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Abstract

This document contains draft of G.8113.2/Y.1372.2 (Operations, Administration and Maintenance mechanisms for MPLS-TP networks using the tools defined for MPLS) for consent.

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CONTENTS

Operations, Administration and Maintenance mechanisms for MPLS-TP networks using the tools defined for MPLS

1 Scope

This Recommendation specifies the default mechanisms for user-plane OAM (Operations, Administration and Maintenance) in MPLS-TP networks to meet the MPLS-TP OAM requirements defined in [IETF RFC 5860]. It also specifies the MPLS-TP OAM packet formats, syntax and semantics of MPLS-TP OAM packet fields. An optional set of OAM tools based on G.8013/Y.1731 is described in G.8113.1/Y.1372.1. Annex B of G.8110.1 provides reference scenarios for the interconnection of domains that use the OAM mechanisms defined in this Recommendation and domains that normally use the OAM mechanisms defined in G.8113.1/Y.1372.1.

The OAM mechanisms defined in this Recommendation assume common forwarding of the MPLS-TP user packets and MPLS-TP OAM packets. In transport networks using co-routed bidirectional point-to-point connections, the OAM return path is always in-band.

This Recommendation is compliant with the transport profile of MPLS as defined by the IETF. 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 RFCs will take precedence.

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

[ITU-T G.806] ITU-T Recommendation G.806 (2004), *Characteristics of transport equipment – Description methodology and generic functionality.*

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

[ITU-T G.7710] ITU-T Recommendation G.7710 (2007), *Common equipment management function requirements.*

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

[ITU-T G.8010] ITU-T Recommendation G.8010/Y.1306 (2004), *Architecture of Ethernet layer networks*, plus Amendment 1 (2006) and Amendment 2 (2010).

[ITU-T G.8021] ITU-T Recommendation G.8021 (2010), *Characteristics of Ethernet transport network equipment functional blocks.*

[ITU-T G.8110.1] ITU-T Recommendation G.8110.1/Y.1370.1 (2011), *Architecture of MPLS Transport Profile (MPLS-TP) layer networks.*

[ITU-T M.20] ITU-T Recommendation M.20 (1992), *Maintenance philosophy for telecommunication networks*.

[ITU-T M.1400] ITU-T Recommendation M.1400 (2006), *Designations for interconnections among operators' networks*

[IETF RFC 3031] IETF RFC 3031 (2001), *Multiprotocol Label Switching Architecture.*

[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 3692] IETF RFC 3692 (2004), *Assigning Experimental and Testing Numbers Considered Useful.*

[IETF RFC 4379] IETF RFC 4379 (2006), *Detecting Multi-Protocol Label Switched (MPLS) Data Plane Failures*

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

[IETF RFC 5226] IETF RFC 5226 (2008), *Guidelines for Writing an IANA Considerations Section in RFCs*

[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 5654] IETF RFC 5654 (2009), *Requirements of an MPLS Transport Profile.*

[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 OAM in MPLS Transport Networks*.

[IETF RFC 5881] IETF RFC 5881 (2010), *Bidirectional Forwarding Detection (BFD) for IPv4 and IPv6 (Single Hop)*

[IETF RFC 5884] IETF RFC 5884 (2010), *Bidirectional Forwarding Detection (BFD) for MPLS Label Switched Paths (LSPs)*

[IETF RFC 5921] IETF RFC 5921 (2010), *A Framework for MPLS in Transport Networks.*

[IETF RFC 6215] IETF RFC 6215 (2011), *MPLS Transport Profile User-to-Network and Network-to-Network Interfaces*

[IETF RFC 6374] IETF RFC 6374 (2011), *Packet Loss and Delay Measurement for MPLS Networks*.

[IETF RFC 6375] IETF RFC 6375 (2011), *A Packet Loss and Delay Measurement Profile for MPLS-based Transport Networks*.

[IETF RFC oam-framework] IETF RFC draft-ietf-mpls-tp-oam-framework *Operations, Administration and Maintenance Framework for MPLS-based Transport Networks.*

[IETF RFC cc-cv-rdi] IETF RFC draft-ietf-mpls-tp-cc-cv-rdi, *Proactive Connectivity Verification, Continuity Check and Remote Defect Indication for MPLS-TP*.

[IETF RFC fault] IETF RFC draft-ietf-mpls-tp-fault, *MPLS Fault Management OAM*.

[IETF RFC on-demand-cv] IETF RFC draft-ietf-mpls-tp-on-demand-cv, *MPLS On-demand Connectivity Verification and Route Tracing*.

Editor's Note: References to in-progress RFCs need to be modified here and in the body when RFC numbers are assigned.

3 Definitions

This Recommendation introduces some terminology, which is required to discuss the functional network components associated with OAM. These definitions are consistent with G.805 terminology.

3.1 defect: see [ITU-T G.806].

3.2 failure: see [ITU-T G.806].

