DetNet SRv6 Data Plane Encapsulation
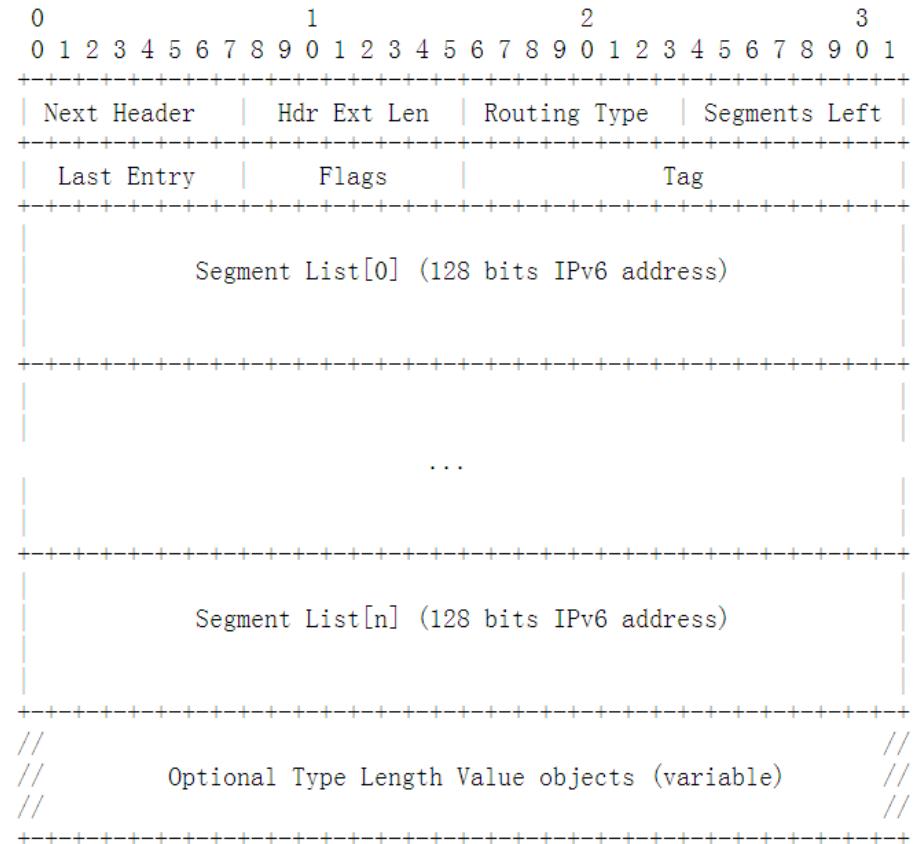
draft-geng-dp-sol-srv6-00

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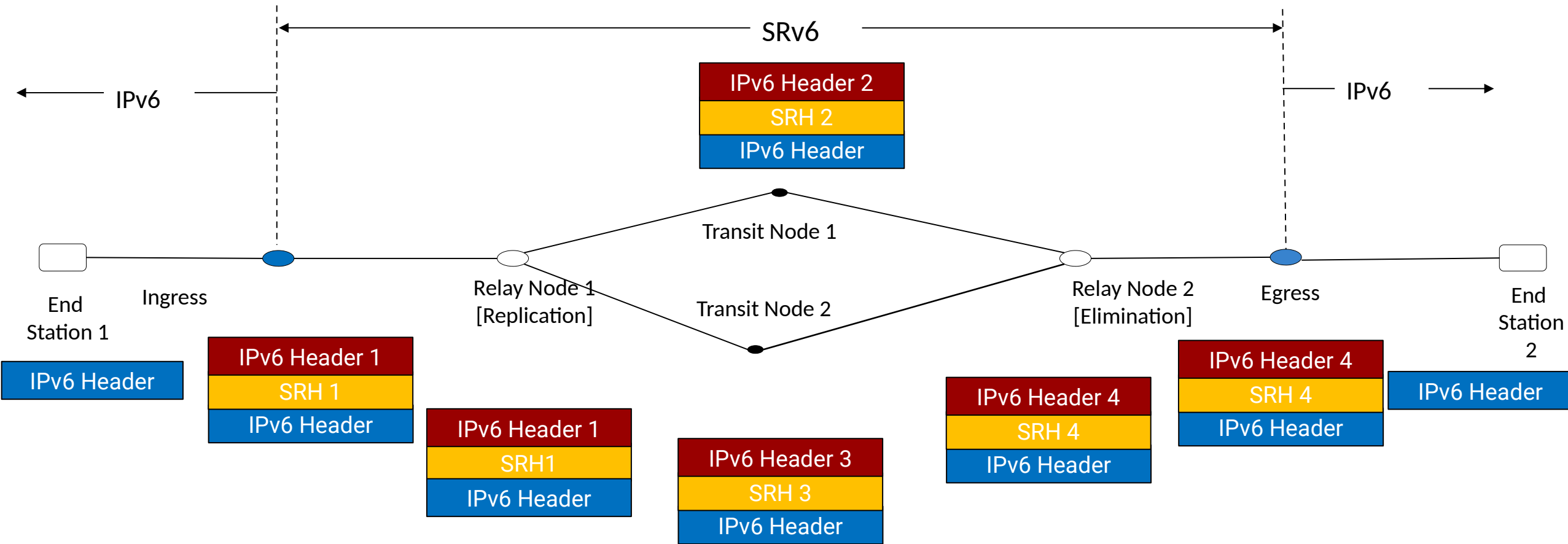Mach Chen   (mach.chen@huawei.com)

