

MEF

Carrier Ethernet Interconnect

MEF Reference Presentation

November 2011

MEF Reference Presentations

- **Intention**

- These MEF reference presentations are intended to give general overviews of the MEF work and have been approved by the MEF Marketing Committee
- Further details on the topic are to be found in related specifications, technical overviews, white papers in the MEF public site Information Center:
<http://metroethernetforum.org/InformationCenter>

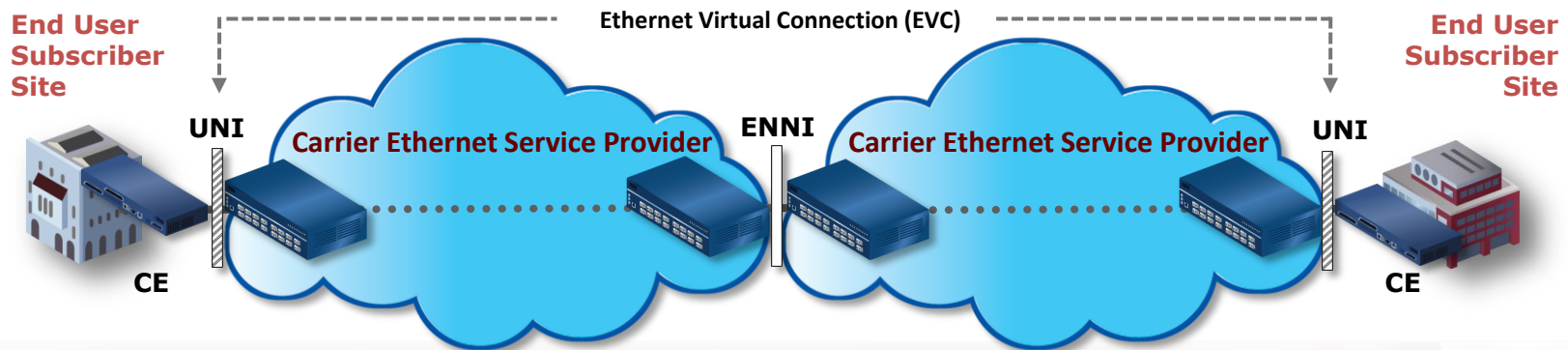
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Topics

- Definition and Benefits
- Carrier Ethernet Services
- Carrier Ethernet Interconnect Review
- MEF Carrier Ethernet Interconnect Program
- Carrier Ethernet Expansion Continues



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Carrier Ethernet Interconnect
Definition and Benefits

Why Carrier Ethernet Interconnect?

- **Fulfills the goal of providing business with a seamless, local and worldwide business network that is available everywhere ...**
 - At lowest cost
 - Is highly granular, highest quality, highest performance delivery of today's business applications
 - Is highly dependable and manageable
 - Is a platform for new differentiated business-class services
 - *Fulfills MEF mission*

Interconnect Buyer, Seller / Wholesale Benefits

- **Buyer Benefits**

- Reduce **operating costs**
- Reduce **capital costs**
- Increase **footprint** and reach larger and/or new markets to generate new revenue
- Reduce **time to market** and improve **financial benefits**
- Increase **business efficiencies**



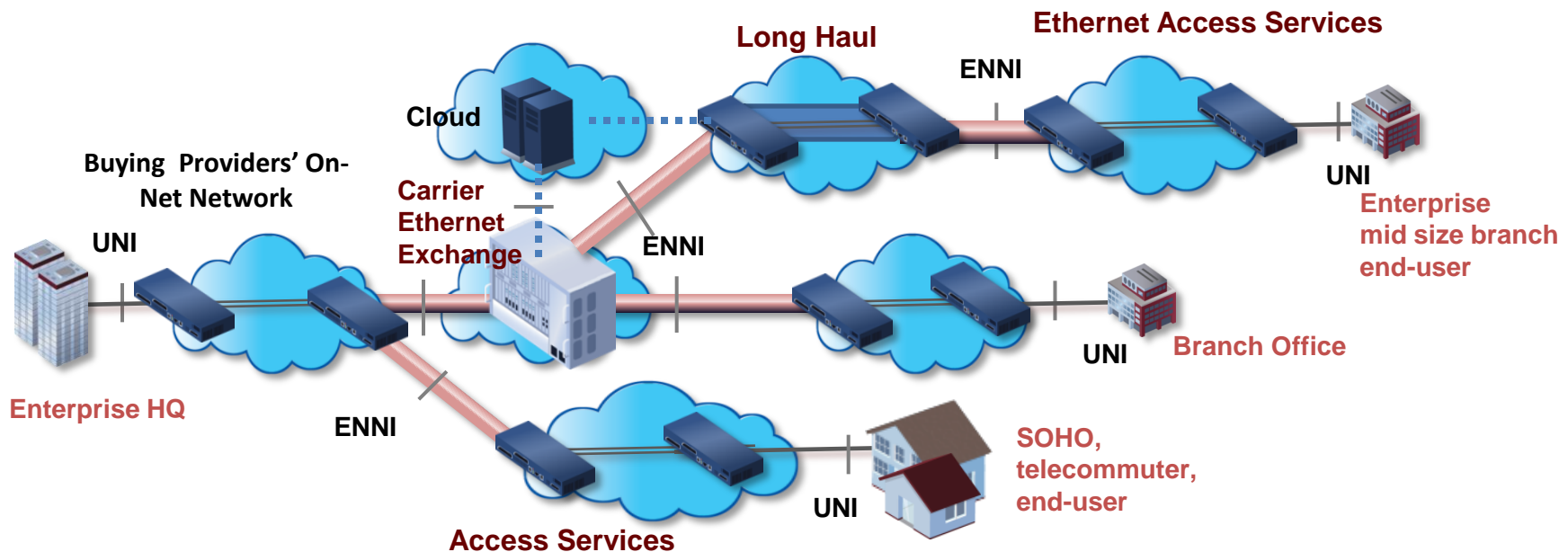
- **Seller / Wholesale Benefits**

- Leverage **existing footprint to generate new business**
- Reduce **capital and operating costs**
- Reduce **time to market** and improve **financial benefits**
- Increase **business efficiencies**



Carrier Ethernet Interconnect: Hot Topic in 2011

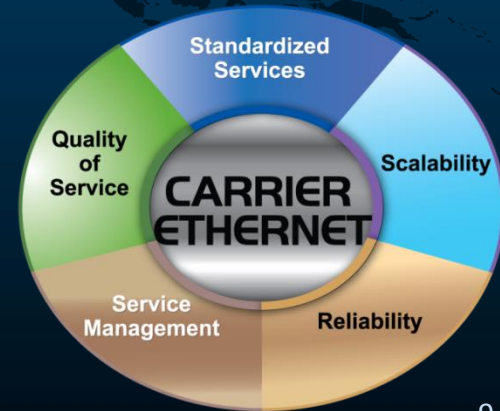
- **Carrier Ethernet Interconnect, Exchanges: big impact in 2011**
 - Development and delivery of all-new new definitions to expand business between providers has had big impact in the market
 - Carrier Ethernet Exchanges that support all 5 Carrier Ethernet attributes are key to profitable scalability



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Carrier Ethernet Interconnect Ethernet Services

Carrier Ethernet Interconnect exists to connect standardized Carrier Ethernet services locally, regionally and globally



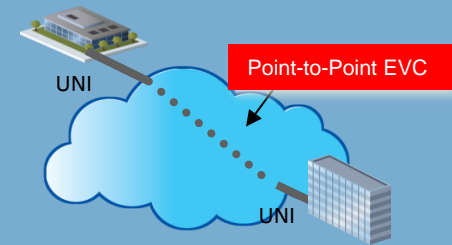
MEF Carrier Ethernet Service Types

Features

- Low latency
- Predictable QoS
- 1 mbps to 10 gbps
- Standardized
- Reliable
- Manageable
- Optimal Line Usage
- Low cost

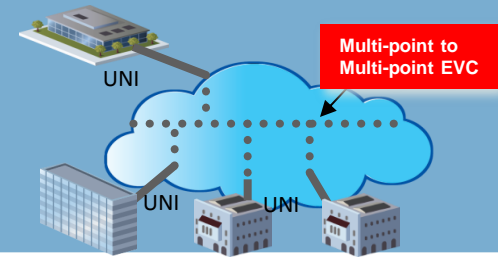
E-Line Service Type for

- Virtual Private Lines (EVPL)
- Ethernet Private Lines (EPL)
- Ethernet Internet Access



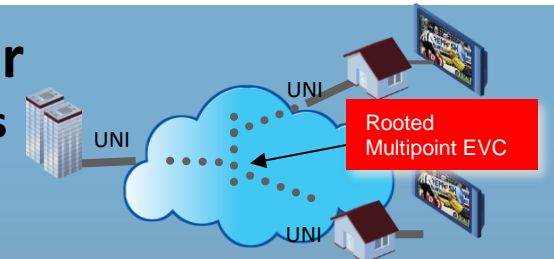
E-LAN Service Type for

- Multipoint L2 VPNs
- Transparent LAN Service
- Multicast networks



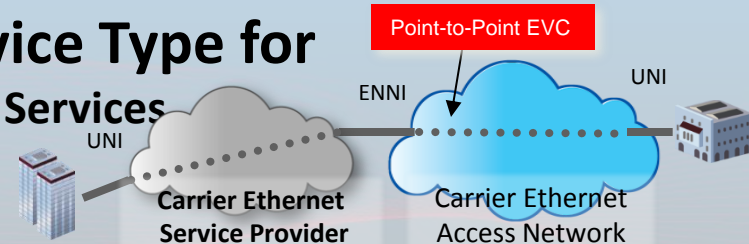
E-Tree Service Type for

- Rooted multi-point L2 VPNs
- Broadcast networks
- Telemetry networks



E- Access* Service Type for

- Wholesale Access Services
- Access EPL
- Access EVPL



Impact of Carrier Ethernet Services on Enterprises

- Enables high-bandwidth, low-latency, applications
- Key cost and service value benefits
- Top market sectors

Applications

Internet Access

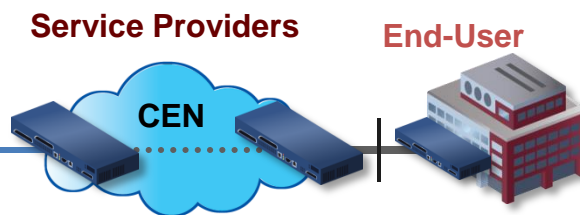
Cloud, DR, SAN
Virtualization,

Media Apps

Digital
Imaging

Sectors:

Finance, Retail,
Medical, EDU, Gov



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Carrier Ethernet Interconnect
Ethernet Access Services

A Preview of New Services

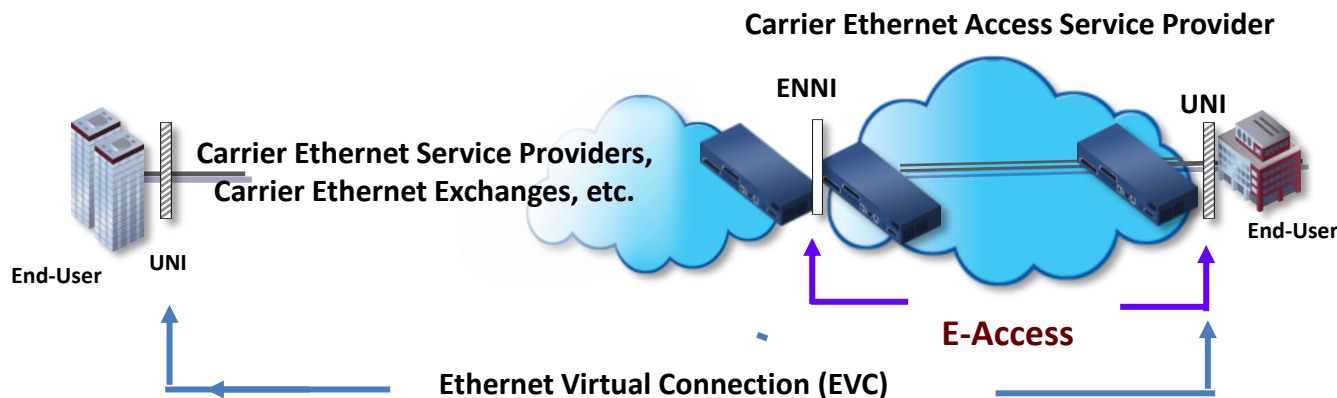
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New Wholesale Access Services