3.3 MPLS Transport Profile: Set of MPLS functions used to support packet transport services and network operations.

4 Abbreviations

This Recommendation uses the following abbreviations:

1DM	One-way Delay Measurement
A	Adaptation function
ACH	Associated Channel Header
AIS	Alarm Indication Signal
C	Customer
CC	Continuity Check
CSF	Client Signal Fail
CV	Connectivity Verification
DM	Delay Measurement
DMM	Delay Measurement Message
DMR	Delay Measurement Reply
DT	Diagnostic Test
EXM	Experimental OAM Message
EXP	Experimental
EXR	Experimental OAM Reply
G-ACh	Generic Associated Channel
GAL	G-ACh Label
IANA	Internet Assigned Numbers Authority
IETF	Internet Engineering Task Force
IP	Internet Protocol

LCK	Locked Signal
LER	Label Edge Router
LI	Lock Instruct
LKR	Lock Report
LM	Loss Measurement
LMM	Loss Measurement Message
LMR	Loss Measurement Reply
LOC	Loss Of Continuity
LSP	Label Switched Path
LSR	Label Switch Router
MCC	Management Communication Channel
ME	Maintenance Entity
MEL	MEG Level
MEG	Maintenance Entity Group
MEP	MEG End Point
MIP	MEG Intermediate Point
MMG	Mis-merge
MPLS	Multi-Protocol Label Switching
MPLS-TP	MPLS Transport Profile
N	Network
NE	Network Element
OAM	Operation, Administration & Maintenance
PDU	Protocol Data Unit
PSN	Packet Switched Network
PWE3	PseudoWire Emulation Edge-to-Edge
RDI	Remote Defect Indication
RFC	Request for Comments
SCC	Signaling Communication Channel
Sk	Sink
So	Source
SPME	Sub-Path Maintenance Entity
SSF	Server Signal Fail
TCM	Tandem Connection Monitoring
TTL	Time To Live
UNI	User Network Interface

UNM UNexpected Mep

UNP UNexpected Period

5 Conventions

The diagrammatic conventions for Maintenance Entity (ME) Group (MEG) End Point (MEP) and MEG Intermediate Point (MIP) compound functions are those of [ITU-T G.8010].

6 Functional Components

6.1 Maintenance Entity (ME)

A Maintenance Entity (ME) is the association between two MEG End Points (MEPs) that applies maintenance and monitoring operations to a network connection or a tandem connection.

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

6.2 Maintenance End Group (MEG)

A Maintenance Entity Group (MEG) is the 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 Sub-Path Maintenance Entity (SPME), as described in [IETF RFC oam-framework], that has a 1:1 relationship with the monitored connection. The SPME is then monitored using normal 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 were previously in between becomes an intermediate node for the SPME.

TCMs can nest but not overlap.

6.3 MEG End Points (MEPs)

A MEG end point (MEP) marks the end point of a MEG which is responsible for initiating and terminating OAM packets for fault management and performance monitoring.

A 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 a MEG at the given (sub-) layer, OAM packets never leak outside of a MEG in a properly configured error free implementation.

A MEP may be a per-node MEP or a per-interface MEP.
Per-node MEP is a MEP which is located somewhere within one node. There is no other MEG Intermediate Point (MIP) or MEP in the same MEG within the same node.

