Enabling

ETHERNET SERVICES

in the Metro Network & First Mile

Examining the development of standardisation for Metro Ethernet services and the resulting impact on commercial take up …

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Native Networks

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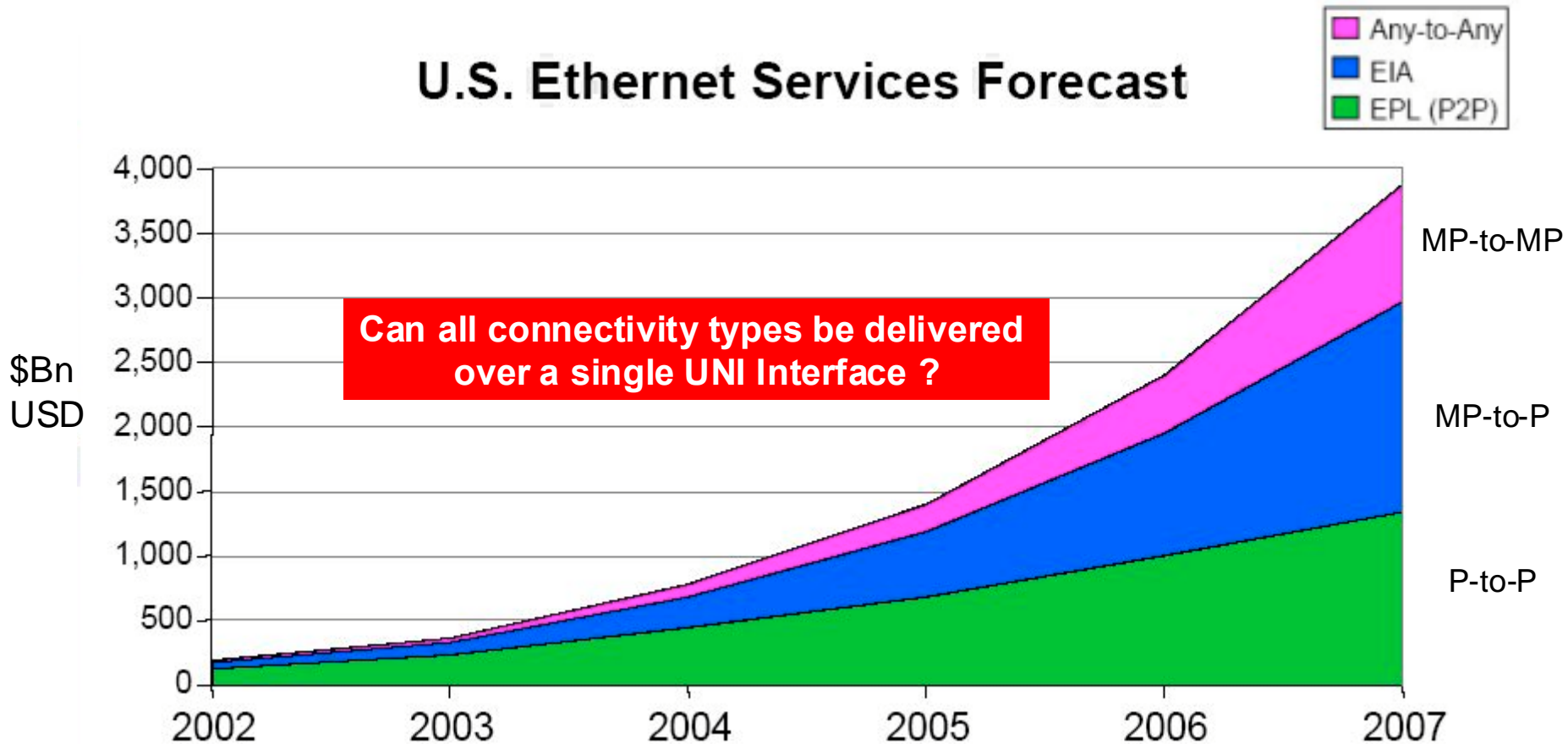
METRO Ethernet Forum

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Agenda

- Metro Ethernet Overview
  - Value, Simplicity, Scalability

- Metro Ethernet Forum
  - Overview
  - Standardisation Activity

- Commercial Take-up

- Conclusions

Metro Ethernet Overview

Metro Ethernet Market

U.S. Ethernet Services Forecast

Legend:
- Any-to-Any
- EIA
- EPL (P2P)

Can all connectivity types be delivered over a single UNI Interface ?

Y-axis: $Bn USD — 0, 500, 1,000, 1,500, 2,000, 2,500, 3,000, 3,500, 4,000

X-axis: 2002, 2003, 2004, 2005, 2006, 2007

Labels: MP-to-MP, MP-to-P, P-to-P

Source: Yankee Group - Aug 2003

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The Ethernet Advantage - Value

- **Reliable and "less expensive"* alternative to Leased Line communication networks**

- **Allows Enterprises to deploy new applications quickly and easily with minimal capital investment**

- **Leverage existing human capital – no new training is required – build on in-building communication skills**

* Perception/expectation or reality?

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Value of Metro Ethernet to Enterprise

- **Drive down capital and operational costs through:**
  - Ethernet and optical components technology progress curves
  - Network simplification
  - More efficient bandwidth procurement
- **Increase reliability over the long run because of:**
  - Network simplification
  - Architectural stability
  - Topological flexibility to mesh sites
  - Broader variety of affordable protection schemes
- **Better support of high-b/w or low-latency applications, like:**
  - Streaming media, distance learning, videoconferencing, imaging
  - Packetized voice applications
  - SANs/Disaster Recovery

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Metro Ethernet Applications

- **Corporate LAN Interconnection**
- **Multi-application Transport**
- **Metro Virtual Private Network**
- **Point-to-Point High Speed Connectivity**
- **Network Attached Storage**
- **LAN Video/Video Training**
- **Pre-press**
- **CAD/CAM**

- **Backup Applications**
- **Medical Data Transfer**
- **Imaging**
- **Network Tape Backup and Restore**
- **Scientific Modeling**
- **Streaming Media**
- **Server Backup**
- **Back-end Server Applications**
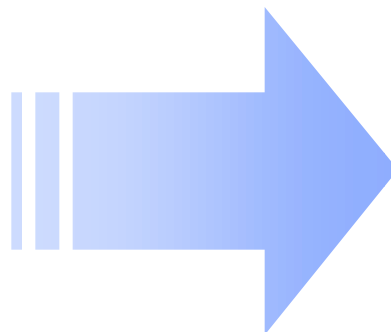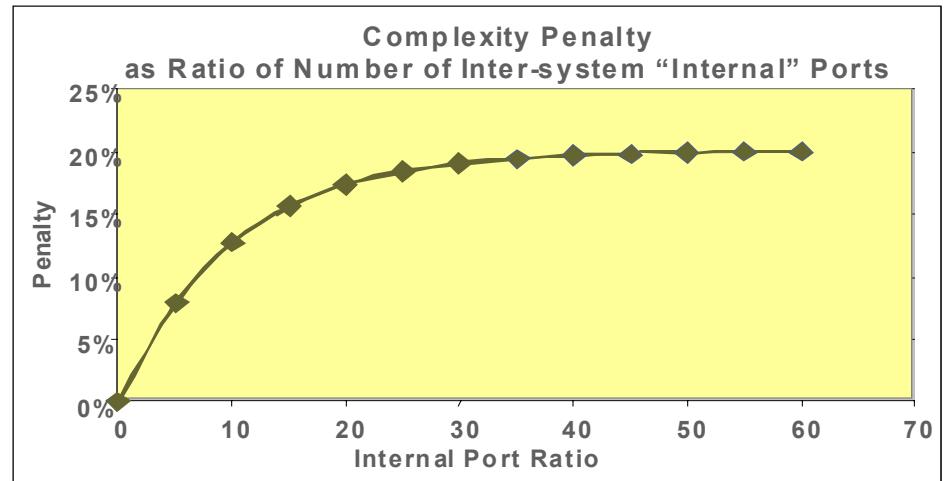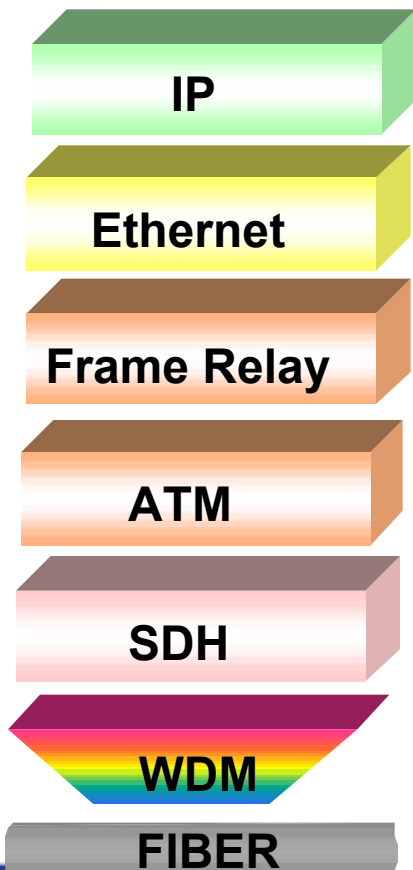- **Storage Applications (iSCSI)**
- **Disaster Recovery**

The Ethernet Advantage - Simplicity

- **Flexible, reliable, high-capacity solution simplifies network architecture**

- **Transparent transport reduces the complexity of engineering and network management**