New MEF Ethernet Access Services

- Establishes industry standard for **buying, selling, deploying** Ethernet Access Services
- Enables new providers to much more easily capitalize on wholesale Ethernet business opportunities
- Lowers costs and reduces time to market
- Key for local, regional and global adoption of Carrier Ethernet



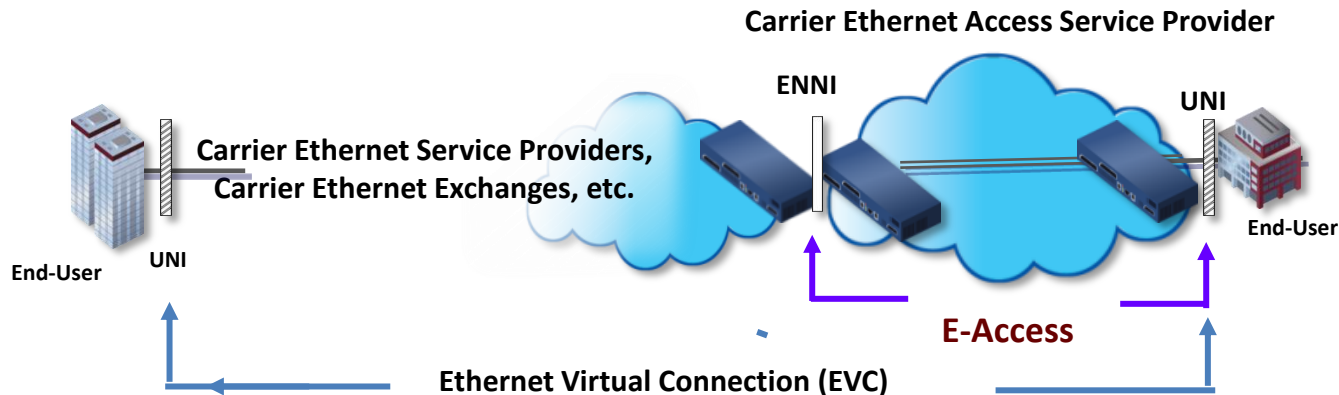
MEF Ethernet Access Services

- New **E-Access** Service Type is defined to normalize and accelerate provisioning
- New definitions for **UNI-ENNI** Carrier Ethernet Access Services
- Two most popular Services supported in first phase
- New MEF Certification follows new E-Access specification

Service Type	Port-Based Service (at the UNI)	VLAN-Aware Service (at the UNI)
E-Access	Access EPL Ethernet Private Line	Access EVPL Ethernet Virtual Private Line



2012



Strong Wholesale Ethernet Revenue Growth

Compound Annual Growth Rate (CAGR)

Excerpt 1: Wholesale Ethernet Revenues by Bandwidth Level

	2009	2010	2011	2012	2013	2014	CAGR
>1 Gbit/s	\$216.15M	\$281M	\$365.29M	\$480.36M	\$619.67M	\$796.27M	29.8%
Growth Rate		30%	30%	31.5%	29%	28.5%	
>100 Mbit/s-1 Gbit/s	\$280.5M	\$378.68M	\$515M	\$708.12M	\$1.02B	\$1.422B	38.4%
Growth Rate		35%	36%	37.5%	44%	39.5%	
>10 Mbit/s-100 Mbit/s	\$218.63M	\$349.8M	\$573.67M	\$869.11M	\$1.208B	\$1.564B	48.2%
Growth Rate		60%	64%	51.5%	39%	29.5%	
<10 Mbit/s	\$109.73M	\$162.03M	\$233M	\$329.45M	\$434.76M	\$532.89M	37.2%
Growth Rate		47.7%	43.8%	41.4%	32%	22.6%	

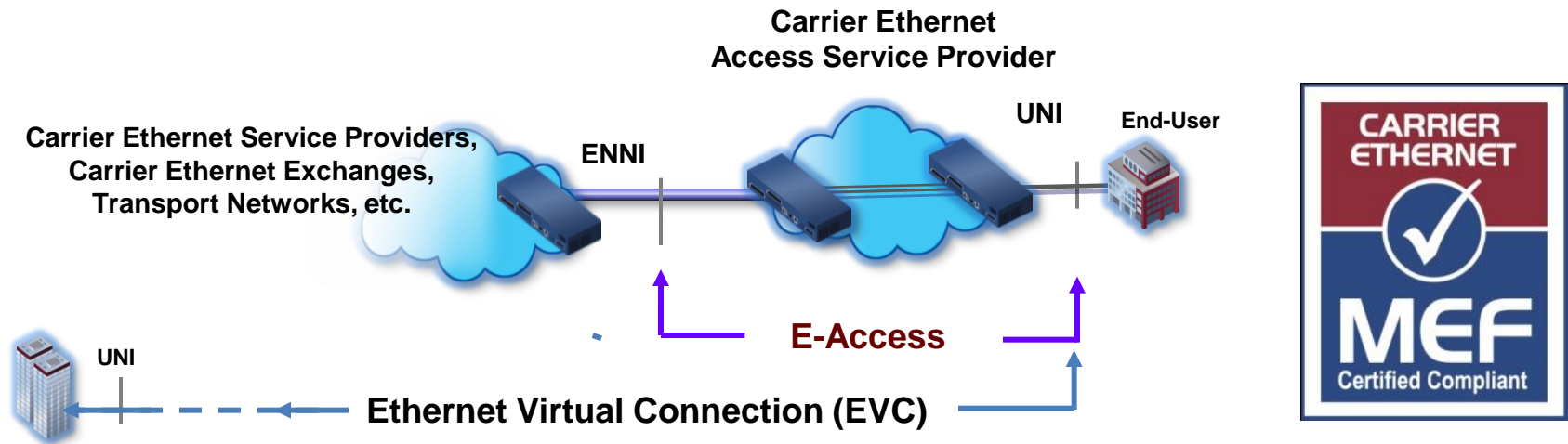
Source: Heavy Reading

MEF Wholesale Access Survey results

- 93% see themselves buying more wholesale access services
- 90% see themselves selling more wholesale access services

Ethernet Access Services – Certification

- **Enhances Existing Program:**
 - From MEF9,&14 (UNI-UNI), MEF 21(UNI) for Carrier Ethernet Interconnect
 - Certified services provide trusted baseline for market adoption
 - Requirement in many RFPs, Cost savings and accelerates deployment
 - 47 service providers and 77 equipment manufacturers MEF-certified
- **New Certification for Ethernet Access Services***
 - Access EPL, Access EVPL, Functionality and Performance
 - MEF 9 and 14 UNI-UNI certification recommended but not prerequisite



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E-Access Services Technical Overview

A dark blue world map is visible in the background, showing the outlines of continents and countries. The map is centered horizontally and vertically, with the text overlaid on it.

Ethernet Service Classification and Definitions for Ethernet Access Services (UNI to ENNI)

Service Type	Port-Based Service (at the UNI)	VLAN-Aware Service (at the UNI)
E-Access	Access Ethernet Private Line (Access EPL)	Access Ethernet Virtual Private Line (Access EVPL)

- **Ethernet Access Services classified into two categories** (just like EVC-based services):
 - **Port-based at the UNI endpoint**
 - Single OVC Instance per UNI (dedicated UNI endpoint)
 - **VLAN-aware at the UNI endpoint**
 - Multiple OVC Instances per UNI endpoint (multiplexed UNI endpoint)
- **ENNI supports multiplexed Access EPLs or Access EVPLs**

Access EPL = Port-based P2P Ethernet access service
Access EVPL = VLAN-aware P2P Ethernet access service

Ethernet Access Services FAQs

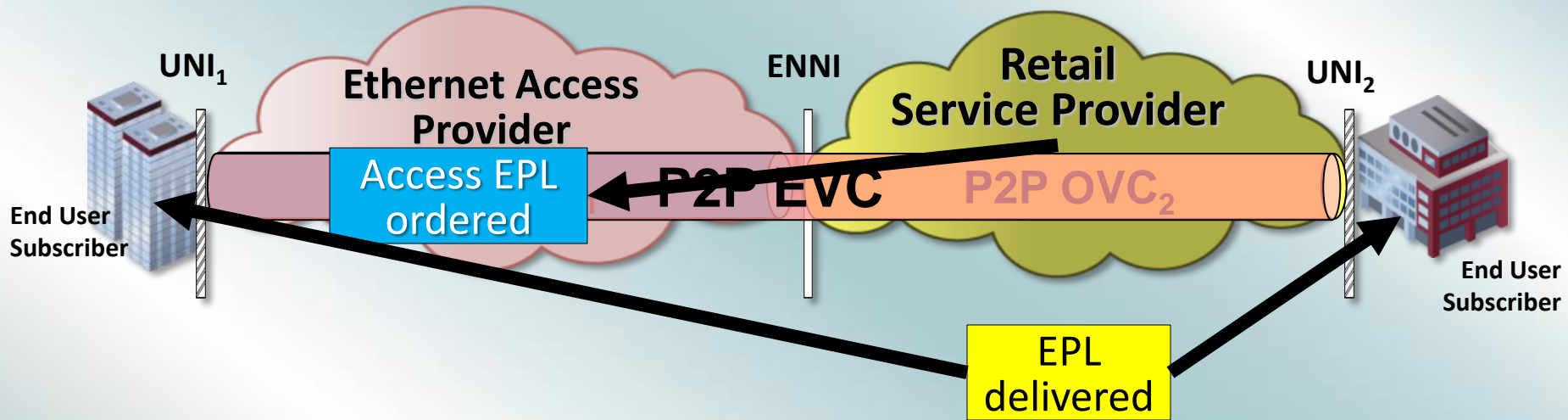
- **Ethernet Access Services are currently point-to-point. Does this limit retail services to E-Line ?**
 - No. Any E-Line (P2P) and E-LAN (MP2MP) services can be delivered using Ethernet Access Services.
- **Access EPL is defined with a single CoS. Does this limit a retail service to a single CoS?**
 - No. Retail provider can define a multi-CoS service.
 - Access EPL CoS must be selected to meet the multi-CoS requirements

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E-Access Use Cases & Examples

