



Carrier Ethernet Metro Ethernet Architectures

Eli Baruch
Senior Director, Product Management
ARRIS

Agenda

- **What's all the fuss about?**
- **Ethernet Services**
- **Basic Elements - UNI & NID**
- **Carrier Ethernet in MSO space**
- **Q&A**

What's all the fuss about?

Benefits of Ethernet

- Unprecedented Scalability
- Unprecedented Reach
- Location and Technology Agnostic
- Enabled, Expedited New Applications
- Ideal for Converged Networks
- High Bandwidth, Increments on Demand
- Independently Certified Performance
- Control
- Reliability
- Predictability
- Risk Reduction
- Simple Implementation
- etc.
- **Cost Reduction, Revenue Acceleration**

Ethernet directions:

UP



Down



Thru



Over



Across



So what is this Carrier Ethernet thing?

Is it a service, a network, or a technology?

Is it the same everywhere?

Is it only Ethernet?

What does it look like for me?

How can it help my organization?

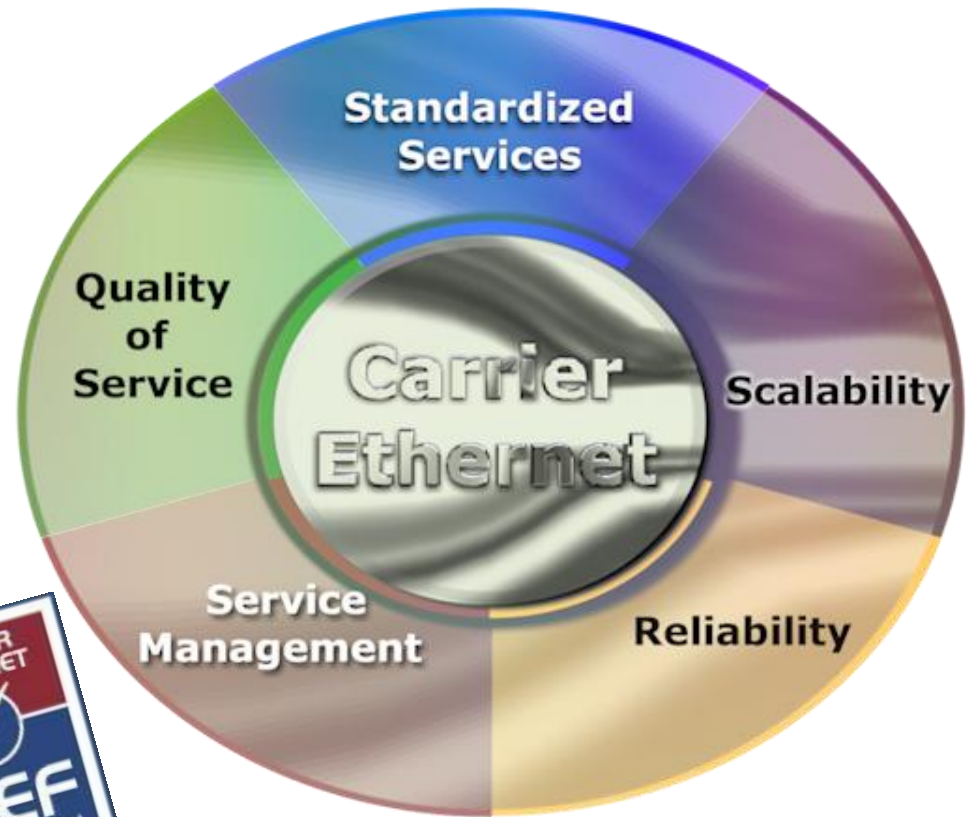
How is it going to save time, money, make life easier?

How can it enable new applications?

I'll try to answer all these questions

Carrier Ethernet - Driven by the Metro Ethernet Forum

Carrier Ethernet is
A ubiquitous, standardized,
carrier-class
SERVICE
Defined by **five attributes**
That distinguish it
From familiar
LAN based
Ethernet



MEF Specifications for
E-Line, ELAN, CES, ENNI, EMS, etc.



MEF Certifications



Carrier Ethernet

Carrier Ethernet Defined

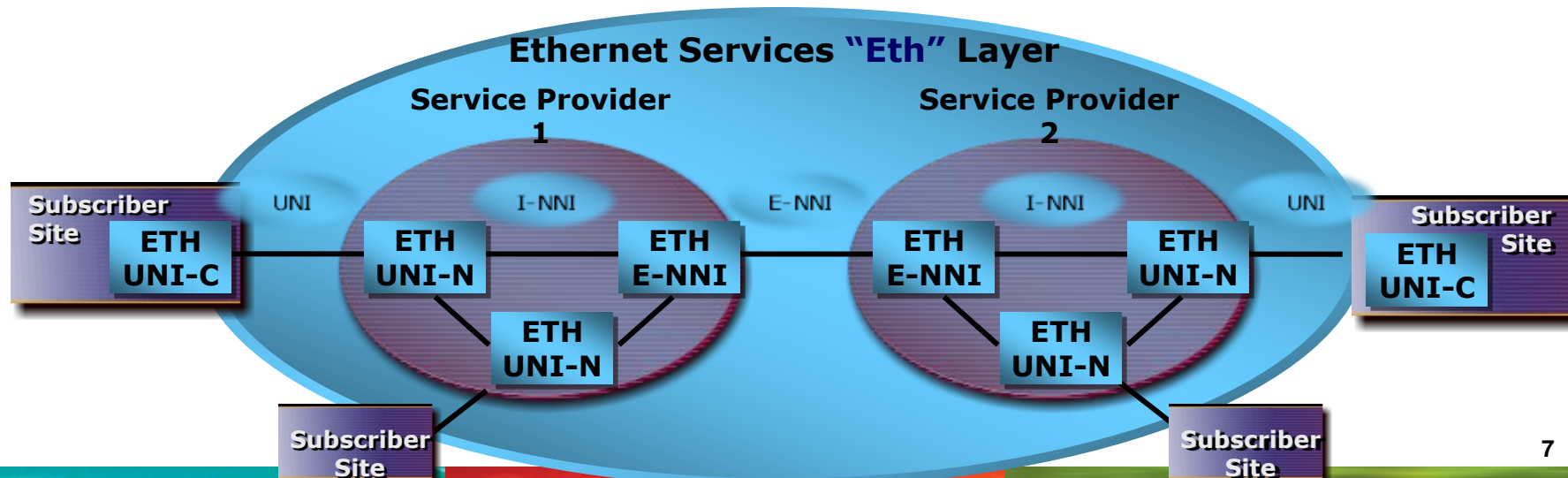
Definition	Carrier Ethernet is a ubiquitous, standardized, carrier-class SERVICE defined by five attributes that distinguish it from familiar LAN based Ethernet
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The 5 Attributes of Carrier Ethernet