- **Customer Network Management features enterprise managed private MAN**

Simplified Metro Networks

Layer 1/2 (and 3) convergence, Ethernet simplicity, and extension of LAN technology into MANs/WANs means fewer platforms, operational simplifications and lifecycle stability that cut costs and free up IT staff for more strategic tasks.
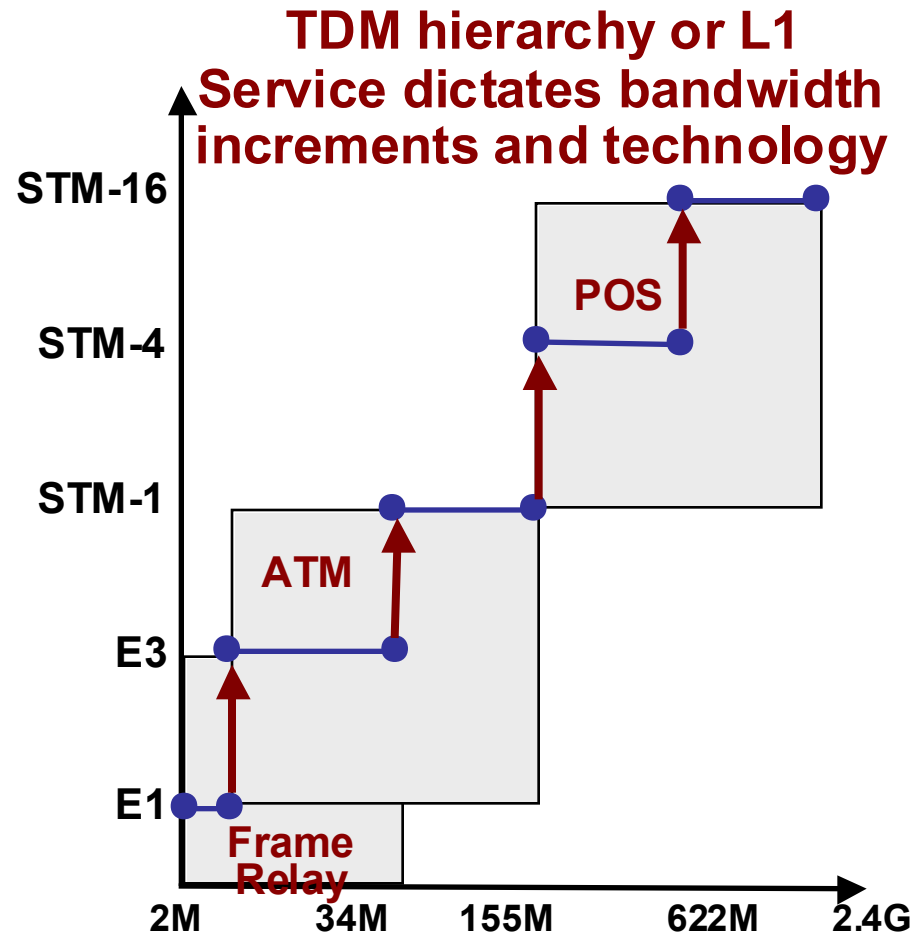

Complexity Penalty as Ratio of Number of Inter-system "Internal" Ports

IP
Ethernet
Frame Relay
ATM
SDH
WDM
FIBER

IP
Ethernet
WDM
FIBER

SDH ?
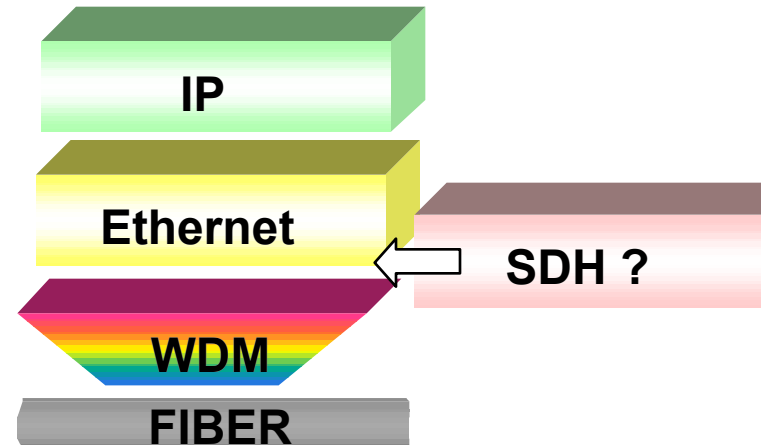
The Ethernet Advantage - Scalability

- **Simple migration to higher performance levels – from 10 Mbps to 1 Gbps and beyond**

- **Clear migration path – leverage existing Ethernet protocol**

- **Provides scalable connectivity by site, bandwidth on demand**

- **Supports expansion without disruption**

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Let's look at TDM Services

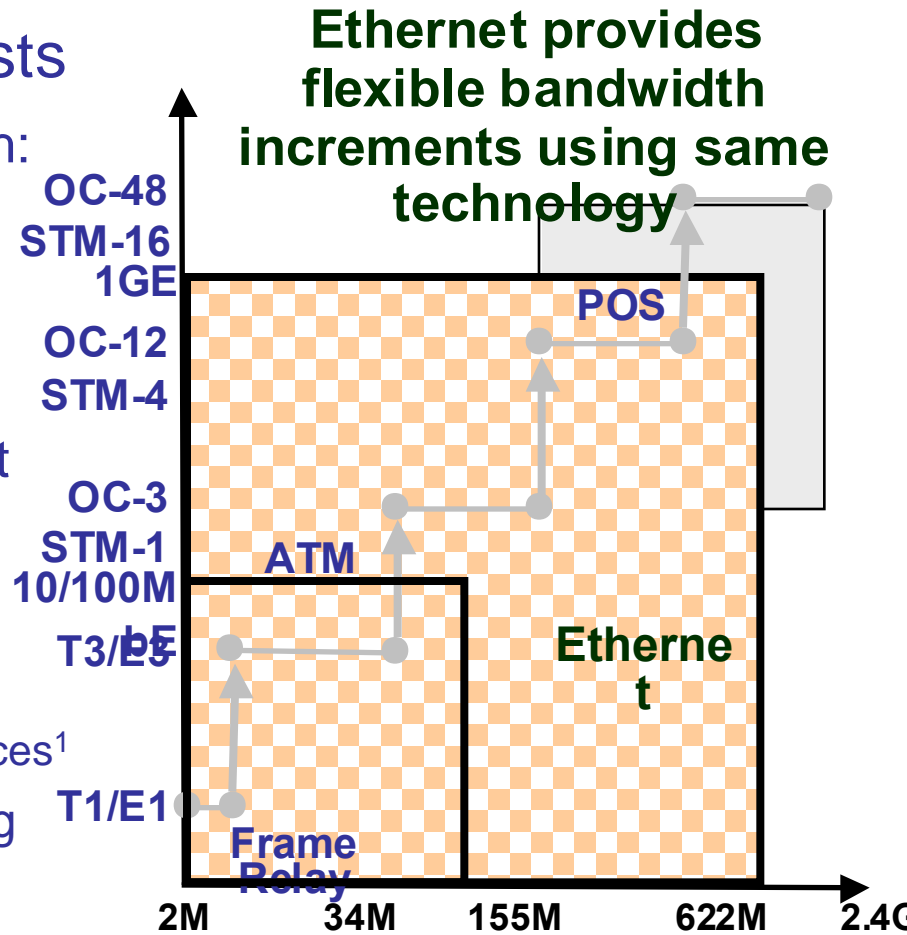## Inflexible Bandwidth Scalability

- Increasing non-Ethernet service bandwidth often requires:
  - New service (step function)
    - E1]E3, FR]ATM
  - New hardware
    - new interface or equipment
  - New service provisioning
    - different protocols / technologies
- Often resulting in:
  - Oversubscribing to meet growing bandwidth needs

TDM hierarchy or L1 Service dictates bandwidth increments and technology

STM-16

POS

STM-4

STM-1

ATM

E3

E1

Frame Relay

2M   34M   155M   622M   2.4G

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Scalable Ethernet Services

Flexible Bandwidth Scalability Costs

- Increasing Ethernet service bandwidth:
  - Requires just bandwidth provisioning
  - Provision only amount of BW needed
- Same protocol for LAN and MAN
- Lower OpEx and CapEx with Ethernet
  - 25-40% lower cost than
    - TDM, Frame Relay, ATM interfaces[1]
  - 10x lower cost
    - than high speed SONET/SDH interfaces[1]
  - Easier and less costly to meet growing bandwidth needs

Ethernet provides flexible bandwidth increments using same technology

OC-48
STM-16
1GE

OC-12
STM-4

POS

OC-3
STM-1
10/100M

ATM

T3/E3

Ethernet

T1/E1

Frame Relay

2M   34M   155M   622M   2.4G

[1] Source: Network Strategy Partners, LLC

Benefits to the End-User

- **Ethernet is Ubiquitous in The LAN**
- **Easy-to-use, "Plug-and-Play" Technology**
- **No Rigid Bandwidth Limitations**
- **Guaranteed Bandwidth with Ability to Burst**
  - **Committed Information Rate (CIR)**
  - **Peak Information Rate (PIR)**
- **Significant CPE Cost Savings**

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Benefits to the Service Provider

- **Multiple Revenue Streams from Single Interface**
  - **Ethernet Internet Access**
  - **Ethernet Private Line (E-LINE)**
  - **Ethernet Virtual Private Line (E-LAN)**
  - **Virtual Private LAN Service**
  - **Ethernet Access/interworking to ATM & Frame Relay**
- **Greater Revenue Potential - Granular Bandwidth**
- **Lower Capital Costs**
- **Lower Operations Costs**
- **Higher Customer Retention**

Metro Ethernet Forum Overview & Activity

Metro Ethernet Forum Mission

Accelerate adoption of Optical Ethernet

as the technology of choice

in metro networks worldwide

MEF Priorities and Scope

- The primary priorities of the MEF are <u>to define</u>:
  - a. **Ethernet Services** for metro transport networks
    - Such services shall be delivered over native Ethernet-based Metro networks and could also be supported by other transport technologies.
  - b. **Carrier-class Ethernet-based metro transport technologies** by specifying *architecture, protocols and management* for Ethernet-based metro transport networks
- The secondary priorities of the MEF are (when deemed necessary) <u>to define</u>:
  - a. Work to be done by other organizations on other transport technologies (liaison activity)
  - b. Non-Ethernet interfaces, if not defined by other organizations.

