CCAMP Working Group	E. Bellagamba, Ed.
Internet-Draft	L. Andersson, Ed.
Intended status: Standards Track	Ericsson
Expires: July 26, 2010	P. Skoldstrom, Ed.
	Acreo AB
	January 22, 2010

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RSVP-TE Extensions for MPLS-TP OAM Configuration
draft-bellagamba-ccamp-rsvp-te-mpls-tp-oam-ext-04

Abstract

This specification is complementary to the GMPLS OAM Configuration Framework [OAM-CONF-FWK] and describes technology specific aspects for the configuration of pro-active MPLS Operations, Administration and Maintenance (OAM) functions.

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1. Introduction

TOC

This document defines the technology specific extensions of RSVP-TE for the configuration of pro-active MPLS Operations, Administration and Maintenance (OAM) functions. In particular it specifies extensions to establish MPLS OAM entities monitoring a signaled LSP, and defines information elements and procedures to configure pro-active MPLS OAM functions. Initialization and control of on-demand MPLS OAM functions are expected to be carried out by directly accessing network nodes via a management interface; hence configuration and control of on-demand OAM functions are out-of-scope of this document.
Pro-active MPLS OAM is based on the Bidirectional Forwarding Detection (BFD) protocol [BFD]. Bidirectional Forwarding Detection (BFD), as

described in [BFD], defines a protocol that provides low-overhead, short-duration detection of failures in the path between two forwarding engines, including the interfaces, data link(s), and to the extent possible the forwarding engines themselves. BFD can be used to track the liveliness of MPLS-TP point-to-point and p2mp connections and detect data plane failures.
MPLS Transport Profile (MPLS-TP) describes a profile of MPLS that enables operational models typical in transport networks, while providing additional OAM, survivability and other maintenance functions not currently supported by MPLS. [MPLS-TP-OAM-REQ] defines the requirements by which the OAM functionality of MPLS-TP should abide. BFD has been chosen to be the basis of pro-active MPLS-TP OAM functions. MPLS OAM extensions for transport applications, which are relevant for this document, are specified in [BFD-CCCV], [MPLS-PM] and [MPLS-FMS].

1.1. Contributing Authors

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The editors gratefully acknowledge the contributions of Attila Takacs and Benoit Tremblay.

1.2. Requirements Language

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The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 (Bradner, S., “Key words for use in RFCs to Indicate Requirement Levels,” March 1997.) [RFC2119].

1.3. Overview of BFD OAM operation

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BFD is a simple hello protocol that in many respects is similar to the detection components of well-known routing protocols. A pair of systems transmits BFD packets periodically over each path between the two systems, and if a system stops receiving BFD packets for long enough, some component in that particular bidirectional path to the neighboring system is assumed to have failed. Systems may also negotiate to not send periodic BFD packets in order to reduce overhead.
A path is only declared to be operational when two-way communication has been established between systems, though this does not preclude the

use of unidirectional links to support bidirectional paths (co-routed or bidirectional or associated bidirectional).
Each system estimates how quickly it can send and receive BFD packets in order to come to an agreement with its neighbor about how rapidly detection of failure will take place. These estimates can be modified in real time in order to adapt to unusual situations. This design also allows for fast systems on a shared medium with a slow system to be able to more rapidly detect failures between the fast systems while allowing the slow system to participate to the best of its ability.
The ability of each system to control the BFD packet transmission rate in both directions provides a mechanism for congestion control, particularly when BFD is used across multiple network hops.
As recommended in [BFD-CCCV], the BFD tool needs to be extended for the proactive CV functionality by the addition of an unique identifier in order to meet the requirements. The document in [BFD-CCCV] specifies the BFD extension and behavior to meet the requirements for MPLS-TP proactive Continuity Check and Connectivity Verification functionality and the RDI functionality as defined in [MPLS-TP-OAM-REQ].

