MPLS Data Plane Encapsulation for In-situ OAM Data

draft-gandhi-mpls-ioam-sr-05

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Agenda

- Requirements and Scope
- Summary
- Next Steps

Requirements and Scope

Requirements:

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

Scope:

- Using 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

IOAM Header

IOAM Header with MPLS Encapsulation

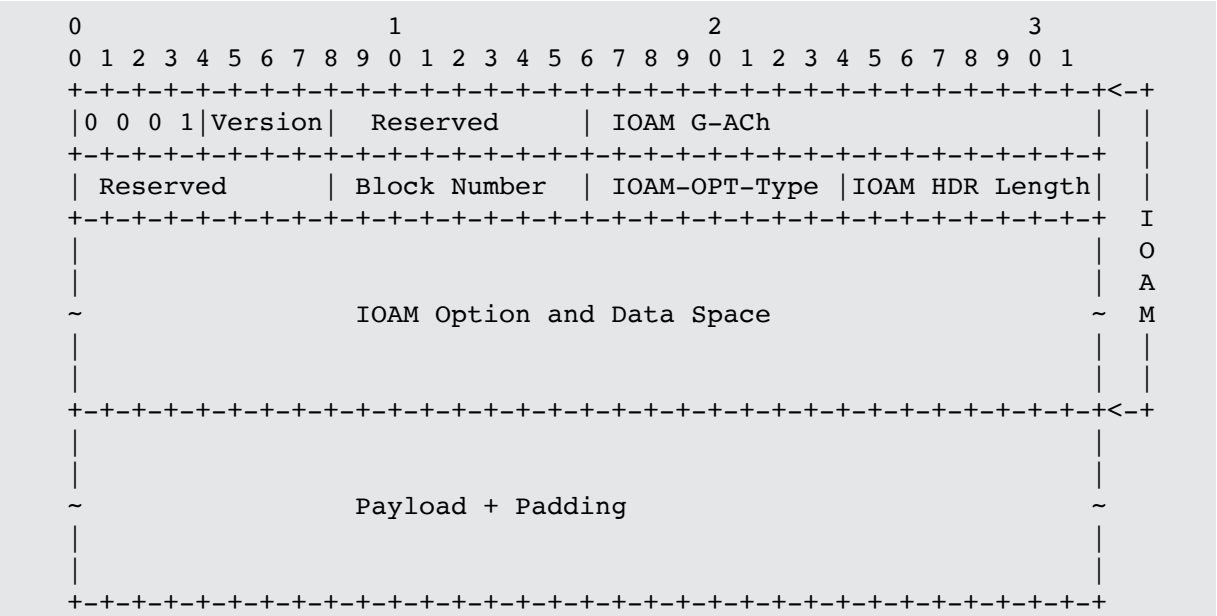


Figure: IOAM Header with MPLS Encapsulation

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
- Block Number can be 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 Label

- “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 transit nodes*) to optimize the IOAM processing on transit nodes when not needed.
- In case of E2E IOAM, the IOAM Option-Type(s) in the data packets are processed on edge nodes only. The transit 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 transit and edge nodes.

