MPLS Data Plane Encapsulation for In-situ OAM Data

draft-gandhi-mpls-ioam-sr-06

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Agenda

- Requirements and Scope
- Summary
- Discussions
- Next Steps

Requirements and Scope

Requirements:

- Transport In-situ OAM (IOAM) data fields with MPLS Encapsulation

Scope:

- Using IOAM data fields defined in:
  - *draft-ietf-ippm-ioam-data*
  - *draft-ietf-ippm-ioam-direct-export*
  - *draft-ietf-ippm-ioam-flags*
- Edge-to-edge (E2E) IOAM
- Hop-by-hop (HbH) IOAM (that includes E2E)

Updates Since Version-04

Updates:

- ✓ Addressed MPLS-RT expert review comments
  - ✓ Added IOAM G-ACh header
  - ✓ Elaborate the IOAM procedures
- ✓ Clarified E2E and HbH Indicator Labels usage for different IOAM Option-Types
- ✓ Added multiple G-ACh / Control Word handling
- ✓ Editorial changes (e.g., cleanup SR text)

Open Items:

- Discuss multiple G-ACh / Control Word headers

MPLS Extensions

IOAM G-ACh for IOAM Data Fields

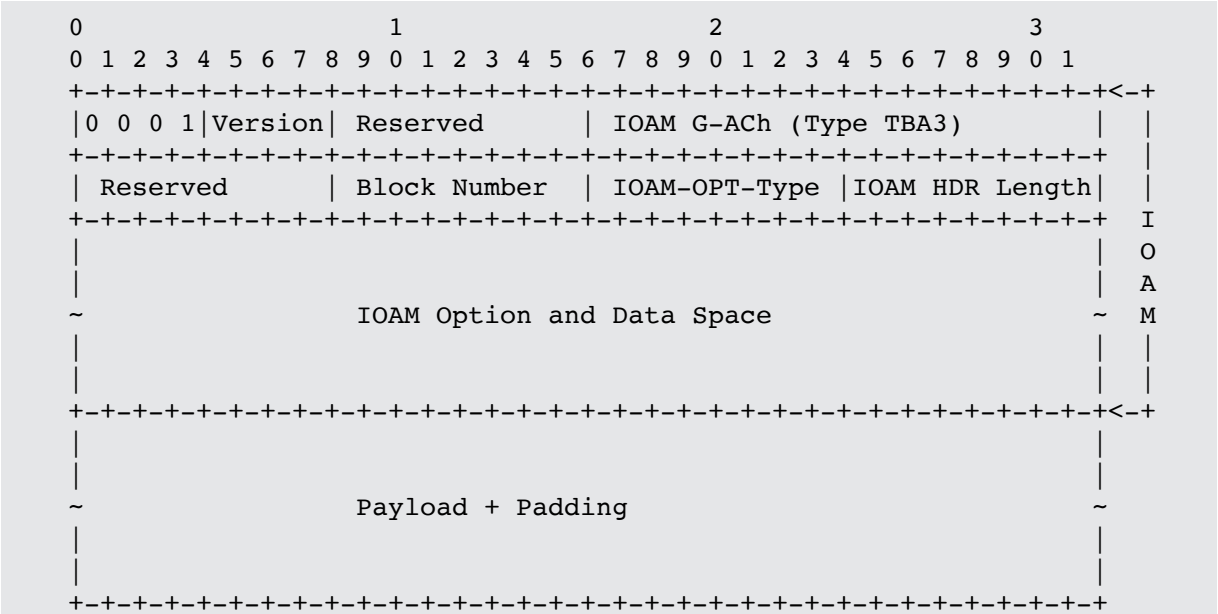

Figure: IOAM G-ACh for IOAM Data Fields

IOAM G-ACh Header

- New Generic Associated Channel (G-ACh) Type (value TBA3) defined for IOAM
- Protocol value *0001b* allows to avoid incorrect IP header based hashing over ECMP paths
- Note: GAL with G-ACh is used for control-channel/OAM packets whereas IOAM Label with G-ACh is used for user data packets
- Block Number is used to:
  - Aggregate IOAM data collected in data plane, e.g. compute measurement metrics for each block of a flow
  - Correlate IOAM data from different nodes

https://www.iana.org/assignments/g-ach-parameters/g-ach-parameters.xhtml#mpls-g-ach-types

IOAM Indicator Labels

- "IOAM Indicator Label" is used to indicate the presence of the IOAM data fields after EOS in the MPLS Encapsulation.
- Separate Indicator Labels are defined for E2E IOAM (for edge nodes) and HbH IOAM (*for edge and intermediate nodes*).
  - The E2E IOAM Label allows to bypass IOAM processing on intermediate nodes in case of E2E IOAM.
- In case of E2E IOAM, the IOAM Option-Type(s) in the data packets are processed on edge nodes only. The intermediate nodes ignore the IOAM Option-Type(s) carried by the data packets.
- In case of HbH IOAM, the IOAM Option-Type(s) in the data packets are processed on intermediate and edge nodes.

