Introducing the Specifications of the MEF

MEF 26.1: ENNI - Phase II

External Network to Network Interface

Agenda

- Approved MEF Specifications
- This presentation
- About this Specification
- In Scope / Out of Scope
- Terminology, Concepts & Relationship to other standards
- Section Review
- Examples/Use Cases
- Summary

Approved MEF Specifications

REF	Description
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 6.1	Metro Ethernet Services Definitions Phase 2
MEF 6.1.1	Layer 2 Control Protocol Handling Amendment to MEF 6.1
MEF 7.1	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 10.2	Ethernet Services Attributes Phase 2*
MEF 10.2.1	Performance Attributes Amendment to MEF 10.2
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 6.1 replaced MEF 6., MEF 7.1 replaced MEF 7, MEF 10.2.1 & MEF 10 .2 replaced MEF 10.1.1, MEF 10.1, MEF 10 which replaced MEF 1 and MEF 5.**

Approved MEF Specifications

REF	Description
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 20	User Network Interface (UNI) Type 2 Implementation Agreement
MEF 21	Abstract Test Suite for UNI Type 2 Part 1: Link OAM
MEF 22	Mobile Backhaul Implementation Agreement Phase 1
MEF 23	Class of Service Implementation Agreement Part 1
MEF 24	Abstract Test Suite for UNI Type 2 Part 2: E-LMI
MEF 25	Abstract Test Suite for UNI Type 2 Part 3: Service OAM
MEF 26	External Network Network Interface (ENNI) – Phase 1
MEF 26.1	External Network Network Interface (ENNI) – Phase 2
MEF 27	Abstract Test Suite For UNI Type 2 Part 5: Enhanced UNI Attributes & Part 6: L2CP Handling
MEF 28	External Network Network Interface (ENNI) Support for UNI Tunnel Access and Virtual UNI
MEF 29	Ethernet Services Constructs
MEF 30	Service OAM Fault Management Implementation Agreement
MEF 31	Service OAM Fault Management Definition of Managed Objects
MEF 32	Requirements for Service Protection Across External Interfaces

MEF Specifications Overview

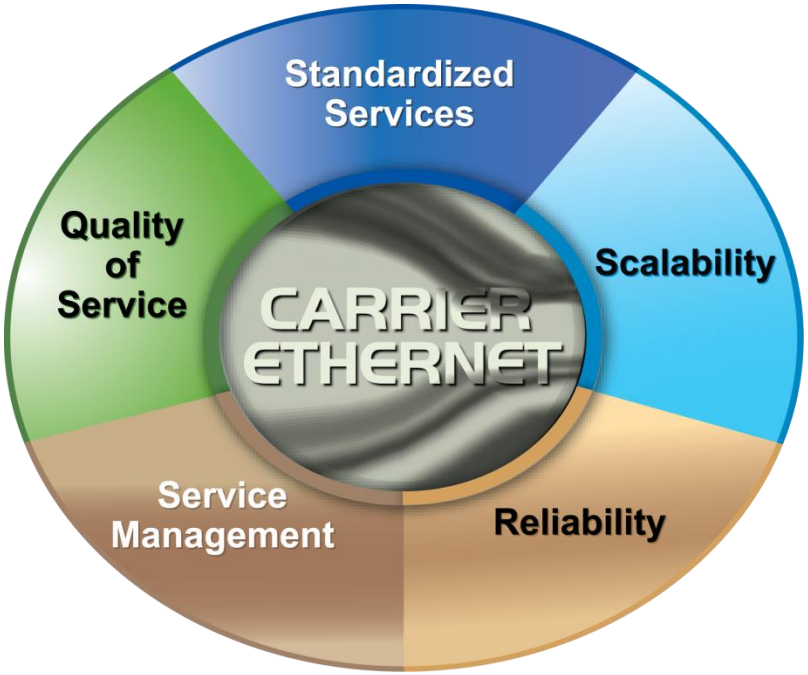
MEF 26	External Network to Network Interface (ENNI) – Phase I
Purpose	Specifies the reference point that is the interface between two Metro Ethernet Networks (MENs) where each operator MEN is under the control of a distinct administration authority. The ENNI is intended to support the extension of Ethernet services across multiple operator MENs.
MEF 26.1	**External Network Network Interface (UTA and VUNI) – Phase II**
Purpose	This Technical Specification extends the ENNI by defining the UNI Tunnel Access (UTA) which associates a Virtual UNI (VUNI), a remote UNI, and at least one supporting OVC.
Audience	All, since it provides the fundamentals required to delivery services that extend Carrier Ethernet over multiple operator MENs and to build devices that support those services . It is especially relevant for Service Providers since it defines the standard mechanisms for interconnecting services across multiple operator's MENs.

This Presentation

- **Purpose:**
  - This presentation is an introduction to MEF 26
- **Audience**
  - Equipment Manufacturers building devices that will carry Carrier Ethernet Services.
  - Useful for Service Providers architecting their systems
- **Other Documents**
  - Presentations of the other specifications and an overview of all specifications is available on the MEF web site
  - Other materials such as white papers and case studies are also available

MEF 26 Enhances Carrier Ethernet Attributes

- Brings Carrier Ethernet to a new level by enabling interconnectivity between Carrier Ethernet networks from multiple operators



MEF 26 Enables Carrier Ethernet Interconnects

Carrier Ethernet growth challenges

- The success of Carrier Ethernet brings its own challenges, not the least of these is supporting interconnections between operators
- Until now, MEF specifications have not covered interconnection process relying on manual or ad hoc processes.

MEF 26

- Introduces a standard interconnection interface
  - Making Carrier Ethernet interconnections simpler
  - Increase the speed with which operators can cooperate to deliver services in Out of Franchise networks
  - Accelerating the global adoption of Carrier Ethernet with a standard Global Interconnection mechanism

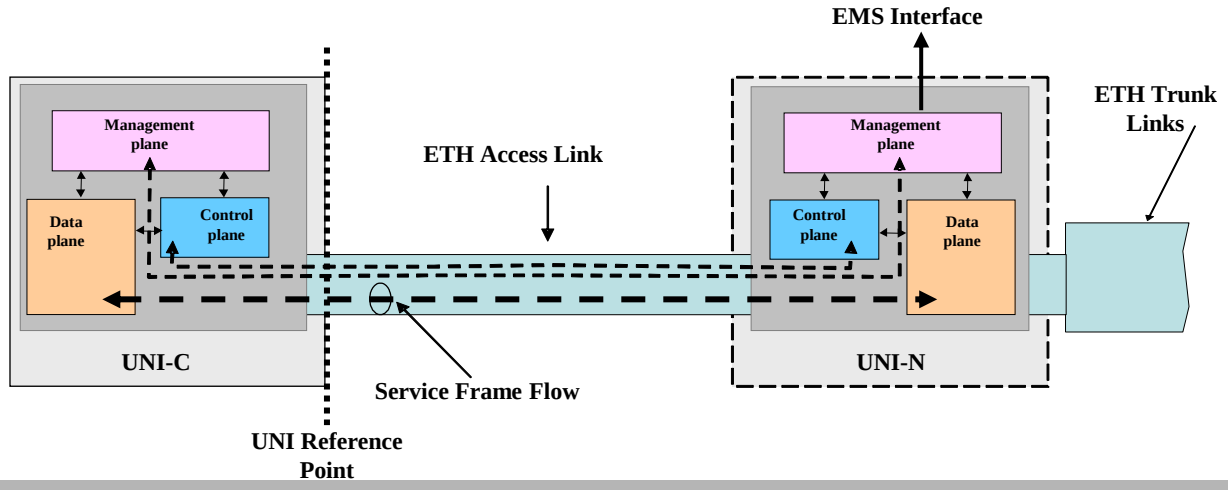
Contents

- **Overview**
- Scope
- Interconnection Interface
- Operator Services Attributes
- Examples
- Summary

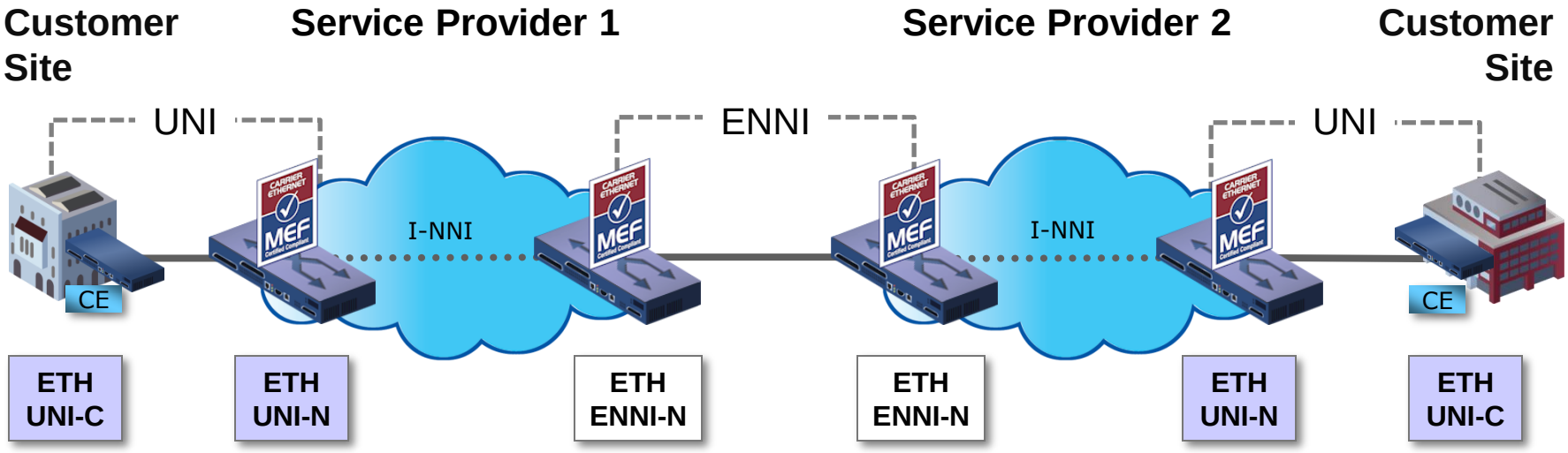
Background – UNI Functional Elements

Relationship between service frames (user generated), control and Carrier Ethernet management frames

