



Carrier Ethernet Attributes & Industry Specifications

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Contents and Audience

- **Contents**

- Carrier Ethernet Definition and 5 Attributes
- Standards Activities Update
- The Technical Work of the MEF
 - An Introduction to the MEF Specifications
 - Future work and MEF Specifications in Preparation

- **Audience**

- Overview for engineers, marketing staff of new member companies
- Top down view for non-members that introduces them to the specifications of the MEF
- Overview for potential members to encourage their participation

Presenter

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Global Expansion from Metro to Carrier Ethernet

- **The Beginning: Metro Ethernet**

- The MEF was formed in 2001 to develop ubiquitous business services for Enterprise users principally accessed over optical metropolitan networks to connect their Enterprise LANs

- **Expansion to Carrier Ethernet**

- The success of Metro Ethernet Services caught the imagination of the world as the concept expanded to include
 - Worldwide services traversing national and global networks
 - Access networks to provide availability to a much wider class of user over fiber, copper, cable, PON, and wireless
 - Economy of scale from the resulting converged business, residential and wireless networks sharing the same infrastructure and services
 - Scalability & rapid deployment of business applications
 - Adoption of the certification program
- While retaining the cost model and simplicity of Ethernet

Issues and Opportunities

- **The MEF's Mission:**

- Accelerate the worldwide adoption of carrier-class Ethernet networks and services

- This mission is in direct response to the opportunities made available by
 1. The need and demand for a simple ubiquitous service
 2. Requirement to scale network services to enable rapid deployment of applications critical to enterprises and service providers.
 3. Availability of low cost, high bandwidth of Ethernet, beyond the LAN
 4. Convergence of business, residential and wireless services
- But what is Carrier Ethernet?

But What Do We Mean By “Ethernet?”

- **Ethernet as a point-to-point link**
 - IEEE 802.3 view
- **Ethernet as a packet switched network (PSN) infrastructure**
 - IEEE 802.1 (bridging) view
 - ITU-T SG15 / SG13 managed Ethernet network view
- **Ethernet as a service**
 - MEF view – user-to-user transfer of 802.3 frames over any transport layer
 - Think E-Line, E-LAN (and soon) E-Tree

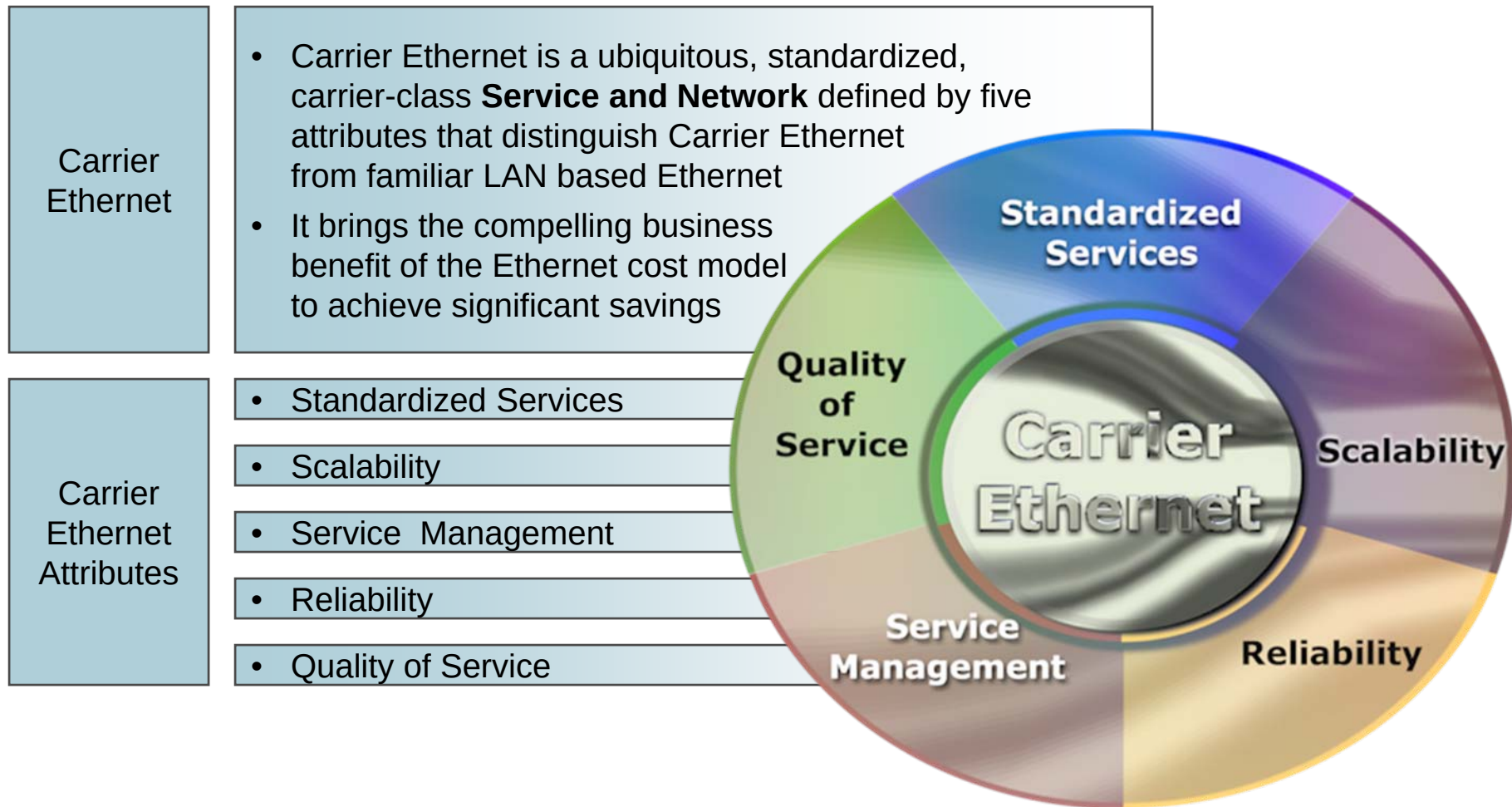


Carrier Ethernet Definition & Overview of the Five Attributes



Carrier Ethernet Defined

The 5 Attributes of Carrier Ethernet

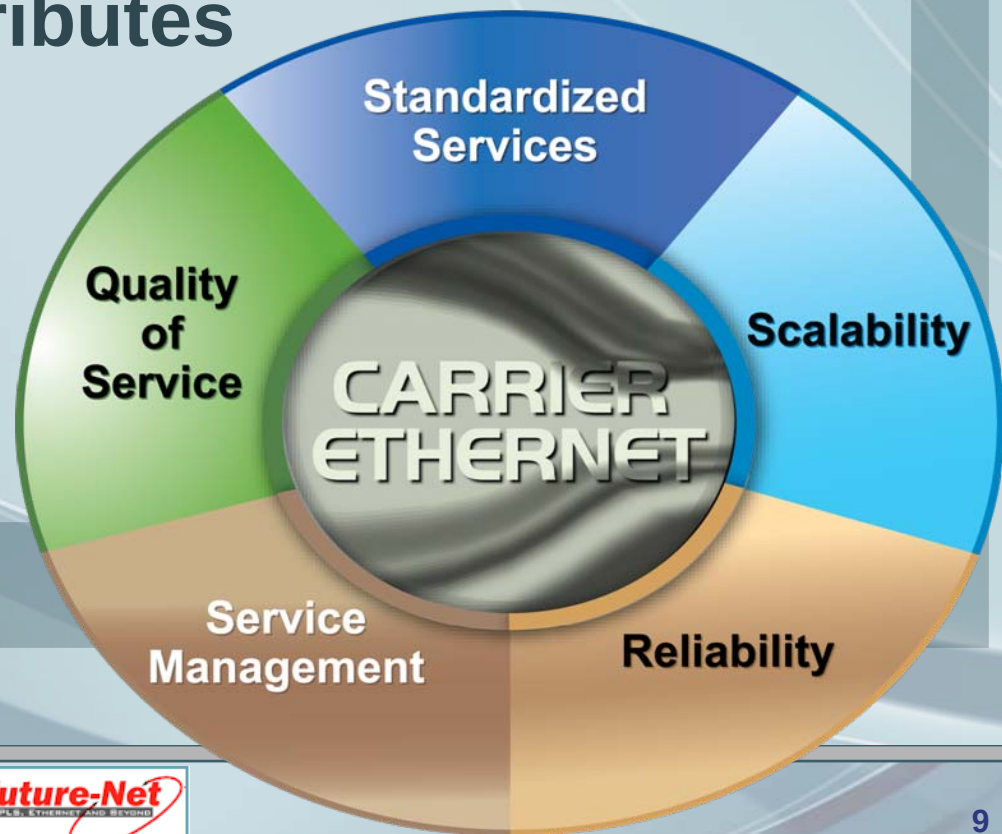


Carrier Ethernet for the Enterprise

Carrier Ethernet is:

A ubiquitous, standardized, carrier-class
Service and Network

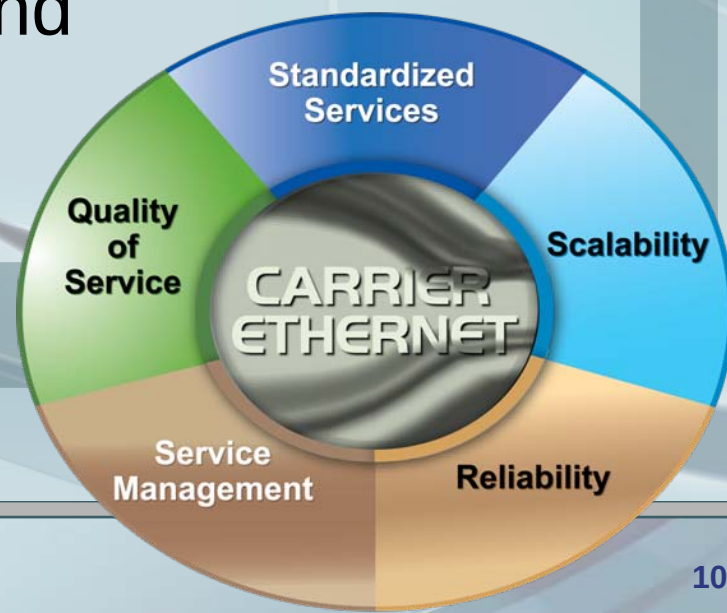
Defined by **five attributes**
that distinguish it
from familiar
LAN based
Ethernet



Carrier Ethernet for the Service Provider

Carrier Ethernet is:

- A set of certified network elements that connect to transport **standardized services** for all users, locally & worldwide
- Carrier Ethernet services are carried over physical Ethernet networks and other legacy transport technologies



The 5 Attributes Carrier Ethernet (1)

Attribute 1: Standardized Services

- E-Line, E-LAN provide transparent, private line, virtual private line and multi-point to multi-point LAN services.
- A ubiquitous service providing globally & locally via standardized equipment
- Requires no changes to customer LAN equipment or networks and accommodates existing network connectivity such as, time-sensitive, TDM traffic and signaling
- Ideally suited to converged voice, video & data networks
- Wide choice and granularity of bandwidth and quality of service options

Standards Enable Standardized Services

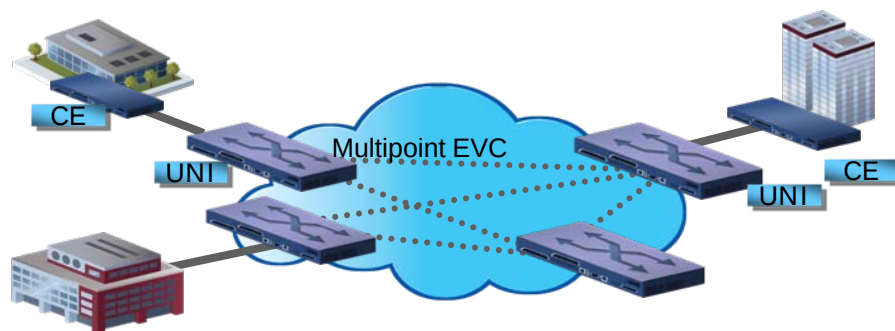
E-Line



Point-to-point EVC,
Like Duplex Ethernet

E-LAN

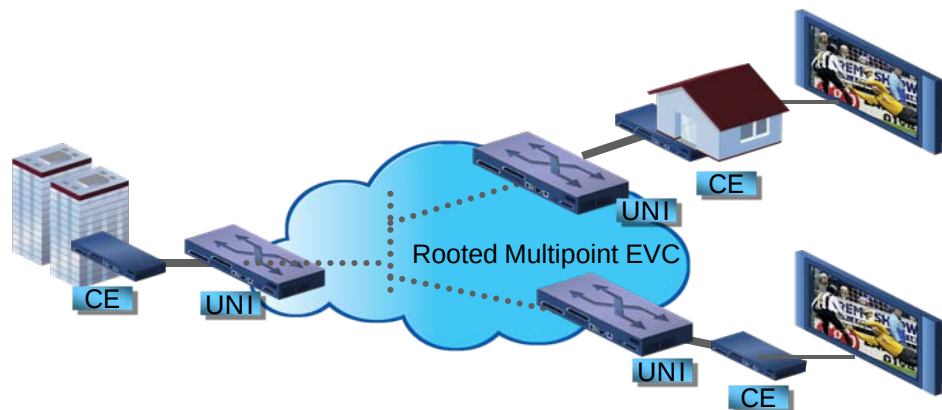
Multi-Site



Multipoint EVC,
Like VLAN,
Any-to-any

E-TREE

Rooted Multipoint
(proposed)

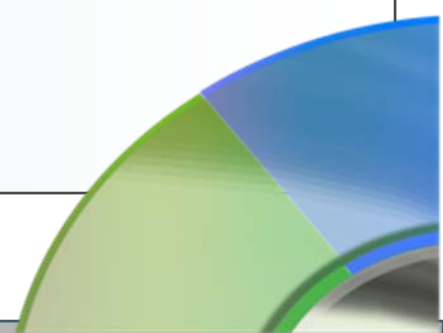


Point-to-multipoint,
Like EPON Ethernet,
Root-to-Leaf and
Leaf-to-Root

The 5 Attributes Carrier Ethernet (2)