E2E IOAM

E2E IOAM Header with MPLS Encapsulation

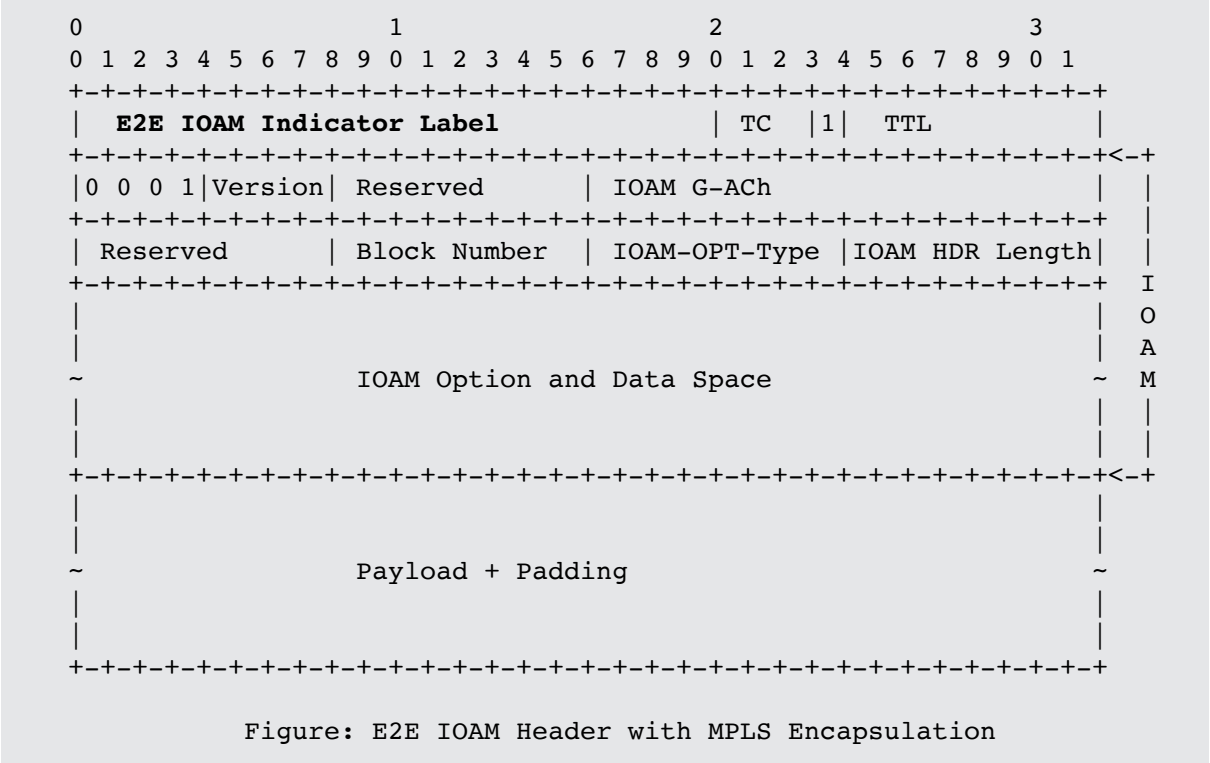


Figure: E2E IOAM Header with MPLS Encapsulation

E2E IOAM Indicator Label Allocation Methods

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

E2E IOAM Indicator Label - Comparisons

	Method	Extra Label Stack Size (Note 2)	Location on Stack
1	eSPL Labels	+2 (Note 1)	Bottom
2	Global Label	+1	Bottom
3	Signal/Advertise Label	+1 (compared to PHP)	Bottom

1. This is true for any mechanism that we are defining using eSPL
   - SFC: https://tools.ietf.org/html/rfc8595
   - E2E: draft-cheng-mpls-inband-pm-encapsulation
2. IOAM data packets may require Entropy label for ECMP to work around hashing issue due to ACH

E2E IOAM Procedure

1. The encapsulating node inserts an E2E Indicator Label and one or more IOAM data field(s) in the MPLS encapsulation.
2. The transit (intermediate) nodes do not process IOAM data.
3. The decapsulating node “punts the timestamped copy” of the data packet including IOAM data field(s).
    a. The decapsulating node processes IOAM data field(s) from the punted packet.
4. The decapsulating node also pops the IOAM Indicator Label and the IOAM data field(s) from the MPLS encapsulation.
    a. The decapsulating node forwards the data packet downstream.