- Subscriber to Subscriber service frames (including Subscriber's data, control and management frames) are handled by UNI-C and UNI-N data plane functional elements
- Control frames between Subscriber and Service Provider are handled by UNI-C and UNI-N control plane functional elements
- Management frames between Subscriber and Service Provider are handled by UNI-C and UNI-N management plane functional elements



Carrier Ethernet Architecture



UNI	User Network Interface
UNI-C	UNI-customer side
UNI-N	UNI-network side

NNI	Network to Network Interface
ENNI	External NNI
I-NNI	Internal NNI

The UNI is the physical demarcation point between the responsibility of the Service Provider and the responsibility of the Subscriber.

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- Overview
- **Scope**
- Definition and Architecture
- Operator Services Attributes
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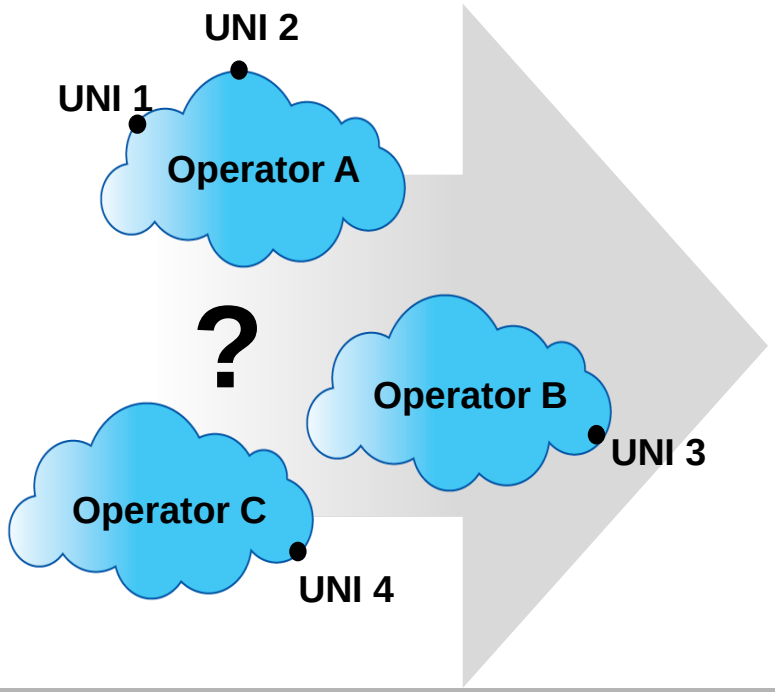
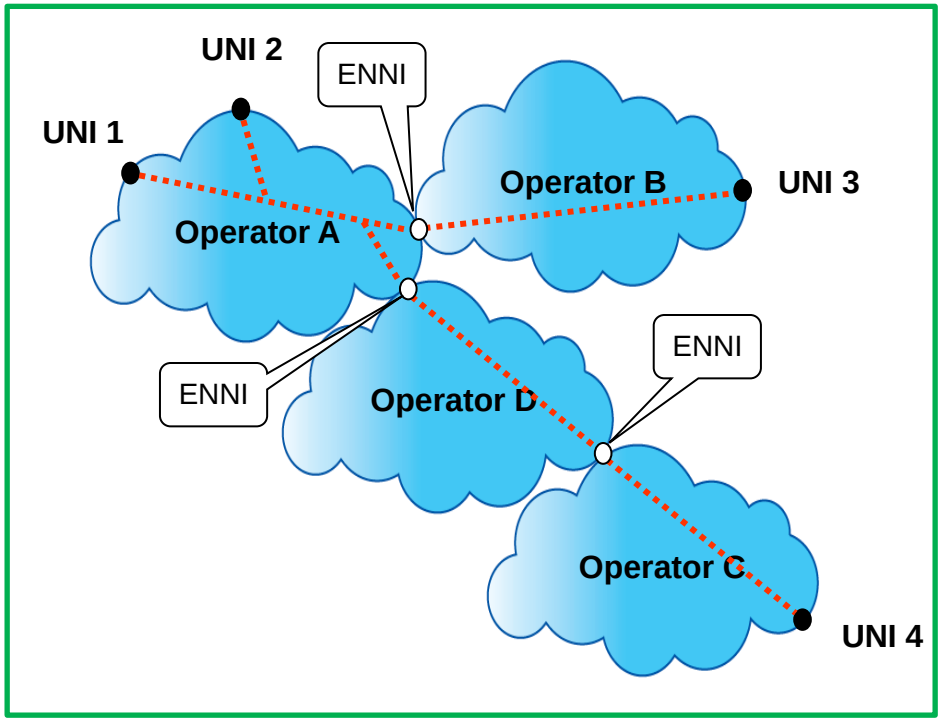
The Scope of MEF 26

1. **Standard approach to implementing Ethernet Services as specified in MEF 10.2 and MEF 6.1 among UNIs supported by different Operator MENs**
2. **Specifies a standard Interconnection Interface between Operator MENs – the ENNI definition**
3. **Specifies Operator Services Attributes – the OVC definition**

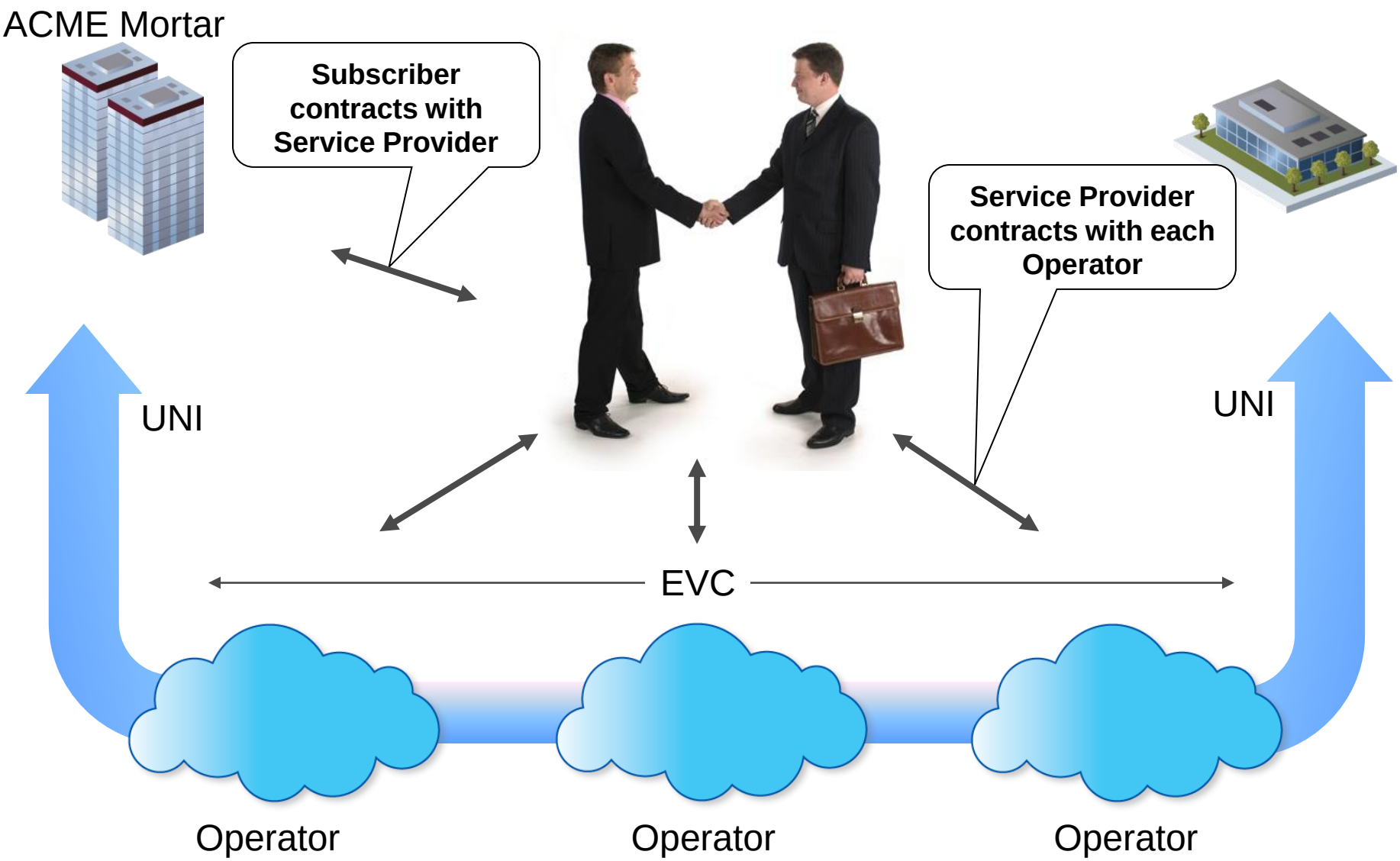




What's new in MEF 26.1

- **MEF 26.1 Consolidates the work in MEF 26, 26.0.1, 26.0.2, 26.0.3**
- **Introduces specifications for the support of Rooted-Multipoint EVCs as defined in MEF 10.2.**
- **The definition and requirements for tunneling frames containing a Layer 2 Control Protocol on an Operator Virtual Connection.**
- **Service Level Specification definitions and related requirements.**