MEF Membership

Membership is Growing…

As of 6/12/03

- ADC
- Agere Systems
- Agilent Technologies
- Alcatel
- AMCC
- Appian Communications
- Atrica Inc.
- Avaya, Inc.
- Axerra
- BellSouth
- Ciena Corp.
- Cisco Systems
- Coriolis Networks
- Corning
- Corrigent Systems
- Crosswave Communications, Inc.
- Ensemble Communications

- Ericsson AB
- Extreme Networks
- Foundry Networks
- France Telecom R&D LLC
- Fujitsu Network Communications
- Harmonic
- Hatteras Networks, Inc.
- Hitachi America, Ltd
- Huawei Tech Co. Ltd.
- Industrial Technology Research Institute
- Internet Photonics, Inc.
- JDS Uniphase
- Juniper Networks
- KDDI R&D Laboratories, Inc.
- Korea Telecom
- Lantern Communications, Inc.
- Lucent Technologies
- Luminous Networks, Inc.

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MEF Membership
Membership is Growing …
As of 6/12/03

- **Lycium Networks**
- **Mahi Networks**
- **MetNet Communications, Inc.**
- **Mindspeed Technologies**
- **Native Networks**
- **NEC Corp.**
- **Nortel Networks Corp.**
- **NTT Advanced Technology Corp.**
- **PMC-Sierra**
- **Procket Networks**
- **Raza Microelectronics**
- **Redux Communications**
- **Riverstone Networks**
- **Rockefeller Group Telecommunications Services, Inc.**
- **SBC Communications, Inc.**
- **Scientific Atlanta**

- **Siemens A/G**
- **SII Network Systems**
- **Spirent Communications**
- **Telcordia Technologies**
- **Telesyn**
- **Terabeam**
- **TiMetra Inc.**
- **T|Pack A/S**
- **UNH- InterOperability Lab**
- **UTStarcom**
- **Verizon Communications**
- **Vitesse Semiconductor**
- **Vivace Networks, Inc.**
- **Zarlink Semiconductor**
- **ZTE Corporation**

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Approach to Technical Standards

Build on existing standards work from other industry bodies – MEF only fills the technical gaps for Metro Ethernet Services
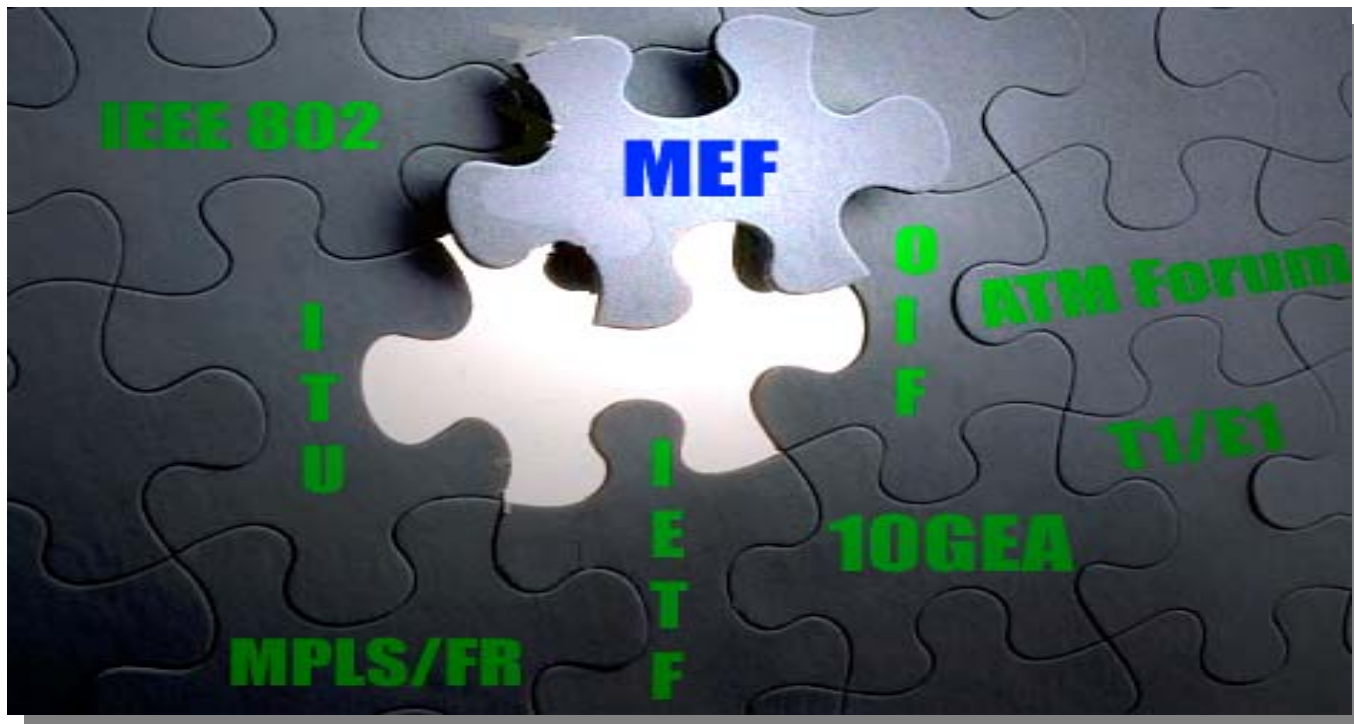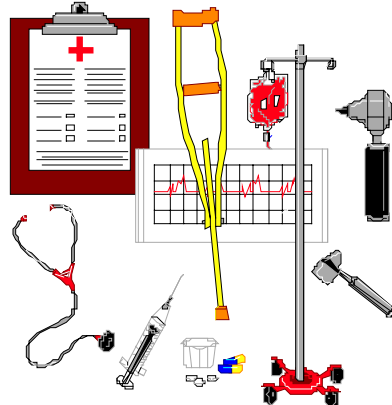
Ethernet Services Standardization
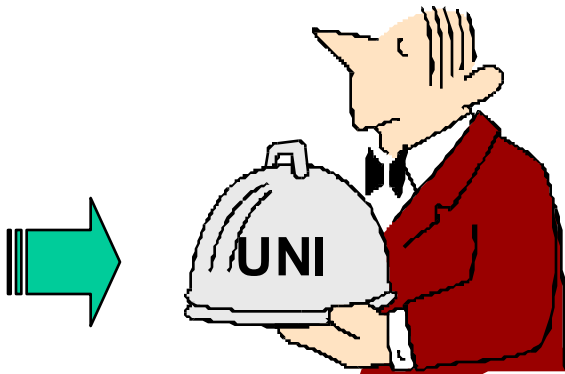
**Services
Metro Ethernet Forum**
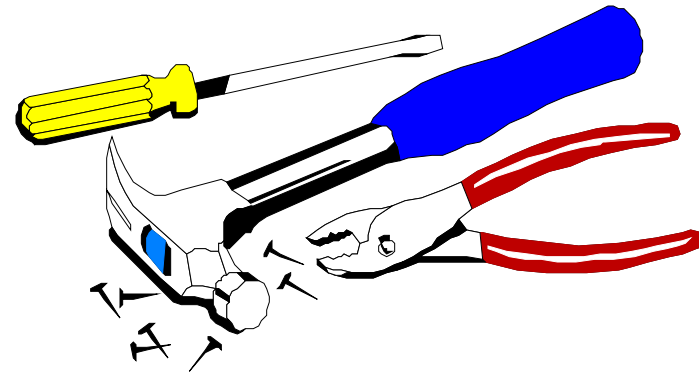
**Network Implementation
IEEE 802.x, ITU-T and IETF
PPVPN**

**OA&M
Metro Ethernet Forum**

Main Technical Work

- Ethernet Service Technical Specifications
  - E-Line and E-LAN Services
- User Network Interface definition (UNI)
- Transport Networks Features
  - Protection – sub 50 millisec resiliency
  - QoS – foundation of end-to-end SLA's
  - NNI – Ethernet hand-off between carriers
- End-to-end management
  - OAM&P – Carrier-class management

MEF Technical Work Dash Board

MEF Technical Committee

Conformance & Performance — **Test Area**

Process Ad-Hoc

TC Rules and Procedures

Management Area

- OAM&P
  - Ethernet Services OAM d4
- EMS Mgmt
  - EMS Requirements d1
- EMS-NMS If
  - EMS-NMS Information Model d3

Architecture Area

- MEN Architecture
  - MEN Architecture FW Part 1 d1
  - MEN Architecture FW Part 2
  - MEN Architecture FW part 3
  - MEN Architecture FW part 4
  - MEN Architecture FW part 5
- UNI — UNI Requirements d2
  - UNI Framework d3
  - UNI PVC IA d1
- EI-NNI
  - EI-NNI TS d1

Protocol & Transport Area

- QOS — QOS Framework d2
- Protection
  - Protection Requirements d3
  - Protection Framework d3
  - MPLS Protection IA d1
- EoS — EoS IA d1
- NI-NNI
  - MPLS NI-NNI D1
- EMF

Services Area

- Ethernet Services
  - Ethernet Services Model d4
  - Ethernet Services Definitions d2
- TM
  - Traffic Performance Parameters d3
- CES
  - CES Requirements d2

