MPLS Data Plane Encapsulation for In-situ OAM Data

draft-gandhi-mpls-ioam-sr-05

Rakesh Gandhi - Cisco Systems (rgandhi@cisco.com) - Presenter
Zafar Ali - Cisco Systems (zali@cisco.com)
Clarence Filsfils - Cisco Systems (cfilsfil@cisco.com)
Frank Brockners - Cisco Systems (fbrockne@cisco.com)
Bin Wen - Comcast (Bin_Wen@cable.comcast.com)
Voitek Kozak - Comcast (Voitek_Kozak@comcast.com)

Agenda

- Requirements and Scope
- Summary
- 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)

MPLS Extensions

IOAM G-ACh for IOAM Data Fields

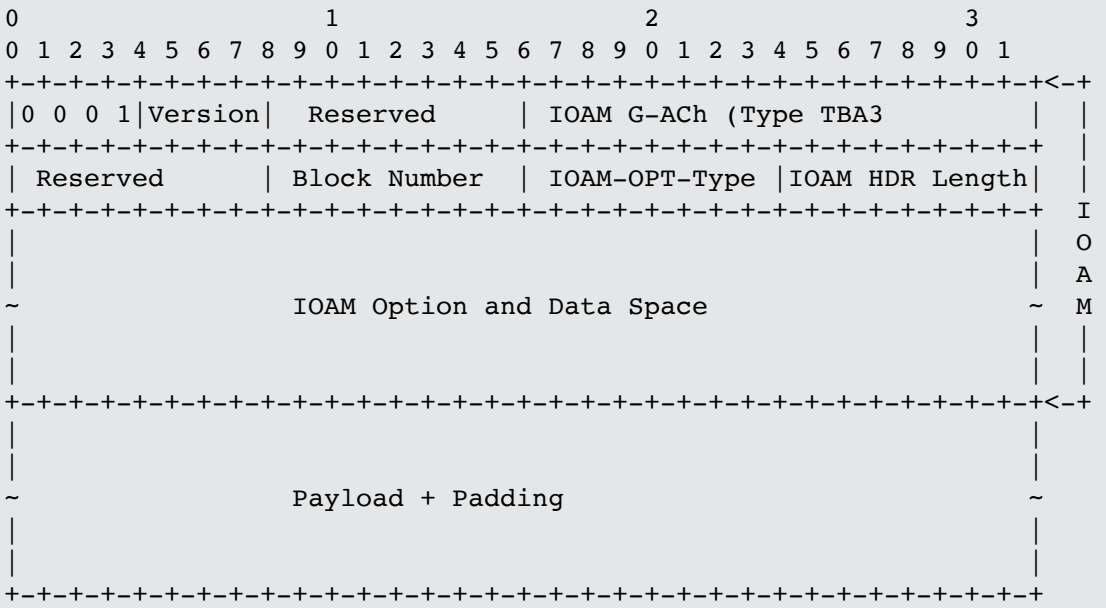

Figure: IOAM G-ACh for IOAM Data Fields

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
- 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 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. **Hence, only E2E Option-Type is carried in the IOAM data field.**
- In case of HbH IOAM, the IOAM Option-Type(s) in the data packets are processed on intermediate and edge nodes. **Hence, both HbH and E2E Option-Types can be carried in the IOAM data field(s).**