The ENNI Service Model



The Three Roles

- **Subscriber (as per MEF 10.2)**
  - Ultimate Customer
  - Service Provider is a single point of contact
- **Service Provider (as per MEF 10.2)**
  - Responsible for pulling together and managing the UNI to UNI Service
  - Is a customer of the Operator MEN(s)
- **Operator (New)**
  - Responsible for behavior of Operator MEN only
  - May have limited knowledge of the UNI to UNI service
- **Many times the Service Provider is also an Operator but this is not required**

Contents

- Overview
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- **Definition and Architecture**
- Operator Services Attributes
- Examples
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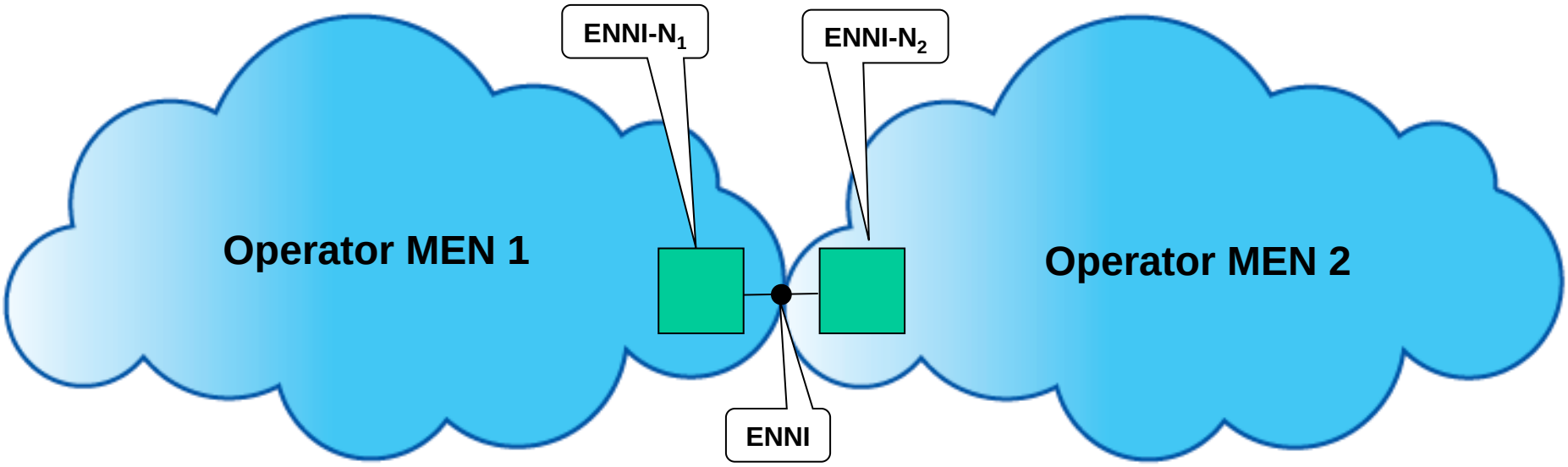
ENNI - Definition

- **ENNI is the reference point representing the boundary between two Operator MENs that are operated as separate administrative domains.**
- **ENNI-N represents the functions necessary to support the protocols and procedures for the interface.**



ENNI Frames are exchanged between ENNI-N_1 and ENNI-N_2

Interconnection Interface Details

- **Physical Layer: Gigabit and 10Gigabit Ethernet IEEE Std 802.3 – 2005**
  - 1000Base-SX, 1000Base-LX, 1000Base T, 10GBASE-SR,
  - 10GBASE-LX4, 10GBASE-LR, 10GBASE-ER, 10GBASE-SW, 10GBASE-LW, 10GBASE-EW IEEE Std 802.3 – 2005
- **One or more physical links**
  - Link aggregation
  - Protection
- **Supported ENNI Frame Formats:**
  - Untagged
  - Single S-Tag (TPID = 0x88A8)
  - Single S-Tag (TPID = 0x88A8) followed by a single C-Tag (TPID = 0x8100)
- **Maximum Transmission Unit**
  - Size ≥ 1526 bytes **required**
  - Size ≥ 2000 bytes recommended

Protection at the ENNI

- **When there are two physical links, the Operator MEN must be able to support Link Aggregation with one link active and the other passive per IEEE Std 802.3 – 2005**
  - All subscriber traffic on active link with other link as backup
- **Operators may use other methods for protection if mutually agreed**

Management at the ENNI

- **The Operator MEN must be able to support Link OAM as per IEEE Std 802.3 – 2005**
- **However it is recommended that the loopback capability be disabled**

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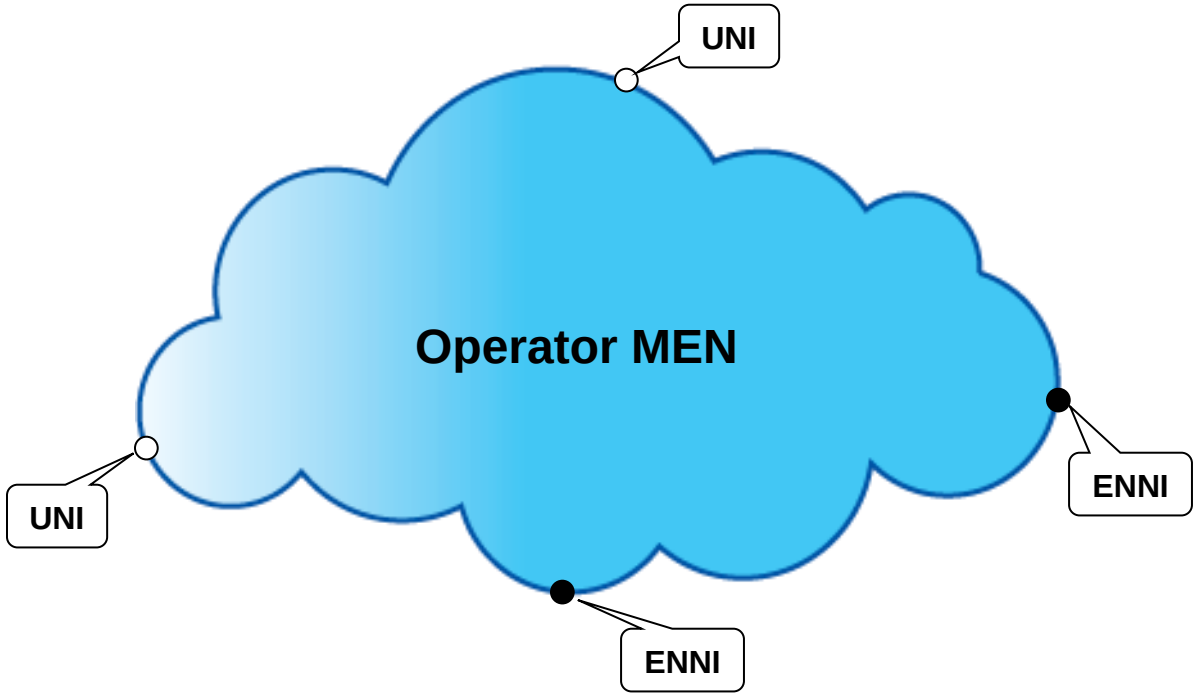
Operator Service Attributes

- **Operator Service Attributes are behaviors that can be observed at and between External Interfaces.**
- **ENNI and UNI are the External Interfaces.**



