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| INTERNATIONAL TELECOMMUNICATION UNION | | **STUDY GROUP 15** |
| **TELECOMMUNICATION STANDARDIZATION SECTOR**  STUDY PERIOD 2013-2016 | | TD 297 Rev.2 (PLEN/15) |
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| **Question(s):** | 10/15, 14/15 | 24 November - 5 December 2014 |
| **TD** | | |
| **Source:** | Editors Gsup.ethpm | |
| **Title:** | Draft new Supplement 53 to ITU-T G-series Recommendations (ex Gsup.ethpm) (for Agreement, 5 December 2014) | |

**Introduction**

This draft provides Draft Supplement “Guidance to performance measurement by Ethernet OAM” for agreement.

After the Shanghai meeting ([q10wd10r2](https://www.itu.int/ifa/t/2013/sg15/exchange/wp3/q10/2014-09-Shanghai/wd/q10wd10r2_Editor_Gsup.ethpm_draft.docx)), the following editorial updates are made:

* Create Annex A and Table 1a, 1b and 1c are included to this annex.
* Moved Table 1 from Editor’s note to the main text in clause 6.2.2.
* Removed all of the Editors’ note and diffmark.

This draft was updated in this meeting. The updated draft with diffmark is available at [q10wd14r4](https://www.itu.int/ifa/t/2013/sg15/exchange/wp3/q10/2014-11-Geneva/q10wd14r4_Gsup.ethpm(TD-PLEN-0297).docx)

**Drafting result in this meeting**

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| --- | --- | --- |
| [ 792 ] | Ministry of Industry and Information Technology (MIIT) | Some considerations and proposals to Gsup.ethpm |

No action for drafting

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| --- | --- | --- |
| [ 1070 ] | Cisco Systems, Inc. | Structure of Gsup.ethpm |

Agreed to update the structure. It is noted that some x.3 (Management requirement) needs sub clauses. We will discuss the necessity of X.3.1 or X.3.2 in some clauses

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| [ 1072 ] | Cisco Systems, Inc. | Editorial Issues in Gsup.ethpm |

Agreed for input to drafting.

Note that:

For item#1, the text in DM and LM, that are hard to replace by ETH-DM and ETH-LM, are replaced by {delay and loss} measurement.

For item #2, clause 6 and 7 are swapped to keep consistency.

For item#6, Editors would like to ask where to be output.

|  |  |  |
| --- | --- | --- |
| [ 1071 ] | Cisco Systems, Inc. | Additional content for Gsup.ethpm |

Agreed for input to drafting. Concern raised in Q10 discussed is shown by highlighted. We will discuss and confirm the text as highlighted.

Draft new Supplement 53 to ITU-T G-series Recommendations

Guidance for Ethernet OAM performance monitoring

# Summary

Supplement 53 to ITU-T G-series Recommendations provides an overview of Ethernet OAM performance monitoring. It describes how Ethernet operations, administration, maintenance (OAM) performance measurements are processed, configured and managed as described in Recommendations ITU-T G.8013, ITU‑T G.8021, and ITU-T G.8051. It also introduces the modeling for Ethernet OAM performance monitoring as described in Recommendation ITU-T G.8052.

This Supplement is of an informative nature and does not imply any specific requirements.

Draft new Supplement 53 to ITU-T G-series Recommendations

Guidance for Ethernet OAM performance monitoring

# 1 Scope

This Supplement provides an overview of Ethernet OAM performance monitoring. It describes how Ethernet OAM performance measurements are processed, configured and managed as described in [ITU-T G.8013], [ITU-T G.8021], and [ITU-T G.8051]. It also introduces the modeling for Ethernet OAM performance monitoring as described in [ITU-T G.8052].

This Supplement is of an informative nature and does not imply any specific requirements.

# 2 References

The following References are quoted in this supplement. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this supplement are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of currently valid ITU-T Recommendations is regularly published.

[ITU-T G.8001] ITU-T Recommendation G.8001/Y.1354 (2013), *Terms and definitions for Ethernet frames over transport*

[ITU-T G.8013] ITU-T Recommendation G.8013/Y.1731 (2013), *OAM functions and mechanisms for Ethernet based networks*

[ITU-T G.8021] ITU-T Recommendation G.8021/Y.1341 (2015), *Characteristics of Ethernet transport network equipment functional blocks*

[ITU-T G.8051] ITU-T Recommendation G.8051/Y.1345 (2013), *Management aspects of the Ethernet Transport (ET) capable network element*

[ITU-T G.8052] ITU-T Recommendation G.8052/Y.1346 (2013), *Protocol-neutral management information model for the Ethernet transport capable network element*

