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The draft recommendation is based on wd14（Stockholm, 12-16 April, 2010）with an updated reference, MEP/MIP definition and tool set according to agreement during meeting in Stockholm. The changes are marked.

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Draft new ITU-T Recommendation G.tpoam

Operations, Administration and Maintenance mechanism for MPLS-TP networks

Summary

This Recommendation provides mechanisms for user-plane OAM (Operation Administration and Maintenance) functionality in MPLS-TP networks according to the requirements and principles given in IETF draft-ietf-mpls-tp-oam-requirements (Requirements for OAM in MPLS Transport Profile). The OAM mechanisms defined in this Recommendation assume common forwarding of the MPLS-TP user packets and MPLS-TP OAM packets.

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Issue	Notes
0.2	Update reference and OAM toolset (06/2010)
0.1	Update reference (04/2010)
0.0	Initial version (05/2009)

1 Scope

This Recommendation specifies mechanisms for user-plane OAM (Operation Administration and Maintenance) in MPLS-TP networks to meet the MPLS-TP OAM requirements defined in IETF draft-ietf-mpls-tp-oam-requirements. It also specifies the MPLS –TP OAM packet formats, syntax and semantics of MPLS-TP OAM packet fields.

The OAM mechanisms defined in this Recommendation assume common forwarding of the MPLS-TP user packets and MPLS-TP OAM packets.

The MPLS-TP OAM mechanisms as described in this Recommendation apply to both bidirectional point-to-point MPLS-TP connections and unidirectional point-to-point and point-to-multipoint MPLS-TP connections.

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

[ITU-T G.8110.1] ITU-T Recommendation G.8110.1/Y.1370.1 (2009), *Architecture of MPLS Transport Profile (MPLS-TP) layer network.*

[ITU-T G.8121] ITU-T Recommendation G.8121 (2009), *Characteristics of MPLS Transport Profile (MPLS-TP) Equipment Functional Blocks.*

[ITU-T G.8131] ITU-T Recommendation G.8131 (2009), *MPLS Transport Profile (MPLS-TP) linear protection switching.*

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

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

[IETF RFC 4385] IETF RFC4385 (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 3443] IETF RFC 3443 (2003), *"Time To Live (TTL) Processing in Multi-Protocol Label Switching (MPLS) Networks".*

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

[IETF RFC 5654] IETF RFC5654 (2009), *"Requirements of an MPLS Transport Profile".*

[IETF RFC 5718] IETF RFC5718 (2010), *"An In-Band Data Communication Network For the MPLS Transport Profile".*

[IETF RFC xxxx] IETF RFC ietf-mpls-tp-oam-requirements (2010), *Requirements for OAM in MPLS Transport Networks.*

[IETF RFCxxxx] IETF RFC ietf-mpls-tp-oam-framework (2010), *"MPLS-TP OAM Framework".*

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.**

[Editor's note]: To be added in a future version.

4 Abbreviations

This Recommendation uses the following abbreviations:

ACH Associated Channel Header

G-ACh Generic Associated Channel

GAL G-ACh Label

MPLS-TP MPLS Transport Profile

[Editor's note]: To be added in a future version.

5 Functional Components

~~*[Editor's note]: Refer to Q12 work on G.8110.1 about the usage of MEG.]*~~

5.1 Maintenance Entity (ME)

A Maintenance Entity (ME) can be viewed as the association between two ~~(or more)~~ Maintenance End Points (MEPs). that applies maintenance and monitoring operations to a transport path or part of a transportation path, defined as Tandem Connection.

In case of unidirectional point-to-point transport paths, a single unidirectional Maintenance Entity is defined to monitor it.

In case of associated bi-directional point-to-point transport paths, two independent unidirectional Maintenance Entities are defined to independently monitor each direction.

In case of co-routed bi-directional point-to-point transport paths, a single bidirectional Maintenance Entity is defined to monitor both directions congruently.

In case of unidirectional point-to-multipoint transport paths, a single unidirectional Maintenance entity for each leaf is defined to monitor the transport path from the root to that leaf. ~~An example of an ME with more than two MEPs is a point-to-multipoint ME monitoring a point-to-multipoint transport path (or point-to-multipoint tandem connection).~~

~~A Maintenance Entity may be defined to monitor and manage unidirectional point-to-point or point-to-multipoint transport paths or tandem connections, or bidirectional point-to-point transport paths and tandem connections in an MPLS-TP layer network.~~

~~MEs can nest but shall not overlap.~~

5.2 Maintenance End Group (MEG)

A Maintenance Entity Group (MEG) is the set of one or more MEs that belongs to the same transport path or part of a transportation path in the same OAM domain and are maintained and monitored as a group.

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~~5.2~~5.3 M~~aintenance~~EG End Points (MEPs)

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M~~aintenance~~EG End Points (MEPs) are the end points of a MEG. MEPs are responsible for activating and controlling all of the OAM functionality for the MEG. A MEP is capable of originating and terminating OAM messages for fault management and performance monitoring.

A MEP may initiate an OAM packet to be transferred to its corresponding 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 fault free implementation.

~~MEPs prevent OAM packets corresponding to a ME from leaking outside that ME:~~

~~- o A MEP sink terminates all the OAM packets that it receives corresponding to its ME and does not forward them further along the path.~~

~~- o A MEP source tunnels all the OAM packets that it receives, upstream from the associated ME, via label stacking. These packets are not processed within the ME as they belong to another ME.~~

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~~5.3~~5.4 MEG~~Maintenance~~ Intermediate Points (MIPs)

A MEG ~~Maintenance~~ Intermediate Point (MIP) is an intermediate point between the two MEPs in an 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 resides within a MEG between MEPs ~~A MIP belongs to only one ME.~~

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 it belongs to.