Overview of SRv6

- SRH

  - Segment Routing can be applied to the IPv6 data plane using a new type of Rou

    ting Extension Header, which is SRH;

- Segment List

  - The Segment List is encoded starting from the last segment of the SR Policy, wh

    ich can steer the packet through an indicated path;

- Optional TLVs

  - TLVs behind the Segment List;

- Network Programming

  - Each segment can be an instruction, which represents a function to be called at

    a specific location in the network;

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Next Header   |  Hdr Ext Len  | Routing Type  | Segments Left |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Last Entry   |     Flags     |              Tag              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|            Segment List[0] (128 bits IPv6 address)            |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|                                                               |
|                              ...                              |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|            Segment List[n] (128 bits IPv6 address)            |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//                                                             //
//         Optional Type Length Value objects (variable)      //
//                                                             //
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
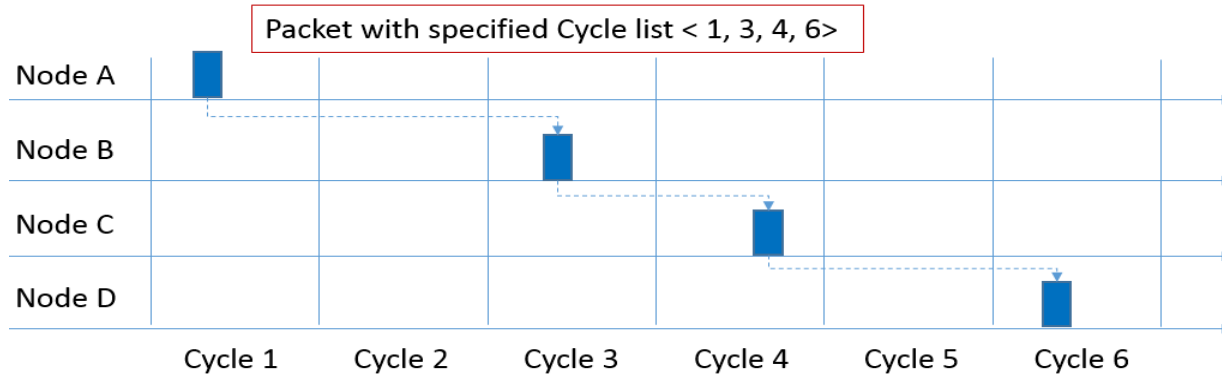
DetNet SRv6 Data Plane Requirement

- A method of identifying the SRv6 payload type; (e.g., DSCP)

- A suitable explicit route to deliver the DetNet flow ; (e.g., Segment List in SRH)

- A method of indicating packet processing, such as PREOF; (detailed in next slides)

- A method of identifying the DetNet flow; (detailed in next slides)

- A method of carrying DetNet sequence number; (detailed in next slides)

- A method of carrying queuing and forwarding indication to do congestion protection; (detailed in next slides)

