

MPLS Data Plane Encapsulation for In Situ OAM Data

draft-gandhi-mpls-ioam-10

Rakesh Gandhi - Cisco Systems (rgandhi@cisco.com) - Presenter

Frank Brockners - Cisco Systems (fbrockne@cisco.com)

Bin Wen - Comcast (Bin_Wen@cable.comcast.com)

Bruno Decraene - Orange (bruno.decraene@orange.com)

Haoyu Song - Futurewei (haoyu.song@futurewei.com)

Abbreviations

Abbreviations	Meaning
AD	Ancillary Data
BOS	Bottom of Stack
bSPL	Base Special Purpose Label
E2E	Edge To Edge
HBH	Hop By Hop
IHS	Ingress-To-Egress, Hop-By-Hop or Select Processing Scope
IOAM	In Situ OAM
ISD	In-Stack Data
MNA	MPLS Network Action
MSD	Maximum Stack Depth
NAI	Network Action Indicator
NAI-OP	Network Action Indicator Opcode
NAS	Network Action Sub-Stack
PSD	Post-Stack Data

Agenda

- Requirements and Scope
- MPLS Extensions
- Next Steps

Requirements and Scope

Requirements:

- Transport In Situ OAM (IOAM) and Direct Export data fields with MPLS Encapsulation

Scope:

- Using IOAM data fields defined in:
 - *RFC 9197 (IOAM data fields)*
 - *RFC 9326 (Direct export)*
- Processing Scope
 - Edge-To-Edge (E2E) IOAM
 - Hop-By-Hop (HBH) IOAM
 - Select IOAM
- MPLS Network Action (MNA) Encoding
 - *In-Stack: draft-ietf-mpls-mna-hdr (Indicator, Unknown Action and Scope)*
 - *Post-Stack: draft-jags-mpls-ps-mna-hdr (IOAM Data fields)*

History of the draft

- October 2018 - Published draft-gandhi-**spring**-ioam-sr-mpls-00
- October 2019 - Published draft-gandhi-**mpls**-ioam-sr-00
- January 2021 - Completed **MPLS-RT** Expert review
- July 2022 - Using MNA Encoding
- October 2022 - Using Post-Stack Extension Header
- [January 2023 - Using latest In-Stack MNA encoding](#)
- [March 2023 - Using latest Post-Stack MNA encoding](#)

MPLS Extensions

MPLS Network Action (MNA) Sub-Stack

- Using MPLS Network Action (MNA) Sub-stack defined in [draft-ietf-mpls-mna-hdr]
- In the first LSE, MNA Label is a bSPL (value TBA1) allocated by IANA in [draft-ietf-mpls-mna-hdr]
- In the second LSE with Network Action:
 - Opcode 2 - Flag-Based NAIs: Set to 0 if there is no In-Stack network action required
 - IHS Scope: Edge-To-Edge (00b), Hop-By-Hop (01b) or Select Node (10b) Processing Scope
 - U Flag: Unknown Action Handling set to 0 for “Skip to the next Network Action”
 - Network Action Sub-Stack Length (NASL): Set to 0 if no additional LSE after this (second) LSE
- Post-Stack Network Action Indicator defined in [draft-jags-mpls-ps-mna-hdr]
 - Post-Stack Network Action Indicator (**P Flag**) is set to “1” when Post-Stack Network Action is present after BOS

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
MNA Label (bSPL value TBA1 by IANA)																				TC		S	TTL								
Opcode = 2							Flag-Based NAIs														P=1 IHS		S	Reserved		U NASL					

