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Encapsulation For MPLS Performance Measurement with Alternate Marking Method
draft-cheng-mpls-inband-pm-encapsulation-04

Abstract

This document defines the encapsulation for MPLS performance measurement with alternate marking method, which performs flow-based packet loss, delay, and jitter measurements on live traffic.

Status of This Memo

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1. Introduction

[RFC8321] describes a passive performance measurement method, which can be used to measure packet loss, delay, and jitter on live traffic. Since this method is based on marking consecutive batches of packets, the method is often referred to as Alternate Marking Method.

[RFC8372] discusses the desired capabilities for MPLS flow identification, in order to perform a better in-band performance monitoring of user data packets. Synonymous Flow Label (SFL), which is introduced in [I-D.ietf-mpls-sfl-framework], is identified as a method of accomplishing MPLS flow identification. This document employs a method, other than SFL, to accomplish MPLS flow identification. The method described in this document is simple and flexible, furthermore, it complies with the current MPLS forwarding paradigm.

On one hand, the method described in this document is complementary to the SFL method [I-D.ietf-mpls-sfl-framework] [I-D.bryant-mpls-sfl-control], the former targets at hop-by-hop performance measurement, and the latter targets at end-to-end

performance measurement, furthermore, the former supports the application scenario where Flow-ID is applied to MPLS LSP and MPLS VPN synchronously, and the latter doesn't support this kind of application scenario. On the other hand, the method described in this document is complementary to the In-situ OAM method [I-D.ietf-ippm-ioam-data] [I-D.ietf-ippm-ioam-direct-export], the former doesn't introduce any new header but the latter introduces a new In-situ OAM header, furthermore, the former allows the network nodes to report the refined data (e.g. calculated performance metrics) associated with a specified flow, nevertheless the latter requests the network nodes to report the data (e.g. ingress interface and egress interface) associated with a specified packet.

This document defines the encapsulation for MPLS performance measurement with alternate marking method, which performs flow-based packet loss, delay, and jitter measurements on live traffic.

1.1. Conventions Used in This Document

1.1.1. Abbreviations

ELC: Entropy Label Capability

ERLD: Entropy Readable Label Depth

FLC: Flow-ID Label Capability

FRLD: Flow-ID Readable Label Depth

LSP: Label Switched Path

MPLS: Multi-Protocol Label Switching

NMS: Network Management System

PM: Performance Measurement

PW: PseudoWire

SFL: Synonymous Flow Label

SID: Segment ID

SR: Segment Routing

TC: Traffic Class

TTL: Time to Live

VC: Virtual Channel

VPN: Virtual Private Network

1.1.2. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

2. Flow-based PM Encapsulation in MPLS

Flow-based MPLS performance measurement encapsulation with alternate marking method has the following format:

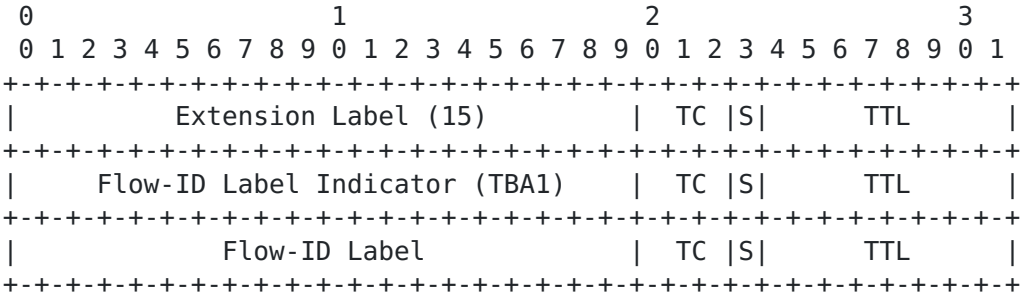

Figure 1: Flow-based PM Encapsulation in MPLS

Flow-ID Label Indicator is an Extended Special Purpose Label (eSPL), which is combined with the Extension Label (XL, value 15) to form a Composite Special Purpose Label (cSPL), as defined in [I-D.ietf-mpls-spl-terminology]. Flow-ID Label Indicator is defined in this document as value TBA1.

