Technical Report

TR-452.5

Quality Attenuation Measurements Using L2 PM OAM

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Executive Summary

The Quality Attenuation (∆Q) measurement general approach is described in TR-452.1 [2], and the specifications for its implementation using Network Layer (L3) Active Test Protocols are detailed in TR-452.2 [3].

This Technical Report addresses the implementation of Quality Attenuation (∆Q) measurement using Data Link Layer (L2) Active Test Protocols.

This allows Quality Attenuation (∆Q) measurement in network segments where L3 endpoints are unavailable and their deployment is not possible or problematic.

1 Purpose and Scope

1.1 Purpose

All the protocols listed in the TR-452.2 [3] – Quality Attenuation Measurements using Active Test Protocols require the Network Layer (L3). In other words, the protocols endpoints must be terminated to an IP Address.

Since such L3 terminations are not always available, possible, or convenient, adding an Active Test Measurement Protocol that works at the Data Link Layer (L2) is quite useful.

A protocol that fits such requirements for Ethernet-Based Networks already exists and is well-supported by the network equipment vendor community: the ITU-T G.8013/Y.1731 [21].

The ITU-T G.8013/Y.1731 [21] is widely used in the Ethernet Metro Area Networks (MAN) and is often the Service Level Agreement (SLA) protocol of choice for the Layer-2 Broadband Access Wholesale Infrastructures.

Furthermore, its addition to the Active Test Protocols supported for Quality Attenuation Measurements provides the Broadband-Forum Quality Experience Delivered (QED) insights and analysis to the environments where the ITU-T G.8013/Y.1731 [21] Protocol is already available, deployed, and used.

1.2 Scope

This Technical Report defines how the ITU-T G.8013/Y.1731 [21] may be used to perform Quality Attenuation measurements in accordance with the TR-452.2 [3].

2 References and Terminology

2.1 Conventions

In this Technical Report, several words are used to signify the requirements of the specification and RFC 8174 [10]. These words are always capitalized. More information can be found be in RFC 2119 [9].

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 [RFC2119] [9] [RFC8174] [10] when, and only when, they appear in all capitals, as shown here.

2.2 References

The following references are of relevance to this Technical Report. At the time of publication, the editions indicated were valid. All references are subject to revision; users of this Technical Report are therefore encouraged to investigate the possibility of applying the most recent edition of the references listed below.

A list of currently valid Broadband Forum Technical Reports is published at www.broadband-forum.org.

Document	Title	Source	Year
[1] TR-390 issue 2	Performance Measurement from IP Edge to Customer Equipment using TWAMP Light	BBF	2020
[2] TR-452.1	Quality Attenuation Measurement Architecture and Requirements	BBF	2020
[3] TR-452.2	Quality Attenuation Measurements using Active Test Protocols	BBF	2022
[4] TR-143	Enabling Network Throughput Performance Tests and Statistical Monitoring	BBF	2008
[5] TR-145	Multi-service Broadband Network Functional Modules and Architecture	BBF	2012
[6] TR-304	Broadband Access Service Attributes and Performance Metrics	BBF	2015
[7] TR-178 issue 2	Multi-service Broadband Network Architecture and Nodal Requirements	BBF	2017
[8] RFC 5357	Two-Way Active Measurement Protocol (TWAMP)	IEEE	2005
[9] RFC 2119	Key words for use in RFCs to Indicate Requirement Levels	IETF	1997
[10] RFC-8174	Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words	IETF	2017
[11] RFC-7799	Active and Passive Metrics and Methods (with Hybrid Types In-Between)	IETF	2016
[12] RFC-4656	A One-way Active Measurement Protocol (OWAMP)	IETF	2006

