Data Fields and Encapsulation for DetNet Enhanced Data Plane

draft-xiong-detnet-data-fields-edp-00

draft-xiong-detnet-6man-queuing-option-04

draft-sx-detnet-mpls-queue-04

draft-xiong-detnet-spring-srh-extensions-00
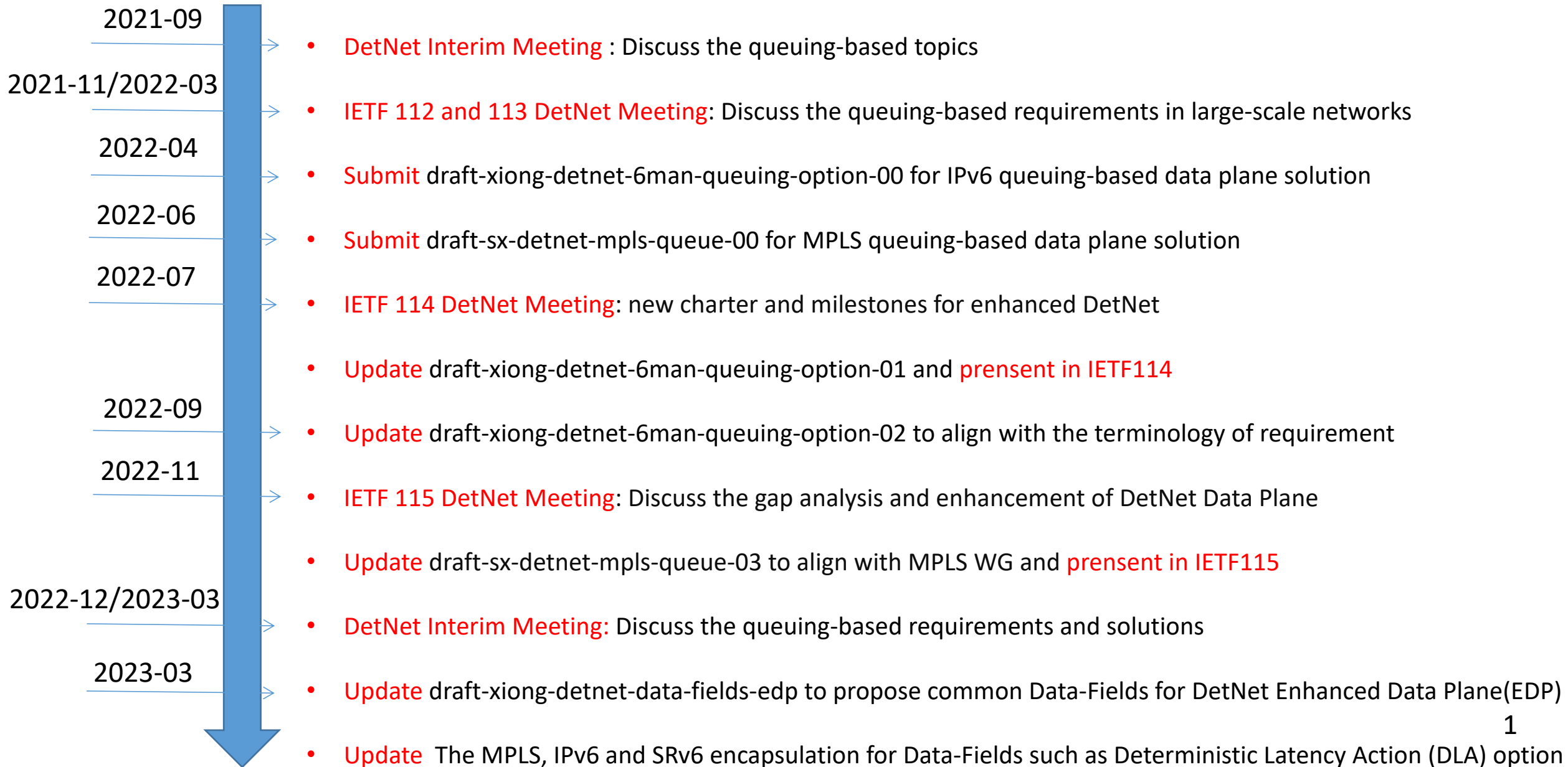
Quan Xiong(ZTE)