HbH IOAM

HbH IOAM Header with MPLS Encapsulation

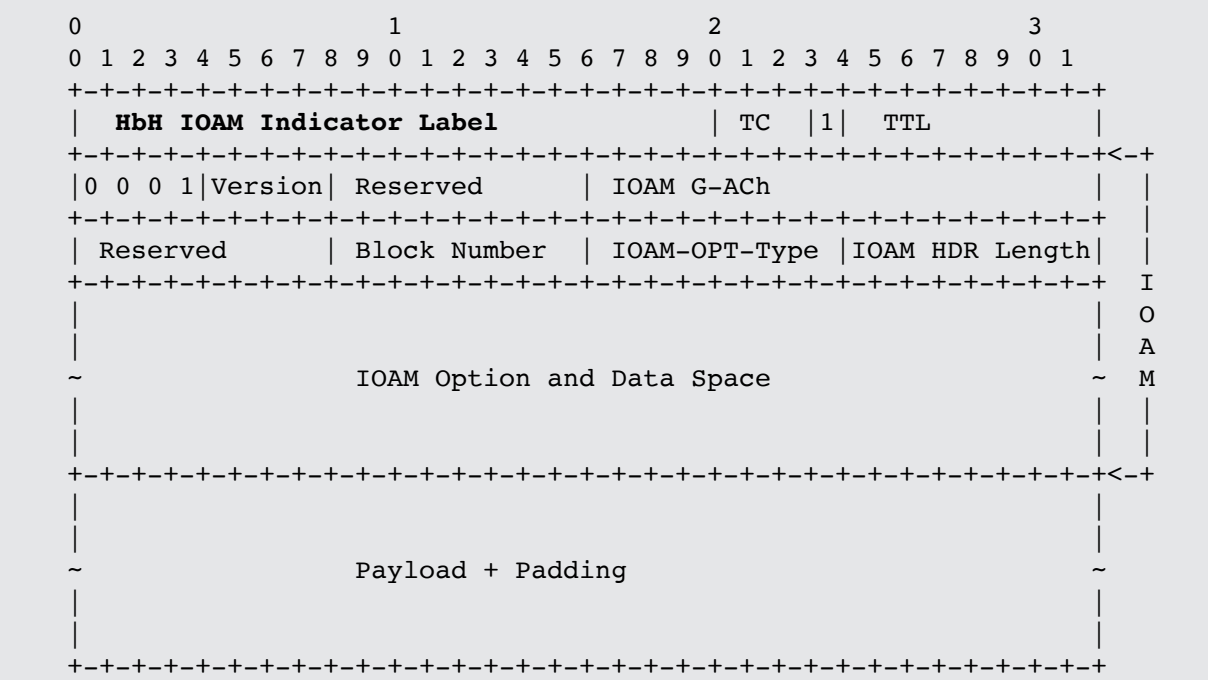


Figure: HbH IOAM Header with MPLS Encapsulation

HbH IOAM Indicator Label Allocation Methods

1. Extension Label (15) and Label assigned by IANA with value TBA2
   - From Extended Special Purpose Labels (eSPL) range
2. Global Label allocated by a controller
   - The controller provisions the label on encapsulating, transit and decapsulating nodes
3. The IOAM Enabled Label allocated by the transit and decapsulating nodes
   - Signaling/advertisement extensions needed to convey the label to all encapsulating nodes (out of scope)

HbH IOAM Indicator Label - Comparisons

	Method	Extra Label Stack Size (Note 4)	Location on Stack	Scan Label Stack (Notes 3)	Different FIB Entry for Local Label
1	eSPL Labels	+2	Bottom (Note 1)	Yes (Note 2)	No
2	Global Label	+1	Bottom	Yes (Note 2)	No
3	Signal/Advertise Label (like SFL)	+0	Incoming Packet with Top Label	No	Yes

1. eSPL at top of the label stack breaks MPLS forwarding in heterogenous network environment with and without IOAM capable nodes
2. Entropy Label similarly also requires transit nodes to scan label stack, however, entropy label processing is optional whereas IOAM processing is not optional
3. A transit node may have a limit on how many labels it can scan. 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
4. IOAM data packets may require Entropy label for ECMP to work around hashing issue due to ACH

HbH IOAM Procedure

1. The encapsulating node inserts a HbH Indicator Label and one or more IOAM data field(s) in the MPLS encapsulation.
2. The transit (intermediate) node processes HbH IOAM data field(s) and forwards the data packet including updated IOAM data field(s).
    a. Transit node (intermediate) may punt the timestamped copy of the data packet for further IOAM processing
3. The decapsulating node "punts the timestamped copy" of the data packet including IOAM data field(s).
    a. The decapsulating node processes IOAM data field(s) from the punted packet.
4. The decapsulating node also pops the IOAM Indicator Label and the IOAM data field(s) from the MPLS encapsulation.
    a. The decapsulating node forwards the data packet downstream.

