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TELECOMMUNICATION
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Operation, administration, maintenance (OAM) management information and data models for the MPLS-TP network element

Recommendation ITU-T G.8152.1/Y.1375.1

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Recommendation ITU-T G.8152.1/Y.1375.1

Operation, administration, maintenance (OAM) management information and data models for the MPLS-TP network element

Summary

Recommendation ITU-T G.8152.1/Y.1375.1 specifies the operation, administration, maintenance (OAM) information model and data models for multi-protocol label switching – transport profile (MPLS-TP) transport network element (NE) to support specific interface protocols and specific management and control functions. The information model is interface protocol neutral and derived from pruning and refactoring the ITU-T G.7711/Y.1702 core information model and ITU-T G.8152/Y.1375 foundation MPLS-TP NE information model. The data models are interface protocol specific and translated from the information model with the assistance of an automated translation tool. The specific data models considered in this Recommendation include, but are not limited to, yet another new generation (YANG) data models. The specific management and control functions covered by this Recommendation are the ITU-T G.8113.1/Y.1372.1 specific OAM functions. The YANG modules of this Recommendation are intended to be compatible with the relevant base generic YANG modules from the IETF for the ITU-T G.8113.1/Y.1372.1 OAM functionality.

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FOREWORD

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Recommendation ITU-T G.8152.1/Y.1375.1

Operation, administration, maintenance (OAM) management information and data models for the MPLS-TP network element

1 Scope

This Recommendation specifies the operation, administration, maintenance (OAM) information model and data models for multi-protocol label switching – transport profile (MPLS-TP) transport network element (NE) to support specific interface protocols and specific management and control functions. The information model is interface protocol neutral and derived from pruning and refactoring the [ITU-T G.7711] core information model and [ITU-T G.8152] foundation MPLS-TP NE information model. The data models are interface protocol specific and translated from the information model with the assistance of an automated translation tool. The specific data models considered in this Recommendation include, but are not limited to, yet another new generation (YANG) data models. The specific management and control functions covered by this Recommendation are the [ITU-T G.8113.1] specific OAM functions.

The YANG modules of this Recommendation are aimed to be compatible with the relevant base generic YANG modules from the IETF for the [ITU-T G.8113.1] OAM functionality.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T G.7711] Recommendation ITU-T G.7711/Y.1702 (2018), *Generic protocol-neutral information model for transport resources.*

[ITU-T G.8013] Recommendation ITU-T G.8013/Y.1731 (2015), *Operation, administration and maintenance (OAM) functions and mechanisms for Ethernet-based networks.*

[ITU-T G.8113.1] Recommendation ITU-T G.8113.1/Y.1372.1 (2015), *Operations, administration and maintenance mechanisms for MPLS-TP in packet transport networks.*

[ITU-T G.8121] Recommendation ITU-T G.8121/Y.1381 (2018), *Characteristics of MPLS-TP equipment functional blocks.*

[ITU-T G.8121.1] Recommendation ITU-T G.8121.1/Y.1381.1 (2018), *Characteristics of MPLS-TP equipment functional blocks supporting ITU-T G.8113.1/Y.1372.1 OAM mechanisms.*

[ITU-T G.8151] Recommendation ITU-T G.8151/Y.1374 (2020), *Management aspects of the MPLS-TP network element*.

[ITU-T G.8152] Recommendation ITU-T G.8152/Y.1735 (2018), *Protocol-neutral management information model for the MPLS-TP network element.*

[IETF RFC 6371] IETF RFC 6371 (2011), *Operations, Administration, and Maintenance Framework For MPLS-Based Transport Networks*.

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[IETF RFC 6991] IETF RFC 6691 (2013), *Common YANG Data Types*.

[IETF RFC 7950] IETF RFC 7950 (2016), *The YANG 1.1 Data Modeling Language.*

[IETF RFC 8340] IETF RFC 8340 (2018), *YANG Tree Diagrams.*

[IETF RFC 8342] IETF RFC 8342 (2018), *Network Management Datastore Architecture (NMDA).*

[IETF RFC 8531] IETF RFC 8531 (2019), *Generic YANG Data Model for Connection-Oriented Operations, Administration, and Maintenance(OAM) Protocols.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 maintenance entity (ME): [ITU-T G.8013]

3.1.2 maintenance entity group (MEG): [ITU-T G.8013]

3.1.3 MEG end point (MEP): [ITU-T G.8013]

3.1.4 MEG intermediate point (MIP): [ITU-T G.8013]

3.1.5 on-demand monitoring: [ITU-T G.8013]

3.1.6 proactive monitoring: [ITU-T G.8013]

