Technical Specification
MEF 35.0.1

SOAM PM Implementation Agreement Amendment 1

October 2013

Disclaimer

The information in this publication is freely available for reproduction and use by any recipient and is believed to be accurate as of its publication date. Such information is subject to change without notice and the Metro Ethernet Forum (MEF) is not responsible for any errors. The MEF does not assume responsibility to update or correct any information in this publication. No representation or warranty, expressed or implied, is made by the MEF concerning the completeness, accuracy, or applicability of any information contained herein and no liability of any kind shall be assumed by the MEF as a result of reliance upon such information.

The information contained herein is intended to be used without modification by the recipient or user of this document. The MEF is not responsible or liable for any modifications to this document made by any other party.

The receipt or any use of this document or its contents does not in any way create, by implication or otherwise:

(a) any express or implied license or right to or under any patent, copyright, trademark or trade secret rights held or claimed by any MEF member company which are or may be associated with the ideas, techniques, concepts or expressions contained herein; nor

(b) any warranty or representation that any MEF member companies will announce any product(s) and/or service(s) related thereto, or if such announcements are made, that such announced product(s) and/or service(s) embody any or all of the ideas, technologies, or concepts contained herein; nor

(c) any form of relationship between any MEF member companies and the recipient or user of this document.

Implementation or use of specific Metro Ethernet standards or recommendations and MEF specifications will be voluntary, and no company shall be obliged to implement them by virtue of participation in the Metro Ethernet Forum. The MEF is a non-profit international organization accelerating industry cooperation on Metro Ethernet technology. The MEF does not, expressly or otherwise, endorse or promote any specific products or services.

Table of Contents

List of Figures

List of Tables

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	EXFO Inc.
AT&T	Iometrix
Ciena	Omnitron
Cisco	NTT AT
Ericsson	RAD
Equinix	Verizon

Introduction

This amendment makes the following changes to MEF 35 [A1-4]:

- Text changes in MEF35 existing sections by adding 1SL, Dual-Ended Synthetic Loss Measurement or PM-4, including:
    - Section 7.2 Frame Loss Measurements
    - Section 8 PM Solutions
    - Section 9 Common Requirements
    - Section 9.2.1 Measurement Interval Data Sets

For the changes made for existing MEF 35 text, the strikethrough text (e.g., ~~and~~) indicates the removed old text. The underline text (e.g., <u>and</u>) indicates the added new text.

- Adds new section 8.4: PM-4: Dual-Ended Synthetic Loss Measurements
- Adds new section A1-1: PM-4 Requirements
- Adds new section 14.5A (Appendix A): Dual-Ended Synthetic Loss PM Function
- Adds new Appendix H: Notes on PM-4 Solutions
- Adds new references

1. Terminology

This amendment adds the following new term(s) to "*Table 1 Terminology and Definitions"*

Term	Definition	Reference
1SL	One-way Frame Loss Message	ITU-T Y.1731 Amendment 1 [A1-3]

7.2 Frame Loss Measurements

This amendment modifies the second bullet of the second paragraph of section 7.2 (Frame Loss Measurement) as shown below in underlined text:

Measuring the loss of synthetic frames (SOAM PM PDUs using SLM/SLR or 1SL), as specified in Y.1731 ~~[1]~~ (07/2011) [A1-1], Y.1731 Amendment 1 (05/2012) [A1-3] and ITU-T G.8021~~Amendment 1 [5]~~ (05/2012) [A1-2].

8. PM Solutions

This amendment adds a row for PM-4 to "*Table 2 PM Solutions Summary*" in section 8 (PM Solutions) as shown below:

PM Solution	MEG Type(s)	Measurement Technique for Loss	PM Function(s)	Mandatory or Optional
PM-1	point-to-point multipoint	Synthetic Testing	Single-Ended Delay Single-Ended Synthetic Loss	Mandatory
PM-2	point-to-point multipoint	n/a	Dual-Ended Delay	Optional
PM-3	point-to-point	Counting Service Frames	Single-Ended Service Loss	Optional
PM-4	point-to-point multipoint	Synthetic Testing	Dual-Ended Synthetic Loss	Optional

This amendment adds a row of Dual-Ended Synthetic Loss to "*Table 3 PM Solutions Summary*" of section 8 (PM Solutions) as shown below:

