Technical Specification

MEF 20

User Network Interface (UNI) Type 2 Implementation Agreement

July, 2008

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1. Abstract

This document specifies an Implementation Agreement (IA) for MEF User to Network Interface (UNI) Type 2. This Implementation Agreement adds new functionalities to MEF UNI Type 1 [MEF13], such as E-LMI based on [MEF16], Link OAM based on clause 57 of [IEEE 802.3], Service OAM based on [ITU-T Y.1731] and [IEEE 802.1ag] and Protection using Link Aggregation based on clause 43 of [IEEE 802.3].

2. Terminology

Term	Definition
AIS	Alarm Indication Signal
BW	Bandwidth
CCM	Connectivity Check Message
CE	Customer Equipment
CFM	Connectivity Fault Management
CoS	Class of Service
CoS ID	Class of Service Identifier
DA	Destination Address
Down-MEP	A MEP in an 802.1 Bridge that sends frames away from the Bridge Relay Entity; see [IEEE 802.1ag]
E-LAN	MEF Multipoint to Multipoint service; see [MEF 10.1]
E-LINE	MEF Point-to-Point service; see [MEF 10.1]
E-LMI	Ethernet Local Management Interface [MEF16]
EVC	Ethernet Virtual Connection: an association between two or more UNIs for the purpose of delivering Ethernet services.
EVC ID	The Identifier for an EVC
IA	Implementation Agreement
GARP	Generic Attribute Registration protocol
LACP	Link Aggregation Control Protocol
LAG	Link Aggregation Group
LB	Loop Back
LBM	Loopback Message
LBR	Loopback Reply
Link OAM	OAM specific to a single link as per clause 57 of [IEEE 802.3]
L2CP	Layer 2 Control Protocols
MD	Maintenance Domain
ME	Maintenance Entity
MEG	Maintenance Entity Group
MEG-Level	Maintenance Entity Group Level
MEP	MEG End Point
MEP ID	Maintenance Entity End Point Identification
MIP	Maintenance Entity Intermediate Point

Term	Definition
MTU	Maximum Transfer Unit
NE	Network Element
OAM	Operation Administration and Management
PDU	Protocol Data Unit
RDI	Remote Defect Indication
Rooted-Multipoint	'MEF Point to Multipoint service; see [MEF 10.1]
Service OAM	Service OAM is OAM used to monitor an individual Service; see [ITU-T Y.1731] and [IEEE 802.1ag]
Subscriber-MEG	The MEG at Subscriber Level
Test-MEG	The MEG used by Service provider to test the connectivity to UNI-C.
TLV	Type, Length, Value
UNI	User Network Interface. The UNI is a demarcation point between the responsibility of the Service Provider and the responsibility of the Subscriber.
UNI ID	The Identifier for a UNI
UNI-C	Part of the UNI that is located at Customer Equipment
UNI-MEG	UNI Maintenance Entity Group
UNI-N	Part of the UNI that is located at Service Provider Equipment
Up-MEP	A MEP in an IEEE 802.1 Bridge that sends frames toward the Bridge Relay Entity; see [IEEE 802.1ag]

3. Scope

3.1 Purpose

This document is an Implementation Agreement that defines the requirements for UNI Type 2. UNI Type 2 is an enhancement to UNI Type 1 as defined in [MEF13], with added functionalities. The new functionalities include capability for UNI-C to retrieve EVC status and configuration information including associated service attributes from UNI-N via E-LMI as per [MEF16]; capability for customer and service provider to check and diagnose the UNI connectivity via Link OAM as per clause 57 of [802.3] and Service OAM as per [ITU-T Y.1731] and [IEEE 802.1ag], and capability to protect UNI against port failure via Link Aggregation as per clause 43 of [IEEE 802.3].

3.2 UNI Types

[MEF 11] introduces 3 types of UNIs: UNI Type 1, UNI Type 2, and UNI Type 3. Each successive type specifies increased capabilities while at the same time retaining backward compatibility with the earlier types. The following sections describe the main operational aspects of these three UNI types:

3.2.1 UNI Type 1

The UNI Type 1 operates in manual configuration mode in which the Service Provider and Customer will have to manually configure the UNI-N and UNI-C for services. UNI Type 1 is described in [MEF13].

3.2.2 UNI Type 2

The UNI Type 2 mode of operation allows UNI-C to retrieve EVC status and configuration information from UNI-N. In addition UNI Type 2 adds fault management and protection functionalities beyond those specified in UNI Type 1. UNI Type 2 is the subject of this IA.

3.2.3 UNI Type 3

The UNI Type 3 mode of operation allows the UNI-C to request, signal and negotiate EVCs and its associated Service Attributes to the UNI-N. UNI Type 3 is out of the scope of this Implementation Agreement and is for further study.

4. Compliance Levels

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in IETF RFC 2119. All key words must be use upper case, bold text.

5. Convention

UNI Type 2 is divided to two categories called UNI Type 2.1 and UNI Type 2.2. Throughout this document the term "UNI Type 2" applies to both UNI Type 2.1 and 2.2.

6. Backward Compatibility

[R1] A UNI-N Type 2 **MUST** support all the mandatory requirements of UNI-N Type 1.1 and UNI-N Type 1.2 as per [MEF13], except for the mandatory requirements in Section 5.1 of [MEF 13].

