Mplify Standard

Mplify 165

Service Access Interface Service Attributes

October 2025

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1 List of Contributing Members

The following members of Mplify participated in the development of this document and have requested to be included in this list.

- AT&T
- Bell Canada
- Colt Technology Services
- Nokia

2 Abstract

This document defines the Service Access Interface which is a physical or virtual Ethernet interface that provides UNI access to multiple Mplify-defined Services that operate at OSI Layer 2 [11] and above, such as the services defined in MEF 6.3 [15], MEF 51.1 [20], MEF 69.1 [25], MEF 70.2 [26], and MEF 140 [27]. These Services are referred to as Service Access Interface Compatible Services in this document.

Service Attributes associated with the Service Access Interface are specified.

Defining a Service Access Interface and the associated Service Attributes allows for:

- multiple Service Access Interface Compatible Services to share a Service Access Interface.
- the instantiation of the Service Access Interface to occur before it is decided which Service Access Interface Compatible Services are to be accessed.
- fewer Service Attribute values to be agreed to when disparate Service Access Interface Compatible Services are accessed via the same Service Access Interface.
- a single data model for the underlying physical layer(s) to be developed that is common for all Service Access Interface Compatible Services for use with automated provisioning capabilities such as LSO.

The Service Access Interface does not include ENNIs as defined in MEF 26.2 [17].

3 Terminology and Abbreviations

This section defines the terms used in this document. In many cases, the normative definitions to terms are found in other documents. In these cases, the third column is used to provide the reference that is controlling, in other Mplify or external documents.

In addition, terms defined in MEF 10.4 [16] and MEF 26.2[17] are included in this document by reference and are not repeated in the table below.

Term	Definition	Reference
C-Tagged Frame	An Ethernet Frame that is either a VLAN Tagged Frame or a Priority Tagged Frame	Adapted from “C-Tagged Service Frame” in MEF 10.4
Egress Ethernet Frame	An Ethernet Frame transmitted on the Service Access Interface toward the Subscriber Network	This document
Ethernet Frame	The first bit of the Destination MAC Address through the last bit of the Frame Check Sequence	IEEE Std 802.3™-2022 [7]
Identifier String	A string composed of a well-defined set of octets that is used to name various components of the Service Access Interface for management purposes	This document
Ingress Ethernet Frame	An Ethernet Frame transmitted on the Service Access Interface toward the Service Provider Network	This document
Interface-related UNI Service Attribute	A UNI Service Attribute that describes a detail of the UNI that is common for all Service Families that use the UNI	This document
Priority Tagged Frame	An Ethernet Frame where the two bytes following the Source Address field is a TPID with the value 0x8100 and a corresponding VLAN ID value of 0x000	Adapted from “Priority Tagged Service Frame” in MEF 10.4
Service Access Interface Compatible Service	A Mplify-defined service that operates at OSI Layer 2 or above	This document
Service	A Service Access Interface Compatible Service	This document
Service Access Interface	A physical or virtual Ethernet or Ethernet-like interface that provides access to Service Access Interface Compatible Services	This document
Service Provider	An organization that provides Service Access Interface Compatible Services to Subscribers via a Service Access Interface	Adapted from MEF 10.4
Service Family	A set of services described within an individual Mplify Standard	This document

Service Multiplexing	Sharing of the Service Access Interface by multiple Services of the same or disparate Service Families	This document
Service-related UNI Service Attribute	A UNI Service Attribute that describes a detail of the UNI that is specific to a Service Family that uses the UNI	This document
S-Tagged Frame	An Ethernet Frame where the two bytes following the Source Address field is a TPID with the value 0x88a8	This document
Subscriber	The end user of a Service Access Interface Compatible Service delivered over a Service Access Interface	Adapted from MEF 10.4
Unique Identifier	A Universally Unique Identifier, UUID, as described in ITU-T X.667 [14]), that is intended for machine-to-machine interactions	This document
Untagged Frame	An Ethernet Frame where the two bytes following the Source Address field of the Ethernet Frame do not contain the value 0x8100 or the value 0x88a8	Adapted from "Untagged Service Frame" in MEF 10.4
User Network Interface	The demarcation point between the responsibility of the Service Provider and the Subscriber	Adapted from MEF 10.4
VLAN Tagged Frame	An Ethernet Frame where the two bytes following the Source Address field is a TPID with the value 0x8100 and the corresponding VLAN ID value is not 0x000	Adapted from "VLAN Tagged Service Frame" in MEF 10.4

Table 1 – Terminology

Abbreviation	Definition	Reference
LAG	Link Aggregation Group	IEEE Std 802.1AX™-2020 [5]
OSI	Open System Interconnection	ISO 7498-1 [11]
TPID	Tag Protocol Identifier	IEEE Std 802.1Q™-2022 [6]
UNI	User Network Interface	Adapted from MEF 10.4

Table 2 – Abbreviations

4 Compliance Levels

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**NOT RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in BCP 14 (RFC 2119 [8], RFC 8174 [10]) when, and only when, they appear in all capitals, as shown here. All key words must be in bold text.

Items that are **REQUIRED** (contain the words **MUST** or **MUST NOT**) are labeled as **[Rx]** for required. Items that are **RECOMMENDED** (contain the words **SHOULD** or **SHOULD NOT**) are labeled as **[Dx]** for desirable. Items that are **OPTIONAL** (contain the words **MAY** or **OPTIONAL**) are labeled as **[Ox]** for optional**.**

5 Document Conventions

5.1 Numerical Prefix Conventions

This document uses the prefix notation to indicate multiplier values as shown in Table 3.

Decimal		Binary	
Symbol	Value	Symbol	Value
k	10^{3}	Ki	2^{10}
M	10^{6}	Mi	2^{20}
G	10^{9}	Gi	2^{30}
T	10^{12}	Ti	2^{40}
P	10^{15}	Pi	2^{50}
E	10^{18}	Ei	2^{60}
Z	10^{21}	Zi	2^{70}
Y	10^{24}	Yi	2^{80}

Table 3 – Numerical Prefix Conventions

5.2 Diagram Conventions

The diagrams in this document have several components that appear frequently. These components are represented in a standard way as described in Figure 1:

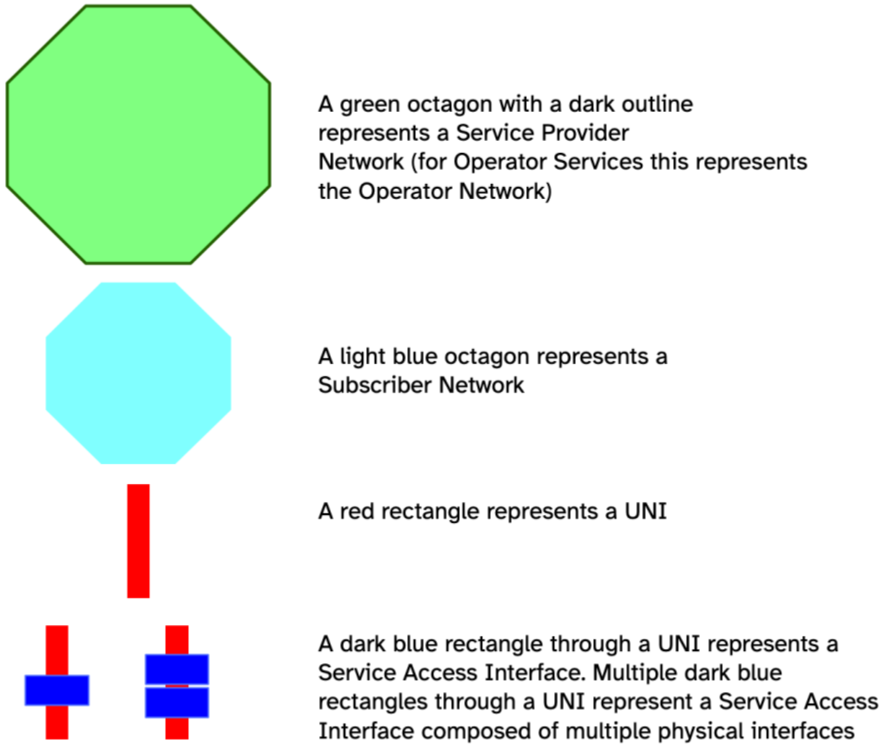

Figure 1 – Diagram Conventions

6 Introduction

Mplify Standards define and/or describe several Services that operate at OSI Layer 2 or above. Each Service Access Interface Compatible Service belongs to one of the following Service Families:

- Subscriber Ethernet Services as defined in MEF 6.3 [15] based on the Service Attributes specified in MEF 10.4 [16],
- Elastic Ethernet Services & Cloud Connectivity as defined in MEF 47.1 [19] based on the Service Attributes defined in MEF 10.4, MEF 26.2 [17], and MEF 47.1 and the Services defined MEF 6.3 and MEF 51.1 [20],
- Operator Ethernet Services as defined in MEF 51.1 based on the Service Attributes specified in MEF 26.2,
- Managed Access E-Line (MAEL) Services as defined in MEF 62 [24] based on the Access E-Line Service defined in MEF 51,
- Subscriber IP Services as defined in MEF 69.1 [25] based on the Service Attributes specified in MEF 61.1 [22] and amendment MEF 61.1.1 [23],
- SD-WAN Services described by the SD-WAN Service Attributes and SD-WAN Service Framework as documented in MEF 70.2 [26], or
- Broadband Access Services as defined in MEF 140 [27] based on the Service Attributes specified in MEF 140 and MEF 26.2.

Each of these Service definitions includes the terms Subscriber, Service Provider and UNI. In this document we define these terms as follows:

- Subscriber defined as the end user of a Service Access Interface Compatible Service delivered over a Service Access Interface
- Service Provider defined as an organization that provides Service Access Interface Compatible Services to Subscribers via a Service Access Interface
- UNI or User Network Interface defined as the demarcation point between the responsibility of the Service Provider and the Subscriber

As noted in section 2, ENNIs as defined in MEF 26.2 are beyond the scope of this document.

The Service definitions include Service Attributes associated with a UNI. Some of these UNI Service Attributes specify the OSI Layer 1 and OSI Layer 2 details for an Ethernet interface between the Subscriber and the Service Provider.[1] Other UNI Service Attributes describe Service-specific details of the networking interface. Service-specific details vary from Service Family to Service Family (e.g., the maximum number of EVC End Points is relevant only to Subscriber Ethernet Services), however many of the UNI Service Attribute values do not vary from Service Family to Service Family, for example, a Link Aggregation Group (LAG) comprising three Ethernet links is the same regardless of the Service Family. Consequently, comparing these Service Attributes across the Service Families exposes the following:

[1] Unlike the other services listed here, MEF 70.2 does not include the detail of the layer 1 and layer 2 characteristics of the UNI.

- In some cases, multiple Service Families each have a Service Attribute that describes the same behavior in the same way. For example, the Service Attribute that specifies whether Link OAM is enabled has the same possible values (*Enabled* and *Disabled*) and similar behaviors for all Service Families. The Service Attribute names are different since the name includes the Service Family (e.g., Subscriber Link OAM Service Attribute vs. IP Access Link Trunk Link OAM Service Attribute).
- In some cases, multiple Service Families each have a Service Attribute or multiple Service Attributes that describe similar behavior in different ways. For example, the single Service Attribute that describes the physical layer characteristics in MEF 10.4, the Subscriber UNI List of Physical Links Service Attribute, is defined as three separate Service Attributes in MEF 26.2, namely the Operator UNI Physical Layer Service Attribute, Operator UNI Synchronous Mode Service Attribute, and Operator UNI Number of Links Service Attribute.
- In some cases, since the various documents are written over a span of years, there are differences as a result of the technologies being used at the time that the documents were written. One example is that each Mplify Standard refers to Ethernet physical interfaces in the version of the IEEE 802.3 standard that was current at the time.

In Carrier Ethernet it is assumed that a single physical interface can terminate both Subscriber (EVC-based) Services and Operator (OVC-based) Services. Subscribers increasingly want IP Services (such as Internet Access Services) delivered over the same physical interface as Carrier Ethernet Services. This results in a situation in which the Service Provider and Subscriber must negotiate values for overlapping Service Attributes and ensure that the values are consistent. This consistency becomes even more important if LSO APIs (see MEF 55.1 [21]) are used to automate business and operational transactions involving the common interface.

Another issue arises when Subscribers request a physical connection to the Service Providers Network prior to deciding which Services will be provided over that connection. This raises the issue of which Service Attributes should be used to describe the configuration of the physical connection.

The Service Access Interface defined in this document addresses these issues. A single set of Service Attributes is defined for the Service Access Interface. They are derived, primarily, from MEF 10.4, as were the Service Attributes in MEF 61.1.1, and therefore this document has a high level of compatibility with those standards. These consolidated Service Attributes can then be used to streamline service delivery of any Service Access Interface Compatible Service via the Service Access Interface.

Since the Service Access Interface is the interface between the Subscriber Network and the Service Provider Network, it is already used by all Mplify Services that operate at OSI Layer 2 and above, but the existing Mplify Services do not refer to the Service Access Interface and merge the concept of a Service Access Interface and its Service Attributes into the UNI Service Attributes.

A Service Access Interface can contain one or more physical links. When multiple physical links are configured at a Service Access Interface, the individual links may terminate at the same device in the Service Provider Network and/or in the Subscriber Network[2], or at different devices in the

[2] Service Provider Network and Subscriber Network are defined in MEF 10.4.

Service Provider Network and/or in the Subscriber Network (e.g., using DRNI as defined in IEEE Std 802.1AX™-2020 [5]).

Three appendices are included. Appendix A provides a template that can be adapted by other Mplify Standards when referring to the Service Access Interface. This is to help ensure that the Service Access Interface is described in a common way across the documents that will use it.

Appendix B describes coexistence of Services whose Service Attributes and Service definitions have been updated to use the Service Access Interface and those that haven't. It includes a mapping of the Service Access Interface Service Attributes to the UNI Service Attributes in each of the other documents.

Appendix C describes how the Service Access Interface fits into Service architectures with multiplexing above OSI Layer 2.

7 Key Concepts

This section details concepts used in the remainder of the document.

7.1 Roles and Services

The parties associated with a Service Access Interface Compatible Service are:

- Subscriber defined as the end user of a Service Access Interface Compatible Service delivered over a Service Access Interface
- Service Provider defined as an organization that provides Service Access Interface Compatible Services to Subscribers via a Service Access Interface

This document assumes that the Service Access Interface is provided by the Service Provider either directly or via a separate entity meeting the requirements of the Service Provider. In either case, from the point of view of the Subscriber, the Service Access Interface is provided by the Service Provider.