PM Function	ITU-T PM Tool	ITU-T PDU(s)
Single-Ended Delay	ITU-T Two-way ETH-DM	DMM/DMR
Dual-Ended Delay	ITU-T One-way ETH-DM	1DM
Single-Ended Service Loss	ITU-T Single-Ended ETH-LM	LMM/LMR
Single-Ended Synthetic Loss	ITU-T Single-Ended ETH-SLM	SLM/SLR
Dual-Ended Synthetic Loss	ITU-T Dual-Ended ETH-SLM	1SL

This amendment modifies Page 19, Line 2 in section 8 (PM Solutions) as shown below in underlined text:

An overview of the PM Functions (Single-Ended Delay, Dual-Ended Delay, Single-Ended Service Loss Measurement, Single-Ended Synthetic Loss Measurement, ~~and~~ Dual-Ended Loss Measurement, and Dual-Ended Synthetic Loss Measurement) is provided in Appendix A – Performance Management Functions (Informative).

This amendment replaces Figure 6 in section 8 "PM Solutions" as follows:

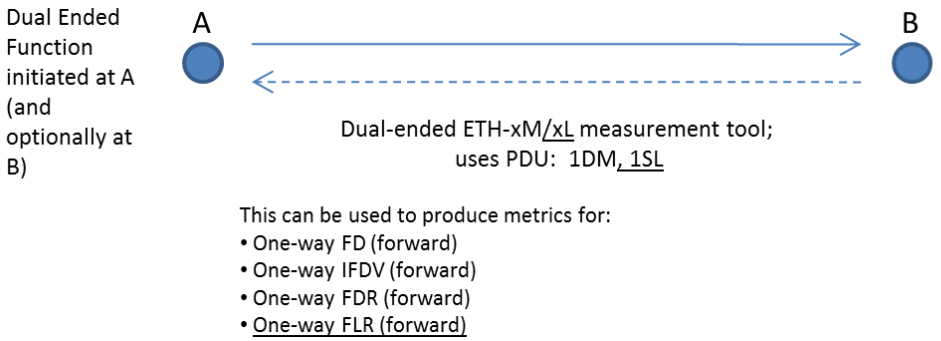

Figure 6 - Metrics that can be collected with Dual-Ended Loss and Delay

This amendment modifies Page 20, Line 3 in section 8 (PM Solutions) as shown below in underlined text:

The following sections serve to briefly describe the individual PM Solutions, which are realized through the NE requirements specified in Section 9 (Common Requirements) and Sections 10 (PM-1), 11 (PM-2), ~~and~~ 12 (PM-3), and A1-1 (PM-4) that follow.

This amendment adds section 8.4 as follows:

8.4 PM-4: Dual-Ended Synthetic Loss Measurements

The PM-4 Solution is an optional solution that uses one way synthetic SOAM PM PDUs to measure performance. This solution uses Dual-Ended frame loss measurement to measure the Frame Loss Ratio (FLR), Availability and Resiliency - the count of High Loss Intervals (HLI, CHLI).

For the PM-4 solution using 1SL PDUs, one-way measurements from a Controller MEP to a Sink MEP (in the forward direction) are taken. Typically, Dual-Ended PM Sessions are configured so that one runs from MEP i to MEP j and another runs from MEP j to MEP i. FLR, Availability and Resiliency are defined in MEF 10.2, and MEF 10.2.1.

.

1SL frames can be unicast or multicast. In multipoint EVCs, use of multicast 1SL frames can help to simplify PM session configuration and reduce SOAM traffic. This is further described in Appendix H.

Like any synthetic measurement approach, a PM Session using Dual-Ended synthetic loss needs to generate enough SOAM frames to be statistically valid (see Appendix D – Statistical Considerations for Synthetic Loss Measurement (Informative)). All synthetic SOAM PM frames need to be similar to the service frames carried by the EVC. In particular, such SOAM PM frames must have representative frame length and be treated by the network elements between the MEPs in the same way that service frames are treated. In addition, it is important that synthetic SOAM PM frames be inserted irrespective of the load / congestion at the insertion point. To do otherwise would bias measurements away from instances of poor network performance.

The following is a list of the performance metrics defined in MEF 10.2 and MEF 10.2.1 that can be measured for each ordered EI pair in the set S using the PM-4 Solution:

- One-way Frame Loss Ratio (MEF 10.2 and MEF 10.2.1 section 6.9.6)
- Availability for an EVC or OVC (MEF 10.2.1 section 6.9.8)
- Resiliency-related metrics (HLI, CHLI) for an EVC or OVC (MEF 10.2.1 section 6.9.9).