[13] RFC-6038	Two-Way Active Measurement Protocol (TWAMP) Reflect Octets and Symmetrical Size Features	IETF	2010
[14] RFC-7594	A Framework for Large-Scale Measurement of Broadband Performance (LMAP)	IETF	2015
[15] RFC-7679	A One-Way Delay Metric for IP Performance Metrics (IPPM)	IETF	2016
[16] RFC-7680	A One-Way Loss Metric for IP Performance Metrics (IPPM)	IETF	2016
[17] RFC 8762	Simple Two-Way Active Measurement Protocol (STAMP)	IETF	2020
[18] RFC 8972	Simple Two-Way Active Measurement Protocol Optional Extensions	IETF	2021
[19] RFC 8877	Guidelines for Defining Packet Timestamps	IETF	2020
[20] STAMP TLV Types registry	STAMP Timestamping Methods sub-registry	IANA	2021
[21] G.8013/Y.1731 Corrigendum 5	Operation, administration and maintenance (OAM) functions and mechanisms for Ethernet-based networks	ITU-T	2019
[22] G.8010/Y.1306 Amendment 3	Architecture of Ethernet layer networks	ITU-T	2021
[23] IEEE 802.1Q-2014	Media Access Control (MAC) Bridges and Virtual Bridged Local Area Networks	IEEE	2014
[24] IEEE 1588v1	Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems	IEEE	2020
[25] MEF 35.1	Service OAM Performance Monitoring Implementation Agreement	MEF	2015

2.3 Definitions

The following terminology is used throughout this Technical Report.

Term	Definition

2.4 Abbreviations

This Technical Report uses the following abbreviations:

Term	Definition
∆Q	Quality Attenuation
1DM	One-way Delay Measurement
BBF	Broadband Forum

DMM	Delay Measurement Messages
DMR	Delay Measurement Reply
ETH-DM	Ethernet Frame Delay Measurement
ETH-SLM	Ethernet Synthetic Frame Loss Measurement
ETH-SLM	Synthetic Frame Loss measurements
IEEE	Institute of Electrical and Electronics Engineers
ITU-T	International Telecommunications Union – Telecommunication Standardization Sector
L2	ISO/OSI Stack Data-Link Layer-2
L3	ISO/OSI Stack Network Layer-3
MAN	Metro Area Networks
MEP	Maintenance End Point
OAM	Operation, Administration, and Maintenance
PDU	Protocol Data Unit
SLA	Service Level Agreement
TLV	Type, Length and Value
TR	Technical Report

3 Technical Report Impact

3.1 Energy Efficiency

TR-452.5 has minimal impact on energy efficiency, although there will be an energy cost associated with performing measurements. It is recommended that the frequency of test packets should be kept as low as possible, so that the incremental cost is small.

3.2 Security

TR-452.5 has no impact on security, insofar as it exploits protocols and network node capabilities that are already defined elsewhere. Appropriate best practices should be followed as recommended in the corresponding standards, for example, as specified in TR-390 [1] and ITU-T G.8013/Y.1731 [21].

3.3 Privacy

TR-452.5 has no impact on privacy.

4 ANNEX D – ITU-T G.8013/Y.1731 Overview

The ITU-T G.8013/Y.1731 [21] is an Operation, Administration, and Maintenance (OAM) Protocol for Ethernet-Based Networks.

Its two main components are:

- Fault Management: Monitoring, Detection, and Isolation;
- Performance Monitoring: Frame Loss and Frame Delay Measurements.

For the Quality Attenuation requirements, just the Performance Monitoring component is needed, specifically its following on-demand or proactive measure functions:

- Ethernet Frame Delay Measurement (ETH-DM);
- Ethernet Synthetic Frame Loss Measurement (ETH-SLM).

See ITU-T G.8013/Y.1731 [21] Paragraph 8 OAM functions for performance monitoring for detailed information.

The Performance Functions, ETH-DM and ETH-SLM, are used to measure Ethernet point-to-point connections and multipoint connectivity as identified in Recommendation ITU-T G.8010/Y.1306 [22] utilizing Unicast MAC addresses.

See ITU-T G.8010/Y.1306 [22] Paragraph 6 Ethernet network topology for detailed information on point-to-point and multipoint definitions.

Monitoring different peer MEPs simultaneously, only for multipoint connectivity, utilizing Multicast MAC addresses, currently not supported, is left open for future studies.

5 ANNEX E – Considerations for test stream generation and observation with L2 PM OAM

The TR-452.2 [3] Paragraph 4 considerations are completely applicable for the measurements taken using the ITU-T G.8013/Y.1731 [21]. Performance Monitoring protocols.

6 ANNEX F – Using active L2 PM OAM test protocols for measuring Quality Attenuation

The TR-452.2 [3] Paragraph 5 specification are completely applicable for the measurements taken using the ITU-T G.8013/Y.1731 [21]. protocol given the following extensions/replacement are applied:

- The UDP packet object has to be replaced by Ethernet Frame;
- The compliant Active Measurement Protocol has to be ITU-T G.8013/Y.1731 [21].

