



**Accelerate Worldwide Adoption of Carrier
Class Ethernet Networks and Services**

Introduction

This MEF brochure provides an easy-to-read introduction to Metro Ethernet for all audiences. It presents compelling business arguments in terms of market potential, and includes benefits to both Service providers supplying, and Enterprises consuming Metro Ethernet services. Basic technology concepts are outlined and the brochure concludes with a discussion of the high-profile role played by the MEF in this dynamic industry space.

Market Overview

Evolution of Ethernet

Ethernet started in the 1970s as a LAN technology. Its advantages - simplicity, high speed and cost effectiveness - make it the LAN technology of choice. Metro networks are traditionally TDM-based for supporting voice applications. But, as data has surpassed voice to become the dominant traffic type, metro networks have become packet-based instead of TDM-based. Ethernet's technical advantages and its ubiquitous presence in enterprise networks make it the most desirable technology for the Metro Area Network (MAN). At the same time, there have been technical advances, including increases in the speed and distance, QoS support and OAM support, that have transformed Ethernet into a carrier technology. Ethernet has become the technology of choice for the MAN.

Why Ethernet has Expanded into the Metro and Beyond

Deploying Ethernet in the metropolitan areas is a compelling and commercially proven approach to break the 'metro bandwidth bottleneck' for the following reasons:

Cost Effectiveness

Ethernet equipment cost is significantly lower than legacy equipment cost. This is partly due to economies-of-scale of Ethernet (ubiquitous adoption) and partly due to the relative technical simplicity of Ethernet. Operating cost of Ethernet networks can be significantly lower than other legacy networks because of Ethernet's simplicity and people's familiarity with it. This also increases employee availability and reduce training cost.

Ease of Interworking

Using Ethernet in both LAN and MAN removes the need for interworking (e.g. Ethernet/ATM) at the Customer Equipment (CE). This allows simpler CEs to be used and reduces configuration requirements. Consequently, it is relatively simple to integrate and interface end-customer IT systems with Ethernet metro service.

Flexibility and Ease of Provisioning

Provisioning cost is also significantly less because the equipment is simple, less interworking, and the high speed of Ethernet allows bandwidth on demand. Ethernet can offer a wide range of speeds, from 1Mb/s to 1Gb/s, in increments as fine as 1Mbps, which can be rapidly provisioned on-demand or even by the customer through a web-based tool.

The Growing Market Opportunity of Carrier Ethernet

Forecasts from a number of market research companies suggest that the market for Ethernet services will grow by at least 30 percent a year worldwide till 2008, reaching multi-billion dollars per year in APAC, Europe, and the U.S¹.

¹ According to an article published by Lightreading Dec 27, 2004

Table 1. Forecasts of Worldwide Ethernet Services Market

| Market Research Company | Region | 2003 | 2008 | CAGR |
|--|--------|----------------|-----------------|-------|
| IDC | U.S. | \$315 million | \$1.2 billion | 30.7% |
| Vertical Systems | U.S. | \$385 million | \$1.4 billion | 30.0% |
| Yankee Group | U.S. | \$400 million | \$4.0 billion | 57.0% |
| Probe Group LLC / Analysys Research Ltd. | Europe | \$866 million | \$5.0 billion | 42.0% |
| Frost & Sullivan | APAC | \$3.84 billion | \$15.24 billion | 31.7% |

According to Infonetics Research, worldwide metro Ethernet equipment revenue hit \$2.9 billion in 2003, and is projected to grow over 150% to \$7.5 billion by 2007, a CAGR of 27%. Worldwide metro Ethernet equipment ports hit 1.1 million in 2003, up from 906,000 in 2002, and will grow over 400% to 5.8 million by 2007, a CAGR of 52%.

What is Metro Ethernet

Metro Ethernet refers to metro Ethernet services or metro Ethernet network or both.

Metro Ethernet Services

The basic model for Ethernet services is shown in Figure 1. Ethernet Service is provided by the Metro Ethernet Network (MEN) provider. Customer Equipment (CE) attaches to the network at the User-Network Interface (UNI) using a standard 10Mbps, 100Mbps, 1Gbps or 10Gbps Ethernet interface.