Standardized Services	E-Line, E-LAN provide transparent, private line, virtual private line and LAN services, locally & globally
	Spans access, metro, global, wired and wireless topologies and physical service provider infrastructures
Scalability	Supports unlimited users engaged in business, information, communications and entertainment applications
	Scalability of bandwidth from 1Mbps to 10Gbps and beyond, in granular increments
Reliability	The ability for the network to detect & recover from incidents without impacting users, with recovery times sub 50ms
Quality of Service	A network managed to carrier-class standards, including extensive OAM, service provisioning and assurance capabilities
Service Management	Service level agreements with a wide choice of bandwidth and quality of service (QoS) options
	Engineered to support the quality characteristics of converged voice, video & data networks

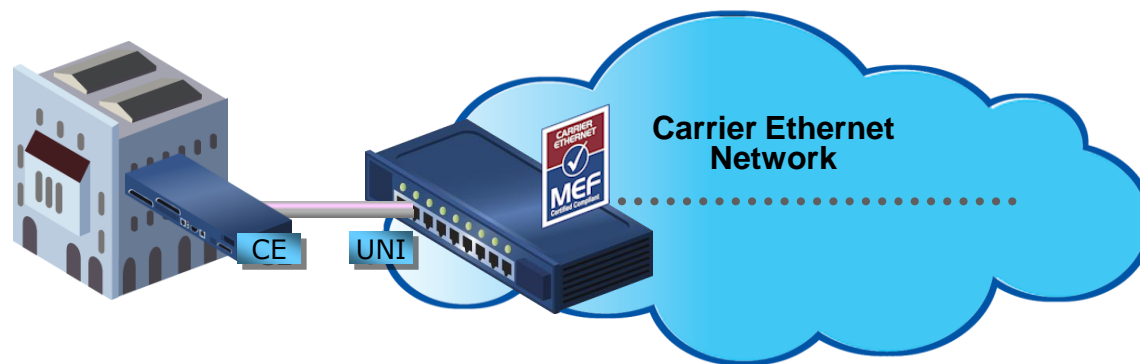
Architecture Building Blocks

- Metro Ethernet Network (MEN) Reference Model
 - User Network Interface (UNI)
 - Network to Network Interfaces (NNIs)
 - Provides common terminology for all MEF technical documents
- User Network Interface (UNI)
 - The demarc for customer or subscriber attachment
- Ethernet Interworking NNI (EI-NNI)
 - Interface between autonomous systems



The User Network Interface (UNI)

- The UNI is the physical interface or port that is the demarcation between the customer and the service provider/Carrier/MSO
- The UNI is always provided by the Service Provider
- The UNI in a Carrier Ethernet Network is a physical Ethernet Interface at operating speeds 10Mbps, 100Mbps, 1Gbps or 10Gbps
- The UNI is often co-located with the CE at the customer's premises

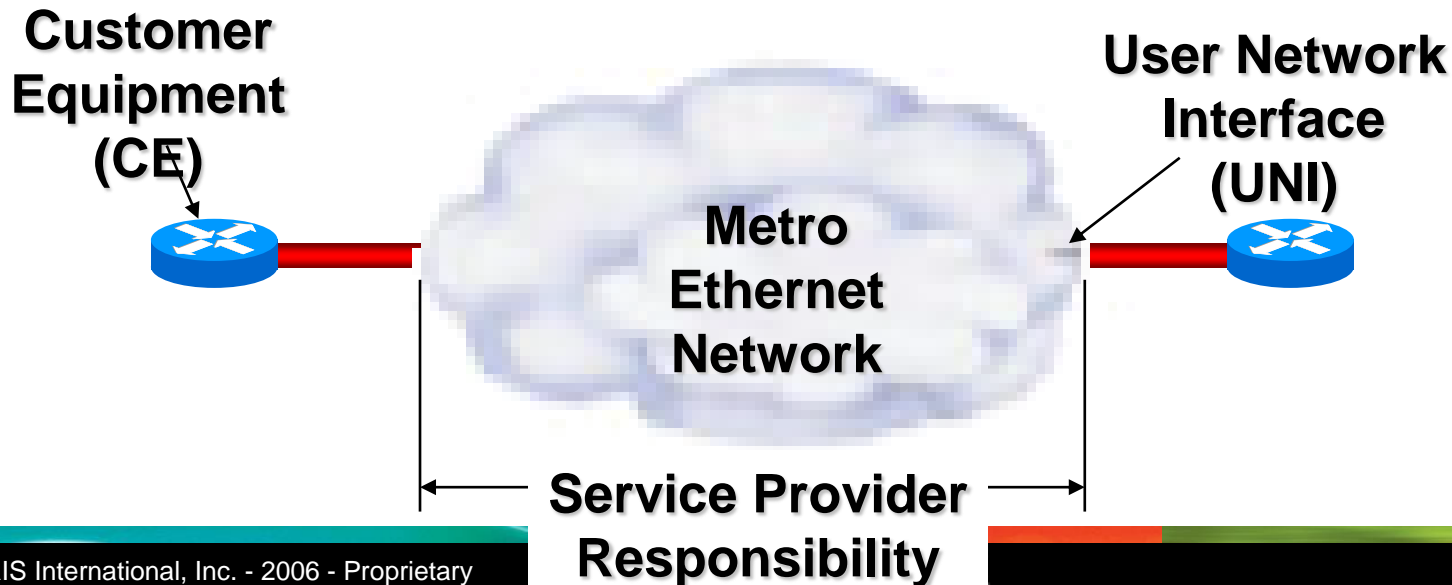


Ethernet Virtual Connection (EVC)

- Service container
- Connects two or more subscriber sites (UNI's)
- An association of two or more UNIs
- Prevents data transfer between sites that are not part of the same EVC
- Three types of EVC
 - Point-to-Point
 - Multipoint-to-Multipoint
 - Rooted Multipoint
- Can be multiplexed on the same UNI
- Defined in MEF 10.1 technical specification

Ethernet Services Model

- Services described as seen by CE, UNI to UNI
- Ethernet Definitions
 - Ethernet Line Services (ELINE)
 - Ethernet LAN Services (ELAN)
 - Circuit Emulation Service (CES)
- Bandwidth Profiles Parameters
 - Committed Information Rate (CIR)
 - Excess Information Rate (EIR)