Legend

- Gray Color = Not Approved Project
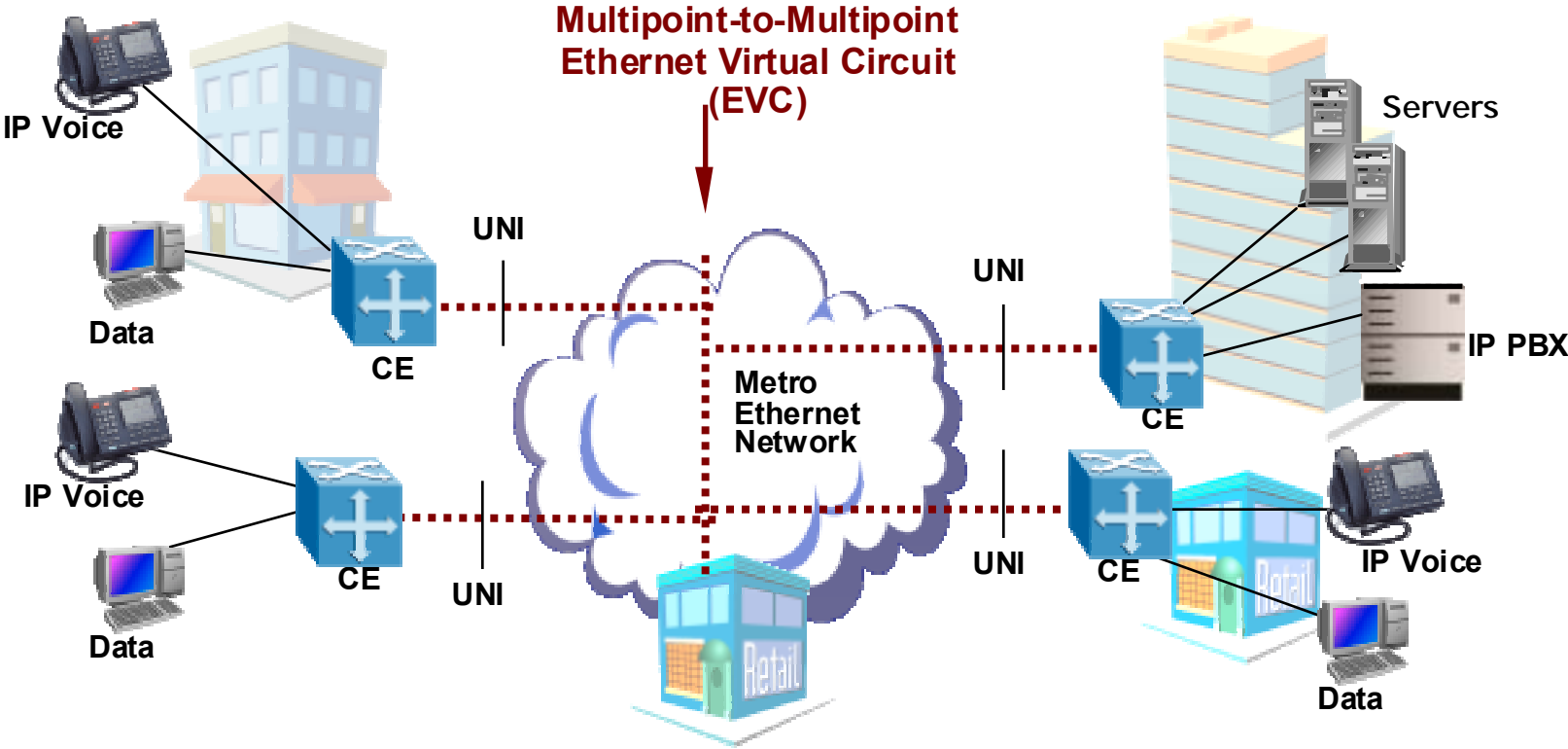- Orange Color = Approved Project
- Blue Color = Draft Status
- Green Color = Approved Standard
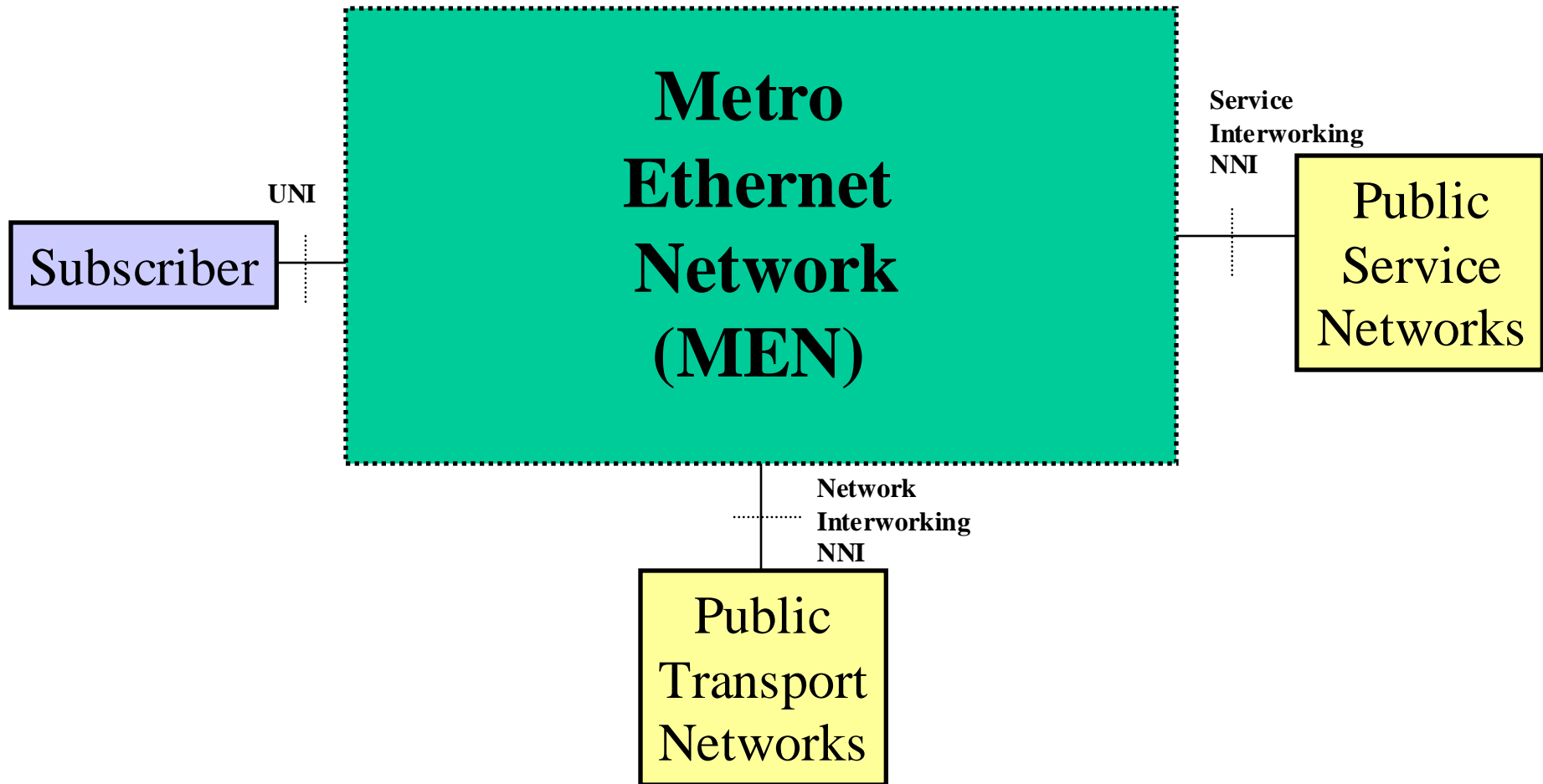- Red Color = Sent to Ballot

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Ethernet Line (E-LINE) Service

Point-to-Point Ethernet Virtual Circuits (EVC)

IP Voice

Data

UNI

Metro Ethernet Network

1 or more UNIs

CE

CE

CE

IP Voice

Data

Servers

IP PBX

Video

UNI

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Data
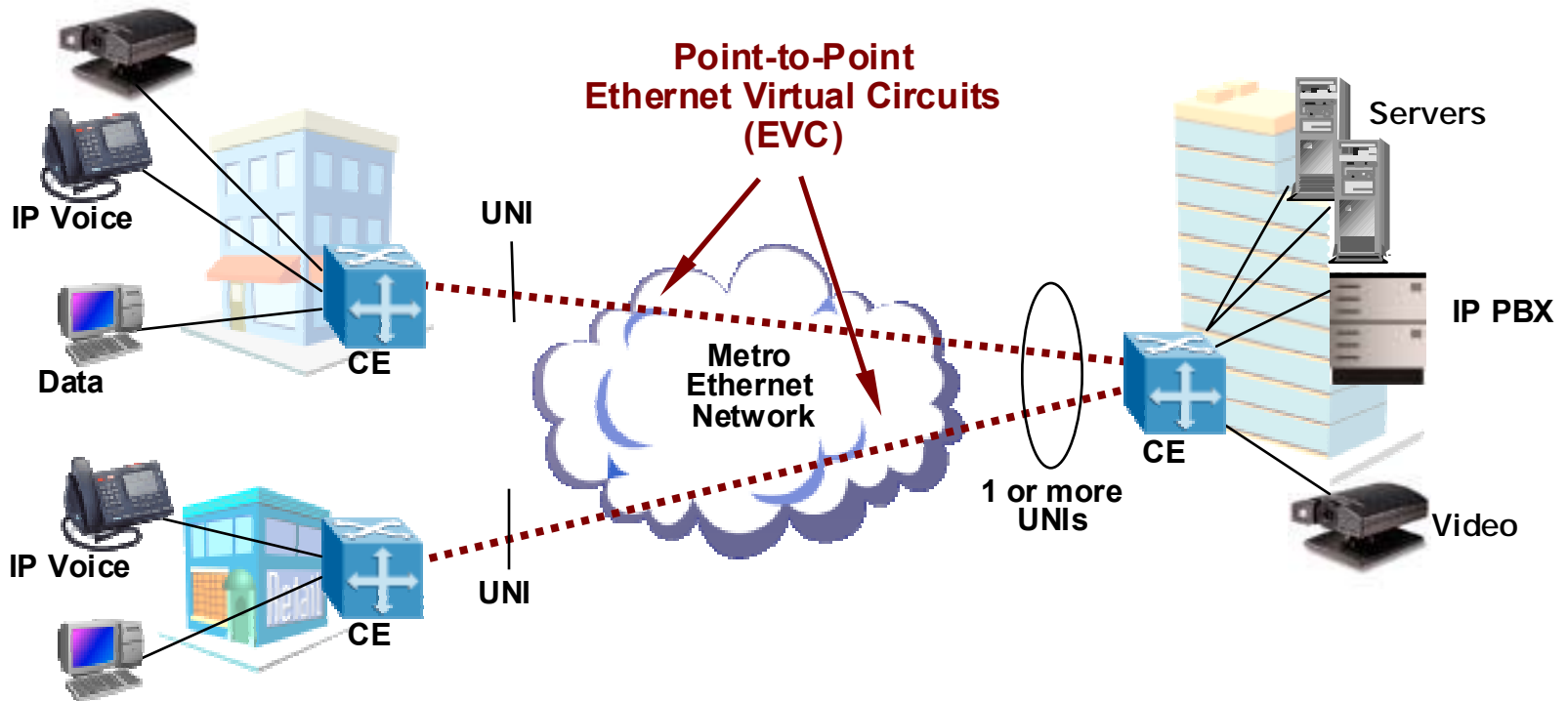
Ethernet LAN (E-LAN) Service