Attribute 2: Scalability

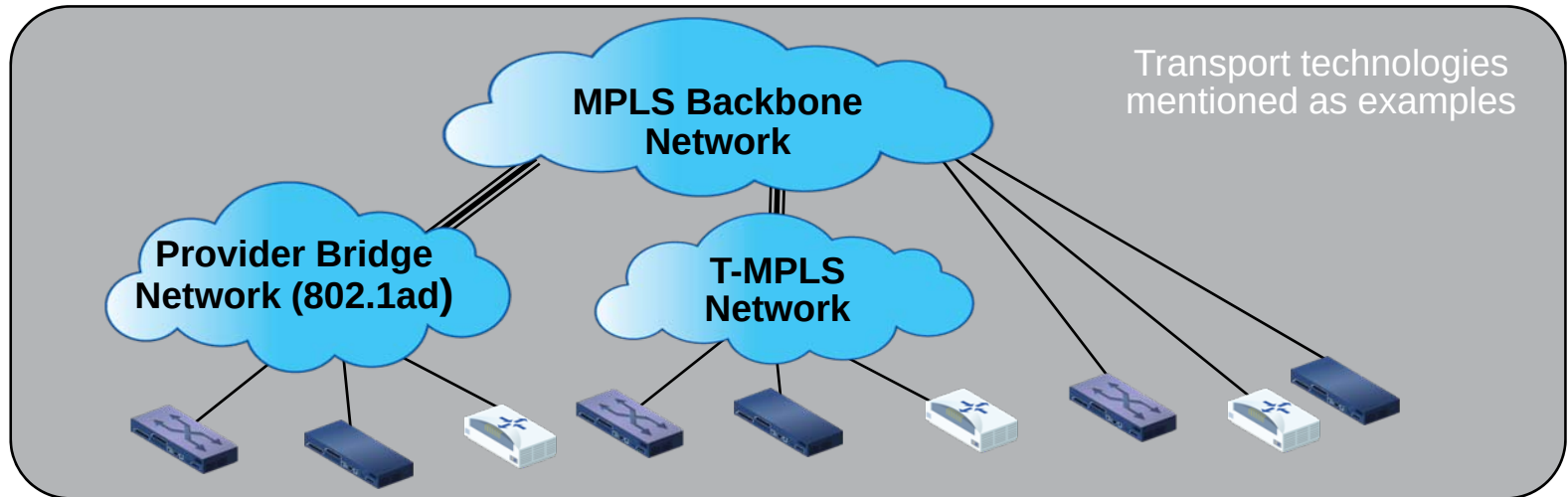
- The ability for millions to use a network service that is ideal for the widest variety of business, information, communications and entertainment applications with voice, video and data
- Spans Access & Metro to National & Global Services over a wide variety of physical infrastructures implemented by a wide range of Service Providers
- Scalability of bandwidth from 1Mbps to 10Gbps and beyond, in granular increments



Standards Enable Scalability

Several transport technologies add the notion of hierarchy to a Carrier Ethernet network (like MPLS, PBB/PBB-TE, T-MPLS)

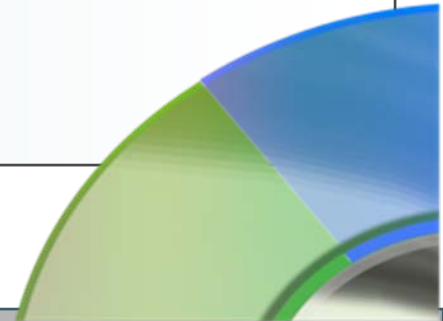
- Avoid MAC table explosion issues
- Bolster security of Ethernet (secure customer separation, isolation of service provider address space)
- Enable service identification and differentiation



The 5 Attributes Carrier Ethernet (3)

Attribute 3: Reliability

- The ability for the network to detect & recover from incidents without impacting users
- Meeting the most demanding quality and availability requirements
- Rapid recovery time when problems do occur, as low as 50ms



The 5 Attributes Carrier Ethernet (4)

Attribute 4: Quality of Service

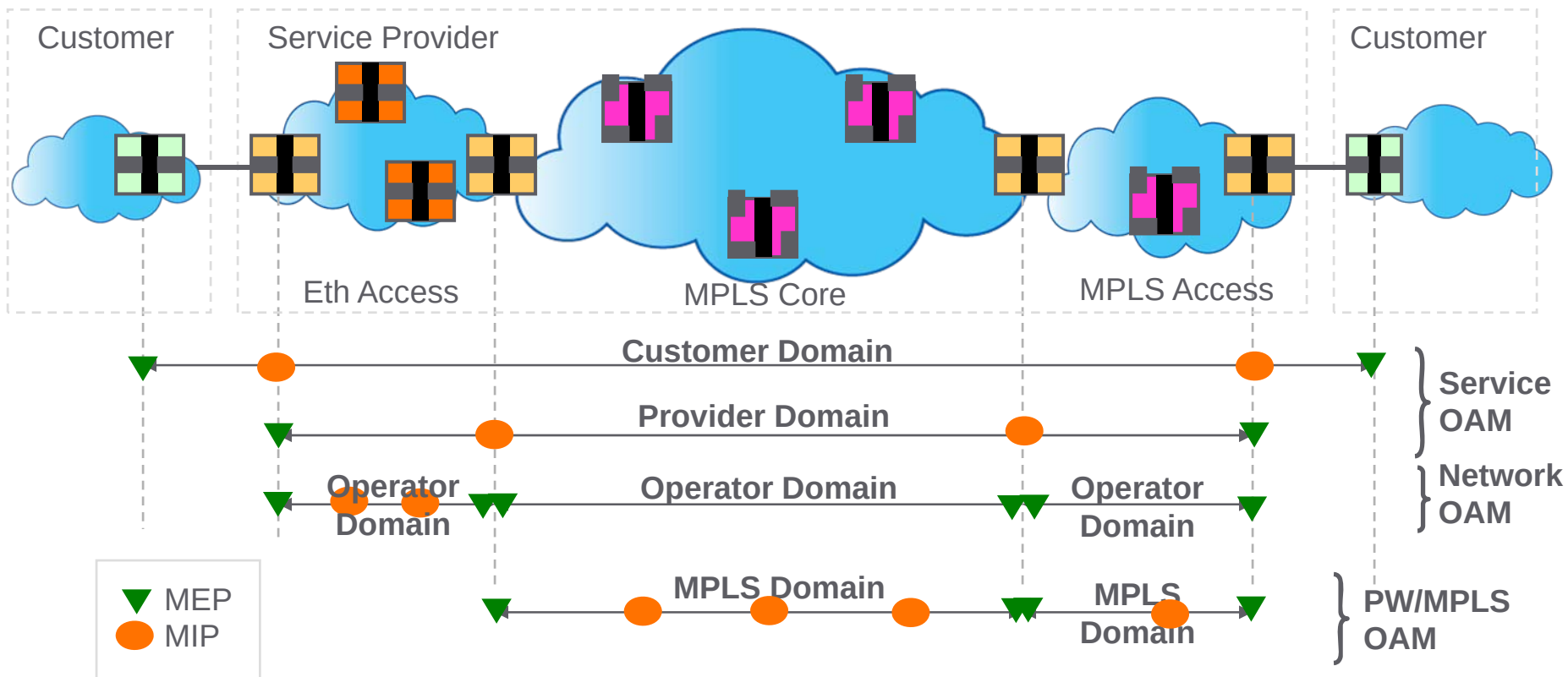
- Wide choice and granularity of bandwidth and quality of service options
- Service Level Agreements (SLAs) that deliver end-to-end performance matching the requirements for voice, video and data over converged business and residential networks
- Provisioning via SLAs that provide end-to-end performance based on CIR, frame loss, delay and delay variation characteristics

The 5 Attributes Carrier Ethernet (5)

Attribute 5: **Service Management**

- The ability to monitor, diagnose and centrally manage the network, using standards-based vendor independent implementations
- Carrier-class OAM
- Rapid service provisioning

Standards Enable Service Management



- Ethernet OAM (802.1ag) can be deployed across different types of technologies used for Metro Ethernet Networks
- Also assists in fast fault detection and isolation (leads to reliability)

MEP = Maintenance End Point

MIP = Maintenance Intermediate Point



Standards Activities Update



Each Standards Body Has Their Approach



The MEF's role is largely additive to these organizations, developing necessary additional specifications that are required to enable Carrier Ethernet. The MEF also provides inputs in support of Carrier Ethernet to these bodies via its participating members and liaisons.

