Technical Specification
MEF 10.3.2

Amendment to MEF 10.3 - UNI Resiliency Enhancement

October 2015

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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.

ADVA Optical Networking SE
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2. Abstract

This document amends MEF 10.3 [1] to enhance the UNI Resiliency Service Attribute to include multiple physical links that can carry different Service Frames simultaneously at a UNI.

3. Introduction

This amendment updates the UNI Resiliency Service Attribute to include multiple physical links that can carry different Service Frames simultaneously at a given UNI. The document is aligned with a frame distribution method specified in IEEE Std 802.1AX™-2014 [2] and requires supporting C-VID based frame distribution at a given UNI.

This document makes the following changes to MEF 10.3 [1].

- Adds the terms in Table A1 - 1 of this document into Table 1 in MEF 10.3.
- Updates the last paragraph in Section 9.4 in MEF 10.3.
- Replaces Section 9.5 in MEF 10.3 with Section 9.5 in this document.
- Adds a new reference into Section 14 in MEF 10.3.
- Adds an Appendix E into MEF 10.3.

The following sections describe the changes to MEF 10.3. Instructions for textual amendments to the base MEF 10.3 text are given in *"green and italic"* type.

4. Changes to Table 1 of MEF 10.3

Add the entries in Table A1 - 1 to Table 1 of MEF 10.3.

Term	Definition	Source
Link Number ID	A positive integer that is uniquely assigned to each physical link at a given UNI.	Adapted from IEEE Std 802.1AX -2014 [A1-1]
Link Selection Priority List	A field in the Port Conversation ID to Aggregation Link Map that consists of a sequence of Link Number IDs that indicates the order of link usage for a Port Conversation ID.	Adapted from IEEE Std 802.1AX -2014 [A1-1]
Port Conversation ID	An identifier for a set of Service Frames that are selected to pass over a physical link at a given UNI.	Adapted from IEEE Std 802.1AX-2014 [A1-1]

Table A1 - 1 – Terminology and Acronyms

5. Changes to Section 9.4 of MEF 10.3

Replace the last paragraph in Section 9.4 of MEF 10.3 with the following paragraph:

When the value of the Number of Links Service Attribute is more than one, a resilience mechanism is required and is identified by the UNI Resiliency Service Attribute specified in Section 9.5 below.

6. Changes to Section 9.5 of MEF 10.3

Replace Section 9.5 in MEF 10.3 with the following section.

Note that "2-Link Active/Standby" replaces the value "2-Link Aggregation" used in MEF 10.3 [1] and this value is retained for backward compatibility with MEF 10.3 in the case where the UNI only supports LAG with a single active link as described in Clause 5.6.1 of IEEE Std 802.1AX – 2008 ([1] in MEF 10.3) .

9.5 UNI Resiliency Service Attribute

A UNI may contain one or more physical links. When multiple physical links are configured at a UNI, the individual links may terminate at the same device at the CEN and/or at the CE, or at different devices at the CEN and/or at the CE (the devices can be located in the same or in different sites at the CEN and/or at the CE). A UNI has one UNI-N at the CEN and one UNI-C at the CE regardless of the number of device(s) where the physical links at a given UNI terminate at either end. Figure A1 - 1 illustrates some configuration examples where a device is shown as a box in the CEN and in the CE. Figure A1 - 1(a) is configured with three physical links that all

terminate at one device in the CEN as well as in the CE; Figure A1 - 1(b) is configured with two links that terminate at different devices in the CEN but at the same device in the CE; Figure A1 - 1(c) is configured with four physical links that terminate at two devices in the CEN and two devices in the CE. The details regarding what constitutes a CEN device or CE device are beyond the scope of this document.