7 ANNEX G – Ethernet Frame Delay Measurement (ETH-DM)

The delay measurements are taken between two Maintenance End Point (MEP) generating and receiving frames with Frame-Delay Measurement (ETH-DM) information.

ITU-T G.8013/Y.1731 [21] Performance Monitoring supports two Ethernet Frame Delay Measurement methods:

- One-Way Measurement with a Dual-Ended Messaging Protocol;
- Two-Way Measurement with a Single-Ended Messaging Protocol.

See ITU-T G.8013/Y.1731 [21] Paragraph 8.2 Frame delay measurement (ETH-DM) for detailed information.

7.1 One-Way / Dual-Ended – Ethernet Frame Delay Measurement

In One-Way ETH-DM mode, the Unidirectional Measurement Frame Delay computation is performed by the Receiving MEP on the One-way Delay Measurement (1DM) frame reception time and on Time Stamp Information Element contained in such Ethernet Frame.

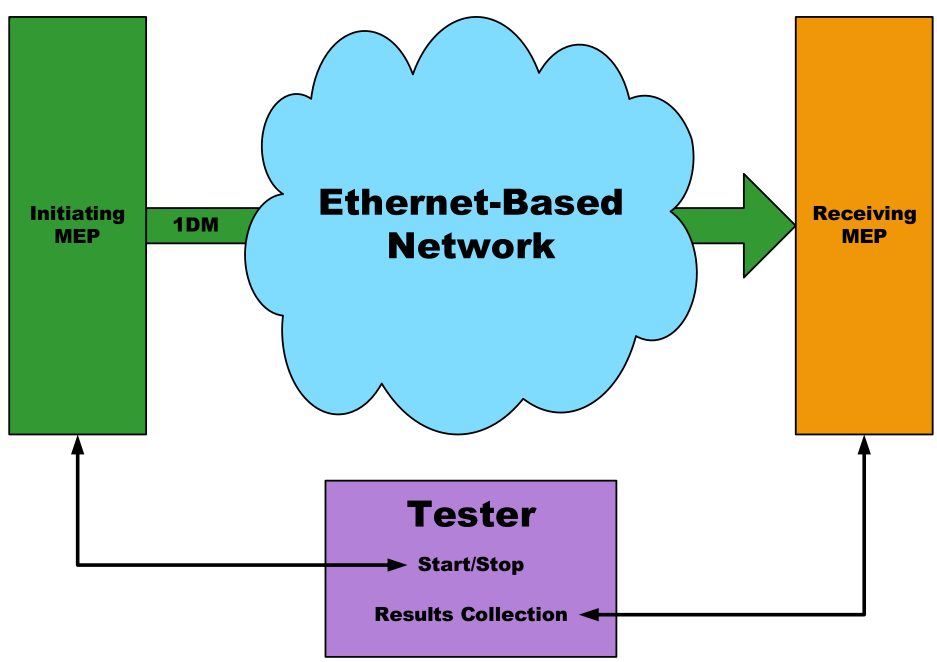

Figure 1 - One-Way Message (1DM) Flow Diagram

See ITU-T G.8013/Y.1731 [21] Paragraph 8.2.1 Dual-ended ETH-DM for detailed information.

7.1.1 One-Way Message (1DM) Transmission

When a One-Way Frame Delay Measurement is started, the Initiating MEP sends a defined sequence of One-Way Delay Massage (1DM) of defined size to the Receiving MEP at a defined rate, setting, for each PDU, the Transmission Timestamp Information Element.

	1		2	3	4
	8 7 6	5 4 3 2 1	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1
1	MEL	Version (1)	OpCode (1DM=45)	Flags	TLV Offset (16)
5	TxTimeStampf				
9					
13	Reserved for 1DM receiving equipment (0)				
17	*(for RxTimeStampf)*				
21	*[Optional TLVs start here; otherwise End TLV]*				
25					
29					
:					
last					End TLV (0)

Figure 2 - 1DM PDU Format

See ITU-T G.8013/Y.1731 [21] Paragraph 9.14 – 1DM PDU for detailed information.