# 3 Definitions

## 3.1 Terms defined elsewhere

**3.1.1 dual-ended** [ITU-T G.8001]

**3.1.2 far-end** [ITU-T G.8001]

**3.1.3 on-demand measurement** [ITU-T G.8001]

**3.1.4 one-way** [ITU-T G.8001]

**3.1.5 proactive measurement** [ITU-T G.8001]

**3.1.6 far-end** [ITU-T G.8001]

**3.1.7 single-ended** [ITU-T G.8001]

**3.1.8 two-way** [ITU-T G.8001]

## 3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

None

# 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

1DM One-way Delay Measurement

1SL One-way Synthetic Loss Measurement

CCM Continuity Check Message

DMM Delay Measurement Message

DMR Delay Measurement Reply

ETH Ethernet MAC layer network

ETH-DM Ethernet Delay Measurement function

ETH-LM Ethernet Loss Measurement function

ETH-SLM Ethernet Synthetic Loss Measurement function

FD Frame Delay

FDV Frame Delay Variation

FLR Frame Loss Ratio

LF Lost Frame

LMM Loss Measurement Message

LMR Loss Measurement Reply

MI Management Interface

OAM Operations, Administration, Maintenance

PDU Protocol Data Unit

PM Performance Management

SLM Synthetic Loss Message

SLR Synthetic Loss Reply

TF Total Frame

# 5 Conventions

None

# Single-Ended ETH-LM

The following subclauses describe the protocol and the process used for the Single-Ended ETH-LM, and the corresponding management requirements and information models.

## 6.1 Protocol

Single-Ended ETH-LM is performed using LMM and LMR PDUs. The measurement information carried in the PDU of the LMM/LMR protocol for both on-demand and proactive single-ended loss measurement is described in clause 8.1.2 of [ITU-T G.8013].

The PDU format for LMM/LMR is described in clauses 9.12 and 9.13 of [ITU-T G.8013].

Loss measurements for different classes of service can be taken concurrently using Single-Ended ETH-LM, by transmitting LMM frames with different PCP values. Similarly, concurrent Proactive and On-demand measurements are supported via use of the “Proactive” flag in LMM and LMR PDUs.

Single-Ended ETH-LM is only applicable in point-to-point MEGs, since it measures the loss of data traffic frames. Also since it is the loss of data traffic frames that is being measured, the size of the LMM/LMR frames has no effect on the measurement. The size of the LMM/LMR frames is fixed.

Measurements using Single-Ended ETH-LM can be inaccurate if the LMM/LMR frames traverse a LAG interface. Further details can be found in Appendix VII of [ITU-T G.8013].

LMM frames are generated with unicast DAs. LMM frames may be generated with a multicast Class 1 DA if multipoint measurements are desired. The detailed behaviour if more than one LMR is received for each LMM is not defined. LMR frames are always generated with unicast DAs.

## 6.2 Process

### 6.2.1 On-demand Process

The overview of the process involved with on-demand Single-Ended ETH-LM using LMM/LMR is described in clause 8.1.9 of [ITU-T G.8021]. The management information (MI) signals and their values for on-demand lSingle-Ended ETH-LM using LMM/LMR are listed in Table 1c.

The results of measurement are represented via ETHDe\_FT\_So\_MI\_LM\_Result (N\_TF, N\_LF, F\_TF, F\_LF) as:

* Near-end Transmitted Frames: N\_TF
* Near-end Lost Frames: N\_LF
* Far-end Transmitted Frames: F\_TF
* Far-end Lost Frames: F\_LF

Results are returned at the end of the test (on receipt of the ETHDe\_FT\_So\_MI\_LM\_Terminate signal) or during the test (on receipt of the ETHDe\_FT\_So\_MI\_LM\_Intermediate\_Request signal).

The counters used for Single-Ended ETH-LM count data traffic frames that pass through a MEP. They also count certain OAM frames, as shown in Table 1. Note that different OAM frames are counted for Single-Ended ETH-LM and Dual-Ended ETH-LM.