Edge-2-Edge IOAM

MPLS Encapsulation with E2E IOAM Data Fields

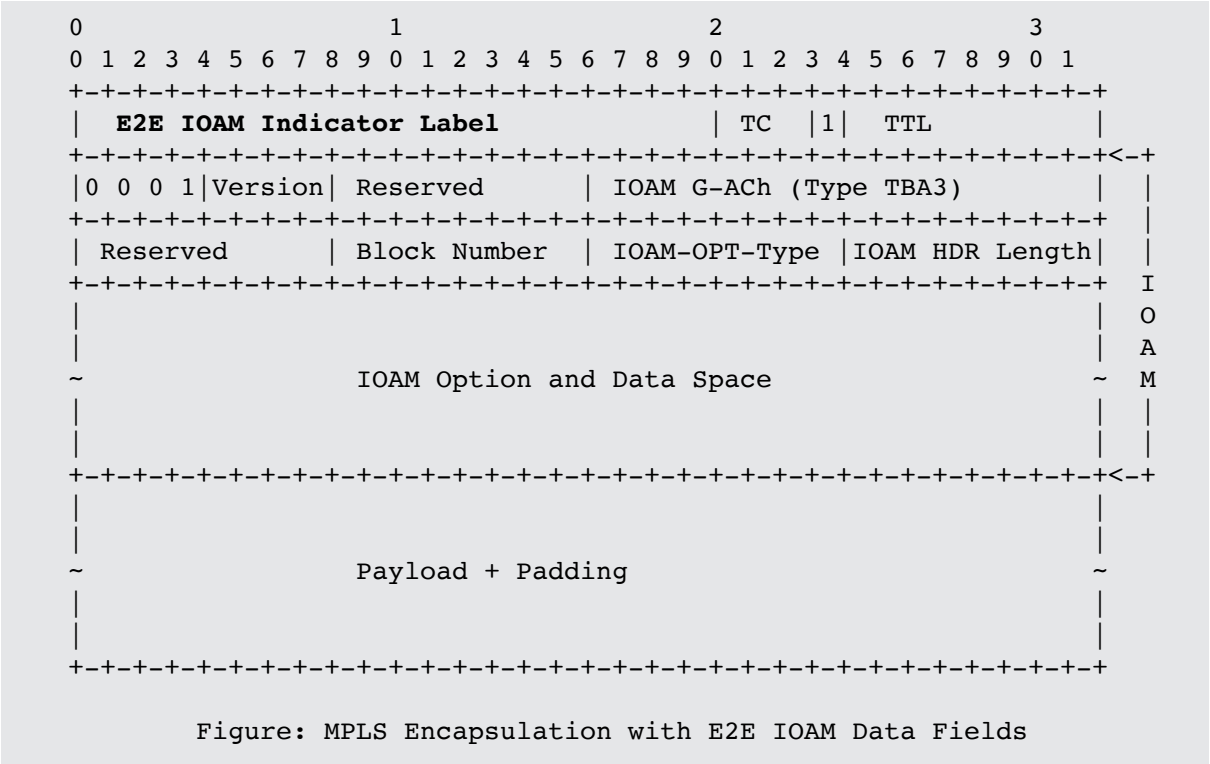

Figure: MPLS Encapsulation with E2E IOAM Data Fields

E2E IOAM Indicator Label Allocation Methods

1. Extension Label (15) and Indicator Label assigned by IANA with value TBA1
   - From Extended Special Purpose Labels (eSPL) range
   - Both Labels are carried at the bottom of the label stack
2. Global Indicator Label allocated by a controller
   - The controller provisions the label on encapsulating and decapsulating nodes
   - The Label is carried at the bottom of the label stack
3. Indicator Label allocated by the decapsulating node
   - Signaling/advertisement extensions needed to convey the label to all encapsulating nodes (out of scope)
   - The Label is carried at the bottom of the label stack