Note: Section 5.1 of [MEF 13] contains UNI Type 1.1 and UNI Type 1.2 PHYs that are only a subset of the UNI Type 2.1 and UNI Type 2.2 PHYs described in this specification under [R78].

[R2] A UNI-N Type 2 **SHOULD** support all the optional requirements of UNI-N Type 1.1 and UNI-N Type 1.2 as per [MEF13]

[R3] A UNI-C Type 2 **MUST** support all the mandatory requirements of UNI-C Type 1.1 and UNI-C Type 1.2 as per [MEF13], except for the mandatory requirements in Section 5.1 of [MEF 13].

Note: Section 5.1 of [MEF 13] contains UNI Type 1.1 and UNI Type 1.2 PHYs that are only a subset of the UNI Type 2.1 and UNI Type 2.2 PHYs described in this specification under [R78].

[R4] A UNI-C Type 2 **SHOULD** support all the optional requirements of UNI-C Type 1.1 and UNI-C Type 1.2 as per [MEF13]

7. Supporting UNI Type 2 Functionalities

7.1 Supporting UNI Type 2.1

[R5] A UNI-N and UNI-C Type 2.1 **MUST** support the following functionalities:

1) Service OAM, as per section 10.2
2) Enhanced UNI Attributes, as per section 12
3) L2CP Handling as per section 13

And **MAY** support the following functionality:

4) E-LMI, as per section 9
5) Link OAM, as per section 10.1
6) Protection, as per section 11

7.2 Supporting UNI Type 2.2

[R6] A UNI-N and UNI-C Type 2.2 **MUST** support the following functionalities:

1) E-LMI, as per section 9
2) Link OAM, as per section 10.1
3) Service OAM, as per section 10.2
4) Protection, as per section 11
5) Enhanced UNI Attributes, as per section 12
6) L2CP Handling as per section 13

7.3 Supporting Subsets of UNI Type 2 Functionalities

[R7] A UNI-N Type 2 **MUST** be able to interoperate with each of the functionalities listed in section 7.1 and 7.2 that is fully implemented by the UNI-C as per this Implementation Agreement.

Note: A UNI-N Type 2 is not required to interoperate with any UNI-C Type 2 functionality listed in 7.1 and 7.2, which is not fully implemented by UNI-C. For example UNI-N is not required to interoperate the E-LMI protocol with a UNI-C that implements only a subset of the mandatory UNI-C aspects of the E-LMI functionalities.

[R8] A UNI-C Type 2 **MUST** be able to interoperate with each of the functionalities listed in section 7.1 and 7.2 that is fully implemented by the UNI-N as per this Implementation Agreement.

Note: A UNI-C Type 2 is not required to interoperate with any individual UNI-N Type 2 functionality listed in section 7.1 and 7.2, which is not fully implemented by UNI-N. For example UNI-C is not required to interoperate the E-LMI protocol with a UNI-N that implements only a subset of the mandatory UNI-N aspects of the E-LMI functionalities.

8. UNI Type 2 Discovery & Configuration

[R9] A UNI-N Type 2 that supports E-LMI, **MUST** use the procedures outlined in section 5.6.11.2 of [MEF16] to determine whether E-LMI is operational at UNI-C or not.

[R10] A UNI-C Type 2 that supports E-LMI, **MUST** use the procedures outlined in section 5.6.11.1 of [MEF16] to determine whether E-LMI is operational at UNI-N or not.

[R11] A UNI-N Type 2 that supports Link OAM **MUST** use the Link OAM Discovery process as outlined in clause 57.3.2.1 of [IEEE 802.3] to determine the peer UNI-C support of Link OAM.

[R12] A UNI-C Type 2 that supports Link OAM **MUST** use the Link OAM Discovery process as outlined in clause 57.3.2.1 of [IEEE 802.3] to determine the UNI-N support of Link OAM.

[R13] A UNI-N Type 2 that supports Link Aggregation **MUST** use LACP as defined in clause 43.3 of [IEEE 802.3] to agree with UNI-C on a Link Aggregation group.

[R14] A UNI-C Type 2 that supports Link Aggregation **MUST** use LACP as defined in 43.3 of [IEEE 802.3] to agree with UNI-N on a Link Aggregation group.

[R15] A UNI-N Type 2 **MUST** be administratively configurable with the UNI-C MEP ID and the MEG-Level corresponding to the UNI-MEG.

[R16] A UNI-C Type 2 **MUST** be administratively configurable with the UNI-N MEP ID and MEG-Level corresponding to the UNI-MEG.

[R17] A UNI-C Type 2 **MUST** be administratively configurable with the MEG-Level for the Test-MEG.

9. Supporting E-LMI

E-LMI is the Ethernet Local Management Interface, based on [MEF 16]. E-LMI support is mandatory for UNI Type 2.2 and optional for UNI Type 2.1. The detail requirements are listed in this section.

[R18] A UNI-N Type 2.1 that supports E-LMI and a UNI-N Type 2.2 **MUST** support all mandatory UNI-N aspects of E-LMI as specified in [MEF 16].

[R19] A UNI-N Type 2.1 that supports E-LMI and a UNI-N Type 2.2 **SHOULD** support all optional UNI-N aspects of E-LMI as specified in [MEF 16].