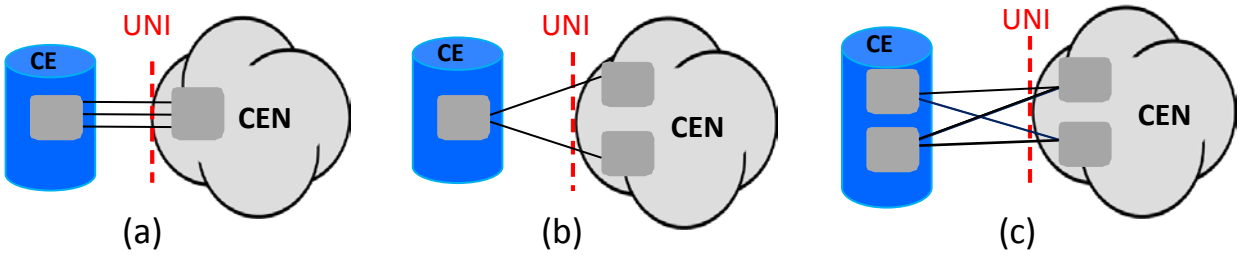


Figure A1 - 1– Examples of Multiple Physical Links at a UNI

The UNI Resiliency Service Attribute specified in this section is agnostic to whether the individual links terminate on a single device or multiple devices in the CEN and in the CE.

The UNI Resiliency Service Attribute value is one of "None," "2-Link Active/Standby," "All-Active", or "Other". The value of this attribute is dependent on the value of the Number of Links Service Attribute. Note that, in previous versions of this document, "2-Link Active/Standby" was known as "2-Link Aggregation".

[A1-R1] If the value for the Number of Links Service Attribute is one, then the UNI Resiliency Service Attribute **MUST** be set to "None".

[A1-R2] If the value for the Number of Links Service Attribute is two, then the UNI Resiliency Service Attribute **MUST** be set to one of "2-Link Active/Standby", "All-Active", or "Other".

[A1-R3] If the value for the Number of Links Service Attribute is three or more, then the UNI Resiliency Service Attribute **MUST** be set to either "All-Active" or "Other".

Table A1 - 2 summarizes the allowed values.

Number of Links	"None"	"2-Link Active/Standby"	"All-Active"	"Other"
1	☑	☐	☐	☐
2	☐	☑	☑	☑
3 or more	☐	☐	☑	☑

Table A1 - 2 – Allowed Values for the UNI Resiliency Service Attribute

The following requirements depend on the value of the UNI Resiliency Service Attribute.

[A1-R4] When the UNI Resiliency Service Attribute is set to "2-Link Active/Standby", the CEN and CE **MUST** use Link Aggregation as specified in

either Clause 5.6.1 of IEEE Std 802.1AX-2008 [1] or Clause 6.7.1 of IEEE Std 802.1AX-2014 [A1-1] with one Link Aggregation Group (LAG) across the links supporting the UNI and with one link in active mode and the other in standby mode.

[A1-R5] When the UNI Resiliency Service Attribute is set to "All-Active", the CEN and CE **MUST** use Link Aggregation as specified in Clause 5.3 of IEEE Std 802.1AX-2014 [A1-1], including the use of the version 2 LACPDUs as specified in Clause 5.3.1h of IEEE Std 802.1AX-2014 [A1-1], with one Link Aggregation Group (LAG) across the links supporting the UNI.

[A1-R6] When the UNI Resiliency Service Attribute is set to "All-Active", the CEN and CE **MUST** use "Per-service frame distribution" as specified in Clause 8.2 of IEEE Std 802.1AX-2014 [A1-1], where the Port Conversation ID is equal to the VLAN ID for VLAN Tagged Service Frames and equal to 0 for Untagged and Priority Tagged Service Frames.

Note that [A1-R6] refers to C-Tag VLAN ID not CE-VLAN ID that is defined in Section 9.9. For VLAN Tagged Service Frames, C-Tag VLAN ID and CE-VLAN ID are identical; for Untagged Service Frames and Priority Tagged Service Frames (C-Tag VLAN ID = 0), C-Tag VLAN ID and CE-VLAN ID are different.

[A1-R7] When the UNI Resiliency Service Attribute is set to "All-Active", the CEN and CE **MUST** be configured such that there is only one aAggActorAdminKey that has the same value as the aAggPortActorAdminKey for the ports terminating the links at the UNI.