E2E IOAM Indicator Label - Comparisons

Methods	Extra Label Stack Size (Note 2)	Location on Stack
1. eSPL Indicator Label	+2 (Note 1)	Bottom
2. Global Indicator Label, 3. Signal/Advertise Indicator Label	+1	Bottom

1. This is true for any mechanism that we are defining using eSPL
   - For example SFC: https://tools.ietf.org/html/rfc8595
2. IOAM data packets may require Entropy label for ECMP to work around hashing issue due to G-ACh for IP packets

E2E IOAM Procedure

1. E2E IOAM includes IOAM processing on encapsulating and decapsulating nodes.
   - Only E2E Option-Type is carried in the IOAM data field.
2. The encapsulating node inserts an E2E Indicator Label and one or more IOAM data field(s) in the MPLS header.
3. The intermediate (intermediate) nodes do not process IOAM data.
4. The decapsulating node “punts the timestamped copy” of the data packet including IOAM data field(s).
   - The decapsulating node processes IOAM data field(s) from the punted packet.
5. The decapsulating node also pops the IOAM Indicator Label and the IOAM data field(s) from the MPLS encapsulation.
   - The decapsulating node forwards the data packet downstream.

Example - SR-MPLS Encapsulation with IOAM Data Fields

Figure: Example SR-MPLS Encapsulation with IOAM Data Fields

Hop-by-Hop IOAM

HbH IOAM Indicator Label Allocation Methods

1. Extension Label (15) and Indicator Label assigned by IANA with value TBA2
   - From Extended Special Purpose Labels (eSPL) range
   - Both Labels are carried at the bottom of the label stack (as top label can break heterogenous network)
2. Global Indicator Label allocated by a controller
   - The controller provisions the label on encapsulating, intermediate and decapsulating nodes
   - The Label is carried at the bottom of the label stack (as top label can break heterogenous network)
3. IOAM FEC Label allocated by the intermediate and decapsulating nodes
   - Signaling/advertisement extensions needed to convey the label to all encapsulating nodes (out of scope)
   - The Label is carried at the top of the label stack

HbH IOAM Indicator Label - Comparisons

Methods	Extra Label Stack Size (Note 2)	Location on Stack	Scan Label Stack (Notes 1)	Different FIB Entry for IOM FEC Local Label
1. eSPL Indicator Label	+2	Bottom	Yes	No
2. Global Indicator Label	+1	Bottom	Yes	No
3. Signal/Advertise IOM FEC Label	+0	Top	No	Yes

1. Intermediate node may have a limit on how many labels it can scan. However, with any indicator scheme, the node will have to look past EOS into the packet to find the IOAM data that needs to be processed
2. IOAM data packets may require Entropy label for ECMP to work around hashing issue due to G-ACh for IP packets

HbH IOAM Procedure

1. HbH IOAM includes IOAM processing on encapsulating, intermediate and decapsulating nodes.
   - Pre-allocated, Incremental, Proof of Transit and E2E Option-Types are carried in the IOAM data field(s).
2. The encapsulating node inserts a HbH Indicator Label and one or more IOAM data field(s) in the MPLS encapsulation.
3. The intermediate nodes process HbH IOAM data field(s) and forward the data packet including updated IOAM data field(s).
4. The decapsulating node "punts the timestamped copy" of the data packet including IOAM data field(s).
   - The decapsulating node processes IOAM data field(s) from the punted packet.
5. The decapsulating node also pops the IOAM Indicator Label and the IOAM data field(s) from the MPLS encapsulation.
   - The decapsulating node forwards the data packet downstream.

MPLS Encapsulation for IOAM Data Fields with Control Word and Another G-ACh

IOAM Data Fields with Control Word and Additional G-ACh

- E2E or HbH IOAM Indicator Label is added after the PW Label with EOS Flag set.
- IOAM Data Fields, including IOAM G-ACh header are added in the MPLS encapsulation after the EOS.
- This allows the intermediate nodes to easily access the HbH IOAM data field(s) after the MPLS header.
- Control Word or additional G-ACh is added after the IOAM Data Fields in the packet.
- The decapsulating node removes the MPLS encapsulation including the IOAM Data Fields and then processes the Control Word or G-ACh following it.
  - The presence of this is known due to the PW Label on the Label Stack.
  - *IOAM HDR Length* allows to locate the Control Word and G-ACh after the IOAM Data Fields.

