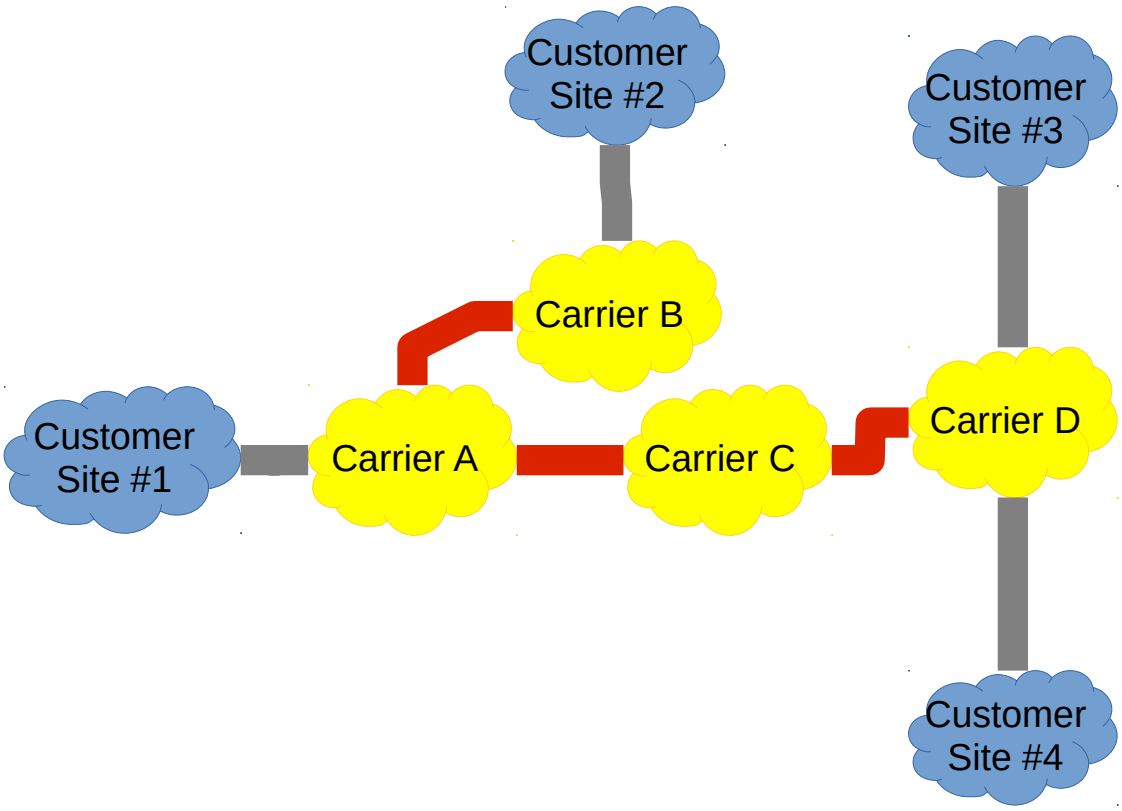

Figure 1: Schema of a typical network topology.

2.1 The Three Rôles

The MEF Service Model identifies and describes the parties that consume Ethernet services as well as parties that provide these services. It divides the picture above into three levels and defines three corresponding rôles:

- Subscriber (MEF 10)
  - ultimate user of the service
  - has the Service Provider as single point of contract
- Service Provider (MEF 10)
  - provides end-to-end Ethernet services to Subscribers
  - may need to contract one or more Operator to provide parts of the service
- Operator (MEF 26)
  - party that owns and manages a carrier network
  - provides Ethernet services in the own network
  - has limited knowledge of the end-to-end service

In real world scenarios, the rôles of Service Provider and Operator will often coincide because the Service Provider owns a carrier network.