MEF External Reference Point Model

MEF External Reference Point

- **UNI**
  - **Reference point between Metro Ethernet Network (MEN) and directly/virtualized attached interfaces of customer equipment.**
  - **Interfaces between MEN and customer equipment.**

- **Service Interworking NNI**
  - **Reference point between MEN and other public service MENs (Operator to Operator).**
  - **Interfaces between MEN and other public services networks (e.g.: ATM/FR & IP etc).**

- **Network Interworking NNI**
  - **Reference point between MEN and other public transport networks.**
  - **Interface between MEN and other public transport networks (SDH/SONET, ATM, GE, etc).**

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Ethernet Service – Basic Model

- CE attaches to UNI
- CE can be
  - router
  - IEEE 802.1Q bridge (switch)
- UNI (User Network Interface)
  - Standard IEEE 802.3 Ethernet PHY and MAC
  - 10Mbps, 100Mbps, 1Gbps or 10Gbps
- Metro Ethernet Network (MEN)
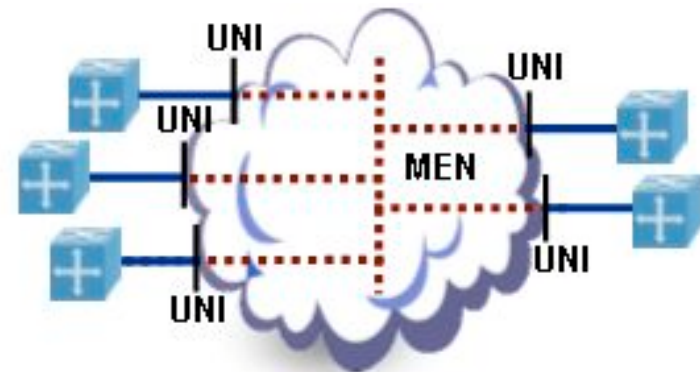 - May use different transport technologies, e.g., SONET, DWDM, MPLS, RPR, etc.
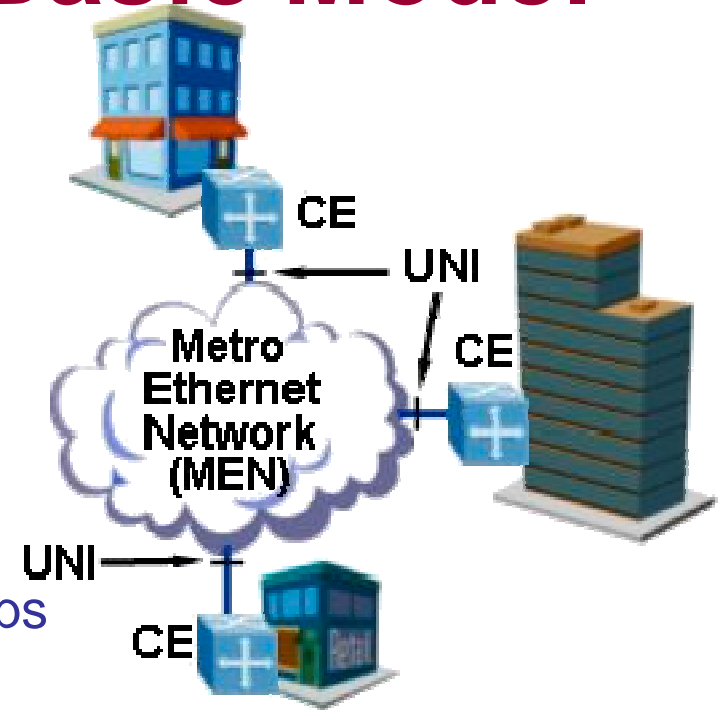
CE = Customer Equipment
UNI = User Network Interface
MEN = Metro Ethernet Network

Ethernet Virtual Connection (EVC)

- An EVC is "an associated between 2 or more UNIs"
- MEF has defined 2 EVC types
    - Point-to-Point
    - Multipoint-to-Multipoint

Point-to-Point EVC

Multipoint-to-Multipoint EVC

EVCs help conceptualize the service connectivity

Defining an Ethernet Service

- Ethernet Service Definition Framework
- A service is defined via
  - Service Type
  - Service Attributes
  - Service Attribute Parameters
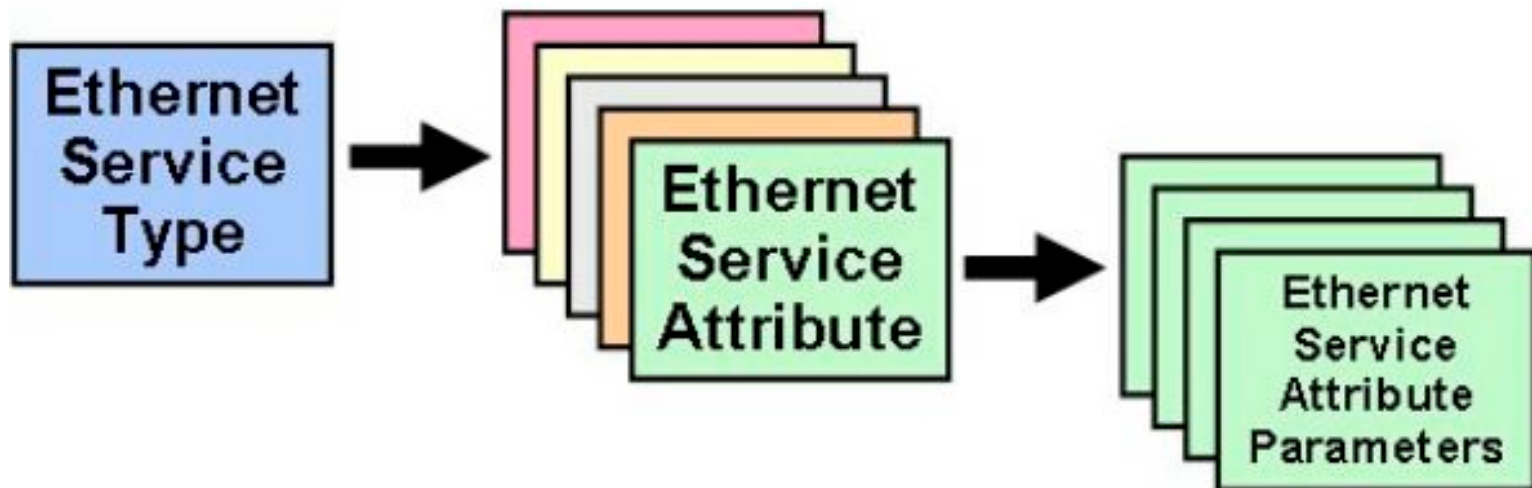
Ethernet Service Types

- Ethernet Service Type
  - Generic Ethernet connectivity service
- Each Ethernet Service Type
  - has a set of Ethernet Service Attributes
- MEF has defined 2 Ethernet Service Types
  - Ethernet Line (E-Line) Service
 - Ethernet LAN (E-LAN) Service

Service Types are generic
constructs used to create services

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Ethernet Service Attributes

- Service Attributes define
  - the capabilities of the Ethernet Service Type
- Service Attributes for both UNI and EVC related to:
  - Physical Interface
  - Bandwidth Profiles
  - Service Performance (CoS) and CoS Identifiers (IDs)
  - Service Frame Delivery and VLAN Tag Support
 - Service Multiplexing

Service Attributes define the service

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E-Line and E-LAN Service Types

- E-Line Service used to create
  - Private Line Services
  - Point-to-Point VPNs
  - Ethernet Internet Access (MP-to-P)

