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Operations, administration and maintenance mechanisms for MPLS-TP in packet transport networks

Recommendation ITU-T G.8113.1/Y.1372.1

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Recommendation ITU-T G.8113.1/Y.1372.1

Operations, administration and maintenance mechanisms for MPLS-TP in packet transport networks

Summary

Recommendation ITU-T G.8113.1/Y.1372.1 specifies mechanisms for user-plane operations, administration and maintenance (OAM) in multi-protocol label switching transport profile (MPLS-TP) networks to meet the MPLS-TP OAM requirements specified in IETF RFC 5860. It also specifies the MPLS-TP OAM packet formats, syntax and semantics of MPLS-TP OAM packet fields.

The OAM mechanisms described in this Recommendation assume common forwarding of the MPLS-TP user packets and MPLS-TP OAM packets. In transport networks, the OAM return path is always in-band.

The MPLS-TP OAM mechanisms described in this Recommendation apply to co-routed bidirectional point-to-point MPLS-TP connections. Unidirectional point-to-point and point-to-multipoint MPLS-TP connections will be addressed in a future edition of this Recommendation.

This Recommendation is compliant with the transport profile of MPLS as specified by the Internet Engineering Task Force [b-IETF RFC 5654]. In the event of a misalignment in MPLS-TP-related architecture, framework and protocols between this ITU-T Recommendation and the normatively referenced IETF RFCs, the requests for comments (RFCs) will take precedence.

History

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Recommendation ITU-T G.8113.1/Y.1372.1

Operations, administration and maintenance mechanisms for MPLS-TP in packet transport networks

1 Scope

This Recommendation specifies mechanisms for operations, administration and maintenance (OAM) for multi-protocol label switching transport profiles (MPLS-TPs) that can be applied in packet transport networks (PTN). It specifies mechanisms for user-plane OAM in MPLS-TP networks to meet the MPLS-TP OAM requirements specified in [IETF RFC 5860]. It also specifies the MPLS-TP OAM packet formats, syntax and semantics of MPLS-TP OAM packet fields.

The OAM mechanisms described in this Recommendation assume common forwarding of the MPLS-TP user packets and MPLS-TP OAM packets. In transport networks, the OAM return path is always in-band.

The MPLS-TP OAM mechanisms described in this Recommendation are applicable in network scenarios, as described in Annex A, and apply to co-routed bidirectional point-to-point MPLS-TP connections. Unidirectional point-to-point and point-to-multipoint MPLS-TP connections will be addressed in a future edition of this Recommendation.

This Recommendation provides a representation of the MPLS-TP technology using the methodologies that have been used for other transport technologies [e.g., synchronous digital hierarchy (SDH), optical transport network (OTN) and Ethernet].[1]

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.805] Recommendation ITU-T G.805 (2000), *Generic functional architecture of transport networks.*

[ITU-T G.806] Recommendation ITU-T G.806 (2012), *Characteristics of transport equipment – Description methodology and generic functionality.*

[ITU-T G.808.1] Recommendation ITU-T G.808.1 (2014) *Generic protection switching – Linear trail and subnetwork protection.*

[ITU-T G.826] Recommendation ITU-T G.826 (2002), *End-to-end error performance parameters and objectives for international, constant bit-rate digital paths and connections.*

[ITU-T G.7710] Recommendation ITU-T G.7710/Y.1701 (2012), *Common equipment management function requirements.*

[1] This Recommendation is intended to be aligned with the IETF RFCs on MPLS referenced normatively by this Recommendation.

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[ITU-T G.7712] Recommendation ITU-T G.7712/Y.1703 (2010), *Architecture and specification of data communication network.*

[ITU-T G.8010] Recommendation ITU-T G.8010/Y.1306 (2004), *Architecture of Ethernet layer networks*.

[ITU-T G.8013] Recommendation ITU-T G.8013/Y.1731 (2015), *Operations, administration and maintenance (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.8110.1] Recommendation ITU-T G.8110.1/Y.1370.1 (2011), *Architecture of Multi-Protocol Label Switching transport profile layer network.*

[ITU-T M.1400] Recommendation ITU-T M.1400 (2015), *Designations for interconnections among operators' networks.*

[IEC 61588] IEC 61588 (2009), *Precision clock synchronization protocol for networked measurement and control systems.*

[IETF RFC 3032] IETF RFC 3032 (2001), *MPLS Label Stack Encoding.*

[IETF RFC 3443] IETF RFC 3443 (2003), *Time To Live (TTL) Processing in Multi-Protocol Label Switching (MPLS) Networks.*

[IETF RFC 4385] IETF RFC 4385 (2006), *Pseudowire Emulation Edge-to-Edge (PWE3) Control Word for Use over an MPLS PSN*.