SRv6 Based PREOF

SRv6 based Bounded Latency

Packet with specified Cycle list < 1, 3, 4, 6>

Node A

Node B

Node C

Node D

Cycle 1   Cycle 2   Cycle 3   Cycle 4   Cycle 5   Cycle 6

IPv6 Hdr
  SA: X, DA: *A1*
SRH Hdr
  SL: A1, *B3*, C4, D5, Z

IPv6 Hdr
  SA: X, DA: *C4*
SRH Hdr
  SL: A1, B3, C4, *D6*, Z

PKT   PKT   B   PKT   D   PKT

Talker   Listener

X   A   C   Z

IPv6 Hdr
  SA: X, DA: *B3*
SRH Hdr
  SL: A1, B3, *C4*, D5, Z

PKT

IPv6 Hdr
  SA: X, DA: *D6*
SRH Hdr
  SL: A1, B3, C4, D6, *Z*

PKT

- Specify the "sending time cycle" of each packet
- Make sure each packet be sent out within the specified cycle
- Hence guarantee the E2E bounded latency
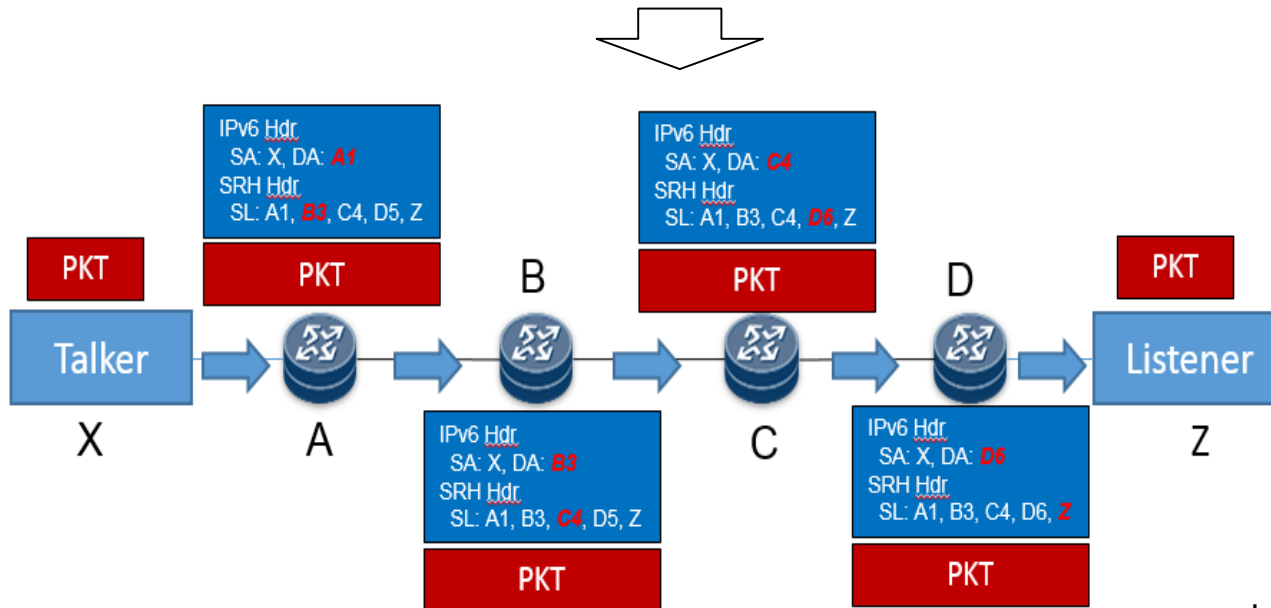
- SID identifies the "sending cycle";
- No per-flow states maintained at intermediate and egress nodes ， naturally support flow aggregation scale to large network, easy to deploy;