- E-LAN Service used to create
  - Multipoint VPNs

Point-to-Point EVC

E-Line Service type

Multipoint-to-Multipoint EVC
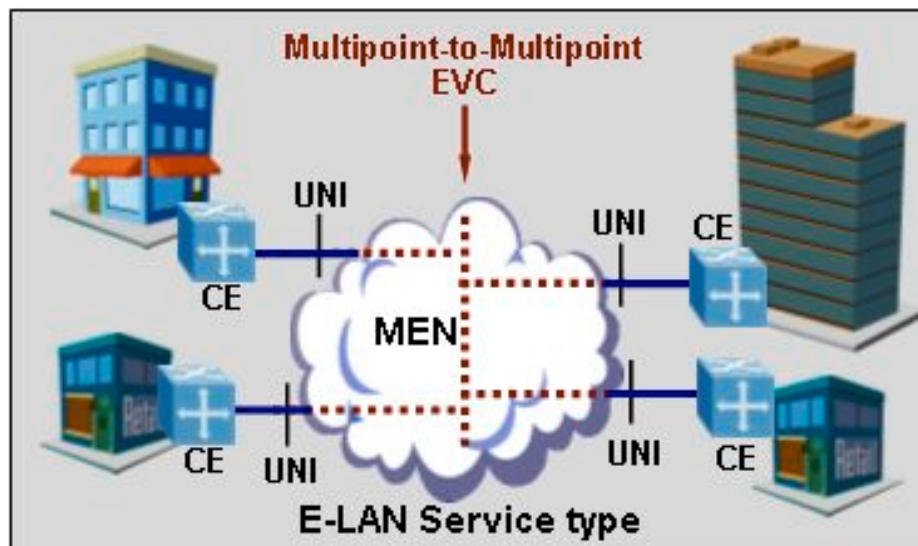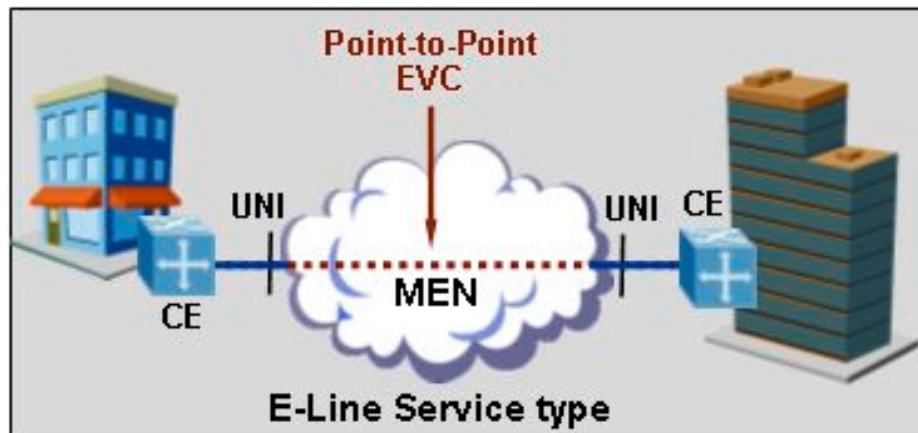
E-LAN Service type

Example: LAN Extension using E-LAN Service

- Service provides
  - Intra-company Connectivity
  - Full transparency of control protocol service frames (BPDUs)
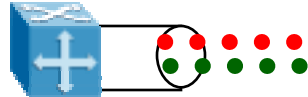- New VLANs added
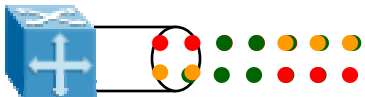 - without coordination with provider
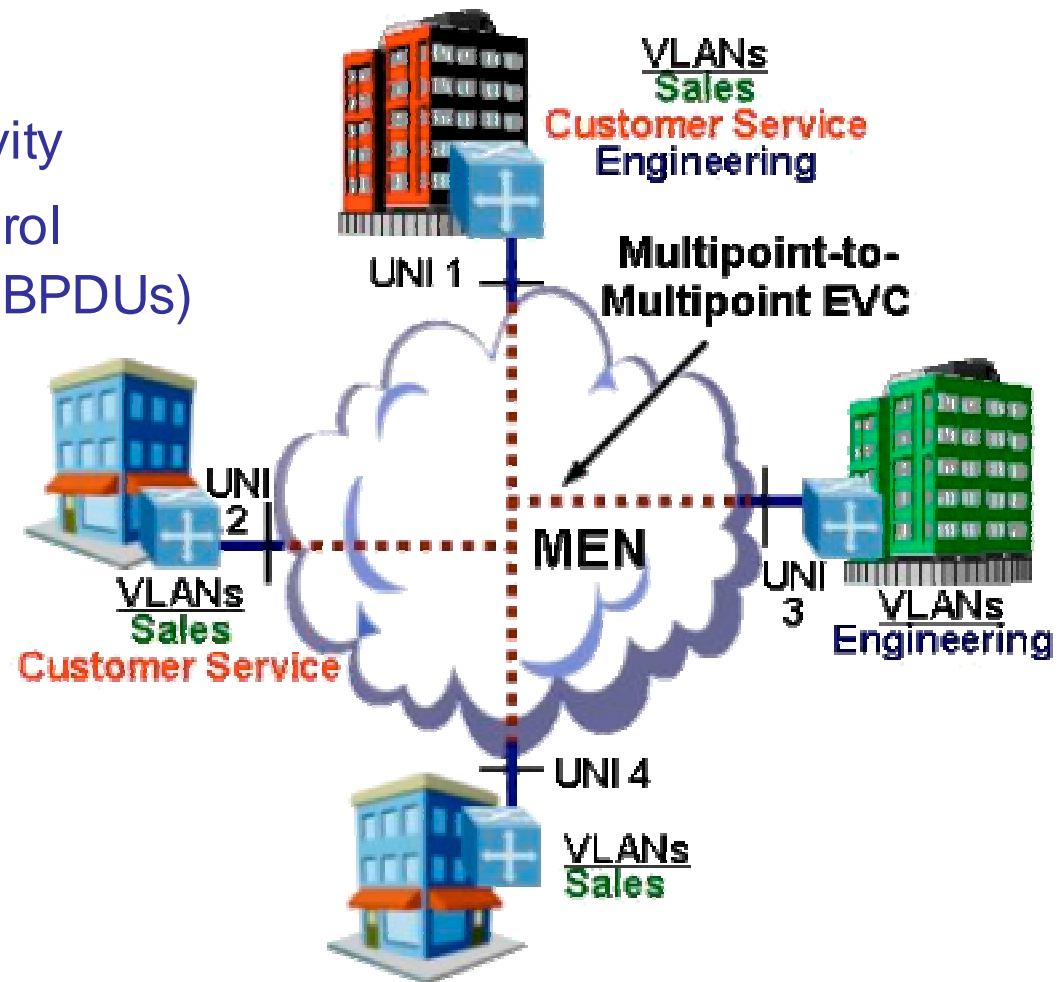
Service makes MEN look like a LAN

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Ethernet SLAs

- Many Enterprise customers will not use Metro Ethernet services
  - unless there are SLAs with performance assurances
- Critical Service Attributes
  - Bandwidth Profile
  - Class of Service (Service Performance)

Enterprise customer required CoS-based SLAs with performance assurances

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Bandwidth Profiles

- Similar to Ethernet traffic management in Enterprise networks

- MEF has defined three bandwidth profiles
  - Ingress Bandwidth Profile Per UNI
  - Ingress Bandwidth Profile Per EVC
  - Ingress Bandwidth Profile Per CoS ID

- 4 parameters <CIR, CBS, PIR, PBS>

Bandwidth in 1Mbps increments

Class of Service (Service Performance)

- Service Performance specified by
  - Availability
  - Frame Delay
  - Frame Jitter
  - Frame Loss
- Service performance determined via
  - CoS ID, e.g., 802.1p user priority per EVC
  - Per UNI (port), i.e., 1 CoS for all EVCs at UNI

Performance Parameters key to supporting Enterprise mission critical data and multimedia applications

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# Example CoS-based Metro Ethernet SLA
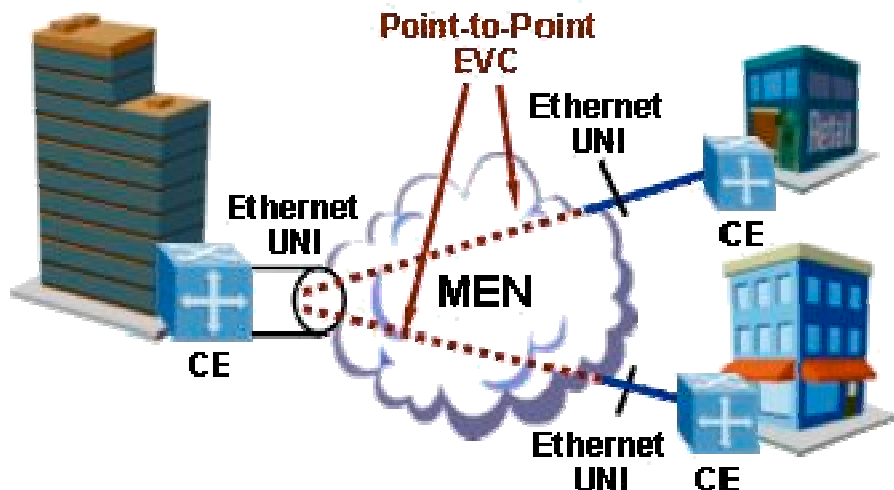
- **E-Line Service**
- **3 Classes of Service**
- **CoS determined via 802.1p**
- **Common SLA used with CoS-based IP VPNs**