[R20] A UNI-C Type 2.1 that supports E-LMI and a UNI-C Type 2.2 **MUST** support all mandatory UNI-C aspects of E-LMI as specified in [MEF 16].

[R21] A UNI-C Type 2.1 that supports E-LMI and a UNI-C Type 2.2 **SHOULD** support all optional UNI-C aspects of E-LMI as specified in [MEF 16].

[R22] A UNI-N Type 2.1 that supports E-LMI and a UNI-N Type 2.2 **SHOULD** allow the configuration of the Minimum Asynchronous Message Interval [MEF16] in the range from 0.5 to 3 seconds with the default of 1 second.

Note: Minimum Asynchronous Message Interval is used to specify minimum time interval between asynchronous messages. Generally this interval is set to 1/10th of the UNI-C's T391 in seconds.

[R23] A UNI-N Type 2.1 that supports E-LMI and a UNI-N Type 2.2 **SHOULD** allow the configuration of the N393 Status Counter Parameter Threshold [MEF16] in the range from 2 to 10, with the default of 4.

Note: The N393 Status Counter Parameter Threshold is used to determine if E-LMI is operational or not. This configurable parameter is a Threshold for the Count of Consecutive Errors.

[R24] A UNI-N Type 2.1 that supports E-LMI and a UNI-N Type 2.2 **SHOULD** allow the configuration of the T392 Polling Verification Timer (PVT) limit [MEF16] in the range from 5 to 30, with the default of 15. A UNI-N Type 2 **SHOULD** allow disabling the Polling Verification Timer.

10. Supporting Ethernet OAM

10.1 LINK OAM

Link OAM is based on clause 57 of [IEEE 802.3]. Link OAM monitors UNI's Physical Layer operation and health and improves fault isolation. Link OAM frames run between UNI-C and UNI-N. This section lists the Link OAM requirements for UNI-N and UNI-C.

Link OAM support is Mandatory for UNI Type 2.2 and is optional for UNI Type 2.1. The detail requirements are listed in this section.

[R25] For each physical link in the UNI, a UNI-N Type 2.1 that supports Link OAM and a UNI Type 2.2 **MUST** support Active DTE mode capabilities as specified in clause 57.2.9 of [IEEE 802.3].

[R26] For each physical link in the UNI, a UNI-C Type 2.1 that supports Link OAM and a UNI Type 2.2 **MUST** support Passive DTE mode capabilities as specified in clause 57.2.9 of [IEEE 802.3].

[R27] For each physical link in the UNI, a UNI-C Type 2.1 that supports Link OAM and a UNI Type 2.2 **MAY** support Active DTE mode capabilities as specified in clause 57.2.9 of [IEEE 802.3].

[R28] For each physical link in the UNI, a UNI-N Type 2.1 that supports Link OAM and a UNI Type 2.2 **SHOULD** support unidirectional OAM operation as per clause 57.2.12 of [IEEE 802.3], when the UNI is one of the 100BASE-X, 1000BASE-X (excluding 1000BASE-PX-D and 1000BASE-PX-U), 10GBASE-R, 10GBASE-W and 10GBASE-X physical layers as specified in clause 66 of [IEEE 802.3].

[R29] For each physical link in the UNI, a UNI-C Type 2.1 that supports Link OAM and a UNI Type 2.2 **SHOULD** support unidirectional OAM operation as per clause 57.2.12 of [IEEE 802.3], when the UNI is one of the 100BASE-X, 1000BASE-X (excluding 1000BASE-PX-D and 1000BASE-PX-U), 10GBASE-R, 10GBASE-W and 10GBASE-X physical layers as specified in clause 66 of [IEEE 802.3].

[R30] For each physical link in the UNI, a UNI-N Type 2.1 that supports Link OAM and a UNI Type 2.2 **MUST** be able to turn off the 802.3x (PAUSE) frame generation to enable proper Link OAM operation over the UNI as per clause 57.1.5.3 of [IEEE 802.3].

[R31] For each physical link in the UNI, a UNI-C Type 2.1 that supports Link OAM and a UNI Type 2.2 **MUST** be able to turn off the 802.3x (PAUSE) frame generation to enable proper Link OAM operation over the UNI as per clause 57.1.5.3 of [IEEE 802.3].

10.2 Service OAM

UNI Type 2 Service OAM is specified to be a minimal, but useful, set of capabilities based on [ITU-T Y.1731] and [IEEE 802.1ag] and is focused on fault management for the Maintenance Entity Groups (MEGs) crossing the UNI for all service types. A UNI may span one or multiple Ethernet Links.

Service OAM support is Mandatory for UNI Type 2.1 and 2.2. The detail requirements are listed in this section.

A Maintenance Entity (ME) is a point-to-point relationship between two MEPs within a single MEG. Note that a MEG includes all unique pairs of MEPs (MEs) in a Maintenance Domain. In a point-to-point EVC, there is just one ME, while in a multi-point EVC, there is more than one MEs.