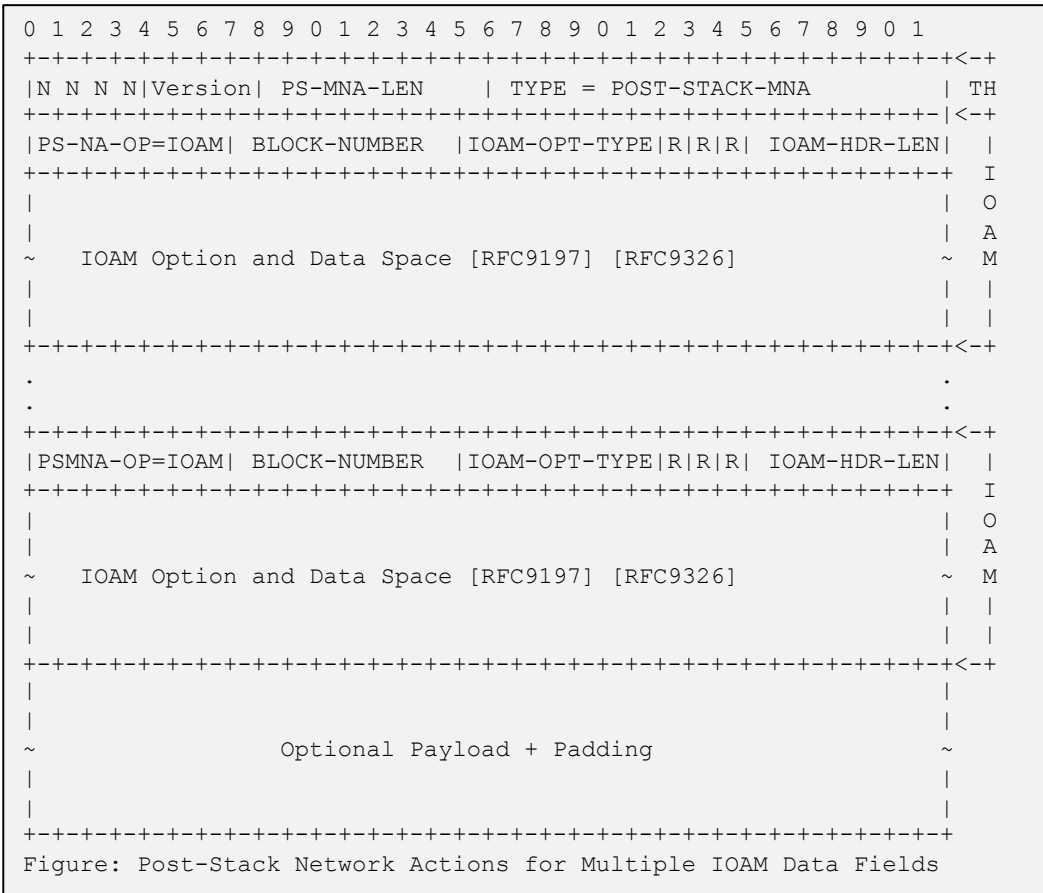
IOAM MNA Processing Scope

- In case of E2E IOAM Scope:
 - E2E IOAM Option-Type(s) in the data packets are processed on edge nodes only.
 - E2E Option-Type (value 3) [RFC9197], Direct Export (DEX) Option-Type (value 4) [RFC9326] can be carried in the IOAM data field with I2E scope.
 - IHS scope is set to I2E (value 0x0).
 - The intermediate nodes ignore the E2E IOAM Option-Type(s) carried by the data packets.
- In case of HBH IOAM Scope:
 - HBH IOAM Option-Type(s) in the data packets are processed on the intermediate and edge nodes.
 - Pre-allocated (value 0) and Proof of Transit (value 2) [RFC9197], Direct Export (DEX) Option-Type (value 4) [RFC9326] can be carried in the IOAM data field with HBH Scope.
 - Incremental Option-Type (value 1) is not supported just like IPv6 case [draft-ietf-ippm-ioam-ipv6-options]
 - IHS scope is set to HBH (value 0x1).
- In case of Select IOAM Scope:
 - HBH IOAM Option-Type(s) in the data packets are processed on Select nodes only.
 - IOAM Option-Types same as defined for HBH IOAM Scope.
 - IHS scope is set to SELECT (value 0x2).

HBH + I2E IOAM Options

Post-Stack Network Actions for Multiple IOAM Options

- Each Post-Stack Network Action(NA) contains one IOAM/DEX Option-Type (with one more IOAM Data fields)
- Different NAs with Opcode for IOAM added to carry different IOAM Option-Types
- When using both HBH and E2E IOAM Option-Types, the HBH IOAM Option-Type MUST be placed before the E2E IOAM Option-Type to easily access HBH IOAM in hardware on intermediate nodes
- Use-case: Trace hop-by-hop interface Identifier and end-to-end latency



IOAM Direct-Export Option-Type

- Direct Export is defined in [RFC9326] that uses DEX IOAM Option-Type 4 carried in packets
- Direct Export Option-Type carries minimum 2 LSEs and up to 10+ LSEs including optional flow ID, optional sequence number, optional timestamps, etc. in addition to the 1 Network Action LSE in a packet
- Direct Export is a viable option in MPLS networks
- MPLS Direct Export solution can combine two network actions:
 1. **Trigger for telemetry of data on intermediate and egress nodes**
 - This can be encoded using the In-Stack Network Action
 - As Telemetry Trigger Network Action flag or Alternate Marking Method Network Action flags
 - Example: Defined in [draft-song-mpls-flag-based-opt]
 2. **Information in Direct Export Option-Type**
 - Direct Export Option-Type information (optional Sequence-Number/Flow-ID/Timestamps, etc.) [draft-ahuang-ippm-dex-timestamp-ext] is strictly used to direct export, and encoded in Post-Stack Network Action
 - Note: In-stack Sequence Number and Timestamp can lead to undesired ECMP behavior on legacy nodes that use the label stack for ECMP hashing
 - This method is as defined in this draft [draft-gandhi-mpls-ioam]