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

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

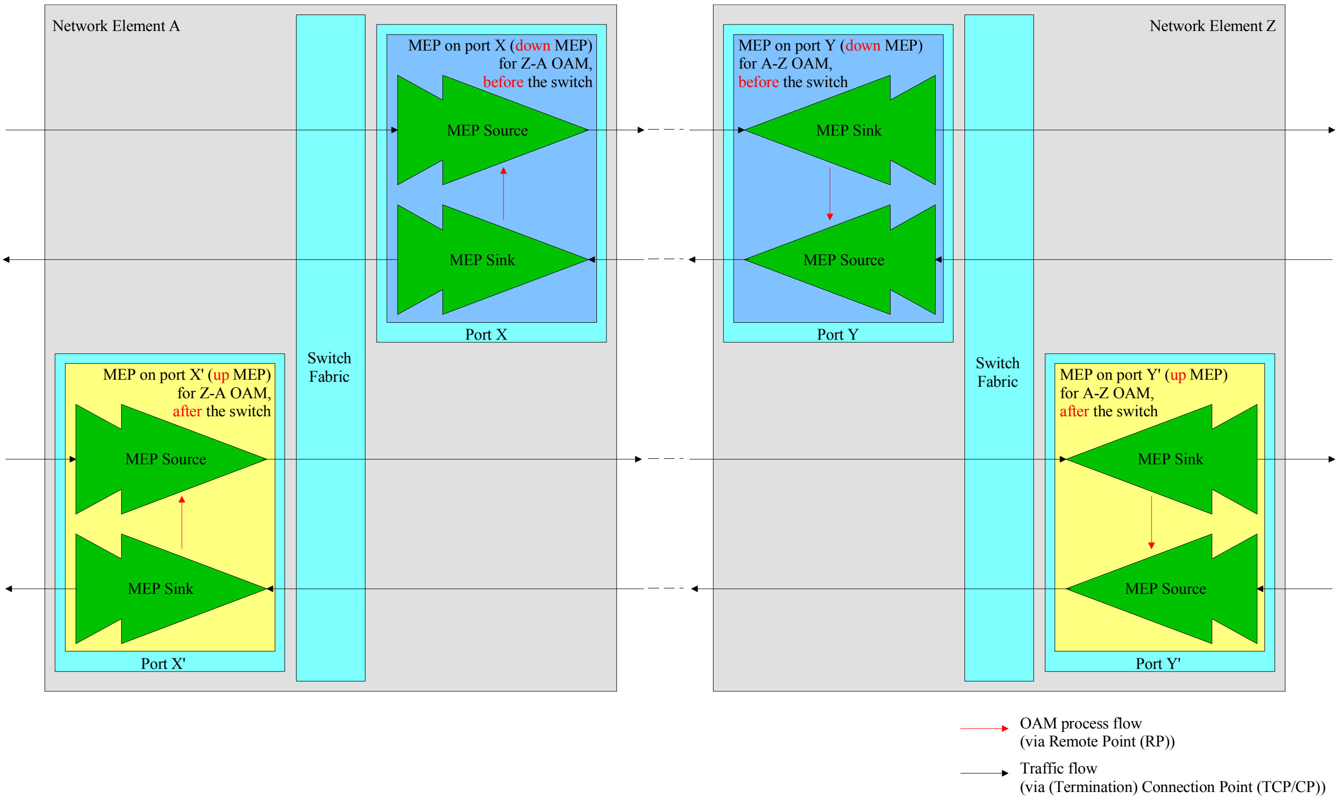

Figure 6-1/G.8113.2: Up/Down MEPs

In Figure 6-1 above, the MEP of the transport entity traversing interface port X of NE-A is a Down MEP. Similarly the MEP of interface port Y of NE-Z is also a Down MEP. Note that an interface port may support multiple transport entities. In the figure, 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 the 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 above, the MEP of the transport entity traversing interface port X’ of NE-A is an Up MEP. Similarly the MEP of interface 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 through 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 described in [IETF RFC oam-framework].

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[1] The connection function is called forwarding engine in [IETF RFC oam-framework]

6.4 MEG Intermediate Points (MIPs)

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

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

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

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

Per-node MIP is a MIP which is located somewhere within one node. There is no other MIP or MEP on the same MEG within the same node.

Per-interface MIP is a MIP which is located on a node interface, independently from the connection function[2]. The MIP can be placed at the ingress interface or at the egress interface of any node along the MEG.

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

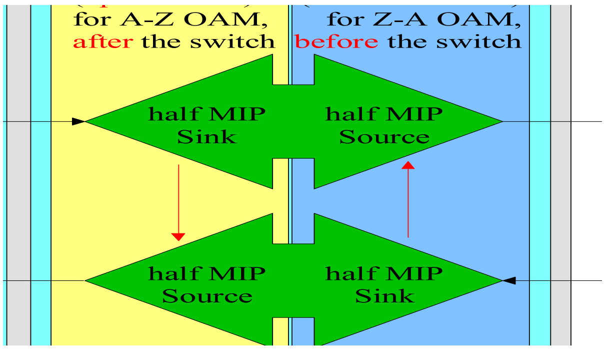

Figure 6-2/G.8113.2: Per-interface Up MEP and MIP in a node at the edge of a MEG

An intermediate node within a MEG can either:

– Support per-node MIP (i.e. a single MIP per node in an unspecified location within the node);
– Support per-interface 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], a MIP is functionally modeled as two back-to-back half MIPs as illustrated in Figure 6-3.

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[2] The connection function is called forwarding engine in [IETF RFC oam-framework]