E2E IOAM

MPLS Encapsulation with E2E IOAM Data Fields

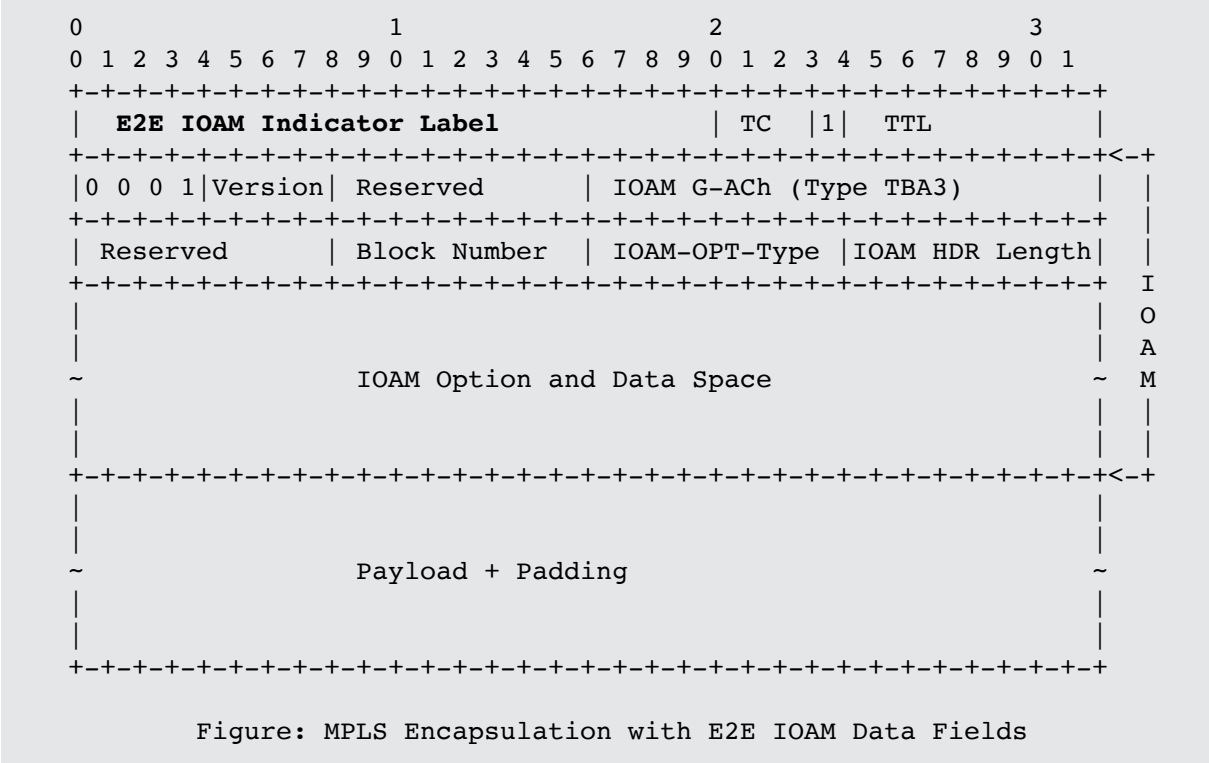

Figure: MPLS Encapsulation with E2E IOAM Data Fields

E2E IOAM Indicator Label Allocation Methods

1. Extension Label (15) and 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 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-ietf-mpls-inband-pm-encapsulation
2. IOAM data packets may require Entropy label for ECMP to work around hashing issue due to ACH for IP packets

E2E IOAM Procedure

1. E2E IOAM includes IOAM processing on encapsulating and decapsulating nodes. **The 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).
   a. 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.
   a. The decapsulating node forwards the data packet downstream.