It is not within the scope of the MEF to endorse or otherwise the work of other standards bodies and associations

Ethernet Standards Summary

Standards Body	Ethernet Services	Architecture/Control	Management and OAM	Ethernet Interfaces
	• MEF 10 – Service Attributes • MEF 3 – Circuit Emulation • MEF 6 – Service Definition • MEF 8 – PDH Emulation • Services Phase 2	• MEF 4 – Generic Architecture • MEF 2 – Protection Req & Framework • MEF 11 – UNI Req & Framework • MEF 12 - Layer Architecture	• MEF 7– EMS-NMS Info Model • MEF 15– NE Management Req • OAM Req & Framework • OAM Protocol – Phase 1 • Performance Monitoring	• MEF 13 - UNI Type 1 • MEF 16 – E-LMI • E-NNI
	–	• 802.3 – MAC • 802.1D/Q – Bridges/VLAN • 802.1ad – Provider Bridges • 802.1ah – Provider Backbone Bridges • 802.1Qay – PBB –TE • 802.1ax – Next-gen Link Aggregation	• 802.3ah – EFM OAM • 802.1ag – CFM	• 802.3 – PHYs • 802.3as - Frame Expansion • 802.3ba 100GigE
	• G.8011 – Carrier Ethernet Services Framework • G.81xx – T-MPLS	• G.8010 – Layer Architecture • G.8021 – Equipment model • G.8010v2 – Layer Architecture • G.8021v2 – Equipment model • Y.17ethmpls - ETH-MPLS Interwork	• Y.1730 – Ethernet OAM Req • Y.1731 – OAM Mechanisms • G.8031 – Protection	• G.8012 – UNI/NNI
	–	–	• TMF814 – EMS to NMS Model	–
	• MFAF.12 – Multi-Service Interworking	–	–	–

Complementary Standards Activities

Goals

- Reach consensus, bring MEF work to other bodies, re-use work of other bodies, work with other bodies, avoid duplication, keep in communications

Scalability

IEEE	802.3ba 40GbE & 100GbE Provider Bridges Provider Backbone Bridges
ITU-T	ITU-T SG 15 has referenced the MEF service work in their documents that describe EPL and EVPL.
IETF	Layer 2 VPNs

Service Management

IEEE	Service OAM (Connection Fault Management) Link OAM (Ethernet in the First Mile)
ITU-T	Study Group 13 for Service OAM Study Group 4 harmonizes with MEF7, E-LMI
OIF	Customer signaling of Ethernet Services

Reliability

IETF	MPLS Fast Reroute, graceful restart
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The Technical Work of the MEF

- **Technical Committee**

- The Technical Committee currently focuses their work:
- Services, Architecture, Architecture, Management, Test & Measurement.
- The Technical Committee has active liaisons with other standards organizations.

- **A Technical Overview of the Work of the MEF**

- A list of the Specifications, timelines, etc., follow
- More detailed technical presentations are available on the MEF website in the Information Center
 - metroethernetforum.org/presentations
 - metroethernetforum.org/techspecs



MEF Current Specifications



Approved MEF Specifications

- **MEF 2** Requirements and Framework for Ethernet Service Protection
- **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** Metro Ethernet Services Definitions Phase I
- **MEF 7** EMS-NMS Information Model
- **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 10.1** Ethernet Services Attributes Phase 2*
- **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
- **MEF 16** Ethernet Local Management Interface
- **MEF 17** Service OAM Framework and Requirements
- **MEF 18** Abstract Test Suite for Circuit Emulation Services
- **MEF 19** Abstract Test Suite for UNI Type 1

* MEF 10 .1 replaces and enhances MEF 10 Ethernet Services Definition Phase 1 and replaced MEF 1 and MEF 5.

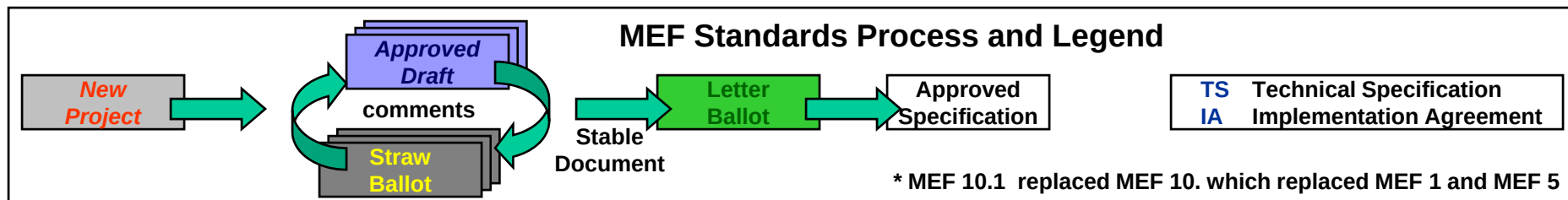
How the MEF Specifications Enable Carrier Ethernet

This chart shows how the MEF specifications enable the attributes of Carrier Ethernet indicating the responsible area within the MEF Technical Committee

MEF Specs	Carrier Ethernet Attributes				
	Standardized Services	Service Management	Reliability	Quality of Service	Scalability
MEF 2			Architecture Area		
MEF 3	Service Area			Service Area	
MEF 4	Architecture Area				
MEF 6	Service Area			Service Area	Service Area
MEF 7		Management Area			
MEF 8	Service Area				
MEF 9	Test & Measurement Area		Test & Measurement Area		
MEF 10.1	Service Area			Service Area	Service Area
MEF 11	Architecture Area				
MEF 12	Architecture Area				Architecture Area
MEF 13	Architecture Area				
MEF 14	Test & Measurement Area		Test & Measurement Area	Test & Measurement Area	
MEF 15		Management Area			
MEF 16		Management Area			
MEF 17		Management Area			
MEF 18	Test & Measurement Area		Test & Measurement Area		
MEF 19	Test & Measurement Area		Test & Measurement Area		

MEF Technical Committee Work Dashboard

Service Area	Architecture Area	Management Area	Test and Measurement Area
MEF 6 – Ethernet Services Definitions (TS)	MEF 2 – Protection Framework and Requirements (TS)	MEF 7 – EMS - NMS Information Model (TS)	MEF 9 – Abstract Test Suite for Ethernet Services at the UNI (TS)
MEF 3 – Circuit Emulation Service Requirements (TS)	MEF 4 – Metro Ethernet Network Architecture Framework Part 1: Generic Framework (TS)	MEF 15 – Requirements for Management of Metro Ethernet Phase 1 – Network Elements (TS)	MEF 14 – Abstract Test Suite for Traffic Management Phase 1 (TS)
MEF 8 Emulation of PDH over MENS (IA)	MEF 11 - UNI Framework and Requirements (TS)	MEF 16 – Ethernet Local Management Interface E-LMI (TS)	MEF 18 Abstract Test Suite for CES over Ethernet (TS)
MEF 10.1 Ethernet Services Attributes Phase 2 (TS)	MEF 12 – Metro Ethernet Network Architecture Framework Part 2: Ethernet Services Layer (TS)	MEF 17 Service OAM Requirements and Framework (TS)	MEF 19 Abstract Test Suite for UNI Type 1 (TS)
Ethernet Services Definitions Phase 2 (TS)	MEF 13 – User Network Interface Type 1 (IA)	Service OAM Performance Management (IA)	UNI Type 2 Test Suite (TS) Part 2 E-LMI
Mobile Backhaul (IA)	UNI Type 2 (IA)	Service OAM Fault Management (IA)	Abstract Test Suite for E-NNI (TS)
Classes of Service (IA)	External NNI (E-NNI) Phase 1 (TS)		UNI Type 2 Test Suite (TS) Part 1 link OAM
MEF 10.1 Update: Attribute Enhancements	Ethernet Service Constructs (TS)		
	NID Specification (TS)		



MEF Specifications Overview

MEF 6 Metro Ethernet Services Definitions Phase I	
Purpose	Defines the Ethernet Services (EPL, EVPL, E-Line, ELAN, etc)
Audience	All, since it provides the fundamentals required to build devices and services that deliver Carrier Ethernet. For Enterprise users it gives the background to Service Level Specifications for Carrier Ethernet Services being offered by their Service Providers and helps to plan Ethernet Services as part of their overall network.
Technical Committee Service Area	