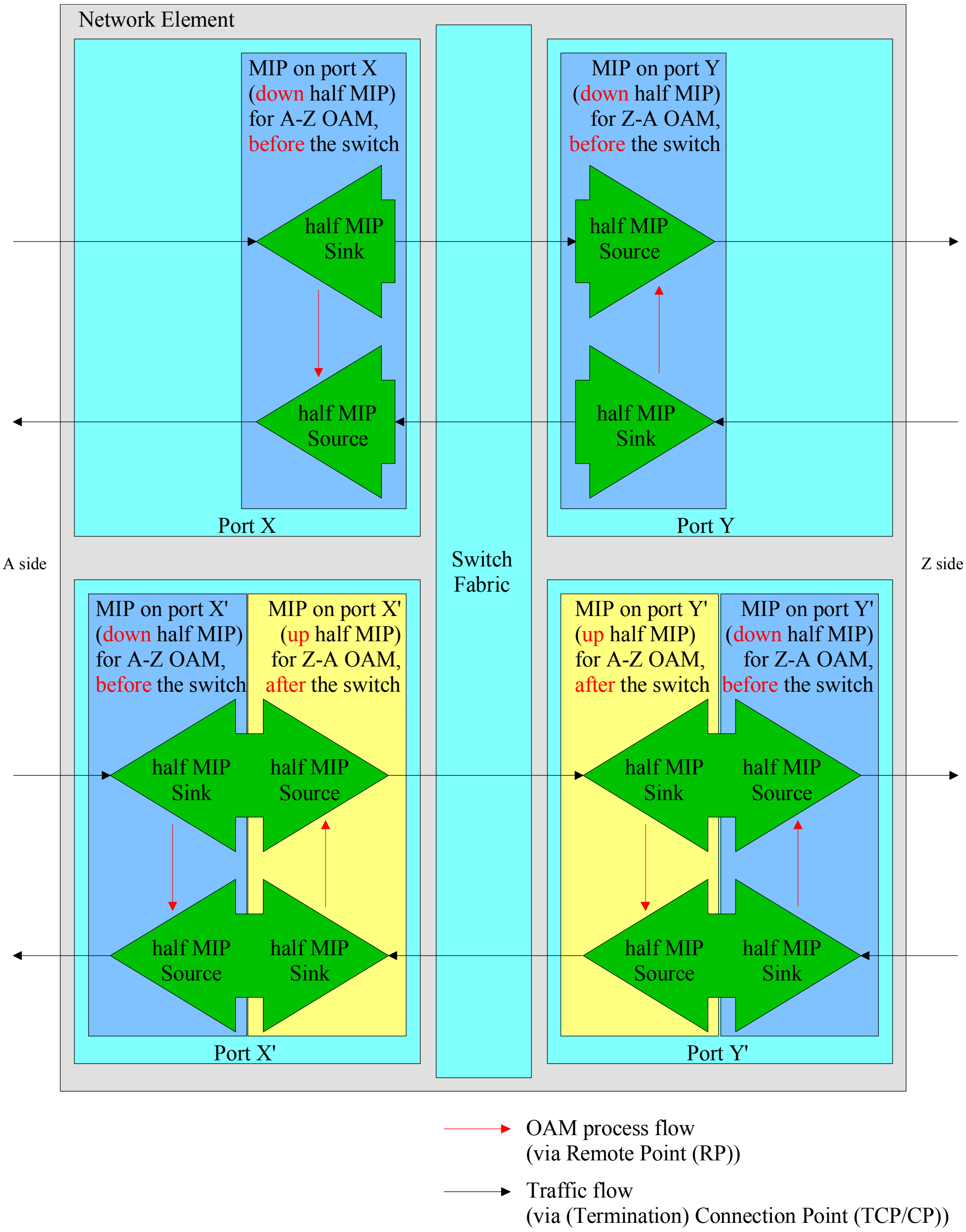

Figure 6-3/G.8113.2: Up/Down half MIPs

In Figure 6-3 above, MIP_{AX} is on the interface port X on the A-side of the NE, MIP_{ZY} is on the interface port Y on the Z-side of the NE, $MIP_{AX'}$ is on the interface port X' on the A-side of the NE, and $MIP_{ZY'}$ is on the interface port Y' on the Z-side of the NE.

MIP_{AX} is a Down half MIP. It can respond to OAM flow coming from A-side and targeted to it. It cannot respond to OAM flow coming from Z-side even targeted to it.

MIP_{ZY} is a Down half MIP. It can respond to OAM flow coming from Z-side and targeted to it. It cannot respond to OAM flow coming from A-side even targeted to it.

$MIP_{AX'}$ is a full MIP, which consists of a Down half MIP and an Up half MIP. It can respond to OAM flow coming from A-side and targeted to it. It can also respond to OAM flow targeted to it coming from Z-side and traversing the connection function.

$MIP_{ZY'}$ is a full MIP, which consists of a Down half MIP and an Up half MIP. It can respond to OAM flow coming from Z-side and targeted to it. It can also respond to OAM flow targeted to it coming from A-side and traversing the connection function.

7 OAM functions

7.1 Identification of OAM packets from user traffic packets

In order to ensure proper operational control, MPLS-TP network elements exchange OAM packets that strictly follow the same path as user traffic packets; that is, OAM packets are subject to the exact same forwarding schemes (e.g. fate sharing) as the user traffic packets. These OAM packets can be distinguished from the user traffic packets by using the G-ACh and GAL constructs, as defined in [IETF RFC 5586].

The G-ACh is a generic associated control channel mechanism for Sections, LSPs and PWs, over which OAM and other control messages can be exchanged.

The GAL is a label based exception mechanism to alert LERs/LSRs of the presence of an Associated Channel Header (ACH) after the bottom of the stack.

