

City College of San Francisco

Computer Networking &
Information Technology



CNIT

Institute for the
Convergence of Optical
& Networking Systems

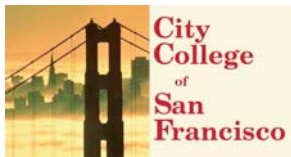
ICONS

Carrier-class Ethernet Redefining Wide Area Services

Pierre Thiry

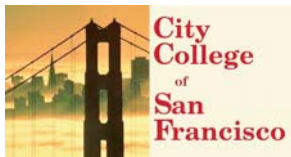
Presentation Outline

- Standards bodies for Ethernet Services:
- Growth of Ethernet into Metro Markets
- Metro Ethernet Services: E-Line and E-LAN
- Evolution of Metro Ethernet to Carrier-class Ethernet
- View from the other side: MFA Forum & MPLS



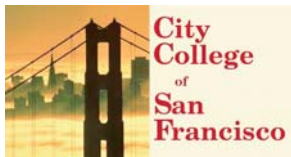
- *People often take the view that standardization is the enemy of creativity. But I think that standards help make creativity possible -- by allowing for the establishment of an infrastructure, which then leads to enormous entrepreneurialism, creativity, and competitiveness.*

-Vint Cerf, TCP/IP co-developer and Internet pioneer, in [Fast Company](#), April 2000.



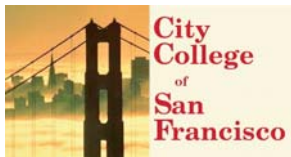
Standards Bodies for Ethernet Services

- Metro Ethernet Forum (MEF): <http://metroethernetforum.org>
- MPLS Frame Relay & ATM (MFA) Forum: <http://www.mfaforum.org/>
- Optical Internetworking Forum (OIF): <http://oiforum.com>
- IETF : Internet Engineering Task Force <http://ietf.org>
- IEEE: 802 LAN/MAN <http://grouper.ieee.org/groups/802/index.html>
- ITU-T: International Telecommunication Union – Telecom Standards



MEF Absorbs EFMA

- MARCH 09, 2005
- The [Metro Ethernet Forum \(MEF\)](#) this week announced that it will absorb the [Ethernet in the First Mile Alliance \(EFMA\)](#) as the two organizations look to push a common agenda of carrier-class Ethernet standards (see [MEF Absorbs EFMA](#)).

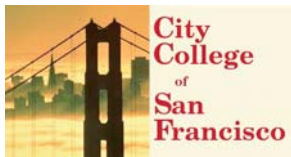


From light reading



What Trend Analysts say about Ethernet services

- U.S. market behind Europe, which [Probe Group LLC](#) forecasts “...will reach \$5 billion by 2008.”
- [Analysis Research Ltd.](#) - “...with 42% CAGR, Ethernet shows the highest growth of all European data services.”
- [Gartner Inc.](#) - “...Western Europe will see a CAGR of 48% to €2 billion (\$2.7 billion), while even more potential for growth exists in Central and Eastern Europe.”
- Asia/Pacific region has seen the fastest uptake of Ethernet services [Frost & Sullivan](#) predicts “Ethernet equipment revenues will reach \$15.24 billion by 2008, up from \$3.84 billion in 2003.”

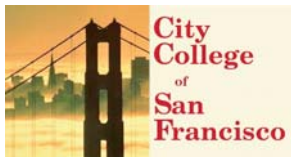


“Ethernet Service Revenues Set to Soar” Lightreading, 12/27/04



Projections of Growth in Carrier Ethernet Services

<i>Analyst</i>	<i>2003</i>	<i>2008</i>	<i>CAGR</i>
Vertical Systems	\$385m	\$1.4b	30.0%
IDC	\$315m	\$1.2b	30.7%
Yankee Group	\$400m	\$4.0b	57.0%



“Ethernet Service Revenues Set to Soar” Lightreading, 12/27/04



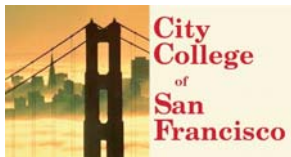
Metro Ethernet Forum

- <http://www.metroethernetforum.org/>
- The MEF has provided standards for two available service types: Ethernet Line (E-Line) point-to-point services and Ethernet LAN (E-LAN) multipoint-to-multipoint services.
- More recently the MEF has tackled the specifications for Carrier-class Ethernet



E-Line services

- E-Line services form a point-to-point Ethernet Virtual Connection (EVC) between two User-Network Interfaces (UNIs).
- In the simplest form, it provides bi-directional symmetrical bandwidth without performance assurances (no QoS, just best effort 10Mbps).
- E-line configurations can also include committed information rate and burst size and be used to set up private line services as well.