Service OAM occurs at different MEG-Levels (the MEG-level is specified within Service OAM frames). The following MEGs are functionally equivalent, but are defined at different MEG-Levels:

- UNI-MEG. The UNI-MEG runs between the UNI-N and the UNI-C at one specific UNI, and the MEG is always point-to-point. This ME monitors the connectivity between the Service Provider and the Subscriber.
- Test-MEG. The Test-MEG runs between two or more UNI-Cs and is defined such that the Service Provider can (temporarily or permanently) insert a Test-MEP on an existing UNI-C or another location on an EVC as a "test" point from which the Service Provider can test connectivity all of the way to any other UNI-C in the EVC. This MEG is for Service Provider or Network Operator testing. For more details and explanation of Test-MEG please refer to Appendix A.
- Subscriber-MEG. The Subscriber-MEG runs between two or more UNI-Cs and provides Subscriber monitoring for an end-to-end service between subscriber endpoints.

These MEGs are illustrated by Figure 1. Each MEG is an association of two or more provisioned maintenance points that require management. The maintenance points are shown as triangles in Figure 1 and are referred to as MEG End Points (MEPs). A Test-MEG, for example, could consist of two Test MEPs as shown in Figure 1, but would generally consist of at least three MEPs (the third being the Service Provider's Test MEP).

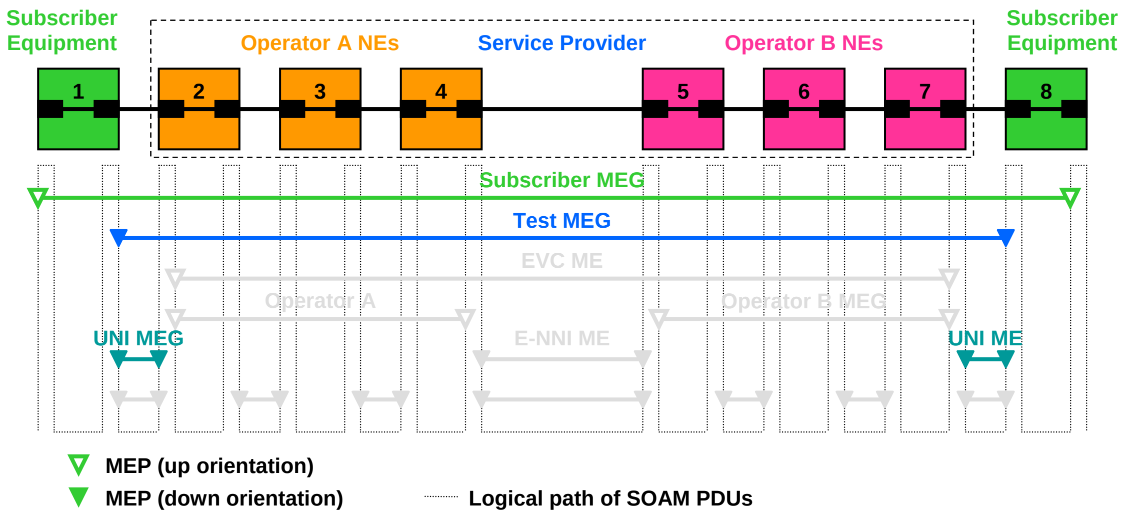

Figure1. UNI Type 2 MEGs

10.2.1 Maintenance Entity Requirements

This section discusses the requirements where Service OAM entities are required to be implemented. In this version of UNI Type 2 IA, the requirements focus on the MEPs that must be implemented on the UNI-C and UNI-N.

This section uses the terms Up-MEP and Down-MEP. Up-MEP and Down-MEP are IEEE terms that are described in [IEEE 802.1ag]. An Up-MEP is a MEP residing in an IEEE 802.1 Ethernet Bridge that transmits CFM PDUs towards, and receives them from, the direction of the Bridge Relay Entity. A Down-MEP is A MEP residing in an IEEE 802.1 Bridge that receives CFM PDUs from, and transmits them towards, the direction of the LAN.

For a more detailed description of Up-MEP and Down-MEP, refer to Appendix B.

[R32] A UNI-C Type 2 **MUST** be able to support a MEP instance on the Subscriber-MEG for each configured EVC. The OAM frames on the Subscriber-MEG **SHOULD** be tagged and use the smallest CE-VLAN ID mapped into that EVC.

[R33] A UNI-C Type 2 **SHOULD** be able to support a MEP instance on the Test-MEG for each configured EVC. The OAM frames on the Test-MEG **SHOULD** be tagged and use the smallest CE-VLAN ID mapped into that EVC.

[R34] A UNI-C Type 2 **MUST** be able to support a single MEP instance on the UNI-MEG, regardless of whether any EVC is configured for that UNI or not. This UNI-MEG is called the "default UNI-MEG" and **MUST** use Untagged OAM frames.

[R35] When the CE is an IEEE 802.1 Bridge, the MEPs corresponding to UNI-MEG and Test-MEG on a UNI-C Type 2 **SHOULD** be Down-MEPs.

[R36] When the CE is an IEEE 802.1 Bridge, the MEPs corresponding to Subscriber-MEG on a UNI-C Type 2 **MAY** either be Up-MEP or Down-MEP.

[R37] A UNI-N Type 2 **MUST** be able to support a single MEP instance on the UNI-MEG, regardless of whether any EVC is configured for that UNI or not. This UNI-MEG, called the "default UNI-MEG" **MUST** use Untagged OAM frames.

[R38] When the Service Provider equipment is an IEEE 802.1 Bridge, the MEP corresponding to UNI-MEG on UNI-N Type 2 **SHOULD** be a Down-MEP.

These required MEP instances are illustrated by the Figure 2.