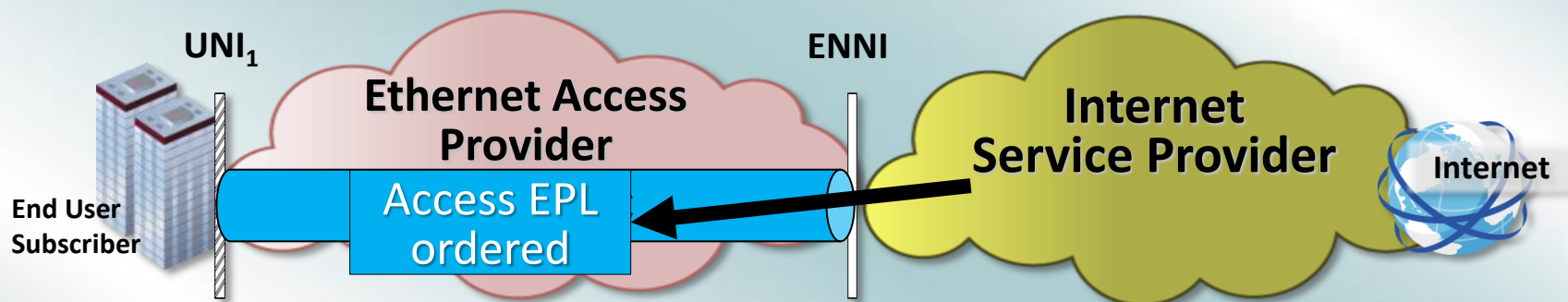
Animated slides

Ethernet Private Line (EPL) example that uses Access EPL



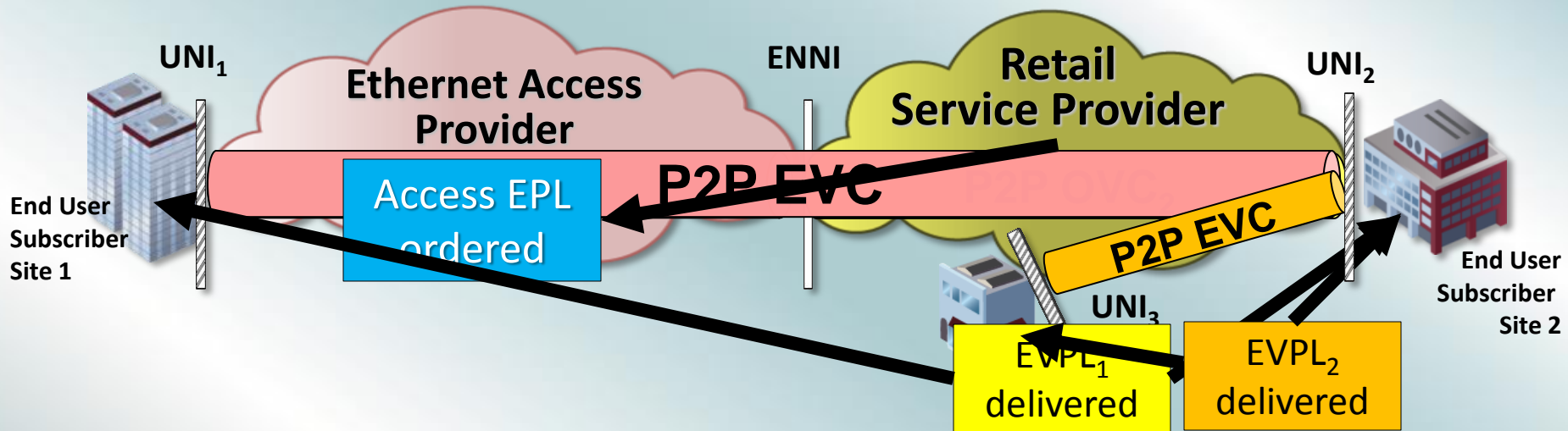
- **Retail Provider orders Access EPL from Ethernet Access Provider**
 - Access provider constructs OVC₁ between Subscriber UNI₁ and ENNI
- **Retail Service Provider constructs OVC**
 - OVC₂ between ENNI and Subscriber UNI₂
- **Retail Provider constructs EVC between subscriber locations**
- **Retail Service Provider delivers EPL to Subscriber**

Internet Access Service example using Access EPL



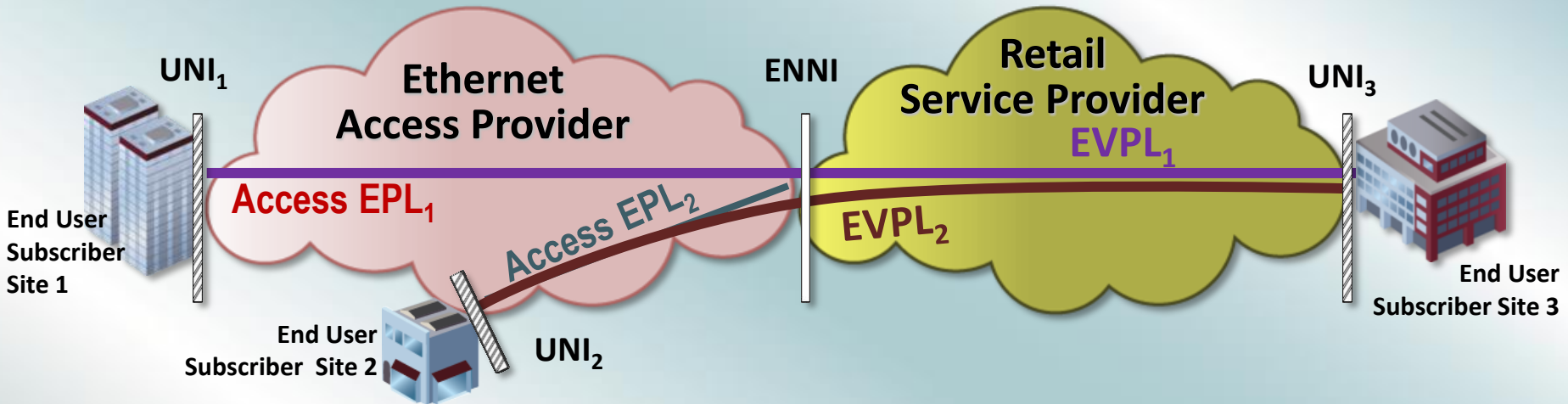
- **ISP orders Access EPL from Ethernet Access Provider**
 - Access provider constructs OVC between Subscriber UNI and ENNI
- **ISP delivers Internet Access Service**

EVPL Example using Access EPL



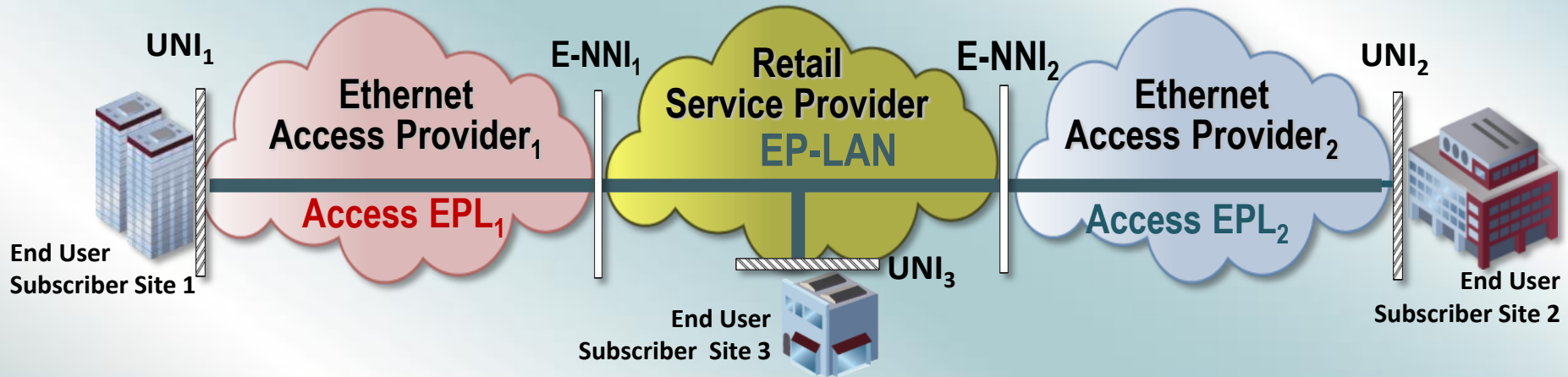
- **Retail Provider orders Access EPL from Ethernet Access Provider**
 - Access Provider constructs OVC between Subscriber UNI₁ and ENNI
- **Retail Service Provider constructs OVC₂ between:**
 - ENNI and Subscriber UNI₂
- **Retail Provider constructs P2P EVC between subscriber sites 1 & 2**
 - Retail Provider delivers EVPL₁ to Subscriber
- **Subscriber adds new site and wants to connect to site 2**
- **Retail Provider constructs P2P EVC between subscriber sites 2 & 3**
 - Retail Service Provider delivers EVPL₂ to Subscriber

EVPL Example using Two Access EPLs



- **Retail Provider buys Access EPL₁ from Ethernet Access Provider**
 - To connect Subscriber Site 1 UNI₁ to ENNI
- **Retail Provider buys Access EPL₂ from Ethernet Access Provider**
 - To connect Subscriber Site 2 UNI₂ to ENNI
- **Retail Service Provider sells EVPL₁ to End User Subscriber**
 - To connect Subscriber Sites 1 and 3
- **Retail Service Provider sells EVPL₂ to End User Subscriber**
 - To connect Subscriber Sites 2 and 3

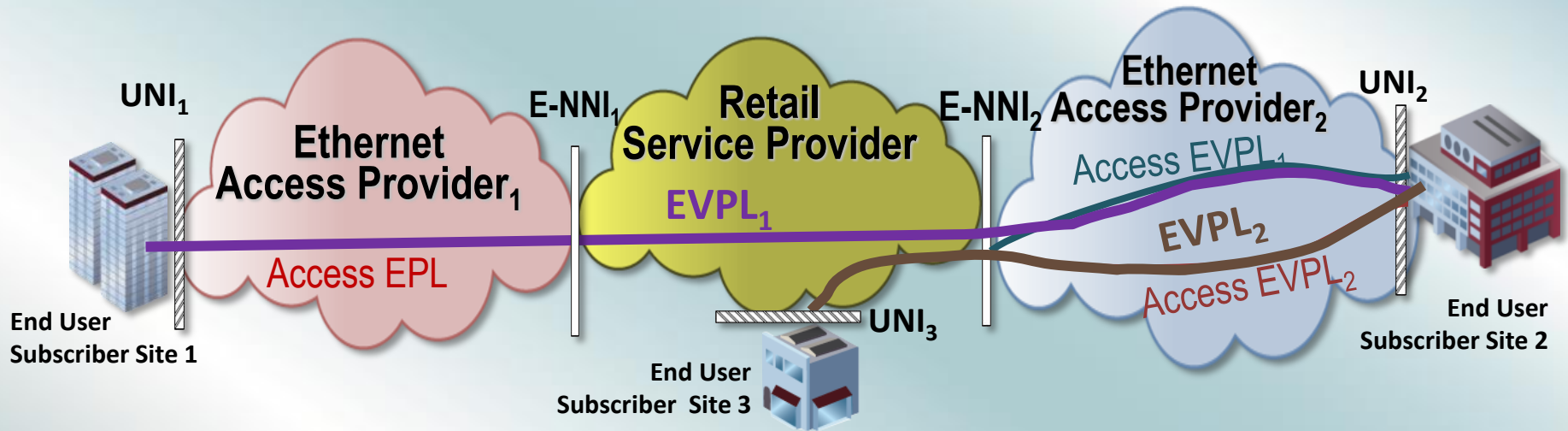
EP-LAN Service example using 2 Access EPL tail circuits



- **Retail Provider buys Access EPL₁ Ethernet Access Provider₁**
 - To connect Subscriber Site 1 UNI₁ to ENNI₁
- **Retail Provider buys Access EPL₂ from Ethernet Access Provider₂**
 - To connect Subscriber Site 2 UNI₂ to ENNI₂
- **Retail Service Provider sells EP-LAN to Subscriber**
 - To connect Subscriber Sites 1, 2 and 3

Two off-net sites reached using Access EPLs

EVPL Example using 1 Access EPL and 2 Access EVPLs



- **Retail Provider buys Access EPL from Ethernet Access Provider₁**
 - To connect Subscriber Site 1 UNI₁ to ENNI₁
- **Retail Provider buys Access EVPL₁ from Ethernet Access Provider₂**
 - To connect Subscriber Site 2 UNI₂ to ENNI₂
- **Retail Service Provider delivers EVPL₁ to Subscriber**
 - To connect Subscriber Sites 1 UNI₁ and 2 UNI₂
- **Retail Provider buys Access EVPL₂ from Ethernet Access Provider₂**
 - To connect Subscriber Site 2 UNI₂ to ENNI₂
 - 2 OVCs multiplexed at UNI₂
- **Retail Service Provider delivers EVPL₂ to Subscriber**
 - To connect Subscriber Site 2 UNI₂ and Site 3 UNI₃

Technical Summary

- **EVCs can be composed of 2 or more OVCs**
 - If there is no ENNI, there are no OVCs
- **New E-Access Ethernet Service Type**
 - Category of services which provide connectivity between one or more UNIs and one ENNI
 - Targeting Wholesale Ethernet Access Services
- **Access EPL (Access Ethernet Private Line)**
 - Port-based P2P Ethernet Access Service Definition
 - Supporting 1 access service per UNI
 - Consists of 1 UNI and 1 ENNI
- **Access EVPL (Access Ethernet Virtual Private Line)**
 - VLAN-aware P2P Ethernet Access Service Definition
 - Supports multiple access services per UNI
 - Consists of 1 UNI and 1 ENNI

Presentation Summary

- **E-Access will accelerate expansion of Carrier Ethernet**
- **Work Completed**
 - Final vote under way: formal approval January 2012
- **Certification targeted for Q2**