This changes the previous picture as follows:

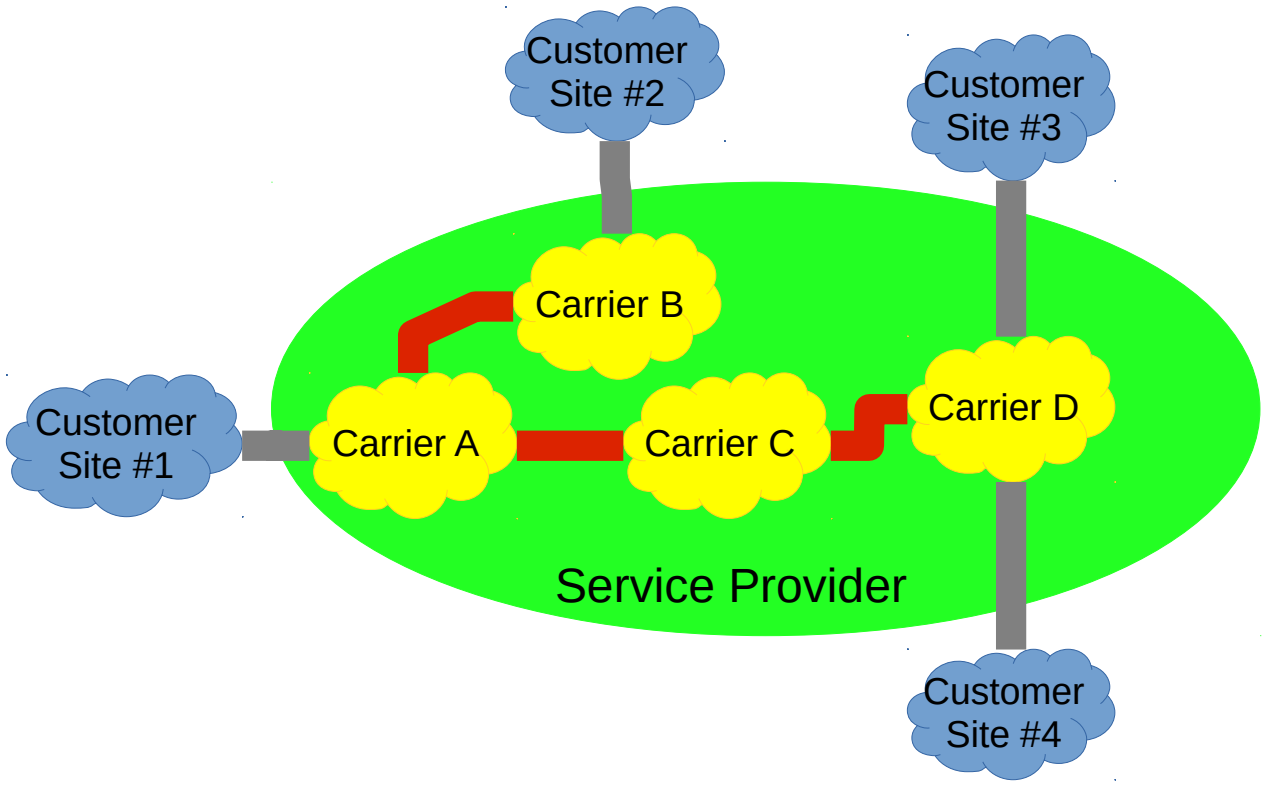

Figure 2: MEF Three Roles

2.2 Architecture Reference Model

MEF defines the interactions between the three rôles by defining standard interfaces between them.

The interface between Subscriber and Service Provider is called User Network Interface (UNI) and demarcates the boundary between the private subscriber network and the public MAN/WAN. It is a reference point in the MEF Architecture that is used to define the Ethernet Virtual Connection (EVC), an abstract service construct that describes connectivity between two or more subscriber sites.

The UNI is a link connecting the Customer Edge (CE) and the Provider Edge (PE) equipment. It carries Ethernet frames selected by the subscriber for transmission across the MAN/WAN (ingress service frames), and Ethernet frames to be delivered to the subscriber by the service provider (egress service frames).