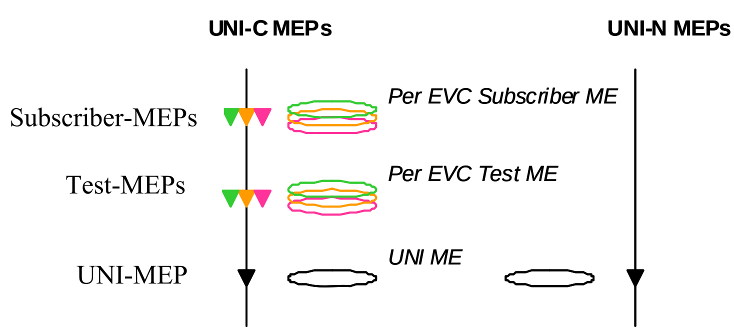

Figure2. UNI Type 2 MEP Instances

10.2.2 MEP Requirements

[R39] A UNI-C and UNI-N Type 2 **MUST** support a configurable MEG-Level for the MEPs. The default MEG-Level values for the various MEGs **SHOULD** be "1" for the UNI-MEG, "5" for the Test-MEG, and "6" for the Subscriber-MEG.

[R40] A UNI-C and UNI-N Type 2 MEP implementation **MUST** be able to process received Multicast CCM frames for each required MEG.

[R41] A UNI-C and UNI-N Type 2 MEP implementation **MUST** be able to process and respond to both Unicast and Multicast LBM frames for each required MEG.

[R42] When CCM transmission is enabled for a MEP in a UNI-C and/or UNI-N Type 2 implementation, the MEP **MUST** be able to generate Multicast CCM frames.

[R43] A UNI-C and UNI-N Type 2 MEP implementation **MUST** be able to generate Unicast LBM frames, and **MAY** be able to generate Multicast LBM frames.

Additional CCM and LBM requirements are covered in later sections.

10.2.3 Continuity Check Requirements

The following requirements apply to the implementation of the continuity check (CC) function as an operation that, when enabled, runs continuously on a MEP for service monitoring. These requirements define default protocol values and the protocol options that are required for UNI Type 2 implementations.

[R44] A UNI-C and UNI-N Type 2 **MUST** have the capability to administratively enable and disable CCM transmission on all local MEPs.

The following requirements define the parameters that control CCM transmission behavior.

[R45] A UNI-C and UNI-N Type 2 **MUST** support a CCM frame rate of 1 frame per second and **MAY** support other values specified in section 7.1.1 of [ITU-T Y.1731]. The default rate **SHOULD** be set to “1 frame per second”.

[R46] CCM transmission **SHOULD** be disabled by default on Subscriber-MEG and Test-MEG, and **SHOULD** be enabled by default on the UNI-MEG.

[R47] A UNI-C and UNI-N Type 2 **MUST** support a configurable priority for transmitted CCM frames for Test-MEG and subscriber-MEG. The default value **SHOULD** be the CoS ID supported by the EVC, which yields the lowest frame loss performance. Untagged UNI-MEG CCM frames **SHOULD** be transmitted with the highest priority supported by the UNI.

The MEF has defined EVC ID and UNI ID attributes that are unique across the MEN, but has not defined a maximum length or format. Therefore a limited length identifier is needed for each. This identifier is referred to as the Representative Value. The Representative Value for each EVC ID must be no more than 45 ASCII characters and it must have a one to one relationship with the EVC ID. The Representative Value for each UNI ID must be no more than 45 ASCII characters and it must have a one to one relationship with the UNI ID.

[R48] The Maintenance Association Identifier (MAID) is used by the CC function, and is required to be unique across MEGs at the same MEG-Level. The MAID has two components consisting of the MD Name and the Short MA Name. The MD Name **SHOULD** use the "null" format and the Short MA Name **SHOULD** use the "text" format, allowing for a maximum length of 45 ASCII characters for the Short MA Name. The Short MA Name is provisioned and **SHOULD** default to a the Representative Value that is uniquely related, but not necessarily equal, to the EVC ID or UNI ID as following:

a. The Representative Value of the UNI ID for the default UNI-MEG (i.e., the default UNI-MEG using untagged OAM frames)

b. The Representative Value of the EVC ID for the Test-MEG

c. The Representative Value of the EVC ID for the Subscriber-MEG

Note: Since the EVC ID or UNI ID may exceed the maximum length of the Short MA Name, an abbreviated form may be required. Note that a Maintenance Domain (MD) is associated with a single MEG-Level.

[R49] A UNI-N and UNI-C Type 2 **SHOULD** support counters for each MEP that counts the number of CCM frames transmitted.

[R50] A UNI-N and UNI-C Type 2 **SHOULD** support the CC defect and fault alarm hierarchy per clause 20.1.2 of [IEEE 802.1ag]. If this is supported, the highest priority alarm **MUST** be made available to management and **SHOULD** mask lower priority alarms.

[R51] A UNI-N and UN-C Type 2 MEP **MUST** support the minimum CC fault priority level [IEEE 802.1ag] for which a CC alarm will be generated. An alarm will be generated only if the fault has equal or greater priority than this minimum fault level. The default value **SHOULD** be set to "RDI".

