MEF Standard

MEF 61.1.1

Amendment to MEF 61.1: UNI Access Link Trunks, IP Addresses, and Mean Time to Repair Performance Metric

July 2022

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1 List of Contributing Members

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

- AT&T
- Bell Canada
- Cisco Systems

2 Abstract

This amendment to MEF 61.1 [1] enhances three Service Attribute areas in order to facilitate deployment of IP Services. The three areas addressed are:

- Layer 1 and Layer 2 characteristics and attributes for UNI Access Links
- Clarifications and limited enhancements to IP Address usage and administration
- A new Mean Time To Repair (MTTR) Performance Metric

To address the first area, this amendment defines a new service component, the UNI Access Link Trunk, in section A1-1. Section A1-1 defines several Service Attributes applicable to all UNI Access Link Trunks and additional Service Attributes applicable to UNI Access Link Trunks based on Ethernet. This amendment also completes the definition of the UNI Access Link L2 Technology Service Attribute in section 13.3 of MEF 61.1 by specifying the value as a UNI Access Link Trunk with corresponding de-multiplexing information.

To address the second area, changes are made to parameters of the IPVC Cloud Service Attribute in order to:

- Clarify the use of NAT (by amending section 10.13.4 in MEF 61.1 [1]) and
- Support Subscribers who have registered their own IP address space (by amending section 10.13.6 in MEF 61.1 [1]).

To address the third area, a new Performance Metric, Mean Time to Repair, has been added as a new section, 10.9.10, in MEF 61.1 [1].

3 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 [2], RFC 8174 [3]) 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**.**

4 Introduction

MEF 61.1 [1] includes section 13.3, UNI Access Link L2 Technology Service Attribute, that acknowledges that the IP Packets that arrive at the IPVC UNI are carried over a communications channel that includes a physical layer (Layer 1) and a datalink layer (Layer 2). Although subsections of section 13.3 provide examples of Layer 2 technologies that can be used to carry a UNI Access Link, no Service Attributes or normative language relating to these technologies are contained in MEF 61.1.

As deployment of MEF Services is increasingly automated using LSO APIs, it is important to ensure that all components of a service are defined with Service Attributes whose values can be included in payloads that are included in the APIs between the relevant business entities (Subscriber, Service Provider, etc.). This amendment defines Service Attributes for Ethernet-based UNI Access Links (including Link Aggregation as defined in [A1-4]). As such, it fully specifies the cases exemplified in sections 13.3.1 and 13.3.3 of MEF 61.1.

Since a single (Layer 1) physical channel (e.g., Ethernet connection) can carry multiple logical Layer 2 channels (e.g., individual VLANs) and each such Layer 2 channel can represent a different UNI Access Link, this amendment defines a new component, the UNI Access Link Trunk. The UNI Access Link Trunk encompasses all aspects of Layer 1 and Layer 2 that are common to the UNI Access Links that are carried on the physical link(s). These are captured in a new section of the document, section A1-1, that is included after the current section 13 and before the current section 14.

This new section includes Service Attributes for Ethernet UNI Access Link Trunks. Section 13.3 is modified to reflect its original intent, i.e., a Service Attribute that indicates the Layer 2 technology of the UNI Access Link (the Trunk and Trunk Type), as well as additional information, when needed, to indicate which subchannel on the Trunk is associated with the UNI Access Link.

In addition to the changes described for UNI Access Links, this amendment addresses two issues that have been identified in the administration and usage of IP addresses for Internet Access at the UNI by:

- Clarifying the description of the IPVC Cloud Service Attribute Cloud NAT parameter, and
- Including support for Subscribers who have registered their own IP address space.

Addressing these two items requires changes to two parameters in the IPVC Cloud Service Attribute (see sections 10.13.4 and 10.13.6 in MEF 61.1).

This amendment also includes the definition of a new Performance Metric, Mean Time To Repair (MTTR)[1]. This Performance Metric is widely used in IP Services, especially Internet Access services, but was not included in MEF 61.1.

In this amendment, changes are shown as follows:

- Instructions for how to apply the amendment are shown in *blue italics*

[1] The definition of MTTR for IP Services differs from the way this term is used in some other contexts.

- In content modified by the amendment, text to be removed is shown with ~~red strikethrough~~
- In content modified by the amendment, text to be added is shown in red

5 Changes to Section 3 (Terminology and Abbreviations)

Add the terms shown below to Table 1

Term	Definition	Reference
Link Number ID	An integer ≥ 1 that is uniquely assigned to each physical link in a given Ethernet UNI Access Link Trunk.	Adapted from MEF 10.4 [64]
Link Selection Priority List	A sequence of Link Number IDs, in the order of usage preference, highest to lowest, for the link that is to carry Layer 2 frames corresponding to a given Port Conversation ID.	Adapted from MEF 10.4 [64]
UNI Access Link Trunk	A construct that encapsulates the details of the Layer 1 and Layer 2 configuration shared by one or more UNI Access Links.	This document

Table 1 – Terminology and Abbreviations

6 Changes to Section 7 (Key Concepts)

The changes to this section do not add new content but support the new content added in other sections of the document.

6.1 Changes to Section 7.2 (Service Attributes)

Modify the bulleted list near the end of section 7.2 and subsequent note as follows:

- IPVC Service Attributes (section 10).
- IPVC End Point Service Attributes (section 11).
- UNI Service Attributes (section 12).
- UNI Access Link Service Attributes (section 13).
- UNI Access Link Trunk Service Attributes (section A1-1)

Note: UNIs, ~~and~~ UNI Access Links, and UNI Access Link Trunks are described in section 7.3; IPVCs and IPVC End Points are described in section 7.4.

6.2 Changes to Section 7.3 (UNIs and UNI Access Links)

Modify section 7.3 as follows

7.3 UNIs, ~~and~~ UNI Access Links, and UNI Access Link Trunks

A User Network Interface (UNI) is the demarcation point between the responsibility of the SP and the responsibility of the Subscriber. Note that a given UNI always relates to a single SP and a single Subscriber.

A Subscriber Network is an interconnected IP network belonging to a single Subscriber – different parts of a Subscriber Network can be connected to each other directly, or via a Subscriber IP Service obtained from a Service Provider. A Subscriber Network is connected to the Service Provider at one or more UNIs. A given UNI can only connect one Subscriber Network to the SP.

A given UNI consists of one or more distinct IP links, each of which is a single IP hop from a service perspective (i.e., there is no intermediate router that processes the IP Packets traversing the link). Each such IP link is known as a UNI Access Link~~,~~ and is a subnetwork corresponding to a distinct IP subnet (which can have both IPv4 and IPv6 addressing). Some examples of UNI Access Links are as follows (this is not an exhaustive list):

- A~~a~~ distinct physical connection.
- A~~a~~ logical Layer 2 connection (for example, an Ethernet VLAN with a given VLAN ID). Such a Layer 2 connection might be over a single physical link, an aggregation of physical links (e.g., an Ethernet Link Aggregation Group) or an entire Layer 2 network (e.g., an Ethernet Switch or an Ethernet E-Access service).
- An IP tunnel (e.g., using GRE) over another IP network (e.g., over the Internet). In this case the UNI Access Link is the tunnel (which is a single IP hop), not the underlying IP network.

Each UNI Access Link is carried by an underlying construct that encapsulates the Layer 1 and Layer 2 characteristics of the link. This construct is the UNI Access Link Trunk (see section A1-1). A UNI Access Link Trunk may carry packets for a single UNI Access Link, as in the case where the UNI Access Link is a direct physical connection, or may carry packets for multiple UNI Access Links, for example when the UNI Access Link is an Ethernet VLAN. The UNI Access Link Trunk itself may be a single physical link, may comprise multiple physical links such as an Ethernet Link Aggregation Group, or may be logical such as an IP tunnel.

When a Subscriber Network is connected to an SP Network by a number of UNI Access Links, the Subscriber and SP need to agree how the UNI Access Links are grouped together to form UNIs (via the UNI List of UNI Access Links Service Attribute, section 12.3). Each UNI Access Link belongs to exactly one UNI.