MEF 10.1 Ethernet Services Attributes Phase 2	
Purpose	Defines the service attributes and parameters required to offer the services defined in MEF 6. Updated from Original MEF 10
Audience	All, since it provides the fundamentals required to build devices and services that deliver Carrier Ethernet. For Enterprise users it gives the background to Service Level Specifications for Carrier Ethernet Services being offered by their Service Providers and helps to plan Ethernet Services as part of their overall network.
Technical Committee Service Area	

MEF Specifications Overview

MEF 3 Circuit Emulation Service Definitions, Framework and Requirements in Metro Ethernet Networks	
Purpose	Circuit Emulation Service “tunnels” TDM traffic through a Metro Ethernet network allowing inclusion of legacy networks within a Carrier Ethernet environment
Audience	Equipment Manufacturers supporting devices that provide Circuit Emulation over Carrier Ethernet Services. Useful for Service Providers architecting their systems.
Technical Committee Service Area	

MEF 8 Implementation Agreement for the Emulation of PDH Circuits over Metro Ethernet Networks	
Purpose	Gives precise instructions for implementing interoperable CES equipment that reliably transport TDM circuits across Metro Ethernet Networks while meeting the required performance of circuit emulated TDM services as defined in ITU-T and ANSI TDM standards
Audience	Equipment Manufacturers supporting devices that provide Circuit Emulation over Carrier Ethernet Services. Useful for Service Providers architecting their systems.
Technical Committee Service Area	

MEF Specifications Overview

MEF 4 Metro Ethernet Network Architecture Framework Part 1: Generic Framework	
Purpose	Introduces the framework and terminology for the services (Eth) layer
Audience	All (Equipment Manufacturers, Service Providers & Enterprises), since it provides the fundamental understanding of the Carrier Ethernet architecture
Technical Committee Architecture Area	

MEF 12 Metro Ethernet Network Architecture Framework Part 2: Ethernet Services Layer	
Purpose	Defines the Ethernet Services (ETH) Layer as the specific layer network responsible for delivery of Ethernet Protocol Data Units across internal and external interfaces.
Audience	Equipment Manufacturers building devices that will carry Carrier Ethernet Services. Useful for Service Providers architecting their systems.
Technical Committee Architecture Area	

MEF Specifications Overview

MEF 11 User Network Interface (UNI) Requirements and Framework	
Purpose	Defines a split demarcation function between the customer (Subscriber), and the Service Provider
Audience	Equipment Manufacturers building devices that will carry Carrier Ethernet Services. Useful for Service Providers architecting their systems.

Technical Committee Architecture Area

MEF 13 User Network Interface (UNI) Type 1 Implementation Agreement	
Purpose	This allows existing Ethernet devices (switch, router, workstation, etc) acting as Customer Edge devices to be compliant to this IA with no additional software or hardware upgrades
Audience	Equipment Manufacturers building devices that will carry CE Services. Useful for Service Providers architecting their systems.

Technical Committee Architecture Area

MEF Specifications Overview

MEF 2 Requirements and Framework for Ethernet Service Protection	
Purpose	Defines a broad frame work for hop-by-hop and end-to-end service level protection.
Audience	Equipment Manufacturers building devices that will carry Carrier Ethernet Services. Useful for Service Providers architecting their systems.

Technical Committee Architecture Area

MEF Specifications Overview

MEF 7 EMS-NMS* Information Model *Element Management System–Network Management System	
Purpose	Provides a standard for carrier management systems to enable configuration and fault management of Metro Ethernet services.
Audience	Equipment Manufacturers building devices that will carry Carrier Ethernet Services. Useful for Service Providers architecting their systems.
Technical Committee Management Area	

MEF 15 Requirements for Management of Metro Ethernet Phase 1 Network Elements	
Purpose	Specifies the network management requirements to be met by Network Elements supporting Ethernet Service Phase 1
Audience	Equipment Manufacturers building devices that will carry Carrier Ethernet Services. Useful for Service Providers architecting their systems.
Technical Committee Management Area	

MEF Specifications Overview

MEF 16 Ethernet Local Management Interface (E-LMI)	
Purpose	Enables customer equipment to receive information regarding the status and attributes of Ethernet Services thus allowing automatic configuration and improved Subscriber network performance.
Audience	Equipment manufacturers of Customer Edge devices and of Service Provider equipment. Useful for Service Providers architecting their systems.
Technical Committee Management Area	

MEF 17 Service OAM Requirements & Framework – Phase 1	
Purpose	Provides requirements to be satisfied by the Service OAM mechanisms in MENs and framework for discussing and implementing those mechanisms. It also provides context for several MEF specifications (UNI type 2 and E-NNI) and the work of other standards bodies
Audience	Equipment Manufacturers building devices and Service Providers architecting their systems.
Technical Committee Management Area	

MEF Specifications Overview



MEF 9 Abstract Test Suite for Ethernet Services at the UNI	
Purpose	Defines the test suite for conformance of Ethernet services and equipment when deployed at the UNI
Audience	Equipment Manufacturers building devices that are designed to conform to MEF Specifications. Service Providers who want to assure their end customers that their services comply with MEF Specifications.
Technical Committee Test and Measurement Area	

MEF 14 Abstract Test Suite for Traffic Management Phase 1	
Purpose	Defines the requirements and corresponding test procedures for Service Performance and Bandwidth Profile Service Attributes that may be specified as part of a Service Level Specification (SLS) for an Ethernet Service
Audience	Equipment Manufacturers building devices that are designed to conform to MEF Specifications. Service Providers conducting who require that their services comply to MEF Specifications
Technical Committee Test and Measurement Area	

MEF Specifications Overview



MEF 18 Abstract Test Suite for CES	
Purpose	Specifies testing procedures for pass/fail assessment of conformance with each of the operating modes in MEF 8.
Audience	Equipment Manufacturers building devices that will carry TDM traffic across Carrier Ethernet Networks. Useful for Service Providers architecting their systems.
Technical Committee Test and Measurement Area	

MEF 19 Abstract Test Suite for UNI Type 1	
Purpose	Supplements the MEF test specifications MEF 9, and MEF 14 with test procedures for UNI manual configuration mode defined in MEF 13
Audience	Equipment Manufacturers building devices that will carry CE Services. Useful for Service Providers architecting their systems.
Technical Committee Test and Measurement Area	

MEF Development Work

- **Future Technical Work**

- The MEF technical work continues on all elements of Carrier Ethernet (OAM, Network to Network Interfaces, implementation agreements, etc.) This includes coordination with other standards bodies.

- **Deployment now brings immediate benefits**

- Immediate benefits are being obtained today based on implementing today's specifications. These benefits increase as the specifications complete

- **MEF Timescales**

- The MEF continues to exist during the foreseeable future to complete our mission



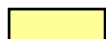
MEF Future Specifications



Ethernet Services Definitions Phase 2

Editor: Bill Bjorkman, Verizon Business

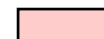
Service Type	Port-Based (All-to-One Bundling)	VLAN-Based (Service Multiplexed)
E-Line	Ethernet Private Line	Ethernet Virtual Private Line
E-LAN	Ethernet Private LAN*	Ethernet Virtual Private LAN*
E-Tree*	Ethernet Private Tree*	Ethernet Virtual Private Tree*



