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Guidance for Ethernet OAM performance monitoring

ITU-T G-series Recommendations – Supplement 53

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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 operations, administration, maintenance (OAM) performance monitoring. It describes how Ethernet 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 modelling 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.

History

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1 Scope

This Supplement provides an overview of Ethernet operations, administration, maintenance (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

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

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

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

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

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

3 Definitions

3.1 Terms defined elsewhere

This Supplement uses the following 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 single-ended [ITU-T G.8001]

3.1.7 two-way [ITU-T G.8001]

3.2 Terms defined in this Supplement

None.

4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

1DM One-way Delay Measurement

1SL	One-way Synthetic Loss Measurement
CCM	Continuity Check Message
DA	Destination MAC Address
DMM	Delay Measurement Message
DMR	Delay Measurement Reply
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
MEG	ME Group
MEP	MEG End Point
MI	Management Information
OAM	Operations, Administration, Maintenance
PCP	Priority Code Point
PDU	Protocol Data Unit
PM	Performance Management
SLM	Synthetic Loss Message
SLR	Synthetic Loss Reply
TF	Total Frame
TLV	Type, Length and Value

5 Conventions

None.

6 Single-ended Ethernet loss measurement function

The following clauses describe the protocol and the process used for the single-ended Ethernet loss measurement function (ETH-LM) and the corresponding management requirements and information models.

6.1 Protocol

Single-ended ETH-LM is performed using loss measurement message (LMM) and loss measurement reply (LMR) protocol data units (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 priority code point (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 ME groups (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 link aggregation group (LAG) interface. Further details can be found in Appendix VII of [ITU-T G.8013].

LMM frames are generated with unicast destination MAC addresses (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 single-ended ETH-LM using LMM/LMR are listed in Table I.3.

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 MEG end point (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 frame loss ratio (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 MI signals and their values for proactive single-ended ETH-LM are listed in Table I.1.

The results of measurement are represented via ETH_RI_LM_Result (N_TF, N_LF, F_TF, F_LF) [1...MLM] 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 clause 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:

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 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 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 for proactive single-ended ETH-LM are also specified in clause 8.5 of [ITU-T G.8051]. [ITU-T G.8021] defines the primitives mentioned in the above 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 in [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.

7 Dual-ended ETH-LM

The following clauses 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 continuity check message (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 Process

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 MI signals and their values for proactive dual-ended ETH-LM using CCM are listed in Table I.1.

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

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
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 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].

8 Single-ended Ethernet delay measurement function

The following clauses describe the protocol and the process used for the single-ended Ethernet delay measurement function (ETH-DM) and the corresponding management requirements and information models.

8.1 Protocol

Single-ended ETH-DM is performed using delay measurement message (DMM) and delay measurement reply (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 type, length and value (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.

8.2 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 MI signals and their values for on-demand single-ended ETH-DM using DMM/DMR are listed in Table I.3.

The results of measurement are represented via ETHDe_FT_So_MI_DM_Result (count, B_FD[], F_FD[], N_FD[]) as:

– Bidirectional frame delay (FD): 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 MI signals and their values for proactive single-ended ETH-DM using DMM/DMR are listed in Table I.1.

The results of measurement are represented via ETH_RI_DM_Result (B_FD, F_FD, N_FD) [1...M] 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 frame delay variation (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].

8.3 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.

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 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 are 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 in [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.

9 Dual-ended ETH-DM

The following clauses 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 one-way delay measurement (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 MI signals and their values for on-demand dual-ended ETH-DM using 1DM are listed in Table I.3.

The results of measurement are 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 MI signals and their values for proactive dual-ended ETH-DM using 1DM are listed in Table I.1.

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 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 in 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].

10 Single-ended ETH-SLM

The following clauses describe the protocol and the process used for the single-ended Ethernet synthetic loss measurement function (ETH-SLM), and the corresponding management requirements and information models.

10.1 Protocol

Single-ended ETH-SLM is performed using synthetic loss message (SLM) and synthetic loss reply (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 1DA 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 MI signals and their values for on-demand single-ended ETH-SLM using SLM/SLR are listed in Table I.3.

The results of measurement are 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 MI signals and their values for proactive single-ended ETH-SLM using SLM/SLR are listed in Table I.2.

The results of measurement are represented via ETH_RI_SLM_Result (N_TF, N_LF, F_TF, F_LF) [1...M_{LM}] 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 clauses 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 in [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.