This document does not constrain how UNI Access Links for a given Subscriber Network are grouped into UNIs. Typically, UNI Access Links that terminate at the same physical location in the Subscriber Network, and which have similar properties in terms of intended use, are grouped into a single UNI. UNI Access Links that terminate at a remote physical location in the Subscriber Network, or which have a different intended use (such as for a backup link) are typically treated as separate UNIs. Note that the choice of how UNI Access Links are assigned to UNIs can affect how traffic is forwarded over them, as well as how assurance-related attributes such as Bandwidth Profiles and SLS performance objectives can be applied.

UNI Access Links in a given UNI can be connected to one or multiple devices at the Subscriber and at the Service Provider. Some examples are shown in Figure 3 – other arrangements are also possible. Note that the various examples shown can have different pros and cons; this document does not state a preference for any particular arrangement. Note also that the services to which the UNIs are connected are not shown.

6.3 Changes to Section 7.11 (IP Subscriber Services Framework)

Modify the bulleted list in section 7.11 as follows:

- Exactly one IPVC, with a corresponding set of IPVC Service Attributes (see section 10)
- One or more UNIs where the Subscriber accesses the service, each with a corresponding set of UNI Service Attributes (see section 12).
- Exactly one IPVC EP for the IPVC at each of those UNIs, where each IPVC EP has a corresponding set of IPVC EP Service Attributes (see section 11).
- One or more UNI Access Links in each UNI, each with a corresponding set of UNI Access Link Service Attributes (see section 13).
- One or more UNI Access Link Trunks each carrying one or more UNI Access Links. Each UNI Access Link Trunk has a corresponding set of UNI Access Link Trunk Service Attributes (see section A1-1).

7 Changes to Section 8.5 (Operator IP Service Framework)

Modify the bulleted list entitled "A complete Operator IP Service consists of" as follows:

- Exactly one Operator IPVC, with a corresponding set of IPVC Service Attributes (see section 10).
- Zero or more UNIs, each with a corresponding set of UNI Service Attributes (see section 12).
- One or more ENNIs, each with a corresponding set of ENNI Service Attributes (see section 14).
- Exactly one IPVC EP for the IPVC at each of the UNIs and each of the ENNIs, where each IPVC EP has a corresponding set of IPVC EP Service Attributes (see section 11).
- One or more UNI Access Links in each UNI, each with a corresponding set of UNI Access Link Service Attributes (see section 13).
- Zero or more UNI Access Link Trunks each carrying one or more UNI Access Links. Each UNI Access Link Trunk has a corresponding set of UNI Access Link Trunk Service Attributes (see section A1-1).

8 Changes to Section 10.9 (Performance Metrics)

A new Performance Metric, Mean Time To Repair, is added as section 10.9.10. Section 10.9 is modified to include the new Performance Metric in the list of Performance Metrics. Section 10.9.9 is modified to clarify some of the terminology and also to allow consistent terminology with the new section.

8.1 Changes to Section 10.9

The bulleted list of Performance Metrics in section 10.9 is modified as follows:

- One-way Packet Delay Percentile (section 10.9.4).
- One-way Mean Packet Delay (section 10.9.5).
- One-way Inter-Packet Delay Variation (section 10.9.6).
- One-way Packet Delay Range (section 10.9.7).
- One-way Packet Loss Ratio (section 10.9.8).
- Service Uptime (section 10.9.9).
- Mean Time To Repair (section 10.9.10).

8.2 Changes to Section 10.9.9

Change the first paragraph of the section as follows:

The Service Uptime Performance Metric is the proportion of time, during a given time period T_k, that the service is working from the perspective of the Subscriber (for a Subscriber IP Service) or the perspective of the SP/SO (for an Operator IP Service), excluding any pre-agreed ~~exceptions, for example~~ maintenance periods~~intervals~~.

Change the first and second bullets in [R37] as follows:

- Let $O(T_k)$ be the total ~~duration~~ time during time period T_k in which at least one outage was in effect, excluding pre-agreed maintenance periods. ~~of outages~~ ~~during time period T_k.~~ If there were no outages during T_k, then $O(T_k)=0$.

- Let $M(T_k)$ be the total ~~duration~~ time during time period T_k in which at least one ~~of~~ pre-agreed maintenance period ~~or exception~~ was in effect ~~during time period T_k~~. If there were no pre-agreed maintenance periods during T_k, then $M(T_k)=0$.

Change the paragraph following [R39] as follows:

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 through the network. This definition can be refined based on further commercial considerations, such as exceptions for ~~acts of god or other~~ events beyond the Service Provider's or Operator's control. The exact definition is outside the scope of this document. The definition of an outage may or may not include maintenance periods, however the definition of $O(T_k)$ in [R37] explicitly excludes them.

Change [R40] as follows:

> [R40] If the SLS contains an entry for the Service Uptime Performance Metric, it MUST define the objective as being met over time period T k for an SLS entry of the form specified in Table 9 if and only if $U(T_k) \geq \widehat{U}$, where $U(T_k)$ is expressed as a percentage.

8.3 New Section 10.9.10

Add this section 10.9.10 after 10.9.9.

10.9.10 Mean Time To Repair Performance Metric

The Mean Time To Repair (MTTR) Performance Metric is the arithmetic mean, i.e., average, of the durations of all outages that start in a given time period T_k, excluding any pre-agreed maintenance periods. This means that an outage that crosses the boundary of a reporting period (T_k) is counted for MTTR in the period in which it started.

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 through the network. This definition can be refined based on further commercial considerations, such as exceptions for events beyond the Service Provider's or Operator's control. An exact definition is outside the scope of this document.

A period of an outage can be calculated as a single outage or multiple outages. For example, if site 1 becomes unreachable at $t=1$ and this is resolved at $t=4$, this is a single outage with a duration of 3. If, however, site 2 becomes unreachable at $t=3$ (while the first outage is active) and becomes reachable 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 two failures are considered 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 or SP/SO and Operator agree that outages are reported and resolved.

[A1-R1] If the SLS for a Subscriber IP Service contains an entry for the Mean Time To Repair Performance Metric, the Subscriber and the Service Provider **MUST** agree on the definition of an outage, including determining when an outage starts and ends.

[A1-R2] If the SLS for an Operator IP Service contains an entry for the Mean Time To Repair Performance Metric, the SP/SO and the Operator **MUST** agree on the definition of an outage, including determining when an outage starts and ends.

[A1-R3] If the SLS contains entries for both the Service Uptime Performance Metric and the Mean Time To Repair Performance Metric, then the definition of what constitutes an outage **MUST** be the same in the calculation of each of the Performance Metrics.

[A1-R4] If the SLS contains entries for both the Service Uptime Performance Metric and the Mean Time To Repair Performance Metric, then the definition of what constitutes a pre-agreed maintenance period **MUST** be the same in the calculation of each of the Performance Metrics.

[A1-R5] If the SLS contains an entry for the Mean Time To Repair Performance Metric, then pre-agreed maintenance periods **MUST NOT** overlap in time.

[A1-R5] ensures that maintenance periods are subtracted from outages only once.

Table A1-1 lists the contents of an SLS entry for the Mean Time To Repair Performance Metric.

Item	Description	Values
Performance Metric	Name of the Performance Metric	Mean Time To Repair
$\hat{R}$	Mean Time To Repair Objective	A time duration in time units

Table A1-1 – Parameters for Mean Time To Repair

As a result of requirements [A1-R1] and [A1-R2], each outage period, *U*, has an agreed-on start time, U_{start}, and end time, U_{end}. Since the maintenance periods are agreed on, each maintenance period, *M*, has an agreed-on start time, M_{start}, and end time, M_{end}.

[A1-R6] If the SLS contains an entry for the value of the Mean Time To Repair Performance Metric, it **MUST** be defined as follows, for a given time period, T_k:

- 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 maintenance periods that overlap with outage *U*. Let $Md(U, T_k)$ be the sum of the durations of the parts of these maintenance periods that overlap with outage *U*. If there are no maintenance periods that overlap with *U*, then $Md(U, T_k)$ is 0.
- Let $Vd(U, T_k) = Od(U, T_k) - Md(U, T_k)$ for each outage *U* that starts in T_k.
- Then the Mean Time to Repair $R(T_k)$ 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 $R(T_k)$ is 0.