HbH IOAM Header with MPLS Encapsulation

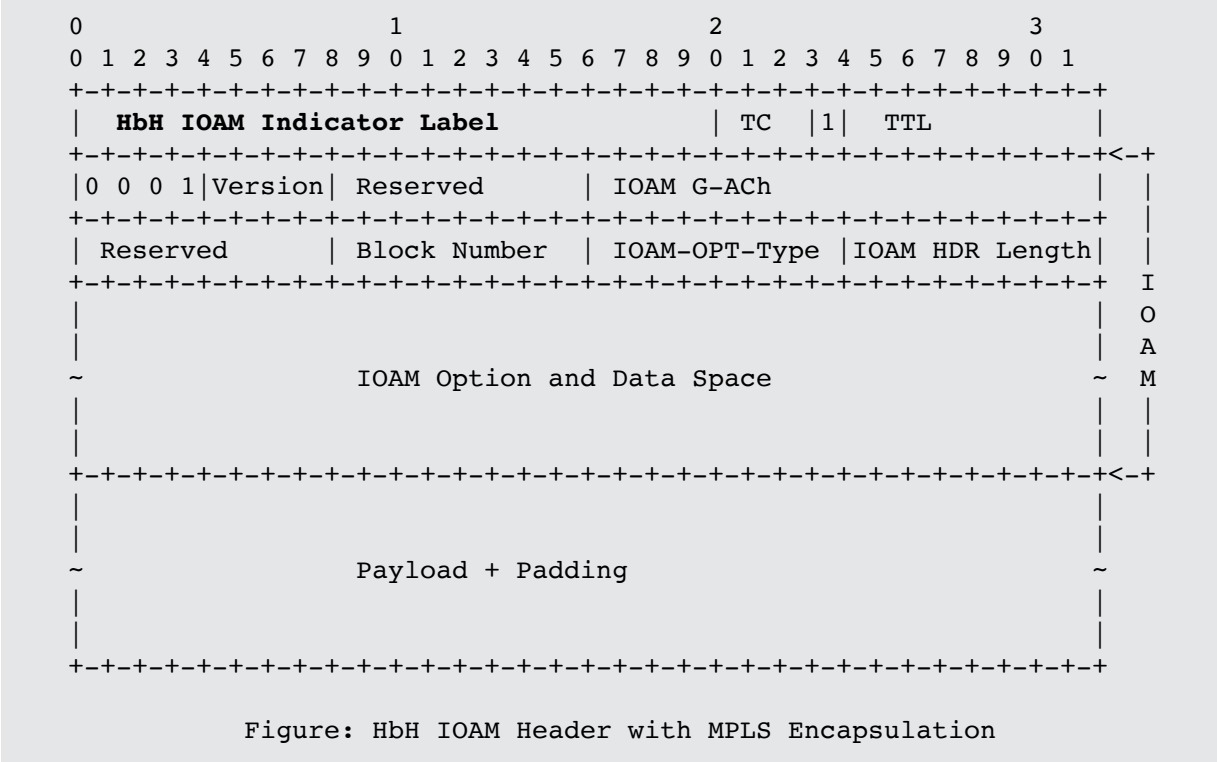


Figure: HbH IOAM Header with MPLS Encapsulation

Next Steps

- Welcome your comments and suggestions
- Requesting MPLS WG adoption

Thank you

Example IOAM Header

Example IOAM Header with SR-MPLS Encapsulation

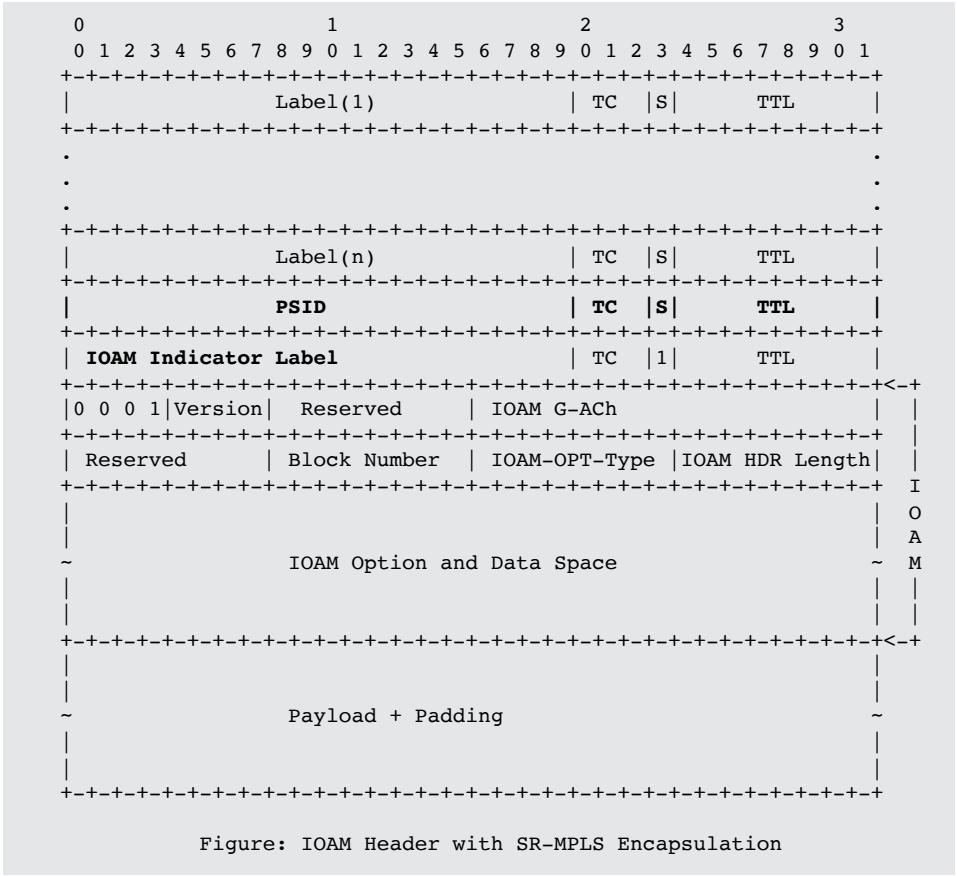


Figure: IOAM Header with SR-MPLS Encapsulation

IOAM Header with Other Control Words/ACHs

- IOAM header is part of the MPLS encapsulation, any other control word / ACH is added after the IOAM header in the data packet.
- The transit nodes can easily process the IOAM data field(s) after the EOS in the data packets.
- The decapsulating node removes the MPLS encapsulation including the IOAM header and then processes the other control word /ACH following it.
- *IOAM HDR Length* allows to find the Control word /ACH after the IOAM header.

Example 1 - IOAM Header with Control Word [RFC4385]