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 the MIP itself.

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~~5.4~~5.5 Server MEP

A Server MEP represents the compound function of the Server (sub-)layer termination function and Server/MPLS-TP adaptation function which is used to notify the MPLS-TP layer MEPs upon failure detection by the Server (sub-)layer termination function or Server/MPLS-TP adaptation function, where the Server (sub-)layer termination function is expected to run OAM mechanisms specific to the Server (sub-)layer.

6 OAM mechanisms

6.1 Identification of OAM packets from normal user traffic

OAM packets are subject to the exact same forwarding schemes (e.g. fate sharing) as the user traffic, but they can be distinguished from the user traffic using GAL and G-ACh constructs.

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

6.1.1 G- ACh

VCCV can use an Associated Channel Header (ACH) to provide a PW-associated control channel between a PW's end points for exchanging OAM and other control messages.

The Generic Associated Channel (G-ACh) is associated channel that generalizes the applicability of the ACH for PWs in a transport context while maintaining compatibility with the PW associated channel. The ACH, specified in RFC 4385, may be used with additional code points to support additional OAM functions on the G-ACh.

G-ACh applies to Sections, LSPs and PWs.

The format of G-ACh is specified in Sub-clause 7.1.

6.1.2 GAL

G-ACh Label (GAL) is used to indicate that a packet contains an ACH followed by a non-service payload thus generalizing the associated control channel mechanism to LSPs and Sections.

One of the reserved label values defined in RFC 3032 [5] is assigned for this purpose. The value of the label is suggested as 13.

The GAL provides an alert based exception mechanism to:

- o differentiate specific packets (i.e., G-ACh packets) from others, such as user-plane ones,
- o indicate that the ACH appears immediately after the bottom of the label stack.

The GAL MUST only be used where both these purposes apply. In MPLS-TP, the GAL MUST be used with packets on a G-ACh on LSPs, Concatenated Segments of LSPs, and with Sections, and MUST NOT be used with PWs. It MUST always be at the bottom of the label stack (i.e., S bit set to 1).

The format of GAL is specified in Sub-clause 7.1.

6.2 OAM tools specification

[Editors' notes]: The following tool set is based on WD21 and WD28 of Q9,10,12,14 joint Stockholm meeting, April 2010

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Pro-active OAM	Fault management	Continuity Check and Connectivity Verification (CC/CV)
		Remote Defect Indication (RDI)
		Alarm supression（FDI/AIS）
		Client Failure Indication（CSF）
	Performance management	Loss measurement（LM）
		Delay measurement（DM）
On demand OAM	Fault management	Loopback（LB）
		Link trace（LT）
		Diagnostic test（TST）
		Lock（LCK）
	Performance management	Loss measurement（LM）
		Delay measurement（DM）
Other OAM	Automatic Protection Switching (APS)	
	Management communication channel/ Signaling communication channel (MCC/SCC)	
	Clock (SSM）	
	Vendor specifc（VS）	
	Experimental specific（ES）	

6.2.1 Proactive OAM

6.2.1.1 OAM Functions for Fault Management

[Editor's note]: To be added after the relevant IETF RFCs/I-Ds regarding MPLS-TP OAM tools are available.

- **Continuity Check and Connectivity Verification**
- **Remote Defect Indication**
- **Alarm suppression**
- **Client Failure Indication**

6.2.1.2 OAM Functions for Performance Monitoring

[Editor's note]: To be added after the relevant IETF RFCs/I-Ds regarding MPLS-TP OAM tools are available.

- **Loss measurement**
- **Delay measurement**

6.2.2 On demand OAM

6.2.2.1 OAM Functions for Fault Management

- **Loopback**
- **Link trace**
- **Diagnostic test**
- **Lock**

6.2.2.2 OAM Functions for Performance Monitoring

- **Loss measurement**
- **Delay measurement**

6.2.3 Other Functions

[Editor's note]: To be added after the relevant IETF RFCs/I-Ds regarding MPLS-TP OAM tools are available.

- **Automatic protection switching**
- **Management communication channel/ Signaling communication channel**
- **Clock**
- **Vendor specifc**
- **Experimental specific**

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7 OAM Packet Formats

7.1 Common OAM packets

The format of GAL is as follows:

1								2								3								4							
1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Label (13)																TC				S				TTL							

The value of GAL is suggested as 13.

The Traffic Class (TC) field (formerly known as the EXP field) of the Label Stack Entry (LSE) containing the GAL follows the definition and processing rules specified and referenced in IETF RFC 5462.

S bit is set to 1. GAL MUST always be at the bottom of the label stack.

The Time-To-Live (TTL) field of the LSE that contains the GAL MUST be set to at least 1 and follow the definition and processing rules specified in RFC 3443.

The format of Associated Channel Header is as follows:

1								2								3								4							
1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
0001				Version(0)				Reserved (0)								Channel Type															

The first nibble is set to 0001b to indicate a control channel associated with a PW, an LSP or a Section.

The Version field is set to 0.

The Reserved field is set to 0 and ignored on reception.

Channel Type indicates the specific OAM protocol carried in the associated control channel. The values are TBD.

7.2 OAM PDU Formats

[Editor's note]: Based on the OAM functions defined in Clause 6

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Bibliography

[ITU-T Y.Sup4] ITU-T Supplement Y.Sup4 (2008), *Supplement on Transport requirements for T-MPLS OAM and considerations for the application of IETF MPLS technology*.

[IETF RFC 5317] IETF RFC 5317(2009), J*oint Working Team (JWT) Report on MPLS Architectural Considerations for a Transport Profile.*

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