3.1.7 maintenance domain (MD): [IETF RFC 8531]

3.1.8 maintenance association (MA): [IETF RFC 8531]

3.1.9 session: [IETF RFC 8531]

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

1DM	One-way Delay Measurement
1DMo	On-demand one-way Delay Measurement
1DMp	Proactive one-way Delay Measurement
TH	One-way Throughput Test
AIS	Alarm Indication Signal
APS	Automatic Protection Switching
CCM	Continuity Check Message
CTP	Connection Termination Point
DM	Delay Measurement
DMo	On-demand Delay Measurement
DMp	Proactive Delay Measurement
DMM	Delay Measurement Message
DMR	Delay Measurement Reply
DT	Diagnostic Test

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LCK	Locked
LM	Loss Measurement
LMo	On-demand Loss Measurement
LMp	Proactive Loss Measurement
LMM	Loss Measurement Message
LMR	Loss Measurement Reply
LOC	Loss of Continuity
LSP	Label Switched Path
LT	Link Trace
MCC	Management Communication Channel
ME	Maintenance Entity
MEG	Maintenance Entity Group
MEP	Maintenance entity group End Point
MD	Maintenance Domain
MA	Maintenance Association
MI	Management Information
MIB	Management Information Base
MIP	Maintenance entity group Intermediate Point
MPLS	Multi-Protocol Label Switching
MPLS-TP	Multi-Protocol Label Switching – Transport Profile
NC	Network Connection
NE	Network Element
OAM	Operation, Administration and Maintenance
PDU	Protocol Data Unit
PM	Performance Monitoring
PW	Pseudowire
RDI	Remote Defect Indication
RT	Route Trace
SCC	Signalling Communication Channel
Sk	Sink
SLA	Service Level Agreement
SL	Synthetic Loss Measurement
SLp	Proactive Synthetic Loss Measurement
SLo	On-demand Synthetic Loss Measurement
SN	Sub-Network
SNC	Sub-Network Connection
SNCP	Sub-Network Connection Protection

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SNMP	Simple Network Management Protocol
So	Source
SQ	Sequence
TCM	Tandem Connection Monitoring
TCS	Traffic Conditioning and Shaping
TH	Throughput
TST	Test
TP	Termination Point
TT	Trail Termination
TTL	Time-To-Live
TTP	Trail Termination Point
UML	Unified Modelling Language
YANG	Yet Another New Generation

5 Conventions

5.1 Information modelling conventions

See clause 5.1 of [ITU-T G.7711].

5.1.1 UML modelling conventions

See clause 5.1 of [ITU-T G.7711].

5.1.2 Model artefact lifecycle stereotypes conventions

See clause 5.2 of [ITU-T G.7711].

5.1.3 Forwarding entity terminology conventions

See clause 5.3 of [ITU-T G.7711].

5.1.4 Conditional package conventions

See clause 5.4 of [ITU-T G.7711].

5.1.5 Pictorial diagram conventions

See clause 5.5 of [ITU-T G.7711].

5.2 Equipment function conventions

5.2.1 Maintenance entity group end point (MEP) [ITU-T G.8121]

See clause 5.2.1 of [ITU-T G.8152].

5.2.2 Maintenance entity group intermediate point (MIP) [ITU-T G.8121]

See clause 5.2.2 of [ITU-T G.8152].

5.2.3 MEPs and MIPs along a maintenance entity

See clause 5.2.3 of [ITU-T G.8152].

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5.3 Colour code conventions

The following "colour code" is used in this Recommendation:

Table 5-1 – Colour code convention

"colour code"	ITU-T G.8152.1 object class
	Object classes imported from [ITU-T G.8152]
	Object classes reverse-engineered from IETF
	Preliminary or experimental object classes in this Recommendation
	Object classes in this Recommendation
	Abstract object classes in this Recommendation

6 Functions of MPLS-TP OAM

The specific functions covered by this Recommendation are OAM functions of [ITU-T G.8121], [ITU-T G.8121.1] and [ITU-T G.8113.1]. The OAM capability support is listed in Table 6-1. The right-most column is used to describe the involved object instances of the OAM functions.