Generic PW Control Word [RFC4385] with IOAM Data Fields

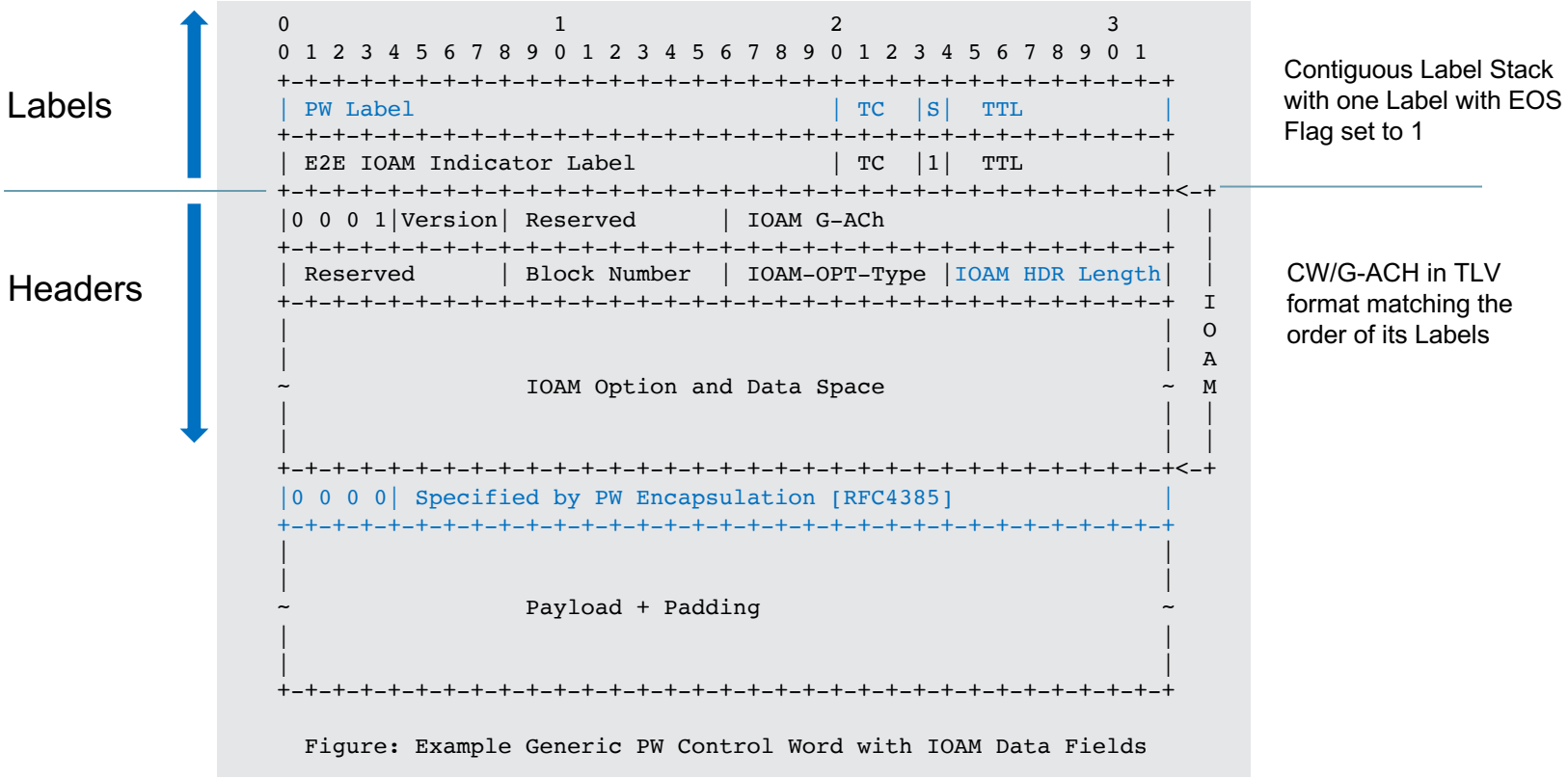

Figure: Example Generic PW Control Word with IOAM Data Fields

MPLS Encap with Additional G-ACh [RFC5586] with IOAM Data Fields

Labels

Headers

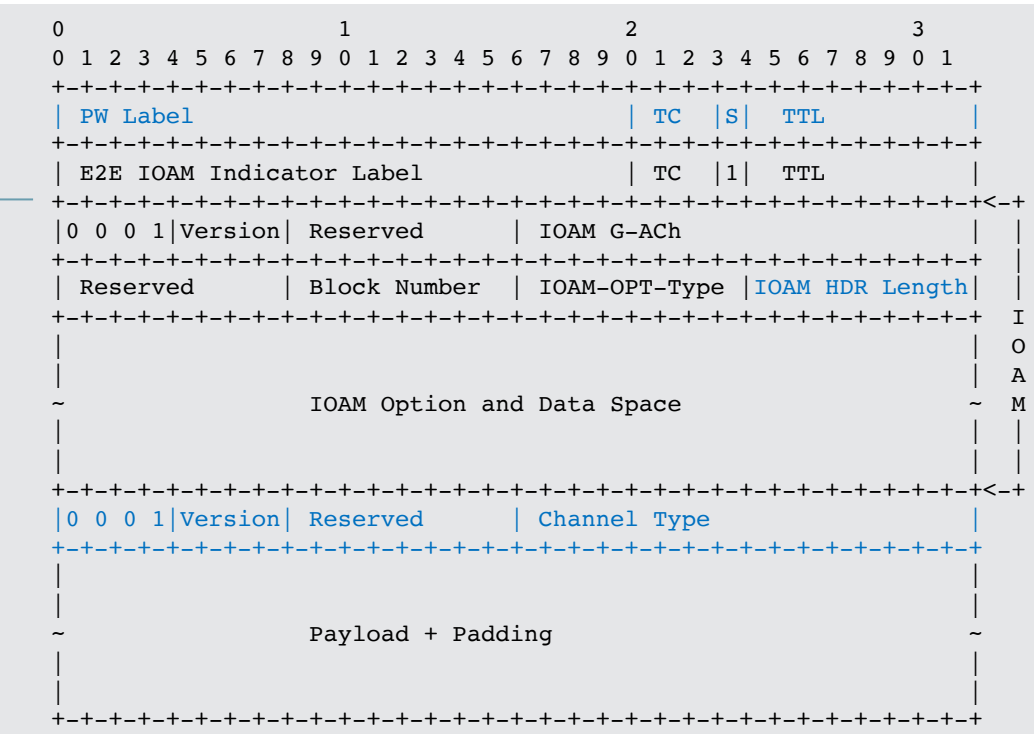

Figure: Example MPLS Encapsulation with Additional G-ACh with IOAM Data Fields

Contiguous Label Stack with one Label with EOS Flag set to 1

CW/G-ACH in TLV format matching the order of its Labels

Next Steps

- Welcome your comments and suggestions
- Requesting WG adoption
  - Address any open items as part of WG process