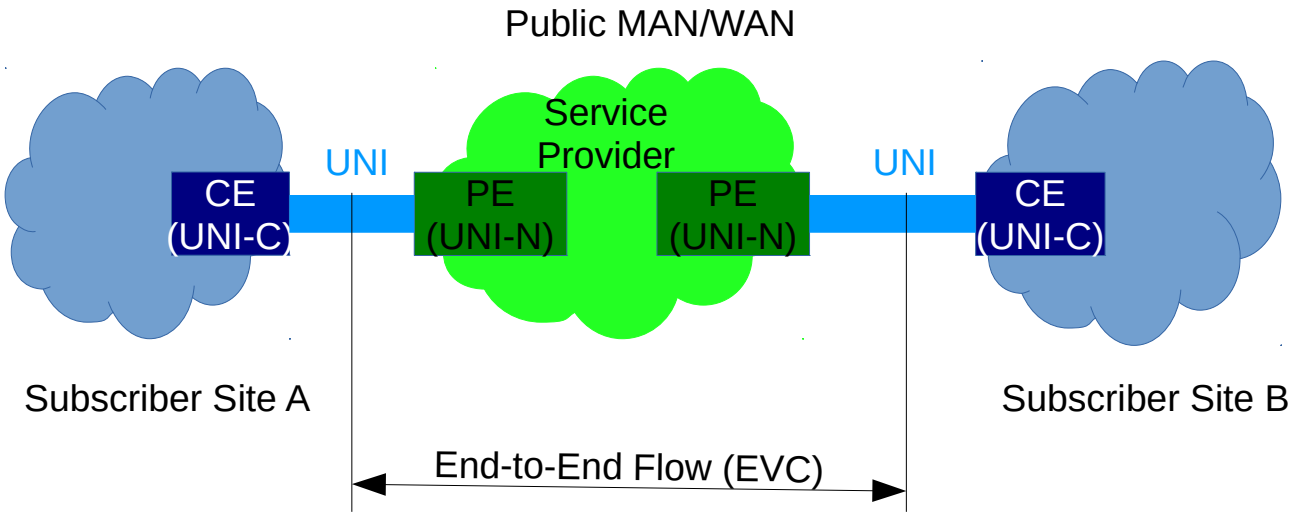

Figure 3: Architecture Reference Model, Subscriber View

The Service Provider may need help from 3rd party carrier network operators to deliver end-to-end connectivity to Subscribers. The standardized External Network to Network Interface (ENNI) was defined by the MEF as an interconnect for passing EVCs between multiple Operator networks.

The Service Provider leases Operator Virtual Connections (OVC) from network Operators in much the same way as the subscriber leases an Ethernet Virtual Connection. The ENNI demarcates the boundary between different network Operators and allows the standardized exchange of Ethernet service frames.