HbH IOAM

MPLS Encapsulation with HbH IOAM Data Fields

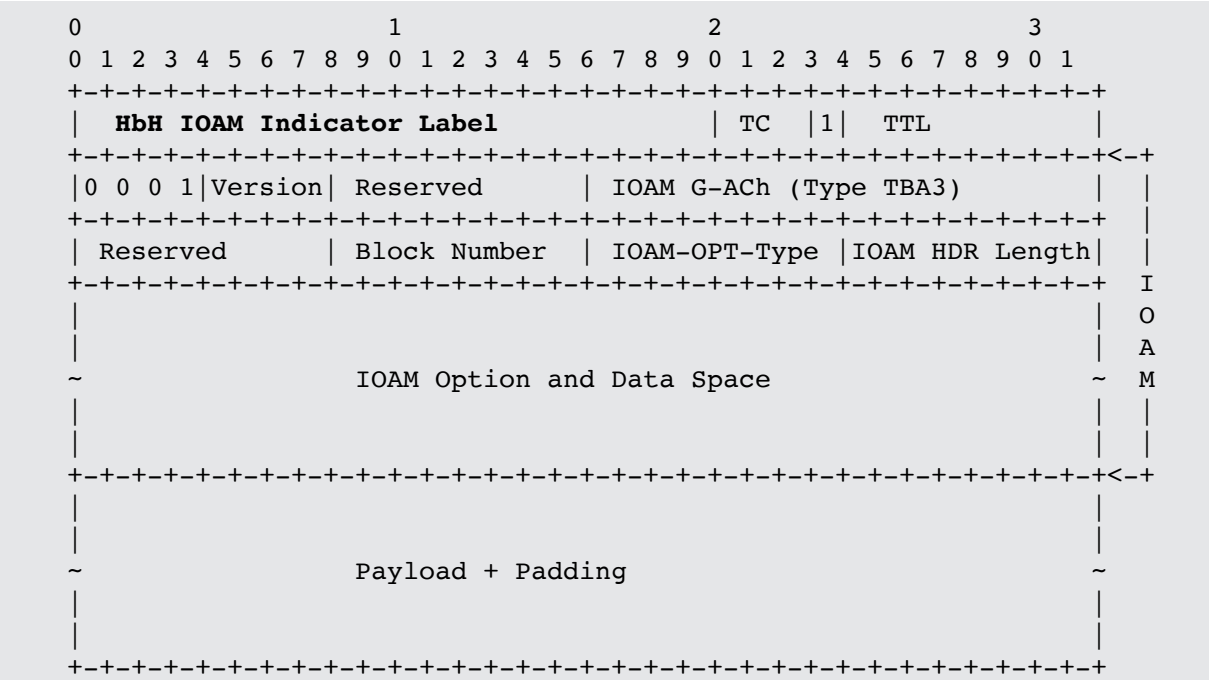

Figure: MPLS Encapsulation with HbH IOAM Data Fields

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, intermediate and decapsulating nodes
3. The IOAM Label allocated by the intermediate 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 intermediate nodes to scan label stack, however, entropy label processing is optional whereas IOAM processing is not optional
3. A 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
4. IOAM data packets may require Entropy label for ECMP to work around hashing issue due to ACH for IP packets

HbH IOAM Procedure

1. HbH IOAM includes IOAM processing on encapsulating, intermediate and decapsulating nodes. **Both HbH and E2E Option-Types can be 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 (intermediate) nodes process HbH IOAM data field(s) and forward the data packet including updated IOAM data field(s).
    a. The intermediate (intermediate) nodes may punt the timestamped copy of the data packet for further IOAM processing.
4. 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.
5. 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.

Next Steps

- Welcome your comments and suggestions
- Requesting MPLS WG adoption

Thank you

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

IOAM Data Fields with Control Word and Another G-ACh

- IOAM Data Fields, including IOAM G-ACh header are added in the MPLS encapsulation after the MPLS header.
- The Control Word or another G-ACh MUST be added after the IOAM Data Fields in the packet.
- This allows the intermediate nodes to easily access the IOAM data field(s) after the MPLS header.
- The decapsulating node can remove the MPLS encapsulation including the IOAM Data Fields and then process the Control Word or G-ACh following it.
- *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