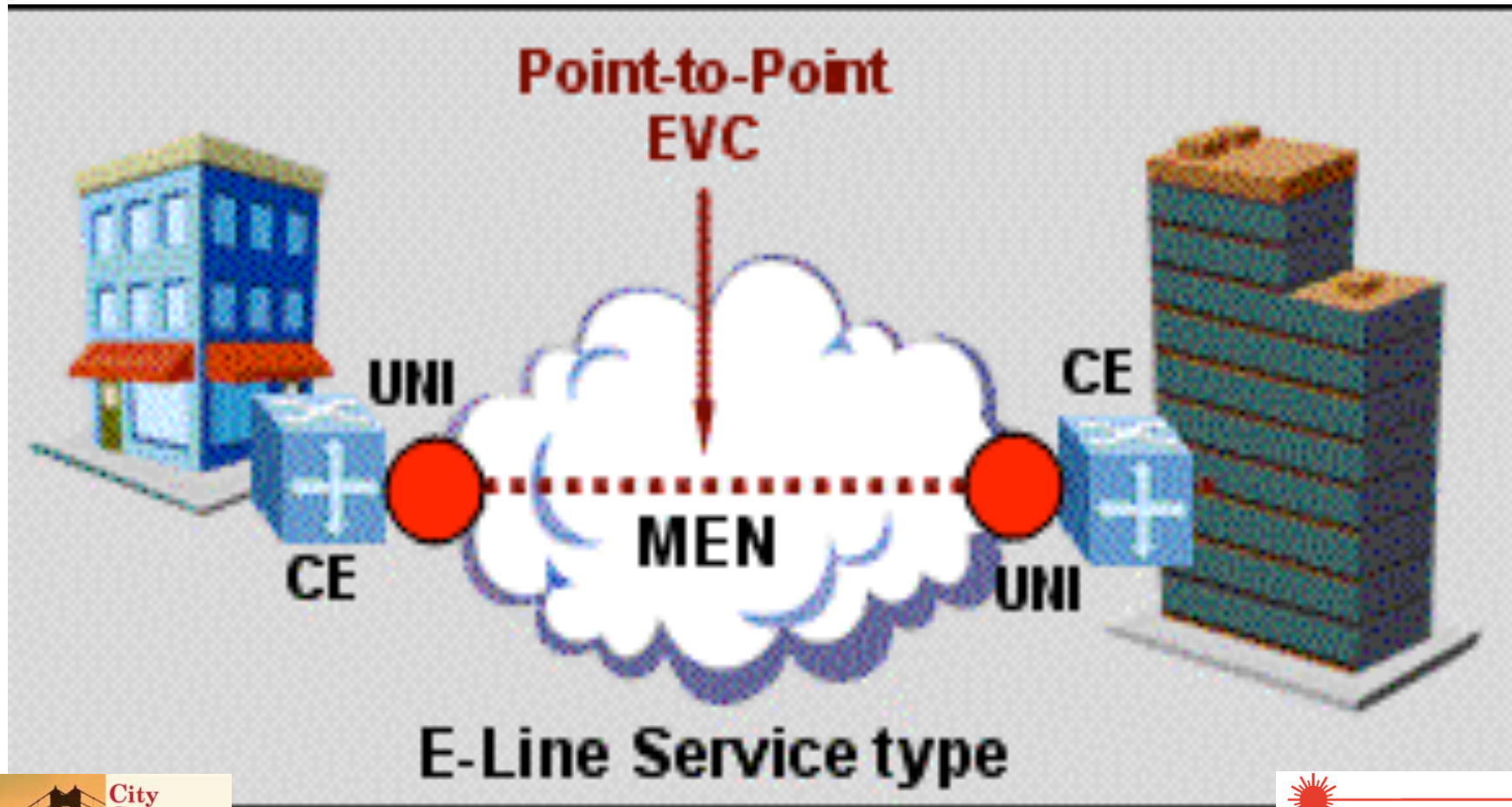


Many Enterprise customers will not use Metro Ethernet services unless:

- There are Service Level Agreements (SLAs) with performance assurances
- There is availability of service to all critical locations



E-Line services



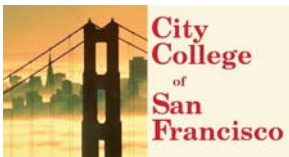
Two types of E-line services:

- "Ethernet Private Line" (the Ethernet analogy to a dedicated TDM private line such as T1 or T3)
- "Ethernet Virtual Private Line" (the Ethernet analogy to a service using a shared network infrastructure similar to a Frame Relay).



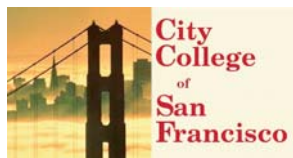
Bandwidth

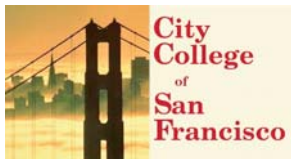
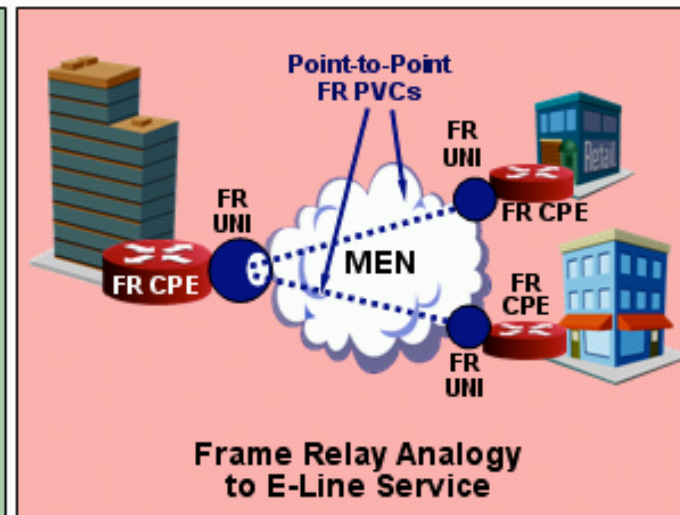
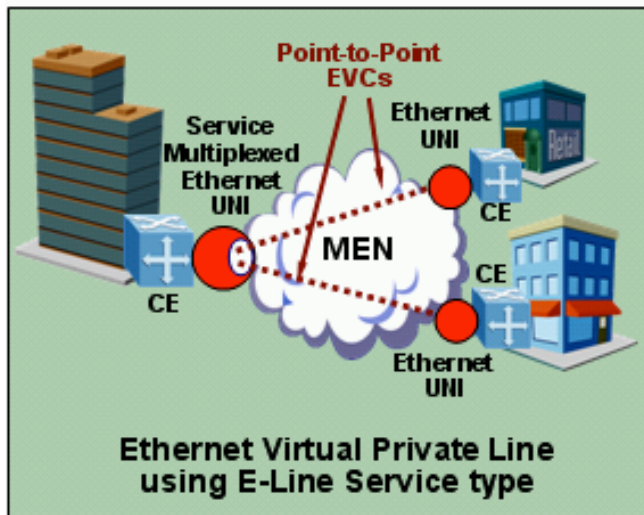
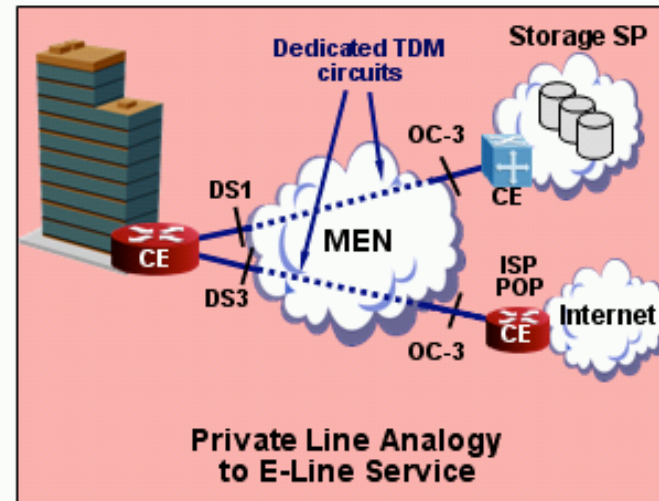
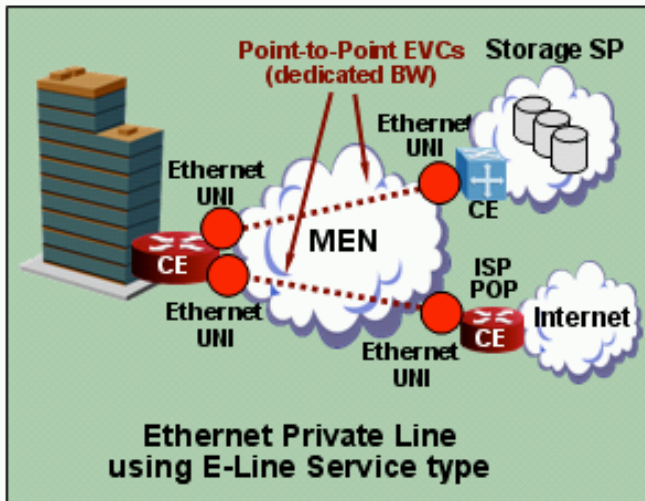
- **MEF has defined three bandwidth profiles**
 - Ingress Bandwidth Profile Per Ingress UNI
 - Ingress Bandwidth Profile Per EVC
 - Ingress Bandwidth Profile Per CoS ID
- **4 main parameters <CIR, CBS, EIR, EBS>**
 - CIR/CBS determines frame delivery per service level objectives
 - EIR/EBS determines amount of excess frame delivery allowed