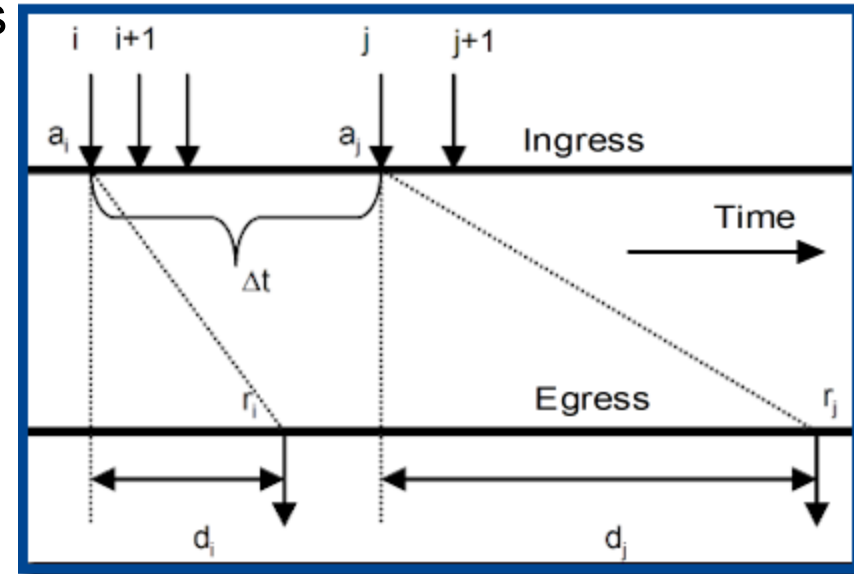
Service Attributes and Parameters

■ EVC Service Attributes

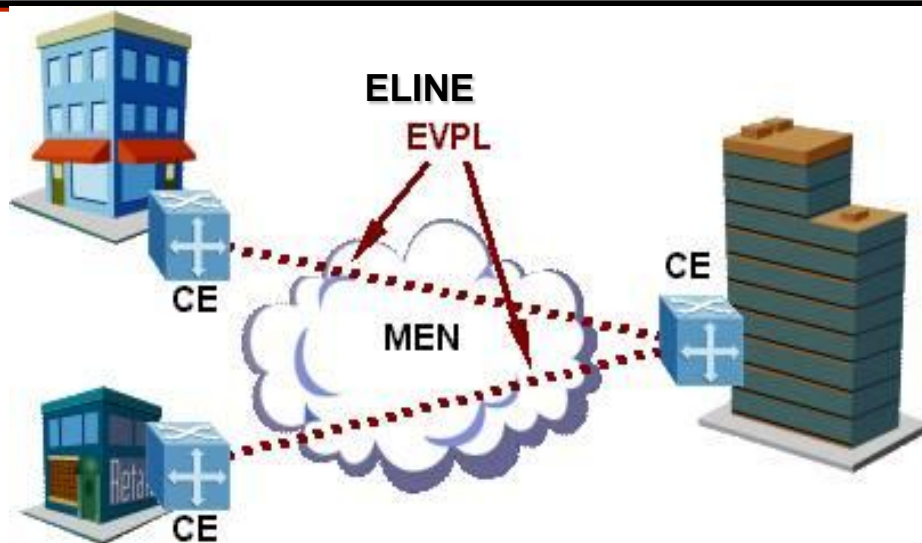
- Details regarding the EVC including
- QoS assignment and tagging options
- Bandwidth Profiles
- Latency
- Frame Loss
- Frame Delay Variation

■ Bandwidth Profiles

- Committed Information Rate
- Excess Information Rate
- Rate Enforcement - shaping and policing
- Burst Size (window)

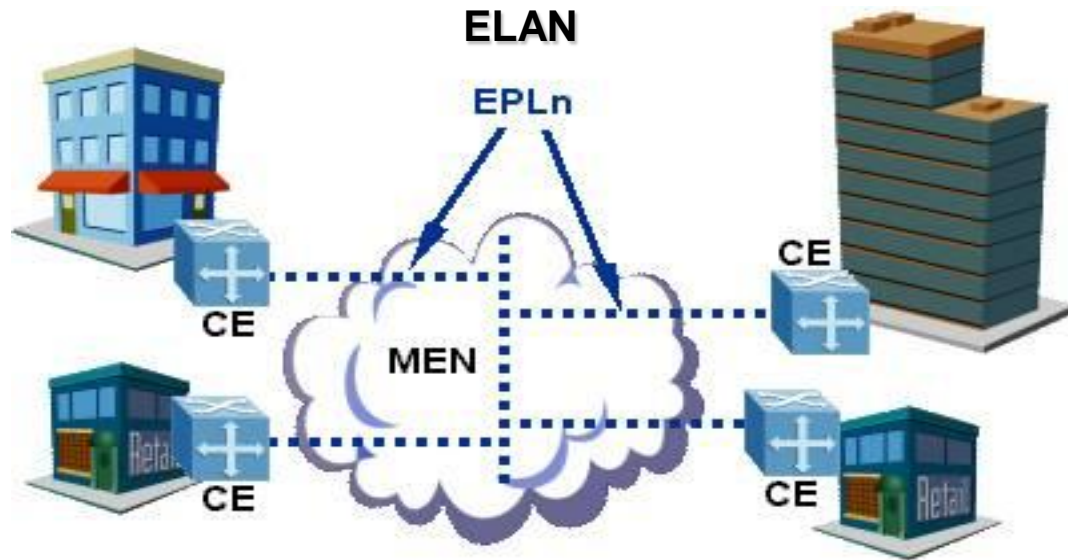


Ethernet Line Service (ELINE)



- ELINE service is Point-to-Point
- May replace TDM private line or build a Frame Relay/ATM like service
- EPL
 - Dedicated UNIs for Point-to-Point connections
 - Single Ethernet Virtual Connection (EVC) per UNI
 - The most popular Ethernet service due to its simplicity
- EVPL
 - Supports Service Multiplexed UNI (i.e. multiple EVCs per UNI)
 - Allows single physical connection (UNI) to customer premise equipment for multiple virtual connections

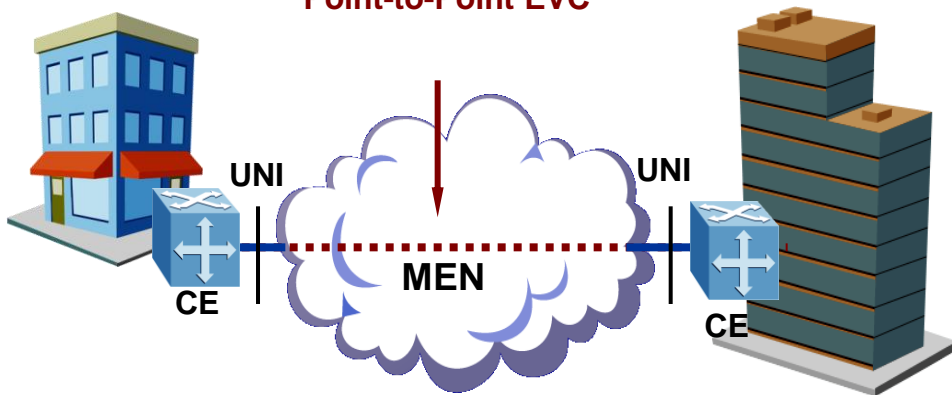
Ethernet LAN Service (ELAN)