Operator Virtual Connection (OVC) – 1

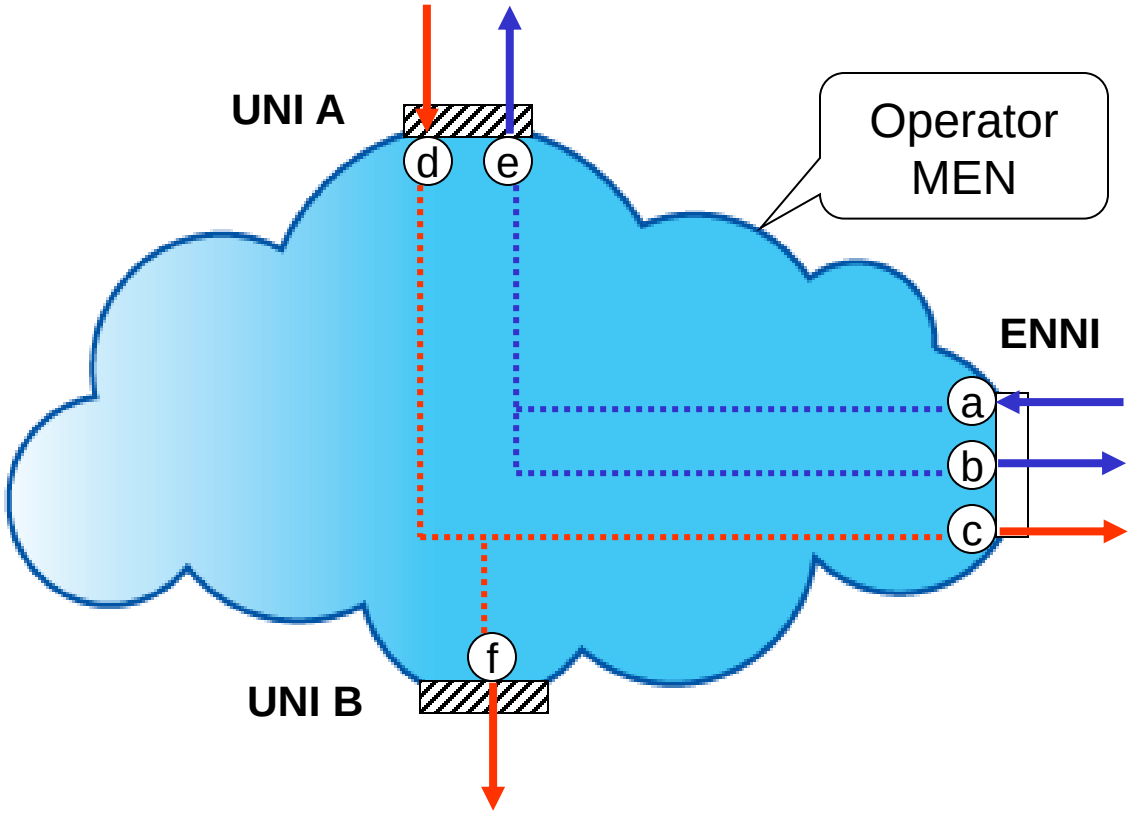
- **Similar in concept to an EVC**
- **An OVC constrains the exchange of frames between the External Interfaces of an Operator MEN**
  - UNI to ENNI
  - ENNI to UNI
  - UNI to UNI
  - ENNI to ENNI
- **The OVC can support Hairpin Switching* at an ENNI**
  - An ingress ENNI Frame can result in an egress ENNI Frame at the same ENNI
  - To describe this behavior the concept of an OVC End Point is introduced

*Covered later in this presentation

Operator Virtual Connection (OVC) – 2

- **An OVC is the association of OVC End Points.**
- **Each OVC End Point is associated with a UNI or an ENNI and at least one must be associated with an ENNI**
- **At each ENNI there is a way to map each S-Tagged ENNI Frame to at most one OVC End Point (and thus to at most one OVC)**
- **At each UNI there is a way to map each Service Frame to at most one OVC End Point (and thus to at most one OVC)**
- **An ingress frame mapped to an OVC End Point associated by an OVC can only result in an egress frame that is mapped to a different OVC End Point that is associated by the OVC**

Two OVCs

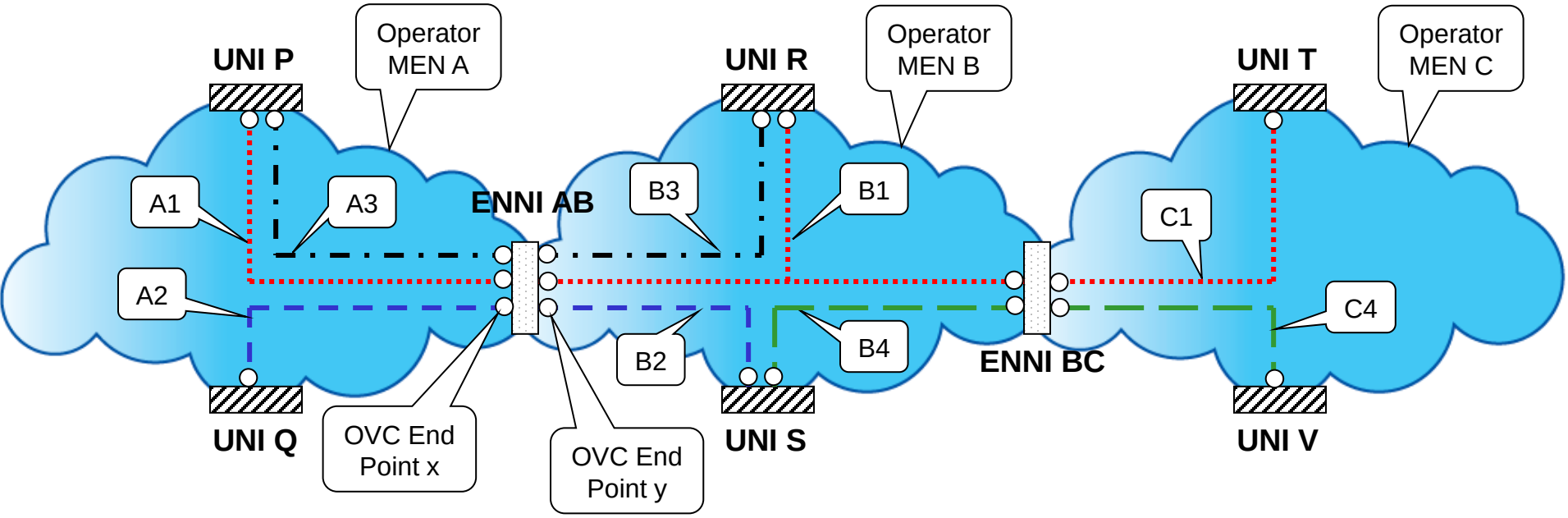


- **An OVC can associate more than one OVC End Point that is at an ENNI**
- **An OVC can associate at most one OVC End Point that is at a UNI**

a **OVC End Point**

..... **OVC**

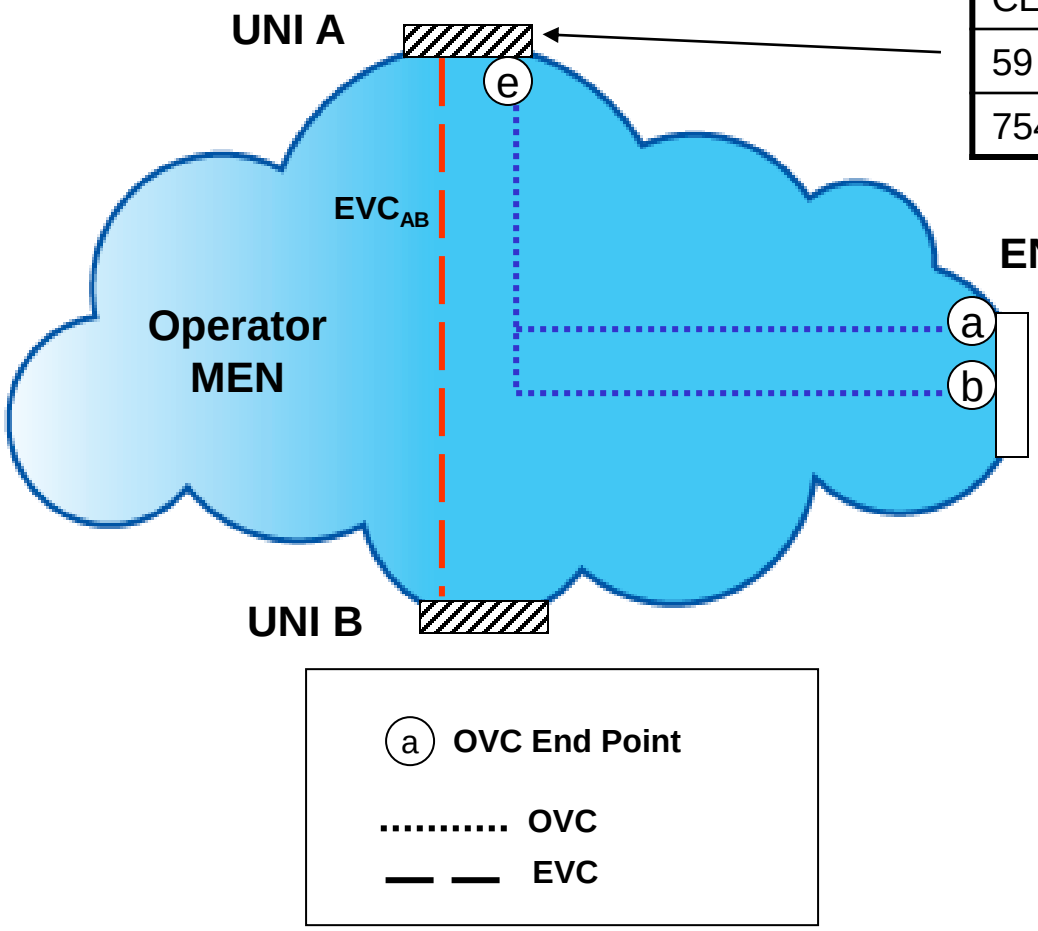
Building EVCs with OVCs



EVC	UNIs	OVCs
1 (red)	**UNI P, UNI R, UNI T**	**A1, B1, C1**
2 (blue)	**UNI Q, UNI S**	**A2, B2**
3 (black)	**UNI P, UNI R**	**A3, B3**
4 (green)	**UNI S, UNI V**	**B4, C4**

Mapping Service Frames to OVC End Points

At the UNI, the CE-VLAN ID of the Service Frame is used to map the frame to either an OVC End Point or an EVC