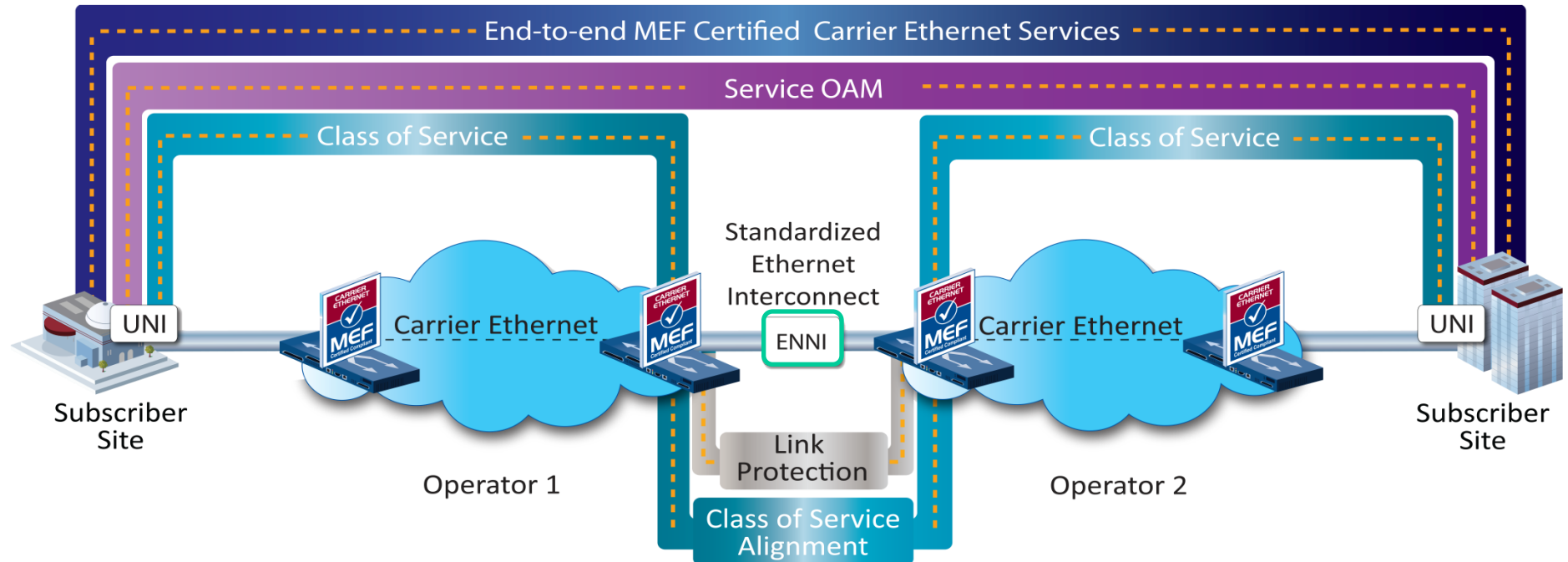
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Carrier Ethernet Interconnect Technical Elements

**Driving Ethernet global adoption
through standards-based interconnect**

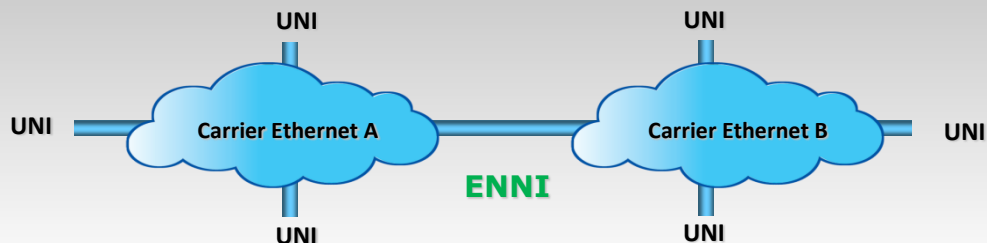
Interconnect Technical Components

The MEF Carrier Ethernet Interconnect specifications ensures support for all Carrier Ethernet attributes between service providers



Interconnect elements required to enable interconnected Carrier Ethernet services

Interconnect Related Specifications



Interconnect Work Completed:

- EMS-NMS Information Model (MEF 7.1)
- Carrier Ethernet Class of Service (MEF 23)
- External Network Network Interface (MEF 26)
- UNI Tunneling Access UTA (MEF 28)

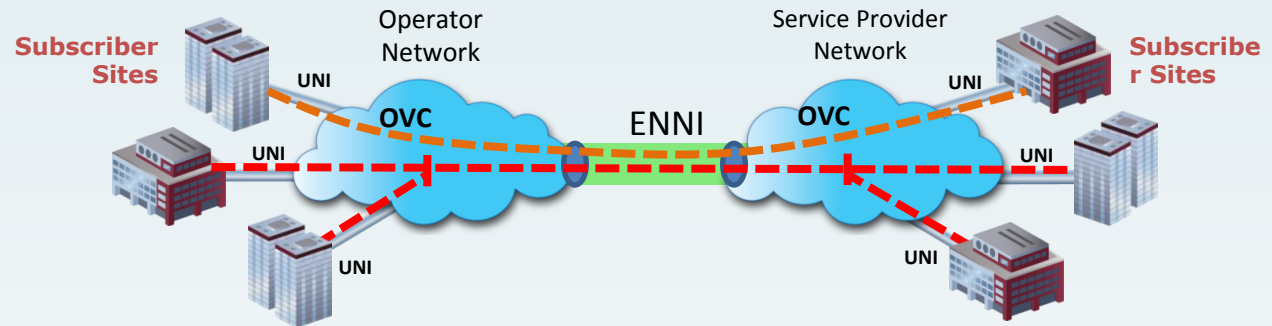
Related Work in Progress:

- Ethernet Access Services Definitions
- Service OAM Fault Management
- Service OAM Performance Management
- Hybrid NID Model
- Throughput Performance Monitoring
- Bandwidth Profile
- Various enhancements service definitions

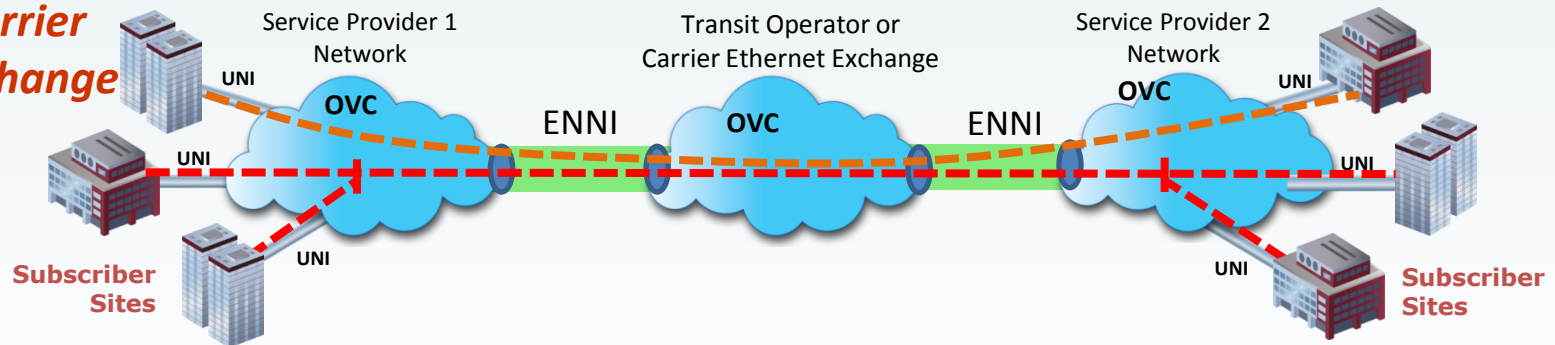
The Scope of ENNI (MEF26)

Specifies the Interconnect Between Carrier Ethernet Service Providers

Simple 2-carrier Model



Transit or Carrier Ethernet Exchange Model



- **External Network-to-Network Interface (ENNI) for service availability**

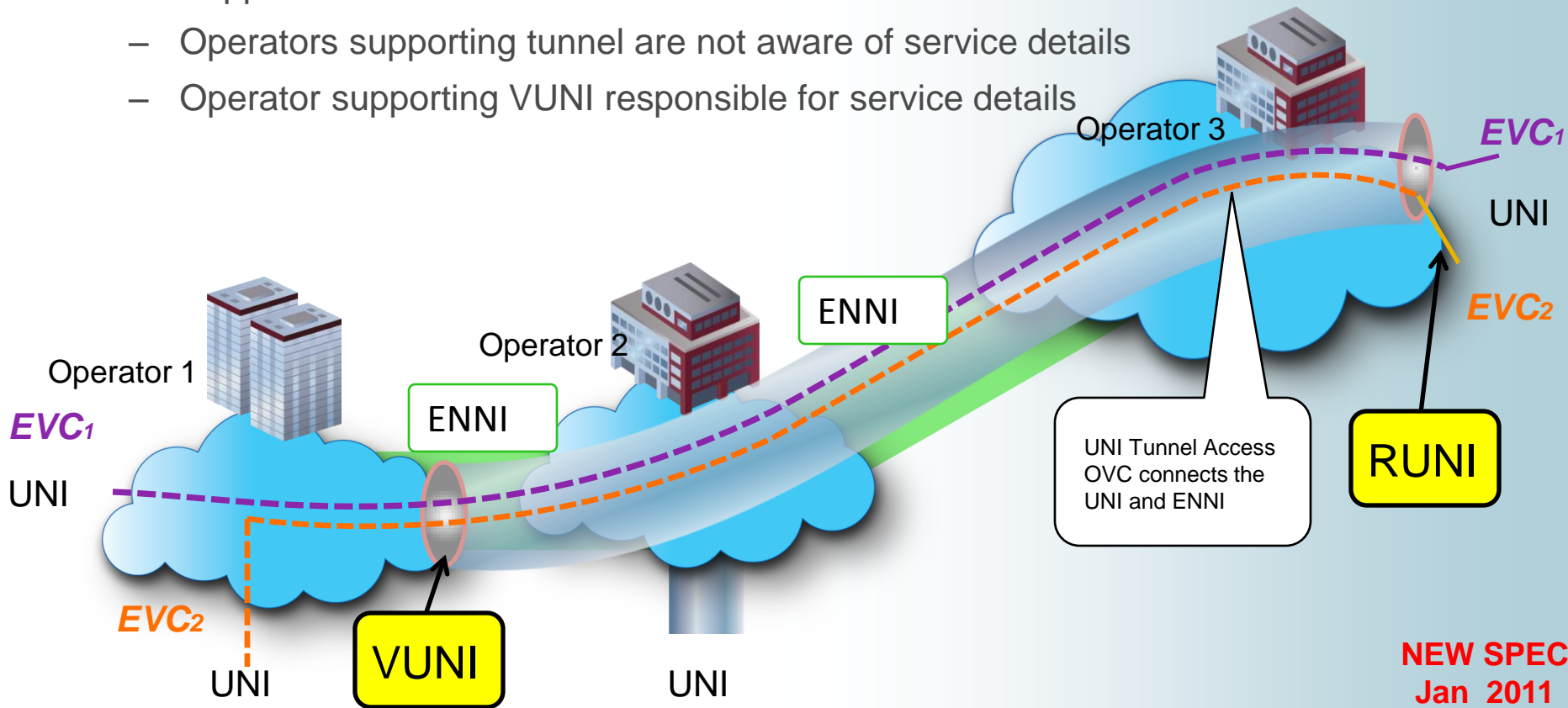
- Simple 2-carrier and multi-carrier service models
- Ethernet Virtual Connection (EVC) between UNIs spread across multiple networks
- Operator Virtual Connection (OVC) for each EVC segment. OVC Term is used within MEF 26
- UNI-ENNI OVC is equivalent to E-Access service type

- **Key ENNI requirements**

- Services: p2p and mp EVC types, single and multiple CoS per EVC
- Encapsulation: Standard S-Tag frame format
- Scalability: 1 and 10 Gbps PHYs
- ENNI Protection: 2-link LAG, active/standby, LACP