11 Dual-ended ETH-SLM

The following clauses describe the protocol and the process used for the dual-ended ETH-SLM and the corresponding management requirements and information models.

11.1 Protocol

Dual-ended ETH-SLM is performed using one-way synthetic loss measurement (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.

11.2 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 MI signals and their values for on-demand dual-ended ETH-SLM using 1SL are listed in Table I.3.

The results of measurement are 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 MI signals and their values for proactive dual-ended ETH-SLM using 1SL are listed in Table I.2.

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.

11.3 Management requirement

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

The Ethernet-specific requirements for dual-ended ETH-SLM are the same as single-ended ETH-LM. Only N_TF and N_LF are considered. See clauses 6.3.1 for on-demand and 6.3.2 for proactive, respectively.

11.4 Information model

The protocol-neutral information model for Ethernet network element management is defined in [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.

Appendix I

MIs and their values for performance measurement OAM mechanisms

Table I.1 provides MIs and their values for proactive loss measurement and delay measurement from Table 8-2 in [ITU-T G.8051].

Table I.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 Tables I.1 and I.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 I.3 provides MIs and their values for on-demand performance measurement (PM) from Table 8-5 in [ITU-T G.8051].

Table I.1 – MIs and their values for proactive loss measurement and delay measurement

	Source			Sink		
	MI signal	Value Range	Default Value	MI signal	Value Range	Default Value
MEP	ETHx_FT_So_MI_MEL	0, 1, 2, 3, 4, 5, 6, 7	by agreement	ETHx_FT_Sk_MI_MEL	0, 1, 2, 3, 4, 5, 6, 7	By agreement
	ETHx_FT_So_MI_MEG_ID	See Annex A of [ITU-T Y.1731]	–	ETHx_FT_Sk_MI_MEG_ID	See Annex A of [ITU-T Y.1731]	–
	ETHx_FT_So_MI_MEP_ID	0..8191; see Figure 9.2-3 of [ITU‑T Y.1731]	–	ETHx_FT_Sk_MI_PeerMEP_ID[i]	List of peer MEP IDs; 0..8191 for each ID; see Figure 9.2-3 of [ITU‑T Y.1731]	–
	ETHx_FT_So_MI_MEP_MAC	Per [ITU-T G.8021]	–			
CC	ETHx_FT_So_MI_CC_Enable	true, false	FALSE	ETHx_FT_Sk_MI_CC_Enable	true, false	FALSE
	ETHx_FT_So_MI_LMC_Enable	true, false	TRUE	ETHx_FT_Sk_MI_LMC_Enable	true, false	TRUE
	ETHx_FT_So_MI_CC_Period	3.33 ms, 10 ms, 100 ms, 1 s, 10 s, 1 min, 10 min	1 s	ETHx_FT_Sk_MI_CC_Period	3.33 ms, 10 ms, 100 ms, 1 s, 10 s, 1 min, 10 min	1 s
	ETHx_FT_So_MI_CC_Pri	0, 1, 2, 3, 4, 5, 6, 7	7	ETHx_FT_Sk_MI_CC_Pri	0..7	7
				ETHx_FT_Sk_MI_1second	–	–
				ETHx_FT_Sk_MI_LM_DEGM	2-10; see Table 7-1 of [ITU‑T G.806]	10
				ETHx_FT_Sk_MI_LM_M	2-10;	10
				ETHx_FT_Sk_MI_LM_DEGTHR	0% .. 100%; see Table 7-1 of [ITU‑T G.806]	30%
				ETHx_FT_Sk_MI_LM_TFMIN	FFS	FFS
LM	ETHx_FT_So_MI_LML_Enable[1…M_{LM}]	true, false	TRUE			
	ETHx_FT_So_MI_LM_MAC_DA[1…M_{LM}]	Per [ITU-T G.8021]	–			
	ETHx_FT_So_MI_LM_Period[1…M_{LM}]	100 ms, 1 s, 10 s	100 ms			
	ETHx_FT_So_MI_LM_Pri[1…M_{LM}]	0, 1, 2, 3, 4, 5, 6, 7	7			
1DM	ETHx_FT_So_MI_1DM_Enable[1…M_{1DM}]	true, false	FALSE	ETHx_FT_Sk_MI_1DM_Enable[1…M_{1DM}]	true, false	FALSE
	ETHx_FT_So_MI_1DM_MAC_DA[1…M_{1DM}]	Per [ITU-T G.8021]	–	ETHx_FT_Sk_MI_1DM_MAC_SA[1…M_{1DM}]	Per [ITU-T G.8021]	–
	ETHx_FT_So_MI_1DM_Test_ID[1…M_{1DM}]	Non-negative integer (optional)	–	ETHx_FT_Sk_MI_1DM_Test_ID[1…M_{1DM}]	Non-negative integer (optional)	–
	ETHx_FT_So_MI_1DM_Length[1…M_{1DM}]	Non-negative integer representing number of byte for the length of the padding TLV. Note that the total fame size of the DM PDU should be between 64 and 9216 bytes.	0			
	ETHx_FT_So_MI_1DM_Period[1…M_{1DM}]	100 ms, 1s, 10 s	100 ms			
	ETHx_FT_So_MI_1DM_Pri[1…M_{1DM}]	0, 1, 2, 3, 4, 5, 6, 7	7			
DM	ETHx_FT_So_MI_DM_Enable[1…M_{DM}]	true, false	FALSE			
	ETHx_FT_So_MI_DM_MAC_DA[1…M_{DM}]	Per [ITU-T G.8021]	–			
	ETHx_FT_So_MI_DM_Test_ID[1…M_{DM}]	Non-negative integer (optional)	–			
	ETHx_FT_So_MI_DM_Length[1…M_{DM}]	Non-negative integer representing number of byte for the length of the padding TLV. Note that the total fame size of the delay measurement (DM) protocol data unit (PDU) should be between 64 and 9216 bytes.	0			
	ETHx_FT_So_MI_DM_Period[1…M_{DM}]	100 ms, 1 s, 10 s	100 ms			
	ETHx_FT_So_MI_DM_Pri[1…M_{DM}]	0, 1, 2, 3, 4, 5, 6, 7	7			