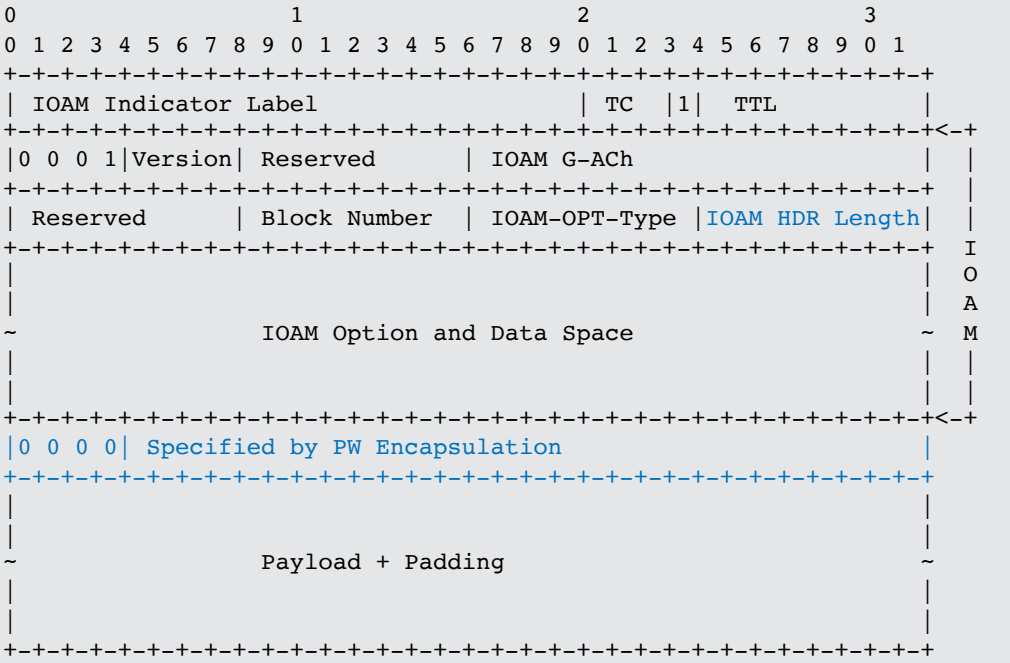


Figure: IOAM Header with MPLS encapsulation with Control Word

Example 2 - IOAM Header with DetNet Control Word

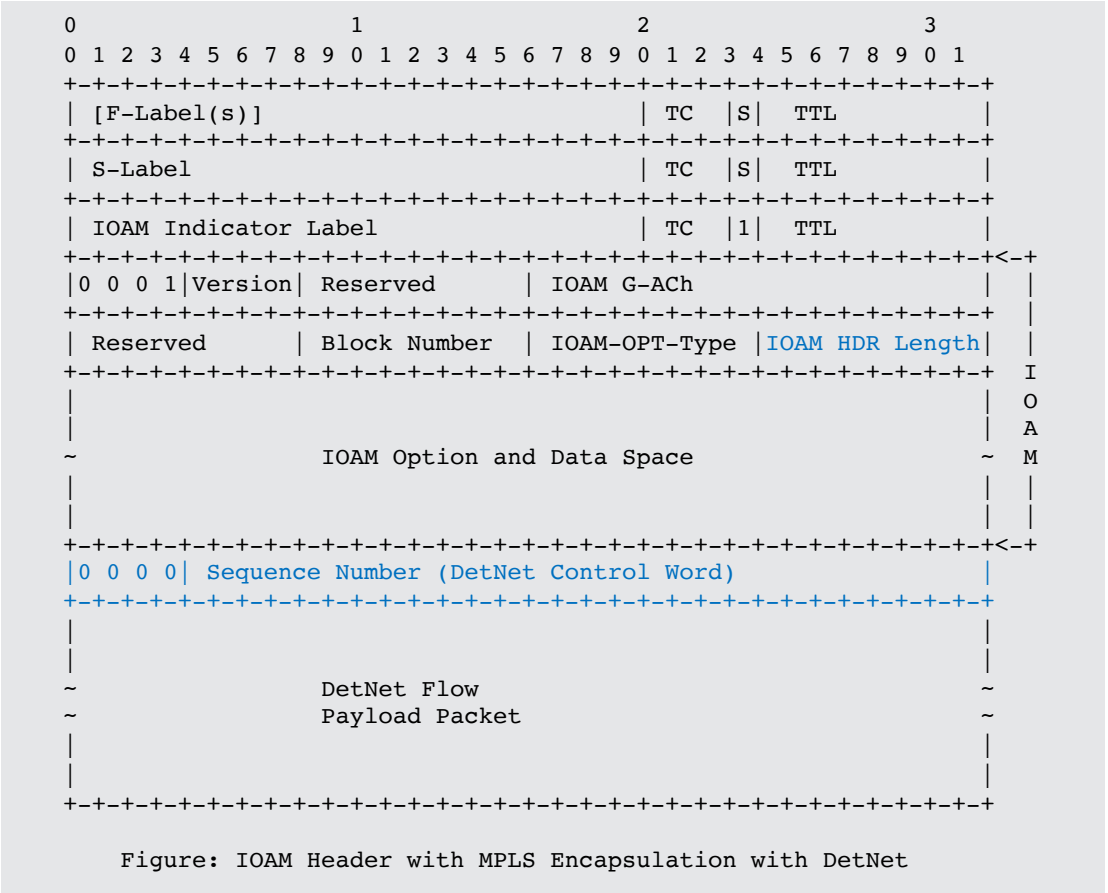


Figure: IOAM Header with MPLS Encapsulation with DetNet

- https://tools.ietf.org/html/draft-ietf-detnet-mpls-13