- E2E Jitter<= 2*cycle
- E2E Bounded Latency = (2*Cycle + process delay)*hops + link delay

https://tools.ietf.org/html/draft-chen-detnet-sr-based-bounded-latency
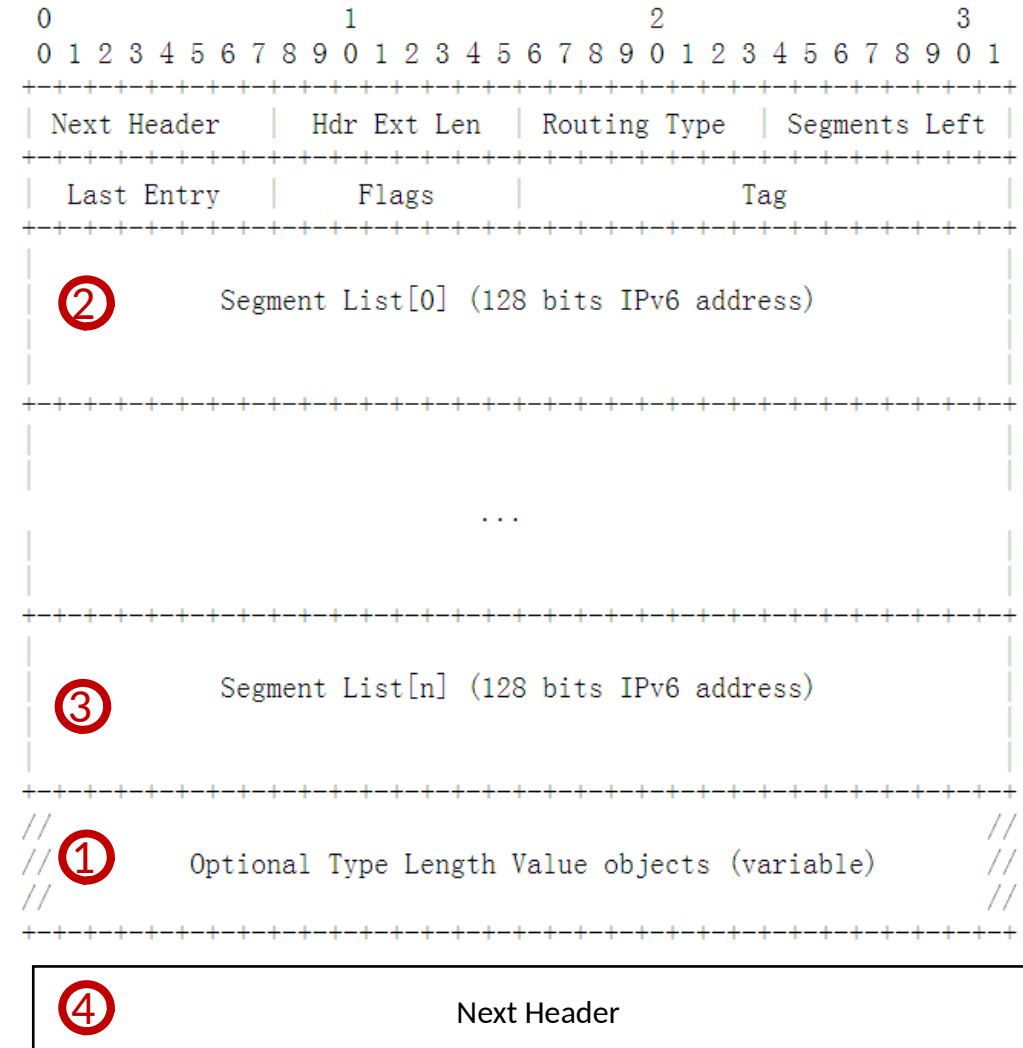
Next Step

- Do we want to work on SRv6 based DetNet data plane solution?

- Keep refining the document according to WG comments and feedbacks.

- Seek collaboration on this work.

# Thanks

DetNet SRv6 Data Plane Solution

Flow Identification(20bits) and Sequence Number(28bits) a

e carried in:

- **Option1:** SRH TLVs

- **Opiton2 :** arguments in the SID for Relay Node

- **Option3:** DetNet SID in segment list

- **Option4:** DetNet SRH inside the SRH

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Next Header   |  Hdr Ext Len  | Routing Type  | Segments Left |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Last Entry   |     Flags     |              Tag              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
②          Segment List[0] (128 bits IPv6 address)             |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|                             . . .                             |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
③          Segment List[n] (128 bits IPv6 address)             |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//                                                             //
// ①      Optional Type Length Value objects (variable)        //
//                                                             //
//                                                             //
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