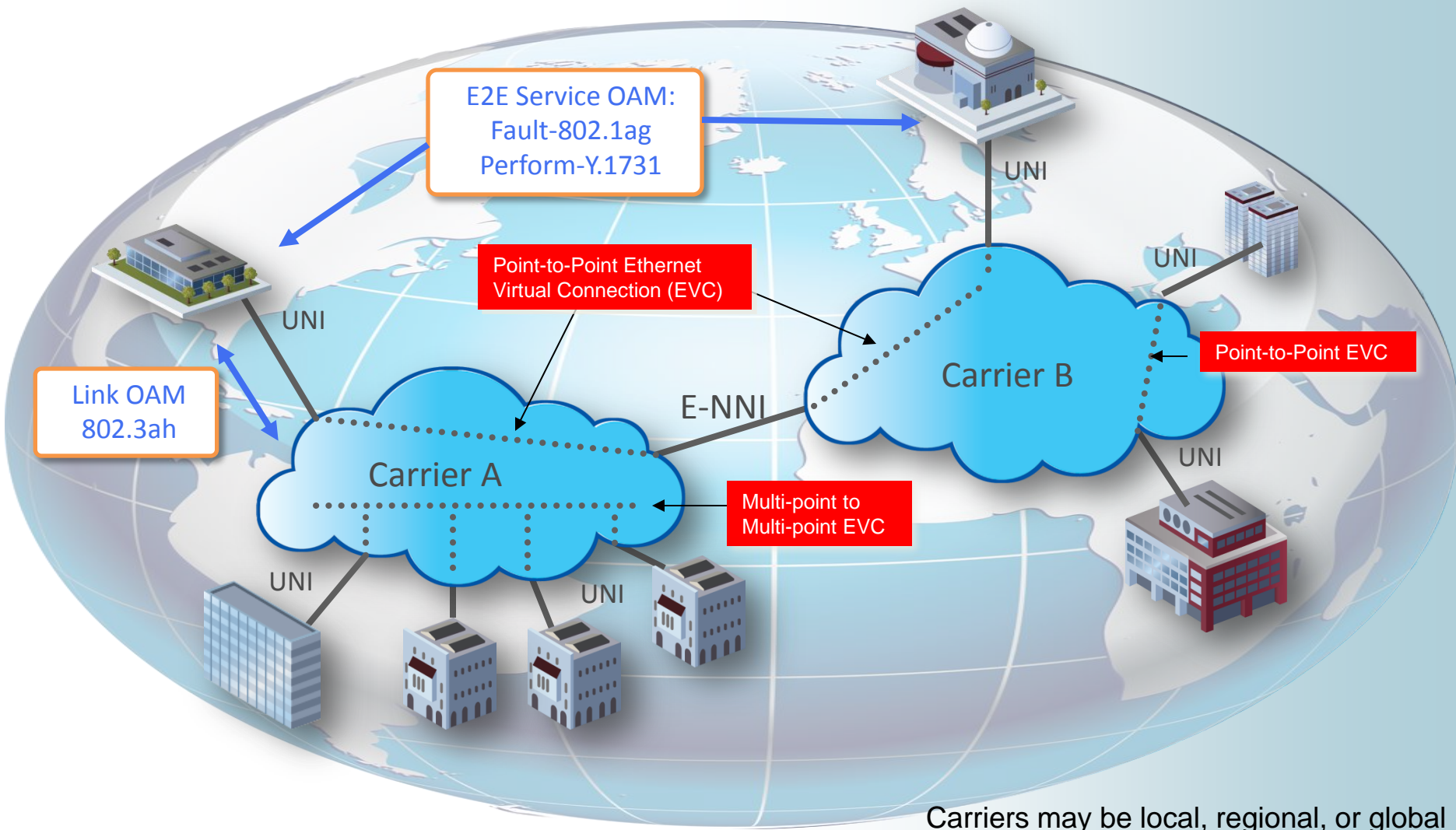
MEF 28 UNI Tunnel Access Service

- **UNI Tunnel Access (UTA) OVC connects the Virtual UNI (VUNI) and Remote UNI (RUNI)**
 - Supports wholesale access model
 - Operators supporting tunnel are not aware of service details
 - Operator supporting VUNI responsible for service details

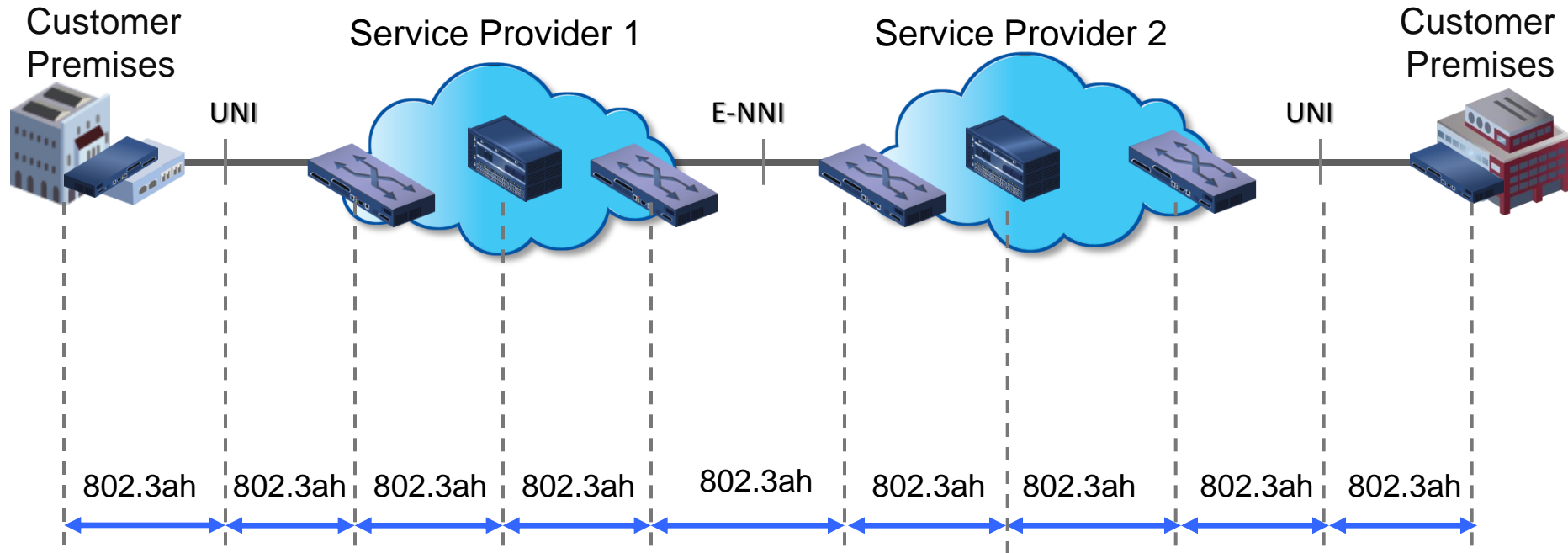


NEW SPEC
Jan 2011

Global Services Require World-Class OAM

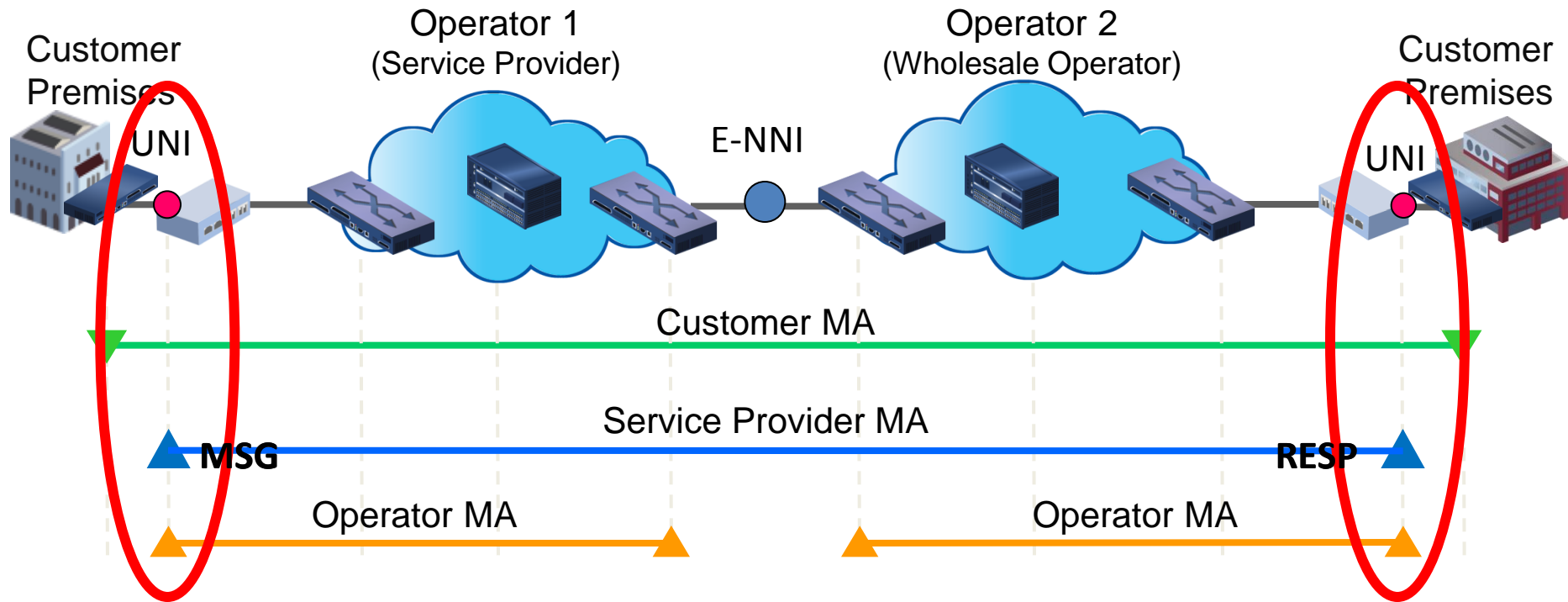


Link OAM



- IEEE 802.3ah – Per physical network link (point-to-point):
- Good for single links, but does not monitor across EVC
- Used for troubleshooting network links

Service OAM Framework

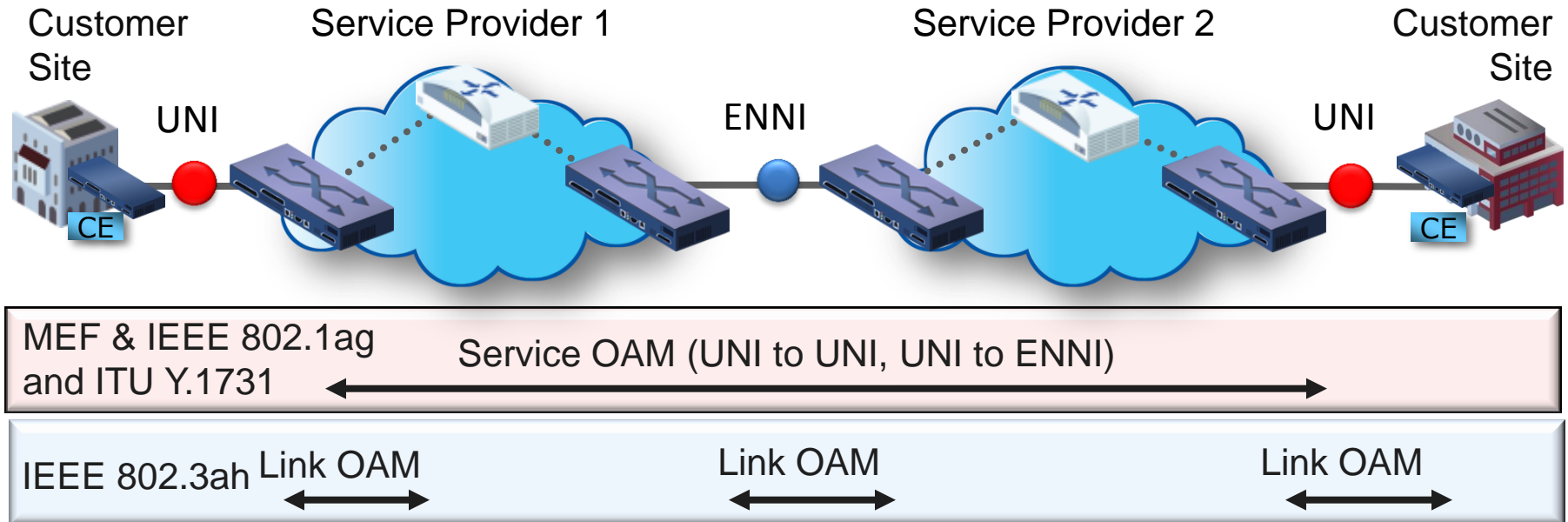


Y.1731 Message Based Performance Measurements

- Delay Measurement (DM), Delay Variation Measurement (DVM)
- Loss Measurement (LM)