[A1-R7] If the SLS contains an entry for Mean Time To Repair Performance Metric, it **MUST** define the objective as being met over a time period T_k for an SLS entry of the form specified in Table A1-1 if and only if $R(T_k) \leq \hat{R}$.

Figure A1-1 shows some of the common cases described by the definition of $R(T_k)$:

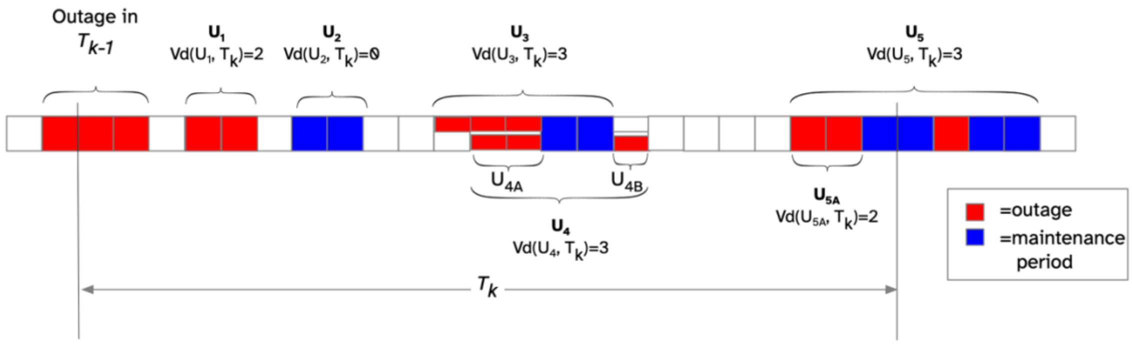

Figure A1-1 – Examples of Outages and Maintenance Periods

The MTTR calculation depends on an agreement between the Service Provider and Subscriber or SP/SO and Operator on how maintenance periods relate to outages. In particular, maintenance periods could be considered outages (or part of an existing outage) although they are subtracted out in the MTTR calculation as noted in third bullet of [A1-R6]. Alternatively, maintenance periods could be considered not part of outages and would, in effect, terminate any outages that they are adjacent to. The example in Figure A1-1 shows several outages and maintenance periods. The time divisions shown in the diagram are to illustrate the duration of each outage and maintenance period—in practice outages and maintenance periods can start and end at any time.

The MTTR for the indicated period, T_k, can be determined as follows:

- The first outage started during the period before T_k so it is not included in the MTTR computation for T_k.
- The next outage (U_1) is the simplest case, an outage with no overlapping maintenance periods. The duration of the outage is 2.
- Outage U_2 is an isolated maintenance period, i.e., not adjacent to any outages. Maintenance periods, as noted above, may or may not be considered as an outage. If maintenance periods are considered as outages, then this is a case where the duration of the outage is 0 and is not included in the MTTR calculation.
- Outage U_3 is an outage that ends with a maintenance period of duration 2. If the maintenance period is considered part of the outage, then the duration of the outage is 5 but
  $Vd(U_3, T_k) = 3$ after the maintenance period duration is subtracted out. If the maintenance period is not considered part of the outage, the duration is 3 and $Vd(U_3, T_k) = 3$.
- Outage U_4 is an outage that starts while outage U_3 is in progress (for example, it might have been reported on a separate trouble ticket). In this example, the agreement between the SP and Subscriber or SP/SO and Operator is such that these are treated as separate outages, even though they overlap in time. U_4 has an initial component with duration 2 followed by a maintenance period of duration 2. When the maintenance period ends, the outage is still in progress. If the maintenance period is considered part of the outage, this is an outage with a duration of 5 but $Vd(U_4, T_k) = 3$ after the maintenance period duration is subtracted out. If the maintenance period is not considered part of the outage, then this could also be treated as two outages (shown as U_{4A} and U_{4B}), one with duration 2 and one with duration 1, likely resulting in a different value for MTTR.

- 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 maintenance periods, one that straddles the boundary between T_k and T_{k+1} and one that is entirely in T_{k+1}. If the maintenance 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 maintenance period duration is subtracted out. However, if the maintenance 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 maintenance period is in T_{k+1} so it is not counted in the MTTR for T_k.

Based on the example in Figure A1-1 and the subsequent bullet list, there are two possible computations for MTTR:

- If the maintenance periods are considered part of the outage, then MTTR = $R(T_k) =$ 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 maintenance periods are not considered part of the outage, then MTTR = $R(T_k) =$ 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**

9 Changes to Section 10.13 (IPVC Cloud Service Attribute)

Enhancing IP Addressing and administration requires modification of two parameters in the IPVC Cloud Service Attribute (section 10.13) in MEF 61.1 [1].

10.13 IPVC Cloud Service Attribute

Update the last row of Table 10 as follows.

Cloud Subscriber Prefix List	List of ~~Public~~ public IP Prefixes used in the Subscriber Network and their origin.	~~List of IP Prefixes.~~ 2-tuple containing the list of IP Prefixes and the origin of the IP Prefixes.

10.13.4 Cloud Network Address Translation

Change the first paragraph and R55 as shown below. The rest of the section remains unchanged.

The Cloud Network Address Translation (NAT) parameter is either *Disabled* or an IPv4 Prefix. If the value of the parameter is an IPv4 Prefix then the Service Provider performs ~~An IPv4 Prefix can be specified for Internet access services, in which case~~ NAT ~~is enabled~~ and any IPv4 addresses used by the Subscriber are translated to an address in the given IPv4 Prefix. Note that the IPv4 Prefix can be specified with a prefix length of 32, in which case it corresponds to a single IPv4 address. This can be useful, for example, when the Subscriber needs a fixed IPv4 address.

> **[R55]** If the value of the Cloud Type parameter is *Internet Access*~~, when~~ and the value of the Cloud NAT parameter is ~~not *Disabled*,~~ an IPv4 Prefix, then it **MUST** be a publicly assigned IPv4 Prefix.

10.13.6 Cloud Subscriber Prefix List

Update section 10.13.6 as shown.

~~The Cloud Subscriber Prefix List parameter is a list of public IP Prefixes that are used in the Subscriber Network. Agreeing on this list allows the SP to implement security filtering for traffic to or from IP addresses that are not within the listed prefixes.~~

~~The list can be empty, or can contain IPv4 or IPv6 Prefixes or both. The listed prefixes might have been allocated to the Subscriber by the SP, or from some other source (e.g. another SP or a Regional Internet Registry).~~

The value of the Cloud Subscriber Prefix List parameter is *None* or a 2-tuple ⟨*prefixes*, *origin*⟩, where:

- *prefixes* is a non-empty list of public IP Prefixes that are used in the Subscriber Network, and
- *origin* is either *SP* or *Other* and indicates whether the IP Prefixes are assigned to the Subscriber by the SP or obtained by the Subscriber from another source.

Agreeing on a list of public IP Prefixes allows the SP to implement security filtering for traffic to or from IP addresses that are not within the listed prefixes. The list can contain IPv4 or IPv6 Prefixes or both.

A set of public IP Prefixes may be assigned to the Subscriber for use within the Subscriber Network by the SP, or the Subscriber may obtain such prefixes from another source, for example directly from a Regional Internet Registry.

> **[R61]** If the Cloud Type parameter (see section 10.13.1) is not *Internet Access*, the Cloud Subscriber Prefix List **MUST** be ~~empty~~ *None*.

If NAT is enabled, the Subscriber's addresses are translated by the SP so ~~this parameter~~ the Cloud Subscriber Prefix List parameter is not needed.

> **[R62**] If the Cloud Network Address Translation parameter (see section 10.13.4) is not *Disabled*, the Cloud Subscriber Prefix List **MUST** be ~~empty~~ *None*.