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2. Overview of MPLS OAM for Transport Applications

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[MPLS-TP-OAM-FWK] describes how MPLS OAM mechanisms are operated to meet transport requirements outlined in [MPLS-TP-OAM-REQ].
[BFD-CCCV] specifies two BFD operation modes: 1) "CC mode", which uses periodic BFD message exchanges with symmetric timer settings, supporting Continuity Check, 2) "CV/CC mode" which sends unique maintenance entity identifiers in the periodic BFD messages supporting Connectivity Verification as well as Continuity Check.
[MPLS-PM] specifies mechanisms for performance monitoring of LSPs, in particular it specifies loss and delay measurement OAM functions.
[MPLS-FMS] specifies fault management signals with which a server LSP can notify client LSPs about various fault conditions to suppress alarms or to be used as triggers for actions in the client LSPs. The following signals are defined: Alarm Indication Signal (AIS), Link Down Indication (LDI) and Locked Report (LKR). To indicate client faults associated with the attachment circuits Client Signal Failure Indication (CSF) can be used. CSF is described in [MPLS-TP-OAM-FWK].
[MPLS-TP-OAM-FWK] describes the mapping of fault conditions to consequent actions. Some of these mappings may be configured by the operator, depending on the application of the LSP. The following defects are identified: Loss Of Continuity (LOC), Misconnectivity, MEP Misconfiguration and Period Misconfiguration. Out of these defect conditions, the following consequent actions may be configurable: 1) whether or not the LOC defect should result in blocking the outgoing data traffic; 2) whether or not the "Period Misconfiguration defect" should result a signal fail condition.

3. RSVP-TE Extensions

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3.1. MPLS OAM Configuration Operation Overview

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RSVP-TE can be used to simply establish (i.e., bootstrap) a BFD session or it can configure, at different level of details, all pro-active MPLS OAM functions. When RSVP-TE is used to configure BFD, BFD MUST be run in asynchronous mode and both sides should be in active mode.

In the simplest scenario RSVP-TE signaling is used only to bootstrap the BFD session. In this case in the Path message the OAM Type in the "OAM Configuration TLV" is set to "MPLS OAM". Only the "CC" OAM Function flag is set in the "OAM Configuration TLV" and a "BFD Configuration sub-TLV" is inserted in the "OAM Configuration TLV", carrying a "Local Discriminator sub-TLV" with the discriminator value selected locally for the BFD session of the signaled LSP. The N bit MUST be set to enable timer negotiation/re-negotiation via BFD Control Messages. The receiving node MUST use the Local Discriminator value received in the Path message to identify the remote end of the BFD session, select a local discriminator value and MUST start sending BFD Control Messages after it sent the Resv message. The Resv message MUST include the LSP_ATTRIBUTES Object reflecting back the contents of the "OAM Configuration TLV", except that the "Local Discriminator sub-TLV" MUST carry the discriminator value used by the sender of the Resv message. Timer negotiation is left to subsequent BFD control messages. This operation is similar to LSP Ping based bootstrapping described in [BFD-MPLS].

For detailed MPLS OAM configuration RSVP-TE can be used to configure all parameters of pro-active MPLS OAM mechanisms. If "CC mode" OAM is to be established, the OAM Type in the "OAM Configuration TLV" is set to MPLS OAM, only the "CC" OAM Function flag is set in the "OAM Configuration TLV" and the "BFD Configuration TLV" is inserted in the "OAM Configuration TLV". The "Local Discriminator sub-TLV" is used as described above. Timer negotiation in this case is done via the RSVP-TE control plane, hence the N bit MUST be cleared to disable timer negotiation/re-negotiation via BFD Control Messages. The "Timer Negotiation Parameters sub-TLV" MUST be present in the "BFD configuration TLV" to specify the acceptable interval for the BFD CC messages.

When timer negotiation is done via the RSVP-TE control plane, two configuration options are available: symmetric and asymmetric configuration. If symmetric configuration is required, S flag in "BFD configuration TLV" MUST be set. If the flag is cleared, the

configuration is completed asymmetrically in the two directions. Section 3.3.2 includes a detailed explanation of such configuration.
In the case of the "CV/CC mode" OAM [BFD-CCCV], the "CV" flag MUST be set in addition to the CC flag in the "OAM Configuration TLV". The information required to support this functionality is defined in [MPLS-TP-IDENTIF] and can be found respectively in the SESSION and SENDER_TEMPLATE object with no need of further sub-TLV as described in section 3.2.
Additional OAM functions can be requested by setting the PM/Loss and PM/Delay OAM Function flags in the "OAM Configuration TLV". If these flags are set, corresponding sub-TLVs may be included in the "OAM Configuration TLV".
If Fault Management Signals [MPLS-FMS] are required, the Fault Management Signals (FMS) OAM Function flag needs to be set in the "OAM Configuration TLV". If this flag is set, an additional "FMS sub-TLV" may be included in the OAM Configuration TLV.