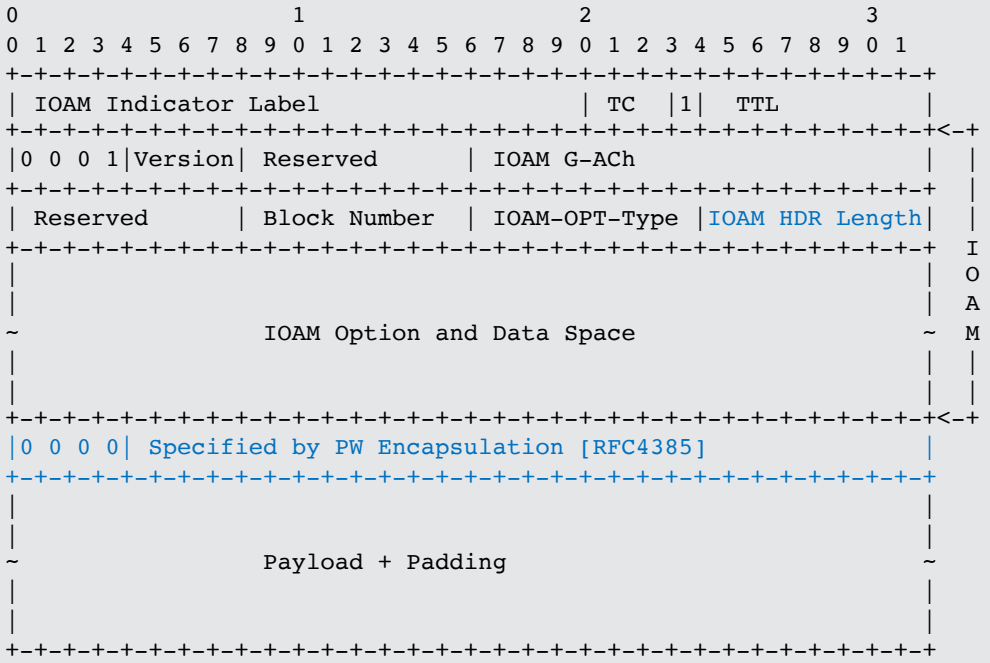

Figure: Example Generic PW Control Word with E2E IOAM Data Fields

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

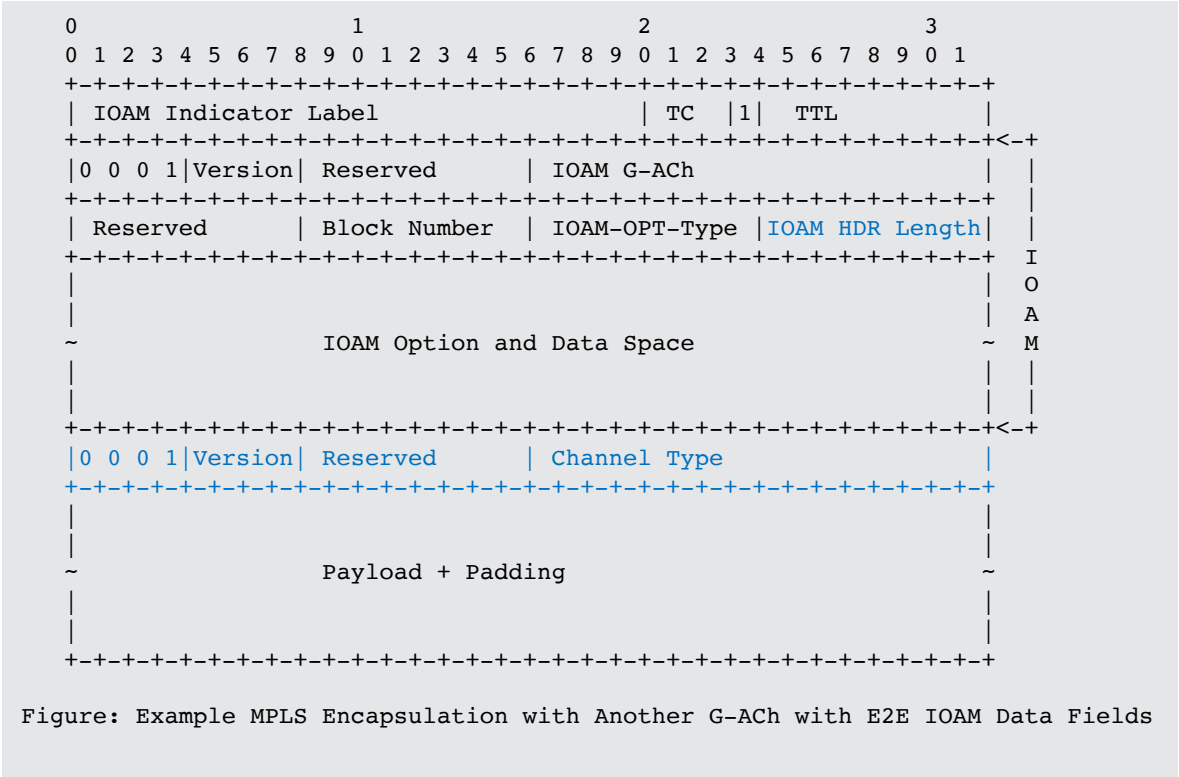

Figure: Example MPLS Encapsulation with Another G-ACh with E2E IOAM Data Fields

Example MPLS Encapsulations for IOAM Data Fields

Example 1 - SR-MPLS Encapsulation with IOAM Data Fields