The aAggActorAdminKey and aAggPortActorAdminKey are managed objects defined in IEEE Std 802.1AX-2014. Ensuring that there is only one aAggActorAdminKey with the same value as the aAggPortActorAdminKey for the ports at the UNI assures that only a single Link Aggregation Group is formed at the UNI. This eliminates that possibility of any loops potentially arising from multiple UNI links coming up independently or forming separate Link Aggregation Groups.

[A1-O1] When the UNI Resiliency Service Attribute is set to "Other", any resiliency mechanism **MAY** be implemented.

The other resiliency mechanism referred to in [A1-O1] is beyond the scope of this document. An example is a resiliency mechanism that uses Link Aggregation as specified in Clause 5.3 of IEEE Std 802.1AX-2014 [A1-1], but frame distribution based on something other than C-Tag VLAN ID.

9.5.1 Port Conversation ID to Aggregation Link Map Service Attribute

The Port Conversation ID to Aggregation Link Map Service Attribute value is the mapping of each Port Conversation ID (see [A1-R6]) to a Link Selection Priority List at the UNI. The Link Selection Priority List is a sequence of Link Number IDs, in the order of usage preference, highest to lowest, for the link that is to carry the Service Frames corresponding to that Port

Conversation ID. The value of a Link Number ID has local significance to the LAG at a given UNI.

[A1-R8] When the UNI Resiliency Service Attribute is set to "All-Active", the set of Link Number IDs **MUST** be {1, 2… m} where m is the value of the Number of Links Service Attribute.

[A1-R8] mandates the value of Link Number IDs that are used in the Port Conversation ID to Aggregation Link Map Service Attribute; this avoids the need to negotiate the values between the Service Provider and Subscriber for a given UNI. 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. 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 in the absence of any link failures.

The Port Conversation ID to Aggregation Link Map Service Attribute is required when the UNI Resiliency Service Attribute is set to "All-Active" and can be used when the UNI Resiliency Service Attribute is set to "Other". However the use of the Port Conversation ID to Aggregation Link Map Service Attribute for the latter case is beyond the scope of this document.

[A1-R9] When the UNI Resiliency Service Attribute is set to "All-Active", the Service Provider and the Subscriber **MUST** mutually agree on the value of the Port Conversation ID to Aggregation Link Map Service Attribute.

Note that the Port Conversation ID to Aggregation Link Map Service Attribute is equivalent to the aAggConversationAdminLink[] that is defined in Clause 7.3.1 of IEEE Std 802.1AX-2014 [A1-1].

The distribution of Service Frames across the different physical links at a given UNI is based on the agreed values in the Port Conversation ID to Aggregation Link Map Service Attribute. If the first link in the Link Selection Priority List for a given Port Conversation ID is operationally available in the LAG, all of the Service Frames with the corresponding Port Conversation ID are carried on that link in both directions. If the first link fails, then the second link in the list is used if the second link is operational, and so on. If all links in the list fail, the Service Frames with the corresponding Port Conversation ID are not carried over the UNI in either direction, i.e., they are dropped, even if a link that is not in the list is still operational.

The number of links in a Link Selection Priority List in the Port Conversation ID to Aggregation Link Map Service Attribute for a given UNI is, by definition, less than or equal to the value of the Number of Links Service Attribute for that UNI. A shorter list results in lower resilience for the Service Frames corresponding to the Port Conversation ID. Note that a Port Conversation ID may have an empty Link Selection Priority List in the Port Conversation ID to Aggregation Link Map Service Attribute at a given UNI, in which case Service Frames with the corresponding Port Conversation ID are not carried across the UNI.

If a particular Link Number ID is in a Link Selection Priority List in the Port Conversation ID to Link Aggregation Map Service Attribute, but not the first link in any list in the attribute, then the

physical link associated with that Link Number ID does not carry any Service Frames if all other links at the UNI are operational. In this case, the link can be considered as a "backup link" that is reserved for protection against failure of another link.