④ | Next Header |

SRv6 Data Plane Solution Option1-Encapsulation

- Flow Identification(20bits) and Sequence Number(28bits) are carried as arguments in the SID for Relay Node
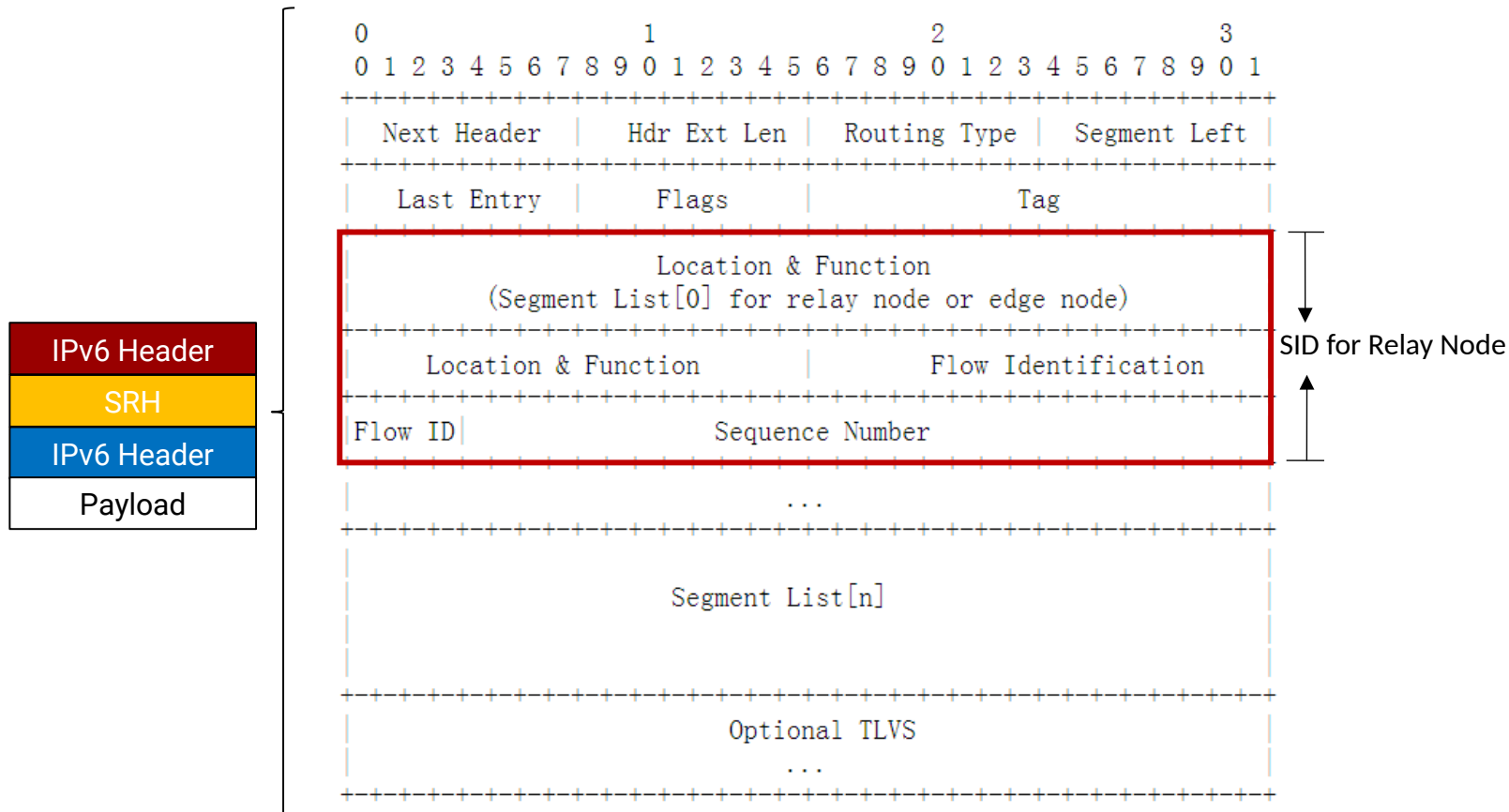
- Location & Function: the 80 most significant bits that are used for routing
- Flow Identification: 20 bits, which is used for DetNet flow identification in the DetNet relay node;
- Sequence Number: 28 bits, which are used for dis crime packets in the same DetNet flow;