7.1.2 One-Way Message (1DM) Reception

When the Receiving MEP gets a valid 1DM Message, it computes the One-Way Delay on its contained Timestamp Information Element and its Reception Time.

7.1.3 Notes on One-Way Ethernet Frame Delay Measurement

The ITU-T G.8013/Y.1731 [21]. One-Way Ethernet Frame Delay measurement methodology is the same implemented in the IETF RFC 4656 OWAMP [12] as detailed in the TR-452.2 [3] Annex A.

For both protocols, their time computation precision and accuracy strictly depend on the close synchronization of the system clocks between the measurement End Points.

7.2 Two-Way / Single-Ended – Ethernet Frame Delay Measurement

In Two-Way ETH-DM mode, the Round-Trip Ethernet Frame Delays computation is performed by the Initiating MEP on Delay Measurement Reply (DMR) frame reception time and the Time Stamp Information Elements contained in such frame.

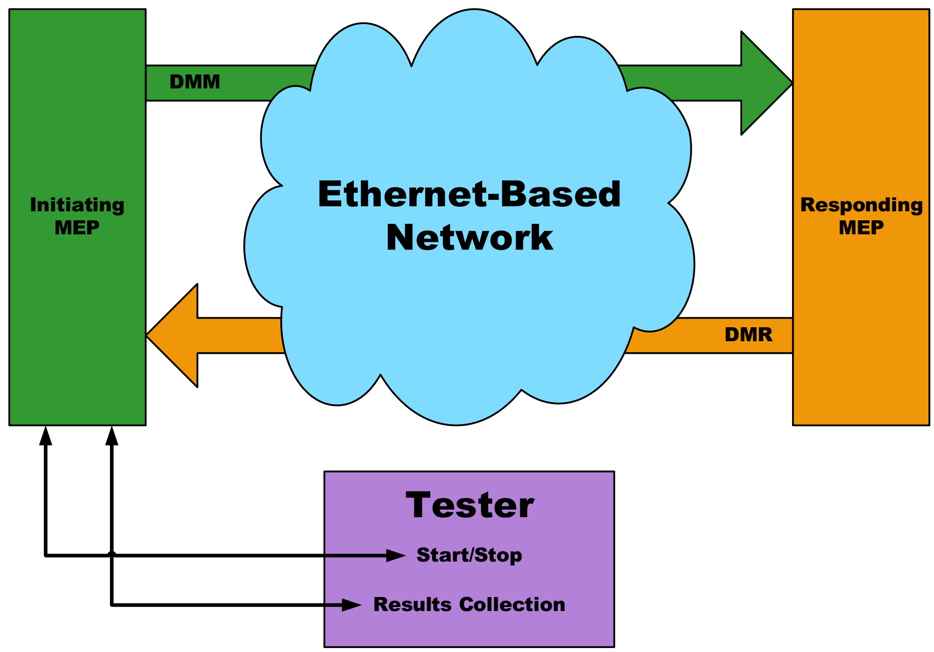

Figure 3 - Two-Way ETH-DM Frame Flow Diagram

See ITU-T G.8013/Y.1731 [21] Paragraph 8.2.2 Single-ended ETH-DM for detailed information.

7.2.1 Delay Measurement Message (DMM) Transmission

When a Two-Way Ethernet Frame Delay Measurement is started, the Initiating MEP sends a defined number of Delay Measurement Messages (DMM) of defined size to the Responding MEP at a defined rate, setting, for each PDU, the DMM Transmission Timestamp Information Element.

	1								2								3								4							
	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
1	MEL			Version (1)					OpCode (DMM=47)								Flags								TLV Offset (32)							
5	TxTimeStampf																															
9																																
13	Reserved for DMM receiving equipment (0) *(for RxTimeStampf)*																															
17																																
21	Reserved for DMR (0) *(for TxTimeStampb)*																															
25																																
29	Reserved for DMR receiving equipment (0)																															
33																																
37	*[Optional TLV(s) start(s) here; otherwise End TLV]*																															
41																																
45																																
:																																
last																									End TLV (0)							

Figure 4 - DMM PDU Format

See ITU-T G.8013/Y.1731 [21] Paragraph 9.15 – DMM PDU for detailed information.