Each Service Access Interface Compatible Service defines a demarcation point, the UNI, between the responsibility of the Service Provider and the responsibility of the Subscriber, along with Service Attributes for the UNI. The names of the Service Attributes differ between Service Families but always includes "UNI". The details of the demarcation point and associated Service Attributes can vary among these Service Families. The Service Access Interface and its associated Service Attributes defined in this document consolidates a subset of the UNI Service Attributes, thus allowing any Service Access Interface Compatible Service to use the Service Access Interface and allowing different Service Families to share a Service Access Interface.

Each Service Access Interface Compatible Service accepts Ingress Ethernet Frames[3] and delivers Egress Ethernet Frames at a UNI. The Service Access Interface describes these behaviors by defining a 'communications channel' between the Service Provider Network and the Subscriber Network for Ethernet Frames at a UNI.

7.2 Ethernet Frames and Ethernet Frame Types

Ethernet Frames[4] are exchanged between the Subscriber Network and the Service Provider Network across the UNI via the Service Access Interface. An Ethernet Frame transmitted on the Service Access Interface toward the Service Provider Network is called an Ingress Ethernet Frame. An Ethernet Frame transmitted on the Service Access Interface toward the Subscriber Network is called an Egress Ethernet Frame. Ethernet Frames are exchanged via a standard Physical Layer (section 9.5) or by other means from which an IEEE Std 802.3™-2022 [7] Ethernet Frame can be inferred (see sections 9.3 and 9.4).

The format of an Ethernet Frame is specified in IEEE Std 802.3™-2022 as the first bit of the Destination MAC Address through the last bit of the Frame Check Sequence.

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[3] Even for packet-level Services such as IP Services, when traversing a UNI, the packets are encapsulated in Ethernet Frames.

[4] This document uses the term Ethernet Frame interchangeably with MAC frame as defined in IEEE Std 802.3™-2022. MEF 10.4 [16] and MEF 26.2 [17] use the term Service Frame for Ethernet Frames that cross a UNI.

Figure 2 depicts two types of Ethernet Frames that are carried on the Service Access Interface: Untagged Frames and C-Tagged Frames. The numbers in parentheses represent the number of bytes in each field.

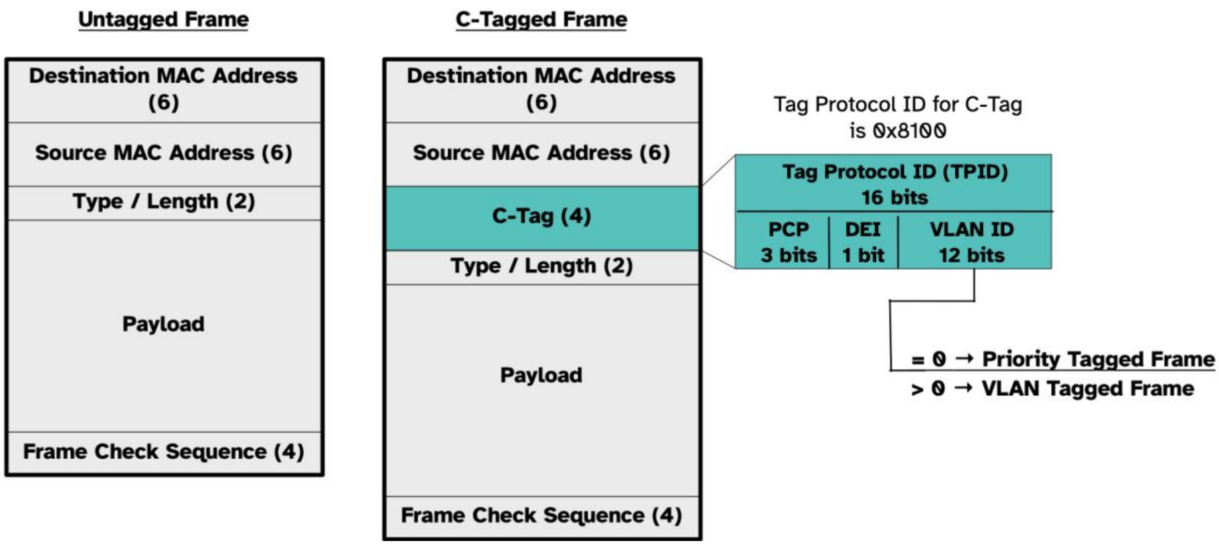

Figure 2 – Untagged and C-Tagged Ethernet Frame Formats

IEEE Std 802.3-2022 requires all Ethernet Frames to be at least 64 bytes long which includes a 46-byte payload (which can be padded to 46 bytes if necessary). IEEE Std 802.3-2022 also requires all Ethernet implementations to support at least one of three maximum payloads:

- Basic frame with a maximum payload of 1500 bytes (total frame size = 1518 bytes). Support of the basic frame is not sufficient for any of the Mplify-defined Services.
- Q-tagged frame with a maximum payload of 1504 bytes (total frame size = 1522 bytes) for implementations that are required to support a single VLAN tag. All Service Access Interface Compatible Services except Operator Ethernet Services (which include Broadband Access E-Line and Broadband Access E-LAN) require support of Q-tagged Frames at a minimum.
- Envelope frame with a maximum payload of 1982 bytes (total frame size = 2000) to support multiple VLAN tags as well as higher layer protocols that can require multiple protocols headers. Mplify Operator Ethernet Services are required to support two VLAN tags (total frame size = 1526 bytes) but are not required to support a full envelope frame. Many Ethernet implementations support Ethernet Frames longer than 2000 bytes. These are often referred to as "jumbo frames" and Mplify Standards, in general, do not preclude this.

The following frame types are referred to throughout this document:

- VLAN Tagged Frame: An Ethernet Frame where the two bytes following the Source Address field is a TPID with the value 0x8100 and the corresponding VLAN ID value is not 0x000
- Priority Tagged Frame: An Ethernet Frame where the two bytes following the Source Address field is TPID with the value 0x8100 and a corresponding VLAN ID value of 0x000

- C-Tagged Frame: An Ethernet Frame that is either a VLAN Tagged or a Priority Tagged Frame
- S-Tagged Frame: An Ethernet Frame where the two bytes following the Source Address field is a TPID with the value 0x88a8
- Untagged Frame: An Ethernet Frame where the two bytes following the Source Address field of the Ethernet Frame do not contain the value 0x8100 or the value 0x88a8

In VLAN Tagged Frames, the VLAN Tag includes 2 bytes following the TPID which consists of three fields:

1. The PCP field in the first 3 bits
2. The DEI field in the fourth bit
3. The VLAN ID field in the last 12 bits

Note that the behavior for S-Tagged Frames at the Service Access Interface is beyond the scope of this document and the term "S-Tagged Frame" does not appear in the remainder of this document. Consequently, the behavior experienced by S-Tagged Frames can vary from Service Provider to Service Provider. A Subscriber who wants to use S-Tagged Frames is urged to check with the Service Provider to determine the behavior for such Ethernet Frames.

7.3 Identifiers

This document describes two different types of identifiers: Identifier Strings and Unique Identifiers.

7.3.1 Identifier String

An Identifier String is a string that can be used by personnel at the Service Provider and the Subscriber to discuss a particular construct such as a UNI, a Service Access Interface, an EVC, an IPVC End Point, etc.

The length of the Identifier String is not limited by this document.[5]

Since the Identifier String is intended to be human readable, the allowable character set is chosen to contain printable ASCII characters.

[R1] An Identifier String **MUST** be a string consisting of one or more UTF-8 characters in the range of 32–126 (0x20 to 0x7e), inclusive.

[R2] The value of an Identifier String **MUST** be unique across all Identifier Strings used as values for all Service Attributes agreed on by the Service Provider and the Subscriber.

[5] Some existing Mplify Standards limit the length of these strings. For example, MEF 10.4 [16] and MEF 26.2 [17] limit them to 45 octets and MEF 61.1 [22] limits them to 53 octets. MEF 70.2 [26] does not impose a limit.

7.3.2 Unique Identifier

A Unique Identifier is a Universally Unique Identifier, a UUID, as described in ITU-T X.667 [14]), that is intended for machine-to-machine interactions such as LSO APIs.

The UUID, which is constructed in a such a way as to make the probability of generating duplicate UUIDs extremely low, is a 128 bit sequence that can be written as 32 hex digits (i.e., 0-9 and a-e) broken up in groups using hyphens. An example grouping is 8-4-4-4-12, such as `550e8400-e29b-41d4-a716-446655440000`.

[R3] A Unique Identifier **MUST** be a Universally Unique Identifier (UUID) as described in ITU-T X.667 [14].

8 Service Access Interface and UNI

In all Mplify Services, the UNI is defined as the demarcation point between the responsibility of the Service Provider and the Subscriber. This is illustrated in Figure 3 where the Subscriber has responsibility for everything in the Subscriber Network (left octagon) while the Service Provider has responsibility for everything in the Service Provider Network (right octagon).

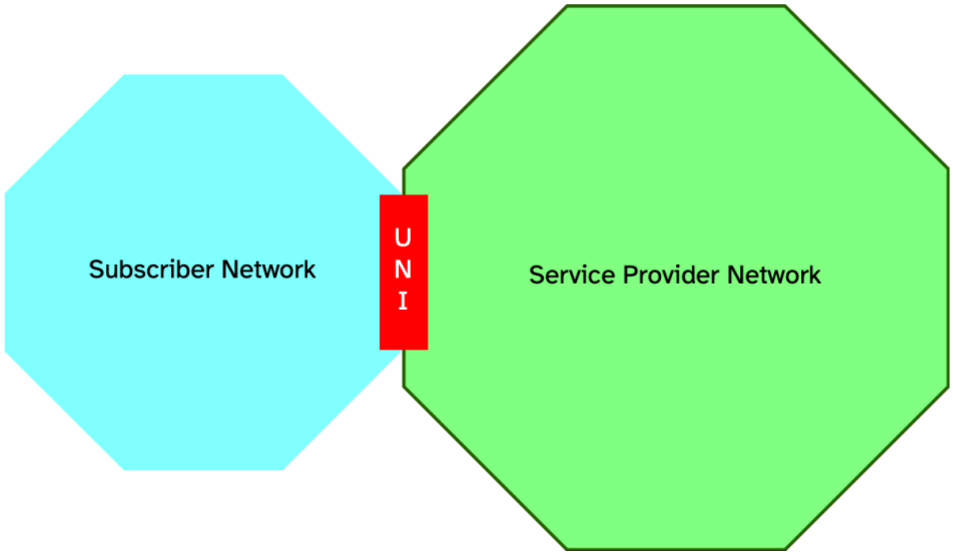

Figure 3 – Graphical Representation of the UNI as a Demarcation Point

This approach allows the Service documents to discuss the UNI purely as a demarcation point without dealing with the actual implementation. Each Service Family has a set of UNI Service Attributes that describe the behavior of the Service as observed by the Subscriber at the UNI and whose values are agreed upon by the Service Provider and Subscriber.

In the remainder of this section:

- Section 8.1 shows how UNI Service Attributes can be decomposed into two groups,
- Section 8.2 describes how the Service Access Interface can use multiple physical links,
- Section 8.3 depicts the Service Access Interface and Service-related UNI Service Attributes in the context of the overall Service architecture, and
- Section 8.4 describes how this decomposition can be used when multiple Service instances are accessed via the Service Access Interface.

8.1 Decomposition of the UNI Service Attributes

In all the Mplify Service documents the “UNI Service Attributes” (they have slightly different titles in each document) describe the behavior and functionality associated with the UNI and the network interface that provides connectivity between the Service Provider Network and the Subscriber Network. Since the Service Provider and the Subscriber agree to the values of these Service Attributes, both organizations can configure their networks to achieve interoperability.

The UNI Service Attributes in Mplify Service Standards can be partitioned into two groups. The first group, the Interface-related UNI Service Attributes, contains UNI Service Attributes that describe details of the UNI that are common across all of the Service Families that use the UNI. These Service Attributes describe the details of the OSI Layer 1 and OSI Layer 2 characteristics of the connectivity between the Service Provider Network and the Subscriber Network. One example is the Subscriber UNI List of Physical Links Service Attribute in MEF 10.4 [16]. The second group, the Service-related UNI Service Attributes, contains the UNI Service Attributes specific to a Service Family using the UNI. One example is the UNI Routing Protocols Service Attribute in MEF 61.1 [22]. This dichotomy is shown in Figure 4.

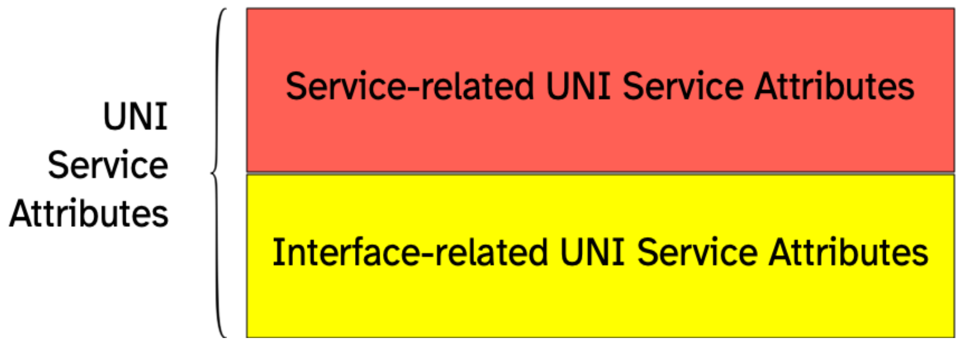

Figure 4 – UNI Service Attributes Partitioning

Figure 4 shows the partitioning of UNI Service Attributes: the Service-related UNI Service Attributes (the upper set shown in red) and the Interface-related UNI Service Attributes (the lower set shown in yellow). Although included in the UNI Service Attributes for each Service Family, the Interface-related UNI Service Attribute values specify behaviors that are independent of the Service Family or Service Families being delivered.

This representation of the UNI Service Attributes begins to expose the problem addressed by this document. A single demarcation point can be a demarcation for multiple Services. This is referred to as Service Multiplexing. The Services can be in the same Service Family, e.g., three EVPLs (Subscriber Ethernet Service), or in different Service Families, e.g., EVPL and Internet Access (IP Service).

Service Multiplexing can result in two (or more) sets of UNI Service Attributes for a single demarcation point. If the Services are in the same Service Family, there is only one set of UNI Service Attributes. But if they are in different Service Families, for example Subscriber Ethernet and Operator Ethernet or Subscriber Ethernet and IP, then there are different sets of UNI Service Attributes for both the Service-related and the Interface-related UNI Service Attributes and aligning the values of the Interface-related UNI Service Attributes is required and complex.