Measurements end-to-end, NIDs at the customer UNI

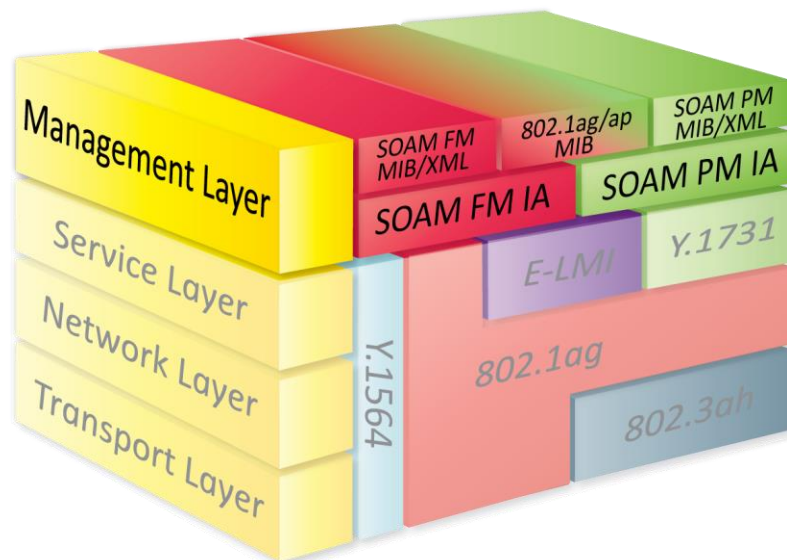
SOAM Performance Management



- Performance Management Implementation Agreement provides details for monitoring service performance
- Measurement of Frame Delay, Frame Delay Variation, Frame Loss Ratio

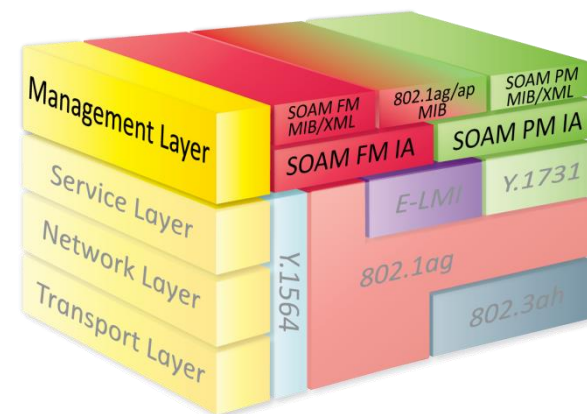


- **SOAM Fault Management Implementation Agreement**
 - Defines the Framework for Service OAM.
 - Provides mechanisms to detect, verify, isolate and report end-to-end Ethernet connectivity faults
 - Continuity Check, Remote Defect Indication Signal, Loopback, Linktrace, Alarm Indication Signal, Locked Signal, Test Signal
- **SOAM Fault Management MIB**
 - Facilitates multivendor fault detection and trouble shooting

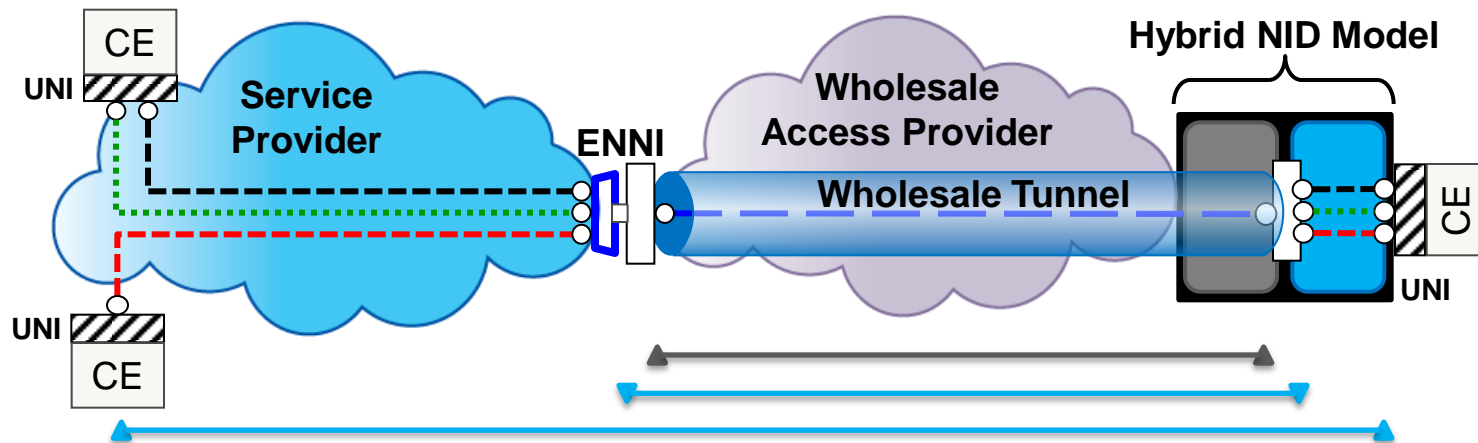


Interconnect Related Specifications

- **MEF 23 Class of Service Alignment**
 - Common Class of Service lexicon for service providers
 - CENs may implement different number of CoS: alignment is at the ENNI
- **SOAM Fault Management Implementation Agreement ***
 - Provides mechanisms to detect, verify, isolate and report end-to-end Ethernet connectivity faults
 - Continuity Check, Remote Defect Indication Signal, Loopback, Linktrace, Alarm Indication Signal, Locked Signal, Test Signal
- **Service OAM Fault Management MIB**
 - Facilitates multivendor fault detection and trouble shooting
- **Service OAM Performance Management ***
 - Performance Management Implementation Agreement provides details for monitoring service performance
 - Measurement of Frame Delay, Frame Delay Variation, Frame Loss Ratio
 - Y.1731 Message Based Performance Measurements



Hybrid NID Model



Service Provider

- **NID at customer premise**
 - Manage UNI, EVC, SOAM
- **Clear separation from Wholesale Provider**
 - Autonomy, secure access
- **Demarcation point**
 - At UNI, trust but verify

Wholesale Access Provider

- **Deploys the Hybrid NID**
 - PM and CFM of Wholesale Tunnel
- **Tunnel**
 - Terminated at Demarcation inside Hybrid NID
- **Demarcation point**
 - SLA Assurance of Wholesale Service

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Carrier Ethernet Interconnect
Certification

Interconnect: MEF Certification

MEF Certification

- Certified services provide fundamental, well respected basis for interoperability
- Ongoing program to match new specifications
- Major market driver for Carrier Ethernet
- Represents many years of expert test development
- Saves months of ad-hoc testing for new services



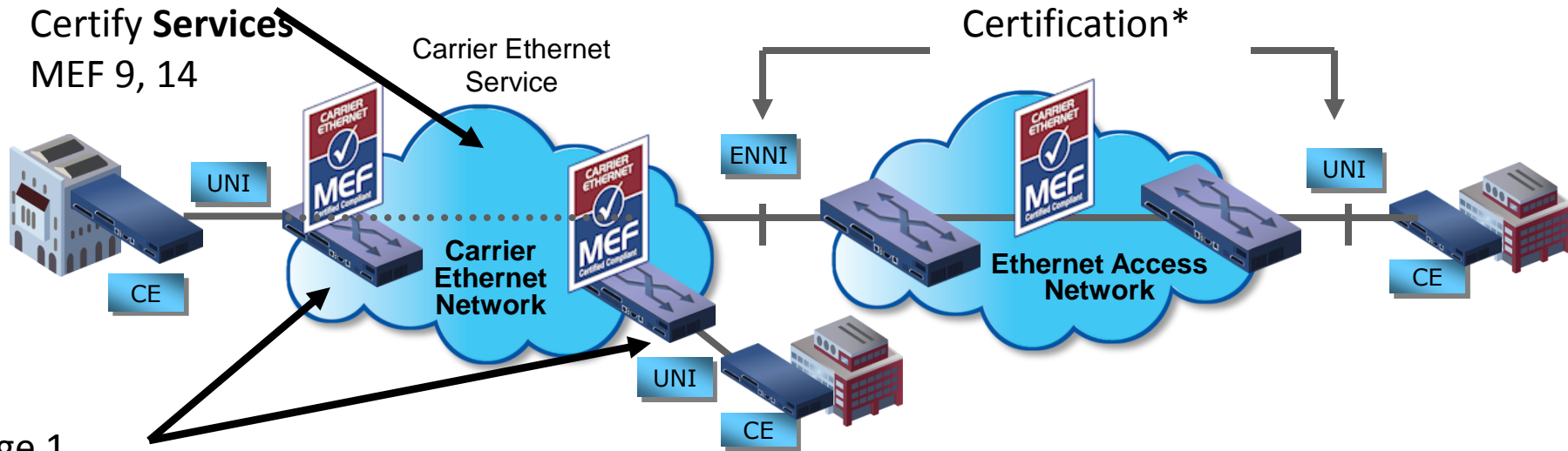
- **47 service providers and 77 equipment providers are MEF-certified**

Certification Enabling Standardization

MEF 9 E-LINE/E-LAN Service Functionality
MEF 14 E-LINE/E-LAN Service Performance
MEF 18 Circuit Emulation over Ethernet
MEF 21 Ethernet Link OAM Compliance



Stage 2
Certify **Services**
MEF 9, 14



Stage 1
Implement Certified **Equipment**
MEF 9, 14

* Mid 2011

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Carrier Ethernet Interconnect

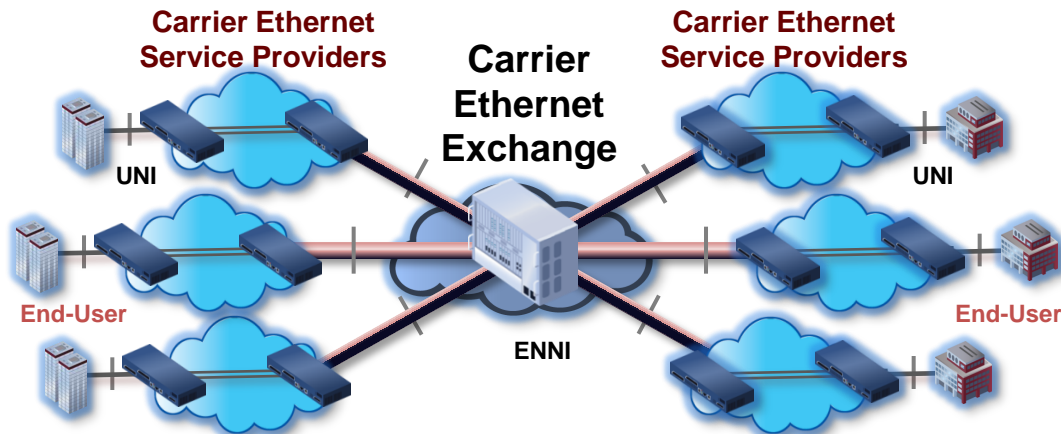
Carrier Ethernet Exchanges and Direct Connections

Bringing Scalability

Implementation Options and Definition

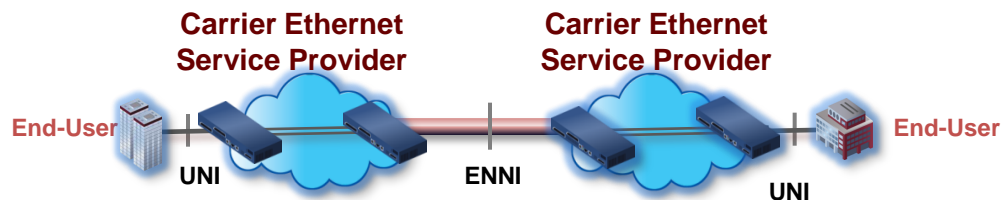
Definition: Carrier Ethernet Exchange

“An interconnect point among service providers where Carrier Ethernet services are exchanged”



Definition: Direct Connect:

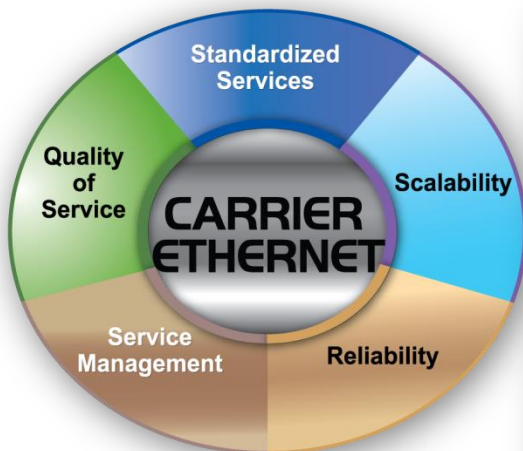
“A bilateral ENNI between two Carrier Ethernet service providers”



Both must facilitate all 5 attributes of Carrier Ethernet

Carrier Ethernet Exchange Fundamentals

A Carrier Ethernet Exchange must facilitate all 5 attributes of Carrier Ethernet



Services – must support **Translation** of MEF EVPL, E-Line, E-LAN service types and profiles with multiple CoS

Scalability – **Scalability**. Must support and access millions of EVCs and worldwide locations with scalable processes

Quality of Service – **Service Monitoring**
Must support enforceable, measurable, end-to-end service (frame delay, delay variation, availability).