**Table 1 –Counting OAM Frames for Single-Ended ETH-LM**

| **MEG Level of the OAM Frame** | **OAM Frame OpCode** | **Counted or Not Counted** | **Atomic Function that receives the PDU** |
| --- | --- | --- | --- |
| Higher than MEP | Any | Counted | ETHx\_FT\_Sk or ETHDe\_FT\_Sk at a higher MEG Level |
| Equal to MEP (including frames generated by the MEP) | APS, CSF | Counted | ETHx/ETH\_A\_Sk |
| CCM | Counted | ETHx\_FT\_Sk |
| LBM, LBR,  LTM, LTR | Not counted | ETHDe\_FT\_Sk |
| TST | Not counted | ETHDe\_FT\_Sk |
| AIS | Not Specified,  only used when no data traffic is flowing | ETHx/ETH\_A\_Sk |
| LCK | Not Specified,  only used when no data traffic is flowing | ETHx/ETH\_A\_Sk |
| DMM, DMR, 1DM | Not counted | ETHx\_FT\_Sk or ETHDe\_FT\_Sk |
| LMM, LMR | Not counted | ETHx\_FT\_Sk or ETHDe\_FT\_Sk |
| SLM, SLR, 1SL | Not counted | ETHx\_FT\_Sk or ETHDe\_FT\_Sk |
| Lower than MEP | Any | Not counted | ETHx\_FT\_Sk or ETHDe\_FT\_Sk at a lower MEG Level |

It is assumed that the impact on FLR evaluation of counting OAM frames is negligible, as long as both MEPs count the same set of OAM frames.

### 6.2.2 Proactive Process

The overview of the process involved with proactive Single-Ended ETH-LM is described in clause 8.1.9 of [ITU-T G.8021]. The management information (MI) signals and their values for proactive Single-Ended ETH-LM are listed in Table 1a.

The result of measurement in the process is represented as ETH\_RI\_LM\_Result (N\_TF, N\_LF, F\_TF, F\_LF) [1...MLM]. Finally, the results of measurement are represented as:

* Near-end Transmitted Frames: ETHx\_FT\_Sk\_MI\_pN\_TF
* Near-end Lost Frames: ETHx\_FT\_Sk\_MI\_pN\_LF
* Far-end Transmitted Frames: ETHx\_FT\_Sk\_MI\_pF\_TF
* Far-end Lost Frames: ETHx\_FT\_Sk\_MI\_pF\_LF

The counters used for proactive Single-Ended ETH-LM are the same as those used for on-demand. See 6.2.1.

It is assumed that the impact on FLR evaluation of counting OAM frames is negligible, as long as both MEPs count the same set of OAM frames.

## 6.3 Management requirement

The generic requirements of performance monitoring are described in clause 10.2 of [ITU-T G.7710], including current and history, such as 15-minute and 24-hour, data collection and thresholding.

### 6.3.1 Management requirement for on-demand

The Ethernet specific requirements for on-demand Single-Ended ETH-LM are specified in clause 10.2 of [ITU-T G.8051]. The relevant items for On-demand LM are 2), 5), 6), 7) and 16).

In the clause, it describes four on-demand measurements:

* + Single instance
  + Repetitive instance
  + Single series
  + Repetitive series

In each measurement, the mandatory parameters, such as Start time, Stop time, Reception period, Message period, and Measurement interval are shown in the Figure 10-1 of [ITU-T G.8051].

The value ranges of the MI signals and the default values of the input MI signals are also specified in clause 8.6 of [ITU-T G.8051]. [ITU-T G.8021] defines the primitives mentioned in the above bullet list. [ITU-T G.8051] defines the calculation algorithm of Near-end and Far-end Frame Loss Ratio (TN\_FLR and TF\_FLR).

### 6.3.2 Management requirement for proactive

The Ethernet specific requirements for proactive Single-Ended ETH-LM are specified in clause 10.2 of [ITU-T G.8051]. Item 17) describes the requirement and it is in common with proactive Dual-Ended ETH-LM in clause 7.3.

The value ranges of the MI signals and the default values of the input MI signals used for are proactive Single-Ended ETH-LM also specified in clause 8.5 of [ITU-T G.8051]. [ITU-T G.8021] defines the primitives mentioned in the above bullet list. [ITU-T G.8051] defines the calculation algorithm of the temporal minimum, average, and maximum statistics of Near-end and Far-end Frame Loss Ratio (mN\_FLR, aN\_FLR, xN\_FLR, mF\_FLR, aF\_FLR, xF\_FLR).

## 6.4 Information model

The protocol-neutral information model for Ethernet network element management is defined [ITU-T G.8052]. The modelling of on-demand and proactive Single-Ended ETH-LM is provided in the on-demand measurement class diagram in Figure 7-8 of [ITU-T G.8052] and in the proactive measurement class diagram in Figure 7-13 of [ITU-T G.8052] respectively.

# Dual-Ended ETH-LM

The following subclauses describe the protocol and the process used for the Dual-Ended ETH-LM, and the corresponding management requirements and information models.

## 7.1 Protocol

Dual-Ended ETH-LM is performed using CCM PDUs. The measurement information carried in the PDU of the CCM protocol for proactive Dual-Ended ETH-LM is described in clause 8.1.1 of [ITU-T G.8013]. On-demand Dual-Ended ETH-LM is not supported.