No change

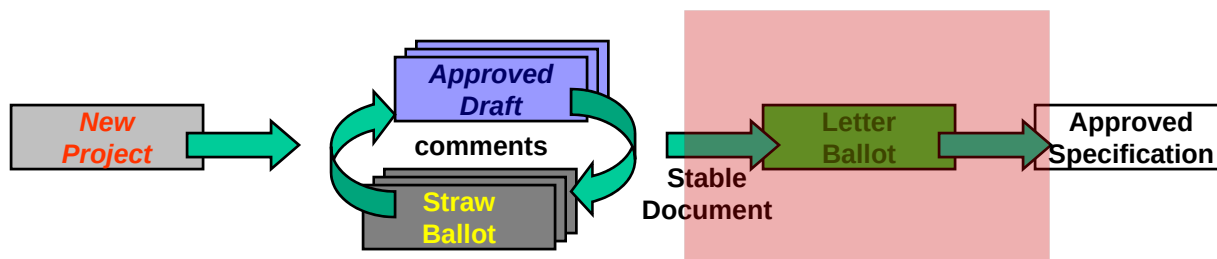


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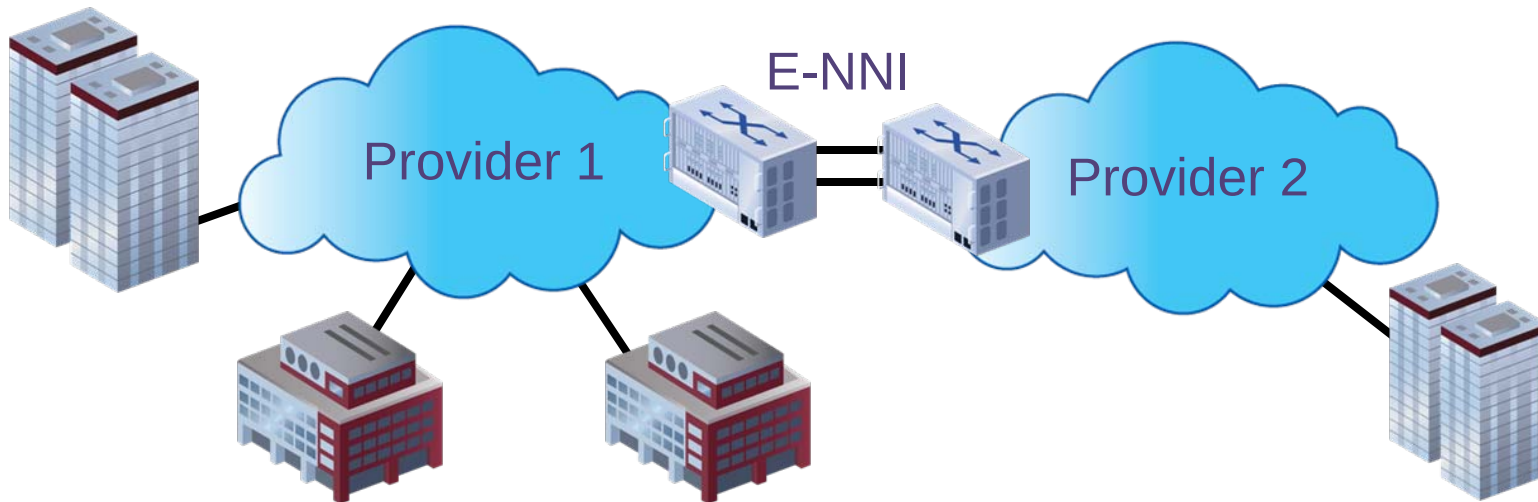
New

- Proposes a new service type (E-Tree)
- Adds four new services – two each to E-LAN and E-Tree
- Draft 5 currently in Straw Ballot stage

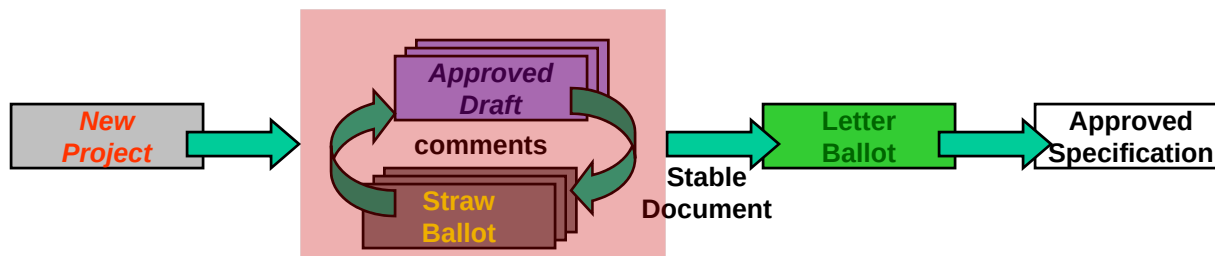


E-NNI Specification

Editor: Steve Holmgren, at&t

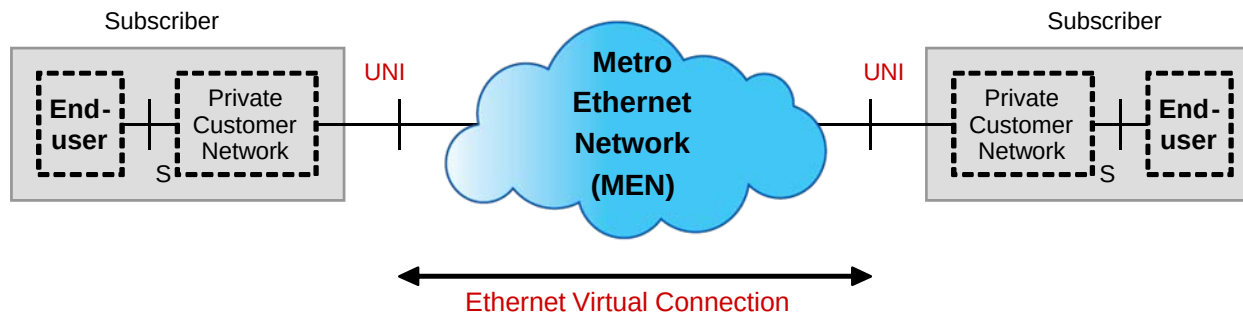


- Nobody has footprint everywhere. The interconnection of Carrier Ethernet networks is one of the last hurdles for ubiquitous Ethernet services
- Need a common language for peering
- E-NNI is a reference point representing the boundary between two Carrier Ethernet Networks, each in a different administrative domain
- Draft # 6 is the latest version

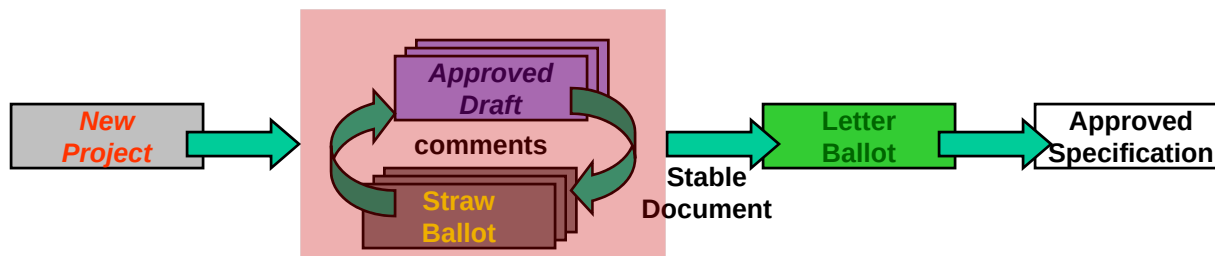


UNI Type 2

Editor: Shahram Davari, PMC-Sierra



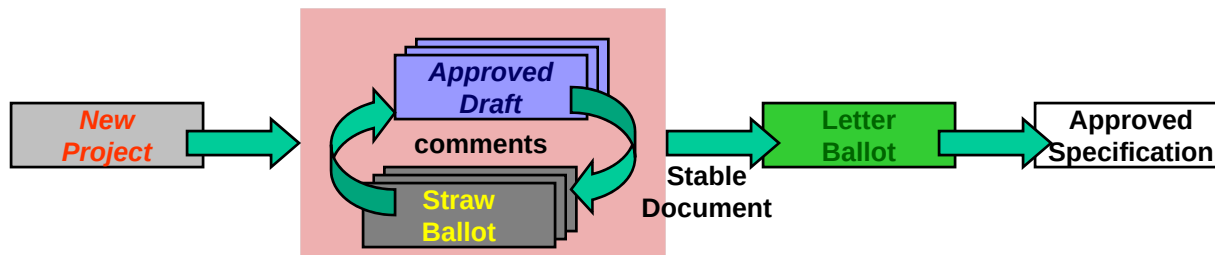
- Allows provider equipment to provision, configure and distribute EVC information and attributes to customer equipment.
- Allows customer equipment to retrieve EVC status and configuration information from service provider equipment.
- Adds fault management and protection functionalities beyond those specified in UNI Type 1.
- Letter Ballot initiated January 2008