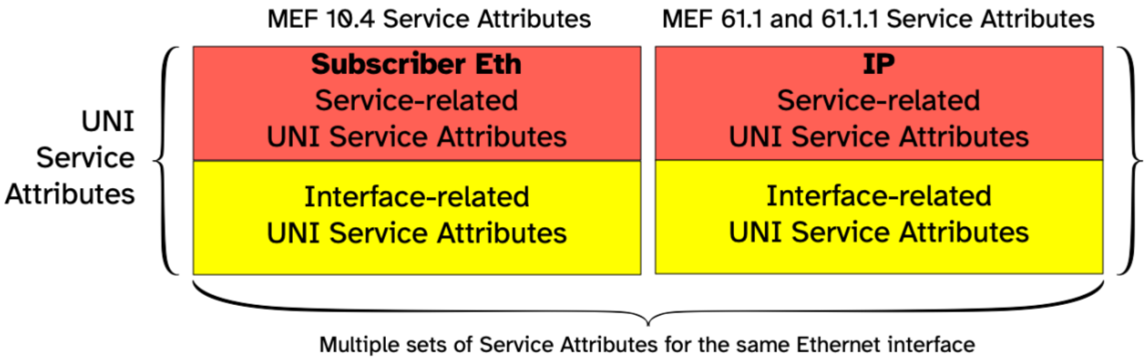

Figure 5 – Example of Multiple Sets of UNI Service Attributes

This document focuses on the Interface-related UNI Service Attributes. As shown in Figure 5, if a Subscriber Ethernet Service and an IP Service are delivered at the same demarcation point there are two different sets of Service Attributes for describing the same Ethernet interface. The Service Attributes describe similar behavior, but from Service Family to Service Family the structure, and in some cases the allowed values, can be different.

Having the Interface-related UNI Service Attributes directly associated with each Service Family poses the following questions:

1. If the Service Provider deploys equipment implementing the demarcation point before it is known what Subscriber service(s) are going to be provided, which set of Service-Family-specific Interface-related UNI Service Attributes and values need to be implemented?

2. If the Service Provider is delivering multiple Services at the demarcation point and those Services are in different Service Families:

    a. Does the Subscriber have to support multiple different sets of Service-Family-specific Interface-related Service Attributes for communicating with the Service Provider?

    b. Does the Service Provider have to implement multiple different sets of Service-Family-specific Interface-related Service Attributes?

    c. How are the differences between the various sets of Service-Family-specific Interface-related Service Attributes dealt with operationally?

This document addresses these issues by defining a Service Access Interface that is the interface between the Service Provider Network and the Subscriber Network. The Service Access Interface has a single set of Service Attributes derived from the various Interface-related Service Attributes in the current Service Family Standards and represent the Interface-related Service Attributes for all of these Service Families.

Services whose definitions refer to the Service Access Interface Service Attributes can simultaneously operate with Services that do not refer to the Service Access Interface. Appendix B identifies each Service Access Interface Compatible Service and discusses how the Interface-related Service Attributes for each Service Family can map into or compatibly coexist with the corresponding Service Access Interface Service Attributes.

With the Service Access Interface Service Attributes, Figure 5 can be modified as shown in Figure 6:

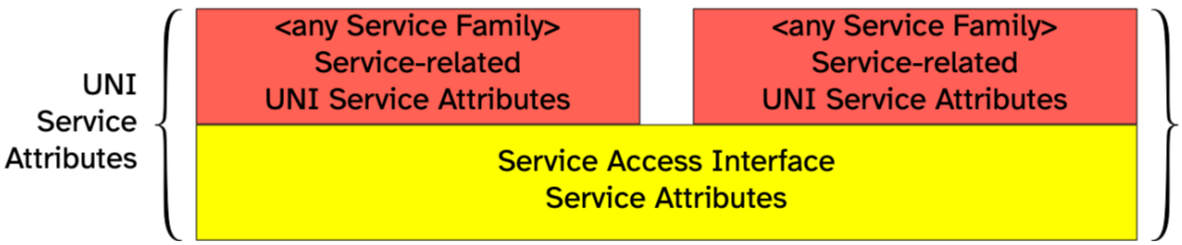

Figure 6 – Multiple Service Families with the Single Service Access Interface

8.2 Interface Multiplexing at the Service Access Interface

In some networking systems, interfaces can be composed of a set of multiplexed (sub-)interfaces for the sake of redundancy or capacity or both.

With Ethernet, this is accomplished using Link Aggregation or LAG (IEEE Std 802.1AX [5]). The Service Access Interface includes Service Attributes that allow for the use of Link Aggregation, as shown in Figure 7:

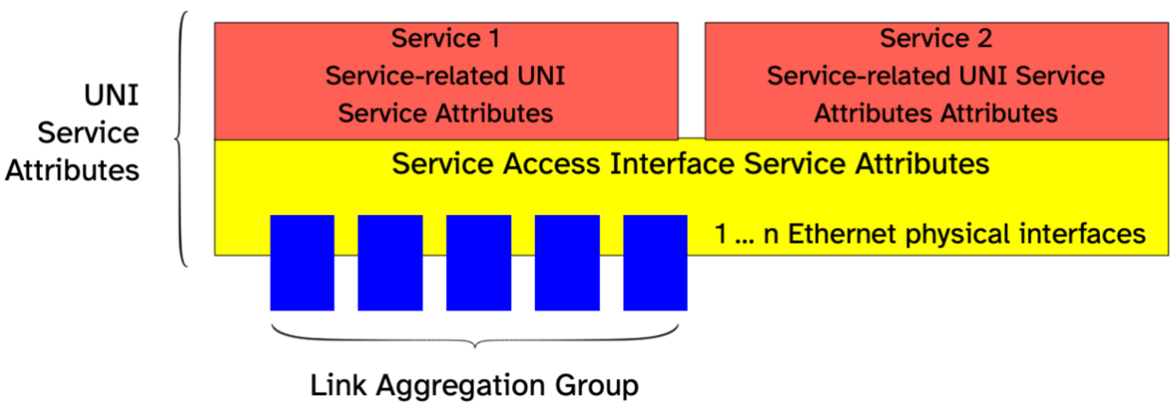

Figure 7 – Service Access Interface with Link Aggregation

In Figure 7, the Service Access Interface is a Link Aggregation Group composed of 5 Ethernet physical interfaces (the blue rectangles).

If a Service Family operates above OSI Layer 2 (for example IP Services operating at OSI Layer 3), there can be multiplexing of multiple Service Access Interfaces. This document is not concerned with higher-level multiplexing since it is focused on the implementation of a single Service Access Interface, but it is important to understand the relationships when applying the Service Access Interface Service Attributes to the various Service Families. Refer to Appendix C for additional discussion of multiplexing above OSI Layer 2.

8.3 Service Access Interface in the Service Context

Figure 8 shows the two components that compose the UNI Service Attributes — the Service Access Interface and Service-related UNI Service Attributes — in the context of the overall Service architecture with two Services being multiplexed at the UNI.

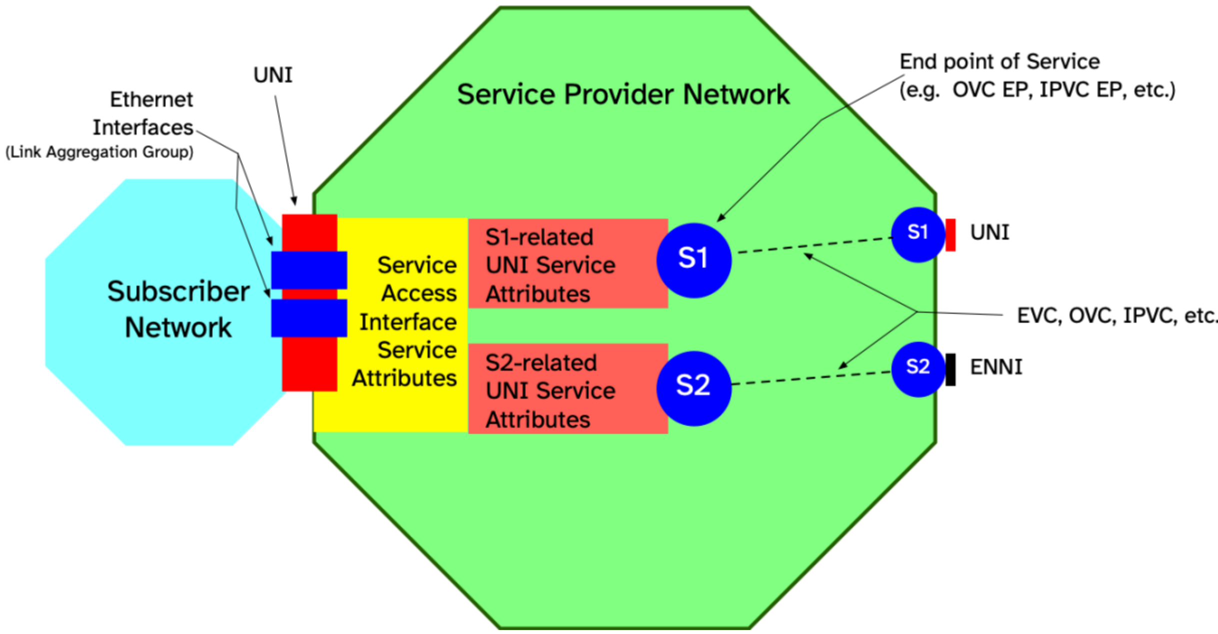

Figure 8 – Service Access Interface and UNI Service Attributes in a Service Context

8.4 Services and Service Multiplexing at the Service Access Interface

As noted in the previous section, the Service Access Interface can be shared by multiple Services of the same or disparate Service Families. This is referred to as Service Multiplexing in several Mplify Standards.

When Ethernet Frames are mapped to a Service at a Service Access Interface using the Service Attribute identified in Table 4 (below), they are mapped by one of the following five methods:

- *List* of one or more C-tag VLAN IDs in the range 1…4094,
- *All* indicating all Ethernet Frames, Untagged, Priority Tagged, and VLAN Tagged,
- *UT/PT* indicating (only) Untagged and Priority Tagged Frames,
- *All-NP* indicating all Untagged and VLAN Tagged Frames i.e., not Priority Tagged[6], or
- *UT* indicating only Untagged Frames

[6] The values *All-NP* and *UT* are intended for use by Broadband Access Services as specified in MEF 140 (Broadband Access E-Line and Broadband Access E-LAN). Some Broadband networks cannot process Priority Tagged Frames.

Each Service Family has a different Service Attribute to map Ethernet Frames to a Service and each Service Family supports a subset of the allowed mapping methods described above. Table 4 lists the Service Access Interface Compatible Services and how Ethernet Frames are mapped to each.[7]

Service Family	Mplify Standard	Relevant Service Attribute	Allowed Mapping Methods
Subscriber Ethernet Services and Elastic Ethernet Services	MEF 10.4	EVC End Point Map	*List, All, UT/PT*
Operator Ethernet Services and MAEL and Elastic Ethernet Services	MEF 26.2	OVC End Point Map	*List*[8] (described as Form U)
Broadband Access E-Line and Broadband Access E-LAN Services	MEF 140	OVC End Point Map	*List, All, All-NP, UT/PT, UT*
IP Services	MEF 61.1.1	UNI Access Link L2 Technology	*List* with one entry, *UT/PT*
SD-WAN Services	MEF 70.2	SD-WAN UNI L2 Interface	*List* with one entry, *UT/PT*

Table 4 – Mapping Frames to Services for each Service Family

It is not necessary that a Service Family support all five methods. For example, an IP Service that can only map a single C-Tag VLAN ID would not include *All* as an applicable method. In addition to the requirements below, the Service Access Interface Service Multiplexing Service Attribute (section 9.6) specifies parameters and requirements for mapping C-Tag VLAN IDs to Services at the Service Access Interface.

[R4] At the Service Access Interface, Untagged and Priority Tagged Frames **MUST** be mapped using either the *UT/PT* or *UT* method to, at most, one Service.

[R5] At the Service Access Interface, a given C-Tag VLAN ID value **MUST** be mapped to no more than one Service.

Note that [R5] implies that if a Service is mapping *All* or *All-NP* Frames at the Service Access Interface then no other Service can exist on the Service Access Interface at the same time.

[7] These are not the allowed values for the specified Service Attributes, but rather an indication of which of the five methods for mapping frames are supported. For example, for SD-WAN the Service Attribute values are *CVLAN x* and *Untagged*.

[8] Untagged and Priority Tagged Frames are mapped to an OVC via a Default CE-VLAN ID which can be included in the specified *List*.

9 Service Access Interface Service Attributes

This section contains definitions of Service Attributes that apply to a Service Access Interface. There is one instance of these Service Attributes for each Service Access Interface. The Service Attributes are summarized in Table 5, and each is described in more detail in the subsequent sections.

Attribute Name	Summary Description	Possible Values
Service Access Interface Identifier	Identification of the Service Access Interface suitable for human-to-human interactions	Identifier String or a null string (see section 9.1)
Service Access Interface Unique Identifier	Identification of the Service Access Interface suitable for machine-to-machine interactions	Unique Identifier or a null string (see section 9.2)
Service Access Interface Instantiation	Specifies whether the Service Access Interface is implemented on a physical Ethernet interface or virtually.	*Physical* or *Virtual* (see section 9.3)
Service Access Interface Virtual Frame Map	If the value of the Service Interface Instantiation Service Attribute is *Virtual*, the Service Access Interface Virtual Frame Map provides the details of how blocks of data that cross the virtual interface are mapped to Ethernet Frames.	See section 9.4
Service Access Interface List of Physical Links	Each physical link that composes the Service Access Interface is described by an entry in the list. Each entry describes 7 parameters of the interface.	List of 7-tuples ⟨*id, uid, pl, fs, pt, ct, gn*⟩ (see section 9.5)
Service Access Interface Service Multiplexing Limits	Parameters limiting how the Service Access Interface can be shared by multiple Services.	2-tuple ⟨*maxServices, maxVlans*⟩ (see section 9.6)
Service Access Interface Link Aggregation	Parameters for the use of Link Aggregation at the Service Access Interface.	3-tuple ⟨*lag, lacpVersion, portMap*⟩ (see section 9.7)
Service Access Interface Ethernet Frame Format	Describes the allowable format of Ethernet Frames that traverse the Service Access Interface.	*As specified in Clause 3 of IEEE Std 802.3™-2022*[7] (see section 9.8)
Service Access Interface Maximum Ethernet Frame Size	Specifies the maximum size of an Ethernet Frame that can traverse the Service Access Interface.	Integer ≥ 1522 (see section 0)
Service Access Interface Link OAM	Indicates whether Link OAM is used on the Service Access Interface.	*Enabled* or *Disabled* (see section 9.10)

Attribute Name	Summary Description	Possible Values
Service Access Interface L2CP Peering	A possibly empty list of Layer 2 Control Protocols that are peered by a process in the Service Provider Network.	See MEF 45.1 [18] and section 9.11.
Service Access Interface Performance Objectives Evaluation Intervals	Defines the sequence of time windows used to evaluate performance of the Service Access Interface.	2-tuple $\langle s, T \rangle$ (see section 9.12)
Service Access Interface Availability Objective	Defines an objective for Availability of the Service Access Interface.	Real number expressed as a percent 0-100% (see section 9.13)
Service Access Interface Mean Time To Repair Objective	Defines an objective for the Mean Time To Repair an outage on the Service Access Interface.	Non-negative real number of minutes (see section 9.14)

Table 5 – Service Access Interface Service Attributes Summary

9.1 Service Access Interface Identifier Service Attribute

The value of the Service Access Interface Identifier is a name for the Service Access Interface that is suitable for human interactions. It can be used by the Subscriber and Service Provider to identify the Service Access Interface to each other.