It is not necessary to list the IP Prefixes corresponding to the UNI Access Link connection addresses – these addresses are always assigned and allowed by the SP. IP Data Packets from outside the connection subnets, that are not listed in the Subscriber Prefix List, can be discarded.

> **[O10]** If the Cloud Type parameter (see section 10.13.1) for a cloud access IPVC is *Internet Access*, an Ingress IP Data Packet that is mapped to the IPVC at a UNI, with a source IP address that is not within the IP Prefix identified by the UNI Access Link Connection Addressing Service Attributes (see sections 13.4 and 13.5) and is not within an IP Prefix contained in the Cloud Subscriber Prefix List, **MAY** be discarded.

> **[O11]** If the Cloud Type parameter (see section 10.13.1) for a cloud access IPVC is *Internet Access*, an Egress IP Data Packet that is mapped to the IPVC at a UNI, with a destination IP address that is not within the IP Prefix identified by the UNI Access Link Connection Addressing Service Attributes (see sections 13.4 and 13.5) and is not within an IP Prefix contained in the Cloud Subscriber Prefix List, **MAY** be discarded.

Note that if different filtering is required at different UNIs that all have ~~internet~~ Internet access, this can be achieved by instantiating a separate cloud access IPVC for each UNI.

Note also that if the Cloud Subscriber Prefix List is ~~an empty list~~ *None*, the SP might discard all IP Packets other than those with source or destination IP addresses matching the UNI Access Link connection addresses. If the desired behavior is that the SP does not discard any IP Packets, this can be achieved by specifying a Cloud Subscriber Prefix List containing 0.0.0.0/0 and ::/0.

10 Changes to Section 13.3 (UNI Access Link L2 Technology)

Update section 13.3 as follows:

13.3 UNI Access Link L2 Technology Service Attribute

The fundamental property of a UNI Access Link is the ability to convey IP Packets between the Subscriber and the SP or Operator. The UNI Access Link L2 Technology Service Attribute specifies the UNI Access Link Trunk (see section A1-1) used to carry IP Packets across the UNI along with information needed to identify IP Packets for this UNI Access Link. describes the underlying network layers that carry IP Packets across the UNI. The fundamental property of a UNI Access Link is to be able to convey IP Packets between the Subscriber and the SP or Operator.; however, there are many possible ways to do this, and hence the details of this attribute are beyond the scope of this document. Nevertheless some examples are given below.

The details of the immediately-lower network layer always need to be agreed and hence specified in this Service Attribute and in the Service Attributes for the given UNI Access Link Trunk. The number of other layers that need to be specified depends on the scenario; for example, if the SP supplies a physical connection to the Subscriber, then the details of the physical layer (L1) and the datalink layer (L2) need to be specified. Conversely, if the SP and the Subscriber connect using an IP-Sec tunnel over the public Internet, then the details of the IP-Sec tunnel need to be agreed, but the details of how the SP connects to the Internet and how the Subscriber connects to the Internet do not need to be agreed or specified as part of this attribute.

If the SP uses an Operator IP Service to reach the UNI, then whatever information they agree is agreed between the SP and withthe Subscriber also needs to be agreed between the SP and with the Operator.

In general, sufficient parameters need to be specified to describe the responsibility of the SP as viewed by the Subscriber. Anything which is entirely within the SP's (or Operator's) domain and is not visible to the Subscriber does not need to be specified. For example, if the SP provides a physical Ethernet link, then the attributes of the link need to be specified, but what is connected to the SP's (or Operator's) end of the link does not. The SP or Operator could connect their PE directly to the physical Ethernet connection, or they might carry the IP Packets over an intervening Ethernet access network before they reach the PE. As this is opaque to the Subscriber, it does not need to be specified.

Either the immediately-lower L2 layer, or some even lower layer, might provide resiliency over some or all of the UNI Access Link. For example, if the L2 Technology is Ethernet, the Virtual Router Redundancy Protocol (VRRP, as defined in RFC 5798 [43]) can be used to attach redundant devices to the UNI and have them behave, at the IP layer, as if they were a single device. Such resiliency mechanisms are opaque at the IP layer; for example, if the SP or Operator uses VRRP on the UNI Access Link, the Subscriber does not need to be aware of it (although they might be able to detect it), unless they also use VRRP (see section 13.12). Therefore, the use of such techniques does not need to be specified as part of this attribute.

Multiple UNI Access Links can be carried over the same UNI Access Link Trunk; for example, if Ethernet is used, several UNI Access Links can be carried independently over the same physical

Ethernet link by using VLANs. These could be UNI Access Links for the same UNI, or for different UNIs.

Similarly, a UNI Access Link (or more than one) can be carried over a UNI Access Link Trunk comprising a Layer 2 aggregation of physical links, such as an Ethernet Link Aggregation Group (LAG) as specified in IEEE 802.1AX-2020 [A1-4]. Conversely, a UNI Access Link might not be tied to a particular physical layer, for example if it were carried over a UNI Access Link Trunk which is an IP-Sec tunnel over the Internet or is a software interface between two virtual machines within the same device.

This document specifies the details of the L2 (and L1) technology when the UNI Access Link is carried over Ethernet physical links. The details for other L2 technologies are out of scope for this document.

The value of the UNI Access Link L2 Technology Service Attribute is a 2-tuple ⟨*trunkID*, *demux*⟩ where:

- *trunkID* is a UNI Access Link Trunk Identifier as described in section A1-1
- *demux* is a value that is specific to each type of UNI Access Link Trunk and indicates which Layer 2 sub-channel should be selected for this UNI Access Link

Ethernet UNI Access Link Trunk is the only type specified in this document. This includes Ethernet with and without Link Aggregation.

In this document Ethernet frames are classified as follows:

- Untagged Ethernet frames are frames where the value of the first Type/Length field is not 0x8100.
- Priority tagged Ethernet frames are frames where the first Type/Length field is 0x8100 and the VLAN ID is 0.
- VLAN tagged Ethernet frames are frames where the first Type/Length field is 0x8100 and the VLAN ID is not 0.

The value *UT/PT* refers to untagged and priority tagged frames.

[A1-R8] If the UNI Access Link Trunk identified by *trunkID* is of type *Ethernet*, then the value of the *demux* element **MUST** be either *UT/PT* or a VLAN ID in the range 1 to 4094.

[A1-R9] If the UNI Access Link Trunk identified by *trunkID* is of type *Ethernet*, and the value of the *demux* element is *UT/PT*, then the UNI Access Link Trunk specified by the *trunkID* element **MUST NOT** be used for any other UNI Access Link.

[A1-R10] If the UNI Access Link Trunk identified by *trunkID* is of type *Ethernet*, and the value of *demux* is *UT/PT*, untagged and priority tagged frames **MUST** be mapped to the UNI Access Link.

[A1-R11] If the UNI Access Link Trunk identified by *trunkID* is of type *Ethernet*, and the value of *demux* is *UT/PT*, VLAN tagged frames **MUST NOT** be mapped to the UNI Access Link.

[A1-R12] If the UNI Access Link Trunk identified by *trunkID* is of type *Ethernet*, and the value of *demux* is a VLAN ID, VLAN tagged frames with the specified VLAN ID **MUST** be mapped to the UNI Access Link.

[A1-R13] If the UNI Access Link Trunk identified by *trunkID* is of type *Ethernet*, and the value of *demux* is a VLAN ID, frames that do not have the specified VLAN ID **MUST NOT** be mapped to the UNI Access Link.

[A1-R9] does not allow an Ethernet UNI Access Link Trunk to support UNI Access Links for both untagged and tagged frames. Therefore, if untagged frames are being used on a UNI Access Link Trunk, then the UNI Access Link Trunk can only support a single UNI Access Link.

Figure A1-2 depicts the simplest example of a UNI Access Link Trunk where the value of the UNI Access Link L2 Technology Service Attribute is ⟨*trunk1*, *UT/PT*⟩.