Table 6-1 – OAM capability support

Consolidation of Tables 7-1 of [ITU-T G.8152] and 7-1 of [ITU-T G.8113.1]

OAM function [ITU-T G.8113.1]			**OAM mechanism** [ITU-T G.8121] and [ITU-T G.8121.1]	**Involved object instances**
Proactive performance measurement (PM)	Loss measurement (LM)	Direct near-end loss	CCM (Dual-ended) 8.8.4 of [ITU-T G.8121] 8.8.1 of [ITU-T G.8121.1] 8.2.1 of [ITU-T G.8113.1]	Both the A-end MEP and Z-end MEP
		Direct near-end loss & far-end loss	LM (Single-ended) 8.8.4 of [ITU-T G.8121] 8.8.4 of [ITU-T G.8121.1] 8.2.6 of [ITU-T G.8113.1]	Single MEP
		Synthetic near-end loss	Not supported	
		Synthetic near-end loss & far-end loss	Not supported	
	Delay measurement (DM)	1-way near-end delay	1DM (dual-ended) 8.8.6 of [ITU-T G.8121] 8.8.6 of [ITU-T G.8121.1] 8.2.7 of [ITU-T G.8113.1]	Both the A-end MEP and Z-end MEP
		• 2-way delay, • 1-way near-end delay • 1-way far-end delay	DM (single-ended) 8.8.6 of [ITU-T G.8121] 8.8.6 of [ITU-T G.8121.1] 8.2.8 of [ITU-T G.8113.1]	Single MEP

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Table 6-1 – OAM capability support

Consolidation of Tables 7-1 of [ITU-T G.8152] and 7-1 of [ITU-T G.8113.1]

OAM function [ITU-T G.8113.1]			**OAM mechanism** [ITU-T G.8121] and [ITU-T G.8121.1]	**Involved object instances**
On-demand performance measurement (PM)	Loss measurement (LM)	Direct near-end loss & far-end loss	LM (single-ended) 8.8.5 of [ITU-T G.8121] 8.8.5 of [ITU-T G.8121.1] 8.2.6 of [ITU-T G.8113.1]	Single MEP
		Synthetic near-end loss	Not supported	
		Synthetic near-end loss & far-end loss	Not supported	
	Delay measurement (DM)	1-way near-end delay	1DM (dual-ended) 8.8.7 of [ITU-T G.8121] 8.8.7 of [ITU-T G.8121.1] 8.2.7 of [ITU-T G.8113.1]	Both the A-end MEP and Z-end MEP
		• way near-end delay • way far-end delay • 2-way delay	DM (single-ended) 8.8.7 of [ITU-T G.8121] 8.8.7 of [ITU-T G.8121.1] 8.2.8 of [ITU-T G.8113.1]	Single MEP
	Throughput	1-way throughput test (1TH)	TST (dual-ended) 8.8.8 of [ITU-T G.8121] 8.8.8 of [ITU-T G.8121.1] 8.2.5 of [ITU-T G.8113.1]	Both the A-end MEP and Z-end MEP
Proactive fault management (FM)	Continuity check and connectivity verification (CC of ITU-T CV)		CCM 8.8.1 of [ITU-T G.8121.1] 8.2.1 of [ITU-T G.8113.1]	Gen: A-end MEP of the LSP (or PW or TCM or Section) to Z-end MEP Rec: Z-end MEP
	Remote defect indication (RDI)		RDI bit of CCM 8.8.2 of [ITU-T G.8121.1] 8.2.1 of [ITU-T G.8113.1]	Gen: Z-end MEP of the LSP (or PW or TCM or Section) to A-end MEP Rec: A-end MEP
	Alarm indication signal (AIS)		AIS 8.6.2 and 8.8.10 of [ITU-T G.8121] 8.6.2 and 8.8.10 of [ITU-T G.8121.1] 8.2.3 of [ITU-T G.8113.1]	Gen: Intermediate TP of the LSP (or PW or TCM) to downstream Rec: Downstream MEP
	Locked signal (lock report) (LCK)		LCK 8.6.3 and 8.8.10 of [ITU-T G.8121] 8.6.3 and 8.8.10 of [ITU-T G.8121.1] 8.2.4 of [ITU-T G.8113.1]	Gen: Intermediate TP of the LSP (or PW or TCM) to both upof [ITU-T down stream Rec: Downstream MEP Rec: Upstream MEP

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Table 6-1 – OAM capability support

Consolidation of Tables 7-1 of [ITU-T G.8152] and 7-1 of [ITU-T G.8113.1]