[R6] The value of the Service Access Interface Identifier Service Attribute **MUST** be an Identifier String as defined in section 7.3.1 or a null string (0x00).

9.2 Service Access Interface Unique Identifier Service Attribute

The value of the Service Access Interface Unique Identifier Service Attribute is a universally unique identifier (UUID) that is suitable for machine-to-machine interactions (e.g., APIs) between the Subscriber and Service Provider.

[R7] The value of the Service Access Interface Unique Identifier Service Attribute **MUST** be a Unique Identifier as defined in section 7.3.2 or a null string (0x00).

[R8] For the Service Access Interface, at least one of the Service Access Interface Identifier Service Attribute and the Service Access Interface Unique Identifier Service **MUST NOT** be a null string.

9.3 Service Access Interface Instantiation Service Attribute

The value of the Service Access Interface Instantiation Service Attribute is either *Physical* or *Virtual*.

When the value is *Physical*, the Service Access Interface is implemented using one or more instances of an Ethernet physical layer per [R15].

When the value is *Virtual*, the physical layer is not specified. Figure 9 shows an example where Subscriber and Service Provider functions are implemented in two different Virtual Machines inside a server. The Service Access Interface lies between the two Virtual Machines. The connection from the server to the rest of the Subscriber network (to the left) and the connection from the server to Service Provider (to the right) are beyond the scope of this document.

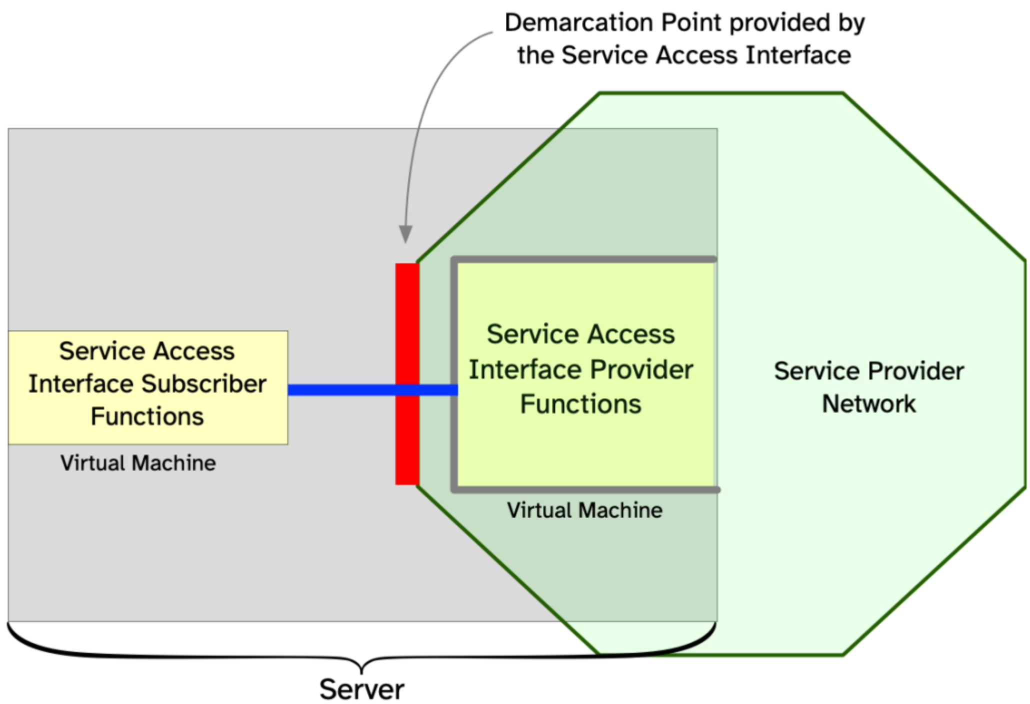

Figure 9 – Example of the Service Access Interface Instantiation Service Attribute = *Virtual*

When the value of the Service Access Interface Instantiation Service Attribute = *Virtual*, each instance of the information passed across the Service Access Interface is called a Virtual Frame and it is said that the Virtual Frame crosses the Service Access Interface. In the case of Figure 9, examples of the Virtual Frame include:

- A pointer to a common memory location that contains information relevant to the Service Access Interface and Services, and
- A block of bits transferred over a backplane.

The details of the Virtual Frame are beyond the scope of this document, but the following requirements apply.

[R9] When the value of the Service Access Interface Instantiation Service Attribute = *Virtual*, there **MUST** exist a map that maps the set of Virtual Frames that cross the Service Access Interface to a sequence of pairs of the form $\langle s,t \rangle$ where s is a standard MAC frame per Clause 3 of IEEE Std 802.3-2022 [7] and t is the arrival time[9] at the UNI for all bits in s.

[9] Note that the arrival time of Ethernet Frames is not used elsewhere in this document but is critical to some aspects of the Service Access Interface Compatible Services as defined in other Mplify documents. One example use is in the application of Bandwidth Profiles.

[R10] When the value of the Service Access Interface Instantiation Service Attribute = *Virtual*, if the result of applying the map referred to in [R9] is $\{\langle s_k, t_k\rangle, k = 0,1,2,\dots\}$, then the following **MUST** hold:

$$t_{k+1} \geq t_k, k = 0,1,2,\dots$$

In other words, applying the map of [R9] to a set of virtual frames yields a corresponding sequence of IEEE Std 802.3-2022 MAC frames, each with an associated Ethernet Frame arrival time, and the arrival times are monotonically increasing as indicated in [R10]. See the Service Access Interface Virtual Frame Map Service Attribute (Section 9.4).

9.4 Service Access Interface Virtual Frame Map Service Attribute

The value of the Service Access Interface Virtual Frame Map Service Attribute is either *Not Applicable* or a map that meets [R9] and [R10].

[R11] When the value of the Service Access Interface Instantiation Service Attribute (Section 9.3) = *Physical*, the value of the Service Access Interface Virtual Frame Map Service Attribute **MUST** be *Not Applicable*.

[R12] When the value of the Service Access Interface Instantiation Service Attribute (Section 9.3) = *Virtual*, the value of the Service Access Interface Virtual Frame Map Service Attribute **MUST** be a map that meets [R9] and [R10].

When the value of the Service Access Interface Instantiation Service Attribute = *Physical*, Ethernet Frames, as described in section 7.2, pass over a standard Ethernet Physical Layer. When the value of the Service Access Interface Service Attribute = *Virtual*, Ethernet Frames, as described in section 7.2, are derived by applying the value of the Service Access Interface Virtual Frame Map Service Attribute.

The details of possible values of the Service Access Interface Virtual Frame Map Service Attribute are beyond the scope of this document but, like all Service Attribute values, need to be agreed to by the Subscriber and Service Provider.

9.5 Service Access Interface List of Physical Links Service Attribute

The value of the Service Access Interface List of Physical Links Service Attribute is a possibly empty list of 7-tuples with one list item for each physical link. Each 7-tuple is of the form ⟨*id, uid, pl, fs, pt, ct, gn*⟩ where:

- *id* is an Identifier String for the physical link or a null string,
- *uid* is a Unique Identifier for the physical link or a null string,
- *pl* specifies a physical layer,
- *fs* indicates if synchronous Ethernet is used on the physical link,
- *pt* indicates if Precision Time Protocol is used on the physical link,
- *ct* indicates the connector type, and
- *gn* indicates the gender of the connector.

[R13] The value of the Service Access Interface List of Physical Links Service Attribute **MUST** be a non-empty list of 7-tuples if and only if the value of the Service Access Interface Instantiation Service Attribute (Section 9.3) = *Physical.*

Requirement [R13] implies that the value of the Service Access Interface List of Physical Links Service Attribute is mandated to be an empty list when the value of the Service Access Interface Instantiation Service Attribute = *Virtual.*

[R14] For each entry in the Service Access Interface List of Physical Links Service Attribute, at least one of *id* and *uid* **MUST NOT** be a null string.

[R15] The value of the *pl* element in each entry in the value of the Service Access Interface List of Physical Links Service Attribute **MUST** be one of the Ethernet physical layers from IEEE Std 802.3™-2022 [7] listed in Table 6.

10BASE-T	40GBASE-T	200GBASE-DR4
10BASE-FL	40GBASE-SR4	200GBASE-FR4
	40GBASE-LR4	200GBASE-LR4
100BASE-TX	40GBASE-ER4	200GBASE-SR4
100BASE-FX	40GBASE-FR	200GBASE-ER4
100BASE-SX	40GBASE-CR4	200GBASE-CR4
100BASE-BX10		200GBASE-CR2
100BASE-LX10	50GBASE-SR	
	50GBASE-FR	400GBASE-SR16
1000BASE-T	50GBASE-LR	400GBASE-DR4
1000BASE-SX	50GBASE-ER	400GBASE-FR8
1000BASE-LX	50GBASE-CR	400GBASE-LR8
1000BASE-BX10		400GBASE-FR4
1000BASE-LX10	100BASE-SR10	400GBASE-LR4-6
	100GBASE-SR4	400GBASE-SR8
2.5GBASE-T	100GBASE-SR2	400GBASE-SR4.2
5GBASE-T	100GBASE-LR4	400GBASE-ER8
	100GBASE-ER4	
10GBASE-T	100GBASE-DR	
10GBASE-SR/SW	100GBASE-FR1	
10GBASE-LX4	100GBASE-LR1	
10GBASE-LR/LW	100GBASE-ZR	
10GBASE-ER/EW	100GBASE-CR10	
10GBASE-CX4	100GBASE-CR4	
	100GBASE-CR2	
25GBASE-T	100GBASE-CR1	
25GBASE-SR		
25GBASE-LR		
25GBASE-ER		
25GBASE-CR		

Table 6 – Ethernet Physical Layers allowed for values of *pl*

The critical parameters associated with the connection such as speed, multi-mode vs. single-mode fiber, wavelengths, etc. are defined by the specific Ethernet physical layer specified in the *pl* element.

[R16] The physical layer specified in the *pl* element in each entry in the value of the Service Access Interface List of Physical Links Service Attribute **MUST** operate in full duplex mode.

[R17] The *fs* element in each entry in the value of the Service Access Interface List of Physical Links Service Attribute **MUST** have one of the following values: *Disabled*, *ESMC*, or *No-ESMC*.

[R18] When the value of the *fs* element in an entry in the value of the Service Access Interface List of Physical Links Service Attribute is *ESMC* or *No-ESMC*, the signal timing on the corresponding physical link **MUST** conform to synchronous Ethernet as defined in ITU-T G.8262/Y.1362 [12], with synchronization provided by the Service Provider to the Subscriber.

[R19] When the value of the *fs* element is *ESMC* in an entry in the value of the Service Access Interface List of Physical Links Service Attribute, SSM for Synchronous Ethernet over the Ethernet Synchronous Messaging Channel (ESMC) protocol as defined in ITU-T G.8264/Y.1364 [13] **MUST** be implemented by the Service Provider on the corresponding physical link.

[R20] When the value of the *fs* element is *No-ESMC* or *Disabled* in an entry in the value of the Service Access Interface List of Physical Links Service Attribute, SSM for Synchronous Ethernet over the Ethernet Synchronous Messaging Channel (ESMC) protocol as defined in ITU-T G.8264/Y.1364 [13] **MUST NOT** be implemented by the Service Provider on the corresponding physical link.

[R21] When the value of the *fs* element is *ESMC* in an entry in the value of the Service Access Interface List of Physical Links Service Attribute, then the ESMC protocol **MUST** be included in the list of protocols specified in the Service Access Interface L2CP Peering Service Attribute (see section 9.11).

Although the L2CP Peering Service Attribute applies to the entire Service Access Interface, it is not necessary for ESMC to operate on every physical link.

The accuracy of the frequency reference provided by a physical link when using Synchronous Ethernet (*fs* is *ESMC* or *No-ESMC)* is beyond the scope of this document.

[R22] The *pt* element in each entry in the value of the Service Access Interface List of Physical Links Service Attribute **MUST** have the value *Enabled* or *Disabled.*

[R23] The Precision Time Protocol as specified in Annex F of IEEE Std 1588™-2019 [4] **MUST** be implemented on a physical link by the Service Provider such that the Subscriber Network can derive a Primary Reference Time Clock traceable time synchronization reference from the Service Provider Network if and only if the value of the pt element in the corresponding entry in the value of the Service Access Interface List of Physical Links Service Attribute is *Enabled*.

The accuracy of the time reference provided on a physical link with *pt* = *Enabled* is beyond the scope of this document.

[R24] The value of the *ct* element in each entry in the value of the Service Access Interface List of Physical Links Service Attribute, **MUST** be one of the connector types listed in Table 7 or *Other*.

Connector Type	Copper/Fiber	Standard
RJ45	Copper	IEC 60603-7 [1], TIA568 [28]
SC	Fiber	IEC 61754-4 [2]
LC	Fiber	IEC 61754-20 [3]

Table 7 – Connector Types – Allowed values of *ct*

If *Other* is specified for the value of *ct,* it indicates that the Subscriber and the Service Provider have agreed to use a connector type that is not included in the list of specified connectors. The connector could be a standard connector (e.g., a very old or very new standard connector) or a non-standard connector.

[R25] If the value of the *ct* element in an entry in the value of the Service Access Interface List of Physical Links Service Attribute is *SC* or *LC*, the fiber polish **MUST** be UPC (Ultra Physical Contact).