3.2. OAM Configuration TLV

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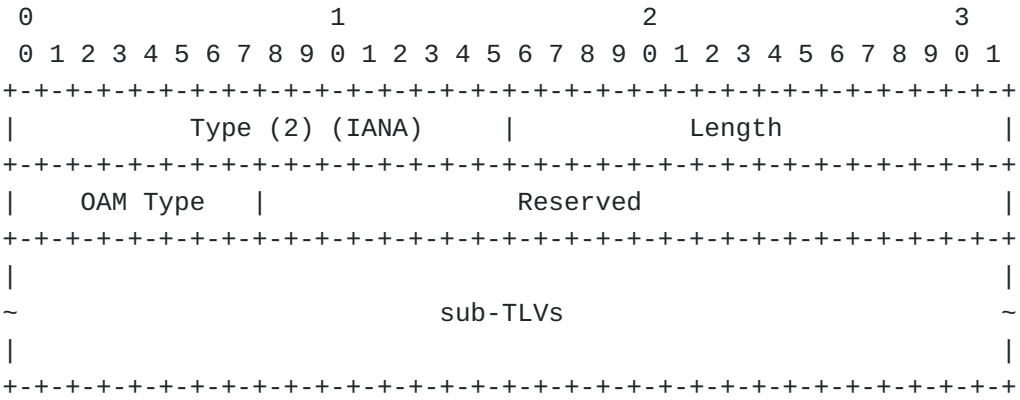
Below is specified the "OAM Configuration TLV", defined in [OAM-CONF-FWK]. It specifies which OAM technology/method should be used for the LSP. The "OAM Configuration TLV" is carried in the LSP_ATTRIBUTES object in Path messages.



Type: indicates the "OAM Configuration TLV" (2) (IANA to assign).
OAM Type: one octet that specifies the technology specific OAM Type. If the requested OAM Type is not supported, an error must be generated: "OAM Problem/Unsupported OAM Type".
This document defines a new OAM Type: "MPLS OAM" (suggested value 2, IANA to assign) from the "RSVP-TE OAM Configuration Registry". The "MPLS OAM" type is to be set in the "OAM Configuration TLV" [OAM-CONF-FWK] to request the establishment of OAM entities for MPLS LSPs.

The receiving LER when the MPLS-TP OAM Type is requested should check which OAM Function Flags are set in the "Function Flags TLV" and look for the corresponding technology specific configuration TLV.
This document specifies the following sub-TLVs to be carried in the "OAM Configuration TLV" for MPLS OAM configuration.

> - "BFD Configuration sub-TLV", which MUST be included if the CC OAM Function flag is set. This sub-TLV MUST carry a "BFD Local Discriminator sub-TLV" and a "Timer Negotiation Parameters sub-TLV" if the N flag is cleared.
>
> - "MPLS OAM PM Loss sub-TLV", which MAY be included if the PM/Loss OAM Function flag is set. If the "MPLS OAM PM Loss sub-TLV" is not included, default configuration values are used.
>
> - "MPLS OAM PM Delay sub-TLV", which MAY be included if the PM/Delay OAM Function flag is set. If the "MPLS OAM PM Delay sub-TLV" is not included, default configuration values are used.
>
> - "MPLS OAM FMS sub-TLV", which MAY be included if the FMS OAM Function flag is set. If the "MPLS OAM FMS sub-TLV" is not included, default configuration values are used.

Moreover, if the CV flag is set, the CC flag MUST be set at the same time. The format of an MPLS-TP CV/CC message is shown in [BFD-CCCV] and it requires, together with the BFD control packet information, the "Unique MEP-ID of source of BFD packet". [MPLS-TP-IDENTIF] defines the composition of such identifier as:
<"Unique MEP-ID of source of BFD packet"> ::=
<src_node_id><src_tunnel_num><lsp_num>
GMPLS signaling [RFC 3473] uses a 5-tuple to uniquely identify an LSP within an operator's network. This tuple is composed of a Tunnel Endpoint Address, Tunnel_ID, Extended Tunnel ID, and Tunnel Sender Address and (GMPLS) LSP_ID.
Hence, the following mapping is used without the need of redefining a new TLV for MPLS-TP proactive CV purpose.