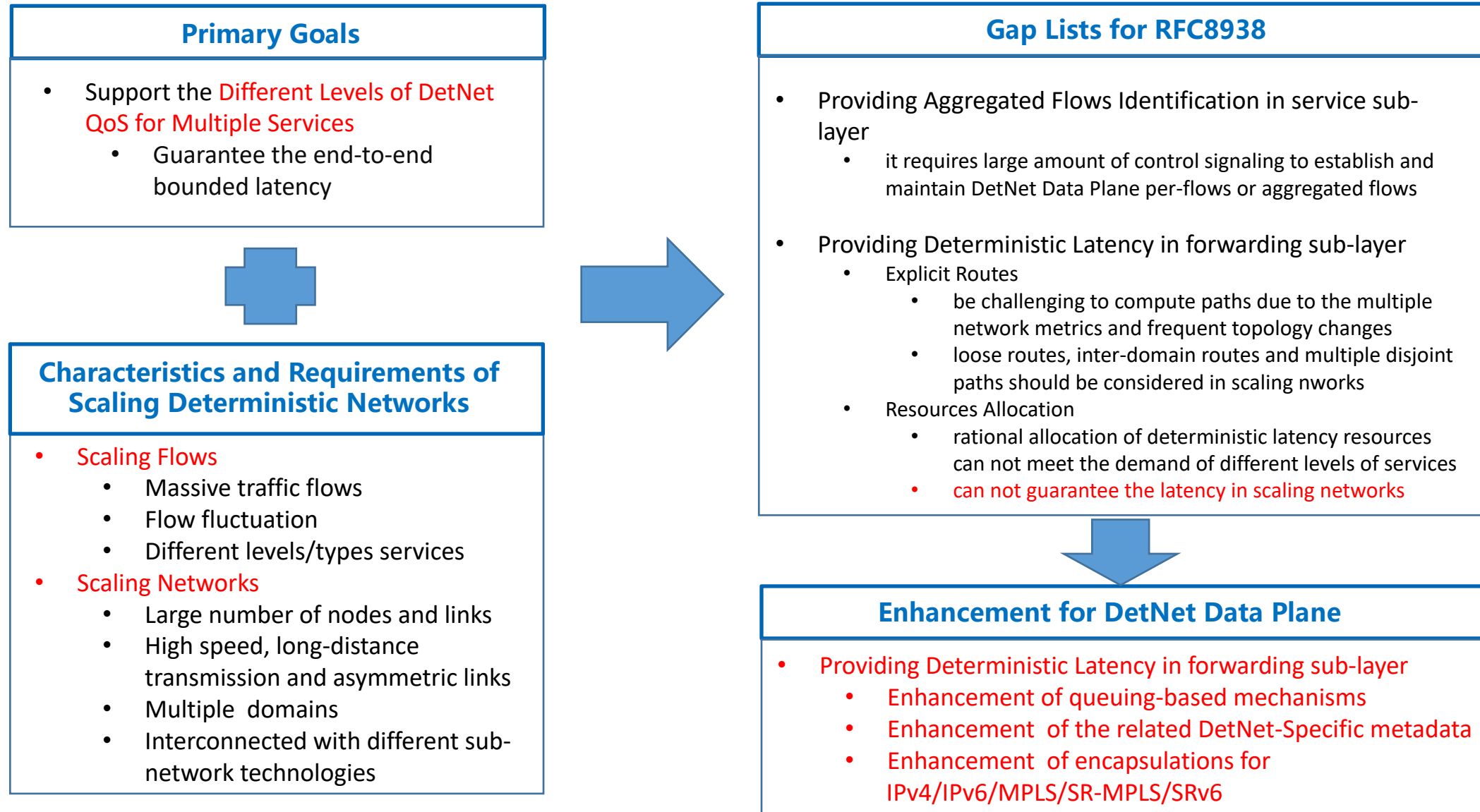Xueyan Song(ZTE)