[R26] The value of the *gn* element in each entry in the value of the Service Access Interface List of Physical Links Service Attribute **MUST** have the value *Socket* or *Plug*.

The value of *gn* in each 7-tuple describes the "side" of the connection presented to the Subscriber by the Service Provider. For example, if a Subscriber is presented with a socket on the Service Provider equipment (*gn* is *Socket*), the Subscriber is expected to provide a cable (copper or fiber) with a plug (with a connector type specified in *ct*). Conversely, if the Service Provider provides the cable, then it is presenting a plug to the Subscriber (*gn* is *Plug*), and the Subscriber is expected to provide equipment that can connect to a plug of type *ct*.

9.6 Service Access Interface Service Multiplexing Limits Service Attribute

The value of the Service Access Interface Service Multiplexing Limits Service Attribute indicates whether the Service Access Interface can be shared by multiple Services, and if so, specifies two limits on the Services sharing the Service Access Interface. (See section 8.4 for a discussion of Service Multiplexing.)

The value of the Service Access Interface Service Multiplexing Limits Service Attribute is a 2-tuple ⟨*maxServices, maxVlans*⟩ where:

- *maxServices* is an integer between 1 and 4095[10] that indicates the maximum number of Services that can share the Service Access Interface, and
- *maxVlans* is an integer between 1 and 4094 that indicates that maximum number of C-Tag VLAN ID values that can be mapped to Services at the Service Access Interface that map VLANs using a *List* of C-Tag VLAN ID values as described in section 8.4.

[R27] There **MUST** be no more than *maxServices* Services simultaneously using the Service Access Interface.

Requirement [R27] implies that if the value of *maxServices* is one, then there is no Service Multiplexing at this Service Access Interface.

[R28] At any given time, at the Service Access Interface, the set of all VLAN ID values mapped to Services using a *List* of C-Tag VLAN ID values as described in section 8.3 **MUST NOT** contain more than *maxVlan* members.

9.7 Service Access Interface Link Aggregation Service Attribute

Link Aggregation, specified in IEEE Std 802.1AX-2020 [5], allows one or more parallel instances of full-duplex point-to-point Ethernet links to be aggregated to form a Link Aggregation Group (LAG) such that the MAC Client (the Service Access Interface) can treat the LAG as if it were a single link. The value of the Service Access Interface Link Aggregation Service Attribute indicates whether the Service Access Interface is a Link Aggregation Group and, if so, specifies parameters that control the mapping of Ethernet Frames to links in the LAG.

The value of the Service Access Interface Link Aggregation Service Attribute is a 3-tuple ⟨*lag, lacpVersion, portMap*⟩ where:

- *lag* has the value *All Active, 2-Link Active/Standby, Other,* or *Not Applicable* and indicates whether and how Link Aggregation is used at the Service Access Interface.
- *lacpVersion* has the value *LACPv1*, *LACPv2*, *Static,* or *None* and indicates which version of the Link Aggregation Control Protocol, LACP, is used. (See clause 6.4 in IEEE Std 802.1AX-2020.). If the value is *Static*, LACP is not used. The value *None* is used when *lag* is *Not Applicable*.
- *portMap* is a possibly empty list of 2-tuples ⟨*vid, lspl*⟩ that represents a C-Tag VLAN ID value to Aggregation Link Map (in clause 6.6 of IEEE Std 802.1AX-2020 this is referred to as “Admin_Conv_Link_Map”). The first element, *vid*, is a C-Tag VLAN ID value, and the second element, *lspl,* (Link Selection Priority List) is a list of Link Number IDs. The components of the *portMap* are described later in this section.

Ethernet Frames must be mapped to links in a Link Aggregation Group in such a way that frames that correspond to a conversation (as defined in IEEE Std 802.1AX™-2020) are all mapped to the

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[10] The value of 4095 allows one service with UT/PT (or UT) and 4094 services each with a single VLAN ID in the range of 1, …, 4094. Note that VLAN ID 4095 is not available for Ethernet Services (see MEF 10.4 [16] and MEF 26.2 [17]) or IP Services (see MEF 61.1.1 [23])

same link, otherwise frame reordering can occur. There are two models for achieving this. In the first model, the LAG implementations on each side independently choose an algorithm. In this case the value of *portMap* is an empty list. In the second model, referred to as "Conversation-sensitive frame collection and distribution" in IEEE Std 802.1AX-2020, one side selects the algorithm and transfers information and parameter values through LACP so that both sides implement the same algorithm. One commonly used approach, and the one used in this document, is to use the C-Tag VLAN ID value in each frame to define a conversation (specified in the value of the *portMap* element). This use of the C-Tag VLAN ID value is referred to as the "Port Conversation ID" in IEEE Std 802.1AX-2020 (see [R37] below).

[R29] If the value of the Service Access Interface List of Physical Links Service Attribute is an empty list, then the value of the *lag* element of the Service Access Interface Link Aggregation Service Attribute **MUST** be *Not Applicable*.

Note that [R13] implies that [R29] applies when the value of the Service Access Interface Instantiation Service Attribute is *Virtual*.

[O1] If the value of the Service Access Interface List of Physical Links Service Attribute is a list with one entry, then the value of the *lag* element in the value of the Service Access Interface Link Aggregation Service Attribute **MAY** have any of the four possible values.

Normally, if there is a single Ethernet link composing the Service Access Interface, Link Aggregation is not used and the value of the *lag* element is *Not Applicable*. The motivation for [O1] is that if there is an intention to add additional Ethernet links in the future, enabling Link Aggregation with the first link allows additional links to be added without major reconfiguration or impact on existing services. Note that [O1] implies that [R69] in MEF 10.4 [16] does not apply.

[R30] If the value of the *lag* element in the value of the Service Access Interface Link Aggregation Service Attribute is *Not Applicable*, the values of the *lacpVersion* and *portMap* elements in the 3-tuple **MUST** be *None* and an empty list, respectively.

[R31] If the value of the Service Access Interface List of Physical Links Service Attribute is a list with greater than one entry, then the value of the *lag* element in the value of the Service Access Interface Link Aggregation Service Attribute **MUST NOT** be *Not Applicable*.

[R32] If the value of the Service Access Interface List of Physical Links Service Attribute contains greater than two 7-tuples, then the value of the *lag* element of the Service Access Interface Link Aggregation Service Attribute **MUST** be *All Active* or *Other*.

[R33] If the value of the *lag* element of the Service Access Interface Link Aggregation Service Attribute is *2-Link Active/Standby*, then the Service Provider Network **MUST** implement Link Aggregation as per clause 6.7.1 of IEEE Std 802.1AX-2020 with one Link Aggregation Group (LAG) across Service Access Interface physical links that is configured such that all Service Frames are carried on only one of the two links when both links are operational.[11]

[R34] If the value of the *lag* element of the Service Access Interface Link Aggregation Service Attribute is *2-Link Active/Standby*, then the value of the *portMap* element **MUST** be an empty list.

[R35] If the value of the *lag* element in the value of the Service Access Interface Link Aggregation Service Attribute is *All Active*, then the Service Provider Network **MUST** use Link Aggregation as specified in Clause 5.3 of IEEE Std 802.1AX™-2020 with one Link Aggregation Group across the links composing the Service Access Interface.

[O2] If the value of the *lag* element in the value of the Service Access Interface Link Aggregation Service Attribute is *Other*, then the Subscriber and the Service Provider **MAY** agree to any other resiliency mechanism.

Other resiliency mechanisms referred to in [O2] are beyond the scope of this document.

[R36] If the value of the *lag* element in the value of the Service Access Interface Link Aggregation Service Attribute is *All Active*, the Service Provider Network **MUST** be configured such that there is only one *aAggActorAdminKey* that has the same value as the *aAggPortActorAdminKey* for the ports terminating the links in the Service Access Interface.

The *aAggActorAdminKey* and *aAggPortActorAdminKey* are managed objects defined in IEEE Std 802.1AX-2020. Ensuring that there is only one *aAggActorAdminKey* with the same value as the *aAggPortActorAdminKey* for the ports terminating the links in the Service Access Interface ensures that only a single Link Aggregation Group is formed. This eliminates the possibility of any loops potentially arising from multiple links coming up independently or forming separate Link Aggregation Groups. Note that for Link Aggregation to operate correctly, the Subscriber Network needs to be configured so that there is only one *aAggActorAdminKey* that has the same value as the *aAggPortActorAdminKey* for the ports terminating the links in the Service Access Interface.

[R37] If the value of *portMap* is not an empty list, then the Service Provider Network **MUST** use "Conversation-sensitive frame collection and distribution" as specified in clause 6.6 of IEEE Std 802.1AX-2020, where the Port Conversation ID value is equal to the C-Tag VLAN ID value for VLAN Tagged Frames and equal to 0 for Untagged and Priority Tagged Frames.

[11] The referenced section in 802.1AX describes the algorithm for determining the active link.

[R38] If the value of *portMap* is not an empty list, then any Ingress Ethernet Frame with a C-Tag VLAN ID value that is not included in the *vid* element in any entry in the value of *portMap* **MUST** be discarded by the Service Provider Network.

[R39] If the value of *portMap* is not an empty list, then each Egress Ethernet Frame **MUST** have a C-Tag VLAN ID value that is included in the *vid* element of an entry in the value of *portMap*.

When a Service starts using the Service Access Interface, it is important that all C-Tag VLAN ID values in use by the Service (see section 8.4) are correctly mapped to links in the Link Aggregation Group. Similarly, if the configuration of a Service changes (some C-Tag VLAN ID values added and/or removed), the configuration of the Link Aggregation Group has to change accordingly.

[R40] If the value of *portMap* is not an empty list, then the value of the *lacpVersion* element **MUST** be *LACPv2.*

[R41] If the value of the *lacpVersion* element is *LACPv1* or *LACPv2*, then the LACP protocol **MUST** be included in the list of protocols specified in the Service Access Interface L2CP Peering Service Attribute (see section 9.11).

The *portMap* element provides a mapping of each C-Tag VLAN ID value to a Link Selection Priority List. The Link Selection Priority List is a sequence of Link Number IDs in order of usage preference from highest to lowest for the link that is to carry frames corresponding to a given C-Tag VLAN ID value. A Link Number ID is an integer ≥ 1 that is uniquely assigned to each physical link in a given Service Access Interface and has local significance to the Link Aggregation Group at the Service Access Interface. The assignment of Link Number IDs to physical links does not have to be configured on either end, it is negotiated automatically by LACP. Hence, it does not need to be agreed on between the Subscriber and the Service Provider. Table 8 provides an example of a C-Tag VLAN ID to Aggregation Link Map (*portMap*).

VLAN ID	Link Selection Priority List (decreasing order)
34	3, 1, 2
35	2, 1

Table 8 – Example of a C-Tag VLAN ID to Aggregation Link Map

This map indicates that C-Tag VLAN ID 34 should use link 3, if available. If link 3 fails, it would use link 1, and if link 1 fails it would use link 2. Similarly, C-Tag VLAN ID 35 should use link 2, if available, and fail over to link 1.

This map provides a means of describing how traffic is split and also provides a means to indicate a level of resilience to link failure. In the example above, C-Tag VLAN ID 34 has more resilience than C-Tag VLAN ID 35 because C-Tag VLAN ID 34 has two fallback links whereas C-Tag VLAN ID 35 has only one.

[R42] When the value of the *portMap* element is not an empty list, the set of Link Number IDs for the Service Access Interface **MUST** be {*1, 2, …, m*} where *m* is the number of Physical Links included in the value of the Service Access Interface List of Physical Links Service Attribute.

Requirement [R42] mandates the value of Link Number IDs that are used in the value of the *portMap*; this avoids the need to negotiate the values between the Service Provider and Subscriber for a given Service Access Interface. The Service Provider and Subscriber do not need to agree on an association of each Link Number ID to a physical link (or the physical port terminating the link) as this association is made during the operation of LACP. However, although not required to do so, the Service Provider and Subscriber can agree on an association of each Link Number ID to a physical link, which could be useful if there is a preference for which physical link carries specific Service Frames.

When multiple physical links are configured for a Service Access Interface, the individual links may terminate at the same device in the Service Provider Network and/or in the Subscriber Network, or at different devices in the Service Provider Network and/or in the Subscriber Network. Implementing the Service Access Interface across multiple devices can have an impact on the implementation of many functions such as bandwidth management, source MAC address learning, Service OAM, etc. The details of implementing the Service Access Interface across multiple devices is beyond the scope of this document.

Note that the Service-specific standards may impose additional requirements or limitations on the value of *portmap*, such as [R81] in MEF 10.4 [16].

9.8 Service Access Interface Ethernet Frame Format Service Attribute

The value of the Service Access Interface Ethernet Frame Format Service Attribute specifies the allowed formats of Ethernet Frames.

[R43] The format of an Ethernet Frame **MUST** be that of the MAC frame that is specified in Clause 3 of IEEE Std 802.3™-2022 [7].

Requirement [R43] constrains the value of the Service Access Interface Virtual Frame Map Service Attribute (see section 9.4) when the value of the Service Access Interface Instantiation Service Attribute = *Virtual* (see section 9.3). This is because the Ethernet Frame is the result of applying the value of the Service Access Interface Virtual Frame Map Service Attribute to the Virtual Frame.

Note that [R43] means that Ethernet Frames are discarded by the Service Provider if they are not property constructed. For example, an Ethernet Frame with an incorrect Frame Check Sequence is discarded. However this document does not preclude the use of Ethernet Frames that are longer than the maximum specified in IEEE Std 802.3™-2022.

9.9 Service Access Interface Maximum Ethernet Frame Size Service Attribute

The value for the Service Access Interface Maximum Ethernet Frame Size Service Attribute is an integer number of bytes ≥ 1522.

This Service Attribute indicates the size of the largest Ethernet Frame that can cross the Service Access Interface. All Ethernet implementations are required in IEEE Std 802.3-2022 be able to send and receive 1518-byte Ethernet Frames (referred to as a basic frame in IEEE Std 802.3-2022).[12] However, to ensure that a VLAN tag (4 bytes) can be added to a 1518-byte Untagged Frame, the value for this Service Attribute is required to be at least 1522 bytes (referred to as a Q-tagged frame in IEEE Std 802.3-2022).

[R44] An Ingress Ethernet Frame at a Service Access Interface **MUST** be discarded if:

- The Ethernet Frame is untagged and has a length that is larger than the value of Service Access Interface Maximum Ethernet Frame Size Service Attribute minus 4, or
- The Ethernet Frame is C-Tagged and has a length that is larger than the value of Service Access Interface Maximum Ethernet Frame Service Attribute.