- Service is Multipoint-to-Multipoint fully connected
 - Supports dedicated or service-multiplexed UNIs
 - Supports transparent LAN services and multipoint Layer 2 VPNs

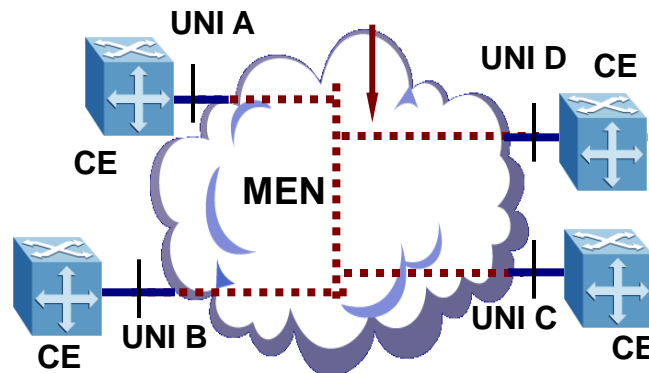
Four Basic Ethernet Service

Point-to-Point EVC

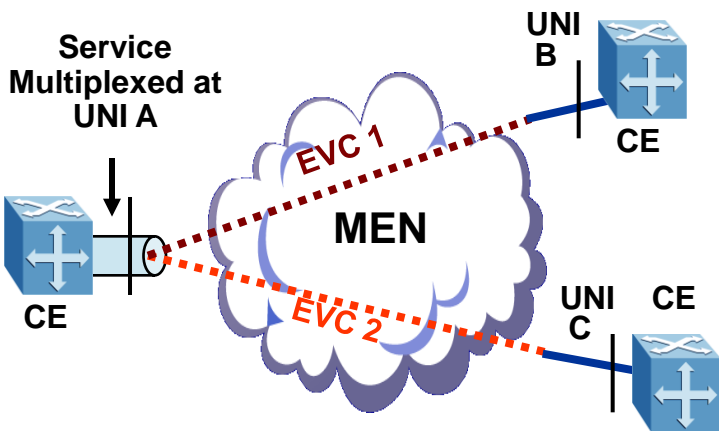


Ethernet Privet Line (EPL)

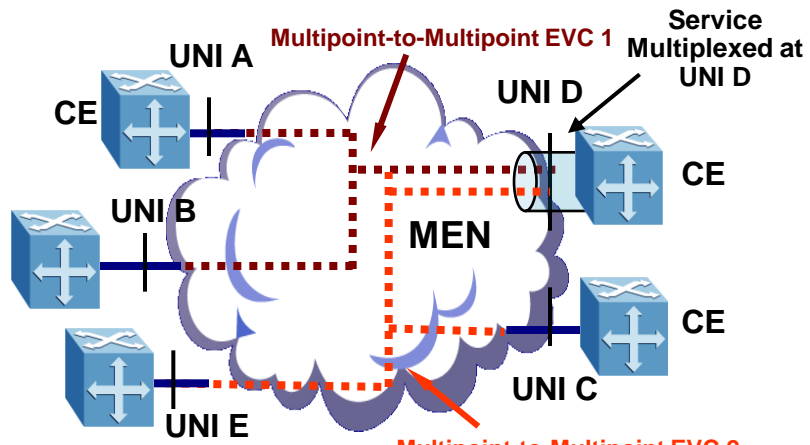
Multipoint-to-Multipoint EVC



Ethernet LAN Service (E-LAN)



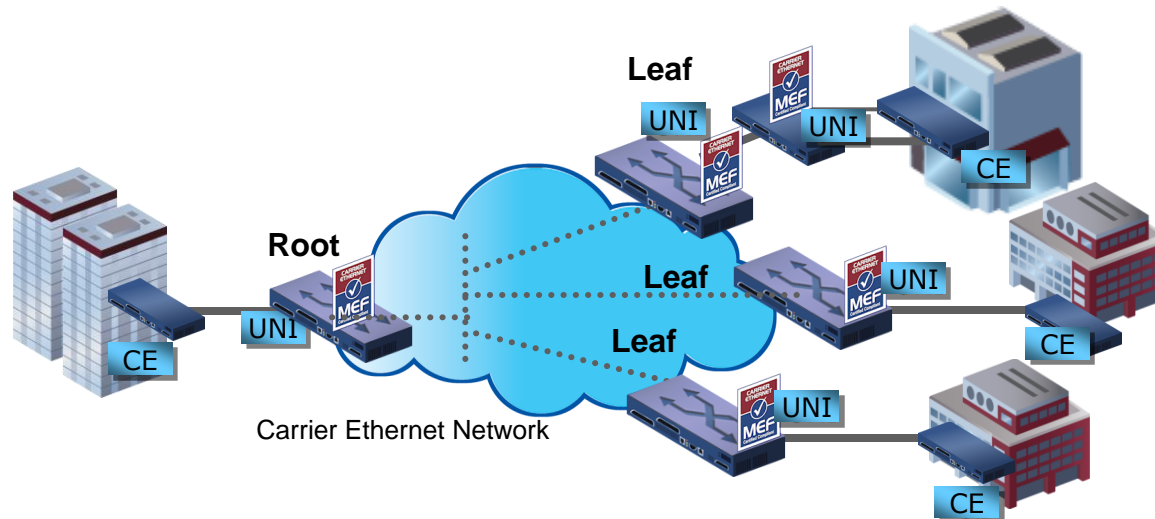
Ethernet Virtual Privet Line (EVPL)



Ethernet LAN Service (E-LAN)