Example 3 - IOAM Header with DetNet Control Word

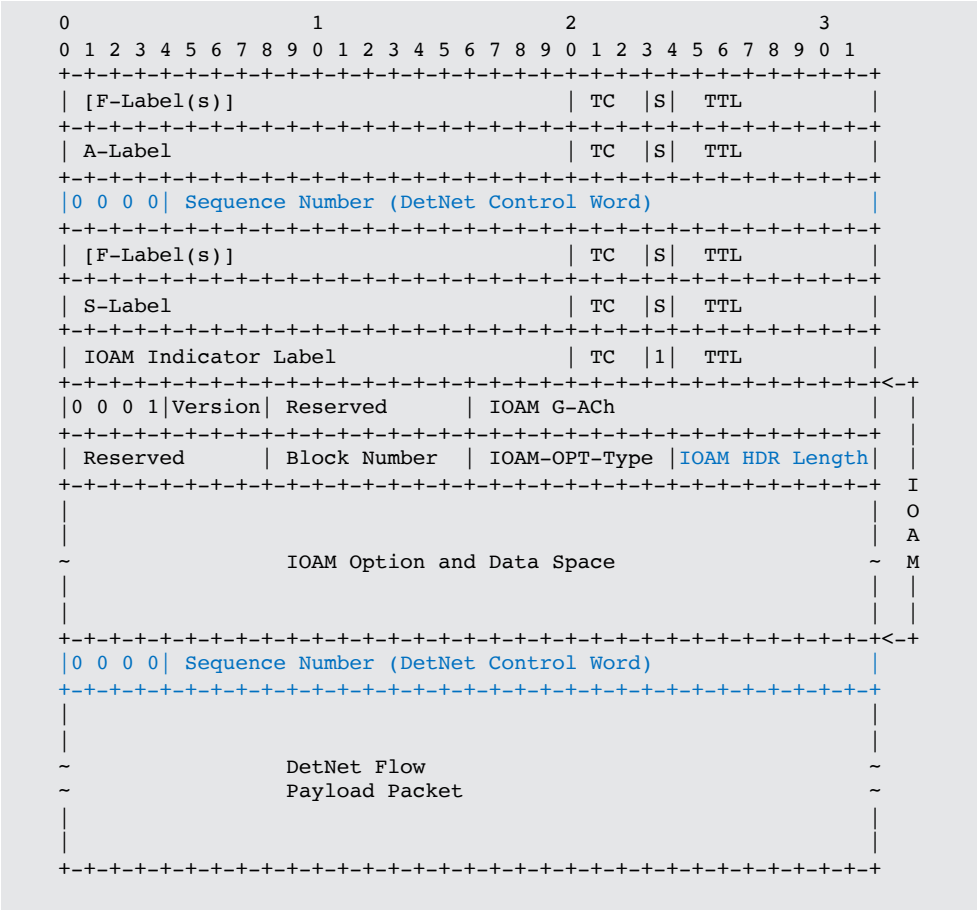


Figure: IOAM Header with MPLS Encapsulation with DetNet

- https://tools.ietf.org/html/draft-ietf-detnet-mpls-13

Example 4- IOAM Header with Generic Delivery Functions