Classes of Service

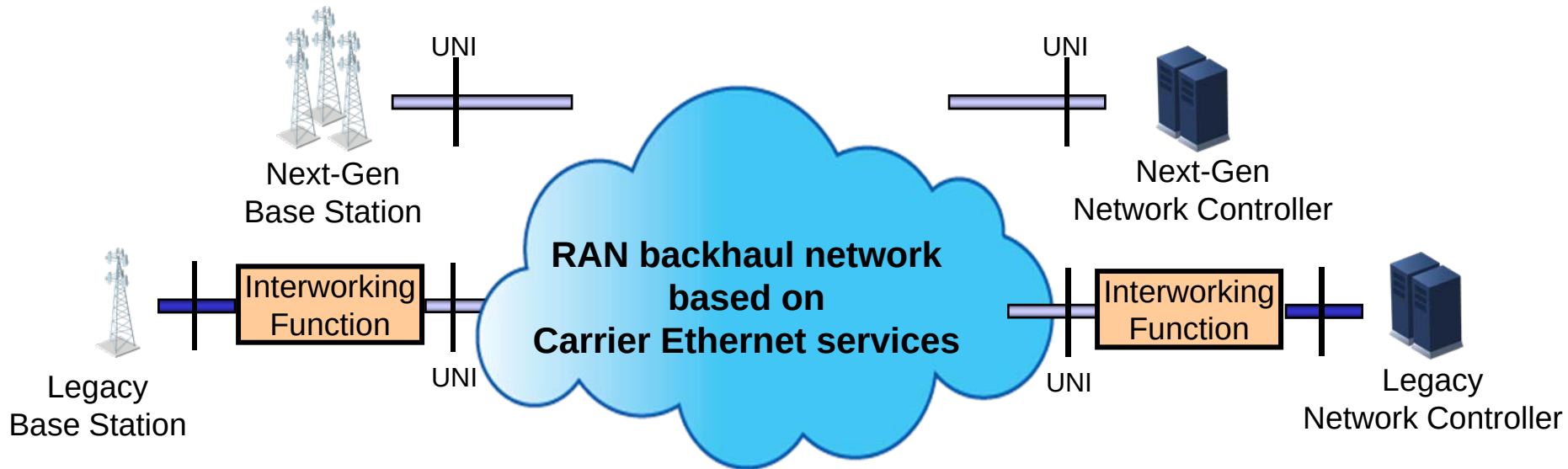
Editor: Bill Rembert, at&t

- **Accelerate adoption of Carrier Ethernet by minimizing confusion that will result from each Service Provider inventing their own CoS schemes.**
 - Multiple schemes result in a multiplicity of diverse CoS definitions that don't easily map to provide end to end CoS
 - Interconnect (via E-NNI) simplification
- **Agree on 2 class and 3 class common models**
 - Ensure key applications can be given sufficient forwarding performance end-to-end to meet application requirements
 - A Service Provider may well offer additional classes
- **Stretch goal is to quantify models**

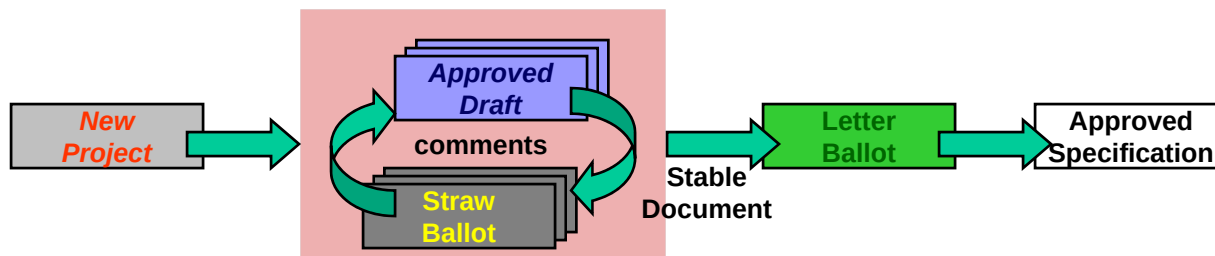


Mobile Backhaul Implementation Agreement

Editor: Jonathan Olsson, Ericsson

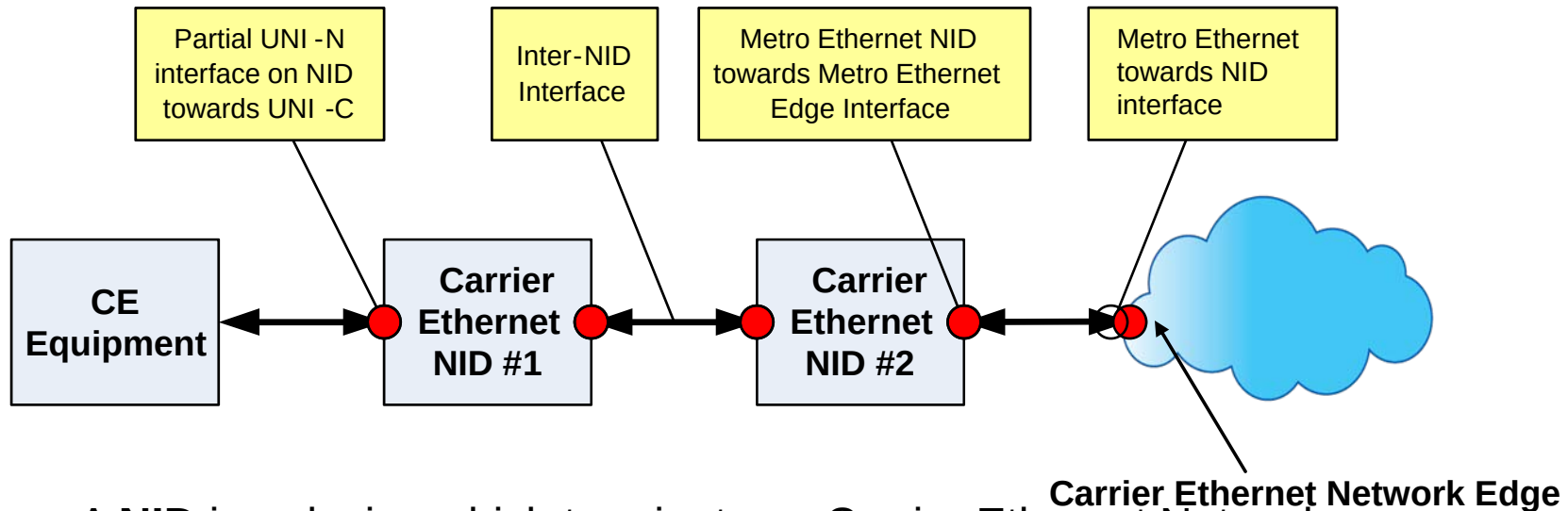


- Provide scalable, economic, dependable Carrier Ethernet-based solution for radio access network (RAN) backhaul
- Implementation Agreement (IA) provides guidelines how to apply MEF standards for
 - Legacy mobile backhaul transport
 - Hybrid offload (HSPA/data via CE, voice via TDM/ATM) transport
 - Next generation (IP-only base station) transport