[R45] An Egress Ethernet Frame at a Service Access Interface **MUST** have length less than or equal to:

- The value of Service Access Interface Maximum Ethernet Frame Service Attribute minus 4 if the Ethernet Frame is untagged, or
- The value of Service Access Interface Maximum Ethernet Frame Service Attribute if the Ethernet Frame is C-Tagged.

The value for the Service Access Interface Maximum Ethernet Frame Size Service Attribute can be different for each Service Access Interface that provides access to a Service instance. In order for a Service instance to operate correctly, frames carried by the Service instance need to be based on the Service Access Interface that has the smallest value of the Service Access Interface Maximum Frame Size Service Attribute. Consider the situation shown in Figure 10.

[12] See section 7.2 for a discussion of Ethernet Frame types.

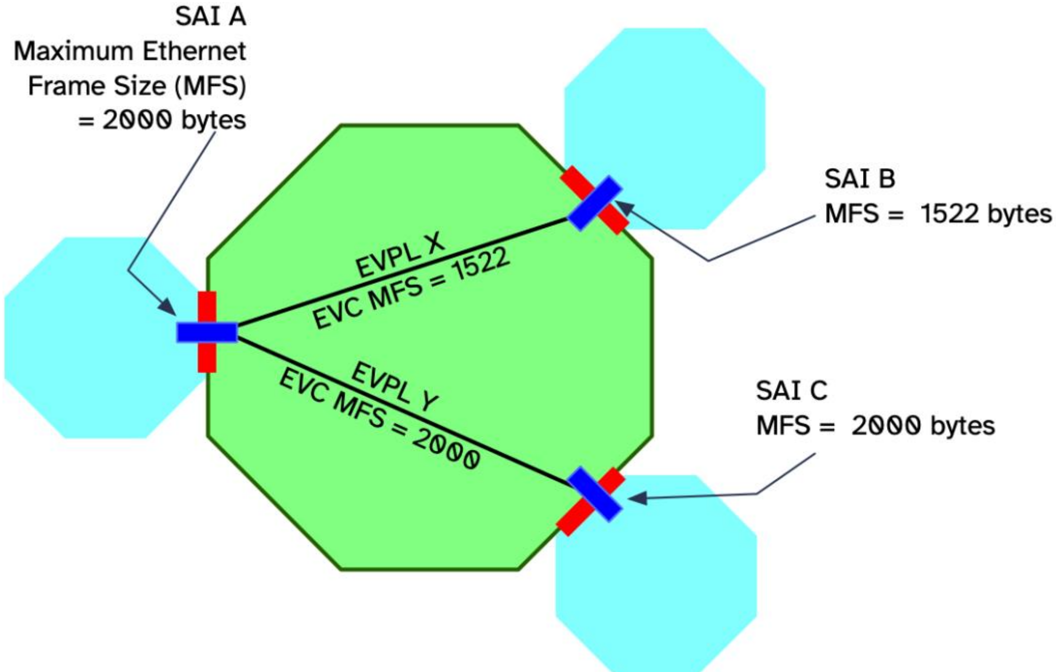

Figure 10 – Multiple Services Sharing a Service Access Interface

Figure 10 shows a Service Access Interface, SAI A, with two EVPLs, EVPL X going to SAI B, and EVPL Y going to SAI C. SAI A and SAI C can support 2000 byte frames, but SAI B cannot. This means that a 2000 byte frame that ingresses at SAI A can be delivered to SAI C but would be discarded at the egress at SAI B (see [R45]). Limiting SAI A to 1522 bytes is not an appropriate solution to this problem since that would limit the traffic on EVPL Y. The solution is to enforce a maximum frame size for each Service that can be enforced at ingress. For example, the Subscriber Ethernet Services have an EVC Maximum Frame Size Service Attribute that provides this mechanism. By specifying an EVC Maximum Frame Size of 1522 for EVPL X and 2000 for EVPL Y, each Service can be configured to operate correctly.

9.10 Service Access Interface Link OAM Service Attribute

The value of the Service Access Interface Link OAM Service Attribute is either *Enabled* or *Disabled*. The Service Access Interface Link OAM Service Attribute controls when and how Link OAM per IEEE Std 802.3-2022 [7] is run on the physical links in the Service Access Interface.

[R46] Link OAM as specified in Clause 57 of IEEE Std 802.3-2022 **MUST** be run on all physical links in the Service Access Interface if and only if the value of the Service Access Interface Link OAM Service Attribute = *Enabled*.

[R47] If the value of the Service Access Interface List of Physical Links is an empty list, then the value of the Service Access Interface Link OAM Service Attribute **MUST** be *Disabled*.

[R48] When the value of the Service Access Interface Link OAM Service Attribute = *Enabled*, the Service Provider **MUST** enable Active DTE (Data Termination Equipment) mode capabilities as specified in clause 57.2.9 of IEEE Std 802.3-2022 on each link in the Service Access Interface.

[D1] When the value of the Service Access Interface Link OAM Service Attribute = *Enabled*, Link Events as specified in Clauses 57.2.10 and 57.4.3.2 of IEEE Std 802.3-2022 **SHOULD** be enabled on each link in the Service Access Interface.

[R49] When the value of Service Access Interface Link OAM Service Attribute = *Enabled*, then the Link OAM protocol **MUST** be included in the list of protocols specified in the Service Access Interface L2CP Peering Service Attribute (see section 9.11).

9.11 Service Access Interface L2CP Peering Service Attribute

The L2CP Peering Service Attribute is a possibly empty list of Layer 2 Control Protocols that are peered by a process in the Service Provider Network. Each entry in the list specifies the identification of a specific Layer 2 Control Protocol.

The Service Access Interface L2CP Peering Service Attribute is as defined for L2CP Peering Service Attribute in MEF 45.1 [18] section 8.2.

Note that if LACP is enabled (see [R41] in section 9.7) or Link OAM is enabled (see [R49] in section 9.10) or ESMC is enabled (see [R21] in section 9.5) the enabled protocol(s) have to be included in the value of the Service Access Interface L2CP Peering Service Attribute.

9.12 Service Access Interface Performance Objectives Evaluation Intervals Service Attribute

Performance Objectives (see sections 9.13 and 9.14) are evaluated over a series of consecutive time intervals. The value of this Service Attribute is a 2-tuple $\langle s, T \rangle$ where:

- s is a time that represents the date and time that evaluation of Performance Objectives starts.
- T is a time duration, e.g., 1 month or 2 weeks, that is used in conjunction with s to specify time intervals for determining when Performance Objectives are met.

The time intervals are specified by elements s and T. One time interval, denoted T_0, starts at time s and has duration T. Each subsequent time interval, denoted T_k, starts at time $s + kT$ where k is a non-negative integer, and has duration T; in other words, each new time interval starts as soon as the previous one ends. Each Performance Objective is evaluated for each time interval T_k, so one can say that for a given T_k, the Performance Objective is either met or not met.

Note that T can be specified using any time units; in particular, calendar months are allowable. In this case, if s is specified as, for example, midnight on January 5, 2021, and T is 1 calendar month, then each subsequent T_k will start at midnight on the 5th of the month. Note that if the value of T is based on a number of months (one or more) then the time intervals will be of different lengths. The details of possible values of s and T are beyond the scope of this document.

Note that if the value of the Service Access Interface Availability Objective Service Attribute is 0% (section 9.13) and the value of the Service Access Interface Mean Time To Repair Objective Service Attribute (section 9.14) is 0 minutes (i.e. neither Performance Objective is specified), then the value of Service Access Interface Performance Objectives Evaluation Intervals Service Attribute is ignored.

9.13 Service Access Interface Availability Objective Service Attribute

Service Access Interface Availability is the proportion of time, during a given time interval, T_k (as defined in section 9.12), that the Service Access Interface is working from the perspective of the Subscriber, excluding any agreed exceptions, e.g., maintenance intervals. The value of this Service Attribute, denoted by $\widehat{SA}$, is a percentage between 0% and 100% that is the commitment by the Service Provider to make the percentage of time that the Service Access Interface is available greater than or equal to $\widehat{SA}$ during each time interval, T_k. A value of 0% indicates that the Service Provider is not making an Availability commitment for the Service Access Interface.

In the following sections, an "outage" is a time period during which the Service Access Interface is unavailable, which may be shorter than, equal to, or longer than a time interval, T_k. What constitutes an outage is by agreement of the Service Provider and Subscriber (see [R50]).

In the following sections, an "exception" is defined as a time period during which the Service Access Interface may be unavailable but is not counted against the Availability Objective. What constitutes an exception is by agreement of the Service Provider and Subscriber (see [R51]).

The definition of what constitutes a period of Service Access Interface unavailability is often (but does not have to be) based on the raising and resolution of customer complaints (trouble tickets) rather than the actual performance of data traffic across the Service Access Interface. This definition can be refined based on further commercial considerations, such as exceptions for events beyond the Service Provider's control. An exact definition is outside the scope of this document.

[R50] If the value of the Service Access Interface Availability Objective Service Attribute is not 0% for the Service Access Interface, the Subscriber and Service Provider **MUST** agree on what constitutes a period of unavailability for the Service Access Interface.

[R51] If the value of the Service Access Interface Availability Objective Service Attribute is not 0% for the Service Access Interface, the Subscriber and Service Provider **MUST** agree on what constitutes an exception, including determining when an exception starts and ends.

[R52] The Service Access Interface Availability during a time interval T_k **MUST** be defined as follows:

- Let $O(T_k)$ be the total duration of outages for the Service Access Interface during the interval T_k.
- Let $E(T_k)$ be the total duration of exceptions for the Service Access Interface, such as maintenance intervals, during the interval T_k.
- Then define the Service Access Interface Availability as follows:
  - If $T > E(T_k)$, $SA(T_k) = \frac{T-(E(T_k)+O(T_k))}{T-E(T_k)} \times 100$
  - If $T = E(T_k)$, $SA(T_k) = 100\%$

[R53] If the value of the Service Access Interface Availability Objective Service Attribute is not 0%, the Service Access Interface Availability Objective for a given time interval, T_k, **MUST** be considered met for the Service Access Interface if and only if $SA(T_k) \geq \widehat{SA}$.

9.14 Service Access Interface Mean Time To Repair Objective Service Attribute

The Service Access Interface Mean Time To Repair (MTTR) is the arithmetic mean, i.e., average, of the durations of all outages of the Service Access Interface that start in a given interval T_k (as defined in section 9.12), excluding any agreed exceptions, e.g., maintenance periods. This means that an outage that crosses the boundary of an interval (T_k) is counted for MTTR in the time interval in which it started.

The value of the Service Access Interface Mean Time To Repair Objective Service Attribute is a non-negative real number, $\widehat{SR}$, expressed as a time duration in minutes. This value is the commitment by the Service Provider to limit the value of the MTTR to be less than or equal to $\widehat{SR}$ for every T_k. If the value of this Service Attribute is 0, then there is no commitment by the Service Provider for MTTR for the Service Access Interface.

A period when a Service Access Interface is unavailable can be considered as a single outage or as multiple outages for the purpose of the MTTR calculation. For example, if outages are based on trouble tickets and a trouble ticket is raised for the Service Access Interface at $t=1$ and this is resolved at $t=4$, then this is a single outage with a duration of 3. If, however, a second trouble ticket is raised for the Service Access Interface at $t=3$ (while the first outage is active) and is resolved at $t=7$ there are at least two ways this can be computed. If this is considered as two outages, then the MTTR can be computed on the two independently (duration of 3 for the first outage and duration of 4 for the second outage). But if the issues identified in the two trouble tickets are treated as a single outage, then the MTTR is computed based on that single outage of duration 6. The result depends on how the Subscriber and the Service Provider agree that outages are reported and resolved.

[R54] If the value of the Service Access Interface Mean Time To Repair Objective Service Attribute is not 0 minutes for the Service Access Interface, the Subscriber and Service Provider **MUST** agree on the definition of an outage, including determining when an outage starts and ends.

[R55] If the value of the Service Access Interface Mean Time To Repair Objective Service Attribute is not 0 minutes for the Service Access Interface, the Subscriber and Service Provider **MUST** agree on what constitutes an exception, including determining when an exception starts and ends.

[R56] If the value of the Service Access Interface Availability Objective Service Attribute (section 9.12) is not 0% for the Service Access Interface and the value of the Service Access Interface Mean Time To Repair Objective Service Attribute is not 0 minutes for the Service Access Interface, then the agreement of what constitutes an outage ([R50] and [R54]) and an exception ([R51] and [R55]) **MUST** be the same in both calculations.

[R57] If the value of the Service Access Interface Mean Time To Repair Objective Service Attribute is not 0 minutes for the Service Access Interface, then agreed exception periods **MUST NOT** overlap in time.

The effect of requirement [R57] is that any separate and overlapping exception periods are considered as one exception period that is the union of the separate ones. The requirement is to ensure that exception periods are subtracted from outages only once.

As a result of requirement [R54] each outage period, U, has an agreed-on start time, U_{start}, and end time, U_{end}. Since the exception periods are agreed on, each exception period, E, has an agreed-on start time, E_{start}, and end time, E_{end}.

[R58] The Service Access Interface Mean Time To Repair during a time interval T_k **MUST** be defined as follows:

- Let $Od(U, T_k)$ be the duration of an outage U that starts in T_k; that is, $Od(U, T_k) = U_{end} - U_{start}$, where U_{start} is during T_k.
- Consider any exception periods that overlap with outage U. Let $Ed(U, T_k)$ be the sum of the durations of the parts of these exception periods that overlap with outage U. If there are no exception periods that overlap with U, then $Ed(U, T_k)$ is 0.
- Let $Vd(U, T_k) = Od(U, T_k) - Ed(U, T_k)$ for each outage U that starts in T_k.

Then the Mean Time to Repair $SR(T_k)$ is the arithmetic mean of the values $Vd(U, T_k)$ for all outages U that start in T_k (i.e., U_{start} is during T_k) for which $Vd(U, T_k) > 0$. If there are no such outages, then $SR(T_k)$ is 0.

The definition of what constitutes an outage is often (but does not have to be) based on the raising and resolution of customer complaints (trouble tickets) rather than the actual performance of data traffic across the Service Access Interface. This definition can be refined based on further commercial considerations, such as exceptions for events beyond the Service Provider's control. An exact definition is outside the scope of this document.

[R59] If the value of the Service Access Interface Mean Time To Repair Objective Service Attribute is not 0 minutes, then the Service Access Interface Mean Time To Repair Objective for a given time interval, T_k, **MUST** be considered met if and only if $SR(T_k) \leq \widehat{SR}$.