Figure: Example SR-MPLS Encapsulation with IOAM Data Fields

Example 2 - DetNet Control Word [RFC8964] with IOAM Data Fields

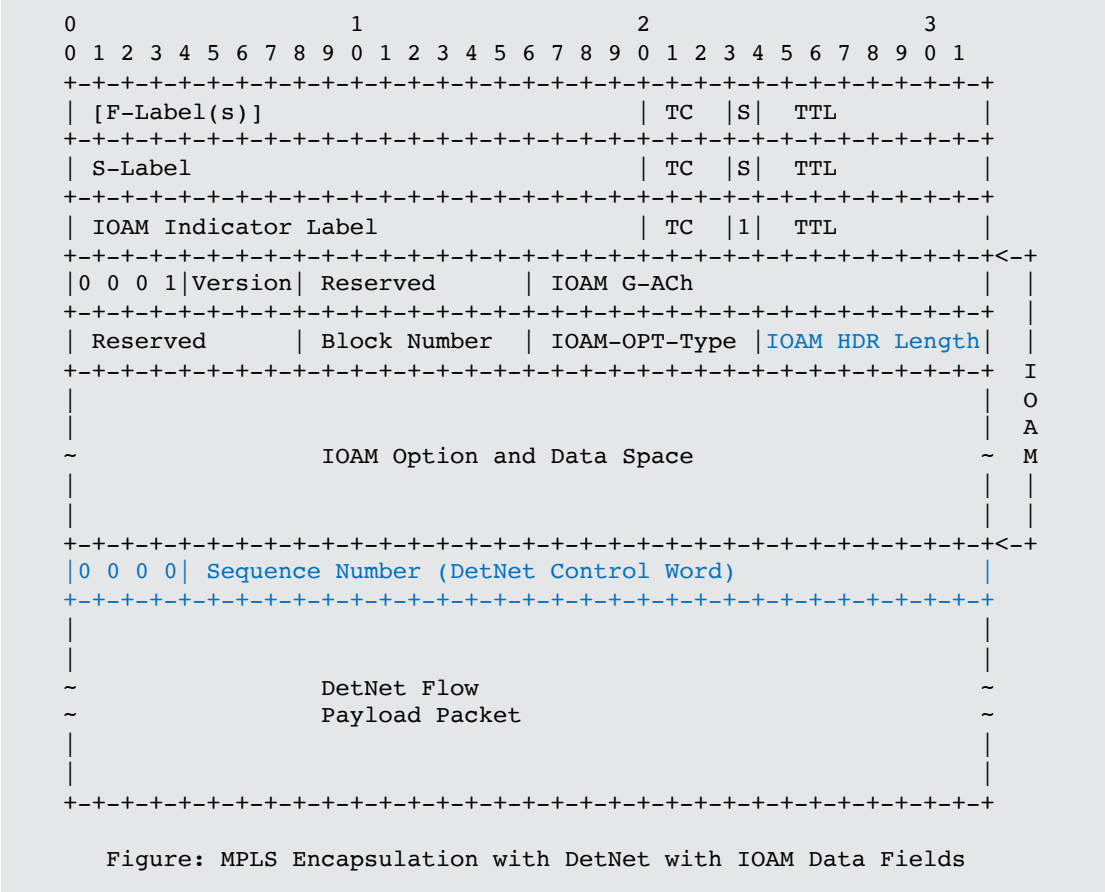

Figure: MPLS Encapsulation with DetNet with IOAM Data Fields

Example 3 - DetNet Control Word [RFC8964] with IOAM Data Fields

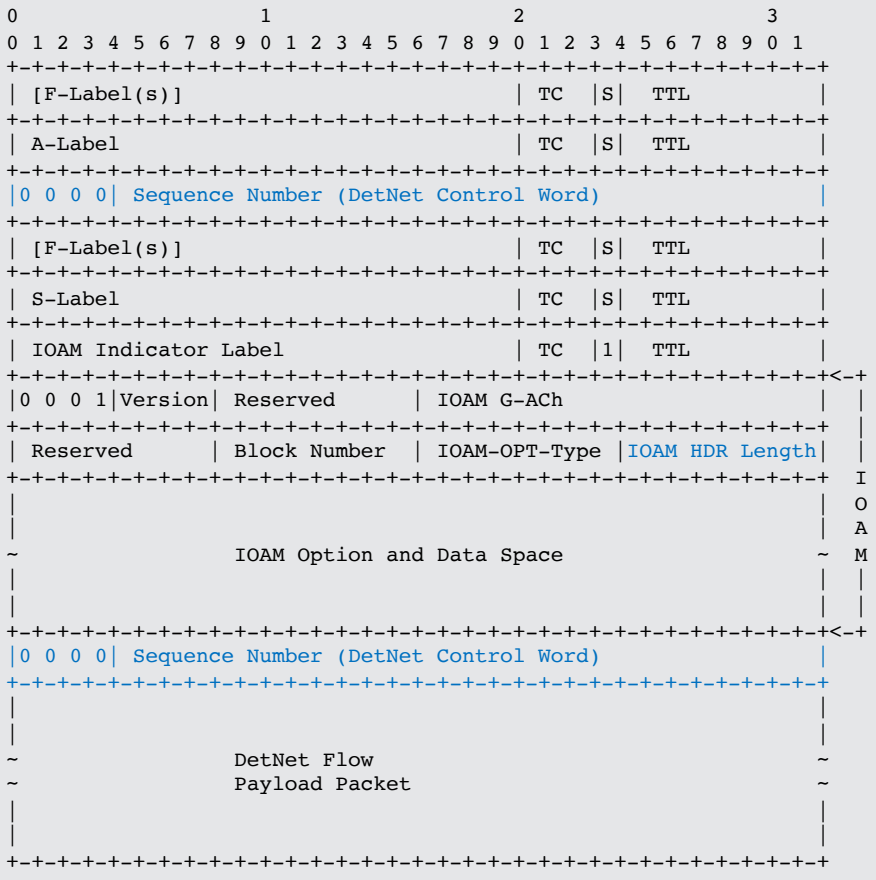