OAM function [ITU-T G.8113.1]		**OAM mechanism** [ITU-T G.8121] and [ITU-T G.8121.1]	**Involved object instances**
	Client signal failure (CSF)	CSF 8.7.3 of [ITU-T G.8121] 8.7.3 of [ITU-T G.8121.1] 8.2.9 of [ITU-T G.8113.1]	Gen: A-end MEP to Z-end MEP Rec: Z-end MEP
On-demand fault management (FM)	Connectivity verification (CV)	LB 8.8.3 of [ITU-T G.8121] 8.8.3 of [ITU-T G.8121.1] 8.2.2 of [ITU-T G.8113.1]	Gen: A-end MEP of the LSP (or PW or TCM or Section) to Z-end MEP Rec: Z-end MEP or Intermediate MIP
	Lock instruction (LKI) – Out of scope of this Recommendation		–
	Route tracing (RT) – For further study	RT 8.8.9 of [ITU-T G.8121] 8.8.9 of [ITU-T G.8121.1] 7.2.1.3 of [ITU-T G.8113.1]	For further study
	Diagnostic test (DT)	LB (bidirectional) 8.8.3 of [ITU-T G.8121.1] 8.2.2 of [ITU-T G.8113.1] TST (unidirectional) 8.8.8 of [ITU-T G.8121.1] 8.2.5 of [ITU-T G.8113.1]	Gen: A-end MEP of the LSP (or PW or TCM or Section) to Z-end MEP Rec: Z-end MEP and Respond back to A-end MEP
OAM for other applications	Automatic protection switching (APS) – Out of scope of this Recommendation		–
	Management communication channel (MCC)of ITU-T signalling communication channel (SCC) – Out of scope of this Recommendation		–

In Table 6-1, there are five types of MPLS-TP OAM, include proactive OAM for performance measurement, on-demand OAM for performance measurement, proactive OAM for fault management and on-demand OAM for fault management and OAM for other applications. The functions of OAM for other applications are out of the scope of this Recommendation. All these MPLS-TP OAM functions are applicable to MPLS-TP sections, label switched paths (LSPs) and pseudowires (PWs).

6.1 Proactive OAM for performance measurement

The proactive OAM for performance measurement is used for performance monitoring purposes. There are two types of functions in Table 6-1: proactive loss measurement and proactive delay measurement.

6.1.1 Proactive loss measurement (LM)

The proactive loss measurement (LM) function is used to measure packet loss on a connection for performance-monitoring purposes. It is performed continuously, and its result is used to verify the performance of the connection against the service level agreement (SLA). This function can be

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performed by two methods: dual-ended proactive LM by continuity check message (CCM) and single-ended proactive LM by loss measurement message/loss measurement reply (LMM/LMR). The CCM process for dual-ended proactive LM is defined in clauses 8.8.4 of [ITU-T G.8121] and 8.8.1 of [ITU-T G.8121.1]. This process calculates the number of transmitted and lost packets per second. The LMM/LMR process for single-ended LM is defined in clause 8.8.4 of [ITU-T G.8121.1]. This process counts the number of transmitted and received packets.

6.1.2 Proactive delay measurement

The proactive delay measurement is used to measure packet delay (PD) and packet delay variation (PDV) on a connection for performance-monitoring purposes. It is performed continuously, and its result is used to verify the performance of the connection against the service level agreement (SLA). This function can be performed by two methods: single-ended DM by delay measurement message/delay measurement reply (DMM/DMR) and dual-ended DM by one-way delay measurement (1DM). The DMM/DMR process for single-ended proactive DM is defined in clauses 8.8.6.3-8.8.6.6 of [ITU-T G.8121.1]. A source maintenance entity group end point (MEP) sends frames with delay measurement message (DMM) to its peer sink MEP and receives frames with DM reply (DMR) information from its peer sink MEP to carry out two-way frame delay and two-way frame delay variation measurements. The 1DM process for dual-ended proactive DM is defined in clauses 8.8.6 of [ITU-T G.8121] and 8.8.6.7-8.8.6.10 of [ITU-T G.8121.1]. A source MEP sends frames with 1DM packet to its peer sink MEP and sink MEP enables 1DM to calculate one-way frame delay and one-way frame delay variation. This method needs the clocks between the two MEPs should be synchronized.

6.2 On-demand for performance measurement

The on-demand OAM for performance measurement is used for maintenance purposes. It is performed during a configured specific time interval and its result can be used for diagnosis and analysis. There are three types of functions in Table 6-1: on-demand loss measurement, on-demand delay measurement and throughput measurement.

6.2.1 On-demand loss measurement

The on-demand loss measurement is used to measure packet loss for direct near-end and far-end. This function commonly be performed by the method of single-ended on demand LM with LMM/LMR. The LMM/LMR process for single-ended LM is defined in clause 8.8.5 of [ITU-T G.8121] and [ITU-T G.8121.1] and OAM protocol data unit (PDU) formats are defined in clause 8.2.6 of [ITU-T G.8113.1].