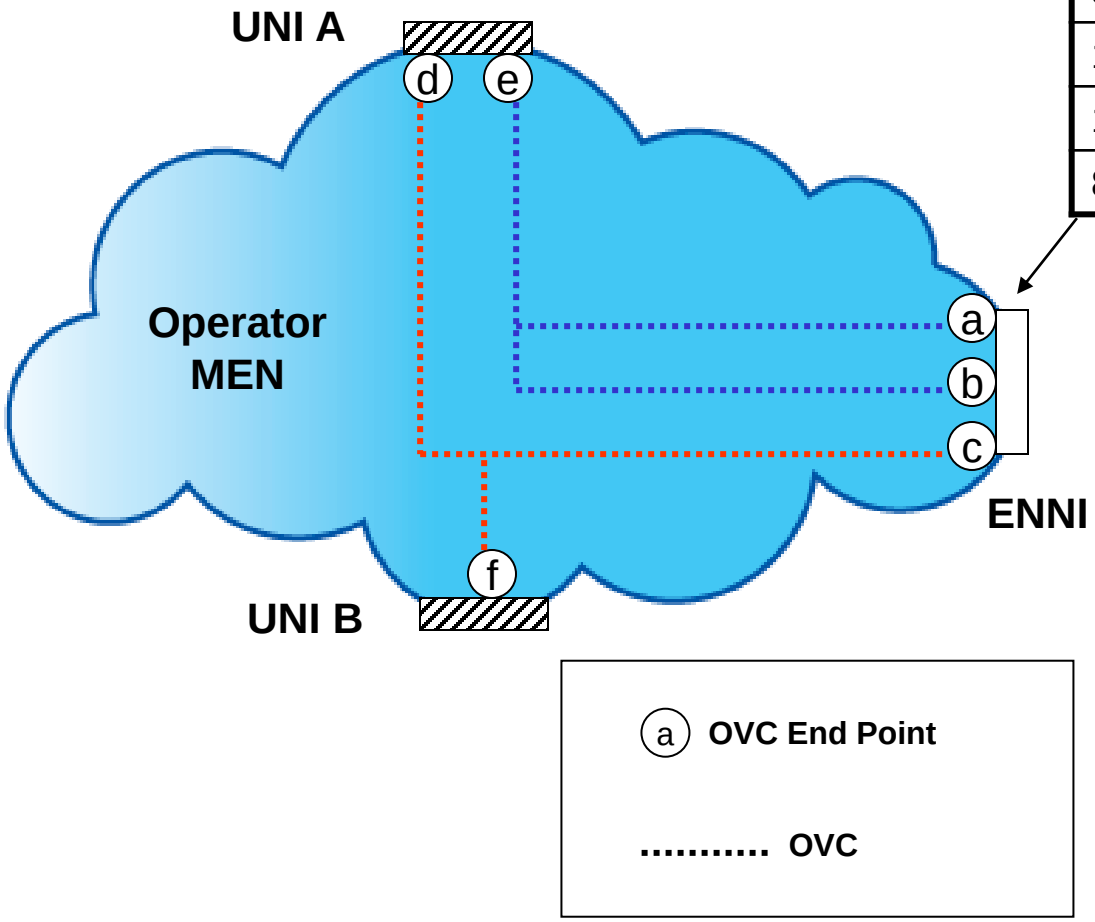


CE-VLAN ID	EVC/OVC End Point
59	OVC End Point e
754	EVC_{AB}

- **The Subscriber at UNI A would perceive that CE-VLAN ID 59 maps to an EVC**
- **UNI A is not necessarily devoted to a single Service Provider**

Mapping ENNI Frames to OVC End Points

S-Tagged ENNI Frames are mapped to OVC End Points via the S-VLAN ID value



End Point Map

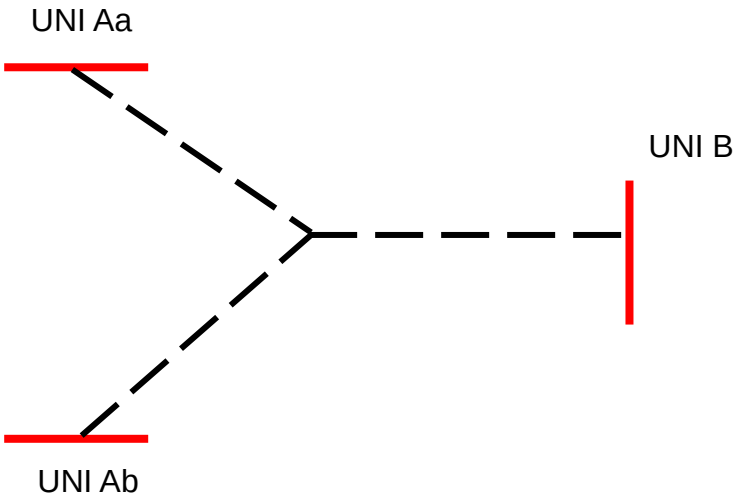
S-VLAN ID	OVC End Point
127	a
128	b
894	c

- **When an ENNI Frame is hairpin switched, the S-VLAN ID value is changed**
- **Multiple S-VLAN ID values can map to the same OVC End Point (called Bundling)**

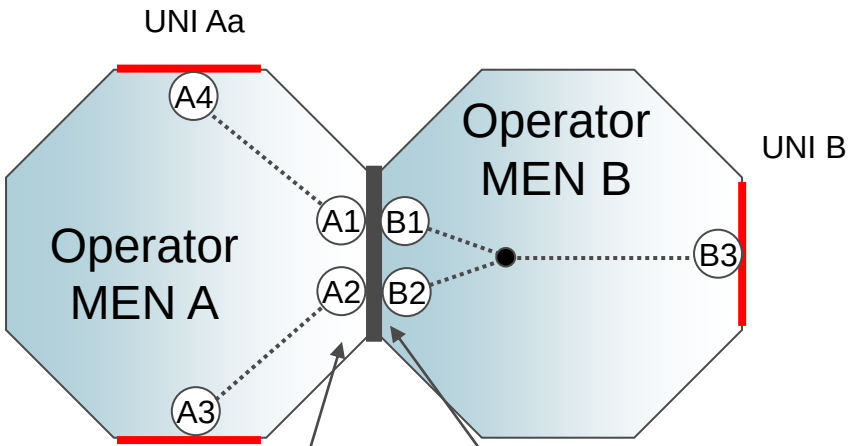
“Stitching Together” OVCs to form EVCs

Service Provider aligns the End Point Maps to build each EVC

Subscriber View



Service Provider View



S-VLAN ID	OVC End Point
2023	A1
1028	A2

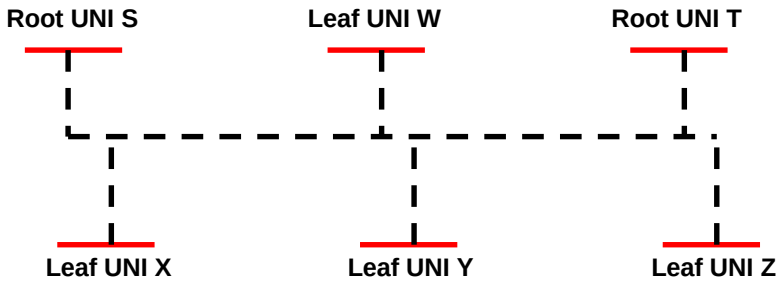
A End Point Map

S-VLAN ID	OVC End Point
2023	B1
1028	B2

B End Point Map

Rooted-Multipoint (RMP) (added in 26.1)

- **An OVC that can associate at least one Leaf or Trunk OVC End Point is defined to have OVC Type of Rooted-Multipoint**
- **The distinction between a Point-to-Point OVC or Multipoint-to-Multipoint OVC and a Rooted-Multipoint OVC with only Root OVC End Points is that a Leaf or Trunk OVC End Point can be added to such a Rooted-Multipoint OVC**
- **To implement a Rooted-Multipoint EVC that spans multiple Operator MENs requires knowing whether the frame is the result of an ingress Service Frame at a Root UNI or a Leaf UNI.**
- **Forwarding behavior of a Rooted-Multipoint (RMP) EVC is specified in MEF10.2**



Subscriber View of the Rooted-Multipoint EVC

Key OVC Service Attributes – 1

- **OVC Type:**
  - Point-to-Point if the OVC associates two OVC End Points
  - Multipoint-to-Multipoint if OVC can associate more than two OVC End Points
  - Rooted Multipoint EVCs
- **OVC End Point List**
  - The End Points associated by the OVC
- **OVC Maximum Transport Unit Size**
  - Must be ≥ 1526 bytes, ≥ 2000 bytes recommended

Key OVC Service Attributes – 2

- **CE-VLAN ID Preservation**
  - An EVC built with OVCs with this attribute = Yes will preserve CE-VLAN IDs as required for EPL and EPLAN
- **CE-VLAN CoS Preservation**
  - An EVC built with OVCs with this attribute = Yes will preserve CE-VLAN CoS as required for EPL and EPLAN

- **S-VLAN ID Preservation**
  - Yes means that S-VLAN ID value is unchanged between ENNIs
  - Yes not allowed when hairpin switching
- **S-VLAN CoS Preservation**
  - Yes means that S-VLAN PCP value is unchanged between ENNIs

Key OVC Service Attributes – 3

- **Color Forwarding (Yes or No)**
  - Yes means Yellow frames cannot be changed to Green
- **Unicast, Multicast, and Broadcast Frame Delivery**
  - Deliver everywhere or deliver selectively, e.g., MAC address learning