TTL expiration is another exception mechanism to alert intermediate LSRs of the presence of an OAM packet that requires processing.

7.1.1 G-ACh

The operation of the MPLS-TP Generic Associated Channel (G-ACh) is described in Section 3.6 of [IETF RFC 5921] and is defined in [IETF RFC 5586].

As defined in [IETF RFC 5586], Channel Types for the Associated Channel Header are allocated through the IETF consensus process. The IETF consensus process is defined in [IETF RFC 5226], where it is termed "IETF Review."

A number of experimental G-ACh Channel Types are provided for experimental use in product development without allocation; refer to [IETF RFC 3692] for further detail.

The use of G-ACh Channel Types other than in accordance with the IANA allocation is not recommended.

7.1.2 GAL

The use of the GAL is defined in Section 4.2 of [IETF RFC 5586].

7.2 OAM functions specification

Table 7-1/G.8113.2 provides a summary of MPLS-TP OAM functions, protocols used, and the corresponding IETF RFCs. All control messages are carried using G-ACh. Functional processing of these messages is described in [b-ITU-T Recommendation G.8121.2].

Table 7-1/G.8113.2: OAM Functions

Fault Management (FM) OAM Functions			
Proactive FM OAM Functions	**OAM Functions**	**Protocol definitions**	**IETF RFCs**
	Continuity Check (CC)	Bidirectional Forwarding Detection (BFD) extensions	[IETF RFC cc-cv-rdi]

	Connectivity Verification (CV)	Bidirectional Forwarding Detection (BFD) extensions	[IETF RFC cc-cv-rdi]
	Remote Defect Indication (RDI)	Flag in CC/CV message	[IETF RFC cc-cv-rdi]
	Alarm Indication Signal (AIS)	AIS message	[IETF RFC fault]
	Link Down Indication (LDI)	Flag in AIS message	[IETF RFC fault]
	Lock Report (LKR)	LKR message	[IETF RFC fault]
On demand FM OAM Functions	Connectivity Verification (CV)	LSP Ping extensions	[IETF RFC on-demand-cv]
	Transport Plane Loopback	Management control	[b-IETF RFC li-lb]
	Lock Indication (LI)	In-band Lock Instruct messages	For further study

Performance Management (PM) OAM Functions			
Proactive PM OAM Functions and **On demand PM OAM Functions**	**OAM Functions**	**Protocol definitions**	**IETF RFCs**
	Packet loss measurement (LM)	LM and DM query messages	[IETF RFC 6374] [IETF RFC 6375]
	Packet delay measurement (DM)	LM and DM query messages	
	Throughput measurement	Supported by LM	
	Delay Variation measurement	Supported by DM	

7.2.1 OAM Functions for Fault Management

7.2.1.1 Proactive OAM Functions for Fault Management

7.2.1.1.1 Continuity Check and Connectivity Verification

The CC/CV OAM functions are supported by the use of Bidirectional Forwarding Detection (BFD) Control Packets.

The source MEP sends BFD control packets periodically at the configured rate. The sink MEP monitors for the arrival of these BFD control packets at the configured rate and detects the defect of loss of continuity (LOC).

The following connectivity verification defects are detected using the CV message:

a) Mis-merge (MMG): unintended connectivity between two MEGs;

b) Unexpected MEP (UNM): unintended connectivity within the MEG with an unexpected MEP;

The following misconfiguration defect is detected using the CC/CV function:

a) Unexpected Period (UNP): BFD control packets are received with a period field value that is different from the configured BFD control packet rate.

CC/CV is used for the fault management, performance monitoring, and to trigger protection switching. A MEP periodically transmits the BFD control packet at the configured transmission period. In transport networks, the following default transmission periods are defined for CC messages:

a) 3.33ms: default transmission period for protection switching application (transmission rate of 300 packets/second)

b) 100ms: default transmission period for performance monitoring application (transmission rate of 10 packets/second)

c) 1s: default transmission period for fault management application (transmission rate of 1 packet/second)

CV messages use a default transmission period of 1s.

Other CC/CV transmission periods are not precluded. For discussion of periodicity see [IETF RFC oam-framework].

Detailed procedures for BFD are described in [IETF RFC cc-cv-rdi].

7.2.1.1.2 Remote Defect Indication

RDI is only used for bidirectional connections and is associated with proactive CC/CV activation.

The RDI OAM function is supported by the use of Bidirectional Forwarding Detection (BFD) Control Packets.

RDI is an indicator that is transmitted by a MEP to communicate to its peer MEP that a signal fail condition exists. When a MEP detects a signal fail condition, it sets the Diagnostic field of the BFD control packets it is transmitting to its peer MEP to one of the values described in [IETF RFC cc-cv-rdi]. The particular value depends on the cause of the signal fail condition.