Table A1 - 3 illustrates an example of a value of the Port Conversation ID to Aggregation Link Map Service Attribute at a UNI that contains three physical links with three Link Number IDs, 1, 2, and 3. In this example, six Port Conversation IDs have a non-empty Link Selection Priority List while other Port Conversation IDs have an empty Link Selection Priority List at the UNI. As shown in Table A1 - 3, the Link Selection Priority List for Port Conversation IDs 0, 1, and 4 contains Link Number IDs 1, 3, and 2 in the sequence. The Link Selection Priority List for Port Conversation ID 5 has 2, 3, and 1; the list for Port Conversation ID 10 has 2, 1, and 3; the list for Port Conversation ID 1000 has 2 and 1. In this example, link 3 is not used when both link 1 and 2 are operational. Thus link 3 is used for protection purposes. The example also indicates that the Service Frames corresponding to Port Conversation IDs 5 and 10 are carried over link 2 when link 2 is operational; when link 2 fails and link 1 and 3 are operational, the Service Frames with Port Conversation ID 5 are carried over link 3 and the Service Frames with Port Conversation ID 10 are carried over link 1. The Service Frames with Port Conversation ID 1000 in the example have less resilience than the Service Frames corresponding to Port Conversation IDs 0, 1, 4, 5, and 10.

Port Conversation ID	**Link Selection Priority List (decreasing order)**
0, 1, 4	1, 3, 2
5	2, 3, 1
10	2, 1, 3
1000	2, 1
All other values	

Table A1 - 3 – Example of a value of the Port Conversation ID to Aggregation Link Map Service Attribute for a UNI

Note that the Table A1 - 3 is an abstract description for the Port Conversation ID to Aggregation Link Map Service Attribute. This description does not constrain how the contents can be described in a protocol, database, service order form, etc.

The value in the Port Conversion ID to Aggregation Link Map Service Attribute is only used for Service Frame distribution at a given UNI. Which EVC a Service Frame is mapped to at the UNI is determined by the CE-VLAN ID/EVC Map Service Attribute (See Section 9.10). The UNI Service Attributes are normally configured to ensure that, for every CE-VLAN ID that is mapped to an EVC in the CE-VLAN ID/EVC Map Service Attribute (including when the All to One Bundling Service Attribute is set to "Enabled"), the corresponding Port Conversation ID maps to a non-empty Link Selection Priority List in the Port Conversation ID to Aggregation Link Map Service Attribute.

[A1-O2] At a given UNI, if an EVC has more than one CE-VLAN ID mapped to it, i.e., the Bundling Service Attribute or the All to One Bundling Service Attribute is

set to "Enabled", the Service Provider **MAY** support a value of the Port Conversation ID to Aggregation Link Map Service Attribute such that Service Frames with different CE-VLAN IDs mapped to the EVC can be carried on different physical links.

The value of the Port Conversation ID to Aggregation Link Map Service Attribute described in [A1-O2] is useful when the bandwidth of an EVC at a given UNI exceeds the capacity of a single link at the UNI. However, in certain configurations (for example when the links terminate on different devices), supporting such map could require a Service Provider to make tradeoffs between the Service Frame distribution and the application of MEF SOAM and Bandwidth Profiles.

[A1-R10] When Ingress Bandwidth Profiles and/or Egress Bandwidth Profiles are used at a given UNI, the Service Provider **MUST** support a value of the Port Conversation ID to Aggregation Link Map Service Attribute such that all Service Frames that map to a given Envelope are carried on the same link.

Note that when Service Frames that map to a given Envelope are carried on different links, it may be difficult to apply the Bandwidth Profile algorithm at the UNI-N, and it may be difficult for the Subscriber to apply shaping at the UNI-C, especially if the different links happen to terminate on different devices. The Service Provider can offer a value in the Port Conversation ID to Aggregation Link Map Service Attribute where Service Frames that map to a given Envelope are carried on different links, if they have the capability to apply the Bandwidth Profile algorithm to such frames (or if there is no Bandwidth Profile configured at the UNI). However, [A1-R10] requires the Service Provider to also support a map where Service Frames that map to a given Envelope are carried on a single link.

7. Changes to Section 14 of MEF 10.3

The following reference is added to Section 14 in MEF 10.3.

[A1-1] IEEE Std 802.1AX™-2014, *IEEE Standard for Local and metropolitan area networks – Link Aggregation,* December 2014.