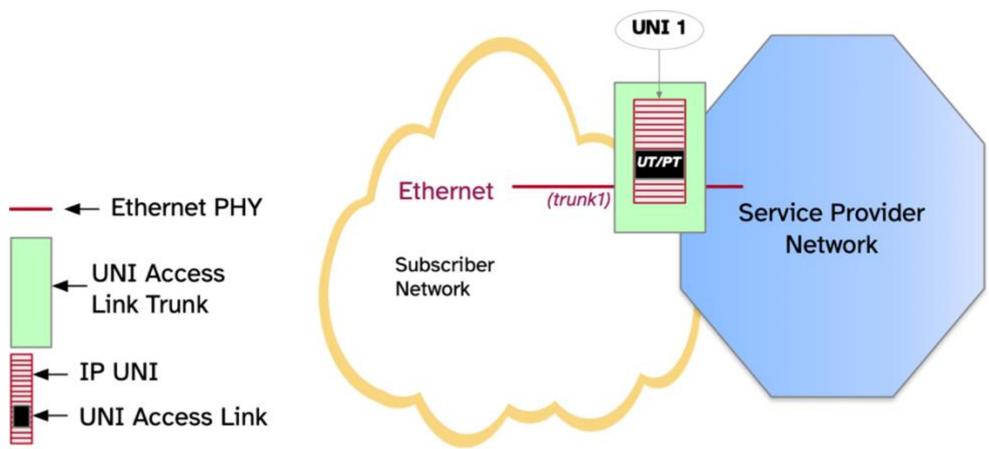

Figure A1-2 – Example of UNI Access Link Trunk

Figure A1-2 shows detail for the UNI Access Link Trunk, which is a single Ethernet link (copper or fiber), the UNI Access Link which comprises all untagged and priority tagged frames on the UNI Access Link Trunk, and the IP UNI.

Figure A1-3 adds a second IP UNI with a UNI Access Link and a second UNI Access Link Trunk. This UNI Access Link Trunk is a Link Aggregation Group containing two physical Ethernets. Again, untagged and priority tagged frames from this UNI Access Link Trunk constitute the UNI Access Link for IP UNI 2. The values of the UNI Access Link L2 Technology Service Attributes are ⟨*trunk1*, *UT/PT*⟩ and ⟨*trunk2*, *UT/PT*⟩ for the two UNI Access Links, respectively.

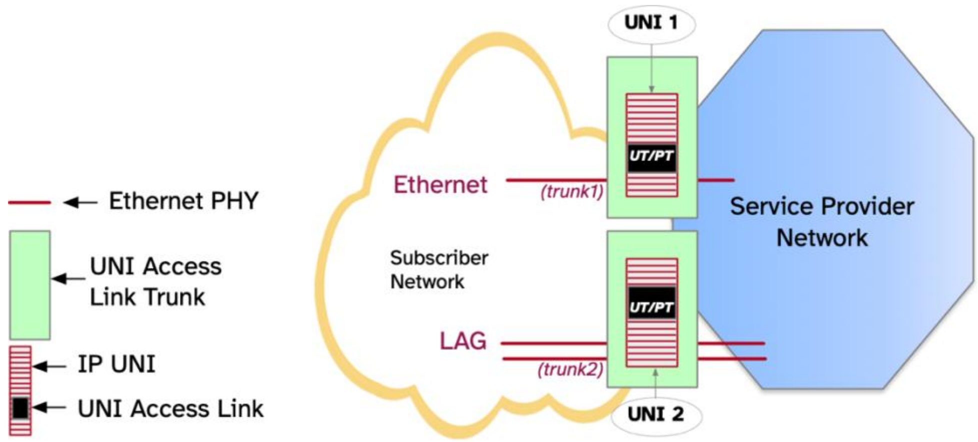

Figure A1-3 – Two UNI Access Link Trunks

Figure A1-4 adds one additional complexity, VLANs. In this diagram, UNI Access Link Trunk 1 (the single Ethernet PHY) is carrying VLAN tagged frames. Frames with VLAN ID 13 constitute a UNI Access Link for IP UNI 1, and frames with VLAN ID 14 constitute a second UNI Access Link for IP UNI 2. As above, untagged and priority tagged frames from the Link Aggregation Group constitute the other UNI Access Link for IP UNI 2. The values of the UNI Access Link L2 Technology Service Attributes are ⟨*trunk1*, *13*⟩ for the UNI Access Link for UNI1 and ⟨*trunk1*, *14*⟩ and ⟨*trunk2*, *UT/PT*⟩ for the two UNI Access Links for UNI2.

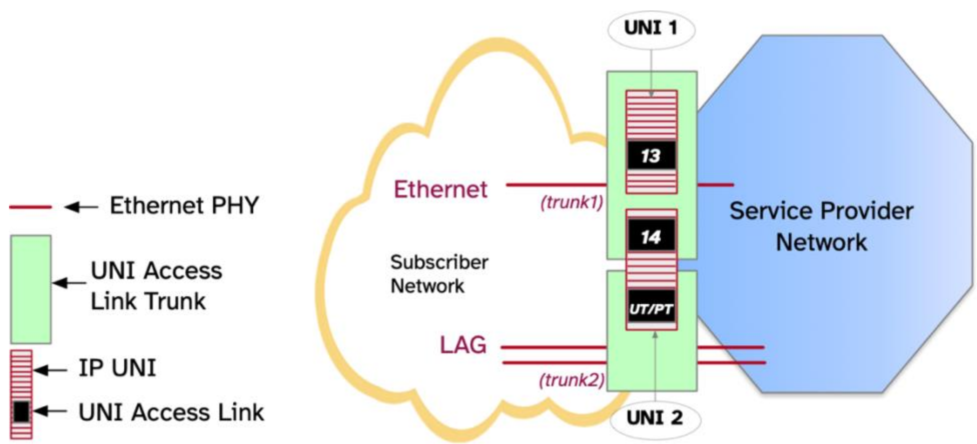

Figure A1-4 – UNI Access Link Trunk with VLANs

*Section 13.3 in MEF 61.1 [**1**] provides six examples of Layer 2 technologies, sections 13.3.1 through 13.3.6, that could be used to carry a UNI Access Link. These sections are removed from section 13.3. This amendment treats each of the six sections differently, as follows:*

- *Sections 13.3.1 Physical Point-to-Point Ethernet and 13.3.3 VLAN over an Ethernet Link Aggregation Group have been removed completely since they are covered by normative text in this amendment.*

- *Section 13.3.2 Multipoint Ethernet Link over WiFi and Section 13.3.5 Point to Point Protocol (PPP) have been moved to the new appendix, A1-A.*

- *Section 13.3.4 Physical Ethernet Link using VRRP is covered by normative text in this amendment and the example provided in this section has been moved to a new appendix, A1-B.*

- *Section 13.3.6 Point-to-point Ethernet Link using an E-Access service is covered by normative text in this amendment and the text of this section has been integrated into the existing Appendix E.*

11 New Section: A1-1 UNI Access Link Trunks

Add this new section between sections 13 and 14 in MEF 61.1 and re-number subsequent sections accordingly.

A1-1 UNI Access Link Trunk Service Attributes

A UNI Access Link Trunk is a construct that encapsulates the details of the Layer 1 and Layer 2 configuration shared by one or more UNI Access Links.

This section specifies the Service Attributes for IP Services that apply to each UNI Access Link Trunk. There is one instance of these attributes for each UNI Access Link Trunk supported by the SP or Operator. These attributes apply to UNI Access Link Trunks for both Subscriber IP Services and Operator IP Services. In the case of the Subscriber IP Services, the Service Attributes are agreed between the Subscriber and an SP, and the SP has responsibility for delivering the service (i.e., most requirements are on the SP). In the case of an Operator IP Service, the Service Attributes are agreed between an SP/SO and an Operator, and the Operator has responsibility for delivering the service (i.e., most requirements are on the Operator). If an SP uses an Operator to reach a UNI, the values of the UNI Access Link Trunk Service Attributes that they agree with the Operator do not necessarily have to be the same as the values they have agreed with the Subscriber, although in most cases they will be.

This document only includes Service Attributes for Ethernet UNI Access Link Trunks. Service Attributes for the use of other technologies for Access Link Trunks are beyond the scope of this document.