Detailed procedures for setting diagnostic codes in BFD messages are described in [IETF RFC cc-cv-rdi].

7.2.1.1.3 Alarm Indication

This function is used to suppress downstream alarms following detection of defect conditions at the server layer/sublayer. The detection of LOC or SSF by a server layer/sublayer MEP causes the generation of OAM packets with AIS information that are forwarded to the downstream MEP(s) in the client layer/sublayer, which allows the suppression of secondary alarms (LOC, etc) in the client layer/sublayer.

A Link Down Indication (LDI) flag in the AIS message is set when a failure is detected in the server layer.

Procedures for sending AIS messages and setting the LDI flag are described in [IETF RFC fault].

7.2.1.1.4 Locked Signal

The lock report (LKR) function is used to communicate to the client layer/sublayer MEPs the administrative locking of a server layer/sublayer MEP and consequential interruption of data traffic forwarding in the client layer/sublayer. It allows a client layer/sublayer MEP receiving packets with LCK information to differentiate between a defect condition and an administrative locking action at the server layer/sublayer MEP. Details of sending LKR messages are described in [IETF RFC fault].

7.2.1.1.5 Client Signal Fail

For further study.

7.2.1.2 On-demand OAM Functions for Fault Management

7.2.1.2.1 Connectivity Verification

LSP-Ping [IETF RFC 4379] is an OAM mechanism for MPLS LSPs. [IETF RFC on-demand-cv] describes extensions to LSP-Ping to include MPLS-TP LSPs. It describes how LSP-Ping can be used for on-demand Connectivity Verification (CV) and Route Tracing functions for MPLS-TP LSPs required in [IETF RFC 5860] and specified in [IETF RFC oam-framework].

In certain MPLS-TP deployment scenarios, IP address scheme may not be available or it may be preferred to use some form of non-IP encapsulation for On-demand CV and route tracing. In such scenarios, On-demand CV and/or route tracing functions are operated without IP addresses, using the ACH specified in [IETF RFC on-demand-cv].

Procedures for on-demand CV are defined in [IETF RFC on-demand-cv].

7.2.1.2.2 Diagnostic test

For further study.

7.2.1.2.3 Transport plane loopback

The transport plane loopback function is controlled by the management plane. For further information see [b-IETF RFC li-lb].

7.2.1.2.4 Lock Indication

For further study.

7.2.2 OAM Functions for Performance Monitoring

7.2.2.1 Proactive OAM Functions for Performance Monitoring

The protocol for MPLS-TP loss and delay measurement functions is defined in [IETF RFC 6374] as profiled in [IETF RFC 6375]. These drafts specify how to measure:

- Packet Loss
- Packet Delay
- Packet Delay Variation
- Throughput

These are two closely-related protocols, one for packet loss measurement (LM) and one for packet delay measurement (DM). These protocols have the following characteristics and capabilities:

- The same LM and DM protocols can be used for both proactive and on-demand measurement.
- The LM and DM protocols use a simple query/response model for bidirectional measurement that allows a single MEP to measure the loss or delay in both directions.
- The LM and DM protocols use query messages for unidirectional loss and delay measurement. The measurement can either be carried out at the downstream MEP(s) or at the upstream MEP if an out-of-band return path is available.

- The LM and DM protocols do not require that the transmit and receive interfaces be the same when performing bidirectional measurement.
- The LM protocol can be used to measure channel throughput as well as packet loss.
- The DM protocol supports varying the measurement message size in order to measure delays associated with different packet sizes.

7.2.2.1.1 Proactive Loss Measurement

The theory of loss measurement is described in section 2.1 of [IETF RFC 6374].

The message formats are defined in section 3.1 of [IETF RFC 6374].

The protocol procedures are defined in section 4.1 of [IETF RFC 6374].

The profile applicable to MPLS-TP is defined in section 2 of [IETF RFC 6375].

7.2.2.2 On-demand OAM Functions for Performance Monitoring

The on-demand OAM functions for performance monitoring are identical to the proactive OAM performance monitoring functions.

7.2.2.2.1 On-demand Loss Measurement

The on-demand loss measurement function is identical to the proactive loss measurement function defined in 7.2.2.1.1.

7.2.2.2.2 On-demand Delay Measurement

The theory of delay measurement is described in section 2.3 of [IETF RFC 6374].

The message formats are defined in section 3.2 of [IETF RFC 6374].

The protocol procedures are defined in section 4.2 of [IETF RFC 6374].

The profile applicable to MPLS-TP is defined in section 3 of [IETF RFC 6375].

7.2.3 Other Functions

7.2.3.1 Management communication channel/Signaling communication channel

The management communications channel (MCC) and signaling communications channel (SCC) are defined in [IETF RFC 5718] and [ITU-T G.7712].

7.2.3.2 Vendor-Specific

Vendor-specific OAM functions are not supported in this Recommendation.