The PDU format for CCM is described in clause 9.2 of [ITU-T G.8013].

Since the measurement information is carried in CCM PDUs, only the PCP value used for CCMs can be measured. This only allows taking measurements for a single class of service using Dual-Ended ETH-LM.

Dual-Ended ETH-LM is only applicable in point-to-point MEGs, since it measures the loss of data traffic frames. Also since it is the loss of data traffic frames that is being measured, the size of the CCM frames has no effect on the measurement. The size of the LMM/LMR frames is fixed.

Measurements using Dual-Ended ETH-LM can be inaccurate if the CCM frames traverse a LAG interface. Further details can be found in Appendix VII of [ITU-T G.8013].

## 7.2 Processes

### 7.2.1 On-demand Process

The process is not supported when using on-demand Dual-Ended ETH-LM.

### 7.2.2 Proactive process

The overview of the process involved with proactive Dual-Ended ETH-LM using CCM is described in clause 8.1.7 of [ITU-T G.8021]. The management information (MI) signals and their values for proactive Dual-Ended ETH-LM using CCM are listed in Table A.1 in Annex A.

The results of measurement in this process are represented as:

* Near-end Transmitted Frames: ETHx\_FT\_Sk\_MI\_pN\_TF
* Near-end Lost Frames: ETHx\_FT\_Sk\_MI\_pN\_LF
* Far-end Transmitted Frames: ETHx\_FT\_Sk\_MI\_pF\_TF
* Far-end Lost Frames: ETHx\_FT\_Sk\_MI\_pF\_LF

The counters used for proactive Dual-Ended ETH-LM count data traffic frames that pass through a MEP. They also count certain OAM frames, as shown in Table 2. Note that different OAM frames are counted for Single-Ended ETH-LM and Dual-Ended ETH-LM.

**Table 2 –Counting OAM Frames for proactive Dual-Ended ETH-LM**

|  |  |  |  |
| --- | --- | --- | --- |
| **MEG Level of the OAM Frame** | **OAM Frame OpCode** | **Counted or Not Counted** | **Atomic Function that receives the PDU** |
| Higher than MEP | Any | Counted | ETHx\_FT\_Sk or ETHDe\_FT\_Sk at a higher MEG Level |
| Equal to MEP (including frames generated by the MEP) | APS, CSF | Counted | ETHx/ETH\_A\_Sk |
| CCM | Not counted | ETHx\_FT\_Sk |
| LBM, LBR,  LTM,LTR | Not counted | ETHDe\_FT\_Sk |
| TST | Not counted | ETHDe\_FT\_Sk |
| AIS | Not Specified,  only used when no data traffic is flowing | ETHx/ETH\_A\_Sk |
| LCK | Not Specified,  only used when no data traffic is flowing | ETHx/ETH\_A\_Sk |
| DMM, DMR, 1DM | Not counted | ETHDe\_FT\_Sk or ETHx\_FT\_Sk |
| LMM, LMR | Not counted | ETHDe\_FT\_Sk or ETHx\_FT\_Sk |
| SLM, SLR, 1SL | Not counted | ETHDe\_FT\_Sk or ETHx\_FT\_Sk |
| Lower than MEP | Any | Not counted | ETHx\_FT\_Sk or ETHDe\_FT\_Sk at a lower MEG Level |

It is assumed that the impact on FLR evaluation of counting OAM frames is negligible, as long as both MEPs count the same set of OAM frames.

## 7.3 Management requirement

The generic requirements of performance monitoring are described in clause 10.2 of [ITU-T G.7710], including current and history, such as 15-minute and 24-hour, data collection and thresholding.

The Ethernet specific requirements for proactive Dual-Ended ETH-LM are specified in clause 10.2 of [ITU-T G.8051]. Item 17) describes the relevant requirement.

The value ranges of the MI signals and the default values of the input MI signals are also specified in clause 8.5 of [ITU-T G.8051]. It is noted that MI\_LMC should be enabled when proactive Dual-Ended ETH-LM using CCM is used. [ITU-T G.8021] defines the primitives mentioned in the above bullet list. [ITU-T G.8051] defines the calculation algorithm of the temporal minimum, average, and maximum statistics of Near-end and Far-end Frame Loss Ratio (mN\_FLR, aN\_FLR, xN\_FLR, mF\_FLR, aF\_FLR, xF\_FLR).

## 7.4 Information model

The protocol-neutral information model for Ethernet network element management is defined in [ITU-T G.8052]. The modelling of Dual-Ended ETH-LM is provided in the proactive measurement class diagram in Figure 7-13 of [ITU-T G.8052].