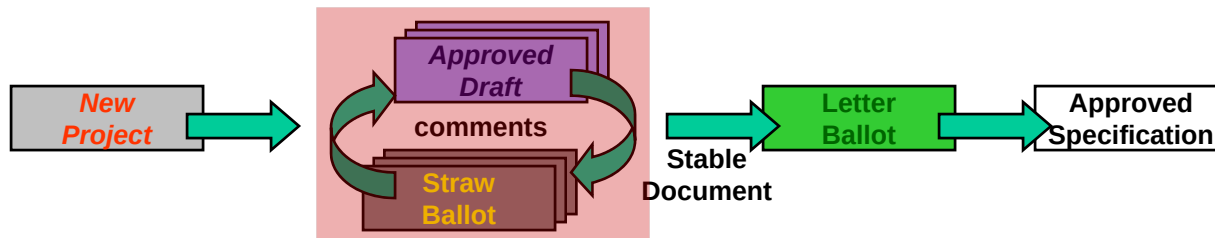


Network Interface Devices (NID) Specification

Editor: Gennadi Lembersky , Telco Systems



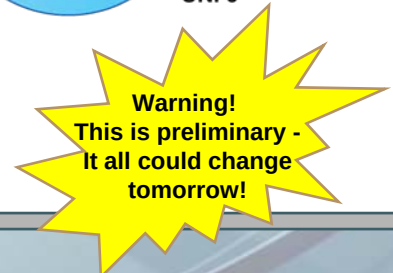
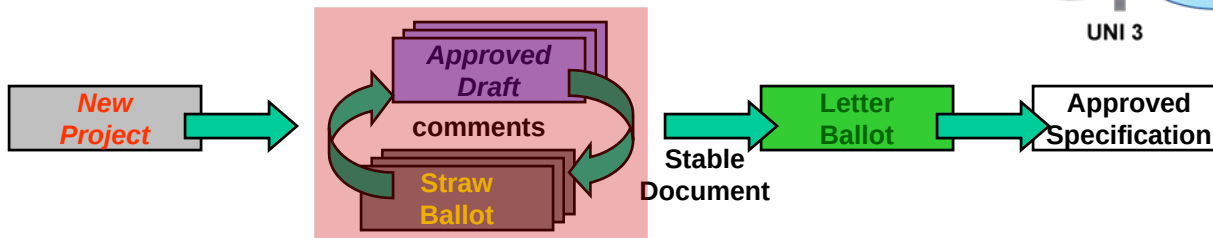
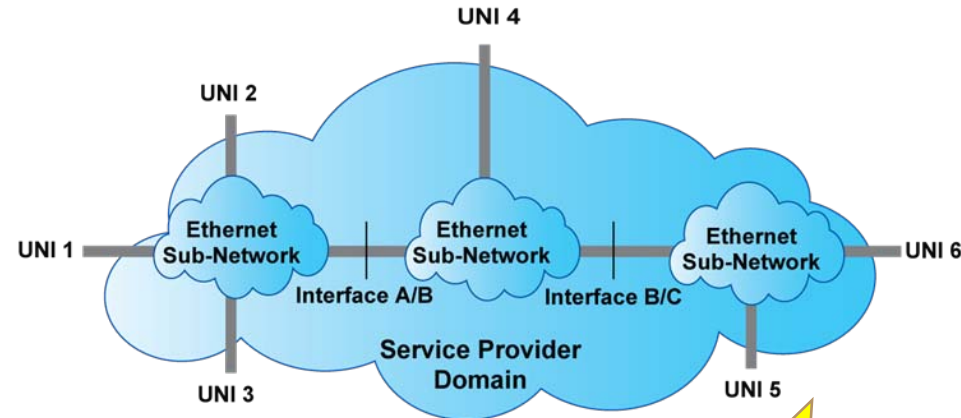
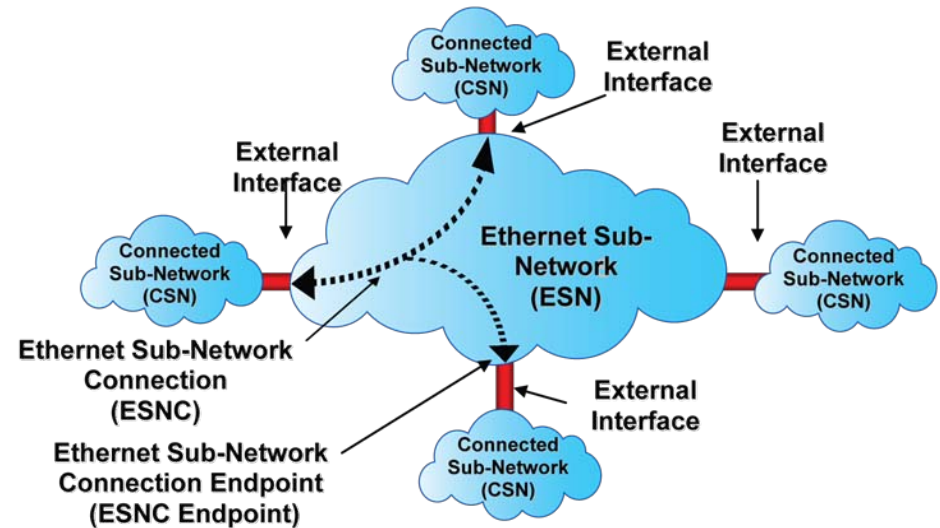
- A **NID** is a device which terminates a Carrier Ethernet Network
 - Ethernet Transport Termination (ETT)
 - Ethernet Service Termination (EST)
 - Ethernet Tunnel Service Termination (ETST - to be defined in the later phases).
- First Approved Draft



Ethernet Service Constructs

Editor: Chris Purdy, Nakina

- Defines constructs to be used by specifications defining specific Ethernet Sub-Networks and/or specific External Interfaces within a Carrier Ethernet network



Abstract Test Suites for Certification

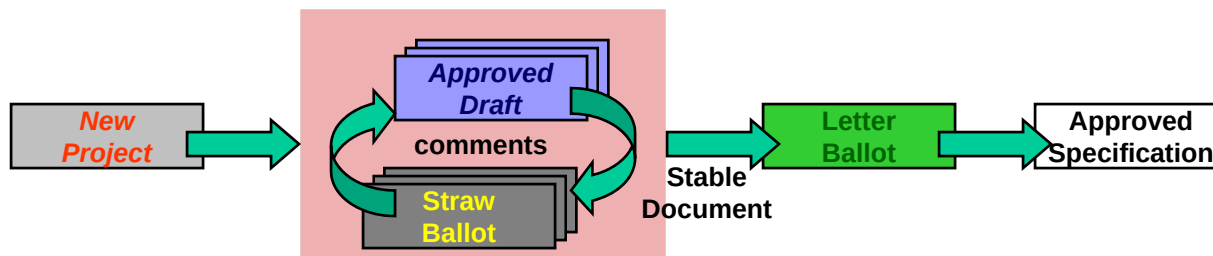
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- **UNI Type 2 Certification**

- More complex to test than UNI Type 1
- Includes Ethernet link and service OAM
- UNI Type 2 service requires backwards compatibility with UNI Type 1
- Components of UNI type 2 test suite such as Link OAM and E-LMI are work in progress

- **E-NNI Certification**

- Abstract Test Suite is work in progress, depends on completion of E-NNI base specification
- Plans to include UNI services as far as they are mapped to E-NNI services



EMS-NMS* Information Model Phase II

MEF [TBA]	EMS-NMS* Information Model Phase II *Element Management System–Network Management System
Purpose	Replacement for MEF 7 with support for E-LMI (MEF 16) and Phase II Service Definitions and Attributes
Audience	Equipment Manufacturers building devices and Service Providers architecting their systems.
Status	Approved Draft

Technical Committee Management Area

Upcoming specifications provide and ideal focal point for new members to make contributions

Warning!
This is preliminary -
It all could change
tomorrow!



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