Figure: MPLS Encapsulation with DetNet with IOAM Data Fields

Example 4 - Generic Delivery Function Encap with IOAM Data Fields

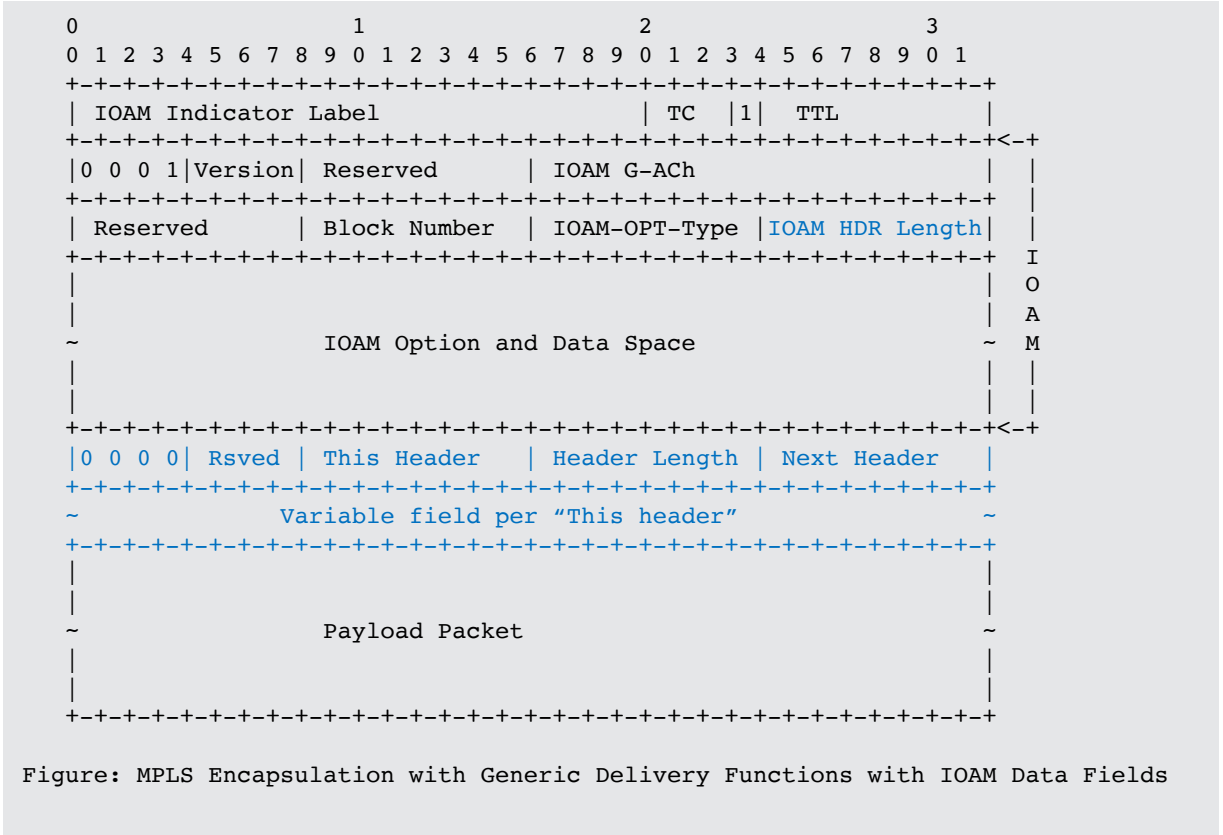

Figure: MPLS Encapsulation with Generic Delivery Functions with IOAM Data Fields

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

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

Thank you