[IETF RFC 5462] IETF RFC 5462 (2009), *Multiprotocol Label Switching (MPLS) Label Stack Entry: "EXP" Field Renamed to "Traffic Class" Field.*

[IETF RFC 5586] IETF RFC 5586 (2009), *MPLS Generic Associated Channel.*

[IETF RFC 5718] IETF RFC 5718 (2010), *An In-Band Data Communication Network For the MPLS Transport Profile*.

[IETF RFC 5860] IETF RFC 5860 (2010), *Requirements for Operations, Administration, and Maintenance (OAM) in MPLS Transport Networks.*

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

[ISO 3166-1] ISO 3166-1 (2013), *Codes for the representation of names of countries and their subdivisions – Part 1: Country codes.*

3 Definitions

This Recommendation introduces terminology that is required to discuss the functional network components associated with OAM. These definitions are consistent with [ITU-T G.805] terminology.

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined in [ITU-T G.806]:

– **defect**

– **failure**

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3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 MPLS transport profile: A set of multi-protocol label switching (MPLS) functions used to support packet transport services and network operations.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

1DM	one-way Delay Measurement
ACH	Associated Channel Header
AIS	Alarm Indication Signal
AP	Access Point
APS	Automatic Protection Switching
CC	Continuity Check; Country Code
CCM	Continuity Check Message
C-DCI	Client – Defect Clear Indication
CFI	Client Failure Indication
CSF	Client Signal Fail
CV	Connectivity Verification
DCC	Data Communication Channel
DM	Delay Measurement
DMM	Delay Measurement Message
DMR	Delay Measurement Reply
DT	Diagnostic Test
EXM	Experimental OAM Message
EXP	Experimental
EXR	Experimental OAM Reply
FC	Frame Count
G-ACh	Generic Associated Channel
GAL	G-ACh Label
ICC	ITU-T Carrier Code
ID	Identifier
IF	Interface
LBM	Loopback Message
LBR	Loopback Reply
LCK	Locked Signal
LM	Loss Measurement
LMM	Loss Measurement Message

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LMR	Loss Measurement Reply
LOC	Loss Of Continuity
LSE	Label Stack Entry
LSP	Label Switched Path
LSR	Label Switch Router
MCC	Management Communication Channel
ME	Maintenance Entity
MEG	Maintenance Entity Group
MEL	MEG Level
MEP	MEG End Point
MIP	MEG Intermediate Point
MMG	Mismerge
MPLS	Multi-Protocol Label Switching
MPLS-TP	MPLS Transport Profile
NE	Network Element
Num	Number
OAM	Operations, Administration and Maintenance
OpCode	Operations Code
OSS	Operations Support System
OTN	Optical Transport Network
PD	Packet Delay
PDU	Protocol Data Unit
PDV	Packet Delay Variation
PHB	Per-Hop Behaviour
PRBS	Pseudo-Random Bit Sequence
PTN	Packet Transport Network
PW	Pseudowire
RDI	Remote Defect Indication
RT	Route Tracing
Rx	Receive
SCC	Signalling Communication Channel
SDH	Synchronous Digital Hierarchy
SES	Severely Errored Second
Sk	Sink
SLA	Service Level Agreement
So	Source
SPME	Sub-Path Maintenance Entity

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TC	Traffic Class
TCM	Tandem Connection Monitoring
TLV	Type, Length and Value
TrCP	Traffic Conditioning Point
TST	Test
TTL	Time To Live
Tx	Transmit
UNI	User Network Interface
UNL	Unexpected MEL
UNM	Unexpected MEP
UNP	Unexpected Periodicity
UNPr	Unexpected Priority
VCCV	Virtual Circuit Connectivity Verification
VS	Vendor-Specific
VSM	Vendor-Specific OAM Message
VSR	Vendor-Specific OAM Reply

5 Conventions

The diagrammatic conventions for maintenance entity group (MEG) end point (MEP) and MEG intermediate point (MIP) compound functions are those of [ITU-T G.8010].

The values of the OAM protocol data unit (PDU) fields are expressed in decimal format.

6 Functional components

6.1 Maintenance entity

A maintenance entity (ME) can be viewed as the association between two MEPs that applies maintenance and monitoring operations to a network connection or a tandem connection.

In the case of a co-routed bidirectional point-to-point connection, a single bidirectional ME is specified to monitor both directions congruently.

6.2 Maintenance entity group

An MEG is a set of one or more MEs that belong to the same connection and are maintained and monitored as a group.

6.2.1 Tandem connection monitoring

Tandem connection monitoring (TCM) can be supported by the instantiation of a sub-path maintenance entity (SPME), as described in [IETF RFC 6371], that has a 1:1 relationship with the monitored connection. The SPME is then monitored using normal label switched path (LSP) monitoring.