Analogous to Entropy Label Indicator [RFC6790], the TC and TTL for the Extension Label and the Flow-ID Label Indicator SHOULD follow the same field values of that label immediately preceding the Extension Label, otherwise, the TC and TTL for the Extension Label and the Flow-ID Label Indicator MAY be different values if it is known that the Extension Label will not be exposed as the top label at any point along the LSP. The S bit for the Extension Label and the Flow-ID Label Indicator MUST be zero.

Flow-ID Label is used as MPLS flow identification [RFC8372], its value should be unique within the administrative domain. Flow-ID

values can be allocated by an external NMS or a controller, based on measurement object instance such as LSP or PW. There is a one-to-one mapping between Flow-ID and flow. The specific method on how to allocate the Flow-ID values is described in Section 4.

Analogous to Entropy Label [RFC6790], the Flow-ID Label can be placed at either the bottom or the middle of the MPLS label stack, and the Flow-ID Label MAY appear multiple times in a label stack. Section 2.1 of this document provides several examples to illustrate how to apply Flow-ID Label in a label stack. Again analogous to Entropy Label, the TTL for the Flow-ID Label MUST be zero to ensure that it is not used inadvertently for forwarding, the TC for the Flow-ID Label may be any value, the S bit for the Flow-ID Label depends on whether or not there are more labels in the label stack.

Besides flow identification, a color-marking field is also necessary for alternate marking method. To achieve the purpose of coloring the MPLS traffic, the current practice when writing this document is to reuse the Flow-ID Label's TC, i.e., using TC's highest order two bits (called double-marking methodology [RFC8321]) as color-marking bits. Alternatively, allocating multiple Flow-ID Labels to the same flow may be used for the purpose of alternate marking.

2.1. Examples for Applying Flow-ID Label in a label stack

Three examples on different layout of Flow-ID Label (4 octets) are illustrated as follows:

(1) Layout of Flow-ID Label when applied to MPLS LSP.

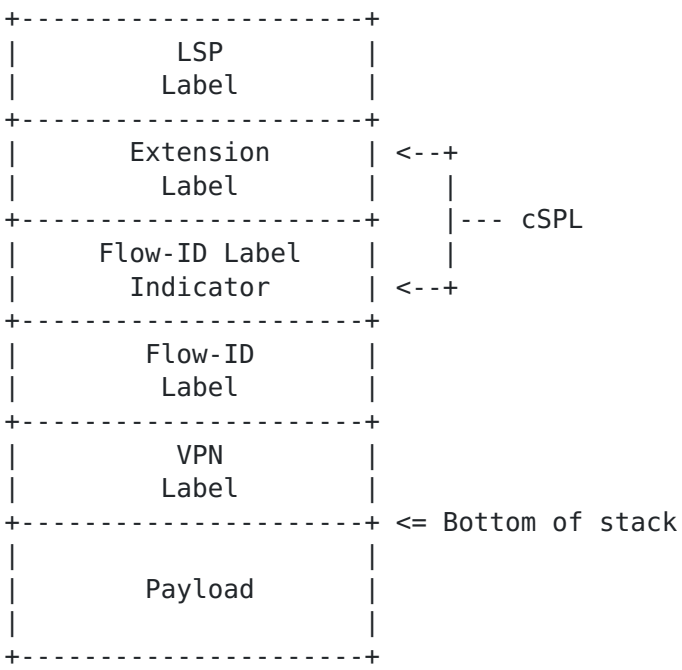

Figure 2: Applying Flow-ID to MPLS LSP

(2) Layout of Flow-ID Label when applied to MPLS VPN traffic.