Rakesh Gandhi(Cisco)

Junfeng Zhao(CAICT)

Dong Yang(Beijing Jiaotong University)

IETF116, DetNet , 2023-03

Recap of the Queuing-based Enhancement

2021-09
- DetNet Interim Meeting : Discuss the queuing-based topics

2021-11/2022-03
- IETF 112 and 113 DetNet Meeting: Discuss the queuing-based requirements in large-scale networks

2022-04
- Submit draft-xiong-detnet-6man-queuing-option-00 for IPv6 queuing-based data plane solution

2022-06
- Submit draft-sx-detnet-mpls-queue-00 for MPLS queuing-based data plane solution

2022-07
- IETF 114 DetNet Meeting: new charter and milestones for enhanced DetNet
- Update draft-xiong-detnet-6man-queuing-option-01 and prensent in IETF114

2022-09
- Update draft-xiong-detnet-6man-queuing-option-02 to align with the terminology of requirement

2022-11
- IETF 115 DetNet Meeting: Discuss the gap analysis and enhancement of DetNet Data Plane
- Update draft-sx-detnet-mpls-queue-03 to align with MPLS WG and prensent in IETF115

2022-12/2023-03
- DetNet Interim Meeting: Discuss the queuing-based requirements and solutions

2023-03
- Update draft-xiong-detnet-data-fields-edp to propose common Data-Fields for DetNet Enhanced Data Plane(EDP)
- Update The MPLS, IPv6 and SRv6 encapsulation for Data-Fields such as Deterministic Latency Action (DLA) option

1

Requirements and Gap analysis

Primary Goals

- Support the Different Levels of DetNet QoS for Multiple Services
  - Guarantee the end-to-end bounded latency

Characteristics and Requirements of Scaling Deterministic Networks

- Scaling Flows
  - Massive traffic flows
  - Flow fluctuation
  - Different levels/types services
- Scaling Networks
  - Large number of nodes and links
  - High speed, long-distance transmission and asymmetric links
  - Multiple domains
  - Interconnected with different sub-network technologies

Gap Lists for RFC8938

- Providing Aggregated Flows Identification in service sub-layer
  - it requires large amount of control signaling to establish and maintain DetNet Data Plane per-flows or aggregated flows

- Providing Deterministic Latency in forwarding sub-layer
  - Explicit Routes
    - be challenging to compute paths due to the multiple network metrics and frequent topology changes
    - loose routes, inter-domain routes and multiple disjoint paths should be considered in scaling nworks
  - Resources Allocation
    - rational allocation of deterministic latency resources can not meet the demand of different levels of services
    - can not guarantee the latency in scaling networks

Enhancement for DetNet Data Plane

- Providing Deterministic Latency in forwarding sub-layer
  - Enhancement of queuing-based mechanisms
  - Enhancement of the related DetNet-Specific metadata
  - Enhancement of encapsulations for IPv4/IPv6/MPLS/SR-MPLS/SRv6

- Refer to draft-ietf-detnet-scaling-requirements and draft-xiong-detnet-enhanced-detnet-gap-analysis.

2

Discussion about the Queuing-based Information

- The packet treatment should indicate the behaviour action ensuring the deterministic latency at DetNet nodes such as queuing-based mechanisms. The deterministic latency action type and related parameters such as queuing-based information should be carried in data plane. And the definitions may follow these polices.

  - The data plane enhancement must be generic and the format must be applied to all functions and queuing mechanisms.

  - Information and metadata MUST be simplified and limited to be carried in DetNet packets for provided deterministic latency related scheduling along the forwarding path. For example, the queuing-based information should be carried in metadata for coordination between nodes.

- Which queuing mechanisms and which queuing-based information should be carried?