The following Service Attributes apply to all UNI Access Link Trunks.

Attribute Name	Summary Description	Possible Values
UNI Access Link Trunk Identifier	Unique identifier for the UNI Access Link Trunk for management purposes.	Printable string that is unique across the SP's or Operator's network.
UNI Access Link Trunk Type	The type of Layer 2 technology of the UNI Access Link Trunk	*Ethernet* or *Other*

Table A1-2 – Service Attributes for all UNI Access Link Trunks

A1-1.1 UNI Access Link Trunk Identifier Service Attribute

The UNI Access Link Trunk Identifier is a unique identifier for the UNI Access Link Trunk. For a Subscriber IP Service, it can be used by the Subscriber and the SP to identify the UNI Access Link Trunk to each other. For an Operator IP Service, it can be used by the SP/SO and the Operator to identify the UNI Access Link Trunk to each other.

[A1-R14] The UNI Access Link Trunk Identifier **MUST** consist only of ASCII characters in the range 32-126 inclusive.

[A1-R15] The length of the UNI Access Link Trunk Identifier **MUST** be less than or equal to 53 characters.

[A1-R16] The value of the UNI Access Link Trunk Identifier **MUST** be unique among all such identifiers for UNI Access Link Trunks supported by the Service Provider (for a Subscriber Service) or Operator (for an Operator Service).

A1-1.2 UNI Access Link Trunk Type Service Attribute

The UNI Access Link Trunk Type Service Attribute specifies the Layer 2 technology that is used to implement the UNI Access Link Trunk. The only UNI Access Link Trunk type supported by Service Attributes in this document is *Ethernet*. If the SP and Subscriber or Operator and SP/SO agree on another type of UNI Access Link Trunk (see Appendix A1-A for examples), the value is *Other*.

[A1-R17] If the value of the UNI Access Link Trunk Type Service Attribute is *Ethernet*, then the data transferred across the UNI Access Link Trunk **MUST** be formatted as Ethernet MAC frames as specified in clause 3 of IEEE Std 802.3 [A1-5].

[A1-R18] If the value of the UNI Access Link Trunk Type Service Attribute is *Other*, then the Subscriber and the Service Provider or SP/SO and Operator **MUST** agree on the format of the data transferred across the UNI Access Link Trunk.

The agreement referred to in [A1-R18] is outside the scope of this document.

A1-1.3 Ethernet UNI Access Link Trunk Service Attributes

An Ethernet UNI Access Link Trunk could be a single point-to-point physical Ethernet channel or multiple physical Ethernet links combined into a Link Aggregation Group (see [A1-4]). The Ethernet frames associated with a given UNI Access Link can be either untagged/priority-tagged or VLAN tagged.

Note that the access medium in the SP or Operator network (e.g., DOCSIS, GPON) need not be Ethernet. The only requirement for an Ethernet UNI Access Link is that the physical interface at the UNI is one of the Ethernet PHYs listed in Table A1-4. This implies that the SP or Operator provides a device (e.g., Cable Modem, ONT) to convert between the access medium and the Ethernet UNI Access Link.

The Ethernet UNI Access Link Trunk Service Attributes listed in Table A1-3 are defined when the value of the UNI Access Link Trunk Type Service Attribute is *Ethernet*. They are described in the following subsections.

Attribute Name	Summary Description	Possible Values
UNI Access Link Trunk List of Ethernet Physical Links	A list of the physical link types along with some additional capabilities	A list of 5-tuples indicating an id, a PHY type, and synchronous capabilities.
UNI Access Link Trunk Ethernet Link Aggregation	Configuration of Link Aggregation for the UNI Access Link Trunk	A 2-tuple indicating whether Link Aggregation is enabled and, if so, the Port Conversation to Aggregation Link Map
UNI Access Link Trunk Ethernet Link OAM	Indicates whether Link OAM is used on the UNI Access Link Trunk	*Enabled* or *Disabled*

Table A1-3 – Service Attributes for Ethernet UNI Access Link Trunks

A1-1.3.1 UNI Access Link Trunk List of Ethernet Physical Links Service Attribute

The value of the UNI Access Link Trunk List of Ethernet Physical Links Service Attribute is a non-empty list of 5-tuples of the form ⟨*id, pl, fs, ct, gn*⟩ with one list item for each physical link.

- The value of *id* is an identifier for the physical link.
- The value of *pl* specifies a physical layer.
- The value of *fs* indicates if the physical link supports Synchronous Ethernet. The value of *fs* is *Disabled*, *ESMC*, or *No-ESMC*.
- The value of *ct* indicates the type of connector presented to the Subscriber
- The value of *gn* indicates the gender of the connector presented to the Subscriber. The value of *gn* is *Socket* or *Plug*.

When the value of the UNI Access Link Trunk List of Physical Links Service Attribute is a list with more than one physical link (5-tuple), a resiliency mechanism is required and is identified by the UNI Access Link Trunk Link Aggregation Service Attribute specified in Section A1-1.3.2.

[A1-R19] The value of *id* in each 5-tuple, ⟨*id, pl, fs, ct, gn*⟩, **MUST** be unique among all physical links composing all UNI Access Link Trunks in the Service Provider Network (for a Subscriber Service) or Operator Network (for an Operator Service).

Note that the uniqueness required by [A1-R19] is across all physical links regardless of the type of UNI Access Link Trunk, not just Ethernet links.

[A1-R20] The value of *id* in each 5-tuple, ⟨*id, pl, fs, ct, gn*⟩, **MUST** contain no more than 53 characters.

[A1-R21] The value of *id* in each 5-tuple, ⟨*id, pl, fs, ct, gn*⟩, **MUST** consist of ASCII characters in the range 32-126 inclusive.

[A1-R22] The value of *pl* in each 5-tuple, ⟨*id*, *pl*, *fs*, *ct*, *gn*⟩, **MUST** be one of the Ethernet PHYs from IEEE Std 802.3-2018 [A1-5] listed in Table A1-4.

10BASE_FB	10BASE_FL	10BASE_FP
10BASE_T	10BASE_T1L	10BASE_T1S
10BASE_TE	10BROAD36	10PASS_TS
100BASE_BX10	100BASE_FX	100BASE_LX10
100BASE_T	100BASE_T1	100BASE_T2
100BASE_T4	100BASE_TX	100BASE_X
1000BASE_BX10	1000BASE_CX	1000BASE_LX
1000BASE_LX10	1000BASE_PX10	1000BASE_PX20
1000BASE_RHA	1000BASE_RHB	1000BASE_RHC
1000BASE_SX	1000BASE_T	1000BASE_T1
1000BASE_X	2_5GBASE_T	2_5GBASE_T1
5GBASE_T	5GBASE_T1	10GBASE_CX4
10GBASE_E	10GBASE_ER	10GBASE_EW
10GBASE_L	10GBASE_LR	10GBASE_LRM
10GBASE_LW	10GBASE_LX4	10GBASE_R
10GBASE_S	10GBASE_SR	10GBASE_SW
10GBASE_T	10GBASE_T1	10GBASE_W
10GBASE_X	25GBASE_CR	25GBASE_CR_S
25GBASE_ER	25GBASE_LR	25GBASE_SR
25GBASE_T	40GBASE_CR4	40GBASE_ER4
40GBASE_FR	40GBASE_LR4	40GBASE_R
40GBASE_SR4	40GBASE_T	50GBASE_CR
50GBASE_ER	50GBASE_FR	50GBASE_LR
50GBASE_SR	100GBASE_CR10	100GBASE_CR2
100GBASE_CR4	100GBASE_DR	100GBASE_ER4
100GBASE_LR4	100GBASE_R	100GBASE_SR10
100GBASE_SR2	100GBASE_SR4	200GBASE_CR4
200GBASE_DR4	200GBASE_ER4	200GBASE_FR4
200GBASE_LR4	200GBASE_SR4	400GBASE_DR4
400GBASE_ER8	400GBASE_FR8	400GBASE_LR8
400GBASE_SR16	400GBASE_SR4_2	400GBASE_SR8

Table A1-4 – Ethernet PHYs for UNI Access Link Trunks – Allowed values of *pl*

[A1-R23] The physical layer specified by each value of *pl* **MUST** operate in full duplex mode if the PHY is capable of full duplex operation.