Service Level Specification

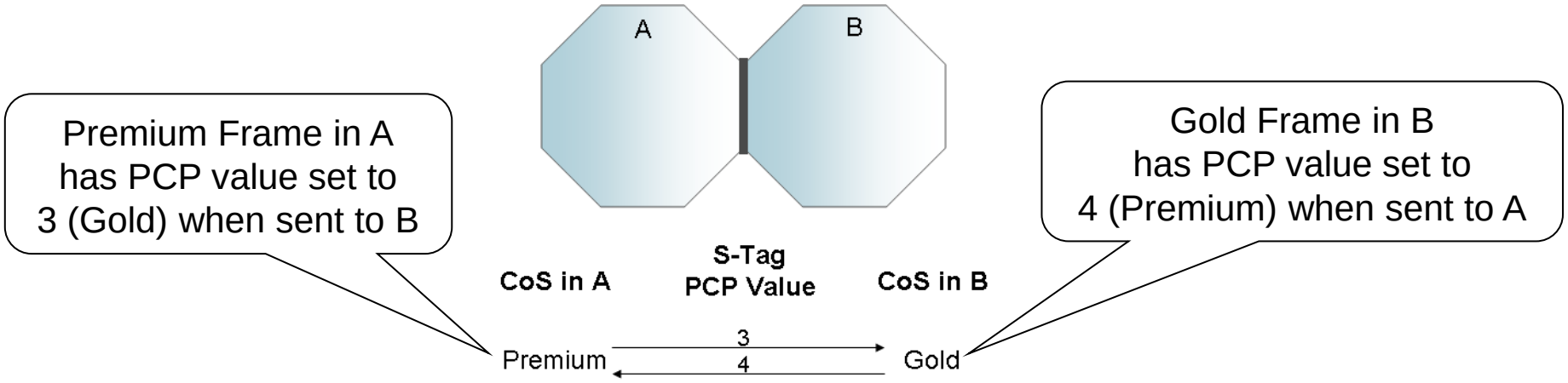
The OVC Related Performance Service Attributes specify the frame delivery performance between External Interfaces (EI). Eight performance metrics are detailed in this specification:

- **One-way Frame Delay,**
- **One-way Frame Delay Range,**
- **One-way Mean Frame Delay,**
- **Inter-Frame Delay Variation,**
- **One-way Frame Loss Ratio,**
- **One-way Availability,**
- **One-way High Loss Intervals, and**
- **One-way Consecutive High Loss Intervals.**

Class of Service at the ENNI

- **Class of Service for an ENNI Frame is indicated by the S-Tag PCP value**
- **Values specified in MEF 23 are mandated for classes H, M, and L**
- **S-Tag PCP value indicates Class of Service for the receiving Operator MEN**

Example when A's Gold is mapped to B's Premium



Class of Service at the UNI

- **Consistent with Subscriber view as specified in MEF 10.2**
  - Based on OVC End Point (all Service Frames mapped to the OVC End Point have the same CoS)*, or
  - Based on C-Tag PCP, or
  - Based on DSCP

*Subscriber perception is that EVC has a single CoS

Bandwidth Profiles at the ENNI

- **Based on same parameters and algorithm as in MEF 10.2**
  - Committed Information Rate (CIR) in bits/sec
  - Committed Burst Size (CBS) in bytes
  - Excess Information Rate (EIR) in bits/sec
  - Excess Burst Size (EBS) in bytes
  - Coupling Flag
  - Color Mode – always set to Color-Aware
- **Ingress Bandwidth Profile (policing)**
  - Applied per OVC End Point or per OVC End Point and Class of Service
  - Green ⇒ SLS applies, Yellow ⇒ no SLS, Red ⇒ discard
- **Egress Bandwidth Profile (shaping)**
  - Applied per OVC End Point or per OVC End Point and Class of Service

Color Marking of ENNI Frames

- **Use either the DEI bit or the PCP of the S-Tag**
- **Yellow indication as specified by MEF 23**

Layer 2 Control Protocol Handling

- **Layer 2 Control Protocol Service Frame is described in MEF 10.2**
- **An ENNI Frame with a Destination MAC Address shown here is | defined to be a Layer 2 Control Protocol ENNI Frame**

MAC Addresses
01-80-C2-00-00-00 through 01-80-C2-00-00-0F
01-80-C2-00-00-20 through 01-80-C2-00-00-2F
01-80-C2-00-00-10

- **L2CP Service Frame or L2CP ENNI Frame is tunneled and delivered to all OVC End Points**
- **Ingress L2CP ENNI Frame that does not have an S-Tag is not to be tunneled because the Operator has no information on which OVC to use to tunnel the frame**

Topics not Covered by the Document

- **Service OAM**
  - Expected to be covered in SOAM Fault Management and SOAM Performance Management documents
- **Additional protocols, e.g., Provider Backbone Bridges, MPLS**
  - Later phase

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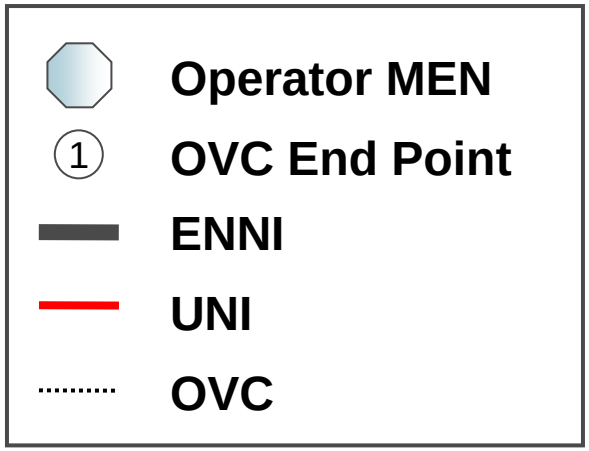
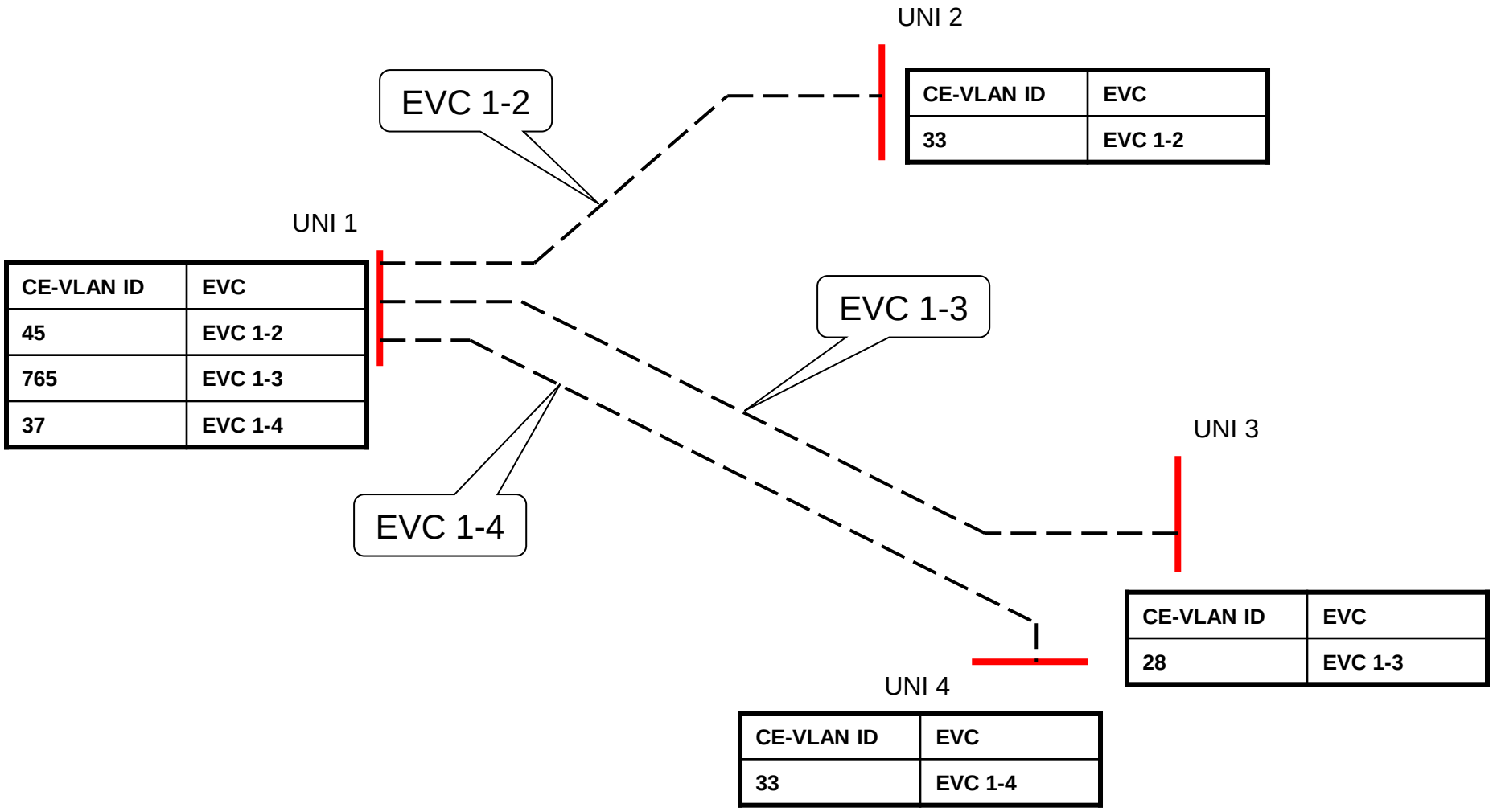
Notation and Conventions

Abbreviation	Object
C-VID	C-VLAN ID value
S-VID	S-VLAN ID value
OEP	OVC End Point Identifier value