Services Using E-Tree Service Type

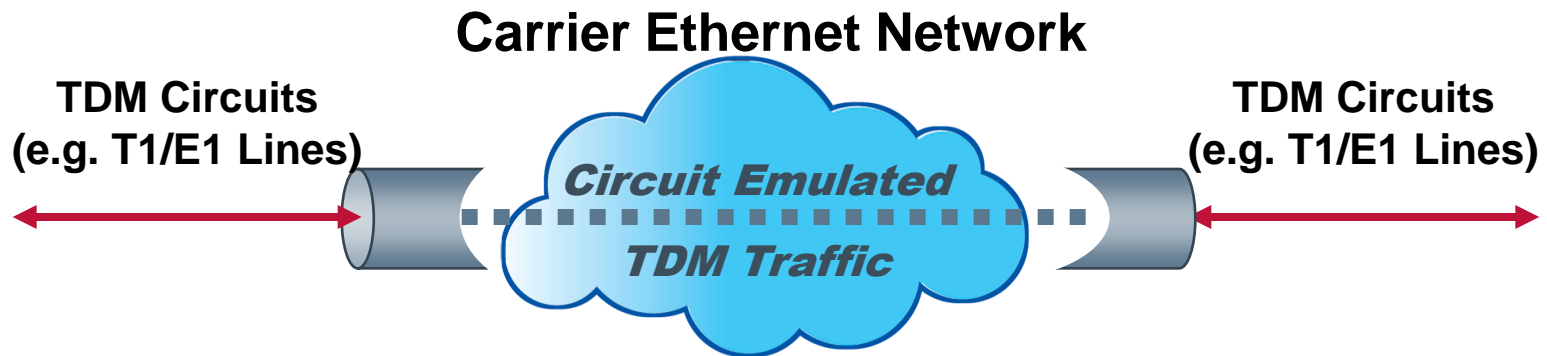
- Ethernet Private Tree (EP-Tree*) and Ethernet Virtual Private Tree (EVP-Tree) Services
 - Provides traffic separation between users with traffic from one “Leaf” being allowed to arrive at one of more “Roots” but never being transmitted to other “Leaves”
 - Targeted at multi-host and franchised applications where user traffic must be kept invisible to other users



* Referenced in MEF 10.1 as Rooted-Multipoint EVC

Circuit Emulation Services over Carrier Ethernet

- Enables TDM Services to be transported across Carrier Ethernet network, re-creating the TDM circuit at the far end
 - Runs on a standard Ethernet Line Service (E-Line)
 - T1 replacement for businesses
 - Enables T1 alongside Ethernet for Cell BH

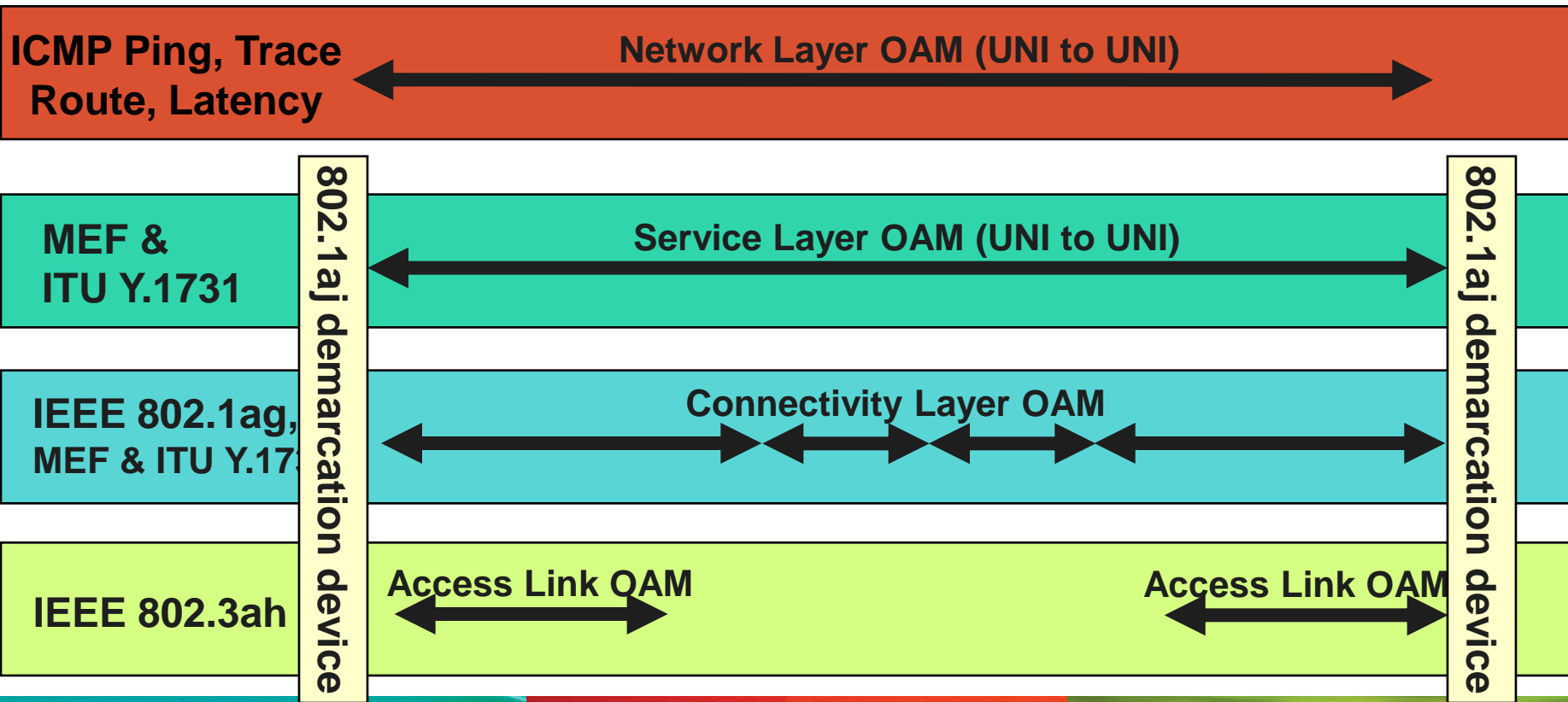
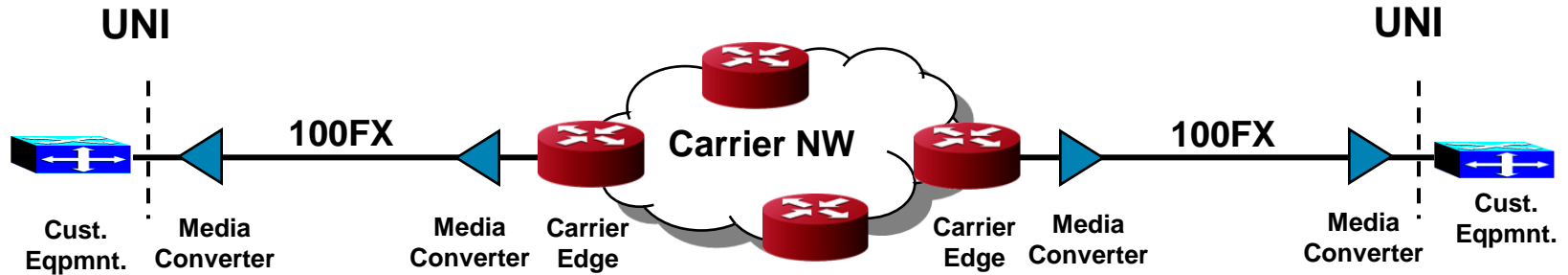