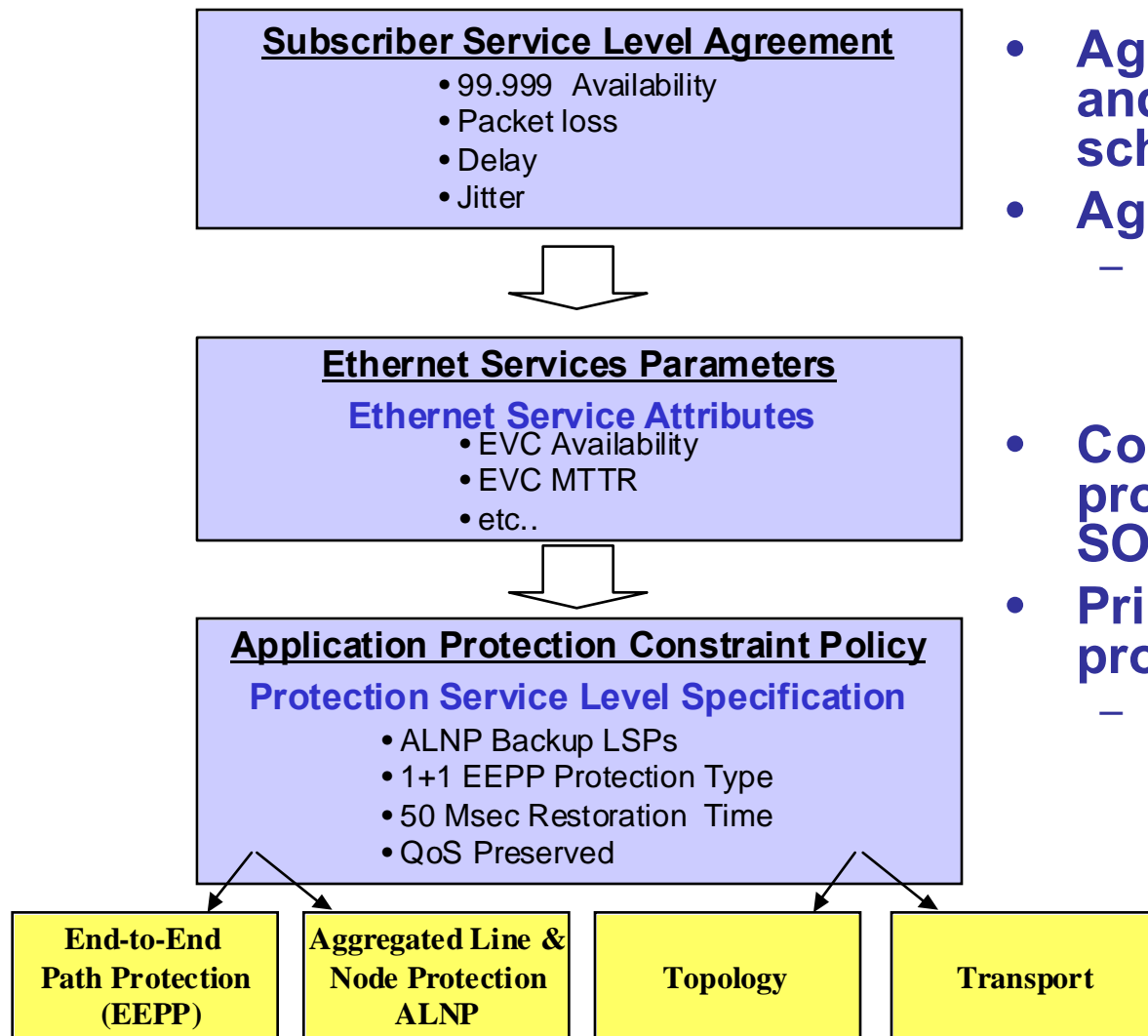| Service Class	Service Characteristics	CoS ID (802.1p)	Bandwidth Profile per EVC per CoS ID	Service Performance
Premium	Service designed to support IP telephony or IP video applications	6	CIR=PIR	Delay < 30ms Jitter < 5ms Loss < 0.1%
Silver	Supports mission critical data applications	3	CIR PIR ≤ UNI Speed	Delay < 30ms Jitter = N/S Loss < 1%
Standard	Best effort service	0	CIR=0 PIR=UNI speed	Delay = N/S Jitter = N/S Loss = N/S

Ethernet OA&M

CE — UNI — OA&M — OA&M — OA&M — UNI — CE
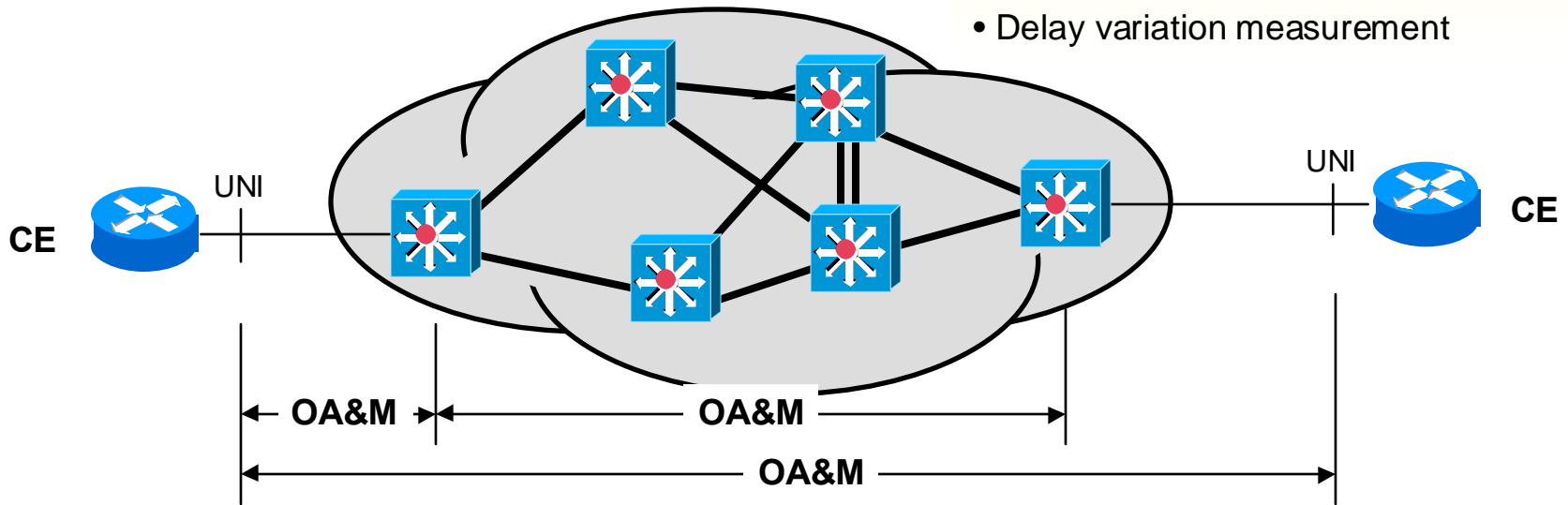
- **Availability**
- **Status Monitoring**
- **Scalability**
- **Extensibility**
- **Security**
- **Tunnel and Transport Independence**
- **Layer 3 Independence**

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Protection

Subscriber Service Level Agreement
- 99.999 Availability
- Packet loss
- Delay
- Jitter

Ethernet Services Parameters

Ethernet Service Attributes
- EVC Availability
- EVC MTTR
- etc..

Application Protection Constraint Policy

Protection Service Level Specification
- ALNP Backup LSPs
- 1+1 EEPP Protection Type
- 50 Msec Restoration Time
- QoS Preserved

End-to-End Path Protection (EEPP)

Aggregated Line & Node Protection ALNP

Topology

Transport

- **Agnostic to any transport and its related protection schemes.**
- **Agnostic to any topology**
  - Does not rely on a certain topology for protection - Can work with any topology (ring, mesh, mixed, etc)
- **Co-exist with any transport protection schemes (e.g.: SONET, RPR, 802.1d.**
- **Primarily designed for the protection of EVCs.**
  - Subscriber's protection scheme is transparent (ie: STP, multi-homed)

# Supercomm 2003 – Proof !
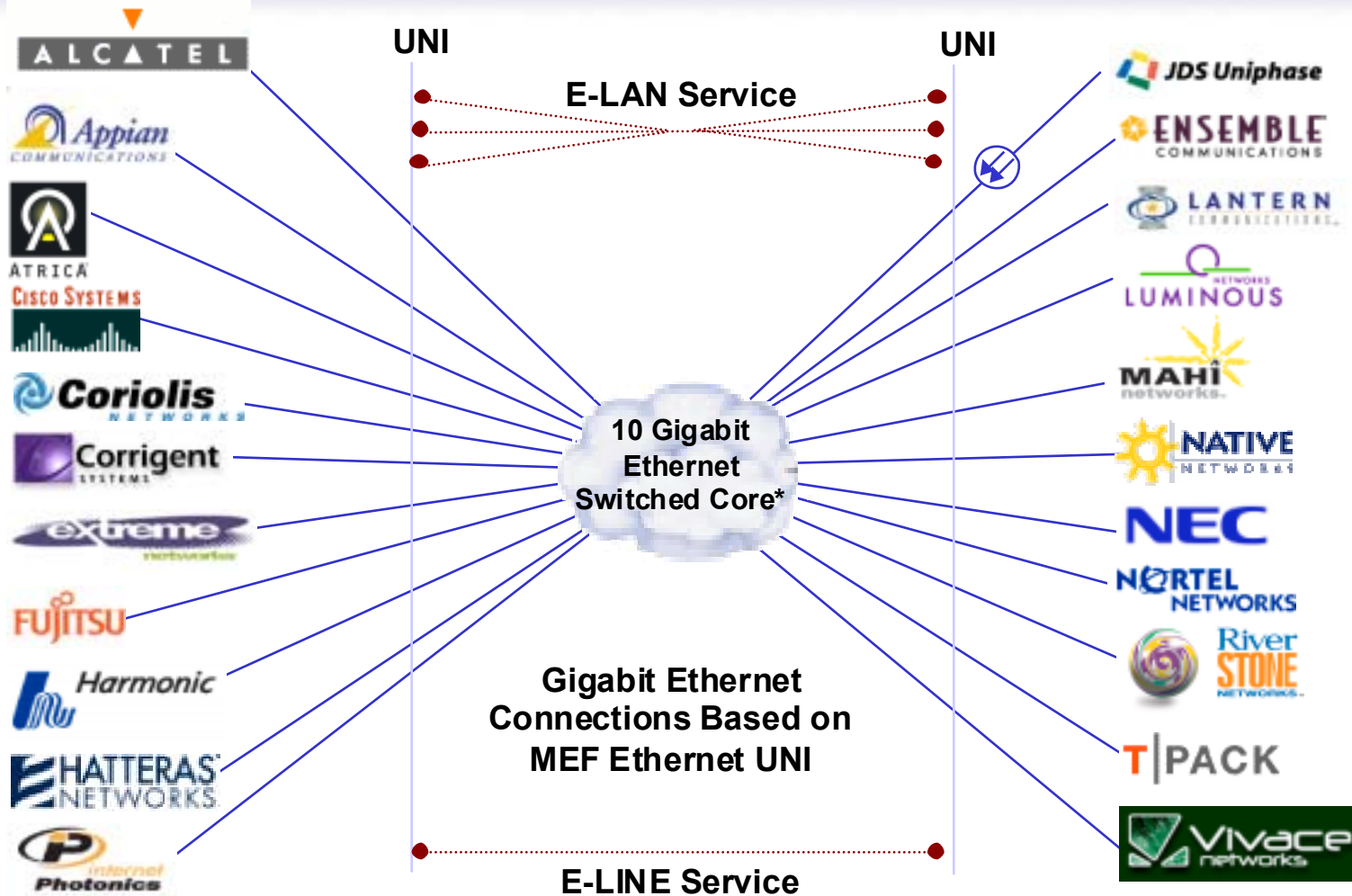
MEF Standards Summary

- MEF is working to fill the gaps between existing standards which are required to realise a complete MEN service solution.