Service Management – **Process Integration**
Must support normalized process human and system for process transactions

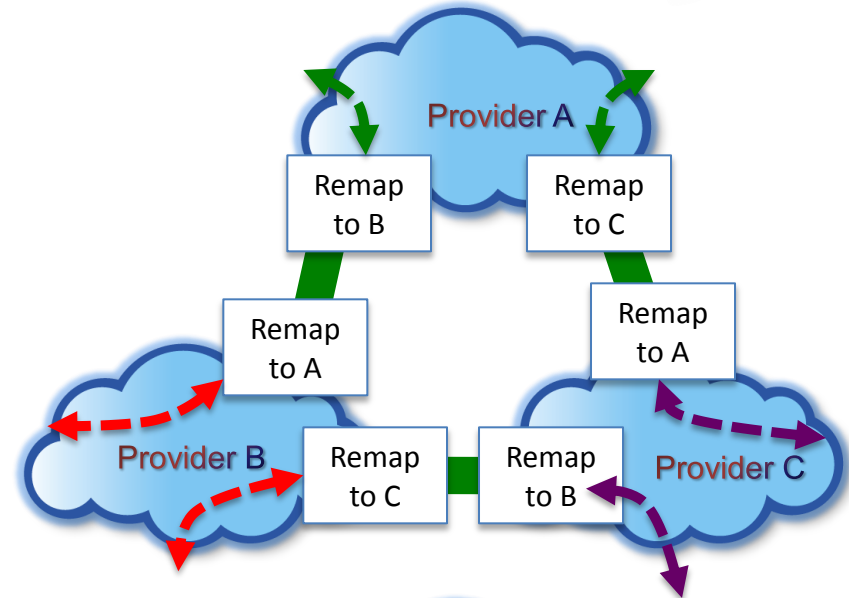
Reliability – **Protection**. Must provide protection: carrier class with geographical diversity

Scalability – the key cost saving and revenue growth driver behind the development of Carrier Ethernet Exchanges

Attribute 1: Standardized Services

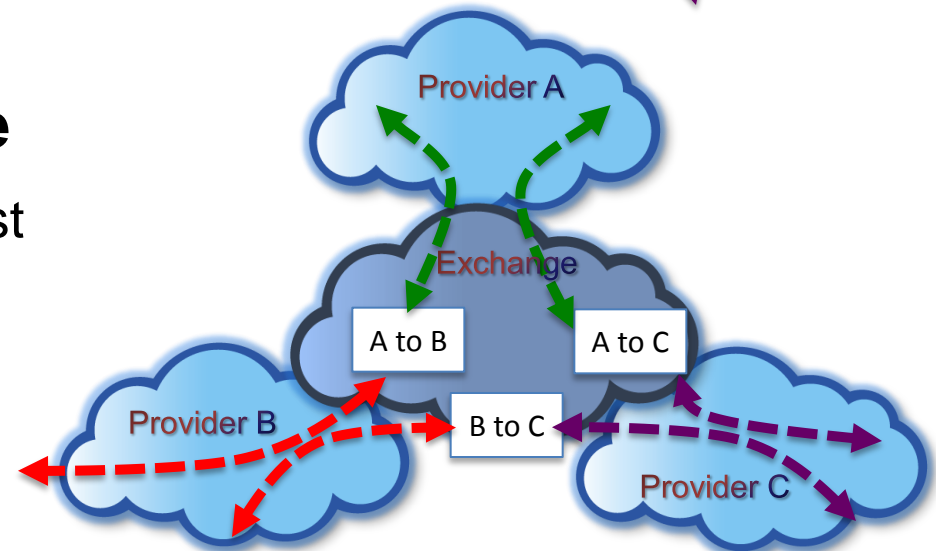
- **Direct Connect**

- Ethernet flexibility allows each provider to have differentiated service offer
- Interconnect requires each service provider to remap its service definitions



- **Carrier Ethernet Exchange**

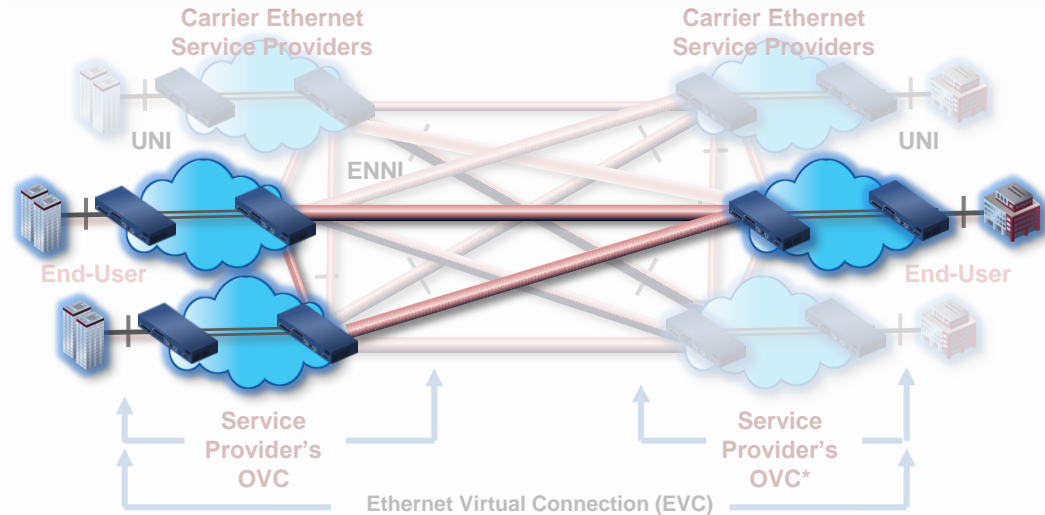
- Carrier Ethernet Exchange must provide service translations supporting all service types
- Preserve differentiation



Attribute 2 : Scalability- Key Attribute

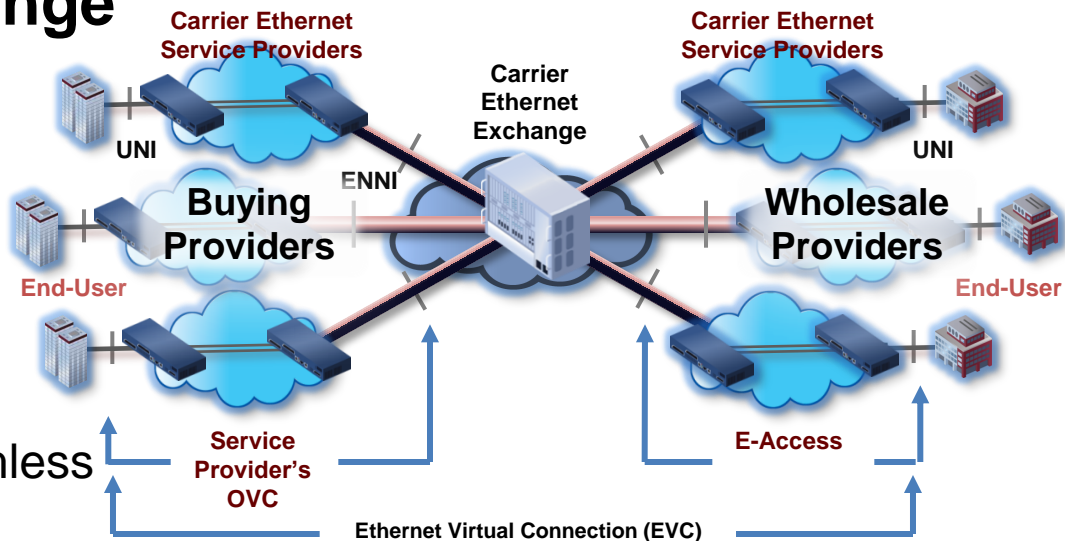
- **Direct Connect**

- Suitable for individual connections
- Does not scale to large number of Providers & EVCs
- geographical diversity



- **Carrier Ethernet Exchange**

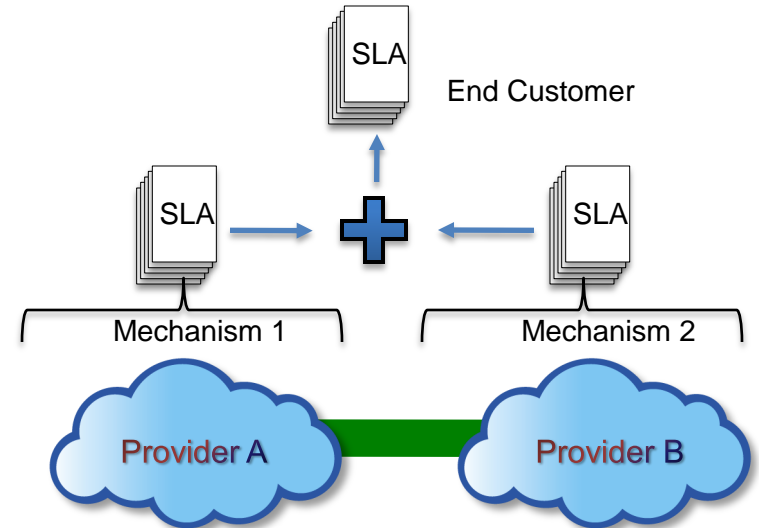
- Exchange must be designed for scale
- Support integration of new providers
- Manage very large number of EVCs;
- Geo-scaling, neutral and seamless



Attribute 3: Quality of Service

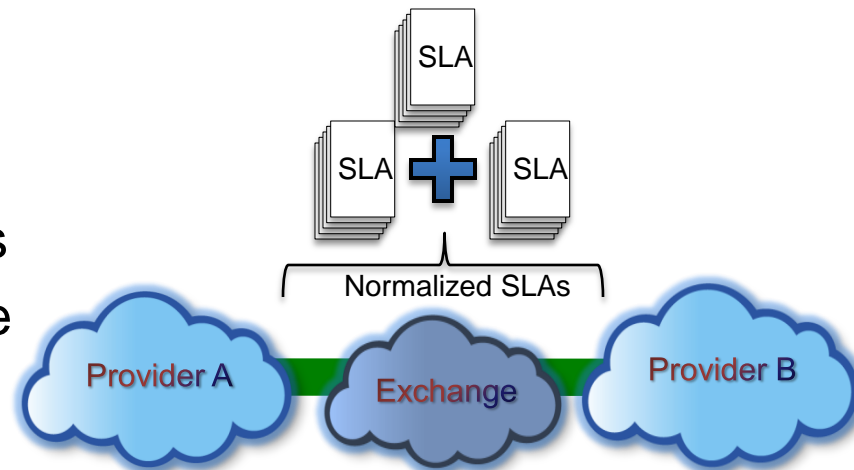
- **Direct Connect**

- Service provider (buyer) must ensure guaranteed QoS edge-to-edge
- Pair must have a way to measure performance of seller's connection



- **Carrier Ethernet Exchange**

- Facilitate of the enforcement and measurement of end-to-end services (FD, DV, FLR, availability) across the separate buyer and seller networks