The Standardization of Services: Approved MEF Specifications

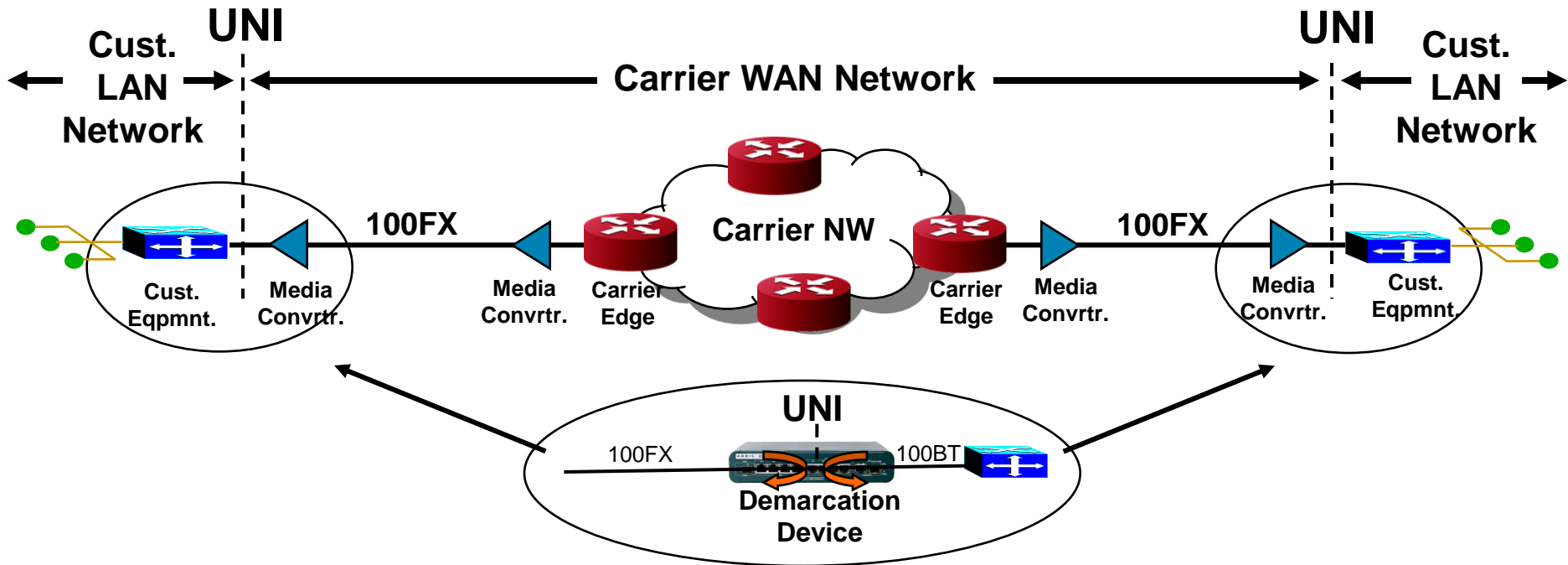
- **MEF 2** Requirements and Framework for Ethernet Service Protection
- **MEF 3** Circuit Emulation Service Definitions, Framework and Requirements in Metro Ethernet Networks
- **MEF 4** Metro Ethernet Network Architecture Framework Part 1: Generic Framework
- **MEF 6** Metro Ethernet Services Definitions 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.

Ethernet OAM Standards Activities



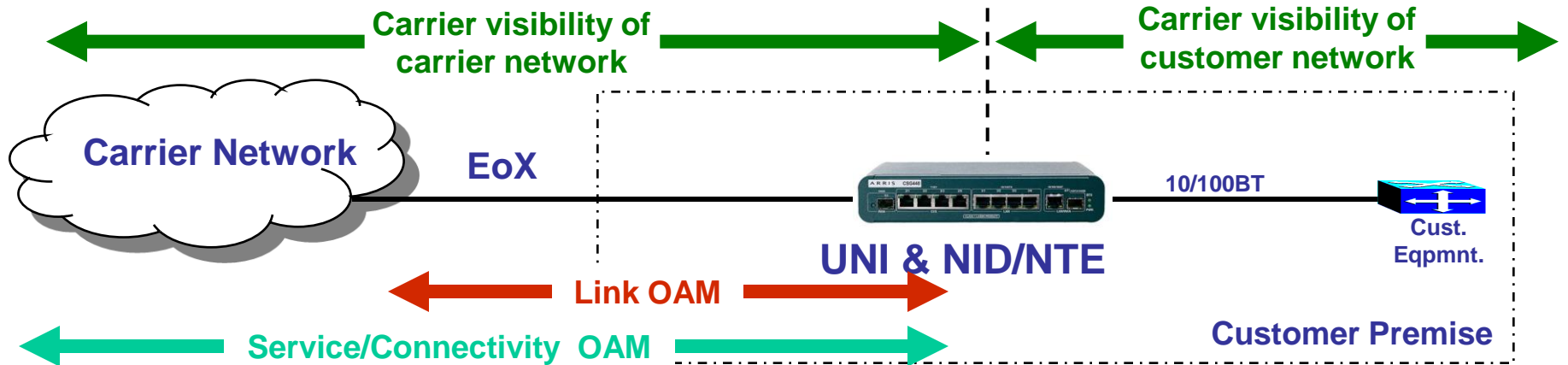
What is Ethernet Demarcation?



Ethernet Demarcation

- Necessary at carrier to customer interface (UNI)
- Provides separation between carrier WAN and enterprise LAN
- Enables testing and monitoring of both LAN and WAN

Network Interface Device (NID or NTE)