[R52] A UNI-N and UNI-C Type 2 MEP **MUST** support a CC fault Alarm time and a CC fault Reset time. The default CC fault Alarm time **SHOULD** be set to 2.5 seconds and the default CC fault reset time **SHOULD** be set to 10 seconds.

Note: CC Alarm time is the time that a defect must be present before a fault Alarm is issued. CC Reset time is the time that a defect must be absents before resetting a fault Alarm.

10.2.4 Loopback Requirements

The following requirements apply to the implementation of the loopback (LB) function as an operation that runs on-demand on a MEP for service troubleshooting. These requirements define default protocol values and the protocol options that are required for UNI Type 2 implementations.

For the purposes of this section, a loopback (LB) session is defined as a sequence that begins with management initiating the transmission of “N” periodic loopback frames from a local-MEP to a remote-MEP in the same MEG. The session ends normally when the last loopback response is received or incurs a timeout. The session may be aborted by management.

[R53] Each LB session **MUST** have the ability to be administratively initiated and stopped.

The following requirements define the parameters that must be provided when initiating a LB session.

[R54] For each LB session, the destination address **MUST** be configurable to any Unicast MAC DA. Multicast destinations **MAY** be supported using the reserved CCM multicast MAC DA in the range of 01-80-C2-00-00-30 to 01-80-C2-00-00-37 that corresponds to the MEG-Level of the MEP.

[R55] For each LB session, the priority of LBM frames **MUST** be configurable. The default priority value **SHOULD** be the CoS ID supported by the EVC, which yields the lowest frame loss performance.

[R56] For each LB session, the number of LBM transmissions **MUST** be configurable. The default value **SHOULD** be “3”.

[R57] For each LB session, the interval between LBM transmissions **MUST** be configurable. The default value **SHOULD** be “1 second”.

[R58] For each LB session, the timeout after a LBM transmission, for an expected LBR result **MAY** be configurable. The default value **SHOULD** be “5 seconds”.

[R59] For each LB session, the size of the LBM frame **MUST** be configurable. This requires that the optional Data TLV **MUST** be supported to allow for frames up to the maximum MTU size. The default LBM frame size **SHOULD** be “64 bytes”.

[R60] For each LB session, the following information **MUST** be maintained: counters for LBM frames transmitted, LBR frames received (i.e., requests and responses), the percentage of lost LBM or LBR frames (i.e., unanswered requests), the minimum, maximum, and average round-trip latency.

11. Supporting Protection

This section specifies requirements for UNI-N and UNI-C to enable UNI protection, in case of a failure. Link Aggregation support is mandatory for UNI Type 2.2 and is Optional for UNI Type 2.1. The detailed requirements are listed in this section.

[R61] A UNI-N Type 2.1 that supports UNI protection and a UNI-N Type 2.2 **MUST** support Link Aggregation as specified in clause 43 of [IEEE 802.3], for UNI protection.

[R62] A UNI-C Type 2.1 that supports UNI protection and a UNI-C Type 2.2 **MUST** support Link Aggregation.

[R63] A UNI-N Type 2.1 that supports Link Aggregation and a UNI Type 2.2 **MUST** support at least two (2) links in the Link Aggregation group (LAG).

[R64] A UNI-C Type 2.1 that supports Link Aggregation and a UNI-C Type 2.2 **MUST** support at least two (2) links in the Link Aggregation group (LAG).

[R65] A UNI-N Type 2.1 that supports Link Aggregation and a UNI-N Type 2.2 **SHOULD** support Link Aggregation across multiple line cards.

Note: A line card can be defined as a field replaceable sub-unit of a larger modular system that supports ports serving service frames, designed to be replaced without affecting the operation of other sub-units. This would include a conventional "line card", but would exclude, for example, a "daughter card" which could not be replaced without removing the carrier card it is on. The above requirement intends to enhance the protection level of the Network Element implementing the UNI-N. Note that some NE might not have multiple line-cards.

[R66] When Link Aggregation of exactly two (2) links is implemented across line cards, one of the links **MAY** be set to Active while the other be set to Standby using LACP, as per clause 43.4 of [IEEE 802.3], to simplify the bandwidth profile enforcement.

Note: Link OAM or Link –level Service OAM should be used for the Standby link. To ensure availability of the Standby link in case of failure of the Active link,

[R67] A UNI-N and UNI-C Type 2.1 that support Link Aggregation and a UNI-N and UNI-C Type 2.2 **SHOULD** support LACP as per [IEEE 802.3]. When LACP is not supported other methods such as shutting down the PHY laser **MAY** be supported to signal LAG change.

[R68] A UNI-N Type 2.1 that supports Link Aggregation and LACP and a UNI-N Type 2.2 that supports LACP **MUST** have its LACP_Activity set to Active mode, to prevent the scenario when both UNI-C and UNI-N are passive waiting for each other to initiate the communication

[R69] A UNI-C Type 2.1 that supports Link Aggregation and LACP and a UNI-C Type 2.2 that supports LACP **MUST** have its LACP_Activity set to Passive mode as default.

12. Supporting Enhanced UNI Attributes

This section list some enhanced UNI features for UNI Type 2 that were not supported in UNI Type 1 [MEF13].