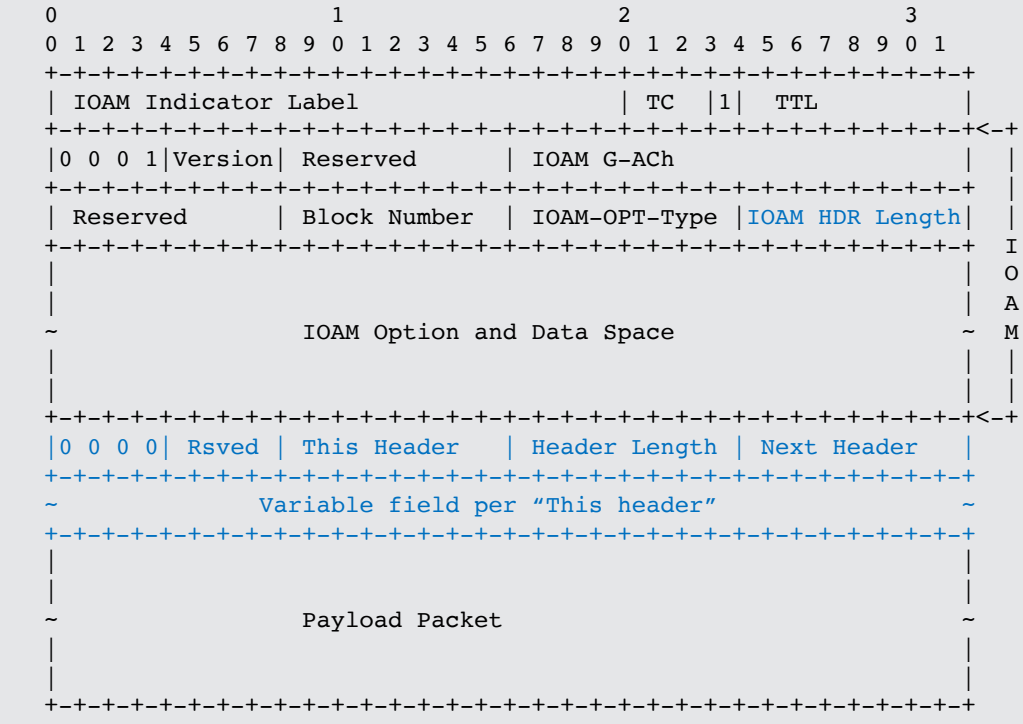


Figure: IOAM Header with MPLS Encapsulation with Generic Delivery Functions

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

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

Example 5 - IOAM Header with Another ACH

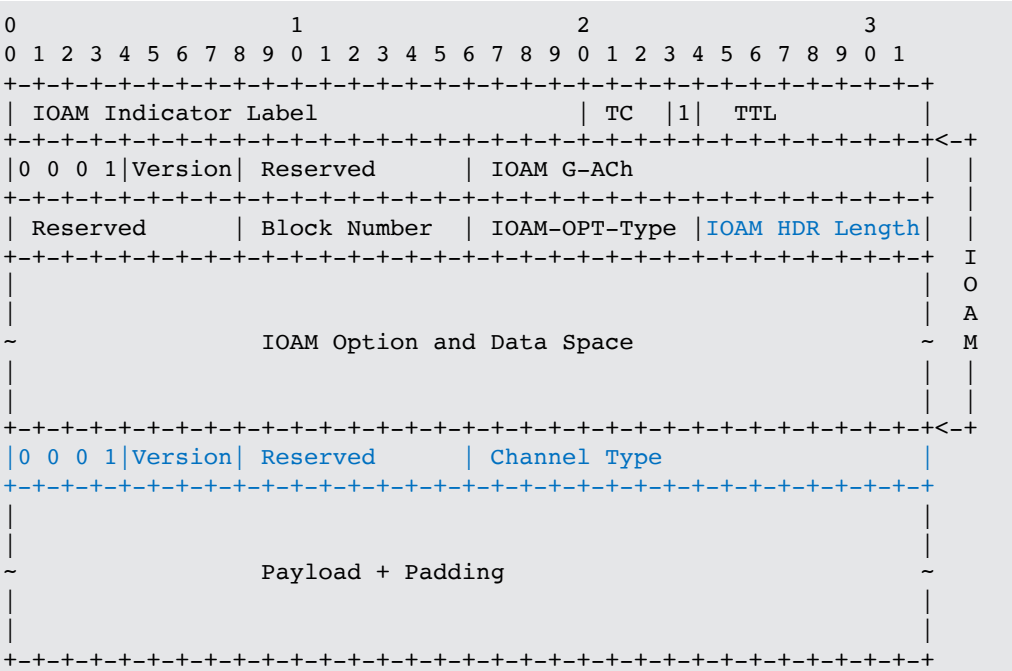