# Single-Ended ETH-DM

The following subclauses describe the protocol and the process used for the Single-Ended ETH-DM, and the corresponding management requirements and information models.

## Protocol

Single-Ended ETH-DM is performed using DMM and DMR PDUs. The measurement information carried in the PDU of the DMM/DMR protocol for both on-demand and proactive Single-Ended ETH-DM is described in clause 8.2.2 of [ITU-T G.8013].

The PDU format for DMM/DMR is described in clauses 9.15 and 9.16 of [ITU-T G.8013].

The frame size of DMM/DMR PDUs can be varied by including a Data TLV. This can aid in testing the delay for different frame sizes or in ensuring the DMM/DMR PDUs are representative of the data traffic.

Separate tests can be run concurrently using Single-Ended ETH-DM, by using the Test ID TLV in DMM PDUs. Separate concurrent tests may be used to take measurements for different classes of service, different frame sizes, or to take proactive and on-demand measurements concurrently.

Single-Ended ETH-DM can be used in point-to-point or multipoint MEGs. DMM frames are generated with unicast DAs. DMM frames may be generated with a multicast Class 1 DA if multipoint measurements are desired. The detailed behaviour if more than one DMR is received for each DMM is not defined. DMR frames are always generated with unicast DAs.

## Process

### 8.2.1 On-demand process

The overview of the process involved with on-demand Single-Ended ETH-DM using DMM/DMR is described in clause 8.1.10 of [ITU-T G.8021]. The management information (MI) signals and their values for on-demand Single-Ended ETH-DM using DMM/DMR are listed in Table 1c.

The result of measuring result is represented via ETHDe\_FT\_So\_MI\_DM\_Result (count, B\_FD[], F\_FD[], N\_FD[]) as:

* Bidirectional Frame Delay: B\_FD
* Far-end Frame Delay: F\_FD
* Near-end Frame Delay: N\_FD

Results are returned at the end of the test (on receipt of the ETHDe\_FT\_So\_MI\_DM\_Terminate signal) or during the test (on receipt of the ETHDe\_FT\_So\_MI\_DM\_Intermediate\_Request signal).

### 8.2.2 Proactive process

The overview of the process involved with proactive Single-Ended ETH-DM using DMM/DMR is described in clause 8.1.10 of [ITU-T G.8021]. The management information (MI) signals and their values for proactive Single-Ended ETH-DM using DMM/DMR are listed in Table 1a.

The result of measurement in the process is represented as ETH\_RI\_DM\_Result (B\_FD, F\_FD, N\_FD) [1...M]. Finally, the results of measurement are represented as:

* Bidirectional Frame Delay: ETHx\_FT\_Sk\_MI\_pB\_FD
* Bidirectional Frame Delay Variation: ETHx\_FT\_Sk\_MI\_pB\_FDV
* Near-end Frame Delay: ETHx\_FT\_Sk\_ MI\_pN\_FD
* Near-end Frame Delay Variation: ETHx\_FT\_Sk\_ MI\_pF\_FDV
* Far-end Frame Delay: ETHx\_FT\_Sk\_MI\_pF\_FD
* Far-end Frame Delay: ETHx\_FT\_Sk\_MI\_pF\_FDV

Note that a detail calculation formula for FDV is for further study.

[ITU-T G.8051] includes requirements for storing the temporal minimum, average, and maximum for each type of the measurements of FD for the current 15 minute and 24 hour registers, and for moving the statistics in the current registers to history registers at the end of the 15 minute and 24 hour periods. These requirements are outside the scope of [ITU-T G.8021].

## Management requirement

The generic requirements of performance monitoring are described in clause 10.2 of [ITU-T G.7710], including current and history, such as 15-minute and 24-hour, data collection and thresholding.

### 8.3.1 Management requirement for on-demand

The generic requirements of performance monitoring are described in clause 10.2 of [ITU-T G.7710].

The Ethernet specific requirements for on-demand Single-Ended ETH-DM are specified in clause 10.2 of [ITU-T G.8051]. The relevant items for on-demand Single-Ended ETH-DM are 2), 5), 6), 7) and 20).

In the clause, it describes four on-demand measurements:

1. Single instance
2. Repetitive instance
3. Single series
4. Repetitive series

In each measurement, the mandatory parameters, such as Start time, Stop time, Reception period, Message period, and Measurement interval are shown in the Figure 10-1 of [ITU-T G.8051].