Example CoS-based Metro Ethernet SLA

Service Class	Service Characteristics	CoS ID	Bandwidth Profile per EVC per CoS ID	Service Performance
Premium	Real-time IP telephony or IP video applications	6, 7	CIR > 0 EIR = 0	Delay < 5ms Jitter < 1ms Loss < 0.001%
Silver	Bursty mission critical data applications requiring low loss and delay (e.g., Storage)	4, 5	CIR > 0 EIR ≤ UNI Speed	Delay < 5ms Jitter = N/S Loss < 0.01%
Bronze	Bursty data applications requiring bandwidth assurances	3, 4	CIR > 0 EIR ≤ UNI Speed	Delay < 15ms Jitter = N/S Loss < 0.1%
Standard	Best effort service	0, 1, 2	CIR=0 EIR=UNI speed	Delay < 30ms Jitter = N/S Loss < 0.5%





Graphics borrowed from MEF presentations

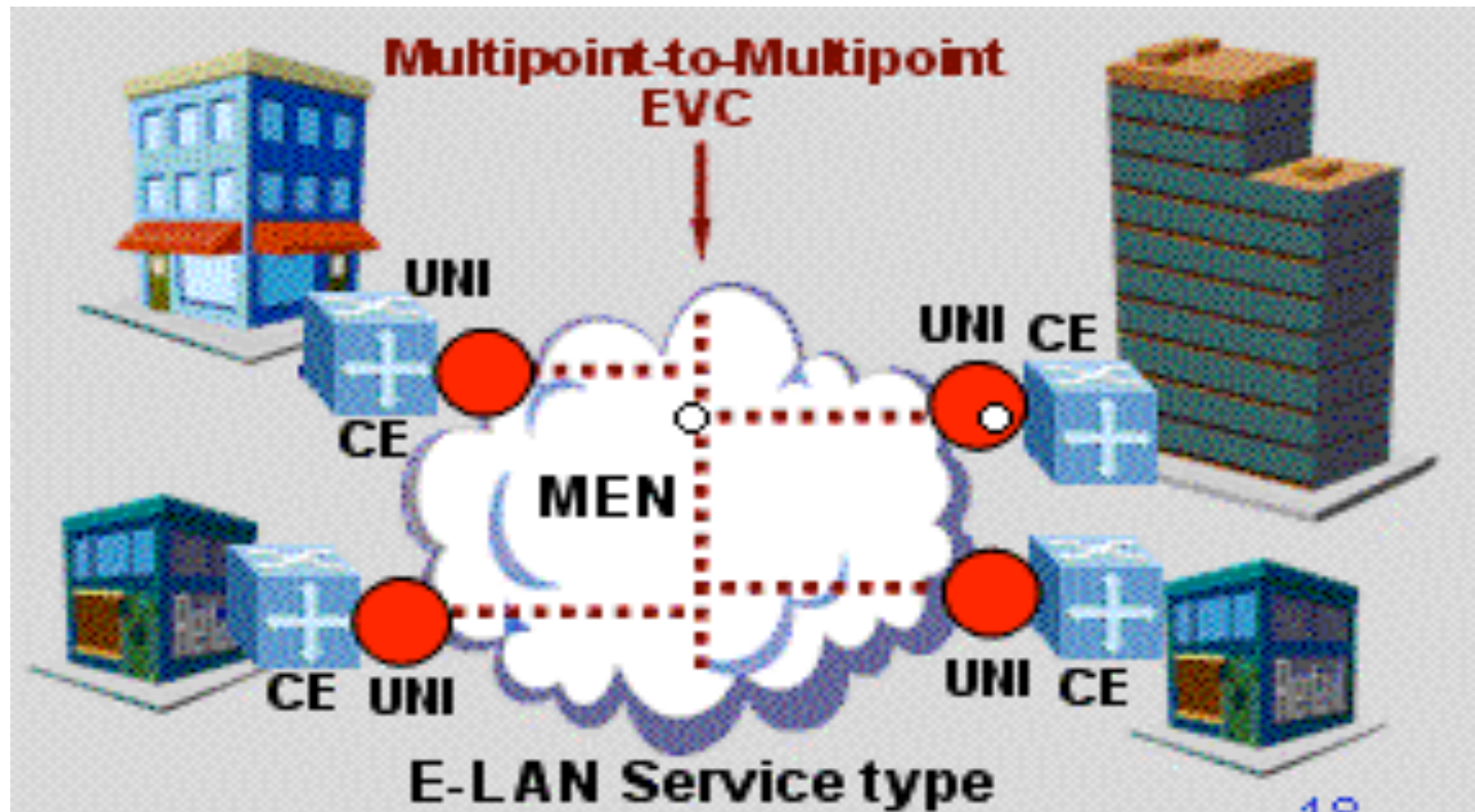


E-LAN Services

- •The Ethernet LAN services provide multipoint connectivity between UNI switch each UNI connected to a multipoint EVC, which simplifies provisioning and service activation.
- •From a subscriber standpoint, E-LAN services look like a LAN in the Metro. Multiplexing of EVCs and committed rates may be supported, as well as Internet connection.

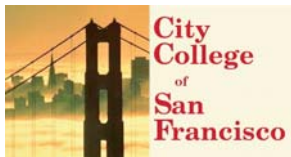


E-LAN Services



Carrier Ethernet Attributes

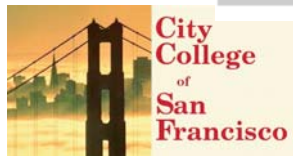
- **Protection/Reliability** - network protection within 50 ms and "five nines" service availability;
- **Hard QoS**, guaranteeing an end-to-end service-level agreement;
- **TDM support** through circuit emulation services.
- **Service management** with carrier-class OAM (Operation, Administration, and Maintenance)
- **Scaleability** to hundreds of thousands of Ethernet virtual connections;