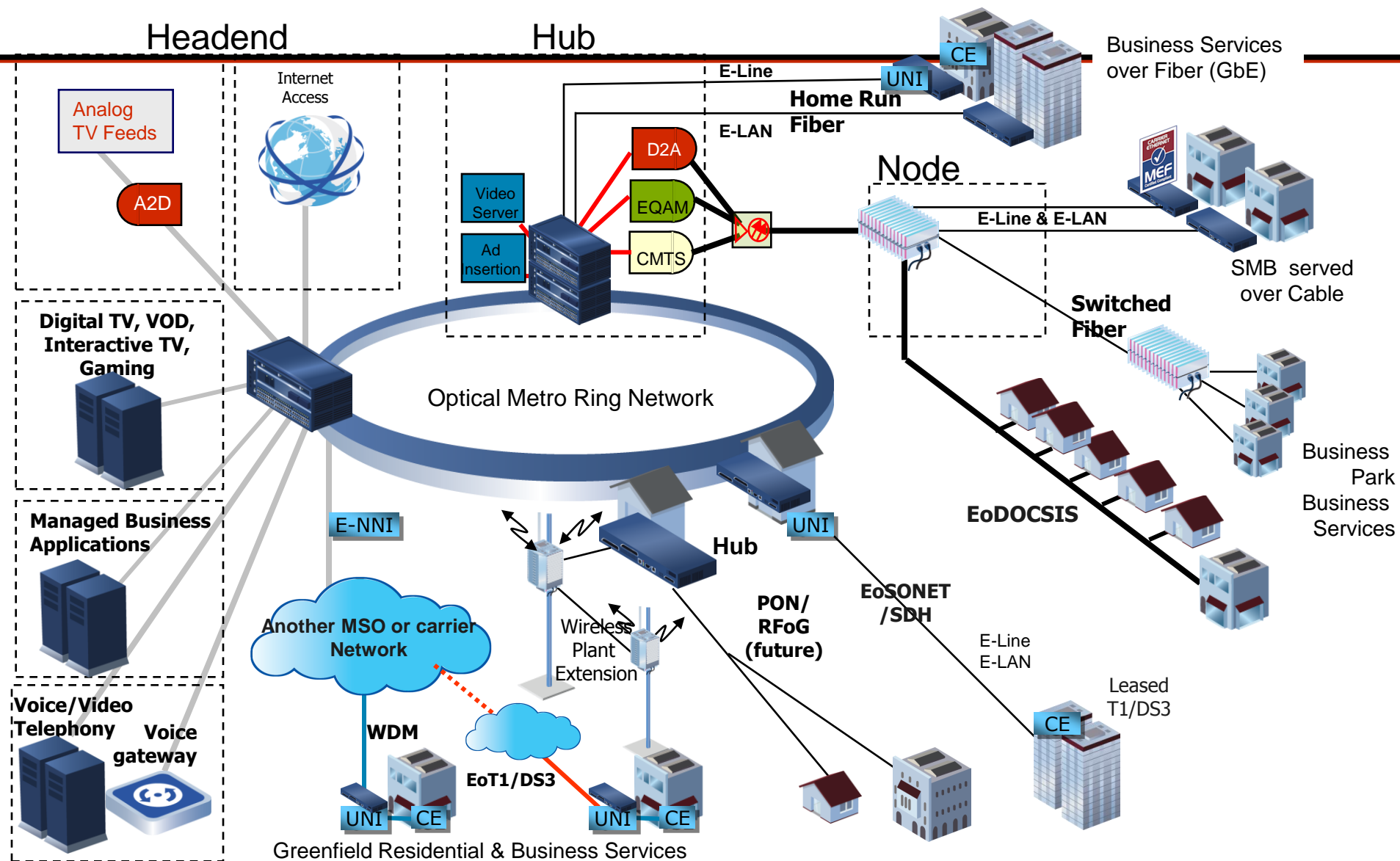


- NID or NTE required at customer handoff for OAM
 - Analogous to smartjack, CSU/DSU or NTE for frame relay
- Link OAM (802.3ah) is necessary but not sufficient
 - Performance monitoring and threshold crossing alarms
 - Remote failure indication - Dying gasp, link fault & critical event
 - Remote loopback (Port)
- Services/Connectivity OAM (802.1ag, ITU, MEF, etc.)
 - SLA monitoring
 - Continuity verification
 - Service level loopback
 - AIS/RDI or fault propagation
 - Test head to generate test suites (RFC-2544)
 - Cable integrity test for customer premise

What does it look like for me?

- Simplified Core network
- Business Ethernet services
- Cellular Backhaul
- Wireless Mesh
- IP Video distribution
- DOCSIS 3.0
- RFoG

Carrier Ethernet Architecture for Cable Operators



Enabling Ubiquitous Ethernet Services

- MEF compliant portfolio
- HFC and Fiber!
 - MEF-certified fiber-delivered Ethernet
 - Ethernet over DOCSIS
- Retail and Carrier
- Standardize services across access technologies

Provides high value alternative to ILEC frame relay and T1 data transport

Business Ethernet in MSO - Today

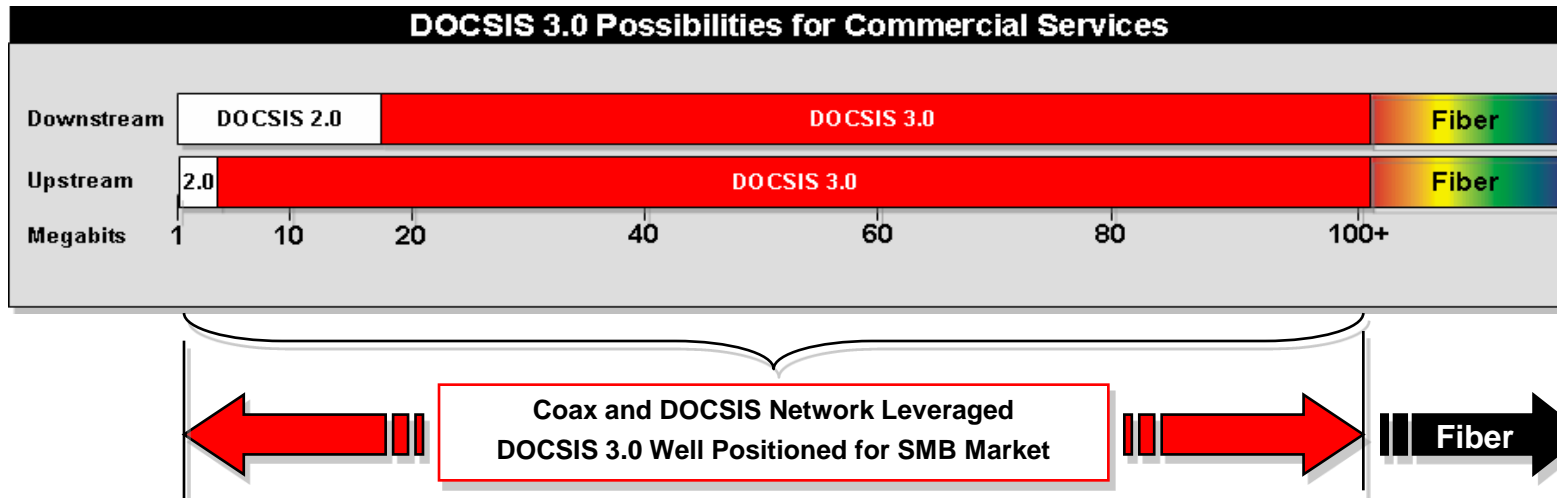
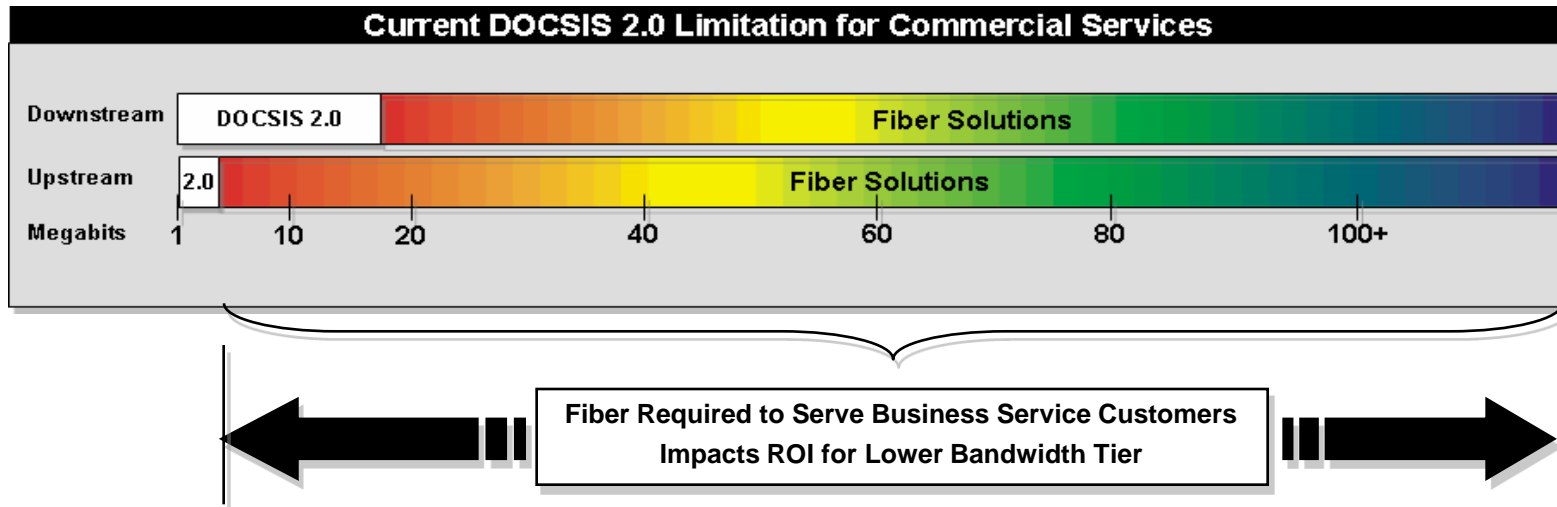
- DOCSIS 2.0
 - Sub 10Mbps Symmetrical Data
 - 20-30Mbps Asymmetrical Data
 - MEF services over DOCSIS L2VPN