The value ranges of the MI signals and the default values of the input MI signals are also specified in clause 8.6 of [ITU-T G.8051]. [ITU-T G.8021] defines the primitives mentioned in the above bullet list. [ITU-T G.8051] defines the calculation algorithm of the Frame Delay Variation (FDV) for Near-end, Far-end, and Bidirectional (N\_FDV[], F\_FDV[], and B\_FDV[]). The calculation of FDV is, however, for further study.

### 8.3.2 Management requirement for proactive

The Ethernet specific requirements for proactive Single-Ended ETH-DM are specified in clause 10.2 of [ITU-T G.8051]. Item 21) describes the relevant requirement.

The value ranges of the MI signals and the default values of the input MI signals used for are proactive Single-Ended ETH-DM also specified in clause 8.5 of [ITU-T G.8051].

## 8.4 Information model

The protocol-neutral information model for Ethernet network element management is defined [ITU-T G.8052]. The modelling of on-demand and proactive Single-Ended ETH-DM is provided in the on-demand measurement class diagram in Figure 7-8 of [ITU-T G.8052] and in the proactive measurement class diagram in Figure 7-13 of [ITU-T G.8052] respectively.

# Dual-Ended ETH-DM

The following subclauses describe the protocol and the process used for the Dual-Ended ETH-LM, and the corresponding management requirements and information models.

## 9.1 Protocol

Dual-Ended ETH-DM is performed using 1DM PDUs. The measurement information carried in the PDU of the 1DM protocol for both on-demand and proactive Dual-Ended ETH-DM is described in clause 8.2.1 of [ITU-T G.8013].

The PDU format for 1DM is described in clause 9.14 of [ITU-T G.8013].

The frame size of 1DM PDUs can be varied by including a Data TLV. This can aid in testing the delay for different frame sizes or in ensuring the 1DM PDUs are representative of the data traffic.

Separate tests can be run concurrently using Dual-Ended ETH-DM, by using the Test ID TLV in 1DM PDUs. Separate concurrent tests may be used to take measurements for different classes of service, different frame sizes, or to take proactive and on-demand measurements concurrently.

Dual-Ended ETH-DM can be used in point-to-point or multipoint MEGs. 1DM frames are generated with unicast or multicast Class 1 DAs.

## 9.2 Process

### 9.2.1 Process for on-demand

The overview of the process involved with on-demand Dual-Ended ETH-DM using 1DM is described in clause 8.1.11 of [ITU-T G.8021]. The management information (MI) signals and their values for on-demand Dual-Ended ETH-DM using 1DM are listed in Table 1c.

The result of measuring result is represented via ETHDe\_FT\_Sk\_MI\_1DM\_Result (count, N\_FD[]) as:

* Near-end Frame Delay: N\_FD

Results are returned at the end of the test (on receipt of the ETHDe\_FT\_Sk\_MI\_1DM\_Terminate signal) or during the test (on receipt of the ETHDe\_FT\_Sk\_MI\_1DM\_Intermediate\_Request signal).

### 9.2.2 Process for proactive

The overview of the process involved with proactive Dual-Ended ETH-DM using 1DM is described in clause 8.1.11 of [ITU-T G.8021]. The management information (MI) signals and their values for proactive Dual-Ended ETH-DM using 1DM are listed in Table 1a.

The results of measurement are represented via 1DM\_Result (N\_FD), as:

* Near-end Frame Delay: ETHx\_FT\_Sk\_ MI\_pN\_FD
* Near-end Frame Delay Variation: ETHx\_FT\_Sk\_ MI\_pF\_FDV

Note that a detail calculation formula for FDV is for further study.

[ITU-T G.8051] includes requirements for storing the temporal minimum, average, and maximum for each type of the measurements of FD for the current 15 minute and 24 hour registers, and for moving the statistics in the current registers to history registers at the end of the 15 minute and 24 hour periods. These requirements are outside the scope of [ITU-T G.8021].

## 9.3 Management requirement

The generic requirements of performance monitoring are described in clause 10.2 of [ITU-T G.7710], including current and history, such as 15-minute and 24-hour, data collection and thresholding.

### 9.3.1 Management requirement for on-demand

The Ethernet specific requirements for on-demand Dual-Ended ETH-DM are specified in clause 10.2 of [ITU-T G.8051]. The relevant items for On-demand 1DM are 2), 5), 6), 7) and 18).

In the clause, it describes four on-demand measurements:

1. Single instance
2. Repetitive instance
3. Single series
4. Repetitive series

In each measurement, the mandatory parameters, such as Start time, Stop time, Reception period, Message period, and Measurement interval are shown in the Figure 10-1 of [ITU-T G.8051].