8. New Appendix for MEF 10.3

Add the following text as Appendix E in MEF 10.3.

Appendix E Examples with the UNI Resiliency Service Attribute set to "All-Active" (Informative)

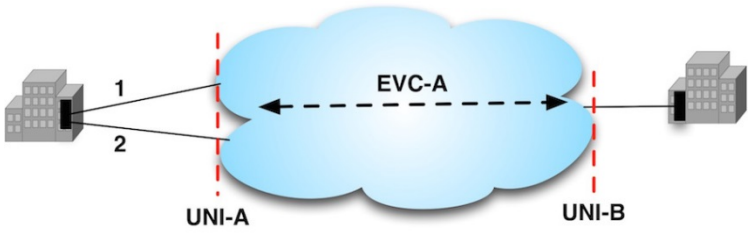
This appendix contains some examples where the UNI Resiliency Service Attribute is set to "All-Active". There are many ways that the attribute can be set to "All-Active" but this appendix does not cover all the cases. Sections E.1 through E.6 are a sequence of examples of various configurations with the UNI Resiliency Service Attribute set to "All-Active" with increasing complexity. In all examples, at UNI-A, the value of the Number of Links Service Attribute is 2

and the UNI Resiliency Service Attribute is set to "All-Active". The value of Link Number IDs is 1 and 2 according to [A1-R8].

Note: In the following examples, for ease of description, it is assumed that all Service Frames include non-zero C-Tag VLAN ID, thus VLAN ID = CE-VLAN ID.

E.1 Single EVC with Single Map Entry

This example has a single EVC at the UNIs, EVC-A, as shown in following figure.



In this case, two CE-VLAN IDs, 13 and 14, are mapped to EVC-A at UNI-A. At UNI-A both VLAN IDs are mapped using the same row of the Port Conversation ID to Aggregation Link Map Service Attribute as follows:

Port Conversation ID	Link Selection Priority List
13, 14	1, 2
All other values	

In this case, at UNI-A, all Service Frames for EVC-A traverse link 1 as long as it is operational and switch to link 2 when link 1 fails. (Note that the UNI-B shown in above Figure has the UNI Resiliency Service Attribute set to "None").

E.2 Single EVC with Multiple Map Entries

This example uses the same EVC as in section E.1, but the two VLAN IDs are mapped using different rows of the Port Conversation ID to Aggregation Link Map Service Attribute. This example illustrates [A1-O2].

Port Conversation ID	Link Selection Priority List
13	1, 2
14	2, 1
All other values	

In this case, Service Frames with VLAN ID = 13 use link 1 and Service Frames with VLAN ID =14 use link 2 as long as both links are operational. If either link fails, both VLAN IDs are carried on the same link.

E.3 Single EVC with All to One Bundling Service Attribute set to "Enabled"

The previous two examples have the All to One Bundling Service Attribute set to "Disabled" at UNI-A.

This example has one EVC with all CE-VLAN IDs mapped to it. The All to One Bundling Service Attribute is set to "Enabled" at UNI-A. All the Service Frames at UNI-A can be mapped using the same row of the Port Conversation ID to Aggregation Link Map Service Attribute as follows:

Port Conversation ID	Link Selection Priority List
All VLAN ID values	1, 2

In this case, all Service Frames for the EVC traverse link 1 as long as it is operational and switch to link 2 when link 1 fails.

The Service Frames, at UNI-A, can also be mapped using different rows of the Port Conversation ID to Aggregation Link Map Service Attribute as follows:

Port Conversation ID	Link Selection Priority List
0,10,13,15,100	1, 2
All other values	2, 1

In this case, the Service Frames with VLAN IDs = 0, 10, 13, 15, 100 traverse link 1 and other Service Frames traverse link 2 when both links are operational. If either link fails, all Service Frames are carried on the same link.