9. Common Requirements

This amendment modifies Page 23, Line 2 in section 9 (Common Requirements) as shown below in underlined text:

This section provides requirements that are applicable to all of the PM Solutions that follow in sections 10 (PM-1), 11 (PM-2), ~~and~~ 12 (PM-3), and A1-1 (PM-4).

9.2.1 Measurement Interval Data Sets

This amendment modifies Page 29, Line 8 in section 9.2.1 "Measurement Interval Data Sets" as shown below in underlined text:

Note that specific requirements relating to the performance parameters that must be stored in a Measurement Interval are enumerated on a per PM Function basis in sections titled PM-1 Requirements, PM-2 Requirements, ~~and~~ PM-3 Requirements, and PM-4 Requirements.

13. References

This amendment inserts the following references in section 13.

[A1-1] International Telecommunication Union, Recommendation Y.1731 (07/2011).

[A1-2] International Telecommunication Union, Recommendation G.8021 (05/2012), "Characteristics of Ethernet transport network equipment functional blocks".

[A1-3] International Telecommunication Union, Recommendation Y.1731 (07/2011) Amendment 1 (05/2012).

[A1-4] MEF 35 "Service OAM Performance Monitoring Implementation Agreement", April 2012

14. Appendix A - Performance Management Functions (Informative)

This amendment adds a subsection 14.5A (to be placed between 14.5 and 14.6 of MEF 35) as follows:

14.5A Dual-Ended Synthetic Loss PM Function

The Dual-Ended Synthetic Loss PM Function is intended to measure one-way synthetic FLR, and is specified for use in a point-to-point or a multipoint service.

One message is defined to enable a uni-directional mechanism, or dual-ended process, to exchange sequence numbers. The One-Way Synthetic Loss Message (1SL) conveys a sequence number which is incremented by 1 by the Controller MEP for each 1SL frame transmitted..

The Sink MEP can estimate one-way service frame loss by calculating the loss of the synthetic 1SL frames, using the sequence numbers in a series of received 1SL frames. Gaps in sequence numbers indicate frames lost. To determine synthetic frame loss over a given interval of time, it is necessary to send a number of 1SL frames over that period, and monitor the received 1SL frames. The accuracy of the measurement depends on the number of 1SL frames sent, as described in Appendix D – Statistical-Considerations for Synthetic Loss Measurement (Informative).

Frame generation and reception processes are defined for 1SL. In addition, a single 1SL Source Control Process and a single 1SL Sink Control Process are defined. The 1SL Source Control Process coordinates 1SL generation to a given destination at a given SOAM PM CoS ID and periodicity. The 1SL Sink Control Process coordinates 1SL reception from a given source. On termination of the 1SL Sink Control process, measures are returned that reflect the one-way synthetic frame loss over the lifetime of the process. The following figure illustrates these processes:

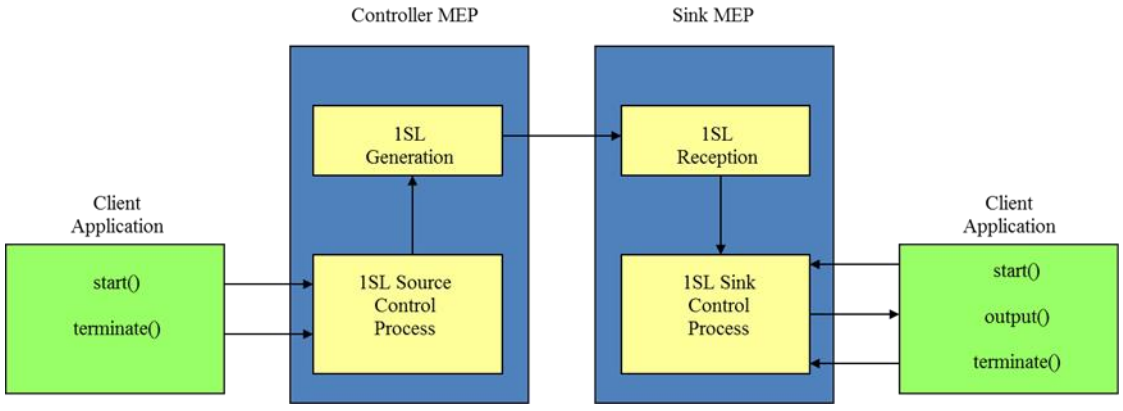

Figure A1-1 - Dual-Ended Loss Processes

The parameters of the signals generated and received by the 1SL Source Control Process are as follows:

Signal	Parameters
start()	DA (destination unicast or Class 1 multicast MAC address)
	VLAN PCP (0..7, not applicable if untagged)
	Period for 1SL generation (ms)
	TestID
	Length
terminate()	None

Table A1-1 – 1SL Source Control Process Signals

The parameters of the signals generated and received by the 1SL Sink Control Process are as follows:

Signal	Parameters
start()	SA (source unicast MAC address)
	TestID
output()	Total 1SL frames transmitted (based on the sequence numbers)
	Total 1SL frames not received
terminate()	None

Table A1-2 – 1SL Sink Control Process Signals

Since this function is a dual-ended process, administrative access to both measurement points is required.

This amendment adds the following section between section 12 and 13 of MEF 35.

A1-1. PM-4 Requirements

The PM-4 solution uses Dual-Ended Synthetic Loss function for Frame Loss Ratio (FLR), Availability, High Loss Intervals (HLI) and Consecutive High Loss Intervals (CHLI) measurements. The mechanisms support both point-to-point and multipoint connections.

Section A1-1.1 lists the requirements for measuring FLR, Availability, HLI and CHLI using Dual-Ended Synthetic Loss function.

[A1-O1] A SOAM PM implementation **MAY** support the dual-ended synthetic loss function as described in Section A1-1.1.

A1-1.1 Dual-Ended Synthetic Loss Function for FLR, Availability, HLI, CHLI

Dual-Ended Synthetic Loss can be configured for multiple classes of service in each direction between a pair of MEPs. Each unique pair of MEPs, direction, and class of service to be measured requires a unique PM Session. Dual-Ended Synthetic Loss supports both point-to-point and multipoint configurations.

On multipoint EVCs any subset of the ordered pairs of MEPs can be used and it is not required to configure measurement for every ordered pair of MEPs, nor for both orders (directions) of any given pair of MEPs. A set of results data will be collected for each ordered pair of MEPs in the configured subset, per class of service. The EMS/NMS will use the data collected for each ordered pair of MEPs in the configured subset and compute a single value for the EVC and class of service as specified in MEF 10.2 [12] and MEF 10.2.1 [13].

When using Dual-Ended Synthetic Loss, a single direction (A->B or B->A) can be measured or both directions can be measured (A->B and B->A.) depending on configuration.

The following requirements apply to a SOAM PM implementation of the Dual-Ended Synthetic Loss function and its client application.

[A1-R1] A SOAM PM implementation **MUST** support the ITU-T Dual-Ended ETH-SLM protocol and procedures as specified by ITU-T Y.1731 Amendment 1 [A1-3] and ITU-T G.8021 [A1-2].

The requirements of this section apply to an instance of the PM-4 solution, as summarized in section 8.4, operating in one direction from a Controller MEP to Sink MEP(s) for a given ME.

The following requirements specify the ***input parameters*** that are to be supported by the client application for each PM Session.

[A1-R2] A SOAM PM implementation **MUST** support a configurable unicast destination MAC address.

[A1-R3] A SOAM PM implementation **MUST** support Class 1 multicast destination MAC address.

[A1-R4] A SOAM PM implementation **MUST** support a configurable SOAM PM CoS ID for 1SL PM session. This requirement is not applicable if the SOAM PM PDUs are untagged.

[A1-D1] The default value of the PCP of a tagged 1SL frame **SHOULD** be a PCP value that yields the lowest frame loss objective for the EVC or OVC.

[A1-D2] Untagged 1SL frames **SHOULD** be transmitted with the highest priority supported by the NE

[A1-R5] A SOAM PM implementation **MUST** support multiple concurrent 1SL PM sessions between the same end points.

For example, multiple sessions could be used to monitor different class of services, different frame lengths, or to support both proactive and on-demand sessions.

[A1-R6] SOAM PM CoS IDs that can be configured **MUST** support at least the following configuration for SOAM PM CoS IDs:

- VLAN ID
- A combination of the PCP and VLAN ID

[A1-R7] If the MEG is tagged and the VLAN DEI is supported, then a SOAM implementation of a Controller MEP **MUST** use a VLAN DEI of 0 (discard ineligible) for 1SL PDU transmission.