SRv6 Data Plane Solution Option1-Replication Function

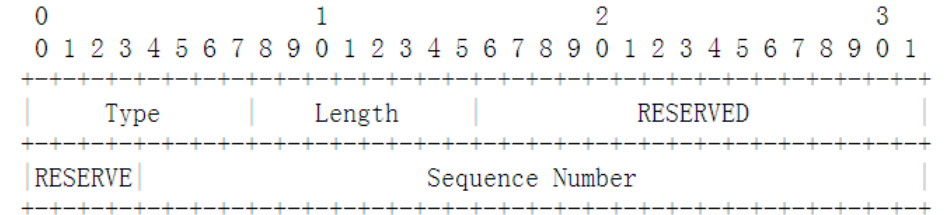- End. B. Replication: Packet Replication Function

1. IF NH=SRH & SL>0 THEN

2. do not decrement SL nor update the IPv6 DA with SRH[SL]

3. reserve the value of argument field(Inherited argument)of segment[0] of SRH

4. write the inherited arguments into the argument field of segment[0] of SRH'1 and SRH'2

5. pop the SRH

6. replicate the packet into two packets: packet'1, packet'2

7. insert SRH'1 to packet'1

8. insert SRH'2 to packet'2

9. set the IPv6 DA of packet'1 to the first segment of the SRv6 Policy of SRH'1

10. set the IPv6 DA of packet'2 to the first segment of the SRv6 Policy of SRH'2

11. ELSE

12. drop the packet

SRv6 Data Plane Solution Option1-Elimination Function

- End. B. Elimination: Packet Elimination Function

    1. IF NH=SRH & SL>0 & "the packet is not a redundant packet" THEN

    2.   do not decrement SL nor update the IPv6 DA with SRH[SL]

    3.   write the inherited arguments into the argument field of segment[0] of SRH'

    4.   pop the SRH

    5.   insert SRH'

    6.   set the IPv6 DA to the first segment of the SRv6 Policy

    7. ELSE

    8.   drop the packet

SRv6 Data Plane Solution Option2-Encapsulation

- Flow Identification(32bits) and Sequence Number(32bits) are carried as TLVs

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Next Header   |  Hdr Ext Len  | Routing Type  | Segment Left  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Last Entry   |    Flags      |            Tag                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|              Location & Function                              |
|      (Segment List[0] for relay node or edge node)            |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
                              ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|               Segment List[n]                                 |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|               Optional TLVs                                   |
|                      ...                                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