7.2.2 Delay Measurement Reply (DMR) Transmission

When a Responding MEP gets a valid DMM Message, it responds with a Delay Measurement Reply (DMR) Message, which contains a copy of the received DMM PDU, on which performs all the required changes and sets the DMR Transmission Timestamp Information Element.

<table>
<tr><td></td><td colspan="8">1</td><td colspan="8">2</td><td colspan="8">3</td><td colspan="8">4</td></tr>
<tr><td></td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td>1</td><td colspan="3">MEL</td><td colspan="5">Version</td><td colspan="8">OpCode (DMR=46)</td><td colspan="8">Flags</td><td colspan="8">TLV Offset</td></tr>
<tr><td>5
9</td><td colspan="32">TxTimeStampf</td></tr>
<tr><td>13
17</td><td colspan="32">RxTimeStampf</td></tr>
<tr><td>21
25</td><td colspan="32">TxTimeStampb</td></tr>
<tr><td>29
33</td><td colspan="32">Reserved for DMR receiving equipment (0)
(for RxTimeStampb)</td></tr>
<tr><td>37
41
45
:</td><td colspan="32">[Optional TLV(s) start(s) here; otherwise End TLV]</td></tr>
<tr><td>last</td><td colspan="24"></td><td colspan="8">End TLV (0)</td></tr>
</table>

Figure 5 - DMR PDU Format

See ITU-T G.8013/Y.1731 [21] Paragraph 9.16 – DMR PDU for detailed information.

7.2.3 Delay Measurement Reply (DMR) Reception

When the Initiating MEP gets a valid DMR Message, it computes the Round-Trip Delays on its contained Timestamp Information Elements and its Reception Time.

7.2.4 Notes on Two-Way Ethernet Frame Delay Measurement

The ITU-T G.8013/Y.1731 [21] One-Way Ethernet Frame Delay measurement methodology is the same implemented in the IETF RFC 5357 TWAMP [8] and IETF RFC 8762 STAMP [17] as respectively detailed in the TR-452.2 [3] Annexes B and C.

For all the protocols listed above, although a close synchronization of the system clocks between the measurement End Points is always preferable, its absence does not invalidate the taken measurements.

8 ANNEX H – Synthetic Ethernet Frame Loss Measurement (ETH-SLM)

The Synthetic Frame Loss measurements are taken between two Maintenance End Point (MEP) generating and receiving frames with Synthetic Frame Loss measurements (ETH-SLM) information.

In this context, the word Synthetic is used to differentiate the frames built explicitly for the On-Demand Frame Loss Measurement from the network traffic frames that flow between the MEPs.

ITU-T G.8013/Y.1731 [21] Performance Monitoring supports two Synthetic Ethernet Frame Delay Measurement methods:

- One-Way Measurement with a Dual-Ended Messaging Protocol;
- Two-Way Measurement with a Single-Ended Messaging Protocol.

See ITU-T G.8013/Y.1731 [21] Paragraph 8.4 – Synthetic loss measurement (ETH-SLM) for detailed information.

8.1 One-Way / Dual-Ended – Synthetic Ethernet Frame Loss Measurement

In One-Way ETH-SLM mode, the Unidirectional Frame Loss Measurement is achieved by comparing the Transmitted Synthetic Frame Counter issued by the Initiating MEP and the Local Received Frame Counter kept by the Receiving MEP