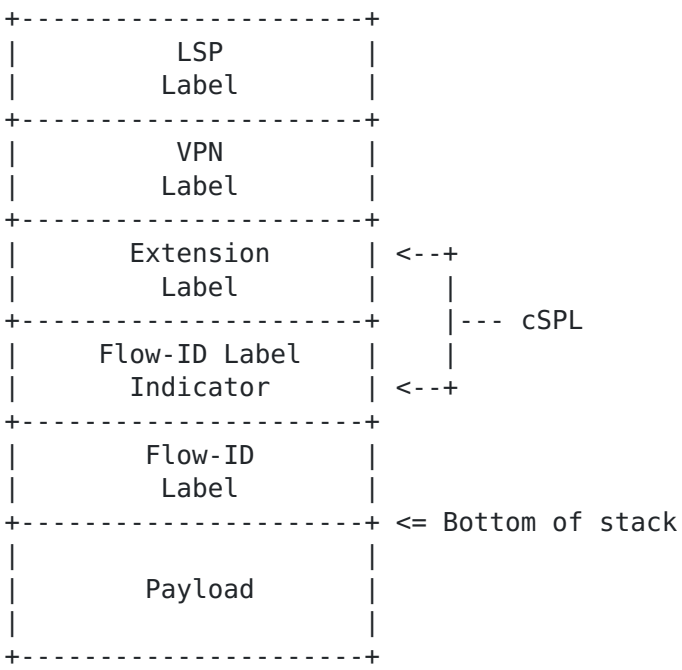

Figure 3: Applying Flow-ID to MPLS VPN

(3) Layout of Flow-ID Label when applied to both MPLS LSP and MPLS VPN traffic.

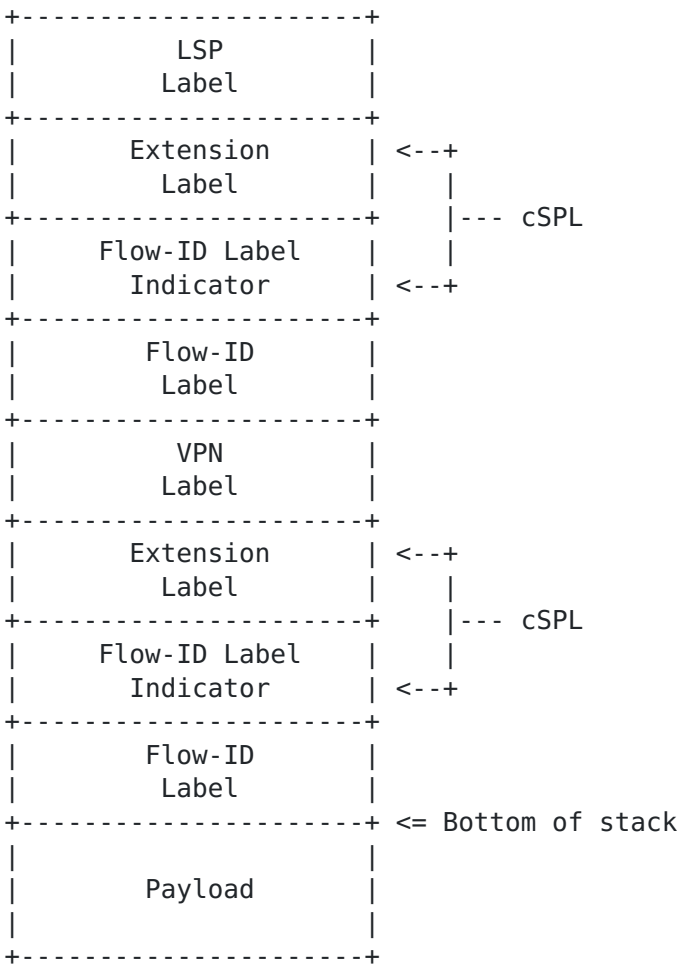

Figure 4: Applying Flow-ID to both MPLS LSP and MPLS VPN

Note that here VPN label can be MPLS PW label, MPLS Ethernet VPN label or MPLS IP VPN label, and it's also called VC label as defined in [RFC4026].

Also note that for this example the two Flow-ID values appearing in a label stack MUST be different, that is to say, Flow-ID Label applied to MPLS LSP and Flow-ID Label applied to MPLS VPN share the same value space.

3. Procedures of Encapsulation, Look-up and Decapsulation

The procedures for Flow-ID label encapsulation, look-up and decapsulation are summarized as follows:

- The ingress node inserts the Extension Label, the Flow-ID Label Indicator, alongside with the Flow-ID label, into the MPLS label stack. At the same time, the ingress node sets the color-marking field, as needed by alternate-marking technique, and sets the Flow-ID value, as defined in this document.

- The transit nodes look up the Flow-ID label with the help of the Extension Label and the Flow-ID Label Indicator, and transmit the collected information to an external NMS or a controller, which includes the values of the block counters and the timestamps of the marked packets, along with the value of the Flow-ID, referring to the procedures of alternate marking method.

- The egress node pops the Extension Label and the Flow-ID Label Indicator, alongside with the Flow-ID label, from the MPLS label stack. This document doesn't introduce any new procedure regarding to the process of the decapsulated packet.