When an SPME is established between non-adjacent nodes, the edges of the SPME become adjacent at the client sub-layer network and any intermediate node that was previously in-between becomes an intermediate node for the SPME.

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TCMs can nest but not overlap.

6.3 Maintenance entity group end points

An MEP marks the end point of an MEG that is responsible for initiating and terminating OAM packets for fault management and performance monitoring.

An MEP may initiate an OAM packet to be transferred to its corresponding peer MEP or to an intermediate MIP that is part of the MEG.

As the MEP corresponds to the termination of the forwarding path for an MEG at the given (sub-) layer, OAM packets never leak outside of an MEG in a properly configured error-free implementation.

An MEP may be a per-node MEP or a per-interface (per-IF) MEP.

A per-node MEP is located somewhere within one node. There is no other MIP or MEP in the same MEG within the same node.

A per-IF MEP is located on a specific IF within the node. In particular a per-IF MEP is called "Up MEP" or "Down MEP" depending on its location relative to the connection function,[2] as shown in Figure 6-1.

NOTE – It is possible that two Up MEPs of an MEG are set, one on each side of the connection function, such that the MEG is entirely internal to the node.

[2] The connection function is called a forwarding engine in [IETF RFC 6371].

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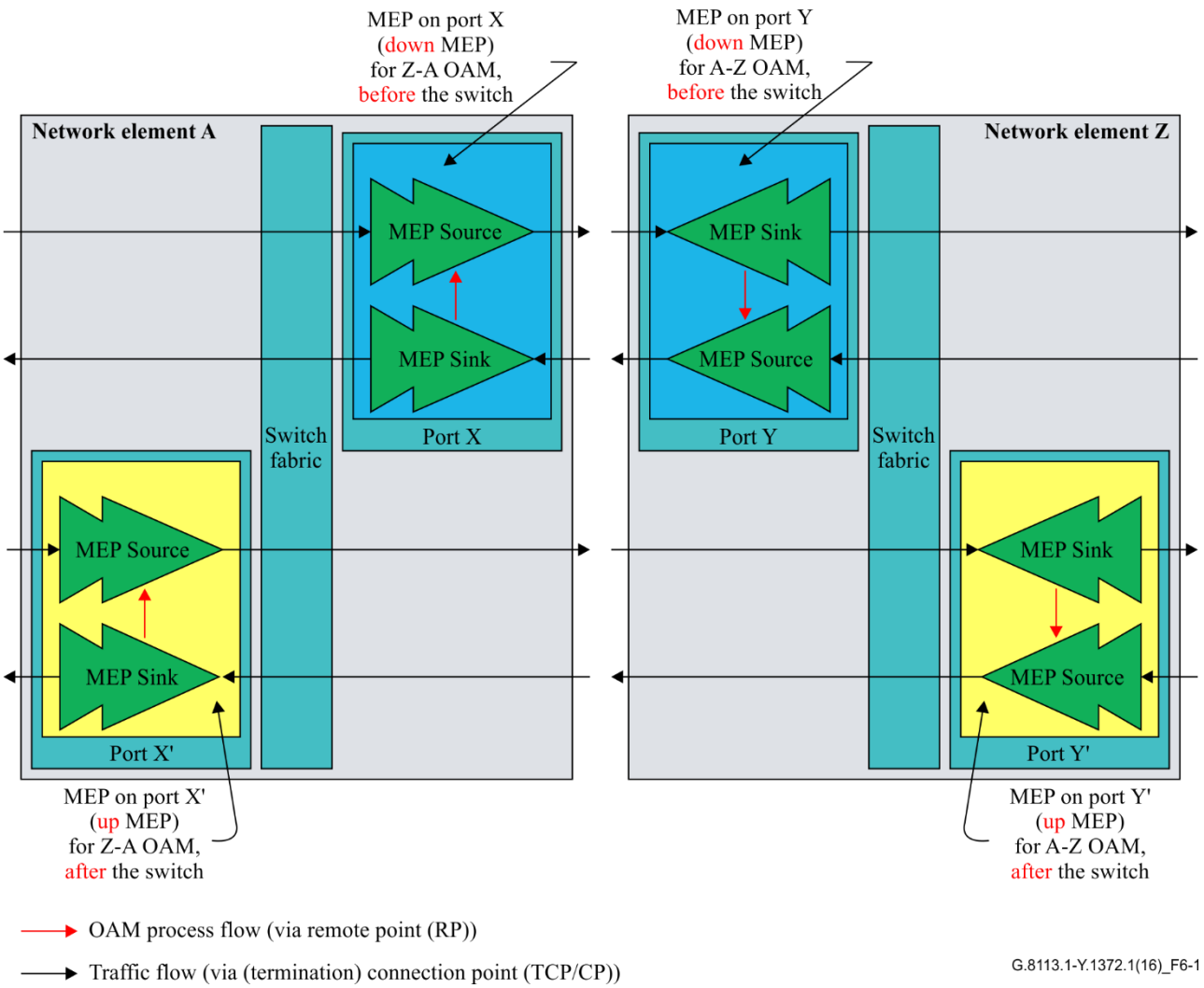