> - Tunnel ID = src_tunnel_num
>
> - Tunnel Sender Address = src_node_id
>
> - LSP ID = LSP_Num

"Tunnel ID" and "Tunnel Sender Address" are included in the "SESSION" object [RFC 3209], which is mandatory in both Path and Resv messages. "LSP ID" will be the same on both directions and it is included in the "SENDER_TEMPLATE" object [RFC 3209] which is mandatory in Path messages.
[Author's note: the same "Unique MEP-ID of source" will be likely required for Performance monitoring purposes. However for the moment in

[MPLS-PM] it is stated: "The question of ACH TLV usage and the manner of supporting metadata such as authentication keys and node identifiers is deliberately omitted. These issues will be addressed in a future version of the document."]

3.3. BFD Configuration TLV

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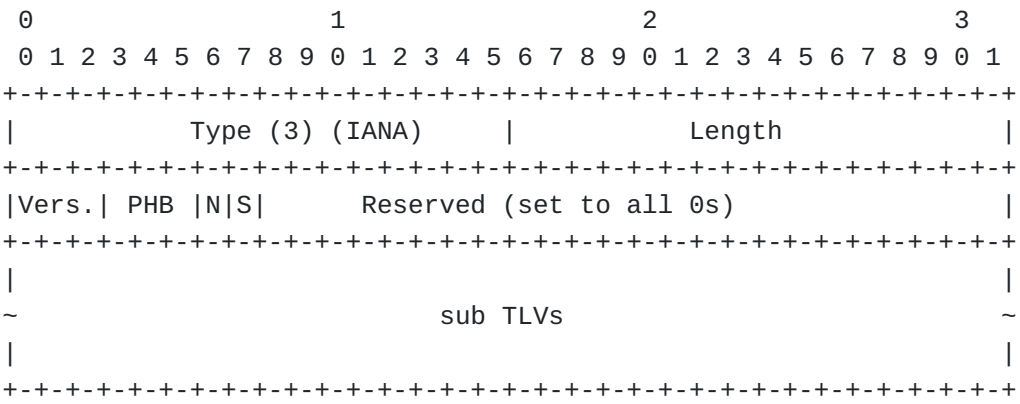
The "BFD Configuration TLV" (depicted below) is defined for BFD OAM specific configuration parameters. The "BFD Configuration TLV" is carried as a sub-TLV of the "OAM Configuration TLV" in the LSP_ATTRIBUTES object both in Path and Resv messages.
This new TLV accommodates generic BFD OAM information and carries sub-TLVs.



Type: indicates a new type, the "BFD Configuration TLV" (IANA to define).
Length: indicates the total length including sub-TLVs.
Version: identifies the BFD protocol version. If a node does not support a specific BFD version an error must be generated: "OAM Problem/Unsupported OAM Version &rdquo".
PHB: Identifies the Per-Hop Behavior (PHB) to be used for periodic continuity monitoring messages.
BFD Negotiation (N): If set timer negotiation/re-negotiation via BFD Control Messages is enabled, when cleared it is disabled.
The "BFD Configuration TLV" MUST include the following sub-TLVs in the Path message:

- "Local Discriminator sub-TLV";

- "Negotiation Timer Parameters sub-TLV" if N flag is cleared.

The "BFD Configuration TLV" MUST include the following sub-TLVs in the Resv message:

- "Local Discriminator sub-TLV;"

- "Negotiation Timer Parameters sub-TLV" if:

  - N flag and S are cleared

  - N flag is cleared and S flag is set and a timing value higher than the one received needs to be used