[A1-R24] When the value of *fs* is *ESMC* or *No-ESMC* in a 5-tuple, ⟨*id*, *pl*, *fs*, *ct*, *gn*⟩, Synchronous Ethernet as defined in ITU-T G.8262/Y.1362 [A1-6] **MUST** be used on the corresponding physical link with synchronization provided by the Service Provider or Operator to the Subscriber.

[A1-R25] When the value of *fs* is *ESMC* in a 5-tuple, ⟨*id*, *pl*, *fs*, *ct*, *gn*⟩, SSM for Synchronous Ethernet using the Ethernet Synchronous Messaging Channel (ESMC) protocol as defined in ITU-T G.8264/Y.1364 [A1-7] **MUST** be used on the corresponding physical link.

[A1-R26] When the value of *fs* is *No-ESMC* or *Disabled* in a 5-tuple, ⟨*id*, *pl*, *fs*, *ct*, *gn*⟩, SSM for Synchronous Ethernet using the Ethernet Synchronous Messaging Channel (ESMC) protocol as defined in ITU-T G.8264/Y.1364 [A1-7] **MUST NOT** be used on the corresponding 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.

[A1-R27] The value of *ct* in each 5-tuple, ⟨*id*, *pl*, *fs*, *ct*, *gn*⟩, **MUST** be one of the connector types listed in Table A1-5 or *Other*.

Connector Type	Copper/Fiber	Standard
RJ45	Copper	IEC 60603-7 [A1-1], TIA568 [A1-8]
SC	Fiber	IEC 61754-4 [A1-2]
LC	Fiber	IEC 61754-20 [A1-3]

Table A1-5 – Connector Types – Allowed values of *ct*

If *Other* is specified for the value of *ct*, it indicates that the Subscriber and the Service Provider or SP/SO and Operator 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.

[A1-R28] If the value of the *ct* element is *SC* or *LC*, the fiber polish **MUST** be UPC (Ultra Physical Contact).

The critical parameters associated with the connection such as speed, multi-mode vs. single-mode fiber, wavelengths, etc. are defined by the specific Ethernet PHY specified in the *pl* element. A Service Provider or Operator may offer additional non-standard values for these parameters, but any agreement to use these non-standard values is beyond the scope of this document.

The value of *gn* describes the "side" of the connection presented to the Subscriber by the Service Provider (for a Subscriber Service) or to the SP/SO by the Operator (for an Operator Service). For example, if a Service Provider presents the Subscriber with a socket on the SP equipment or patch panel (*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 SP 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*.

A1-1.3.2 UNI Access Link Trunk Ethernet Link Aggregation Service Attribute

Link Aggregation, as described in IEEE Std 802.1AX-2020 [A1-4] 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 UNI Access Link) can treat the LAG as if it were a single link.

The UNI Access Link Trunk Ethernet Link Aggregation Service Attribute indicates whether the UNI Access Link Trunk 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 UNI Access Link Trunk Link Aggregation Service Attribute is *None* or a 2-tuple ⟨*lacpversion, portmap*⟩ where:

- *lacpversion* has the value *LACPv1*, *LACPv2*, or *Static* and indicates which version of the Link Aggregation Control Protocol, LACP, is used. (See clause 6.4 in IEEE Std 802.1AX-2020 [A1-4].). If the value is *Static*, LACP is not used.
- *portmap* has the value *None* or a list of 2-tuples ⟨*vid*, *lspl*⟩ that represents a VLAN ID 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 VLAN ID, and the second element, *lspl*, (Link Selection Priority List) is a list of Link Number IDs.

Ethernet frames must be mapped to links in a Link Aggregation Group in such a way that frames that correspond to a conversation[2] are all mapped to the 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 *None*. In the second model, referred to as "Conversation-sensitive frame collection and distribution" in IEEE Std 802.1AX-2020 [A1-4], 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 VLAN ID in each frame to define a conversation (specified in the value of the *portmap* element). This use of the VLAN ID is referred to as the "Port Conversation ID" in IEEE Std 802.1AX-2020 (see [A1-R32] below).

If the value of the UNI Access Link Trunk Link Aggregation Service Attribute is *None*, Link Aggregation is not used.

[A1-R29] If the value of the UNI Access Link Trunk List of Physical Links Service Attribute is a list with exactly one entry, then the value of the UNI Access Link Trunk Link Aggregation Service Attribute **MUST** be *None*.

[A1-R30] If the value of the UNI Access Link Trunk List of Physical Links Service Attribute is a list with greater than one entry, then the value of the UNI Access Link Trunk Link Aggregation Service Attribute **MUST** be a 2-tuple.

[A1-R31] If the value of the UNI Access Link Trunk Link Aggregation Service Attribute is a 2-tuple, then the Service Provider Network (for a Subscriber Service) or Operator Network (for an Operator Service) **MUST** use Link Aggregation as specified in Clause 5.3 of IEEE Std 802.1AX-2020 [A1-4]

[2] IEEE Std 802.1AX defines a conversation as "a set of frames transmitted from one end station to another, with the assumption that the communicating end stations require intermediate systems to maintain the ordering of those frames."

with one Link Aggregation Group across the links composing the UNI Access Link Trunk.

[A1-R32] If the value of *portmap* is not *None*, then the Service Provider Network (for a Subscriber Service) or Operator Network (for an Operator Service) **MUST** use "Conversation-sensitive frame collection and distribution" as specified in Clause 6.6 of IEEE Std 802.1AX-2020 [A1-4] where the Port Conversation ID value is equal to the VLAN ID value for VLAN Tagged frames and equal to 0 for untagged and priority tagged frames.

[A1-R33] If the value of *portmap* is not *None*, any Ethernet frame with a VLAN ID that is not included in any of the 2-tuples **MUST** be discarded.

[A1-R34] If the value of *portmap* is not *None*, then the value of *lacpversion* **MUST** be *LACPv2*.

The *portmap* element provides a mapping of each VLAN ID 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 VLAN ID. A Link Number ID is an integer ≥ 1 that is uniquely assigned to each physical link at a given UNI and has local significance to the Link Aggregation Group at a given UNI Access Link Trunk. The assignment of Link Number IDs to physical links does not have to be configured on either end and it is negotiated automatically by LACP. Hence, it does not need to be agreed on between the Subscriber and the Service Provider or SP/SO and Operator. Table A1-6 provides an example of a CVLAN ID to Aggregation Link Map (*portmap*).

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

Table A1-6 – Example of a VLAN ID to Aggregation Link Map

This map indicates that 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. But 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. In the example above, VLAN ID 34 has more resilience than VLAN ID 35 because VLAN ID 34 has two fallback links whereas VLAN ID 35 has only one.

[A1-R35] When *portmap* is not *None*, the set of Link Number IDs for the UNI Access Link Trunk **MUST** be {*1, 2, …, m*} where *m* is the number of Physical Links included in the value of the UNI Access Link Trunk List of Physical Links Service Attribute.

[A1-R36] When the value of the UNI Access Link Trunk Ethernet Link Aggregation Service Attribute is a 2-tuple, the Service Provider Network (for a

Subscriber Service) or Operator Network (for an Operator Service) **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 UNI Access Link Trunk.

The *aAggActorAdminKey* and *aAggPortActorAdminKey* are managed objects defined in IEEE Std 802.1AX-2020 [A1-4]. Ensuring that there is only one *aAggActorAdminKey* with the same value as the *aAggPortActorAdminKey* for the ports terminating the links in the UNI Access Link Trunk 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 UNI Access Link Trunk.

When multiple physical links are configured at a UNI, the individual links may terminate at the same device in the SP Network and/or in the Subscriber Network, or at different devices in the SP Network and/or in the Subscriber Network. This aspect of the Link Aggregation configuration is beyond the scope of this document.