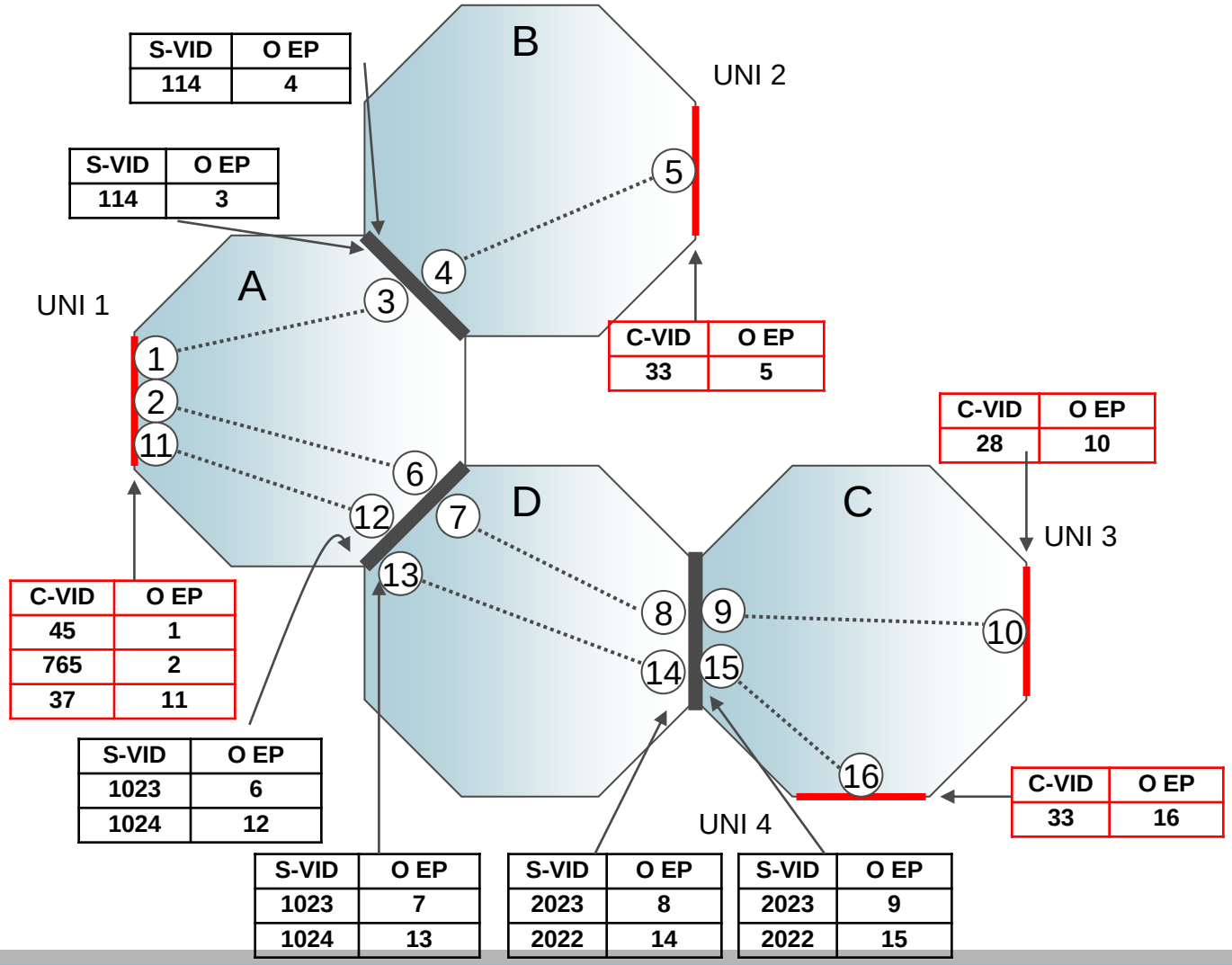
Ethernet Virtual Private Lines to a Hub Location

Subscriber View



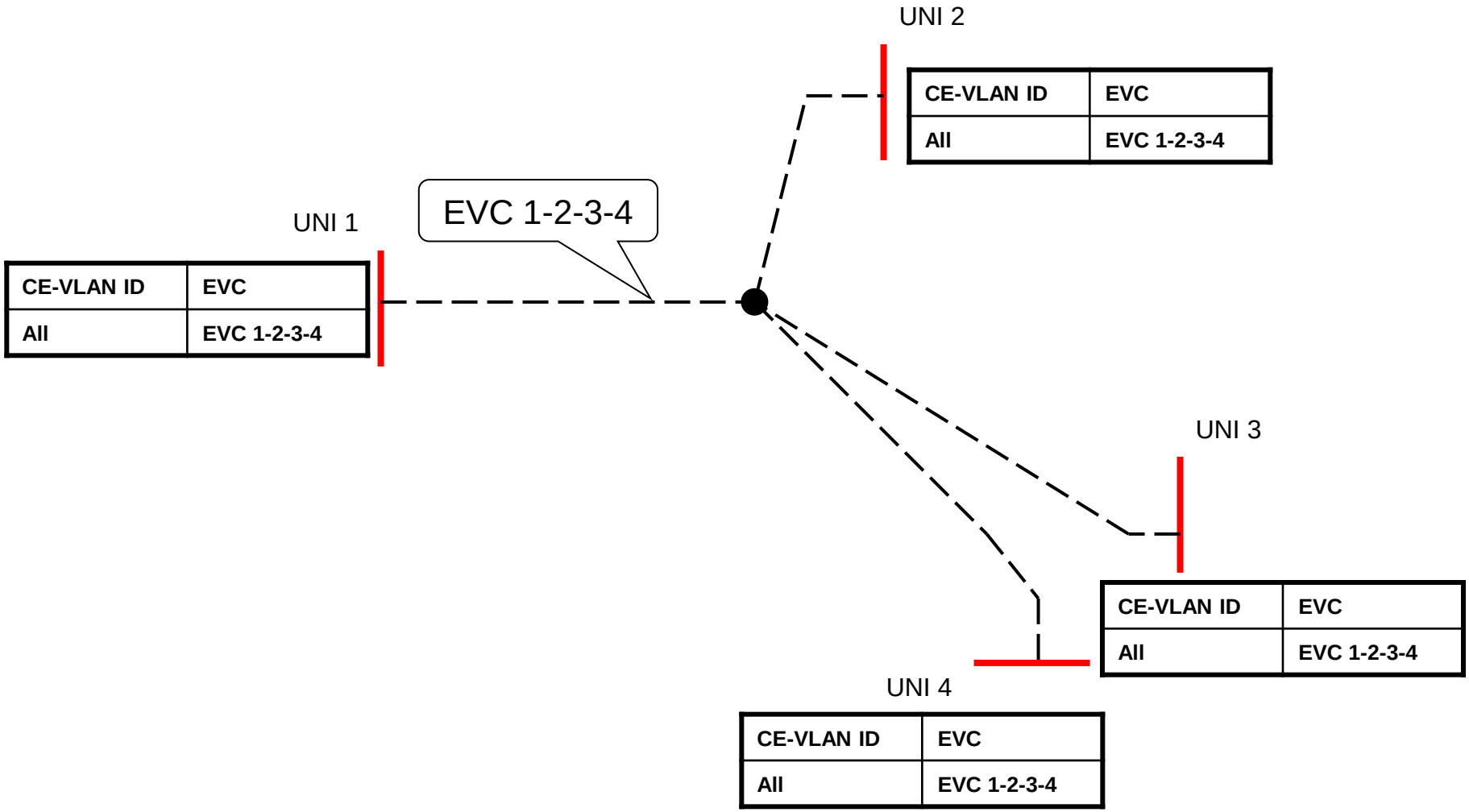
Ethernet Virtual Private Lines to a Hub Location