---

3.3.1. Local Discriminator sub-TLV

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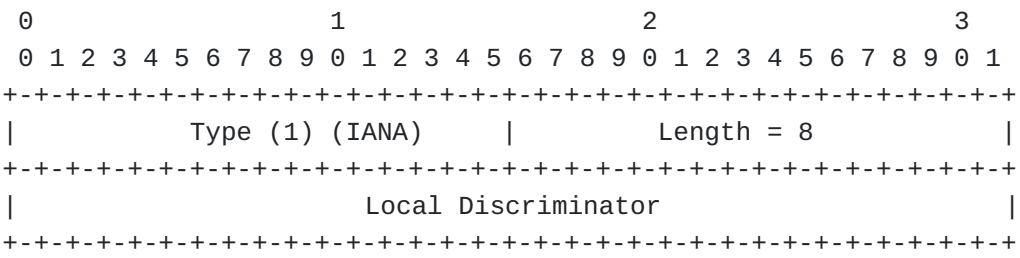
The "Local Discriminator sub-TLV" is carried as a sub-TLV of the BFD Configuration sub-TLV in both Path and Resv messages. It is depicted below.

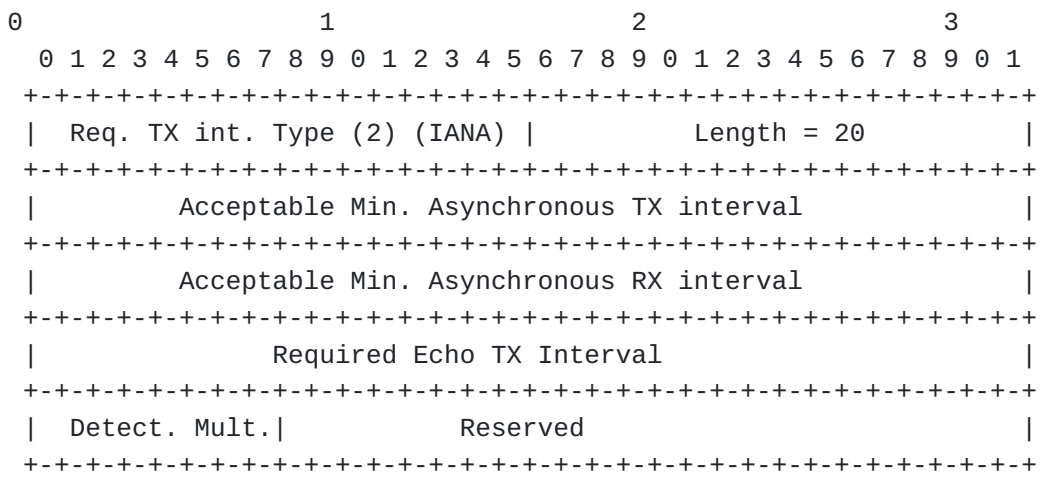


Type: indicates a new type, the Local Discriminator sub TLV (1) (IANA to define).
Length: indicates the TLV total length in octets.
Local Discriminator: A unique, nonzero discriminator value generated by the transmitting system and referring to itself, used to demultiplex multiple BFD sessions between the same pair of systems.

3.3.2. Negotiation Timer Parameters

TOC

The "Negotiation Timer Parameters sub-TLV" is depicted below.



Type: indicates a new type, the "Negotiation Timer Parameters sub-TLV" (IANA to define).
Length: indicates the TLV total length in octets.
Acceptable Min. Asynchronous TX interval: in case of S (symmetric) flag set in the "BFD Configuration" TLV, it expresses the desired time interval (in microseconds) at which the LER initiating the signaling intends to both transmit and receive BFD periodic control packets. If the receiving LER can not support such value, it is allowed to reply back with an interval greater than the one proposed.
In case of S (symmetric) flag cleared in the "BFD Configuration TLV", this field expresses the desired time interval (in microseconds) at which a LER intends to transmit BFD periodic control packets in its transmitting direction.
Acceptable Min. Asynchronous RX interval: in case of S (symmetric) flag set in the "BFD Configuration TLV", this field MUST be equal to "Acceptable Min. Asynchronous TX interval" and has no additional meaning respect to the one described for "Acceptable Min. Asynchronous TX interval".
In case of S (symmetric) flag cleared in the "BFD Configuration TLV", it expresses the minimum time interval (in microseconds) at which LERs can receive BFD periodic control packets. In case this value is greater than the "Acceptable Min. Asynchronous TX interval" received from the other LER, such LER MUST adopt the interval expressed in this "Acceptable Min. Asynchronous RX interval".
Required Echo TX Interval: the minimum interval, in microseconds, between received BFD Echo packets that this system is capable of supporting, less any jitter applied by the sender as described in [BFD] sect. 6.8.9. This value is also an indication for the receiving system of the minimum interval between transmitted BFD Echo packets. If this value is zero, the transmitting system does not support the receipt of BFD Echo packets. If the receiving system can not support this value an error MUST be generated "Unsupported BFD TX rate interval".