A1-1.3.3 UNI Access Link Trunk Ethernet Link OAM Service Attribute

The value of the UNI Access Link Trunk Ethernet Link OAM Service Attribute is either *Enabled* or *Disabled*. The UNI Access Link Trunk Ethernet Link OAM Service Attribute controls when and how Link OAM per IEEE Std 802.3-2018 [A1-5] is run on the physical links in the UNI Access Link Trunk.

[A1-R37] When the value of the UNI Access Link Trunk Ethernet Link OAM Service Attribute = *Enabled*, Link OAM as specified in Clause 57 of IEEE Std 802.3-2018 [A1-5] **MUST** be run on all physical links in the UNI Access Link Trunk.

[A1-R38] For a Subscriber IP Service, when the value of the UNI Access Link Trunk Ethernet 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 – 2018 [A1-5] on each link in the UNI Access Link Trunk.

[A1-R39] For an Operator IP Service, when the value of the UNI Access Link Trunk Ethernet Link OAM Service Attribute = *Enabled*, the Operator **MUST** enable Active DTE (Data Termination Equipment) mode capabilities as specified in clause 57.2.9 of IEEE Std 802.3 – 2018 [A1-5] on each link in the UNI Access Link Trunk.

[A1-D1] When the value of the UNI Access Link Trunk Ethernet Link OAM Service Attribute = *Enabled*, Link Events as specified in Clauses 57.2.10 and 57.4.3.2 of IEEE Std 802.3 – 2018 [A1-5] **SHOULD** be enabled on each link in the UNI Access Link Trunk.

[A1-R40] When the value of the UNI Access Link Trunk Ethernet Link OAM Service Attribute = *Disabled*, then Link OAM as specified in IEEE Std. 802.3-2018 [A1-5] **MUST NOT** be run on any physical link in the UNI Access Link Trunk.

12 Changes to Section 18 (References)

Insert the following additional references into the list in section 18:

[A1-1] IEC 60603-7, *Connectors for electronic equipment – Part 7: Detail specification for 8-way, unshielded, free and fixed connectors*, Edition 4.0, October 2020

[A1-2] 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

[A1-3] 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

[A1-4] IEEE Std 802.1AX-2020, *Link Aggregation*, January 2020

[A1-5] IEEE Std 802.3-2018, *IEEE Standard for Ethernet*, June 2018

[A1-6] ITU-T Recommendation G.8262/Y.1362, *Timing characteristics of synchronous Ethernet equipment slave clock*, January 2015

[A1-7] ITU-T Recommendation G.8264/Y.1364, *Distribution of timing information through packet networks*, May 2014

[A1-8] TIA-568.0-E-2020, *Generic Telecommunications Cabling for Customer Premises*, March 2020

13 Changes to Appendix E (Using Ethernet Access to Implement IP Services)

Replace the first paragraph of Appendix E as follows. This text is adapted from section 13.3.6 Point-to-Point Ethernet Link using an E-Access service.

When a Subscriber acquires an IP Service from a Service Provider, the SP might not be able to reach all the UNIs directly within their own network. In this case, the SP could use an Operator IP Service from another Operator to reach some of the UNIs, as shown in the examples in appendix D.1.

Alternatively, the SP could use an Ethernet Service, such as Access E-Line (MEF 51.1 [69]), to connect the IP UNI to the SP's IP PE. From the Subscriber's perspective, this case is just an Ethernet UNI Access Link Trunk as described in section A1-1. The details of the Access E-Line service are invisible to the Subscriber and hence are not part of the definition of the Subscriber IP Service. They are agreed between the SP and the Ethernet access provider.

Note that the SP could instead use an Access E-LAN Service or an E-Access O-Tree Service (MEF 51.1 [69]) to connect multiple IP UNI Access Links to the SP's IP PE. Again, from the Subscriber's perspective, this is identical to a physical Ethernet connection; the existence and details of the E-Access service are agreed between the SP and the Ethernet access provider and are invisible to the Subscriber.

The use of an Access E-Line Service by the SP is illustrated in the example below.

Continue here with the text of Appendix E starting at the second paragraph.

14 New Appendix: A1-A Examples of Other Layer 2 Technologies

Appendix A1-A Examples of Other Layer 2 Technologies (Informative)

This following introductory paragraph is taken from the last paragraph of Section 13.3 in MEF 61.1 and modified as indicated.

The subsections below give some ~~more detailed~~ examples of ~~the~~ UNI Access Link Trunk ~~L2~~ Layer 2 ~~T~~technolog~~y~~ies. It is stressed that this set of examples is not in any way exhaustive. In particular, the ~~L2~~ Layer 2 ~~T~~technology is not restricted to Ethernet – other examples include ATM, PPP (over ISDN or SDH), HDLC over SDH, PPPoE, etc.

A1-A.1 Multipoint Ethernet Link over WiFi

This section includes the text from 13.3.2 in MEF 61.1 modified as indicated.

It is possible that the UNI Access Link Trunk is a multipoint link, as described in section 13.2. One common case is for residential Internet access services, where the SP supplies a ~~CPE~~ device that contains an Ethernet switch and WiFi access point, along with a Cable or DSL modem. If this is a Provider-M~~m~~anaged CE (see section 12.2 in MEF 61.1 [1]), then the UNI Access Link Trunk is the multipoint Ethernet LAN comprising the switch ports and WiFi.

The ~~L2~~ Layer 2 ~~T~~technology in this case is Ethernet, and ~~it is unlikely that any additional L2 parameters are needed~~ many of the Service Attributes specified in section A1-1 are applicable, including ~~. The lower layer comprises the physical Ethernet ports, where~~ the type of Ethernet PHY for the physical Ethernet ports. ~~would need to be specified, and~~ Additional Service Attributes are needed for the WiFi access point, where the supported WiFi standards (~~i.e.~~ e.g., IEEE Std 802.11a/b/g/n/ac/ax) and the authentication details ~~would~~ need to be specified.

A1-A.2 Point-to-Point Protocol (PPP)

This section includes the text from 13.3.5 in MEF 61.1 modified as indicated.

A common method for connecting Subscribers and Service Providers over point-to-point links is to use the Point-to-Point Protocol (PPP), defined in RFC 1661 [5], or variants of it. As well as a method for encapsulating datagrams, PPP provides a Link Control Protocol (LCP) for establishing, configuring, and testing the data-link connection, and a family of Network Control Protocols (NCPs) for establishing and configuring different network-layer protocols. The original version was often used for dial-up Internet access. Newer variants, e.g., PPP over ATM (PPPoA) and PPP over Ethernet (PPPoE) are used for broadband access over Digital Subscriber Lines (DSL).

~~In these cases, the UNI Access Link L2 Technology Service Attribute is set to PPP, and the appropriate PPP parameters (including LCP and NCP parameters) need to be agreed.~~ In these cases, the UNI Access Link Trunk is a PPP link and Service Attributes for PPP (including LCP and NCP parameters) need to be agreed. The only lower layer is the physical layer over which PPP is running (e.g., DSL, Ethernet or ATM), and any characteristics of the physical layer need to be agreed. Since PPP does not support multiplexing there is a one-to-one relationship between the UNI Access Link and the UNI Access Link Trunk.

15 New Appendix: A1-B Using VRRP to Implement IP Services

The following Appendix contains the text from section 13.3.4 "Ethernet Link using VRRP" of MEF 61.1 modified as indicated.

Appendix A1-B Using VRRP to Implement IP Services (Informative)

Include all of the text from section 13.3.4 in MEF 61.1 with the following change to the last sentence:

The UNI Access Link in this case is provided on a UNI Access Link Trunk that consists of a single physical point-to-point Ethernet connection, and so the values ~~parameters~~ that need to be agreed for the UNI Access Link L2 Technology Service Attribute are ~~the same as those~~ described in section 13.3.1 and for the UNI Access Link Trunk Service Attributes are described in section A1-1.

16 References

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

[2] Internet Engineering Task Force RFC 2119, *Key words for use in RFCs to Indicate Requirement Levels*, March 1997

[3] Internet Engineering Task Force RFC 8174, *Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words*, May 2017