DOCSIS 2.0 has limitations for Business Services -
Speed and product services supported

Limitation force deployment of optical solutions

- Fiber based Ethernet Gateway
 - Ultra High Speed Data 100Mbps + Symmetrical
 - Transparent LAN Services
 - Use existing CWDM fiber
 - Demarcation point between Operator and Customer

DOCSIS 3.0 Features Reduces Fiber Requirements for Business Services



Ethernet Services over DOCSIS

- CableLabs TEI (T1/E1) Specification vs. MEF specs

<http://www.cablelabs.com/specifications/CM-SP-TEI-I04-080215.pdf>

- Compatible with MEF Circuit Emulation Service specs
- Optional distribution of timing from CMTS to CMs
- Special treatment for TE-CMs (vs. CMs)
- Segregation of T1 traffic on an US
- Preferential ranging opportunities
- UGS on US, High QoS on DS
- Enforces CIR, Delay and Delay Variation

Ethernet Services over DOCSIS

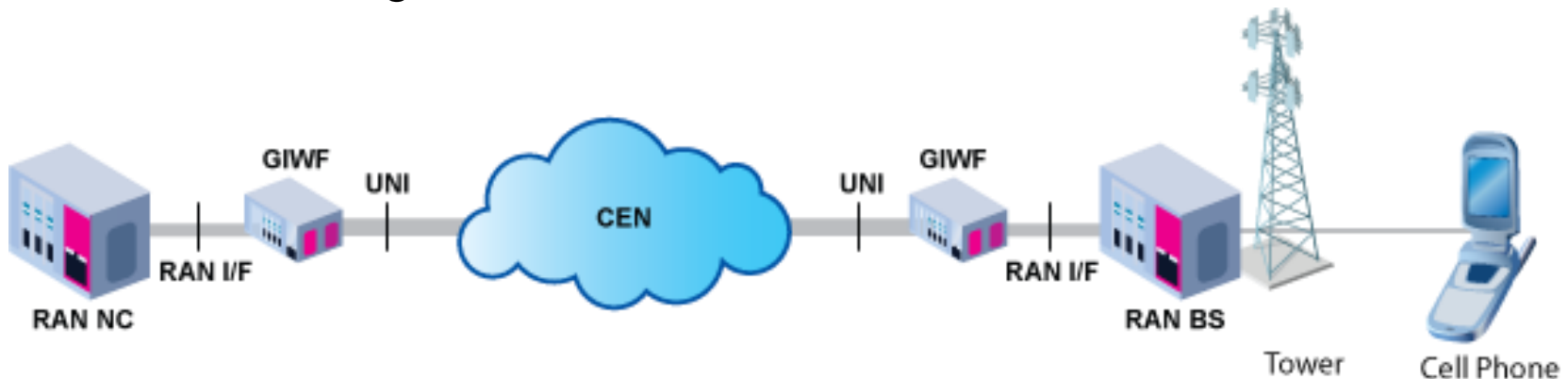
- CableLabs L2VPN Specification vs. MEF specs
<http://www.cablelabs.com/specifications/CM-SP-L2VPN-I07-080215.pdf>
 - The L2VPN feature allows cable operators to offer a Layer 2 Transparent LAN Service to commercial enterprises over DOCSIS.
 - May allow ELINE services as defined by MEF
 - Most L2VPN spec requirements are on the CMTS
 - Requires modifications in CM in order to meet MEF-9
 - Different CMTSs must be provisioned differently if they are to support L2VPN

Ethernet Services over DOCSIS

- Use of L2TPv3 in the creation of Pseudowires to transport Ethernet frames over an IP network.
- Enable MEF-9 services over all existing CMTS regardless of L2VPN.
- Transparent to all CMTS

Mobile Cellular Backhaul

- Cell sites deployment follow the population
 - Telco fiber follows business centers
 - MSO fiber nodes are close to majority of urban towers
- All cell sites rely on T1/E1 for backhaul
 - There isn't enough copper in the ground to scale
 - CES enable emulation of T1 over Ethernet
- As RAN move from TDM or ATM to IP - Ethernet is the Backhaul network of choice
 - MSO fiber allow CES and Ethernet required by cellular operators in order to grow



Q&A



Thank You

Eli Baruch
eli.baruch@arrisi.com