	MEF Standards	Other Standards
Protection	<ul style="list-style-type: none"> ● MEF 2: Ethernet Protection ● MEF 4: Architecture Framework 	<ul style="list-style-type: none"> ● IETF: MPLS Fast Reroute
Hard QOS	<ul style="list-style-type: none"> ● MEF 6: Service Definition ● MEF 10: Service Attributes ● Service Attributes II* ● Service Attributes Testing* ● Service Definition II* 	
TDM Support	<ul style="list-style-type: none"> ● MEF 3: CES Framework ● MEF 8: CES Implementation ● MEF TDM Testing* 	
Service Management	<ul style="list-style-type: none"> ● MEF 7: EMS and NMS Info ● MEF OAM Framework & Requirements* ● MEF Performance Monitoring* ● MEF NE Management Requirements* 	<ul style="list-style-type: none"> ● IEEE 802.1 ● ITU efforts
Scaleability	<ul style="list-style-type: none"> ● MEF 9: UNI Testing ● MEF 11: UNI Framework ● MEF UNI I 1A* ● MEF UNI Type II* ● MEF Ethernet Aggregation* 	<ul style="list-style-type: none"> ● IEEE 802.1

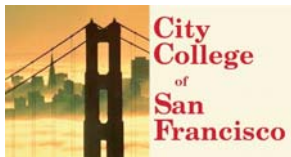
* Standard not yet ratified by the MEF

Source: MEF



MEF Technical Specifications

- **MEF 2 Requirements and Framework for Ethernet Service Protection in Metro Ethernet Networks**
- **MEF 3 Circuit Emulation Service Definitions, Framework and Requirements in Metro Ethernet Networks**
- **MEF 4 Metro Ethernet Network Architecture Framework - Part 1: Generic Framework**
- **MEF 6 Ethernet Services Definitions - Phase I**
- **MEF 7 EMS-NMS Information Mode**
- **MEF 8 Implementation Agreement for the Emulation of PDH Circuits over Metro Ethernet Networks**
- **MEF 9 Abstract Test Suite for Ethernet Services at the UNI**
- **MEF 10 (*Obsoletes MEF 1 and MEF 5*) Ethernet Services Attributes Phase 1**
- **MEF 11 User Network Interface (UNI) Requirements and Framework**
- **MEF 12 Metro Ethernet Network Architecture Framework Part 2: Ethernet Services Layer**
- **MEF 13 User Network Interface (UNI) Type 1 Implementation Agreement**
- **MEF 14 Abstract Test Suite for Traffic Management Phase 1)**
- **MEF 15 Requirements for Management of Metro Ethernet Phase 1 Network Elements)**



The MEF Certification



- The MEF Certification Program is designed to ensure global equipment/services compliance to the MEF standards and eventual interoperability
- 39 equipments of 16 vendors received certification to MEF 9



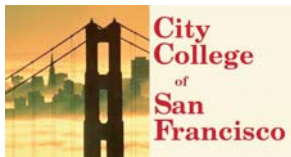
- On October 13, the MEF launched Ethernet Service Certification to certify service providers. Tier 1 providers committed to it.



MFA Forum Tackles Multi-Service Ethernet Interworking

Specification Unifies Heterogeneous Networks for Multiple Services

FREMONT, CA – November 14, 2005 –The MFA Forum announced today it is sending to final ballot a specification for *Multi-Service Interworking- Ethernet over MPLS*. The specification will enable service providers to introduce new Ethernet services in a heterogeneous network of ATM, Frame Relay, HDLC and PPP using MPLS as a communication broker. In addition, the specification will allow service providers to preserve critical ATM and Frame Relay infrastructure and ease migration to MPLS networks. The Forum has also sent to final ballot, *Fault Management for Multiservice Interworking* involving Ethernet over MPLS, particularly in Operations, Administration and Management (OAM) to enhance deployment.