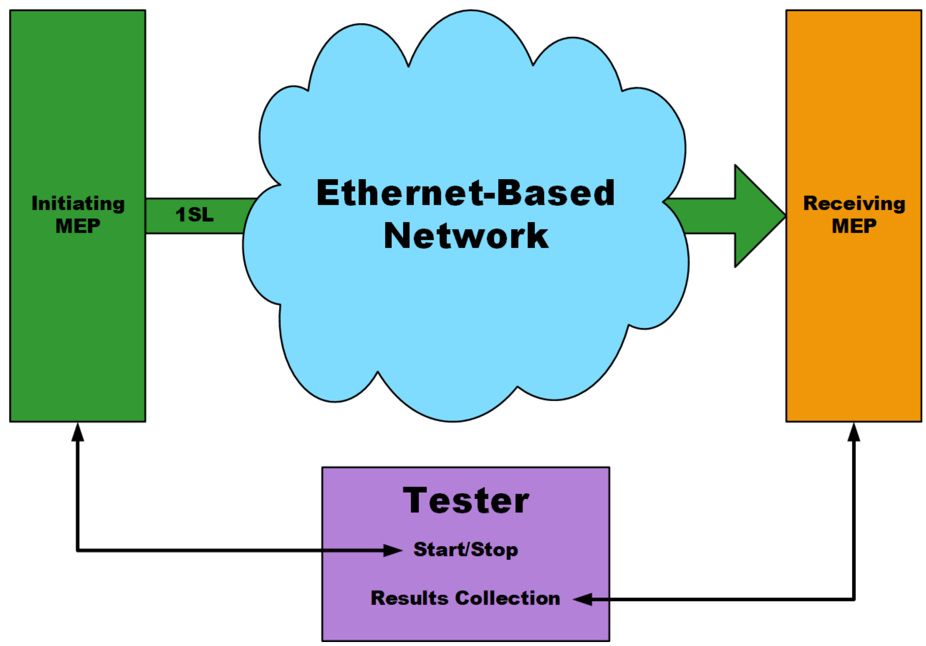

Figure 6 - One-Way Message (1SL) Flow Diagram

See ITU-T G.8013/Y.1731 [21] Paragraph 8.4.1 – Single-ended ETH-SLM for detailed information.

8.1.1 One-Way Message (1SL) Transmission

When a One-Way Synthetic Frame Loss Measurement is started, the Initiating MEP sends a defined sequence of One-Way Synthetic Frame Loss Massage (1SL) of defined size to the Receiving MEP at a defined rate, setting, for each PDU, the Transmitted Synthetic Frame Counter Information Element.

	1 (8 7 6)	1 (5 4 3 2 1)	2 (8 7 6 5 4 3 2 1)	3 (8 7 6 5 4 3 2 1)	4 (8 7 6 5 4 3 2 1)
1	MEL	Version (0)	OpCode (1SL = 53)	Flags (0)	TLV Offset (16)
5	Source MEP ID			Reserved	
9	Test ID				
13	TxFCf				
17	Reserved				
21	*[Optional TLV starts here, otherwise End TLV]*				
25					
:					
last					End TLV (0)

Figure 7 - 1SL PDU Format

See ITU-T G.8013/Y.1731 [21] Paragraph 9.24 – 1SL PDU for detailed information.

8.1.2 One-Way Message (1SL) Reception

When the Receiving MEP gets a valid 1SL Message, it computes the Synthetic Frame Loss comparing the received Transmission Synthetic Frame Counter with its Local Received Synthetic Frame Counter.

8.2 Two-Way / Single-Ended Synthetic Ethernet Frame Loss Measurement

In Two-Way ETH-SFL mode, the Round-Trip Synthetic Frame Losses measurement is achieved comparing the Local Synthetic Frame Transmitted Counter kept by the Initiating MEP and Synthetic Frame Counters received from the Responding MEP.