7.2.3.3 Experimental

A number of experimental G-ACh Channel Types are provided for product development. Use of these is defined in [IETF RFC 3692].

8 OAM Packet Formats

The packet formats for MPLS-TP OAM are defined in the corresponding IETF RFCs as listed below.

8.1 Continuity Check and Connectivity Verification

8.1.1 Bidirectional Forwarding Detection (BFD) message formats

The BFD message format is defined in [IETF RFC 5884]. Descriptions of carrying this message on an MPLS-TP LSP and appending TLVs to carry MEP identification are described in [IETF RFC cc-cv-rdi].

8.1.2 On-demand Connectivity Verification (CV) formats

The formats for on-demand CV are defined in [IETF RFC on-demand-cv].

8.2 Transport plane Loopback formats

Because Loopback is management controlled, there are no control message formats associated with this function

8.3 Alarm Indication Signal (AIS) and Link Down Indication (LDI) formats

The AIS message format and LDI flag are defined in section 4 of [IETF RFC fault].

8.4 Lock Indication (LI) and Lock Report (LKR) formats

The lock instruct message format is for further study.

The lock report message format is defined in section 4 of [IETF RFC fault].

8.5 Test (TST) formats

For further study.

8.6 Loss Measurement (LMM/LMR) formats

The loss message formats are defined in section 3.1 of [IETF RFC 6374].

The profile applicable to MPLS-TP is defined in section 2 of [IETF RFC 6375].

Note that loss and delay measurements may be combined as described in section 3.3 of [IETF RFC 6374].

8.7 One-way Delay Measurement (1DM) formats

The message formats are defined in section 3.2 of [IETF RFC 6374].

The profile applicable to MPLS-TP is defined in section 3 of [IETF RFC 6375].

Note that loss and delay measurements may be combined as described in section 3.3 of [IETF RFC 6374].

8.8 Two-way Delay Measurement (DMM/DMR) formats

The message formats are defined in section 3.2 of [IETF RFC 6374].

The profile applicable to MPLS-TP is defined in section 3 of [IETF RFC 6375].

Note that loss and delay measurements may be combined as described in section 3.3 of RFC [IETF RFC 6374].

8.9 Client Signal Fail (CSF) formats

For further study.

8.10 Experimental (EXM/EXR) formats

A number of experimental G-ACh Channel Types are provided for product development. Use of these is defined in [IETF RFC 3692].

8.11 Management Communication Channel and Signaling Communication Channel formats

[IETF RFC 5718] describes how the G-ACh is used to provide the infrastructure that forms part of the Management Communication Network. A description of the Management Communication Channel (MCC) message format can be found in Section 2 of [IETF RFC 5718]. The Associated Channel Type assigned to this channel by IANA can be found in the Pseudowire Associated Channel Types Registry at http://www.iana.org/assignments/pwe3-parameters. The value assigned for MCC is 0x0001. The value assigned for SCC is 0x0002.

9 MPLS-TP OAM Procedures

The procedures for MPLS-TP OAM are defined in the corresponding IETF RFCs.

9.1 Continuity Check and Connectivity Verification

9.1.1 Bidirectional Forwarding Detection Message (BFD) procedures

The BFD message format is defined in [IETF RFC 5884]. The procedures are based upon [IETF RFC 5881] as updated by [IETF RFC cc-cv-rdi].

9.1.2 On-demand Connectivity Verification (CV) procedures

The on-demand CV procedures are defined in [IETF RFC on-demand-cv].

9.2 Transport plane Loopback procedures

The Loopback procedures are described in section 4 of [b-IETF RFC li-lb].

9.3 Alarm Indication Signal (AIS) and Link Down Indication (LDI) procedures

When the server layer trail termination sink asserts signal fail, it notifies the server/MT_A_Sk function that raises the aAIS consequent action. The aAIS is cleared when the server layer trail termination clears the signal fail condition and notifies the server/MT_A_Sk.

When the aAIS consequent action is raised, the server/MT_A_Sk continuously generates MPLS Fault OAM messages with the message type set to AIS until the aAIS consequent action is cleared. Procedures for sending MPLS Fault OAM can be found in [IETF RFC fault].

It is recommended that AIS is generated once per second.

When a MEP receives an AIS message, it detects the dAIS defect as described in clause 6.1 of [b-ITU-T G.8121.2].

9.4 Lock Indication (LI) and Lock Report (LKR) procedures

The lock instruct procedures are for further study.

The lock report procedures are defined in section 5 of [IETF RFC fault].

9.5 Test (TST) procedures

For further study

9.6 Loss Measurement (LMM/LMR) procedures

The loss measurement procedures are defined in section 4.1 of [IETF RFC 6374].

The profile applicable to MPLS-TP is defined in section 2 of [IETF RFC 6375].

9.7 One-way Delay Measurement (1DM) procedures

The one-way delay measurement procedures are defined in section 4.2 of [IETF RFC 6374].