Figure 11 shows some of the common cases described by the definition of $SR(T_k)$:

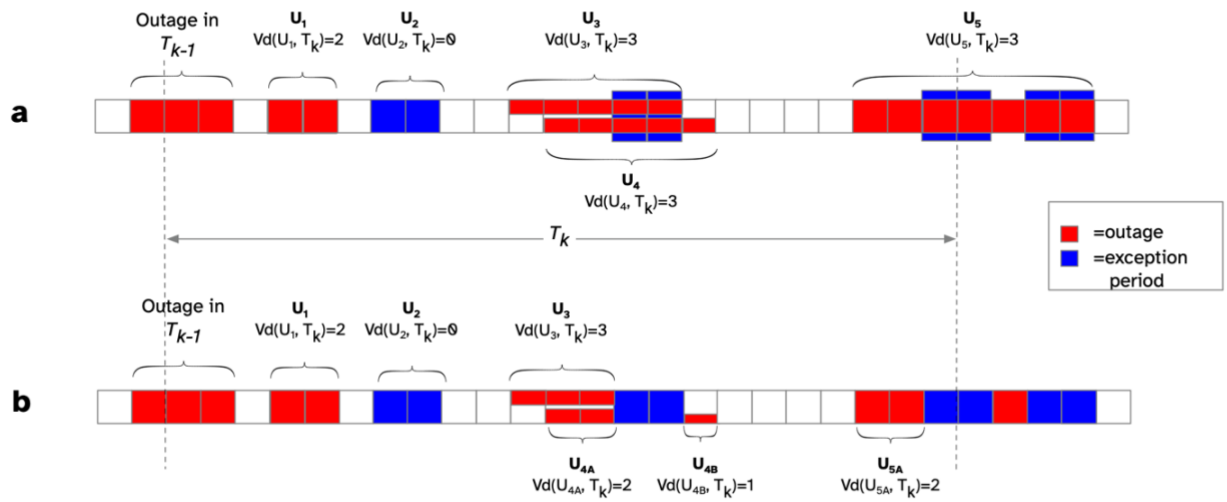

Figure 11 – Examples of Outages and Exception Periods

The MTTR calculation depends on an agreement between the Subscriber and Service Provider on how exception periods relate to outages. For example, exceptions could be defined independently of outages, such that exceptions and outages can overlap, and the exceptions are subtracted out in the MTTR calculation as noted in third bullet of [R58]. This is depicted in the top example (a) in Figure 11. Another possibility is that exception periods are considered to terminate any outages that precede them, such that exceptions and outages cannot overlap. If the Service Access Interface remains unavailable, a new outage could be considered to start at the end of the exception period. This is depicted in the bottom example (b). The examples in Figure 11 shows several outages and exception periods. The time divisions shown in the diagram are to illustrate the duration of each outage and exception period—in practice outages and exception periods can start and end at any time.

In the example shown in Figure 11, the MTTR for the indicated period, T_k, can be determined as follows:

- The first outage started during the evaluation period before T_k, so it is not included in the MTTR computation for T_k.
- Outage U_1 is the simplest case, an outage with no overlapping exception periods. The duration of the outage is 2.
- Outage U_2 is an isolated exception period, i.e., not adjacent to any outages, therefore it is not included in the MTTR calculation.
- Outage U_3 in example *a* overlaps an exception period of duration 2 . The exception period is considered part of the outage, so the duration of the outage is 5 but $Vd(U_3, T_k) = 3$ after the exception period duration is subtracted out.
- Outage U_3 in example *b* is adjacent to an exception period of duration 2. The exception period is not considered part of the outage, so the duration of the outage is 3 and $Vd(U_3, T_k) = 3$.

- Outage U_4 in example *a* is an outage that starts while outage U_3 is in progress (for example, it might have been reported on a separate trouble ticket). There is an initial component with duration 2 followed by an exception period of duration 2. When the exception period ends, the outage is still in progress. The exception period is considered part of the outage, so this is an outage with a duration of 5 but $Vd(U_4, T_k) = 3$ after the exception period duration is subtracted out.
- Outage U_4 in example *b* is actually two separate outages, U_{4A} and U_{4B} since the exception period is not considered part of the outage. U_{4A} has duration 2 and U_{4B} has duration 1, This will likely result in a different value for MTTR for the specified period, T_k.
- Outage U_5 is the most complicated. The outage crosses the boundary into T_{k+1}, but since it started in T_k it is counted in the calculation of MTTR for T_k. It is overlapped by two exception periods, one that straddles the boundary between T_k and T_{k+1} and one that is entirely in T_{k+1}. If the exception periods are considered part of the outage, then this is a single outage with duration 7 but $Vd(U_5, T_k) = 3$ after the exception period duration is subtracted out. This is shown in (a). However, if the exception periods are not considered part of the outage, then the first part is an outage with duration $Vd(U_{5A}, T_k) = 2$ and the continuation of the outage after the exception period is in T_{k+1} so it is not counted in the MTTR for T_k. This is shown in (b).

Based on the example in Figure 11 and the subsequent bullet list, there are two computations for MTTR:

- If the exception periods are considered part of the outage (a), then MTTR = $SR(T_k) =$ average($Vd(U_1, T_k)=2$, $Vd(U_3, T_k)=3$, $Vd(U_4, T_k)=3$, $Vd(U_5, T_k)=3$) = 11/4 = **2.75**, or
- If the exception periods are not considered part of the outage (b), then MTTR = $SR(T_k) =$ average(
  $Vd(U_1, T_k)=2$, $Vd(U_3, T_k)=3$, $Vd(U_{4A}, T_k)=2$, $Vd(U_{4B}, T_k)=1$, $Vd(U_{5A}, T_k)=2$) = 10/5 = **2**

10 References

[1] IEC 60603-7, *Connectors for electronic equipment – Part 7: Detail specification for 8-way, unshielded, free and fixed connectors*, Edition 4.0, October 2020

[2] IEC 61754-4, *Fiber optic interconnecting devices and passive component – Fiber optic connector interfaces – Part 4: Type SC connector family*, Edition 2.0, July 2013

[3] IEC 61754-20, *Fiber optic interconnecting devices and passive component – Fiber optic connector interfaces – Part 20: Type LC connector family*, Edition 2.0, April 2012

[4] IEEE Std 1588™-2019, *IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems*, June 2020. Copyright © 2020 by the Institute for Electrical and Electronic Engineers, Inc. All rights reserved.

[5] IEEE Std 802.1AX™-2020, *Link Aggregation*, January 2020. Copyright © 2020 by the Institute for Electrical and Electronics Engineers, Inc. All rights reserved.

[6] IEEE Std 802.1Q™-2022, *Bridges and Bridged Networks*, September 2022. Copyright © 2022 by the Institute for Electrical and Electronics Engineers, Inc. All rights reserved.

[7] IEEE Std 802.3™-2022, *IEEE Standard for Ethernet*, May 2022. Copyright © 2022 by the Institute for Electrical and Electronics Engineers, Inc. All rights reserved.

[8] IETF RFC 2119, *Key words for use in RFCs to Indicate Requirement Levels*, March 1997

[9] IETF RFC 5798, Virtual Router Redundancy Protocol Version 3 for IPv4 and IPv6, March 2010. Copyright © 2010 IETF Trust and the persons idenfieid as the document authors. All rights reserved.

[10] IETF RFC 8174, *Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words*, May 2017. Copyright © 2017 IETF Trust and the persons identified as the document authors. All rights reserved.

[11] ISO/IEC 7498-1, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*, June, 1996. © ISO/IEC 1994

[12] ITU-T Recommendation G.8262/Y.1362, *Timing characteristics of synchronous Ethernet equipment slave clock*, January 2015

[13] ITU-T Recommendation G.8264/Y.1364, *Distribution of timing information through packet networks*, May 2014

[14] ITU-T Recommendation X.667, *Procedures for the operation of object identifier registration authorities: Generation of universally unique identifiers and their use in object identifiers*, October 2012. Copyright © ITU 2014. All rights reserved.

[15] MEF 6.3, *Subscriber Ethernet Services Definitions*, November 2019

[16] MEF 10.4, *Subscriber Ethernet Service Attributes*, December 2018

[17] MEF 26.2, *External Network Network Interfaces (ENNI) and Operator Service Attributes*, August 2016

[18] MEF 45.1, *Layer 2 Control Protocols in Ethernet Services*, December 2018

[19] MEF 47.1, *Elastic Ethernet Services & Cloud Connectivity*, January 2021

[20] MEF 51.1, *Operator Ethernet Service Definitions*, December 2018

[21] MEF 55.1, *Lifecycle Service Orchestration (LSO): Reference Architecture and Framework*, January 2021

[22] MEF 61.1, *IP Service Attributes*, May 2019

[23] MEF 61.1.1, *Amendment to MEF 61.1: UNI Access Link Trunks, IP Addresses, and Mean Time to Repair Performance Metric*, July 2022

[24] MEF 62, *Managed Access E-Line Service Implementation Agreement*, May 2018

[25] MEF 69.1, *Subscriber IP Service Definitions*, February 2022

[26] MEF 70.2, *SD-WAN Service Attributes and Service Framework*, November 2023

[27] MEF 140, *Broadband Access E-Line and Broadband Access E-LAN Service Definitions*, June 2025

[28] TIA-568.0-E-2020, *Generic Telecommunications Cabling for Customer Premises*, March 2020

Appendix A Text for Referencing Service Access Interface (Informative)

Documents that refer to the Service Access Interface as the means of communication between the Subscriber and the Service Provider can adapt the following text to describe the Service Access Interface. One of the bullet items in the following text would be selected and an example of an additional adaptation would be to substitute the word "Standard" for "document" to be consistent with the rest of the referring document.

"Mplify Services that operate at OSI Layer 2 and above such as ⟨*placeholder*⟩ access Services at the UNI via an Ethernet interface. This Ethernet interface could provide access to multiple Services, including Services addressed in other Mplify Standards. The implementation and attributes of this interface are associated with a construct called the Service Access Interface. Details and Service Attributes for the Service Access Interface are documented in Mplify 165 and are referenced as needed in this document."

The ⟨*placeholder*⟩ in the paragraph above could be one of the following:

- the Services based on the Service Attributes in this document
- the Services defined in this document
- the Services defined in this document and based on the Service Attributes defined in Mplify xxx

Appendix B Compatibility of Service Attributes in Current Mplify Service Standards with the Service Access Interface (Informative)

There are five documents that specify Service Attributes for Service Access Interface Compatible Services. They will not be updated to refer to the Service Access Interface at the same time, and some documents may never be updated to refer to the Service Access Interface. It is, nonetheless, desirable that Services that do not refer to the Service Access Interface be able to use a Service Access Interface.

This appendix identifies how the Interface-related Service Attributes for each Service Access Interface Compatible Service can map into and compatibly coexist with the corresponding Service Access Interface Service Attributes.

For each of the Service Access Interface Service Attributes one or two of the following cases applies:

Case 1 – The Service Access Interface Service Attribute and a Service-specific UNI Service Attribute are describing the same thing and both Service Attributes need to have the same value.

Case 2 – The Service Access Interface Service Attribute and a Service-specific UNI Service Attribute have similar names but are describing different behaviors/capabilities and therefore can have different values.

Case 3 – The set of Service-specific UNI Service Attributes does not include a Service Attribute that corresponds to the Service Access Interface Service Attribute, but the Service Access Interface Service Attribute value might have an impact on the Service behavior/capabilities.

Three Service Access Interface Service Attributes are not included in the tables:

- Service Access Interface Identifier Service Attribute – Each Service Access Interface has an Identifier, and each Service-specific UNI has an Identifier, but they are identifying different constructs and therefore are not related.
- Service Access Interface Unique Identifier – This is an attribute of the Service Access Interface that has nothing to do with the associated Service-specific UNI.
- Service Access Interface Service Multiplexing Limits – This Service Attribute provides constraints and limits on some aspects of sharing the Service Access Interface but doesn't have a direct impact on the behavior of any Service-specific UNI.

Note also that none of the documents discussed in the following sections refer to 2022 edition of IEEE Std 802.3™ for their list of supported physical interfaces (the *pl* element in the List of Physical Links), so the list specified in this document in Table 6 includes PHYs that were not included in any of the other documents.

B.1 MEF 10.4 and MEF 6.3 - Subscriber Ethernet

MEF 10.4 [16] defines the Service Attributes for Subscriber Ethernet Services. MEF 6.3 [15] defines several Subscriber Ethernet Services based on the Service Attributes defined in MEF 10.4.

The Service Access Interface Service Attributes are derived from the relevant MEF 10.4 UNI Service Attributes; therefore, compatibility and interoperability are relatively easy to achieve.

Three of the five methods for mapping Ethernet Frames to a Service specified in section 8.4 are derived directly from MEF 10.4 (all except for the *All-NP* and *UT*). Therefore, a Subscriber Ethernet Service based on the Service Attributes defined in MEF 10.4 can share a Service Access Interface with another Mplify Service whose access interface is based on the Service Attributes defined in this document – within the limits imposed by the Service Access Interface Service Multiplexing Limits Service Attribute (section 9.6).

Table 9 provides guidance for mapping Subscriber UNI Service Attributes to Service Access Interface Service Attributes.

Service Access Interface Service Attribute	Subscriber Ethernet UNI Service Attribute	Case	Discussion
Instantiation	Instantiation	1	
Virtual Frame Map	Virtual Frame Map	1	
List of Physical Links	List of Physical Links	1 & 3	The values of *id, pl, fs, pt* need to have the same values. (Case 1) The values of *ct* and *gn* are not included in in MEF 10.4 but they constrain/describe the Subscriber Ethernet Physical Link configuration (Case 3)
Link Aggregation	1. Link Aggregation 2.Port Conversation ID to Aggregation Link Map	1	The structure of the values in MEF 10.4 is different than in this document, but the specified capabilities are the same. Also, the two Service Attributes defined in MEF 10.4 are represented as a single Service Attribute in this document.
Ethernet Frame Format	Service Frame Format	1	
Maximum Ethernet Frame Size	Maximum Service Frame Size	1	
Link OAM	Link OAM	1	
L2CP Peering	L2CP Peering	1	
Performance Objectives Evaluation Intervals	⟨None⟩	3	The Subscriber Ethernet SLS includes similar parameters, but the SLS applies to EVC performance metrics.
Availability Objective	⟨None⟩	3	The Subscriber Ethernet SLS includes Availability performance objectives for the EVC. The Availability of the Service Access Interface could have an impact on the Availability of the EVC.
Mean Time To Repair Objective	⟨None⟩	3	The Mean Time To Repair for the Service Access Interface might have an impact on the performance of the EVC.