Detection time multiplier: The negotiated transmit interval, multiplied by this value, provides the Detection Time for the receiving system in Asynchronous mode.

3.4. MPLS OAM PM Loss TLV

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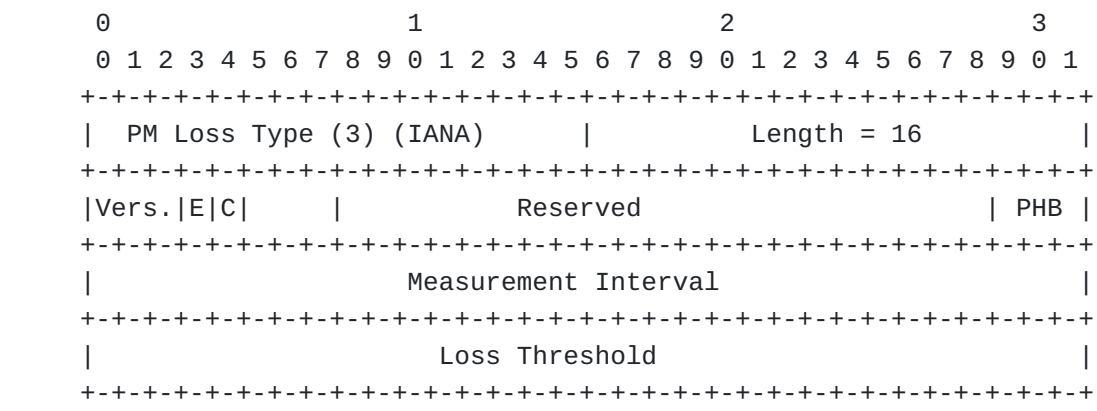

Type: indicates a new type, the "PM Loss" (IANA to define).
Length: indicates the TLV total length in octets.
Version: indicates the Loss measurement protocol version.
Configuration Flags:

> - E: exclude from the Loss Measurement all G-ACh messages
>
> - C: require the use of a counter in the "Querier Context" field described in [MPLS-PM]
>
> - Remaining bits: Reserved for future specification and set to 0.

PHB: identifies the per-hop behavior of packets with loss information.
Measurement Interval: the time interval (in microseconds) at which Loss Measurement query messages MUST be sent on both directions. If the LER receiving the Path message can not support such value, it can reply back with a higher interval.
Loss Threshold: the threshold value of lost packets over which protections MUST be triggered.

3.5. MPLS OAM PM Delay TLV

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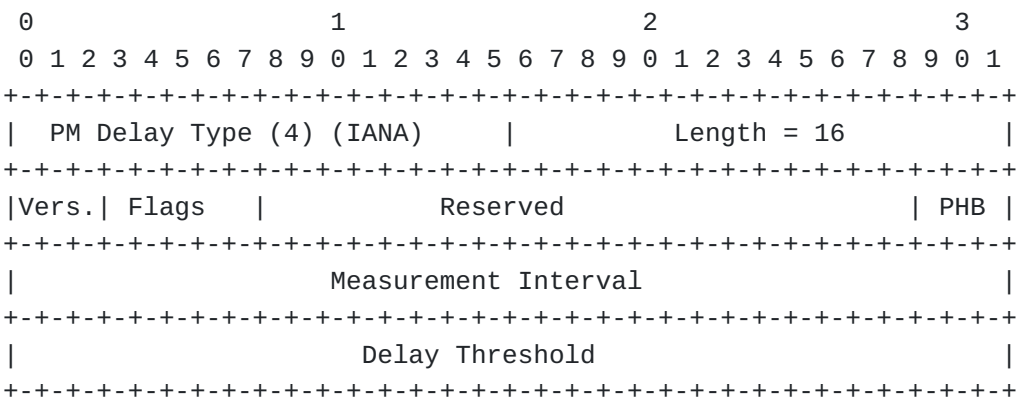
"PM Delay sub-TLV" is depicted below.