Thank you

Example MPLS Encapsulations for IOAM Data Fields

Example - Generic Delivery Function with IOAM Data Fields

Labels

Headers

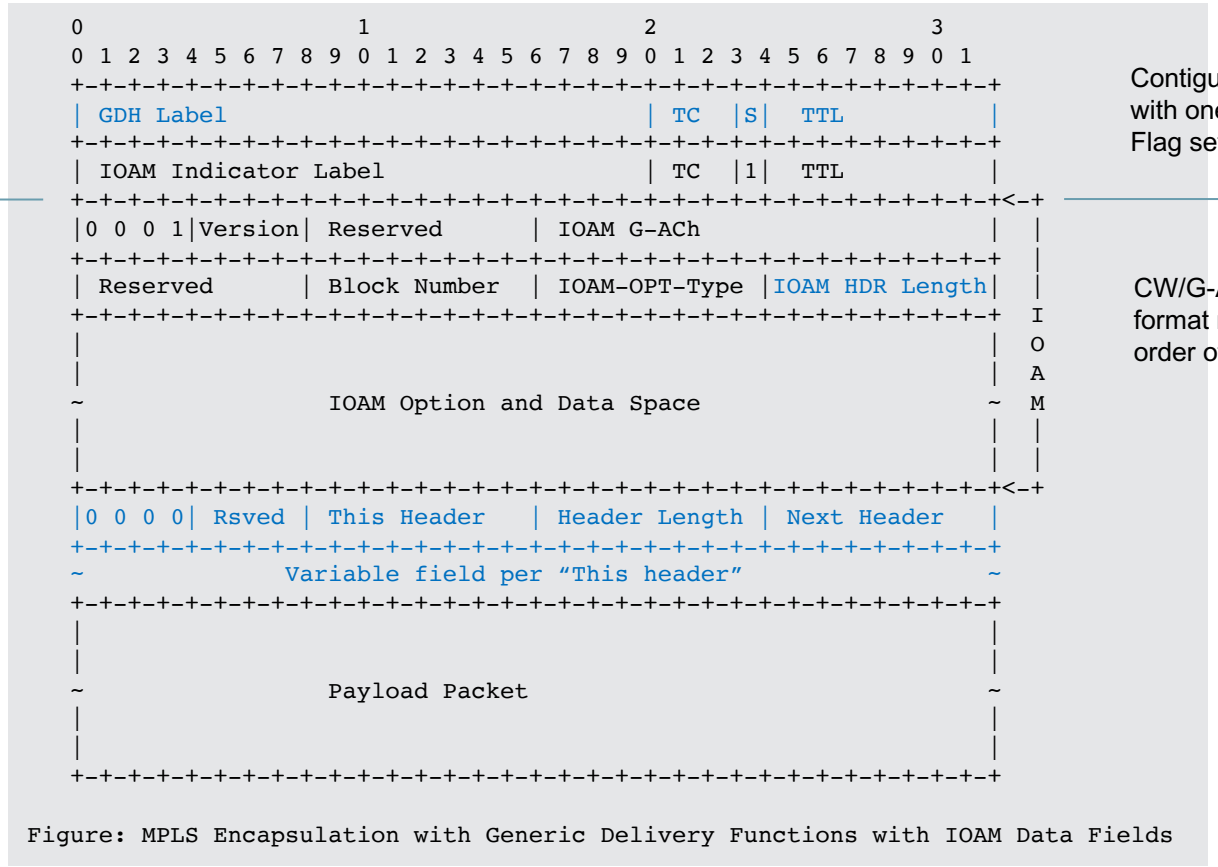

Figure: MPLS Encapsulation with Generic Delivery Functions with IOAM Data Fields

Contiguous Label Stack with one Label with EOS Flag set to 1

CW/G-ACH in TLV format matching the order of its Labels

- https://datatracker.ietf.org/doc/draft-zzhang-intarea-generic-delivery-functions/