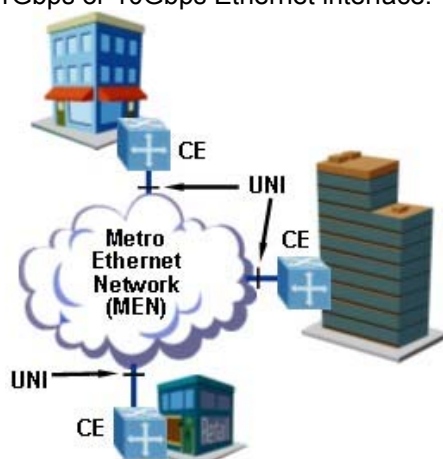


Figure 1 – Basic Model

The Metro Ethernet Forum (MEF) has defined two basic service types discussed below. Other service types may be defined in the future.

Ethernet Line Service

The Ethernet Line Service (E-Line Service) provides a point-to-point Ethernet Virtual Connection (EVC) between two UNIs as illustrated in Figure 2. The E-Line Service is used for Ethernet point-to-point connectivity.

In its simplest form, an E-Line Service can provide symmetrical bandwidth for data sent in either direction with no performance assurances, e.g., best effort service between two 10Mbps UNIs. In more sophisticated forms, an E-Line Service may provide some bandwidth, delay, jitter, and loss performance assurances between two UNIs with different speeds.

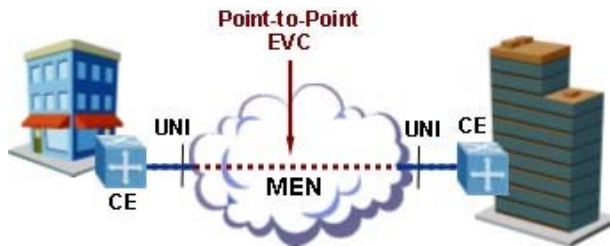


Figure 2: E-Line Service using Point-to-Point EVC

Ethernet LAN Service

The Ethernet LAN Service (E-LAN Service) provides multipoint connectivity, i.e., it may connect two or more UNIs as illustrated in Figure 3. Subscriber data sent from one UNI can be received at one or more of the other UNIs. Each site (UNI) is connected to a multipoint EVC. As new sites (UNIs) are added, they are connected to the same multipoint EVC thus simplifying provisioning and service activation. From a Subscriber standpoint, an E-LAN Service makes the MEN look like a LAN.

An E-LAN Service can be used to create a broad range of services. In its simplest form, an E-LAN Service can provide a best effort service with no performance assurances. In more sophisticated forms, an E-LAN Service may provide services with some bandwidth, delay, jitter, and loss performance assurance.

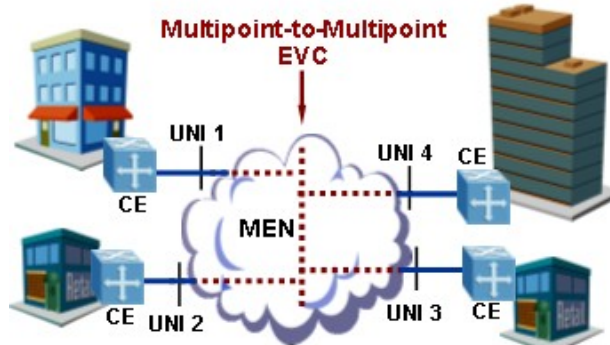


Figure 3: E-LAN Service using Multipoint EVC

Metro Ethernet Network (MEN)

A MEN is a network that connects geographically separated enterprise LANs in a metro area using Ethernet. Multiple MENs can be connected by a Wide Area Network (WAN) to provide national or international coverage. This is illustrated in Figure 4:

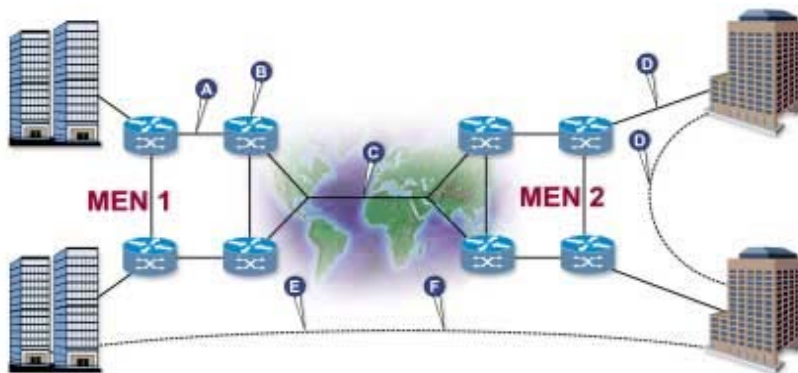


Figure 4. A typical carrier Ethernet network comprising multiple MENs

- A. Links are primarily point-to-point, and can be of any speed from 10Mbps to 10Gbps.
- B. Nodes can be either switches or routers. Nodes are meshed to whatever degree necessary to provide the desired connectivity, services and protection.
- C. WAN links connect MEN's together across large distance.
- D. Ethernet services can be classified topologically into either point-to-point or point-to-multi-point.
- E. Network resilience can be implemented using a combination of various techniques. Protection could be end-to-end (as shown) or node-to-node.
- F. Quality of Service can be realized using a combination of various techniques, providing both 'hard' and 'soft' bandwidth guarantees.

Benefits to the Service Providers

In general, the benefits of metro Ethernet are:

- Simplicity
- High speed, and
- Cost effectiveness

For service providers, these translate into both Operational Expenditure (OpEx) and Capital Expenditure (CapEx) advantages.

OpEx Advantage

Compared to other legacy metro transport technologies such as ATM, Frame Relay and SONET/SDH, Ethernet offers a strong OpEx advantage for service providers:

- The simplicity and maturity of Ethernet increase equipment reliability and thus service availability
- The simplicity of Ethernet simplifies network operations
- Ease of interworking between LAN and MAN/WAN enables faster service provisioning
- The equipment's simplicity and people's familiarity with Ethernet increase employee availability and reduce training cost
- The high speed of Ethernet enables bandwidth on demand, e.g. from 1mbps to 1Gbps without any equipment upgrade

In addition, Ethernet OAM is maturing and will contribute to further OpEx savings.

The MEF worked with 36 service providers to identify actual OpEx savings for Metro Ethernet services compared to legacy Private Line, Frame Relay and ATM services for a typical metro area, with a population of 1 – 2 million people and 50,000 – 80,000 businesses, over a three-year period for Ethernet Line and Ethernet LAN services versus legacy private line and Frame Relay/ATM virtual circuit services. The results provided an impressive OpEx saving:

| Year 1 OpEx savings | Year 2 OpEx savings | Year 3 OpEx savings | 3-year OpEx cumulative |
|---------------------|---------------------|---------------------|------------------------|
| 18% | 20% | 24% | 23% |

Figure 5. Ethernet OpEx advantage

CapEx Advantage

The economy of scale and simplicity of Ethernet make Ethernet equipment more cost effective than other equipment of comparable functionality. The high speed of Ethernet gives service providers more revenue-generating opportunities and increases the life-span of Ethernet equipment. These translate into significant CapEx advantages for service providers. Exact CapEx saving will vary according to the vendor chosen and the

particular network situation, however when combined with associate OpEx savings over the lifecycle of the service, the business case becomes compelling.

Benefits to the Enterprises

For enterprises, the benefits of metro Ethernet are:

- Much higher access speed at a comparable service fee;
- “Pay as you grow” that is made possible by bandwidth on demand;
- Lower cost CE for MAN/WAN access
- Simplicity of multi-point connectivity
- Ease of interconnecting multiple sites into a virtual private LAN
- Increased IT personnel availability and reduced training cost

About the Metro Ethernet Forum

The Metro Ethernet Forum (MEF) is a non-profit organization chartered to accelerate worldwide adoption of carrier class Ethernet networks and services.

MEF is comprised of major incumbent local exchange carriers, leading service providers, top network equipment vendors and other prominent networking companies that share an interest in metro Ethernet. MEF has 62 members worldwide.

MEF Positioning Statement

Mission

The mission of the MEF is to accelerate Worldwide Adoption of Carrier class Ethernet Networks and Services.

Objectives

1. Build consensus and unite service providers, equipment vendors and end-customers on Ethernet service definition, technical specifications and interoperability.
2. Facilitate implementation of existing and new standards, Ethernet service definition, test procedures and technical specifications of the MEF to allow delivery of Ethernet services and make Ethernet-based metro networks carrier-class.
3. Enhance worldwide awareness of the benefits of Ethernet services and Ethernet-based metro transport networks.