The value ranges of the MI signals and the default values of the input MI signals are also specified in clause 8.6 of [ITU-T G.8051]. [ITU-T G.8021] defines the primitives mentioned in the above bullet list. [ITU-T G.8051] defines the calculation algorithm of the Frame Delay Measurement for Near-end (N\_FDV). The calculation of FDV is, however, for further study.

### 9.3.2 Management requirement for proactive

The Ethernet specific requirements for proactive Dual-Ended ETH-DM are specified in clause 10.2 of [ITU-T G.8051]. Item 19) describes the relevant requirement.

The value ranges of the MI signals and the default values of the input MI signals used for are proactive delay measurement using 1DM also specified in clause 8.5 of [ITU-T G.8051].

## 9.4 Information model

The protocol-neutral information model for Ethernet network element management is defined [ITU-T G.8052]. The modelling of on-demand and proactive Dual-Ended ETH-DM using 1DM is provided in the on-demand measurement class diagram in Figure 7-8 of [ITU-T G.8052] and in the proactive measurement class diagram in Figure 7-13 of [ITU-T G.8052].

# Single-Ended ETH-SLM

The following subclauses describe the protocol and the process used for the Single-Ended ETH-SLM, and the corresponding management requirements and information models.

## 10.1 Protocol

Single-Ended ETH-SLM is performed using SLM and SLR PDUs. The measurement information carried in the PDU of the SLM/SLR protocol for both on-demand and proactive Single-Ended ETH-SLM is described in clause 8.4.1 of [ITU-T G.8013].

The PDU format for SLM/SLR is described in clauses 9.22 and 9.23 of [ITU-T G.8013].

The frame size of SLM/SLR PDUs can be varied by including a Data TLV. This can aid in testing the frame loss for different frame sizes or in ensuring the SLM/SLR PDUs are representative of the data traffic.

Separate tests can be run concurrently using Single-Ended ETH-SLM, by using the Test ID in SLM PDUs. Separate concurrent tests may be used to take measurements for different classes of service, different frame sizes, or to take proactive and on-demand measurements concurrently.

Single-Ended ETH-SLM can be used in point-to-point or multipoint MEGs. SLM frames are generated with unicast DAs. SLM frames may be generated with a multicast Class 1 DA if multipoint measurements are desired. The detailed behaviour if more than one SLR is received for each SLM is not defined.. SLR frames are always generated with unicast DAs.

## 10.2 Process

### 10.2.1 Process for on-demand

The overview of the process involved with on-demand Single-Ended ETH-SLM using SLM/SLR is described in clause 8.1.14 of [ITU-T G.8021]. The management information (MI) signals and their values for on-demand Single-Ended ETH-SLM using SLM/SLR are listed in Table 1c.

The result of measuring result is represented via ETHDe\_FT\_So\_MI\_SL\_Result (N\_TF, N\_LF, F\_TF, F\_LF) as:

* Near-end Transmitted Frames: N\_TF
* Near-end Lost Frames: N\_LF
* Far-end Transmitted Frames: F\_TF
* Far-end Lost Frames: F\_LF

Being different from LMM/LMR, only SLM/SLR frames are used for Synthetic loss measurement by calculating the sequence number in SLM /SLR frames. No other OAM frames are counted.

Results are returned at the end of the test (on receipt of the ETHDe\_FT\_So\_MI\_SL\_Terminate signal) or during the test (on receipt of the ETHDe\_FT\_So\_MI\_SL\_Intermediate\_Request signal).

### 10.2.2 Process for proactive

The overview of the process involved with proactive Single-Ended ETH-SLM using SLM/LMR is described in clause 8.1.14 of [ITU-T G.8021]. The management information (MI) signals and their values for proactive Single-Ended ETH-SLM using SLM/SLR are listed in Table A.2 in Annex A.

The result of measurement in the process is represented as ETH\_RI\_SLM\_Result (N\_TF, N\_LF, F\_TF, F\_LF) [1...MLM]. Finally, the results of measurement are represented as:

* Near-end Transmitted Frames: ETHx\_FT\_Sk\_MI\_pN\_TF
* Near-end Lost Frames: ETHx\_FT\_Sk\_MI\_pN\_LF
* Far-end Transmitted Frames: ETHx\_FT\_Sk\_MI\_pF\_TF
* Far-end Lost Frames: ETHx\_FT\_Sk\_MI\_pF\_LF

Being different from ETH-LM, only SLM and SLR frames are used for Synthetic loss measurement by calculating the sequence number in SLM and SLR frames. No other OAM frames are counted.

## 10.3 Management requirement

The generic requirements of performance monitoring are described in clause 10.2 of [ITU-T G.7710].