Next Steps

- Welcome your comments and suggestions
- Requesting MPLS WG adoption

Thank you

Backup

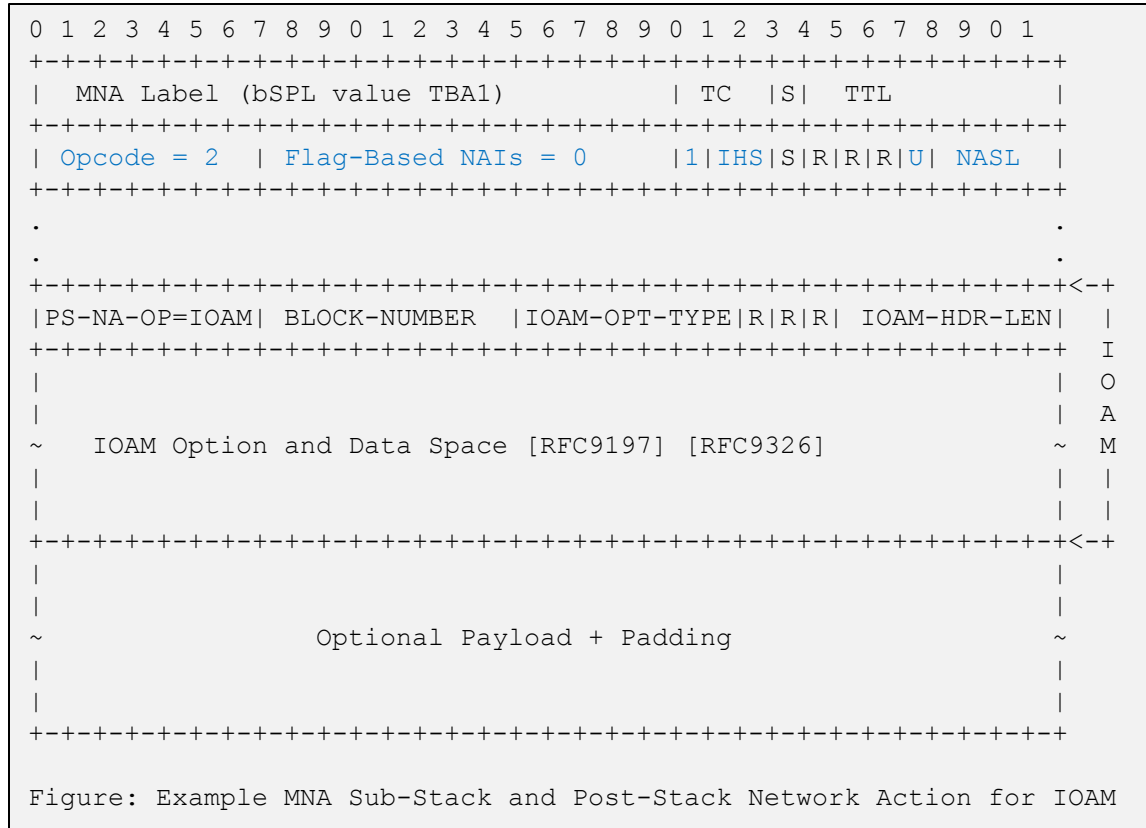
E2E IOAM Procedure

1. E2E IOAM Scope includes IOAM processing on encapsulating and decapsulating nodes.
 - E2E Option-Type (value 3) [RFC9197] as well as Direct Export (DEX) Option-Type (value 4) [RFC9326] can be carried in the IOAM data field.
2. The encapsulating node inserts Network Action Sub-Stack with (1) the MNA bSPL Label (value TBA1) with the P flag set to “1”, and (2) IHS scope set to I2E (value 0) and, (3) one or more IOAM data fields in Post Stack Network Action with IOAM Opcode.
 - The decapsulating node MUST support MPLS Post Stack network action.
3. The intermediate nodes skip the IOAM data fields processing as IHS scope is I2E.
4. The decapsulating node processes IOAM data field(s) in the packet.
 - The decapsulating node MAY “punt the timestamped copy” of the OAM data from the packet including the IOAM data field(s) to slow-path.
5. The decapsulating node MUST remove the MNA with IOAM data field(s) from the packet.
 - The decapsulating node forwards the data packet downstream.

HBH IOAM Procedure

1. HBH IOAM Scope includes IOAM processing on encapsulating, intermediate and decapsulating nodes.
 - Pre-allocated (value 0) and Proof of Transit (value 2) [RFC9197], as well as Direct Export (DEX) Option-Type (value 4) [RFC9326] can be carried in the IOAM data field(s).
 - Incremental Option-Type (value 1) is not supported just like IPv6 case [draft-ietf-ippm-ioam-ipv6-options].
2. The encapsulating node inserts Network Action Sub-Stack with (1) the MNA bSPL Label (value TBA1) with the P flag set to “1”, and (2) IHS scope set to HBH (value 0x1) and, (3) one or more IOAM data fields in Post Stack Network Action with IOAM Opcode.
3. The intermediate nodes process the HBH IOAM data field(s) and forward the data packet downstream including updated IOAM data field(s) upon detecting IHS scope to HBH.
 - The intermediate nodes MAY “punt the timestamped copy” of the OAM data from the packet including the IOAM data field(s) to slow-path (e.g., in case of Direct Export).
 - The intermediate node that does not support the Network Action for IOAM, skips the IOAM processing.
4. On decapsulating node, follow the same procedure as E2E IOAM case.

MNA Sub-Stack and Post-Stack Network Action for IOAM



Thank you