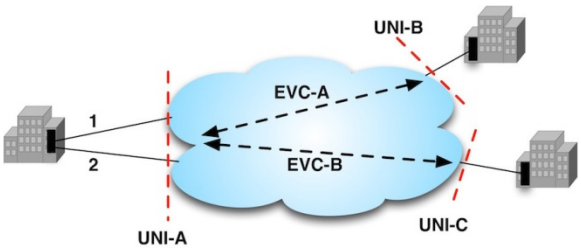
The Service Frames, at UNI-A, can also be mapped using different rows in the following way:

Port Conversation ID	Link Selection Priority List
0,10,13,15,100	1, 2
All other values	1

In this case, the Service Frames with VLAN IDs = 0, 10, 13, 15, 100 have a higher resilience level than other Service Frames. All other Service Frames are dropped if link 1 fails.

E.4 Two EVCs with Multiple Map Entries

This example has two EVCs that are multiplexed at UNI-A. CE-VLAN IDs 13 and 14 map to EVC-A; CE-VLAN ID 23 maps to EVC-B. This configuration is illustrated in the following figure. UNI-A is configured with the Service Multiplexing Service Attribute set to "Enabled" and Bundling Service Attribute set to "Enabled".



The value of the Port Conversation ID to Aggregation Link Map Service Attribute for UNI-A could be configured as follows:

Port Conversation ID	Link Selection Priority List
13	1, 2
14, 23	2, 1
All other values	

In this case, Service Frames with VLAN ID = 13 (EVC-A) use link 1 and Service Frames with VLAN ID = 14 (EVC-A) or VLAN ID = 23 (EVC-B) use link 2 as long as both are operational. If either link fails, the Service Frames with all three VLAN IDs (both EVCs) are carried on the same link.

E.5 Two EVCs with Multiple Class of Service Labels and Single Bandwidth Profile Flow per Envelope

This example has two EVCs that have the same CE-VLAN ID mappings as in section E.4 and has three Envelopes. The EVC-A has two Classes of Service Labels, H and L which are differentiated by the CE-VLAN PCP field (or possibly the IP DSCP field). Service Frames with VLANs 13 or 14 have PCP values mapping to each Class of Service Label. EVC-B only has Class of Service Label H. There is an Ingress Bandwidth Profile per Class of Service Identifier for each Class of Service Label on each EVC. Thus there are three Bandwidth Profile Flows in total and each of them maps to a different Envelope. The configuration of the EVCs is shown in the following table:

EVC	CE-VLAN ID	Class of Service Label
EVC-A	13, 14	H, L (based on PCP or DSCP)
EVC-B	23	H

If the Subscriber and Service Provider agree to configure the UNI such that all Service Frames that map to a given Envelope are mapped to the same link ([A1-R10] mandates this to be supported), then both CE-VLANs for EVC-A have to be carried on the same physical link. This is because EVC-A Service Frames with Class of Service Label H or L could be spread across both CE-VLANs since the Class of Service Label is based on PCP value. EVC-B is in a separate Envelope so it can be placed on either of the links. Therefore a value of the Port Conversation to Aggregation Link Map Service Attribute could be configured as follows:

Port Conversation ID	Link Selection Priority List
13, 14	1, 2
23	2, 1
All other values	

E.6 Two EVCs with Multiple Class of Service Labels and Multiple Bandwidth Profile Flows per Envelope

This example has two EVCs that have the same CE-VLAN ID mappings and the same three Bandwidth Profile Flows as in section E.5 but only has two Envelopes. The first Envelope has two Bandwidth Profile flows that are based on the Class of Service Label H from each of the EVCs, and the second Envelope has single Bandwidth Profile Flow that is based on the Class of Service Label L. If the Subscriber and Service Provider agree to configure the UNI such that all Service Frames that map to a given Envelope are mapped to the same link ([A1-R10] mandates this to be supported), then all EVC-A and EVC-B Service Frames have to traverse on the same link. Thus, in this case, the value of the Port Conversation ID to Aggregation Link Map Service Attribute has only a single non-empty entry:

Port Conversation ID	Link Selection Priority List
13, 14, 23	1, 2
All other values	

9. References

[1] MEF Forum, MEF 10.3, *Ethernet Service Attributes Phase 3*, October 2013.

[2] IEEE Std 802.1AX™-2014, *IEEE Standard for Local and metropolitan area networks – Link Aggregation,* December 2014.