Deliverables

1. Implementation Agreements on existing standards
2. Test Procedures for interoperability
3. Position Statements to propose new standards to existing standards bodies
4. Technical Specifications of new standards in the MEF
5. Marketing evangelism and collateral material

MEF Achievements

Approval of Eleven Technical Specifications as MEF Standards (as of April 2005)

- MEF 1, Ethernet Services Model, Phase 1:
This technical specification defines the attributes of Ethernet Services observable at a User Network Interface (UNI)
- MEF 2, Requirements and Framework for Ethernet Service Protection in Metro Ethernet Networks
This technical specification defines requirements, a model, and a framework for protection of Ethernet services in Metro Ethernet Networks.

- ❑ MEF 3, Circuit Emulation Service Definitions, Framework and Requirements in Metro Ethernet Networks
This technical specification outlines the types of the TDM services that can be offered over a MEN, and the requirements of such services. It covers both PDH services and SONET/SDH services.
- ❑ MEF 4, Metro Ethernet Network Architecture Framework - Part 1: Generic Framework
This technical specification defines generic architectural framework for Metro Ethernet Networks (MEN).
- ❑ MEF 5, Traffic Management Specification: Phase I
This technical specification defines the Traffic and Performance parameters that may be specified as part of an Ethernet service level specification (SLS).
- ❑ MEF 6, Ethernet Services Definitions - Phase I
This document defines two Ethernet Service Types, Ethernet Line (E-Line) and Ethernet LAN (E-LAN), and their associated Service Attributes and parameters.
- ❑ MEF 7: EMS-NMS Information Model
This document provides a set of network-view managed entities that can be used to manage Metro Ethernet networks.
- ❑ MEF 8: Implementation Agreement for the Emulation of PDH Circuits over MENS
This document describes Implementation Agreement for the Emulation of PDH Circuits over MENS
- ❑ MEF 9: Test Procedure for Ethernet Services
This document provides test procedures for verifying metro Ethernet equipment's conformance to the metro Ethernet services defined in MEF 1.
- ❑ MEF 10: MEF 10 (Obsoletes MEF 1 and MEF 5): Ethernet Services Attributes Phase 1
This technical specification defines the attributes of Ethernet Services observable at a User Network Interface (UNI) and from UNI to UNI. It also describes a framework for defining specific instances of Ethernet Services
- ❑ MEF 11: User Network Interface (UNI) Requirements and Framework
This technical specification describes the User to Network Interface (UNI) requirements and framework.

For a list of upcoming MEF technical specifications, please refer to:

<http://www.metroethernetforum.org/TechSpec.htm>

Cooperation With Other Standard Bodies

The goal of the MEF is to create Implementation Agreements (IAs) that leverage existing standards defined by other standard organizations such as IEEE, ITU-T and IETF rather than creating competing standards. Where necessary, the MEF will:

1. Make recommendations to existing standards bodies. MEF has liaisons to IEEE and ITU-T. MEF also works closely with IETF.
2. As a last resort, create standards that are not being developed by other standards bodies.

MEF work is increasingly referenced by other international forums and standard bodies

Certification

The MEF Certification Program is a key part of the Metro Ethernet Forum's mission to accelerate the deployment of Carrier Ethernet in the WAN. It requires that a number of MEF-approved test laboratories will provide certification for Carrier Ethernet products and services according to specifications defined by the MEF. The objective is to assure the service provider community and their customers that these products are compliant with MEF specifications in order to facilitate the selection of equipment and integration of Carrier Ethernet WANs thereby accelerating the adoption of these services and technology worldwide. More information is available on the MEF website.

Membership Benefits

MEF membership provides the following benefits:

1. Influencing and leading the industry direction for Metro Ethernet
2. Increasing your company's visibility and market credibility
3. Acquiring early insight into emerging technologies and implementations
4. Obtaining early insight into Metro Ethernet customer and market trends
5. Strengthening industry contacts for win-win relationships
6. Receiving updates on allied activity in other forums (MPLSF, ITU, etc.)

Companies interested in becoming a member should complete the application form located at <http://www.metroethernetforum.org/MembBenefits.htm> and follow the instructions therein.

Contact Information

Metro Ethernet Forum
19900 MacArthur Blvd. Suite 810
Irvine, CA 92612, U.S.A.
Tel: +1-949-250-7188
Fax: +1-949-250-7136
Email: manager@metroethernetforum.org
www.metroethernetforum.org