Figure 6-1 – Up/Down MEPs

In Figure 6-1, the MEP of the transport entity traversing IF port X of network element A (NE-A) is a Down MEP. Similarly, the MEP of IF port Y of NE-Z is also a Down MEP. Note that an IF port may support multiple transport entities. In Figure 6-1, only one transport entity is shown. For simplicity, refer to these two MEPs as MEP_{AX} and MEP_{ZY}. If these two MEPs belong to the same MEG (i.e., they peer to each other), OAM flow (e.g., loopback OAM packets) from MEP_{AX} to MEP_{ZY} will be processed (looped back) by MEP_{ZY} and the connection function of NE-Z is not involved in this OAM flow. Similarly, OAM packets from MEP_{ZY} to MEP_{AX} will be processed by MEP_{AX} and do not transit the connection function of NE-A.

In Figure 6-1, the MEP of the transport entity traversing IF port X' of NE-A is an Up MEP. Similarly, the MEP of IF port Y' of NE-Z is also an Up MEP. If these two MEPs ($MEP_{AX'}$ and $MEP_{ZY'}$) belong to the same MEG, OAM packets (e.g., loopback packets) from $MEP_{AX'}$ to $MEP_{ZY'}$ will traverse the connection function of NE-Z and then be processed by $MEP_{ZY'}$ and therefore the connection function of NE-Z is involved in this OAM flow. Similarly, the OAM packets from $MEP_{ZY'}$ to $MEP_{AX'}$ will be processed by $MEP_{AX'}$ and transit the connection function of NE-A.

More details are given in [IETF RFC 6371].

6.4 Maintenance entity group intermediate points

An MIP is a point between the two MEPs within an MEG that is capable of reacting to some OAM packets and forwarding all other OAM packets while ensuring fate-sharing with user-plane packets.

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An MIP does not initiate unsolicited OAM packets, but may be addressed by OAM packets initiated by one of the MEPs of the MEG. An MIP can generate OAM packets only in response to OAM packets that are sent on the MEG it belongs to.

MIPs are unaware of any OAM flows running between MEPs or between MEPs and other MIPs. MIPs can only receive (Rx) and process OAM packets addressed to them.

A MIP may be a per-node MIP or a per-IF MIP.

A per-node MIP is located somewhere within one node. There is no other MIP or MEP on the same MEG within the same node.

A per-IF MIP is located on a node IF, independently from the connection function.[3] The MIP can be placed at the ingress IF or at the egress IF of any node along the MEG.

A node at the edge of an MEG that has a per-IF Up MEP can also support a per-IF MIP on the other side of the connection function, as illustrated in Figure 6-2.

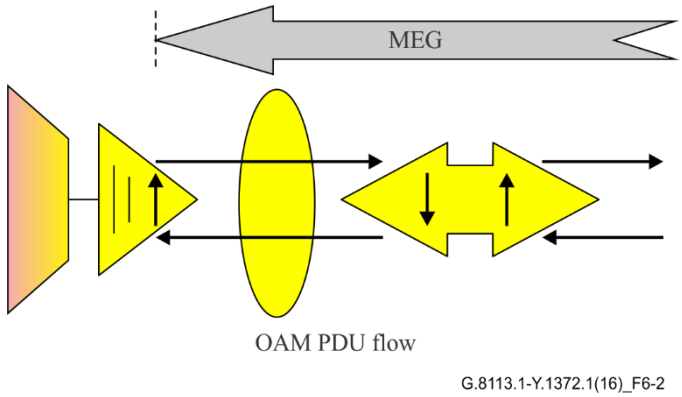

Figure 6-2 – Per-interface Up MEP and MIP in a node at the edge of an MEG

An intermediate node within an MEG can either:

– support a per-node MIP (i.e., a single MIP per node in an unspecified location within the node);

– support per-IF MIPs (i.e., two MIPs per node, one on each side of the forwarding engine, for co-routed point-to-point bidirectional connections).

According to [ITU-T G.8110.1], an MIP is functionally modelled as two back-to-back half MIPs as illustrated in Figure 6-3.

[3] The connection function is called forwarding engine in [IETF RFC 6371].

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