Type: indicates a new type, the "PM Delay" (IANA to define).
Length: indicates the TLV total length in octets.
Version: indicates the Delay measurement protocol version.
Configuration Flags:

> - E: exclude from the Loss Measurement all G-ACh messages
>
> - C: require the use of a counter in the "Querier Context" field described in [MPLS-PM]
>
> - Remaining bits: Reserved for future specification and set to 0.

PHB: - identifies the per-hop behavior of packets with delay information.
Measurement Interval: the time interval (in microseconds) at which Delay Measurement query messages MUST be sent on both directions. If the LER receiving the Path message can not support such value, it can reply back with a higher interval.
Delay Threshold: the threshold value of lost packets over which protections MUST be triggered.
[Author's note: TBD if we want to include the timestamp format negotiation as in [MPLS-PM] 4.2.5.]

3.6. MPLS OAM FMS TLV

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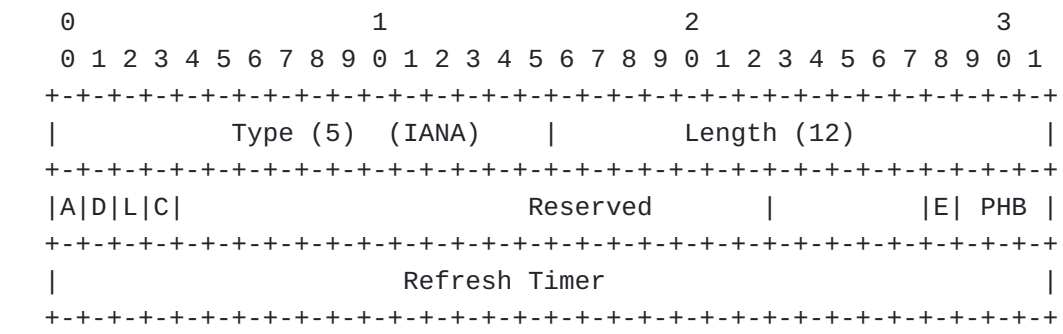

Type: indicates a new type, the "PM Delay" (IANA to define).
Length: indicates the TLV total length in octets.
Signal Flags: are used to enable the following signals:

- A: Alarm Indication Signal (AIS) as described in [MPLS-FMS]

- D: Link Down Indication (LDI) as described in [MPLS-FMS]

- L: Locked Report (LKR) as described in [MPLS-FMS]

- C: Client Signal Failure (CSF) as described in [MPLS-CSF]

Configuration Flags:

- E: used to enable/disable explicitly clearing faults

- PHB: identifies the per-hop behavior of packets with fault management information

Refresh Timer: indicates the refresh timer (in microseconds) of fault indication messages. If the LER receiving the Path message can not support such value, it can reply back with a higher interval.

---

4. IANA Considerations

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This document specifies the following new TLV types:

- "BFD Configuration" type: 2;

- "MPLS OAM PM Loss" type: 3;

- "MPLS OAM PM Delay" type: 4;

- "MPLS OAM PM FMS" type: 5.

sub-TLV types to be carried in the "BFD Configuration sub-TLV":

- "Local Discriminator" sub-TLV type: 1;

- "Negotiation Timer Parameters" sub-TLV type: 2.

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5. BFD OAM configuration errors

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In addition to error values specified in [OAM-CONF-FWK] and [ETH-OAM] this document defines the following values for the "OAM Problem" Error Code:

- "MPLS OAM Unsupported Functionality";

- "OAM Problem/Unsupported TX rate interval".

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6. Acknowledgements

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The authors would like to thank David Allan, Lou Berger, Annamaria Fulignoli, Eric Gray, Andras Kern, David Jocha and David Sinicrope for their useful comments.

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7. Security Considerations

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The signaling of OAM related parameters and the automatic establishment of OAM entities introduces additional security considerations to those discussed in [RFC3473]. In particular, a network element could be overloaded, if an attacker would request liveliness monitoring, with frequent periodic messages, for a high number of LSPs, targeting a single network element.
Security aspects will be covered in more detailed in subsequent versions of this document.

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8. References

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Appendix A. Additional Stuff

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This becomes an Appendix.

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