Converged Network for New Services & Applications



Triple Play
for Wireline, Wireless, Cable Convergence

IP/MPLS
Interworking, New Services, Interop, Future Evolution

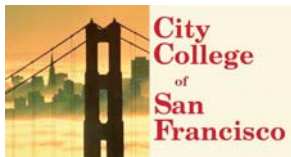
ATM
Interworking,
New Services,
Maintenance

FR
Interworking,
New Services,
Maintenance

**Ethernet,
SONET,
TDM,
PPP**

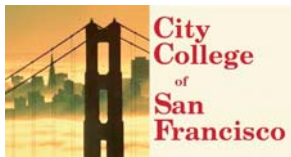
IP/MPLS Convergence Benefits:

- Enables new IP/MPLS service and revenue creation
- Preserves investment in current networks – ATM, FR, TDM
- Reduces overall costs



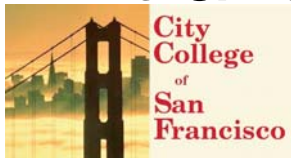
Multiprotocol Label Switching

- MPLS stands for "Multiprotocol Label Switching".
- In an MPLS network, incoming packets are assigned a "label" by a "label edge router (LER)".
- Packets are forwarded along a "label switch path (LSP)" where each "label switch router (LSR)" makes forwarding decisions based solely on the contents of the label.
- At each hop, the LSR strips off the existing label and applies a new label which tells the next hop how to forward the packet.



How MPLS Works

- A label is assigned to the flow of traffic at the Layer 2 level by the LER..
- •The label distribution protocol (LDP) ensures that other MPLS nodes know which routes correspond to which labels.
- •At the destination, another LER strips of the labels to access the data, with efficient transport time and guaranteed QoS.

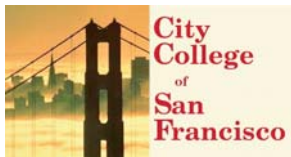


Cisco CCIP career path



- **CCIP Certification**

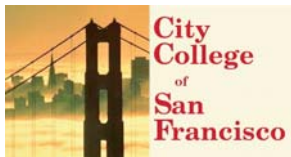
The CCIP (Cisco Certified Internetwork Professional) provides individuals working in service provider organizations with competencies in infrastructure IP networking solutions. CCIP professionals have detailed understanding of networking technologies in the service provider arena including IP routing, IP QoS, BGP, and MPLS.



CCIP exam path

Required Exam(s)

- 642-801 BSCI Building Scalable Cisco Internetworks (BSCI)
- 642-642 QOS Implementing Cisco Quality of Service (QoS)
- 642-661 BGP Configuring BGP on Cisco Routers (BGP)
- 642-611 MPLS Implementing Cisco MPLS (MPLS)



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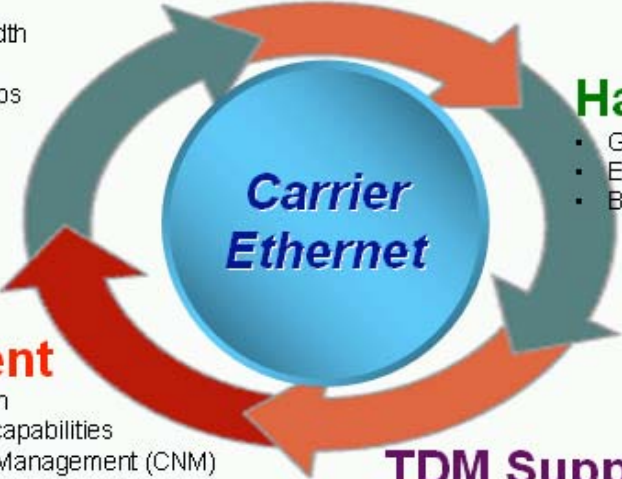
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- www.ccsf.edu/icons



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MEF marketing Carrier Ethernet (I)



CATCH THE CARRIER ETHERNET WAVE

What is Carrier Ethernet ?

Scalability

- Services and Bandwidth
- 100,000's of EVC's
- From Mbps to x10Gbps

Reliability

- Network Protection → 50 ms
- Service Availability → five 9's

Hard QoS

- Guaranteed end to end SLA
- End to End CIR and EIR
- Business, Mobile, Residential

Service Management

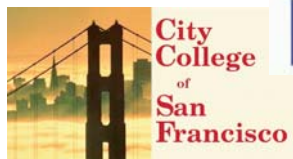

- Fast service creation
- Carrier class OAM capabilities
- Customer Network Management (CNM)

TDM Support

- Seamless integration of TDM
- Circuit Emulation Services
- Support existing voice applications

Carrier Ethernet

METRO Ethernet Forum



MEF marketing of Carrier Ethernet(II)