The profile applicable to MPLS-TP is defined in section 3 of [IETF RFC 6375].

9.8 Two-way Delay Measurement (DMM/DMR) procedures

The two-way delay measurement procedures are defined in section 4.2 of [IETF RFC 6374].

The profile applicable to MPLS-TP is defined in section 3 of [IETF RFC 6375].

9.9 Client Signal Fail (CSF) procedures

For further study

Appendix I

MPLS-TP network scenarios

(This appendix does not form an integral part of this Recommendation)

I.1 MEG nesting example

Figure I.1 provides an example scenario, using the default MEG level, of nested MEGs for customer, provider and operator roles. In the figure, triangles represent MEPs, circles represent MIPs, and diamonds represent Traffic Conditioning Points (TrCPs).

Figure I.1 shows an example of network implementation; MEPs and MIPs should be configured per interface, not per node. Upside-down triangles (▼) indicate Down MEPs and normal triangles (▲) indicate Up MEPs.

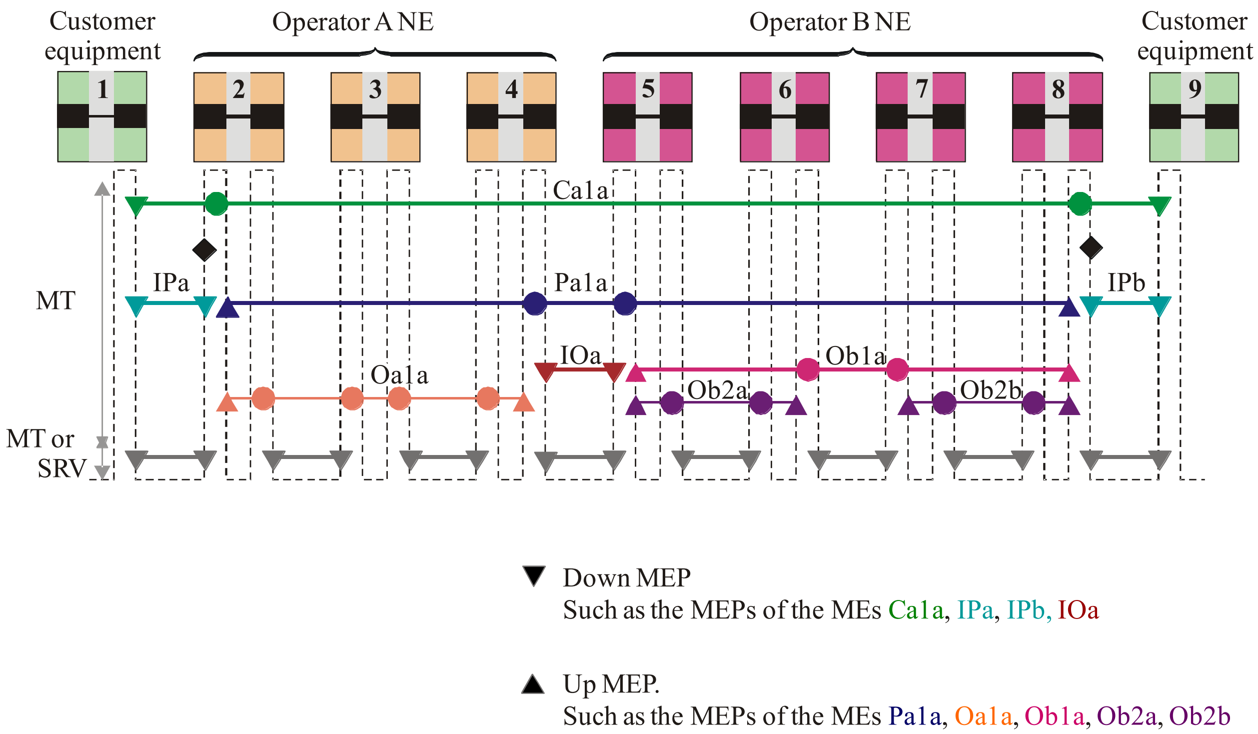

Figure I.1/G.8113.2 – Example MEG nesting

– UNI_C to UNI_C customer ME (Ca1a).

– UNI_N to UNI_N provider ME (Pa1a).

– End-to-end operator MEs (Oa1a and Ob1a).

– Segment operator MEs in operator B's network (Ob2a and Ob2b).

– UNI_C to UNI_N MEs (IPa and IPb) between the customer and provider.

– Inter-operator ME (IOa).

Bibliography

[b-ITU-T G.8121.2] ITU-T Draft Recommendation G.8121.2/Y.1381.2 (2011), *Characteristics of MPLS-TP equipment functional blocks supporting G.8113.2/Y.1372.2*.

[b-IETF RFC li-lb] IETF Internet Draft draft-ietf-mpls-tp-li-lb-04, *MPLS-TP Lock Instruct and Loopback Functions*.

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