[A1-R8] A SOAM PM implementation **MUST** support a configurable period for 1SL PDU transmission.

[A1-R9] The periods of {100 ms, 1 sec, 10 sec} **MUST** be supported for 1SL PDU transmission.

[A1-D3] The period of 10ms **SHOULD** be supported for 1SL PDU transmission.

[A1-D4] The default configured period **SHOULD** be {1 sec}.

[A1-R10] A SOAM PM implementation of the Controller MEP **MUST** support a configurable frame size for 1SL frames, for each PM session.

Note: The frame size does not need to be configured at the Sink MEP.

The frame size corresponds to a valid MEF Service Ethernet frame and is inclusive of the Ethernet header, the 1SL PDU with any required PDU padding, and the FCS. This parameter excludes preamble and minimum inter frame gap. A Data TLV can be used as padding within the 1SL PDU.

[A1-R11] The range of Ethernet frame sizes from 64 through 2000 octets **MUST** be supported.

[A1-D5] The range of Ethernet frame sizes from 2001 through 9600 octets **SHOULD** be supported.

[A1-D6] The default configured frame size **SHOULD** be 64 octets, which is the minimum valid Ethernet frame size.

When the Dual-Ended Synthetic Loss Function is used, each transmitted 1SL frame has two possible outcomes: the 1SL is received; or the 1SL is lost. To calculate the FLR, a number of 1SLs must be transmitted, and the corresponding number lost must be measured. The FLR can then be calculated in the normal way. Note: the more 1SLs used for FLR calculation, the more precise the resulting FLR value will be.

The following requirements apply to the calculation of Availability, which is explained in detail in MEF 10.2.1. A brief summary is that Availability is determined by first calculating the "Availability flr" over a small interval of time Δt and comparing it to a frame loss threshold. If a sufficient number of consecutive Δt intervals exceed the threshold, an Unavailable state is entered. Note that Availability flr is different from FLR, which is calculated over the much larger interval T.

[A1-R12] The number range of 1 through 10 **MUST** be supported for the configurable number of consecutive Availability flr measurements to be used to determine Available/Unavailable state transitions. This parameter is equivalent to the Availability parameter of *n* as specified by MEF 10.2.1.

[A1-D7] The default configured number of n for Availability **SHOULD** be 10.

The Availability flr measurements are the basis to evaluate Availability. Within each small time period Δt (e.g., one second), the loss ratio "Availability flr" is calculated and compared with a threshold *C*. If a window of consecutive Δt *intervals* all have loss ratio exceeding the threshold, then an Unavailable state has been entered and all seconds within that window will be designated as having Available state = 0. Details are in MEF 10.2.1.

[A1-R13] A SOAM PM implementation **MUST** support a configurable Availability frame loss ratio threshold to be used in evaluating the Available/Unavailable state of an Availability indicator per MEF 10.2.1.

[A1-R14] The Availability frame loss ratio threshold range of 0.00 through 1.00 **MUST** be supported.

[A1-D8] The default configured Availability frame loss ratio threshold **SHOULD** be 0.50.

[A1-R15] A SOAM PM implementation at a Sink MEP **MUST** report to the managing system whenever a state transition between Available and Unavailable occurs in the status of an adjacent pair of Availability indicators per MEF 10.2.1.

[A1-R16] The Available state transition report from a Sink MEP **MUST** include the following data:

Data	Description
Source	Controller MEP
Destination	Sink MEP
Cos ID	SOAM PM CoS ID
Timestamp	Reflects the value of the local time-of-day clock in UTC at the time of transition.
State Transition	Reflects whether the state transition was from Available to Unavailable, or Unavailable to Available.

Table A1-3 – Available State Transition Event Data

[A1-R17] If the NE maintains a time-stamped log, an entry **MUST** also be generated with the same data as the report by the Sink MEP.

The following requirements apply to the measurement of HLI and CHLI, which are explained in detail in MEF 10.2.1

[A1-R18] A SOAM PM implementation **MUST** support a configurable parameter to indicate the number of HLIs that constitute a CHLI. This is equivalent to *p* in MEF 10.2.1.

[A1-D9] The default value for the number of HLIs that constitute a CHLI **SHOULD** be 5.

[A1-D10] The range of values for the number of HLIs that constitute a CHLI **SHOULD** be 1 to (n - 1), where n is the Availability parameter as specified in MEF 10.2.1 .