  - Cyclic-based Queuing as defined in [draft-dang-queuing-with-multiple-cyclic-buffers] and cycle information should be carried in metadata.

  - Deadline-based Queuing as defined in [draft-peng-detnet-deadline-based-forwarding] and deadline information should be carried in metadata.

  - Local Deadline Queuing as defined in [draft-stein-srtsn] and local deadline information should be carried in metadata.

  - Timeslot Queuing as defined in [draft-peng-detnet-packet-timeslot-mechanism] and timeslot information should be carried in metadata.

- Whether or not reuse DSCP or existing field?

  - Pros: reusing the DSCP or existing field is reasonable and simple to define and easy to standardize. It may be applicable to IPv4 and IPv6 and MPLS.

  - Cons: DSCP value may be not sufficient and hard to distinguish between the original DiffServ service and the deterministic service. Common data field may be applicable to IPv6/SRv6/MPLS networks.

3

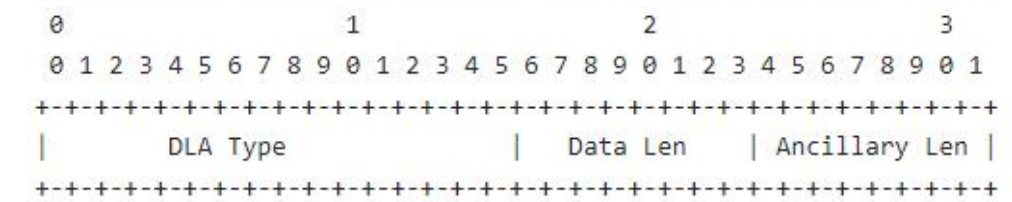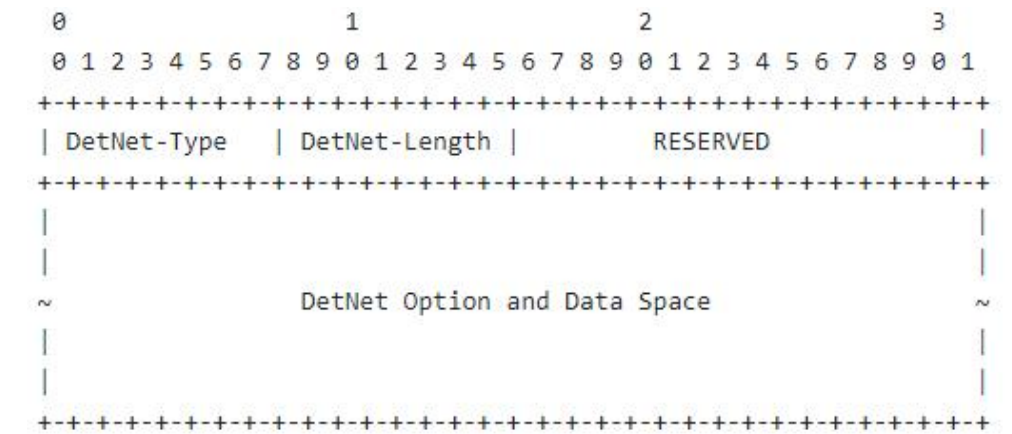# Common Data-Fields for DetNet Enhanced Data Plane

- DetNet Header

  - The common DetNet Header for Enhanced DetNet should be considered to cover all option-types and data such as Deterministic Latency Action (DLA). It can encapsulated into a variety of protocols such as MPLS, IPv6 and SRv6 networks.
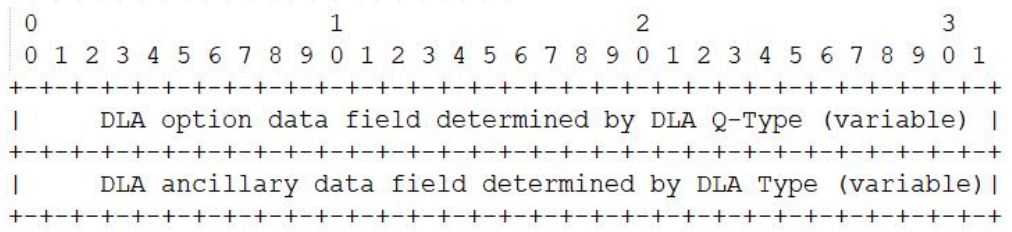
- Deterministic Latency Action (DLA) Option header:

  - DLA type indicates the type of deterministic latency actions for DetNet metadata and can be divided into type and sub-type.
    - Type(8 bits): indicates the behaviour action type of packet treatment for different DetNet service types/levels .
    - Sub-type(8 bits): indicates the type of functions/queuing ensuring the deterministic latency and related metadata.

- Deterministic Latency Action (DLA) Option Data:

  - it may be the function-based or queuing-based information for a node to forward a DetNet flow.

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | DetNet-Type   | DetNet-Length |          RESERVED             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                              |
   |                                                              |
   ~                 DetNet Option and Data Space                 ~
   |                                                              |
   |                                                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |           DLA Type            |  Data Len   | Ancillary Len |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Type  |     Behaviour  Action     |    |Sub-type|  Queuing/Function Action       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|0x0000 |     Unassigned            |    |0x0000 |    Unassigned                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|0x0100 |     Bandwidth guarantee   |    |0x0001 |    Cycle Information            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|0x0200 |     Jitter guarantee      |    |0x0002 |    Deadline Information         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|0x0300 |     Delay guarantee       |    |0x0003 |    Local Deadline Information   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|0x0400 |  Low delay and jitter guarantee |  |0x0004 |   Time Slot Information       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|0x0500 |Ultra-low delay and jitter guarantee |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      DLA option data field determined by DLA Q-Type (variable) |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      DLA ancillary data field determined by DLA Type (variable)|
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

4

DLA Option Encapsulated in IPv6 Data Plane

- Purpose

  - Provide encapsulation for Deterministic Latency Action (DLA) Option to carry the queuing-based information of DetNet flows to achieve the end-to-end deterministic latency in IPv6 and SRv6 data plane.

- Considerations on DetNet DLA option in IPv6 Encapsulation

  - Define new IPv6 options for DetNet to signal deterministic latency action information.

  - The DetNet options may be placed either in an HbH or a DoH EH.