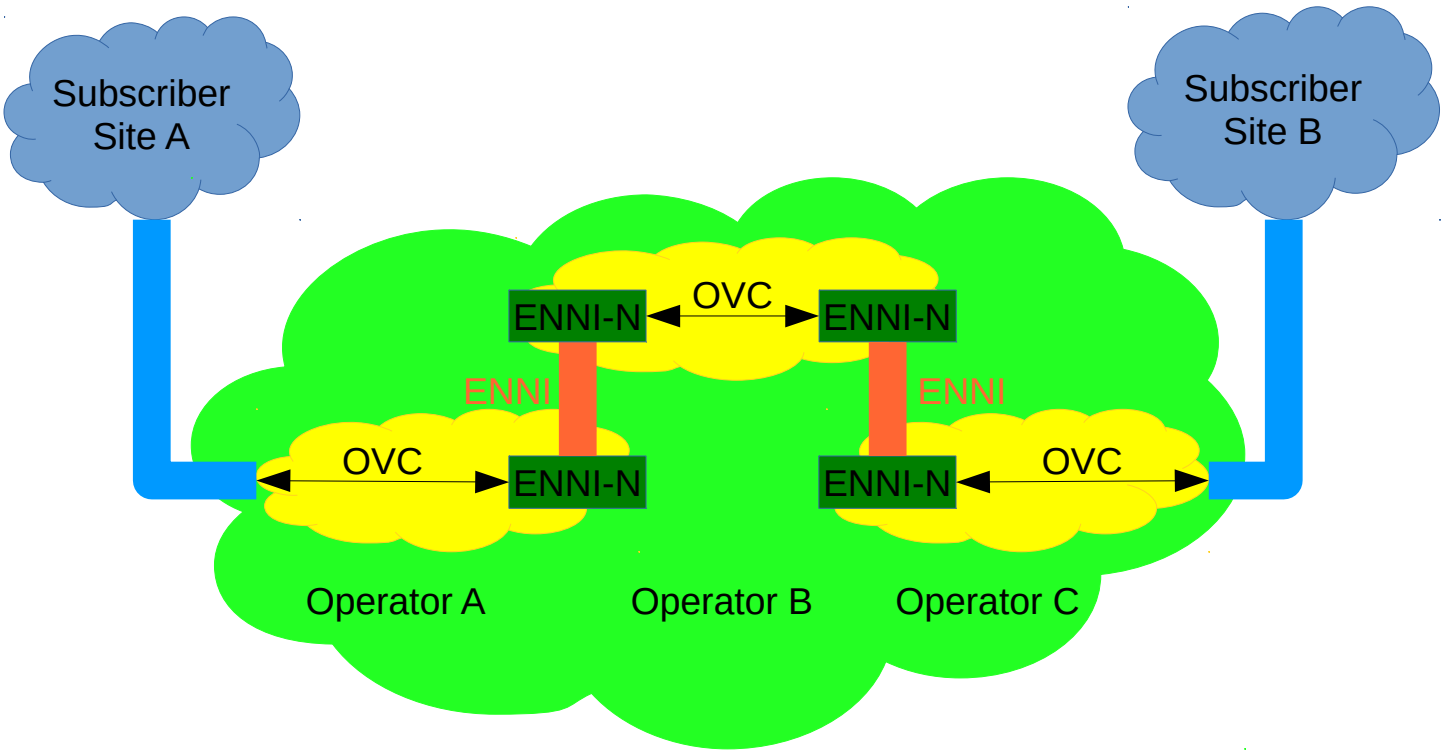

Figure 4: Architecture Reference Model: Service Provider View

It is important to note that the MEF mandates the subscriber data to be carried in Ethernet frames across the architectural reference points, e.g. the UNI and ENNI links, but is does not specify a frame format for the transport across an EVC or an OVC. This leaves the choice of transport technology to the operator, who may choose whatever seems appropriate as long as the ingress Ethernet frames can be reconstructed.

3 Summary

The popularity of Ethernet in Local Area Network (LAN) installations and a growing necessity to transparently interconnect university campuses or company sites in different locations have created a strong demand for the provisioning of virtualized private Ethernet lines over existing carrier operator networks.

The Metro Ethernet Forum (MEF) addresses this demand with the specification of carrier-class Ethernet services and a corresponding architectural model. The specification is restricted to the description of standardized interfaces between involved parties (Subscriber, Service Provider, Network Operator), and thereby allows existing transport infrastructure to be re-used instead of inventing a new one.

The Ethernet services are defined through a standardized set of attributes that define the service behaviour. They include a wide range of bandwidth, CoS and SLA options that make these Ethernet services suitable for almost every purpose. Fast resiliency and a carrier-class OAM address high-availability demands.

The standardized interfaces and the standardized service attributes provide not only for interoperability between involved parties, they also enable rapid and centrally-managed provisioning of Ethernet services.

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