[R70] A UNI-N Type 2 **MUST** be able to support Per-UNI egress BW profiling of CIR as specified in [MEF10.1], in the following granularities:

- ≤ 1Mbps steps up to 10Mpbs
- ≤ 5 Mbps steps beyond 10Mbps and up to 100Mbps
- ≤ 50 Mbps steps beyond 100Mpbs and up to 1Gbps
- ≤ 500 Mbps steps beyond 1Gbps

[R71] A UNI-N Type 2 **MUST** be able to support Per-EVC egress BW profiling of CIR as specified in [MEF10.1], in the following granularities:

- ≤ 1Mbps steps up to 10Mpbs
- ≤ 5 Mbps steps beyond 10Mbps and up to 100Mbps
- ≤ 50 Mbps steps beyond 100Mpbs and up to 1Gbps
- ≤ 500 Mbps steps beyond 1Gbps

[R72] A UNI-N Type 2 **MUST** be able to support Per-CoS ID egress BW profiling of CIR as specified in [MEF10.1], in the following granularities:

- ≤ 1Mbps steps up to 10Mpbs
- ≤ 5 Mbps steps beyond 10Mbps and up to 100Mbps
- ≤ 50 Mbps steps beyond 100Mpbs and up to 1Gbps
- ≤ 500 Mbps steps beyond 1Gbps

[R73] A UNI-N Type 2 **MUST** support an MTU size of 1522 Bytes as per [IEEE 802.3] and **SHOULD** support an MTU size of 2000 Bytes as per [IEEE 802.3as]. It **MAY** support 9600 byte jumbo frames.

[R74] A UNI-C Type 2 **MUST** support an MTU size of 1522 Bytes as per [IEEE 802.3] and **SHOULD** support an MTU size of 2000 Bytes as per [IEEE 802.3as]. It **MAY** support 9600 byte jumbo frames.

[R75] A UNI-N Type 2 **MUST** be able to support Point-to-point, Multipoint-to-Multipoint EVC, and **SHOULD** be able to support Rooted-Multipoint EVCs.

[R76] A UNI-N Type 2 **SHOULD** be able to take on the role of a "root" or "leaf" for each Rooted-Multipoint EVC it supports.

[R77] A UNI-N Type 2 **SHOULD** be capable of operating as a "root" on one Rooted-Multipoint EVC and a "leaf" on another Rooted-Multipoint EVC concurrently.

[R78] A UNI-N and UNI-C Type 2 **MUST** support at least one of the PHYs listed in [IEEE 802.3], excluding 1000BASE-PX-D and 1000BASE-PX-U.

Note: 1000BASE-PX-D and 1000BASE-PX-U are excluded since Link OAM is not supported on these PHYs.

[R79] A UNI-N and UNI-C Type 2 **MUST** support Auto-negotiation for 10/100 and 10/100/1000 UNI rates for the PHYs that support Auto-negotiation.

[R80] A UNI-N and UNI-C Type 2 **MUST** support the capability to disable the Auto-negotiation function.

Note: The Auto-negotiation function may need to be disabled for unidirectional link operation.

13. L2CP and Service OAM Handling

This section provides requirements for the processing of a customer's Layer 2 Control Protocol (L2CP) and Service OAM frames at UNI-N. Since UNI-N Type 2 is designed to simultaneously support currently defined MEF services (MEF10.1), as well as all future MEF services, the L2CP and OAM processing requirements herein are generic and service agnostic. Specific L2CP and OAM handling rules for each Service should be taken from the MEF's Ethernet Service Definition Implementation Agreements..

For a given L2 Control Protocol or OAM there are four possibilities for processing:

1. 'Pass to an EVC' for tunneling
2. 'Peer' at the UNI
3. 'Peer and pass to an EVC' for tunneling
4. 'Discard' at the UNI

This IA however, only specifies two possible processing at UNI-N:

1. 'Pass to EVC'
2. 'Not pass to EVC (Filter)'

"Pass to EVC" means the L2CP or OAM frames could be either Tunneled or Discarded by the EVC depending on the service type. "Filter" means the L2CP or OAM frames could be either Peered or Discarded depending on the service type. The decision to whether "Discard" or "Peer" or "Tunnel" any L2CP or OAM is Service type dependent and orthogonal to the decision to "Pass to EVC" or "Filter", and is outside of the scope of this Implementation Agreement.

Specific L2CP and OAM handling rules for each Service should be taken from the MEF's Ethernet Service Definition Implementation Agreements such as MEF6.1.

[R81] A UNI-N Type 2 **MUST** "Filter" all L2CP packets with the following Multicast MAC DA:

- 01-80-C2-00-00-02 to 01-80-C2-00-00-0A
- 01-80-C2-00-00-0D
- 01-80-C2-00-00-0E

[R82] A UNI-N Type 2 **SHOULD** "Filter" PAUSE frames with the following Multicast MAC DA:

- 01-80-C2-00-00-01

[R83] A UNI-N Type 2 **MUST** have the capability to be configured to either "Pass to EVC" or "Filter" all packets with the following Multicast MAC DA:

- 01-80-C2-00-00-00
- 01-80-C2-00-00-0B
- 01-80-C2-00-00-0C
- 01-80-C2-00-00-0F
- 01-80-C2-00-00-20 to 01-80-C2-00-00-2F
- 01-80-C2-00-00-30 to 01-80-C2-00-00-3F

Several protocols may use the same Multicast MAC DA, for example, multiple protocols use the "slow multicast protocol" address 01-08-C2-00-00-02. For decision to "Peer" or "Discard", additional fields within the service frame may be uses such as Ethertype, Subtype, code, etc.