- Technical work is focused on
  - Ethernet Service Specifications
  - Transport Networks Features for Protection, QoS, and NNIs
  - End-to-end management, OAM&P
  - User Interface definition (UNI)

Commercial Take-up
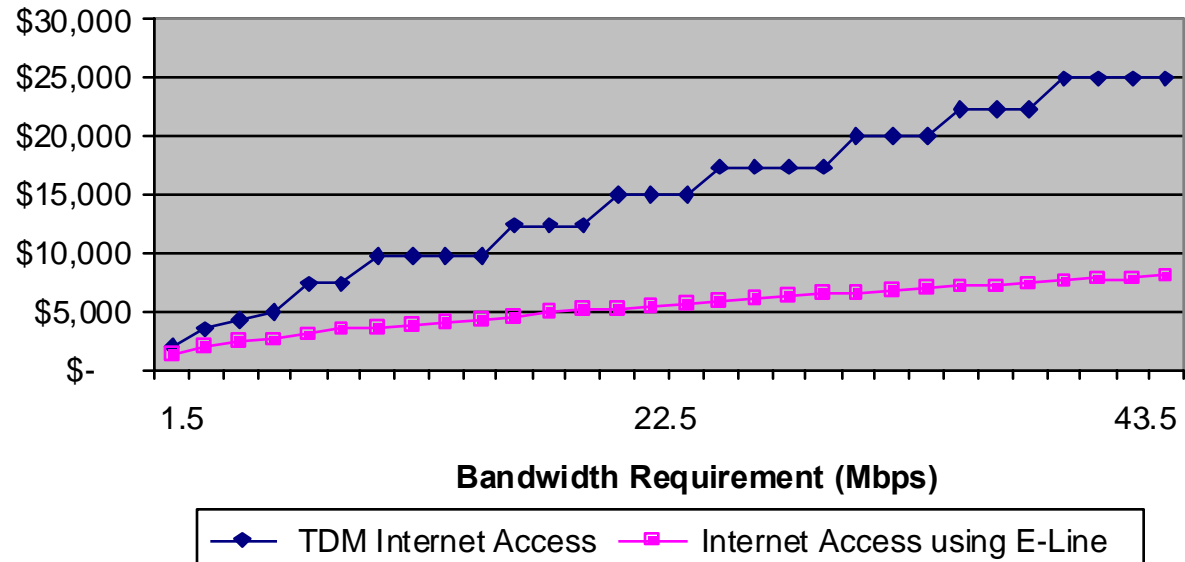
Critical Issues for Metro Ethernet Success …

- Ethernet Service Definitions…
- Ethernet as carrier-class transport technology
  - Protection – sub 50ms
  - QoS – Guaranteed SLA
  - OAM – Manageability
  - UNI – Clear Demarcation and Automation
  - NNI – Multi-Carrier Ethernet service
  - CES – TDM over Ethernet

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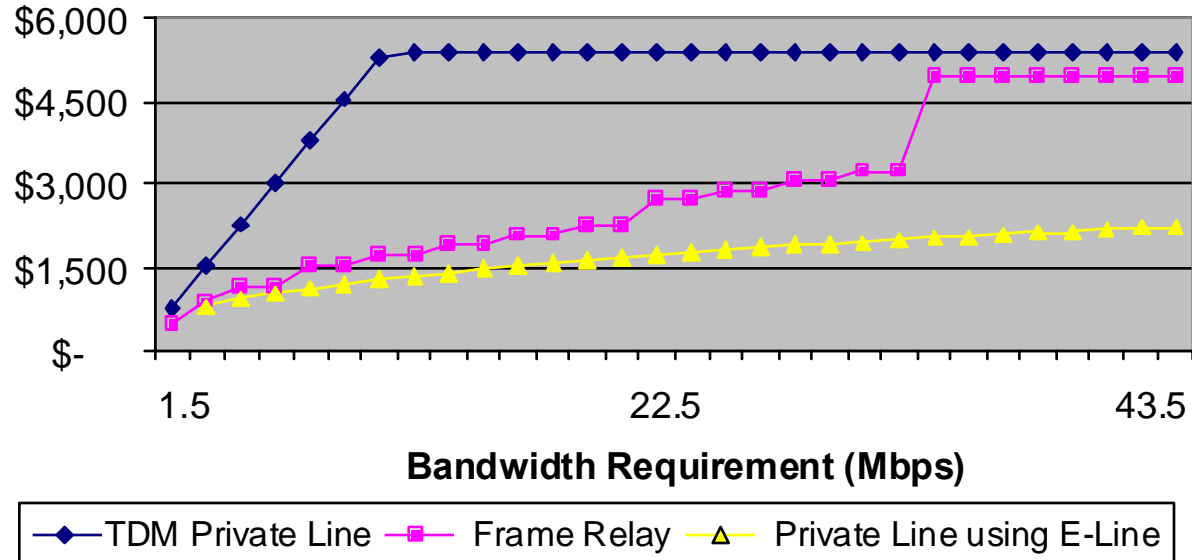
Monthly Service Cost

BellSouth Metro Ethernet Solution

- Ideal for distributed computing environments

- Your furthest location now becomes as close as your LAN connection

Central Office

BellSouth Metro Ethernet Network

Central Office

@ BELLSOUTH®
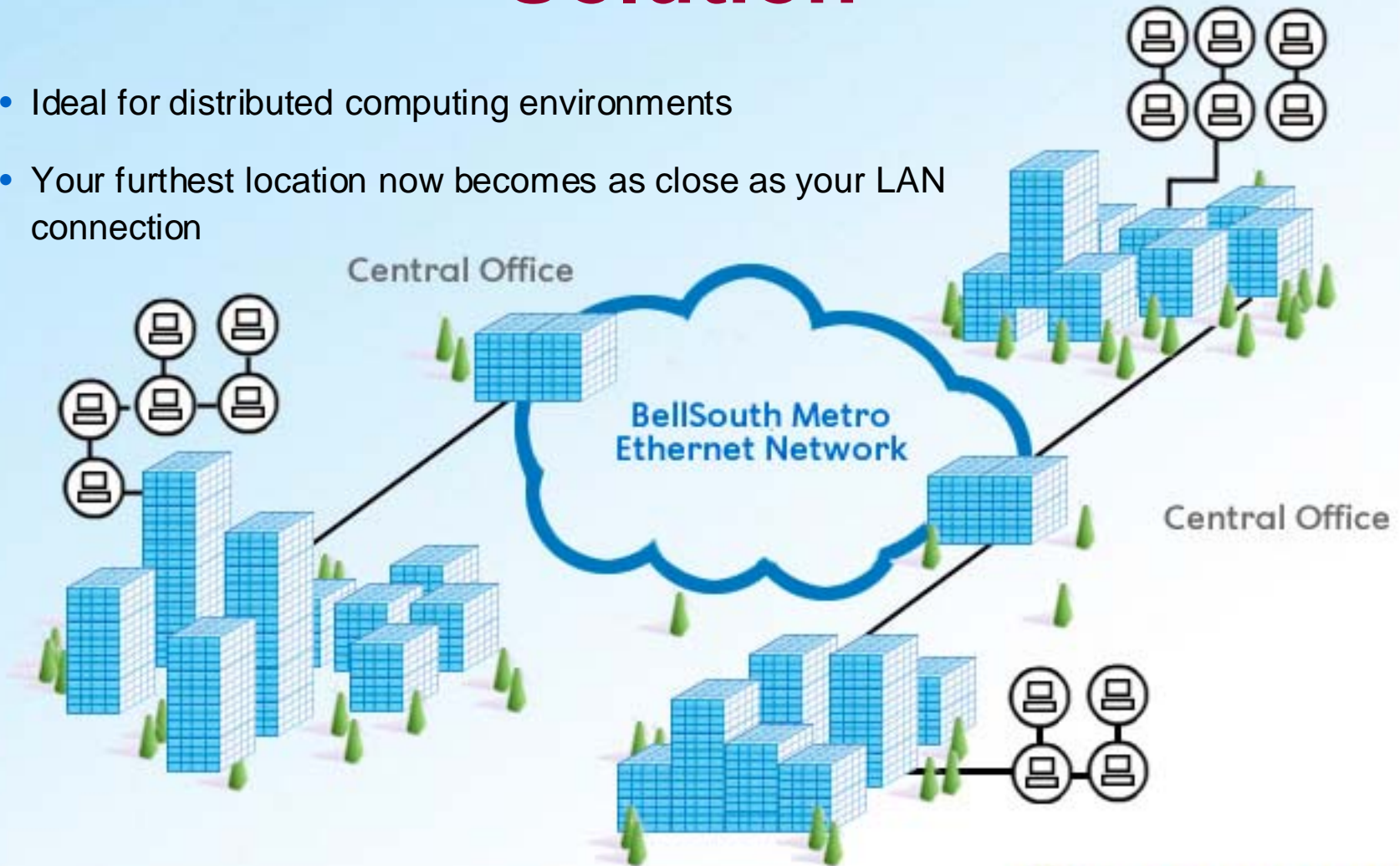
Conclusion: Ethernet Service is a Win-Win

Service Provider Benefits

- **Profitable Price Differentiation**
- **Reduced Operating Cost**
- **Migration to IP without Cannibalizing**
- **Legacy Services**
- **Higher Revenue Velocity**

Enterprise Benefits

- **Affordable Bandwidth Additions**
- **No Wasted Bandwidth**
- **Lower Cost of CPE**
- **Customer Control & Flexibility**

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Working to Deliver Metro Ethernet Services Today!

www.MetroEthernetForum.org