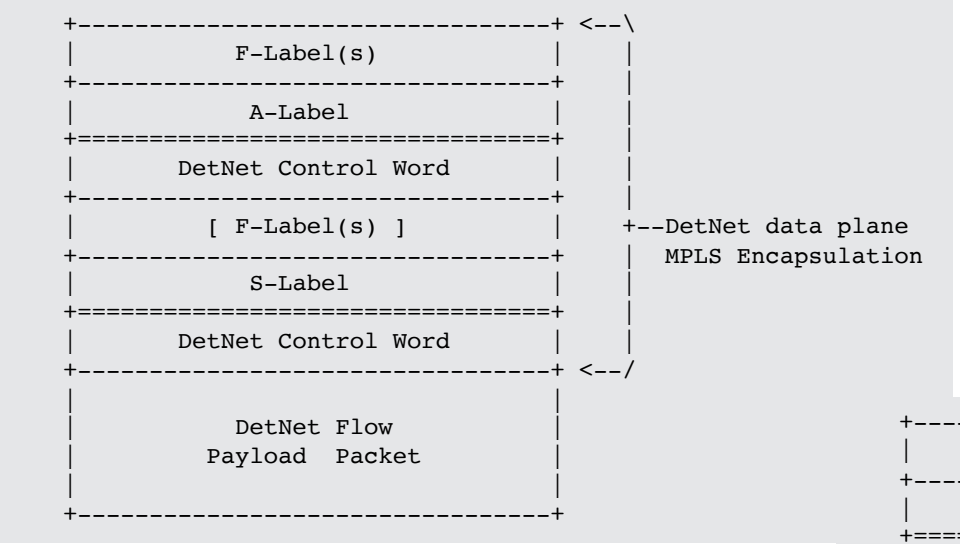
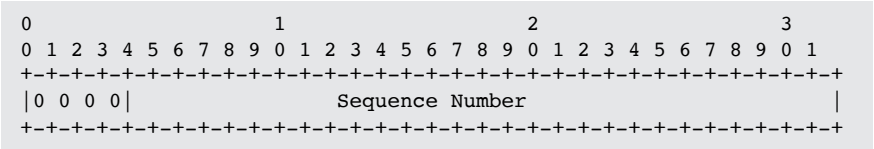


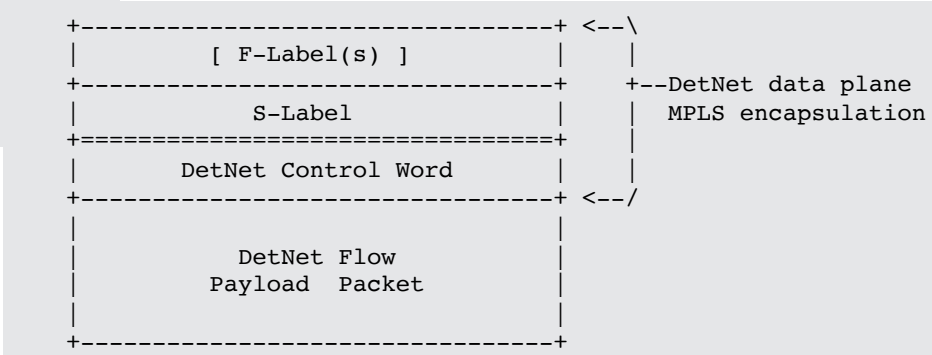
Figure: IOAM Header with MPLS Encapsulation with Another ACH

Thank you

DetNet Draft Examples







- https://tools.ietf.org/html/draft-ietf-detnet-mpls-13