  - Multiple options with the same option type MAY appear in the same hop-by-hop options or destination options header with distinct data.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Option Type   | Opt Data Len | DetNet-Type   | DetNet-Length |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+              DetNet Options Data(variable)                    |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
+-----------------------------------+
|         DetNet App-Flow           |
|       (original IP) Packet        |
+-----------------------------------+
|           other EHs               |
+-----------------------------------+--\
|       IPv6 Hop-by-Hop Ex Hdr      |   |
|        (DetNet DLA Option)        |   | DetNet Options
|                                   |   |
+-----------------------------------+--/
|           IPv6 Header             |
+-----------------------------------+
|           Data-Link               |
+-----------------------------------+
|            Physical               |
+-----------------------------------+
```
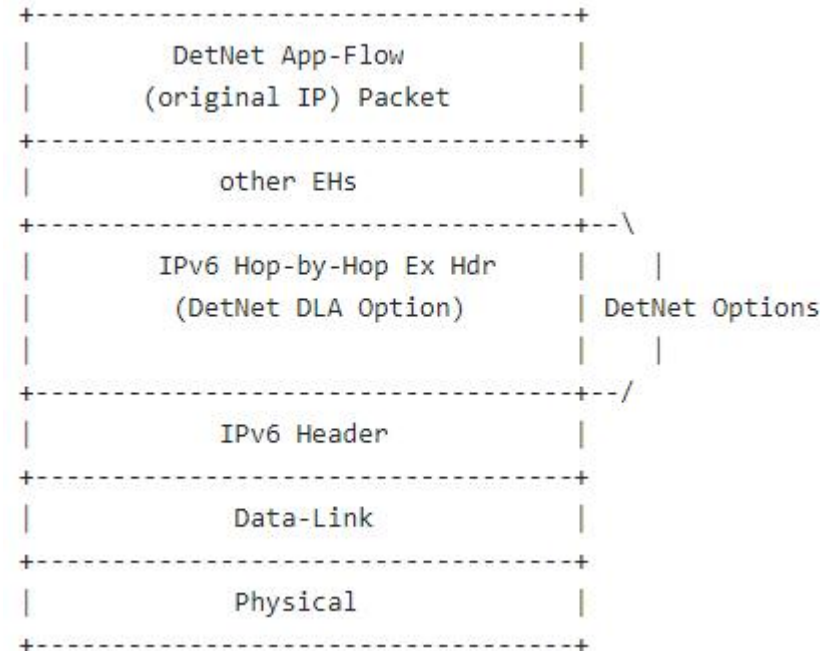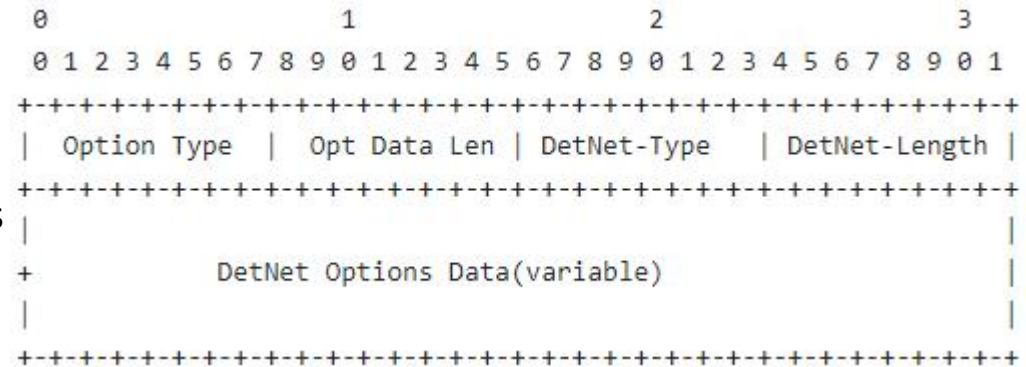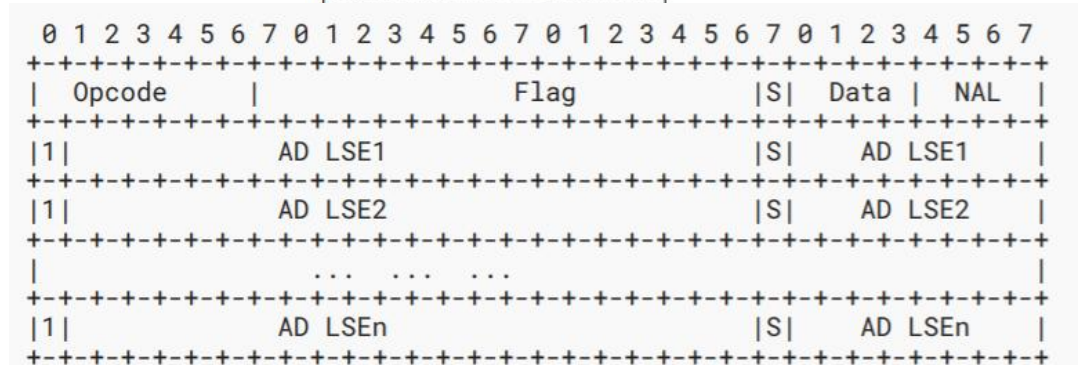
DLA Option Encapsulated in MPLS Data Plane

- Purpose

  - Provide encapsulation for Deterministic Latency Action (DLA) Option to carry the queuing-based metadata of DetNet flows in MPLS data plane specified in [RFC8964].

  - Align with the ongoing work in MPLS WG and the MNA specifications in draft-ietf-mpls-mna-requirements-04 and draft-ietf-mpls-mna-hdr-01

- Considerations on DetNet DLA option in MPLS Encapsulation

  - the SP-Lable (SPL) is added to indicate Deterministic Latency Action (DLA)

  - MNA Format C for DLA

    - **Opcode field**, DLA indicator

    - **Flag field**, flags for DLA queuing mechanisms

    - **Data field**, reserved for future use

    - **NAL field**, DLA action length, the number of AD LSEs

    - **AD LSE**, carries the Ancillary Data for specific DLA latency

    information of queue mechanism