Table 9 – Service Access Interface and Subscriber Ethernet UNI Service Attributes

B.2 MEF 26.2 and MEF 51.1 - Operator Ethernet

MEF 26.2 [17] defines the Service Attributes for Operator Ethernet Services. MEF 51.1 [20] defines several Operator Ethernet Services based on the Service Attributes defined in MEF 26.2.

The methods for mapping Ethernet Frames to a Service described in section 8.4 have important differences from the mapping methods defined by section 16.5 of MEF 26.2. The End Point Map Form U defined in MEF 26.2 specifies a list of C-Tag VLAN IDs. This is equivalent to the *List* specified in section 8.4. However, Untagged and Priority-Tagged frames are mapped differently. Rather than specifying *UT/PT* or *UT*, a Default CE-VLAN ID is defined to represent these frames and this Default CE-VLAN is then included in the *List*. This means that unlike in MEF 10.4 and this document, Untagged and Priority Tagged Frames can be mapped to the same Service as VLAN-Tagged Frames.

If Untagged and Priority Tagged Ethernet Frames are mapped to an Operator Ethernet Service, there will be a conflict if other Services sharing the Service Access Interface use the *UT/PT* or *UT* method. So, mapping Untagged and Priority Tagged Ethernet Frames to an Operator Ethernet Service should be avoided or used with caution.

An Operator Ethernet Service based on the Service Attributes defined in MEF 26.2 can share a Service Access Interface with another Mplify Service whose access interface is based on the Service Attributes defined in this document – within the limits imposed by the Service Access Interface Service Multiplexing Limits Service Attribute (section 9.6).

Table 10 provides guidance for mapping Operator UNI Service Attributes to Service Access Interface Service Attributes.

Service Access Interface Service Attribute	Operator Ethernet UNI Service Attribute	Case	Discussion
Instantiation	⟨None⟩	3	
Virtual Frame Map	⟨None⟩	3	
List of Physical Links	1. Physical Layer 2. Synchronous Mode 3. Number of Links	1 & 3	The Operator UNI Physical Layer Service Attribute does not include an Identifier (*id*) element for each physical link (Case 3). The Physical Layer is equivalent to a list of *pl* elements (Case 1). The Synchronous Mode is derived from the *fs* elements in the list (Case 1). This document uses values *ESMC* and *No-ESMC* to describe the *Enabled* value used in MEF 26.2 (Case 3). The Number of Links is equivalent to the cardinality of the List of Physical Links (Case 1). The values of *pt*, *ct* and *gn* are not included in in MEF 26.2 but they constrain/describe the Operator Ethernet Physical Link configuration (Case 3).
Link Aggregation	1. Link Aggregation 2.Port Conversation ID to Aggregation Link Map	1	The structure of the values in MEF 26.2 is different than in this document, but the specified capabilities are the same. Also, the two Service Attributes defined in MEF 26.2 are represented as a single Service Attribute in this document.
Ethernet Frame Format	Service Frame Format	1	
Maximum Ethernet Frame Size	Maximum Service Frame Size	1	
Link OAM	Link OAM	1	
L2CP Peering	L2CP Peering	1	
Performance Objectives Evaluation Intervals	⟨None⟩	3	The Operator Ethernet SLS includes similar parameters, but the SLS applies to OVC performance metrics and objectives.

Service Access Interface Service Attribute	Operator Ethernet UNI Service Attribute	Case	Discussion
Availability Objective	⟨None⟩	3	The Operator Ethernet SLS includes Availability performance objectives for the OVC. The Availability of the Service Access Interface could have an impact on the Availability of the OVC.
Mean Time To Repair Objective	⟨None⟩	3	The Mean Time To Repair for the Service Access Interface might have an impact on the performance of the OVC.

Table 10 – Service Access Interface and Operator UNI Service Attributes

B.3 MEF 61.1, MEF 61.1.1 and MEF 69.1 - IP Services

MEF 61.1 [22] does not specify any OSI Layer 1 or OSI Layer 2 attributes of the UNI or associated UNI Access Links[13]. MEF 61.1.1 [23] is an amendment to MEF 61.1 that addresses this deficiency. MEF 61.1.1 specifies Service Attributes for a UNI Access Link Trunk. The UNI Access Link Trunk is similar to the Service Access Interface functionality for IP Services in that it defines the OSI Layer 1 and OSI Layer 2 attributes of the UNI Access Link. The Service Attributes for the UNI Access Link Trunk specified in MEF 61.1.1 are derived from MEF 10.4 [16] although several of them are omitted as not being directly relevant to IP Services.

MEF 61.1.1 also specifies Performance Objectives that look like the last two entries in Table 11 but refer to the Service and not the UNI Access Link Trunk so they have no relationship to the Performance Objectives in this document.

The method by which a UNI Access Link Trunk is associated with a UNI Access Link is via a Service Attribute that specifies the identifier of the UNI Access Link Trunk and a single C-Tag VLAN ID (effectively a *List* with one entry) or *UT/PT*. This is consistent with the methods specified in section 8.4.

[13] The UNI in MEF 61.1 is a layer 3 interface which can multiplex multiple layer 2 interfaces referred to as UNI Access Links.

Service Access Interface Service Attribute	IP UNI Access Link Trunk Service Attribute	Case	Discussion
Instantiation	⟨None⟩	3	
Virtual Frame Map	⟨None⟩	3	
List of Physical Links	List of Physical Links	1 & 3	The values of *id, pl, fs, ct, gn* need to have the same value (Case 1). The value of *pt* is not included in in MEF 61.1.1 but it describes an aspect of the UNI Access Link Trunk (Case 3).
Link Aggregation	Link Aggregation	1	The Link Aggregation Service Attribute in this document and in MEF 61.1.1 are both derived from MEF 10.4 and therefore the values should map from one to the other directly.
Ethernet Frame Format	⟨None⟩	3	
Maximum Ethernet Frame Size	⟨None⟩	3	
Link OAM	Link OAM	1	
L2CP Peering	⟨None⟩	3	
Performance Objectives Evaluation Intervals	⟨None⟩	3	MEF 61.1.1 defines evaluation intervals for Service Performance Objectives, but they are not necessarily related to the Service Access Interface Performance Objectives.
Availability Objective	⟨None⟩	3	See text above this table
Mean Time To Repair Objective	⟨None⟩	3	See text above this table

Table 11 – Service Access Interface and IP UNI Service Attributes

B.4 MEF 70.2 - SD-WAN

MEF 70.2 [26] has only two UNI Service Attributes that relate to the Service Access Interface.

The SD-WAN UNI L2 Interface Service Attribute specifies which Ethernet Frames are mapped to the SWVC End Point at the SD-WAN UNI. MEF 70.2, in effect, supports two values both of which are in the list of methods specified in section 8.4:

- A single C-Tag VLAN ID value, which is equivalent to *List* with a single value
- *Untagged*, which is equivalent to *UT/PT*

Table 12 provides guidance for mapping SD-WAN UNI Service Attributes to Service Access Interface Service Attributes.

Service Access Interface Service Attribute	SD-WAN UNI Service Attribute	Case	Discussion
Instantiation	⟨None⟩	3	
Virtual Frame Map	⟨None⟩	3	
List of Physical Links	⟨None⟩	3	
Link Aggregation	⟨None⟩	3	
Ethernet Frame Format	⟨None⟩	3	
Maximum Ethernet Frame Size	Maximum Frame Size	1	
Link OAM	⟨None⟩	3	
L2CP Peering	⟨None⟩	3	
Performance Objectives Evaluation Intervals	Service Performance Objectives Reporting Periods	2	The SD-WAN UNI Availability Objective Service Attribute and the SD-WAN UNI Mean Time To Repair Objective Service Attribute describe different objectives from the objectives for the Service Access interface. Therefore, the values can be different.
Availability Objective	Availability Objective	2	The SD-WAN UNI Availability Objective Service Attribute describes a different objective than the objective for the Service Access interface. Therefore, the values can be different.
Mean Time To Repair Objective	Mean Time To Repair Objective	2	The SD-WAN UNI Mean Time To Repair Service Attribute describes a different objective than the objective for the Service Access interface. Therefore, the values can be different.

Table 12 – Service Access Interface and SD-WAN UNI Service Attributes

B.5 MEF 140 – Broadband Access E-Line and Broadband Access E-LAN

Broadband Access E-Line and Broadband Access E-LAN defined in MEF 140 [27] are Operator Ethernet Services derived from Access E-Line and Access E-LAN defined in MEF 51.1 [20] (based on MEF 26.2 [17]).

In MEF 140, if the value of the Operator UNI List of Physical Layers Service Attribute is a list of Ethernet physical layers, then the comparisons between Service Attributes described in Table 10 apply. However, if the physical layers specified in the value of the Operator UNI List of Physical Layers Service Attribute are not Ethernet physical layers, for example, a coaxial cable with DOCSIS, then the Service is not delivered over a Service Access Interface and is beyond the scope of this document.

Appendix C Multiplexing Above OSI Layer 2 (Informative)

The Service Access Interface is defined at OSI Layer 2. As noted in section 8.2, multiple Ethernet physical interfaces can be multiplexed using Link Aggregation or another technique to increase the available bandwidth or resiliency or both. This is shown in Figure 7 which is reproduced below.

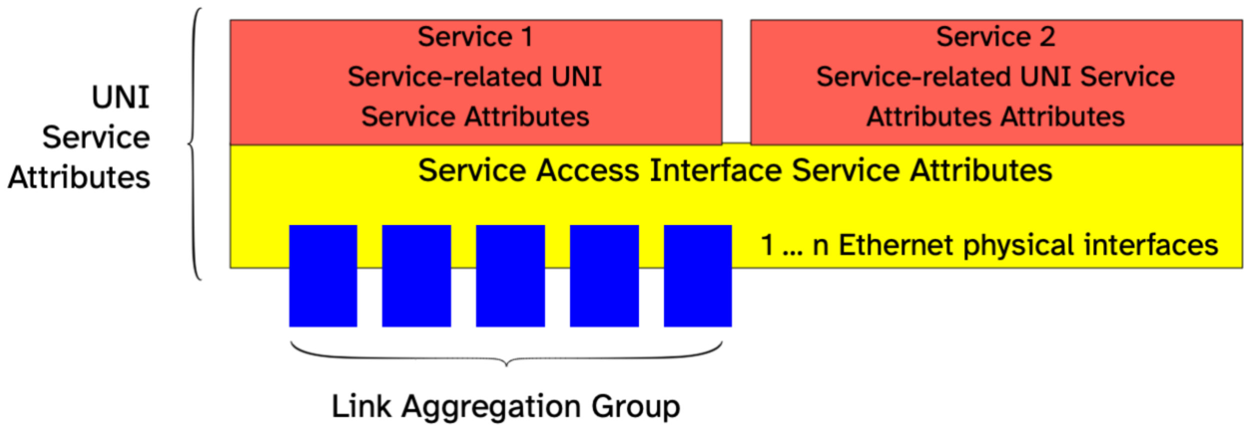

Figure 12 – Service Access Interface Multiplexing

Services that operate above OSI Layer 2, such as IP Services defined in MEF 69.1 [25] and described by the Service Attributes specified in MEF 61.1 [22] and MEF 61.1.1 [23] provide for the IP UNI to be a multiplexed OSI Layer 3 interface using a multiplexing technique, for example VRRP (see RFC5798 [9]).

In MEF 61.1, each of the subchannels that are multiplexed into the IP UNI are referred to as UNI Access Links. Each UNI Access Link is associated with a Service Access Interface which can, in turn, be an aggregate of multiplexed Ethernet physical Interfaces. This is shown in Figure 13, below.

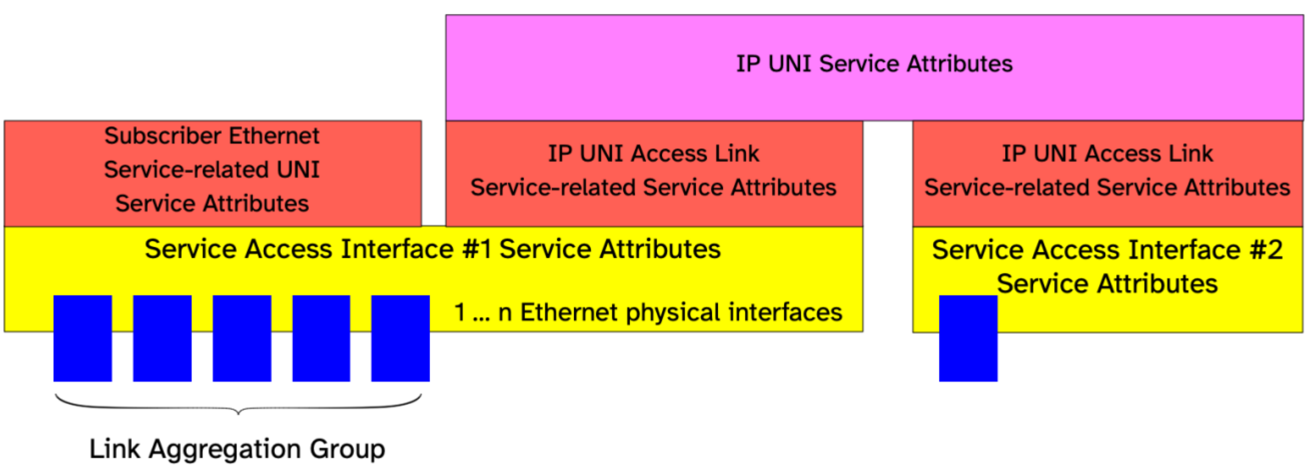

Figure 13 – Example of OSI Layer 3 Multiplexing

Figure 13 shows two Service Access Interfaces (in yellow). Note that the UNI Access Link Trunk defined in MEF 61.1.1 is analogous to the Service Access Interface defined in this document, but the MEF 61.1.1 UNI Access Link Trunk Service Attributes are a subset of the Service Access Interface Service Attributes. Service Access Interface #1 is composed of five Ethernet physical interfaces (blue rectangles) and Service Access Interface #2 has a single Ethernet physical interface. At the top of the diagram are the IP UNI Service Attributes. This IP UNI is composed of two UNI Access Links, one at Service Access Interface #1 and one at Service Access Interface #2. Service Access Interface #1 is also delivering a Subscriber Ethernet Service.

This document is focused on the implementation of a single Service Access Interface. Higher-level multiplexing of multiple Service Access Interfaces is beyond the scope of this document but could be relevant for Services that operate above OSI Layer 2.

Appendix D Acknowledgements (Informative)

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