The Ethernet specific requirements for Single-Ended ETH-SLM are the same as Single-Ended ETH-LM. See clause 6.3.1 for on-demand and 6.3.2 for proactive respectively.

## 10.4 Information model

The protocol-neutral information model for Ethernet network element management is defined [ITU-T G.8052].

The modelling of on-demand and proactive Single-Ended ETH-SLM is provided in the on-demand measurement class diagram in Figure 7-8 of [ITU-T G.8052] and in the proactive measurement class diagram in Figure 7-13 of [ITU-T G.8052] respectively.

# Dual-Ended ETH-SLM

The following subclauses describe the protocol and the process used for the Dual-Ended ETH-SLM, and the corresponding management requirements and information models.

## Protocol

Dual-Ended ETH-SLM is performed using 1SL PDUs. The measurement information carried in the PDU of the 1SL protocol for both on-demand and proactive Dual-Ended ETH-SLM, as called is described in clause 8.4.2 of [ITU-T G.8013].

The PDU format for 1SL is described in clause 9.24 of [ITU-T G.8013].

The frame size of 1SL PDUs can be varied by including a Data TLV. This can aid in testing the frame loss for different frame sizes or in ensuring the 1SL PDUs are representative of the data traffic.

Separate tests can be run concurrently using Dual-Ended ETH-SLM, by using the Test ID in 1SL PDUs. Separate concurrent tests may be used to take measurements for different classes of service, different frame sizes, or to take proactive and on-demand measurements concurrently.

Dual-Ended ETH-SLM can be used in point-to-point or multipoint MEGs. 1SL frames are generated with unicast or multicast Class 1 DAs.

## Process

### 11.2.1 Process for on-demand

The overview of the process involved with on-demand Dual-Ended ETH-SLM using 1SL is described in clause 8.1.15 of [ITU-T G.8021]. The management information (MI) signals and their values for on-demand Dual-Ended ETH-SLM using 1SL are listed in Table A.3 in Annex A.

The result of measuring result is represented via ETHDe\_FT\_Sk\_MI\_1SL\_Result (N\_TF, N\_LF) as:

* Near-end Transmitted Frames: N\_TF
* Near-end Lost Frames: N\_LF

1SL frames are used for Synthetic loss measurement by calculating the sequence number in 1SL frames. No other OAM frames are counted.

### 11.2.2 Process for proactive

The overview of the process involved with proactive Dual-Ended ETH-SLM using 1SL is described in clause 8.1.15 of [ITU-T G.8021]. The management information (MI) signals and their values for proactive Dual-Ended ETH-SLM using 1SL are listed in Table 1b.

The results of measurement are represented via 1SL\_Result (N\_TF, N\_LF) as:

* Near-end Transmitted Frames: ETHx\_FT\_Sk\_MI\_pN\_TF
* Near-end Lost Frames: ETHx\_FT\_Sk\_MI\_pN\_LF

1SL frames are used for Synthetic loss measurement by calculating the sequence number in 1SL frames. No other OAM frames are counted.

## Management requirement

The generic requirements of performance monitoring are described in clause 10.2 of [ITU-T G.7710].

The Ethernet specific requirements for Dual-Ended ETH-SLM are the same as Single-Ended ETH-LM. Only N\_TF and N\_LF are considered. See clause 6.3.1 for on-demand and 6.3.2 for proactive respectively.

## Process

The protocol-neutral information model for Ethernet network element management is defined [ITU-T G.8052].

The modelling of on-demand and proactive Dual-Ended ETH-SLM using 1SL is provided in the on-demand measurement class diagram in Figure 7-8 of [ITU-T G.8052] and in the proactive measurement class diagram in Figure 7-13 of [ITU-T G.8052] respectively.

**Annex A**

**MIs and their values for Performance measurement OAM mechanisms**

Table A.1 provides MIs and their values for Proactive Loss Measurement and Delay Measurement from Table 8-2 in [ITU-T G.8051].

Table A.2 provides MIs and their values for Proactive Synthetic Loss Measurement from Table 8-2 in [ITU-T G.8051].

All the MIs shown in Table A.1 and Table A.2 are input MIs. For proactive measurements, the results are handled internally by the Performance Monitoring process within the ETHx\_FT\_Sk or ETHG\_FT\_Sk atomic function.

Table A.3 provides MIs and their values for On-demand PMs from Table 8-5 in [ITU-T G.8051].

**Table A.1 - MIs and their values for Proactive Loss Measurement and Delay Measurement**



**Table A.2 - MIs and their values for Proactive Synthetic Loss Measurement (from Table 8-2/G.8051)**



**Table A.3 - MIs and their values for On-demand PMs (from Table 8-5/G.8051)**

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