Attribute 4: Service Management

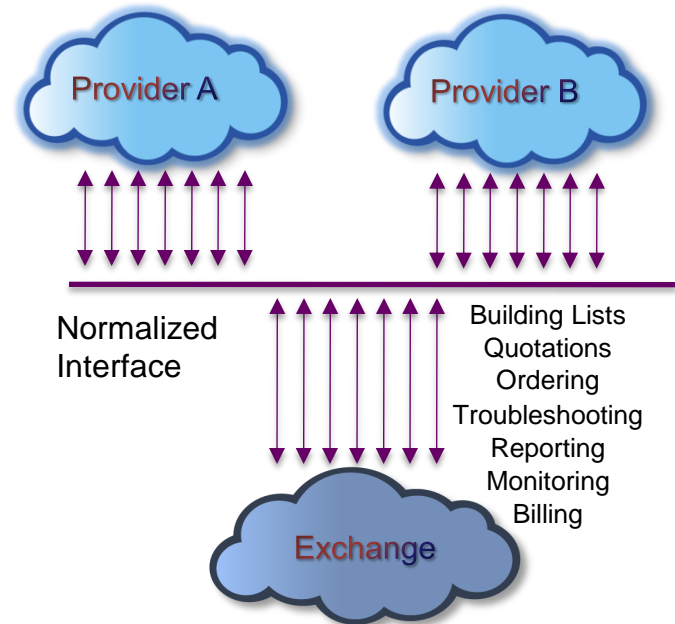
- **Direct Connect**

- Every provider should integrate their service management processes



- **Carrier Ethernet Exchange**

- Exchange should support process integration between carriers providing normalized interfaces (both human and machine)



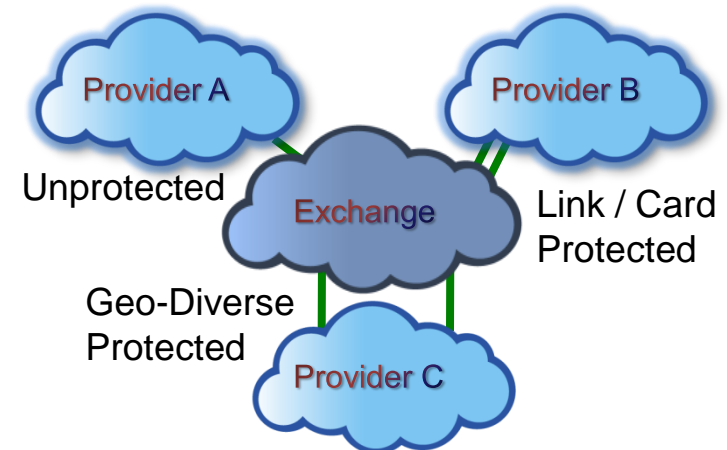
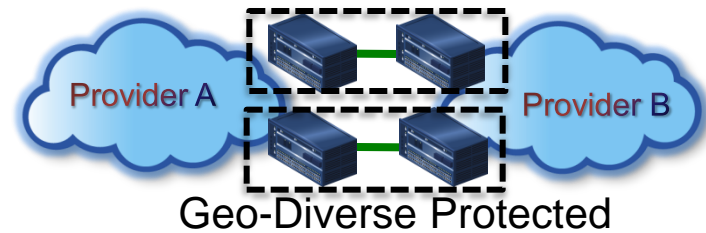
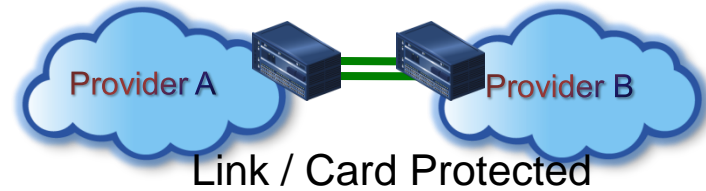
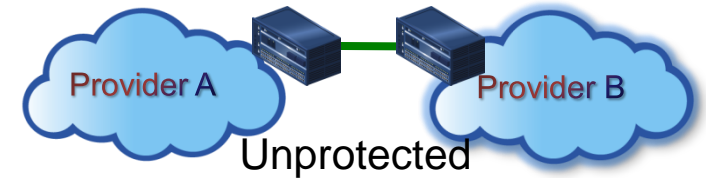
Attribute 5: Reliability

- **Direct Connect**

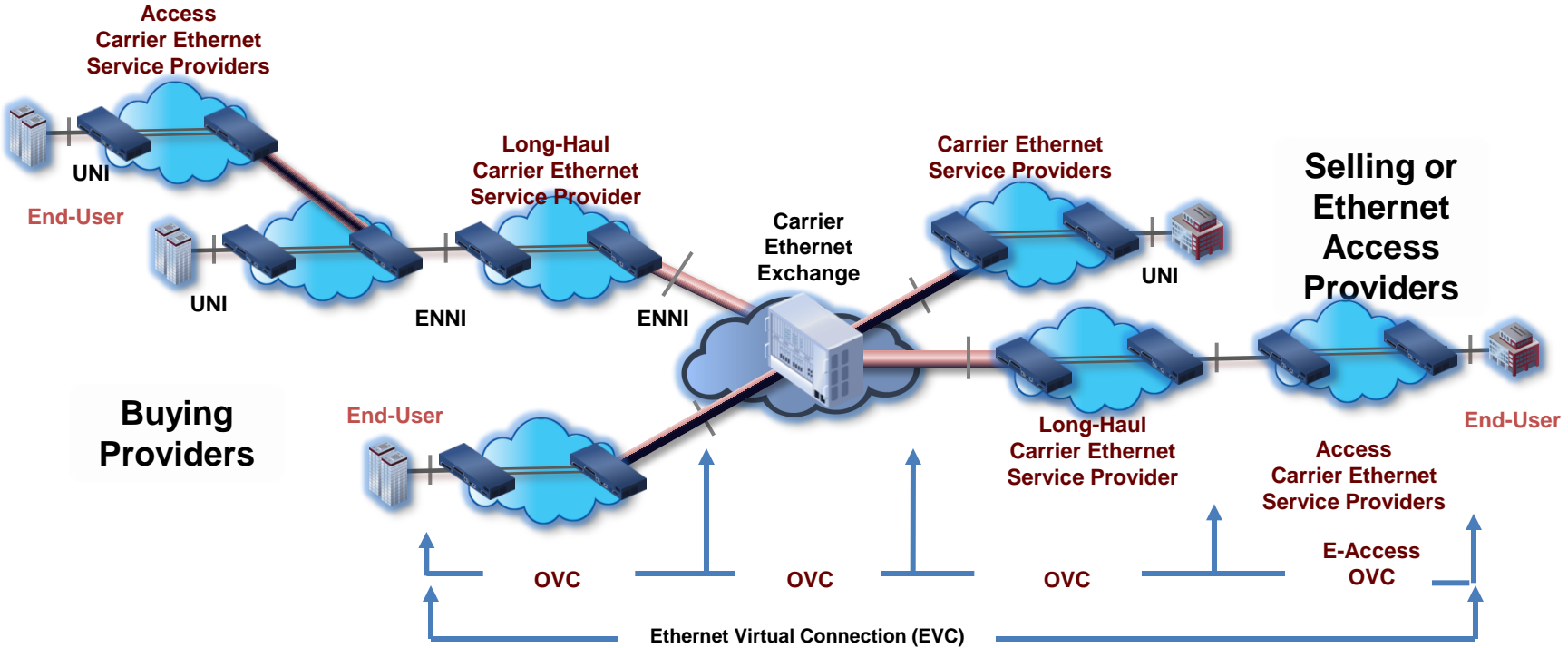
- Pair must decide on service protection mechanism
- Must find a mechanism supported by both carriers

- **Carrier Ethernet Exchange**

- Exchange must support connections ranging from unprotected to full geographic diversity



“Carrier Ethernet Interconnect Connections”



MEF

A dark blue world map is centered in the background of the slide, showing the outlines of continents and countries.

Carrier Ethernet Interconnect
Operational Elements

Key Operational Steps

- **Explore Specifications and Certification**
- **Determine potential Carrier Ethernet service provider partners**
- **Decide on Carrier Ethernet Exchange or direct connect**
- **Agree Service Level Specifications**
- **Use MEF educational and implementation deliverables**
- **Ensure process alignment: ordering, provisioning, billing, service management**

MEF

A dark blue world map is centered in the background of the slide, showing the outlines of continents and countries. It is positioned behind the 'MEF Resources' text.

MEF Resources

Members' Ethernet Business Services Kit

- **Deliverables Summary**

- Ethernet Access Certification (2012)
- MEF Interconnect Questionnaire (available for Members)
 - Assists qualification between ‘buyers’ and ‘sellers of direct connects
 - Supplements MEF specifications with a common lexicon
 - Clarifies relevant service parameters >400
- MEF specifications and overview presentations
- Implementation Guide Marketing FAQs tutorial videos, member network for global expertise & partnerships

Questionnaire

Purpose

- Qualify, select, and deliver Ethernet services over partner networks

Value

- Streamlines initial interactions between the 'buyers' and 'sellers'
- Supplements MEF specifications with a common lexicon for Carrier Ethernet direct connections
- Clarifies relevant service parameters
- Comprehensive baseline for interconnect RFIs and RFQs



Tool for the Ethernet services industry developed by the MEF in Excel format

Questionnaire Sections

- Introduction
- Master
- Document Control
- Acronym Definitions
- 1.0 Physical Interface
- 2.0 Path Diversity + Protection
- 3.0 Ethernet Frames
- 4.0 CoS and SLAs
- 5.0 Service Limitations
- 6.0 Network Management
- 7.0 Performance Reporting
- 8.0 Security
- 9.0 Connection Admission Control Rules
- 10.0 EVC+NNI Speeds and MTU

EPLAN	Ethernet Private LAN
EVPLAN	Ethernet Virtual Private LAN
EVPLAN	Ethernet Virtual Private LAN
ER	extended range LAN PHY
ESP	Ethernet Service Provider (last mile provider)
EVC	Ethernet Virtual Circuit
EW	extended range WAN PHY
FC	Ferrule connector

Remaining Operational Steps.

- **Steps in the Ordering Phase:**

- Understand exact required service attributes
- Order rejections (e.g., knowing why)
- Order status

- **Steps in the Provisioning Phase:**

- Ease of scheduling
- Resolution of issues

- **Additional phases:**

- Service Assurance Phase



MEF Reference Presentations

MEF Reference Presentations Covering the Principal Work of the MEF

Overview presentation of the MEF.	This presentation gives basic and most up-to-date information about the work of the MEF. It also introduces the definitions, scope and impact of Carrier Ethernet, the MEF Certification programs and describes the benefits of joining the MEF.
Overview presentation of the Technical Work of the MEF	Includes a summary of the specifications of the MEF, structure of the technical committee, work in progress and relationships with other Industry Standards bodies. For PowerPoint overviews of individual specifications: click here
Carrier Ethernet Services Overview	This presentation defines the MEF Ethernet Services that represent the principal attribute of a Carrier Ethernet Network
Carrier Ethernet User-Network Interface	This presentation discusses the market impact of MEF 20: UNI Type 2 Implementation agreement
Carrier Ethernet Access Technology Overview	This presentation describes how the MEF specifications bring Carrier Ethernet services to the world's Access networks (with examples of Active Ethernet (Direct Fiber), WDM Fiber, MSO Networks(COAX and Direct Fiber), Bonded Copper, PON Fiber and TDM (Bonded T1/E1, DS3/E3))
Carrier Ethernet Interconnect Program.	This is the latest presentation from the Carrier Ethernet Interconnect Working Group which acts as a framework for all presentations given on this topic.
Carrier Ethernet OAM & Management Overview	This presentation describes the management framework and the OAM elements for fault and performance management expressed in terms of the life cycle of a Carrier Ethernet circuit
Carrier Ethernet for Mobile Backhaul	A comprehensive marketing and technical overview of the MEF's initiative on Mobile Backhaul that has lead to the adoption of Carrier Ethernet as the technology of choice for 3G and 4G backhaul networks
Carrier Ethernet Business Services	A comprehensive presentation aimed at business users
The MEF Certification Programs	A presentation of the MEFs three certification programs: Equipment, Services and Professionals. These programs have been a cornerstone of the success of Carrier Ethernet and its deployment in more than 100 countries around the world.

MEF

End of Presentation