The following requirements specify the ***output data set*** that are to be supported by the client application per Measurement Interval.

[A1-R19] A SOAM PM implementation **MUST** support the following additional data per Measurement Interval per PM Session:

Data	Description
Start Time-of-day timestamp	A 64-bit timestamp of the time-of-day at the start of the Measurement Interval.
End Time-of-day timestamp	A 64-bit timestamp of the time-of-day at the end of the Measurement Interval.
Measurement Interval elapsed time	A 32-bit counter of the number of seconds of the Measurement Interval as calculated by the NE.
Tx frame count	A 32-bit counter reflecting the number of 1SL frames transmitted.
Rx frame count	A 32-bit counter reflecting the number of 1SL frames received.
Count of Availability indicators	A 32-bit counter reflecting the number of Availability indicators evaluated as Available.
Count of Unavailable indicators	A 32-bit counter reflecting the number of Availability indicators evaluated as Unavailable.
Count of HLIs	Count of HLIs during the Measurement Interval.
Count of CHLIs	Count of CHLIs during the Measurement Interval.

Table A1-4 – Mandatory Dual-Ended Synthetic Loss Data Set

Note1: Time of Day synchronization between Controller MEP and Sink MEP is outside the scope of this document.

Note2: The data set is based on the assumptions that the Controller MEP consistently transmits the 1SL PDUs and the performance measurement is processed by the Sink MEP.

[A1-D11] A SOAM PM implementation **SHOULD** support the following additional Availability related data per Measurement Interval per PM Session:

Data	Description
Minimum one-way Availability flr	The minimum one-way Availability flr measurement during this Measurement Interval.
Maximum one-way Availability flr	The maximum one-way Availability flr measurement during this Measurement Interval.
Average one-way Availability flr	The average (arithmetic mean) one-way Availability flr measurement during this Measurement Interval.

Table A1-5 – Optional Dual-Ended Synthetic Loss Data Set

This amendment adds the following section after section 21 of MEF 35.

A1-2. Appendix H – Notes on the PM-4 Solution

When compared to Single-Ended Synthetic Loss measurement, Dual-Ended Synthetic Loss measurement has some advantages for multipoint EVCs, especially those with a large number of MEPs. For point-to-point EVCs, there is little difference between the two mechanisms.

For multipoint EVCs, Dual-Ended Synthetic Loss measurement can help to simplify the SOAM PM configuration, and may reduce the total amount of SOAM traffic in the network if multicast 1SL frames are used. These advantages are best illustrated by an example, as shown below.

Note that MEF 35 limits SLM frames to unicast, due to the additional complexity that would be required in the Controller to handle multiple responses if multicast were used. However, this limitation does not apply to 1SL.

An example for a multipoint EVC and MEPs as follows:

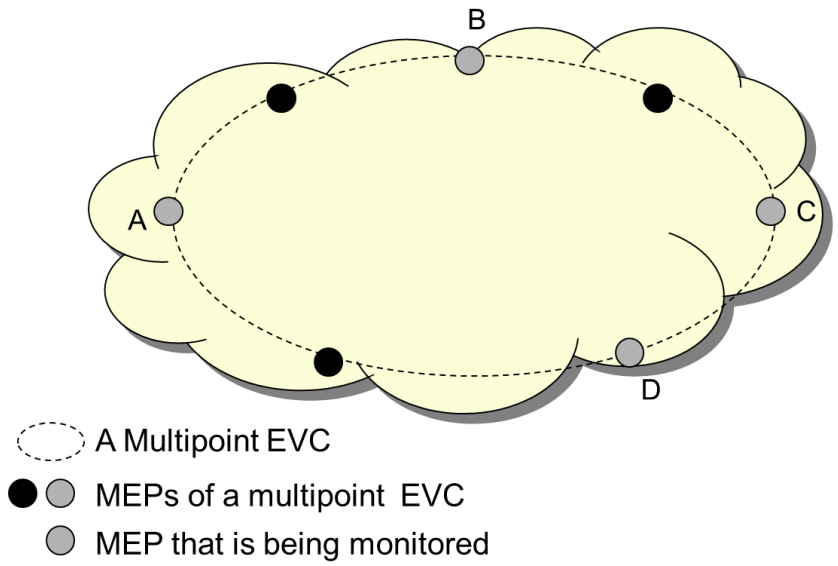

Figure A1-2 – Example of a Multipoint EVC and MEPs

When SLM/SLR is used for Single-Ended Synthetic Loss measurement, one example of the configuration and SOAM PDU flows can be:

MEP at A: 3 Controllers + 0 Responder

MEP at B: 0 Controller + 3 Responders

MEP at C: 1 Controller + 2 Responders

MEP at D: 2 Controllers + 1 Responder

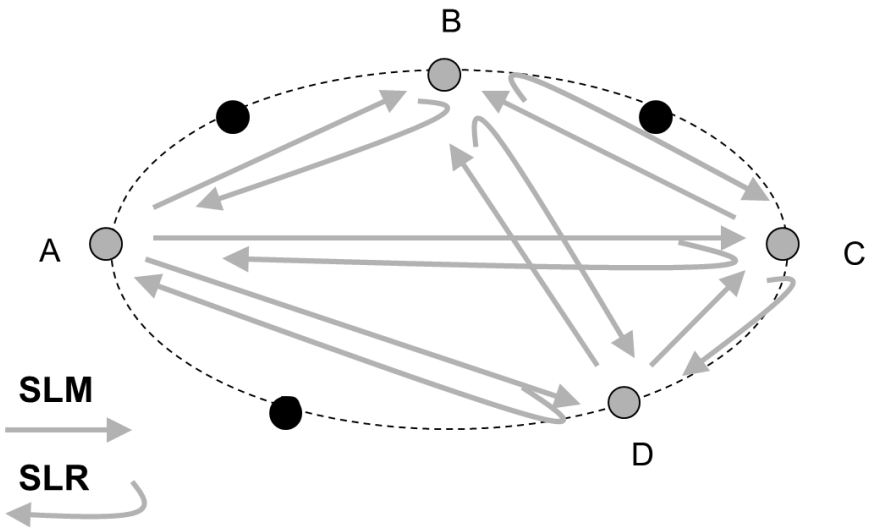

Figure A1-3 - Single-Ended Synthetic Loss Example

Since all SLMs are unicast PDUs, the PDU flows will be 6 SLM flows and 6 SLR flows. In general case, it would be 1/2 *N*(N-1) flows of SLM and SLR respectively, where N is the number of MEPs being monitored of the EVC.

Notice that the configuration of each MEP is different. It requires more careful planning in order to cover all directions for all monitored MEPs.

Alternatively, if we select multicast 1SL for Dual-Ended Synthetic Loss measurement, the configuration can be much simpler and well balanced, compared to using SLM/SLR:

MEP at A: 1 Controller + 3 Sinks

MEP at B: 1 Controller + 3 Sinks

MEP at C: 1 Controller + 3 Sinks

MEP at D: 1 Controller + 3 Sinks

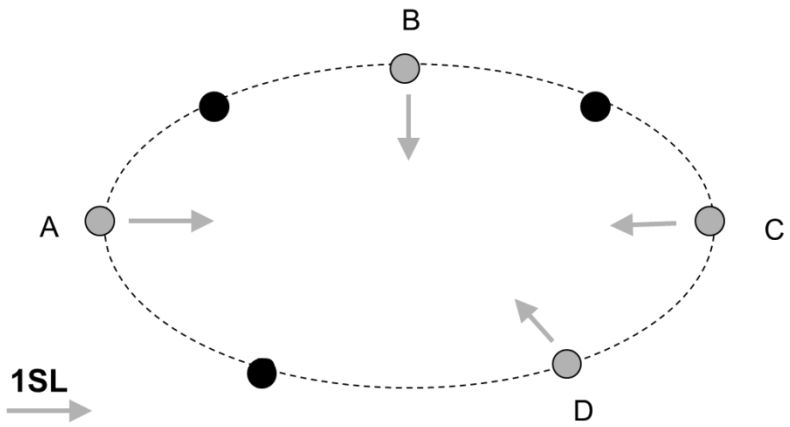

Figure A1-4 - Dual-Ended Synthetic Loss Example

Notice that the configuration of each MEP is the same.

Using multicast 1SL PDUs requires each Controller MEP to send multicast 1SL and each Sink MEP to accept and process the measurement. The number of multicast flows will be N (4 as shown in Figure A1-4). Depending on where the multicast starts, the actual PDU flows in the network will be at most N*(N-1), where N is the number of MEPs being monitored of the EVC.