Table I.2 – MIs and their values for proactive synthetic loss measurement (from Table 8-2 of [ITU-T G.8051])

	Source			Sink		
	MI signal	Value Range	Default Value	MI signal	Value Range	Default Value
MEP	ETHx_FT_So_MI_MEL	0, 1, 2, 3, 4, 5, 6, 7	by agreement	ETHx_FT_Sk_MI_MEL	0, 1, 2, 3, 4, 5, 6, 7	By agreement
	ETHx_FT_So_MI_MEG_ID	See Annex A of [ITU-T Y.1731]	–	ETHx_FT_Sk_MI_MEG_ID	See Annex A of [ITU-T Y.1731]	–
	ETHx_FT_So_MI_MEP_ID	0..8191; see Figure 9.2-3 of [ITU‑T Y.1731]	–	ETHx_FT_Sk_MI_PeerMEP_ID[i]	List of peer MEP IDs; 0..8191 for each ID; see Figure 9.2-3 of [ITU‑T Y.1731]	–
	ETHx_FT_So_MI_MEP_MAC	Per [ITU-T G.8021]	–			
1SL	ETHx_FT_So_MI_1SL_Enable[1…M_{1SL}]	true, false	FALSE	ETHx_FT_Sk_MI_1SL_Enable[1…M_{1SL}]	true, false	FALSE
	ETHx_FT_So_MI_1SL_MAC_DA[1…M_{1SL}]	Per [ITU-T G.8021]	–	ETHx_FT_Sk_MI_1SL_MAC_SA[1…M_{1SL}]	Per [ITU-T G.8021]	–
	ETHx_FT_So_MI_1SL_Test_ID[1…M_{1SL}]	Non-negative integer (optional)	–	ETHx_FT_Sk_MI_1SL_Test_ID[1…M_{1SL}]	Non-negative integer (optional)	–
	ETHx_FT_So_MI_1SL_Length[1…M_{1SL}]	Non-negative integer representing number of byte for the length of the padding TLV. Note that the total fame size of the 1SL PDU should be between 64 and 9216 bytes.	0			
	ETHx_FT_So_MI_1SL_Period[1…M_{1SL}]	10 ms, 100 ms, 1 s, 10 s	100 ms			
	ETHx_FT_So_MI_1SL_Pri[1…M_{1SL}]	0, 1, 2, 3, 4, 5, 6, 7	7			
SL	ETHx_FT_So_MI_SL_Enable[1…M_{SL}]	true, false	FALSE			
	ETHx_FT_So_MI_SL_MAC_DA[1…M_{SL}]	Per [ITU-T G.8021]	–			
	ETHx_FT_So_MI_SL_Test_ID[1…M_{SL}]	Non-negative integer (optional)	–			
	ETHx_FT_So_MI_SL_Length[1…M_{SL}]	Non-negative integer representing number of byte for the length of the padding TLV. Note that the total fame size of the SL PDU should be between 64 and 9216 bytes.	0			
	ETHx_FT_So_MI_SL_Period[1…M_{SL}]	10 ms, 100 ms, 1 s, 10 s	100 ms			
	ETHx_FT_So_MI_SL_Pri[1…M_{SL}]	0, 1, 2, 3, 4, 5, 6, 7	7			