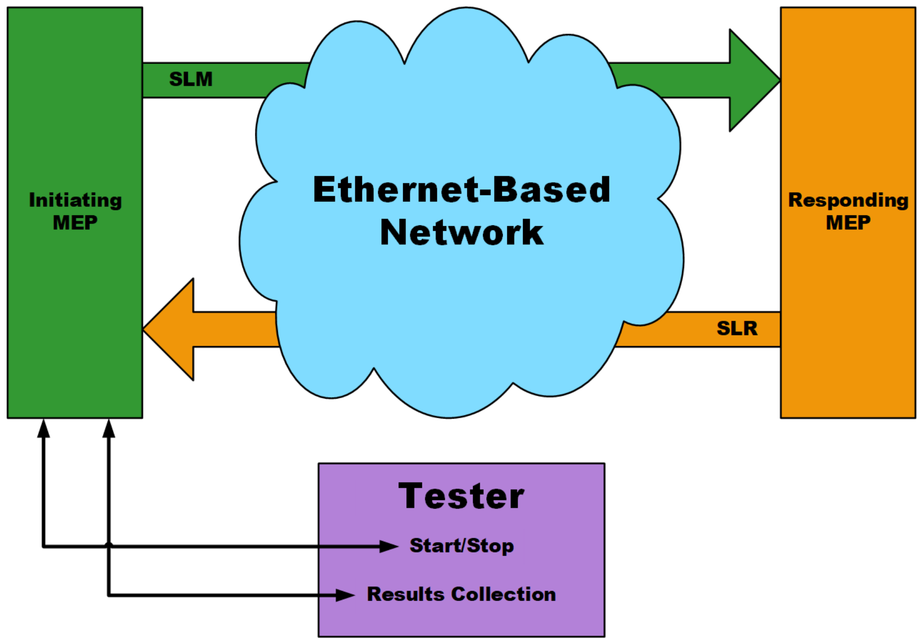

Figure 8 - Two-Way ETH-SFL Frame Flow Diagram

See ITU-T G.8013/Y.1731 [21] Paragraph 8.4.2 – Dual-ended ETH-SLM for detailed information.

8.2.1 Synthetic Frame Loss Measurement Message (SLM) Transmission

When a Two-Way Synthetic Frame Loss Measurement is started, the Initiating MEP sends a defined number of Synthetic Frame Loss Measurement Messages (SFL) of defined size to the Responding MEP at a defined rate, setting, for each PDU, the SLM Transmitted Frame Counter Information Element.

	1		2	3	4
	8 7 6	5 4 3 2 1	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1
1	MEL	Version (0)	OpCode (SLM = 55)	Flags (0)	TLV Offset
5	Source MEP ID			Reserved for Responder MEP ID (0)	
9	Test ID				
13	TxFCf				
17	Reserved for SLR: TxFCb (0)				
21	*[Optional TLV starts here, otherwise End TLV]*				
25					
:					
last					End TLV (0)

Figure 9 - SLM PDU Format

See ITU-T G.8013/Y.1731 [21] Paragraph 9.22 – SLM PDU for detailed information.

8.2.2 Synthetic Frame Loss Measurement Reply (SLR) Transmission

When a Responding MEP gets a valid SLM Message, it responds with a Synthetic Frame Loss Measurement Reply (SLR) frame, which is a copy of the received SLM PDU, on which performs all the required changes and sets the SLR Transmission Counter Information Element.

	1		2	3	4
	8 7 6	5 4 3 2 1	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1
1	MEL	Version	OpCode (SLR = 54)	Flags	TLV Offset(16)
5	Source MEP ID			Responder MEP ID	
9	Test ID				
13	TxFCf				
17	TxFCb				
21	*[Optional TLV starts here, otherwise End TLV]*				
:					
last					End TLV (0)

Figure 10 - SLR PDU Format

See ITU-T G.8013/Y.1731 [21] Paragraph 9.23 – SLR PDU for detailed information.

8.2.3 Synthetic Frame Loss Measurement Reply (SLR) Reception

When the Initiating MEP receives a valid SLR, using its Local SLM Transmitted Counter, the received SLM and SLR Transmitted Counter Information Elements, it computes the Round-Trip Frame Losses.

9 ITU-T G.8013/Y.1731 Two-Way / Dual-Ended Frame Loss and Frame Delay Measurement Correlation

While the IETF RFC 5357 TWAMP [8] and IETF RFC 8762 STAMP [17] perform the delay and the distinct two ways packet loss measurements simultaneously, that is not possible with the ITU-T G.8013/Y.1731 [21], which requires two separate measurements to achieve that.

To overcome this current ITU-T G.8013/Y.1731 [21] limitation, the Two-Way / Dual-Ended Frame Loss and Frame Delay Measurements should be taken as concurrently as possible, using the same number of messages, with the same sizes, and at the same transmission rate.

Then the collected measurement results have to be correlated.

10 ITU-T G.8013/Y.1731 Measurement Caveats

While the ITU-T G.8013/Y.1731 [21] allows configuring the priority of the frames per ETH-DM and ETH-SLM measurement operations, it requires their Drop Eligibility Indicator is always marked as Drop Ineligible.

The latter requirement implies that a strict Best Effort condition for the measurement frames can only be partially achieved.