4. Procedures of Flow-ID allocation

There are two ways of allocating Flow-ID, one way is to allocate Flow-ID by manual trigger from the network operator, and the other way is to allocate Flow-ID by automatic trigger from the ingress node, details are as follows:

- In the case of manual trigger, the network operator would manually input the characteristics (e.g. IP five tuples and IP DSCP) of the measured IP traffic flow, then the NMS or the controller would generate one or two Flow-IDs based on the input from the network operator, and provision the ingress node with the characteristics of the measured IP traffic flow and the corresponding allocated Flow-ID(s).

- In the case of automatic trigger, the ingress node would identify the IP traffic flow entering the measured path, export the characteristics of the identified IP traffic flow to the NMS or the controller by IPFIX [RFC7011], then the NMS or the controller would generate one or two Flow-IDs based on the export from the ingress node, and provision the ingress node with the characteristics of the identified IP traffic flow and the corresponding allocated Flow-ID(s).

The policy pre-configured at the NMS or the controller decides whether one Flow-ID or two Flow-IDs would be generated. If the performance measurement on VPN traffic is enabled, then one Flow-ID applied to MPLS VPN would be generated; if the performance measurement on LSP tunnel is enabled, then one Flow-ID applied to MPLS LSP would be generated; if both of them are enabled, then two

Flow-IDs respectively applied to MPLS VPN and MPLS LSP would be generated.

Whether using manual trigger or using automatic trigger, the NMS or the controller MUST guarantee every generated Flow-ID is unique within the administrative domain.

5. FLC and FRLD Considerations

Analogous to the Entropy Label Capability (ELC) defined in Section 5 of [RFC6790], and the Entropy Readable Label Depth (ERLD) defined in Section 4 of [RFC8662], the Flow-ID Label Capability (FLC) and the Flow-ID Readable Label Depth (FRLD) are defined in this document. Both FLC and FRLD have the similar semantics with ELC and ERLD to a router, except that the Flow-ID is used in its flow identification function while the Entropy is used in its load-balancing function.

The ingress node MUST insert each Flow-ID Label at an appropriate depth, which ensures the node that needs to process the Flow-ID Label has the FLC. How the ingress node knows the Flow-ID Label processing node has the FLC is outside the scope of this document.

The ingress node SHOULD insert each Flow-ID Label within an appropriate FRLD, which is the minimum FRLD of all on-path nodes that needs to read and use the Flow-ID Label in question. How the ingress node knows the appropriate FRLD for each Flow-ID Label is outside the scope of this document.

When SR paths are used as transport, the label stack grows as the number of on-path segments increases, if the number of on-path segments is high, that may become a challenge for the Flow-ID Label to be placed within an appropriate FRLD. In order to overcome this potential challenge, an implementation MAY provide flexibility to the ingress node to place Flow-ID Label between SID labels, i.e., multiple identical Flow-ID Labels at different depths MAY be interleaved with SID labels, when that happens a sophisticated network planning may be needed and it's beyond the scope of this document.

6. Security Considerations

This document introduces the performance measurement domain that is the scope of a Flow-ID Label. The Flow-ID Label Indicator and Flow-ID Label MUST NOT be signaled and distributed outside one performance measurement domain. Improper configuration so that the Flow-ID Label being passed from one domain to another would likely result in potential Flow-ID conflicts.

To prevent packets carrying Flow-ID Label from leaking from one domain to another, the domain boundary nodes SHOULD deploy some policies (e.g., ACL) to filter out the packets. Specifically, in the sending end, the domain boundary node SHOULD filter out the packets that carry the Flow-ID Label Indicator and are sent to other domain; in the receiving end, the domain boundary node SHOULD drop the packets that carry the Flow-ID Label Indicator and are from other domains.

7. IANA Considerations

In the Special-Purpose MPLS Label Values registry defined in [SP-MPLS-Label], a new Extended Special-Purpose MPLS Label Value for Flow-ID Label Indicator is requested from IANA as follows:

Extended Special-Purpose MPLS Label Value	Description	Semantics Definition	Reference
TBA1	Flow-ID Label Indicator	Section 2	This Document

Table 1: New Extended Special-Purpose MPLS Label Value for Flow-ID Label Indicator

8. Acknowledgements

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