14. Appendix A (Test-MEG Definition)

Carriers have expressed the need to test connectivity all the way to customer equipment using OAM protocols, and to do so in a way that is segmented from a subscriber's self use of OAM protocols. This requirement has created the need to utilize a subscriber level OAM for carrier testing purposes. This use is completely conformant with the definition of [ITU-T Y.1731] and [IEEE 802.1ag], and places no new requirements on those protocols.

To accomplish this testing, the UNI-C is required to implement two subscriber level MEPs - one for actual customer testing, and another one for carrier testing to customer equipment. The MEP dedicated to carrier testing at the UNI-C is referred to as the UNI-C Test MEP, and the group of MEs between these UNI-C Test MEPs is referred to as the Test-MEG (made up of one or more Test MEs, as in the standard MEG/ME relationship).

By default, the CC function is disabled on the UNI-C Test MEP. In order to test connectivity and performance to such UNI-C Test MEP, the carrier must have access to an equivalent MEP, referred to as the Carrier Test MEP, from which to source the OAM frames. Where and how to place and utilize a MEP for testing is at the carrier's discretion.

This specification simply requires that the UNI-C implement the responder functionality in the UNI-C Test MEP so the carrier has the option to utilize it for test functions.

The Carrier Test MEP may be a permanent or temporary creation depending upon the needs of the carrier. It may utilize an existing UNI-C to perform these tests, or the Carrier Test MEP may be placed at another location. This specification does not define or limit the placement or utility of a Carrier Test MEP.

It is important to realize that the Carrier Test MEP utilized must obey the rules and procedures of the OAM protocols. This Carrier Test MEP behaves no differently than any other MEP. In particular, the Carrier Test MEP must have access to the data plane that is being measured (for example, the EVC), and the MEP must provide filtering based on the MEG-Level to form a boundary of the domain. It is therefore recommended that the carrier should take care in the placement of Carrier Test MEP because if placed improperly it may have unintended consequences - such as providing a barrier to other OAM domains.

15. Appendix B (Up-MEP and Down-MEP Definition)

Up-MEP and Down-MEPs are defined in [IEEE 802.1ag] for an IEEE 802.1 bridge. This appendix provides a brief description of Up-MEP and Down-MEP.

An Up-MEP is a MEP that monitors the forwarding path internal to an IEEE 802.1 bridge node (CE or PE), while a Down-MEP is a MEP that only monitors the forwarding path external to an IEEE 802.1 bridge node. An Up- MEP is implemented on the ingress port, while a Down-MEP is implemented on the egress port. The ingress port is the port that sends traffic toward the bridge relay, while egress port is the port that sends traffic away from the bridge relay. For example in an IEEE 802.1 bridge, an Up-MEP is a MEP that is implemented on one of the ports and is facing the bridge (sends OAM messages toward the bridge relay), while a Down-MEP is a MEP that is implemented on one of the ports and is facing the MAC on the same port (sends OAM messages toward the MAC and away from the bridge relay).

An Up-MEP may also, via continuity check, convey its port and interface status to its peers. An Up-MEP can only be applied if the CE is a L2 forwarding device (bridge). A CE that is a station such as a router should use a Down-MEP because stations can not forward OAM frames.

These MEP directions are illustrated in Figure 3.

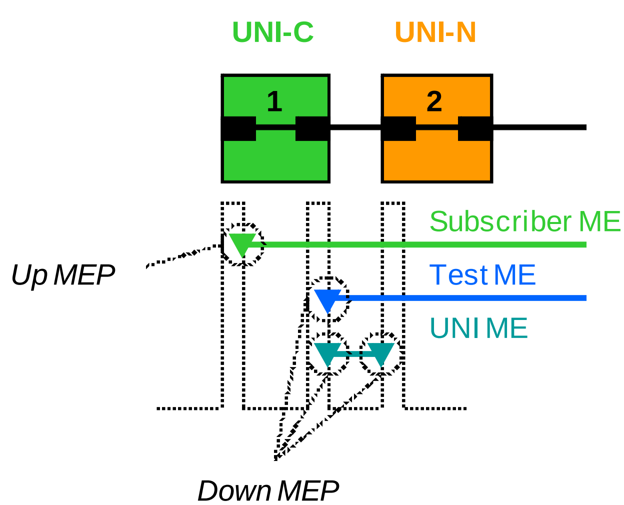

Figure 3 - UNI Type 2 MEP Directions

References

Reference	Reference Details
MEF 11	Metro Ethernet Forum UNI Requirements and Frame work, Nov 2004
MEF 13	Metro Ethernet Forum, UNI Type 1, Nov 2005
MEF 16	Metro Ethernet Forum, Ethernet Local Management Interface (E-LMI), Jan 2006
IEEE 802.1ag	IEEE Virtual Bridged Local Area Networks, Amendment 5:Connectivity Fault Management, 2007
IEEE 802.3	IEEE, Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications, Dec 2005
IEEE 802.3as	IEEE, IEEE, Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications Amendment: frame format extensions, 2006
MEF 10.1	Metro Ethernet Forum, Ethernet Service Attributes, Phase 2
ITU-T Y.1731	ITU-T, OAM Functions and Mechanisms for Ethernet based networks, 2006