See IEEE 802.1Q-2014 [23] Clause 9.6 – VLAN Tag Control Information – Filed b: Drop Eligible Indicator (I-DEI)

11 APPENDIX I – Timestamp Format

All the timestamps carried by the ITU-T G.8013/Y.1731 [21] PDUs are in the TimeRepresentation format as described in IEEE 1588 [24] Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems and detailed in the IETF RFC 8877 [19] Guidelines for Defining Packet Timestamps:

```
4.3 The PTP Truncated Timestamp Format
   The Precision Time Protocol (PTP) [IEEE1588] uses an 80-bit timestamp
   format.  The truncated timestamp format is a 64-bit field, which is
   the 64 least significant bits of the 80-bit PTP timestamp.  Since
   this timestamp format is similar to the one used in PTP, this
   timestamp format should be preferred in network protocols that are
   typically deployed in PTP-capable devices.

   The PTP truncated timestamp format was defined in [IEEE1588v1] and is
   used in several protocols, such as [RFC6374], [RFC7456], [RFC8186],
   and [ITU-T-Y.1731].

        0                   1                   2                   3
        0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       |                            Seconds                            |
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       |                          Nanoseconds                          |
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

                Figure 3: PTP Truncated Timestamp Format

   Timestamp field format:
      Seconds:  Specifies the integer portion of the number of seconds
         since the epoch.
         Size:  32 bits.
         Units:  Seconds.
      Nanoseconds:  Specifies the fractional portion of the number of
         seconds since the epoch.
         Size:  32 bits.
         Units:  Nanoseconds.  The value of this field is in the range 0
```



```
          to (10^(9))-1.

   Epoch:
      The PTP [IEEE1588] epoch is 1 January 1970 00:00:00 TAI.

   Leap seconds:
      This timestamp format is not affected by leap seconds.

   Resolution:
      The resolution is 1 nanosecond.

   Wraparound:
      This time format wraps around every 2^(32) seconds, which is
      roughly 136 years.  The next wraparound will occur in the year
      2106.
```

12 APPENDIX II – Tag Length Value (TLV) Format

The ITU-T G.8013/Y.1731 [21] PDUs carry mandatory and optional information elements that follow the Tag Length Value general format described in the section 9.1 Common OAM information elements.

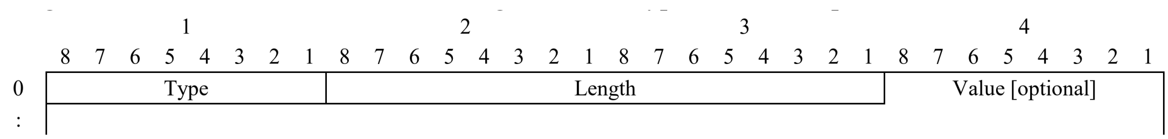

Figure 11 - TLVs General Format

NOTE – In an End TLV, Type = 0, and both Length and Value fields are not used.

See ITU-T G.8013/Y.1731 [21] Figure 9.1-2 for detailed information

13 APPENDIX III – Tag Length Value (TLV) Types

The ITU-T G.8013/Y.1731 [21] PDUs carry mandatory and optional information elements that follow the Tag Length Value, whose allowed Types are listed in section 9.1 Common OAM information elements.

Type value	TLV name
Types common with IEEE 802.1	
0	End TLV
3	Data TLV
5	Reply ingress TLV
6	Reply egress TLV
7	LTM egress identifier TLV
8	LTR egress identifier TLV
2, 4, 9-31, 64-255	Reserved (Note 1)
Types specific to this Recommendation	
32	Test TLV
33-35	Reserved (Note 2)
36	Test ID TLV
37, 38	Reserved (Note 3)
39-63	Reserved (Note 4)
NOTE 1 – Reserved for definition by IEEE 802.1. NOTE 2 – Reserved for definition by [ITU-T G.8113.1]. NOTE 3 – Reserved for definition by MEF. The definition is outside the scope of this Recommendation. NOTE 4 – Reserved for future standardization by ITU-T.	

Figure 12 - TLVs Types Values

See ITU-T G.8013/Y.1731 [21] Table 9-2 for detailed information

14 APPENDIX IV – MEF on ITU-T G.8013/Y.1731 Implementation

MEF (originally known as the Metro Ethernet Forum) ratified the Technical Specification MEF 35.1 [25] Service OAM Performance Monitoring Implementation Agreement.

This document is about the implementation of the ITU-T G.8013/Y.1731 [21]. in Metropolitan Ethernet Area Networks (MENs).

Several of the implementation and deployment issues are the same that occurs using the ITU-T G.8013/Y.1731 [21] as a BBF ∆Q measurement protocol.

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