```
+---------------------------+
|      DetNet App-Flow      |
|      Payload Packet       |
+---------------------------+--\
|     DetNet Control Word   |  |
+---------------------------+  |
|          S-Label          |  | DetNet Data Plane
+---------------------------+  | MPLS Encapsulation
|          SP-Lable         |  |
+---------------------------+  |
|         F-Label(s)        |  |
+---------------------------+--/
|         Data-Link         |
+---------------------------+
|         Physical          |
+---------------------------+
```

```
 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Opcode       |              Flag              |S| Data | NAL |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|1|            AD LSE1                            |S|    AD LSE1  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|1|            AD LSE2                            |S|    AD LSE2  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             ...    ...   ...                    |             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|1|            AD LSEn                            |S|    AD LSEn  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

DLA Option Encapsulated in SRv6 Data Plane
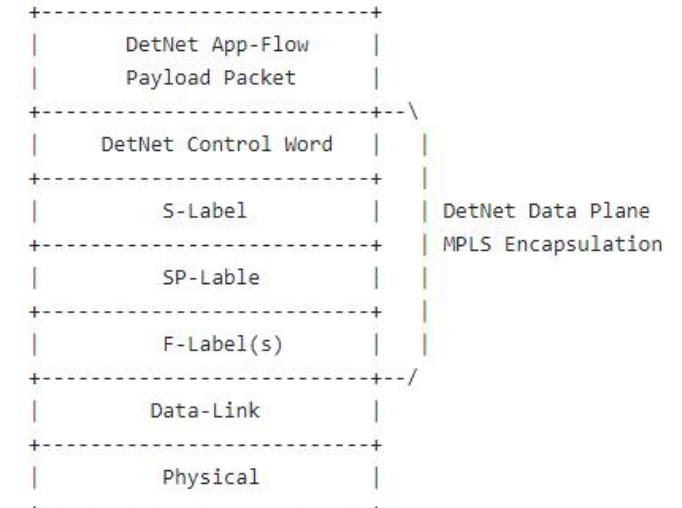
- Purpose
  - Provide encapsulation for Deterministic Latency Action (DLA) Option to carry the queuing-based information of DetNet flows to achieve the end-to-end deterministic latency in SRv6 data plane.

- Considerations on DetNet DLA Option in SRH Encapsulation
  - The DLA data can be carried in SRH extensions including the options such as Segment FUNCITON field, SRH TLV OR the last segment in SRH.
  - DLA option is needed on every hop and it will be processed with STACK mode or SWAP mode due to the specific queuing mechanisms. If it is STACK mode, it may be best to add it in segment function if there is enough bits, otherwise the DLA list will be carried in TLV. If it is SWAP mode, it will be carried in SL[n] or TLV.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| SRH-TLV-Type  |SRH-TLV-Length |   DetNet-Type | DetNet-Length |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      DLA   Type               |    Data Len   | Ancillary Len |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   DLA Data List[0](variable)                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                               . . .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   DLA Data List[n](variable)                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
| SRv6 DetNet Segment (Segment List[n+1] (128-bit IPv6 value)   |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              Segment List[0] (128-bit IPv6 address)           |
|              DLA Option Data List[0]                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|                              . . .                            |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              Segment List[n] (128-bit IPv6 address)           |
|              DLA Option Data List[n]                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Next Steps

- Follow the enhanced DetNet and focus on the queuing mechanisms first and then to discuss which information must be carried and decide the reuse of DSCP and the common encoding format.

- Follow the requirement of scaling DetNet and align with the terminology.

- Comments and Questions are appreciated!