Table I.3 – MIs and their values for on-demand PMs (from Table 8-5 of [ITU-T G.8051])

	Source			Sink		
	MI signal	Value Range	Default Value	MI signal	Value Range	Default Value
MEP	ETHDe_FT_So_MI_MEL	0..7	–	ETHDe_FT_Sk_MI_MEL	0..7	–
	ETHDe_FT_So_MI_MEP_MAC	6 byte MAC unicast address	–	ETHDe_FT_Sk_MI_MEP_MAC	6 byte Unicast MAC address	–
	ETHDe_FT_So_MI_MEP_ID	0..8191; see Figure 9.2-3 of [ITU-T Y.1731]	–			
LM	ETHDe_FT_So_MI_LM_Start(DA,P,Period)	For Period: 100 ms, 1 s, 10 s(Also see Notes 1 and 2 for DA and P)	For Period: 100 ms			
	ETHDe_FT_So_MI_LM_Intermediate_Request	–	–			
	ETHDe_FT_So_MI_LM_Terminate	–	–			
	ETHDe_FT_So_MI_LM_Result(N_TF, N_LF, F_TF, F_LF) (Note 3)	(Note 1)	–			
1SL	ETHDe_FT_So_MI_1SL_Start(DA,P,Test_ID,Length,Period)	For Period: 10 ms, 100 ms, 1 s, 10 s(Also see Notes 1 and 2 for DA and P)	For Period: 100 ms	ETHDe_FT_Sk_MI_1SL_Start(SA,MEP ID, Test ID)	(Notes 1 and 2)	–
				ETHDe_FT_Sk_MI_1SL_Intermediate_Request	–	–
	ETHDe_FT_So_MI_1SL_Terminate	–	–	ETHDe_FT_Sk_MI_1SL_Terminate	–	–
				ETHDe_FT_Sk_MI_1SL_Result(N_TF,N_LF) (Note 3)	(Note 1)	–
SL	ETHDe_FT_So_MI_SL_Start(DA,P, Test_ID,Length,Period)	For Period: 10 ms, 100 ms, 1 s, 10 s(Also see Notes 1 and 2 for DA and P)	For Period: 100 ms			
	ETHDe_FT_So_MI_SL_Intermediate_Request	–	–			
	ETHDe_FT_So_MI_SL_Terminate	–	–			
	ETHDe_FT_So_MI_SL_Result(N_TF,N_LF,F_TF,F_LF) (Note 3)	(Note 1)	–			
1DM	ETHDe_FT_So_MI_1DM_Start(DA,P, Test_ID,Length,Period)	For Period: 100 ms, 1 s, 10 s(Also see Notes 1 and 2 for DA and P)	For Period: 100 ms	ETHDe_FT_Sk_MI_1DM_Start(SA, Test_ID)	6 byte Unicast MAC address, Non-negative integer	–
				ETHDe_FT_Sk_MI_1DM_Intermediate_Request	–	–
	ETHDe_FT_So_MI_1DM_Terminate	–	–	ETHDe_FT_Sk_MI_1DM_Terminate	–	–
				ETHDe_FT_Sk_MI_1DM_Result(count,N_FD[]) (Note 3)	(Note 1)	–
DM	ETHDe_FT_So_MI_DM_Start(DA,P, Test_ID,Length,Period)	For Period: 100 ms, 1 s, 10 s(Also see Notes 1 and 2 for DA and P)	For Period: 100 ms			
	ETHDe_FT_So_MI_DM_Intermediate_Request	–	–			
	ETHDe_FT_So_MI_DM_Terminate	–	–			
	ETHDe_FT_So_MI_DM_Result(count,B_FD[],F_FD[],N_FD[]) (Note 3)					

NOTE 1 – According to [ITU-T G.8021].
NOTE 2 – destination address (DA) is 6 byte MAC address, priority (P) is 0..7, drop eligibility (DE) is 0..1.
NOTE 3 – Output signals

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