- GDF Ingress/Egress Nodes only.
- GDF has no Hop-by-hop processing

Example - Generic Delivery Function with IOAM Data Fields and PW

Labels

Headers

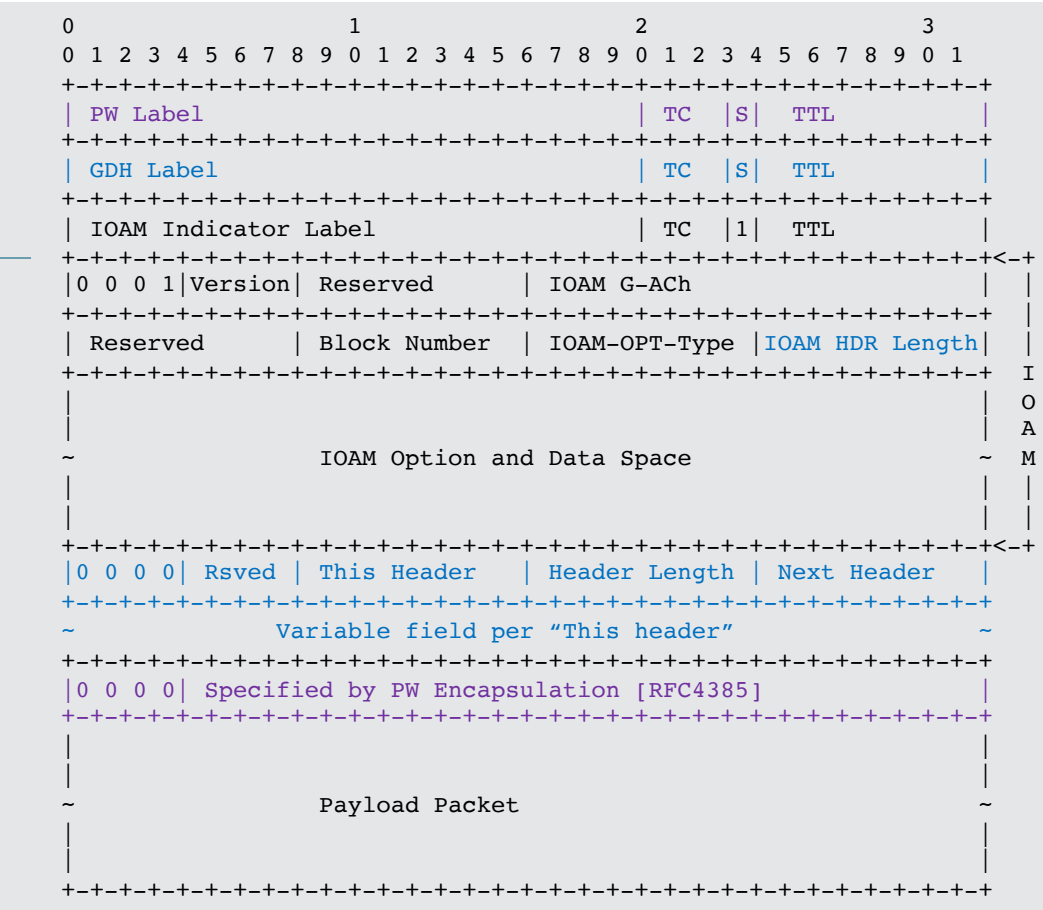

Figure: MPLS Encapsulation with Generic Delivery Functions with IOAM Data Fields

Contiguous Label Stack with one Label with EOS Flag set to 1

CW/G-ACH in TLV format matching the order of its Labels

- https://datatracker.ietf.org/doc/draft-zzhang-intarea-generic-delivery-functions/
- GDF Ingress/Egress Nodes only.
- GDF has no Hop-by-hop processing

Example - DetNet Control Word [RFC8964] with IOAM Data Fields

Labels

Headers

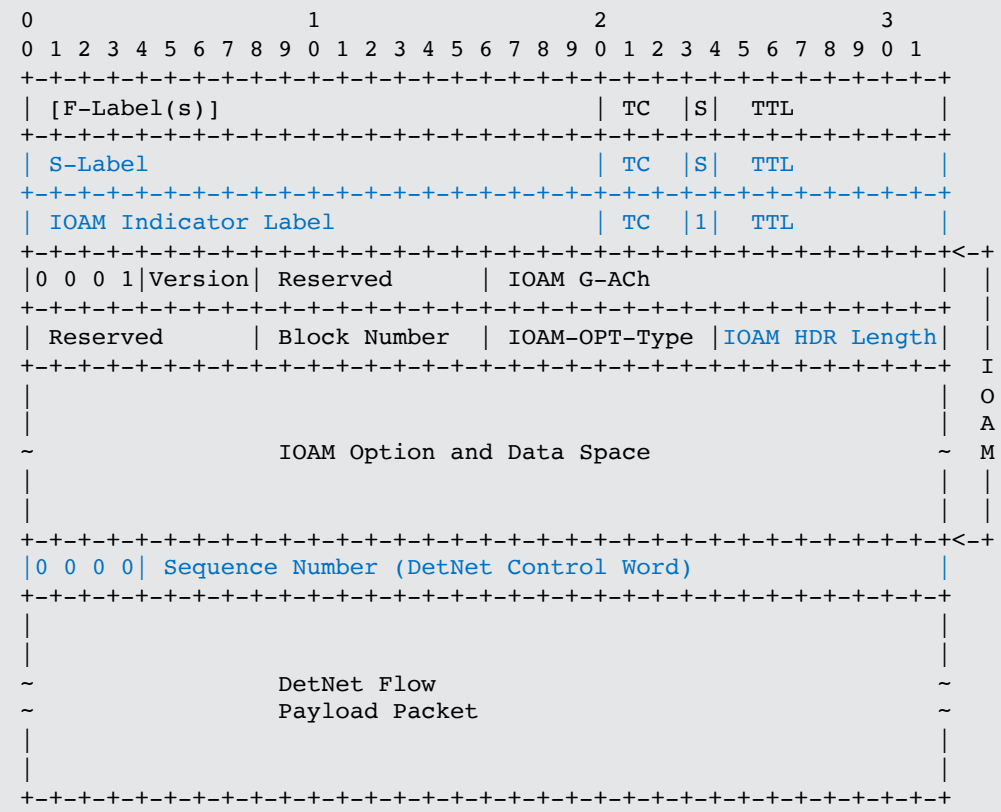

Figure: Example MPLS Encapsulation with DetNet with IOAM Data Fields

Contiguous Label Stack with one Label with EOS Flag set to 1

CW/G-ACH in TLV format matching the order of its Labels

Thank you