Service Provider View



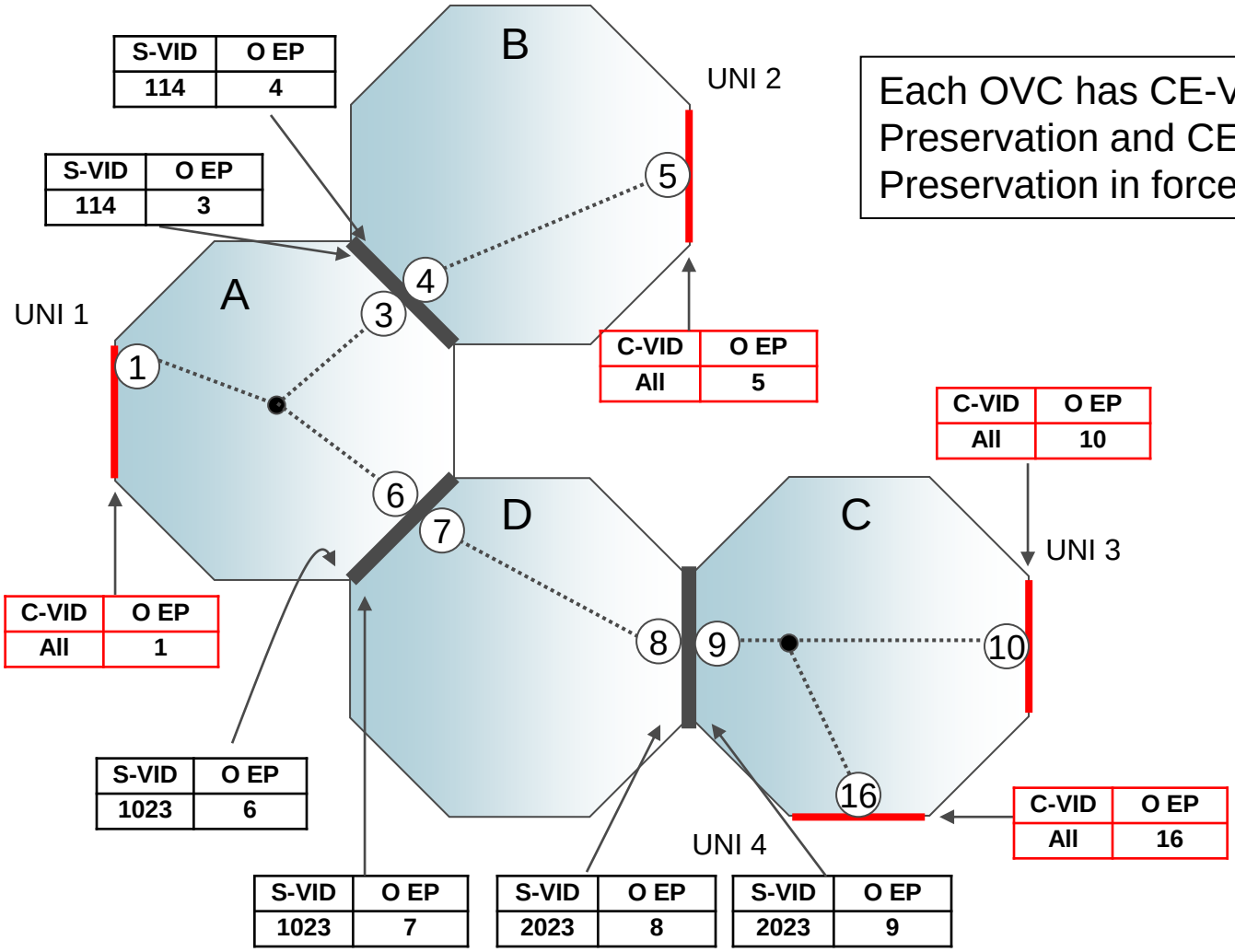
Ethernet Private LAN

Subscriber View



Ethernet Private LAN

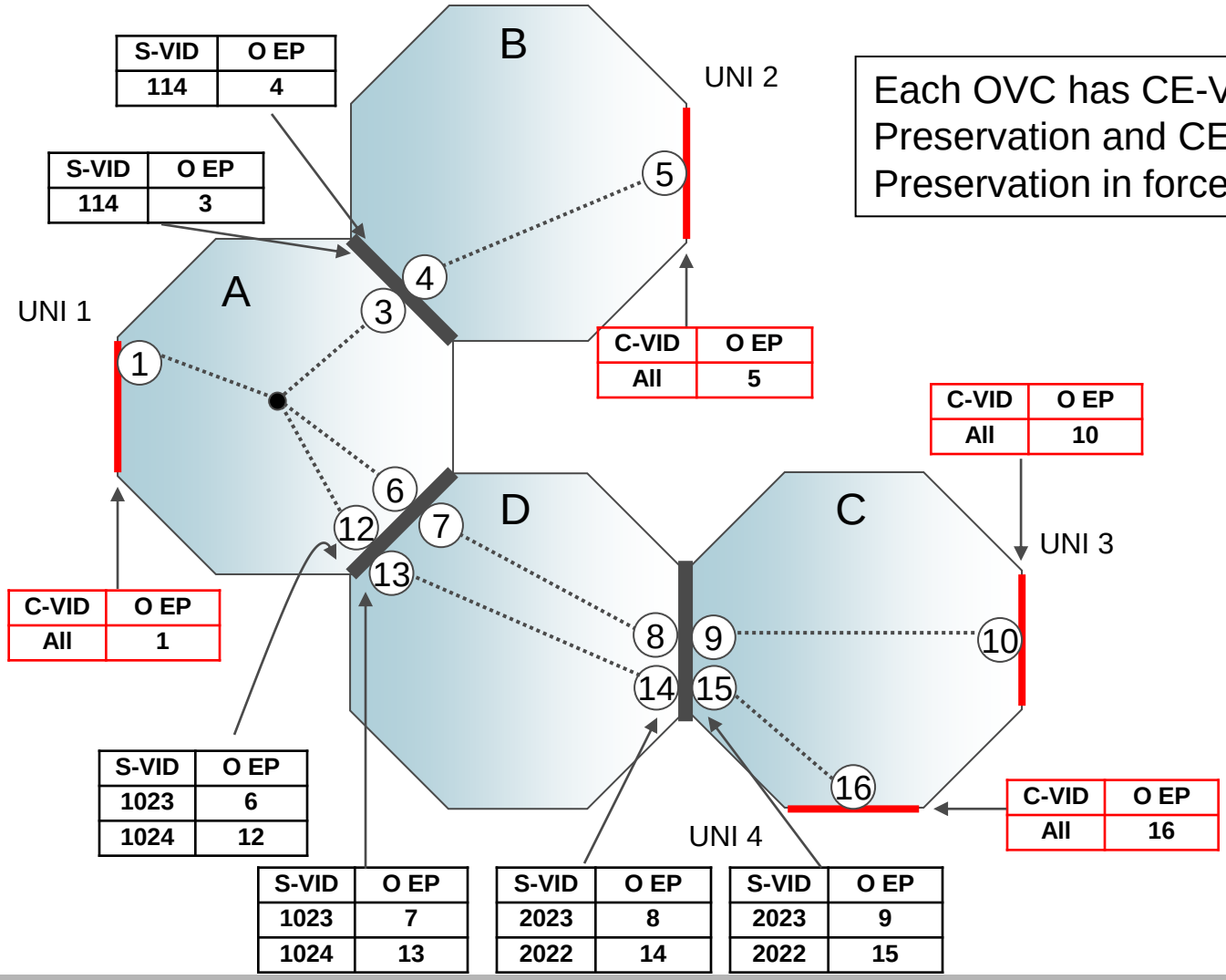
Service Provider View



Each OVC has CE-VLAN ID Preservation and CE-CoS Preservation in force (= Yes).

Ethernet Private LAN with Hairpin Switching

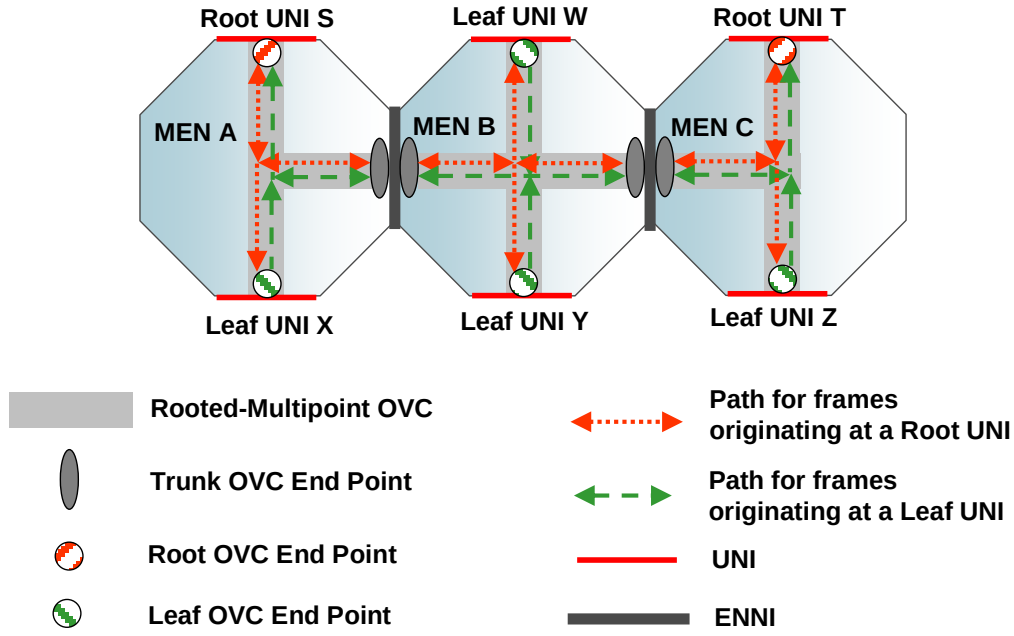
Service Provider View



Each OVC has CE-VLAN ID Preservation and CE-CoS Preservation in force (= Yes).

Rooted-Multipoint EVC – Trunk OVC End Points at the ENNI

- **Rooted-Multipoint EVC using Trunk OVC End Points at the ENNIs that connect three Operator MENs.**
- **Each Operator MEN can receive ENNI Frames that originated at a Root UNI or a Leaf UNI.**
- **Trunk OVC End Points and Trunk Identifiers at the ENNIs allows the Operator MEN to determine the type of ingress UNI and thus properly forward each ENNI Frame.**



Refer to the specification for additional examples

Summary

MEF 26 – Phase I

- Introduces a standard interconnection interface
  - Defines the External Network to Network Interface ENNI
  - Defines Operator Services Attributes
  - Defines a framework for extending an EVC between two UNIs separated by 3rd party operator networks

MEF 26 – Phase II

- Introduces a standard interconnection interface
  - introduces specifications for the support of Rooted-Multipoint EVCs
  - Definition and requirements for tunneling frames containing a Layer 2 Control Protocol on an Operator Virtual Connection
  - Service Level Specification definitions and related requirements

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