SID for Relay Node

IPv6 Header
SRH
IPv6 Header
Payload

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |    Length     |          RESERVED             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|RESERVE|               Sequence Number                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
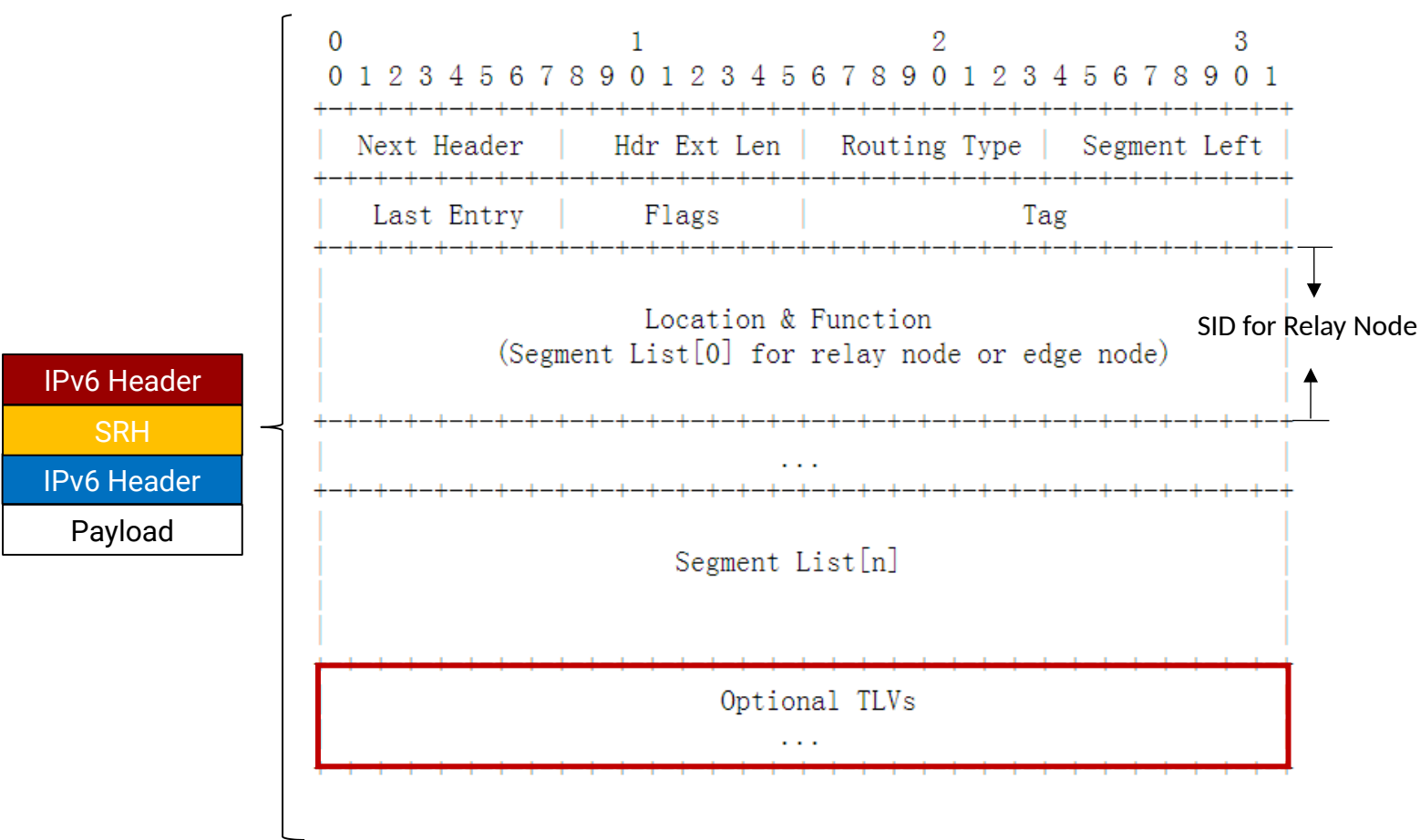
- Type: 8bits, to be assigned by IANA.
- Length: 8.
- RESERVED: 28 bits, MUST be 0 on transmission and ignored on receipt.
- Flow Identification: 20 bits, which is used for identifying DetNet flow.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |    Length     |          RESERVED             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        RESERVED         |          Flow Identification         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
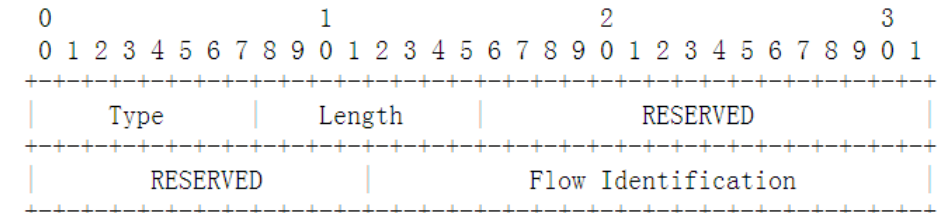
- Type: 8 bits, to be assigned by IANA.
- Length: 8.
- RESERVED: 20 bits. MUST be 0 on transmission and ignored on receipt.
- Sequence Number: 28 bits, which is used for indicating sequence number of a DetNet flow.

SRv6 Data Plane Solution Option2-Replication Function

- End. B.Replication: Packet Replication Function

  1. IF NH=SRH & SL>0 THEN

  2.   do not decrement SL nor update the IPv6 DA with SRH[SL]

  3.   reserve the value of DetNet TLVs of SRH

  4.   add the DetNet TLVs into SRH'1 and SRH'2

  5.   pop the SRH

  6.   replicate the packet into two packets: packet'1, packet'2

  7.   insert SRH'1 to packet'1

  8.   insert SRH'2 to packet'2

  9.   set the IPv6 DA of packet'1 to the first segment of the SRv6 Policy of SRH'1

  10.   set the IPv6 DA of packet'2 to the first segment of the SRv6 Policy of SRH'2