6.2.2 On-demand delay measurement

The on-demand delay measurement is used to measure packet delay for near-end and far-end. This function can be performed by two methods: single-ended DM by DMM/DMR and dual-ended DM by 1DM. The DMM/DMR process for single-ended proactive DM is defined in clauses 8.8.7.3-8.8.7.6 of [ITU-T G.8121.1] and OAM PDU format is defined in clause 8.2.8 of [ITU-T G.8113.1]. A source MEP sends frames with delay measurement message (DMM) to its peer sink MEP and receives frames with DM reply (DMR) information from its peer sink MEP to carry out two-way frame delay and two-way frame delay variation measurements. The 1DM process for dual-ended proactive DM is defined in clauses 8.8.7 of [ITU-T G.8121] and 8.8.7.7-8.8.7.10 of [ITU-T G.8121.1] and OAM PDU format is defined in clause 8.2.7 of [ITU-T G.8113.1]. A source MEP sends frames with 1DM packet to its peer sink MEP and sink MEP enables 1DM to calculate one-way frame delay and one-way frame delay variation. This method needs the clocks between the two MEPs should be synchronized.

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6.2.3 Throughput measurement

Throughput measurement is a test function for measuring the rate of receiving packet percentage at sink MEP when source MEP sends OAM test packets at an increasing rate. This function can be performed by two methods: single-ended throughput and dual-ended throughput. This function commonly is performed by the method of dual-ended throughput test (TST) 1-way throughput test (1TH). The TST (1TH) process for dual-ended throughput is defined in clauses 8.8.8 of [ITU-T G.8121] and 8.8.8.2-8.8.8.5 of [ITU-T G.8121.1] and OAM PDU format is defined in clause 8.2.5 of [ITU-T G.8113.1].

6.3 Proactive fault management

The proactive OAM for fault measurement is used for fault management for monitoring purposes. In Table 6-1, there are five types of functions: continuity check and connectivity verification (CC/CV), remote defect indication (RDI), alarm indication signal (AIS), locked signal (LCK) and client signal failure (CSF).

6.3.1 Continuity check and connectivity verification (CC/CV)

The proactive continuity check and connectivity verification (CC/CV) function is used for fault monitoring. The source (So) MEP sends continuity check/connectivity verification (CC/CV) OAM packets periodically at the configured rate. Then the sink (Sk) MEP monitors the arrival of these CC/CV OAM packets at the configured rate and detects the defect of loss of continuity (LOC). The CC/CV function is defined in clause 7.2.1.1.1 of [ITU-T G.8113.1] and OAM PDU format is defined in clause 8.2.1 of [ITU-T G.8113.1]. The CCM process is defined in clauses 8.8.1.2-8.8.1.3 of [ITU-T G.8121.1].

6.3.2 Remote defect indication (RDI)

The proactive remote defect indication (RDI) is an indicator which can be used by a MEP to communicate to its peer MEPs. When a MEP detects a signal fail condition, it sends an RDI to its peer MEPs. An RDI is used only when proactive CC/CV bidirectional transmission is enabled. The RDI function is defined in clause 7.2.1.1.2 of [ITU-T G.8113.1] and OAM PDU format is defined in clause 8.2.1 of [ITU-T G.8113.1]. The CCM process for RDI is defined in clauses 8.8.1.2 and 8.8.1.3 of [ITU-T G.8121.1].

6.3.3 Alarm indication signal (AIS)

The proactive alarm indication signal (AIS) function is used to suppress alarms from a server MEP to the downstream sink client MEP. The AIS function is defined in clause 7.2.1.1.3 of [ITU-T G.8113.1] and OAM PDU format is defined in clause 8.2.3 of [ITU-T G.8113.1]. The AIS process is defined in clauses 8.6.2 and 8.8.10 of [ITU-T G.8121] and [ITU-T G.8121.1].

6.3.4 Locked signal (Lock report) (LCK)

The proactive locked signal (LCK) function is used to communicate to the client (sub-)layer MEPs the administrative locking of a server (sub-)layer MEP and consequential interruption of data traffic forwarding in the client (sub-)layer. The LCK function is defined in clause 7.2.1.1.4 of [ITU-T G.8113.1] and OAM PDU format is defined in clause 8.2.4 of [ITU-T G.8113.1]. The LCK process is defined in clauses 8.6.3 and 8.8.10 of [ITU-T G.8121] and [ITU-T G.8121.1].

6.3.5 Client signal failure (CSF)

The proactive client signal fail (CSF) function is used to process client defects and propagate a client signal defect to the associated remote MEPs using OAM packets. This function is usually used when the client of the MPLS-TP trail does not support a native defect/alarm indication mechanism. The CSF function is defined in clause 7.2.1.1.5 of [ITU-T G.8113.1] and OAM PDU

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