  11. ELSE

  12.   drop the packet

SRv6 Data Plane Solution Option2-Elimination Function

- End. B. Elimination: Packet Elimination Function

  1. IF NH=SRH & SL>0 & "the packet is not a redundant packet" THEN
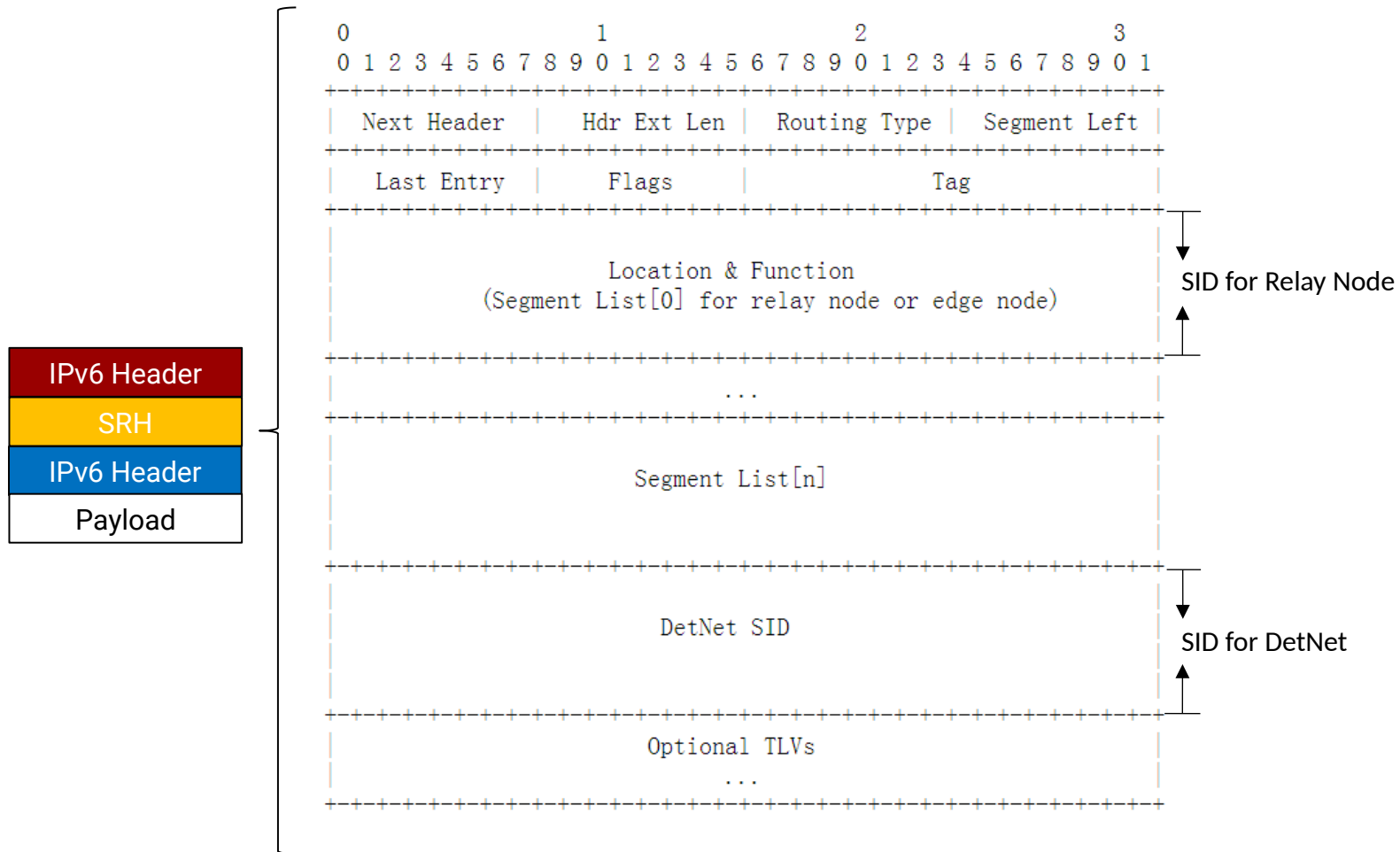
  2.   do not decrement SL nor update the IPv6 DA with SRH[SL]

  3.   reserve the value of DetNet TLVs of SRH

  4.   add the DetNet TLVs into SRH'

  5.   pop the SRH

  6.   insert SRH'

  7.   set the IPv6 DA to the first segment of the SRv6 Policy

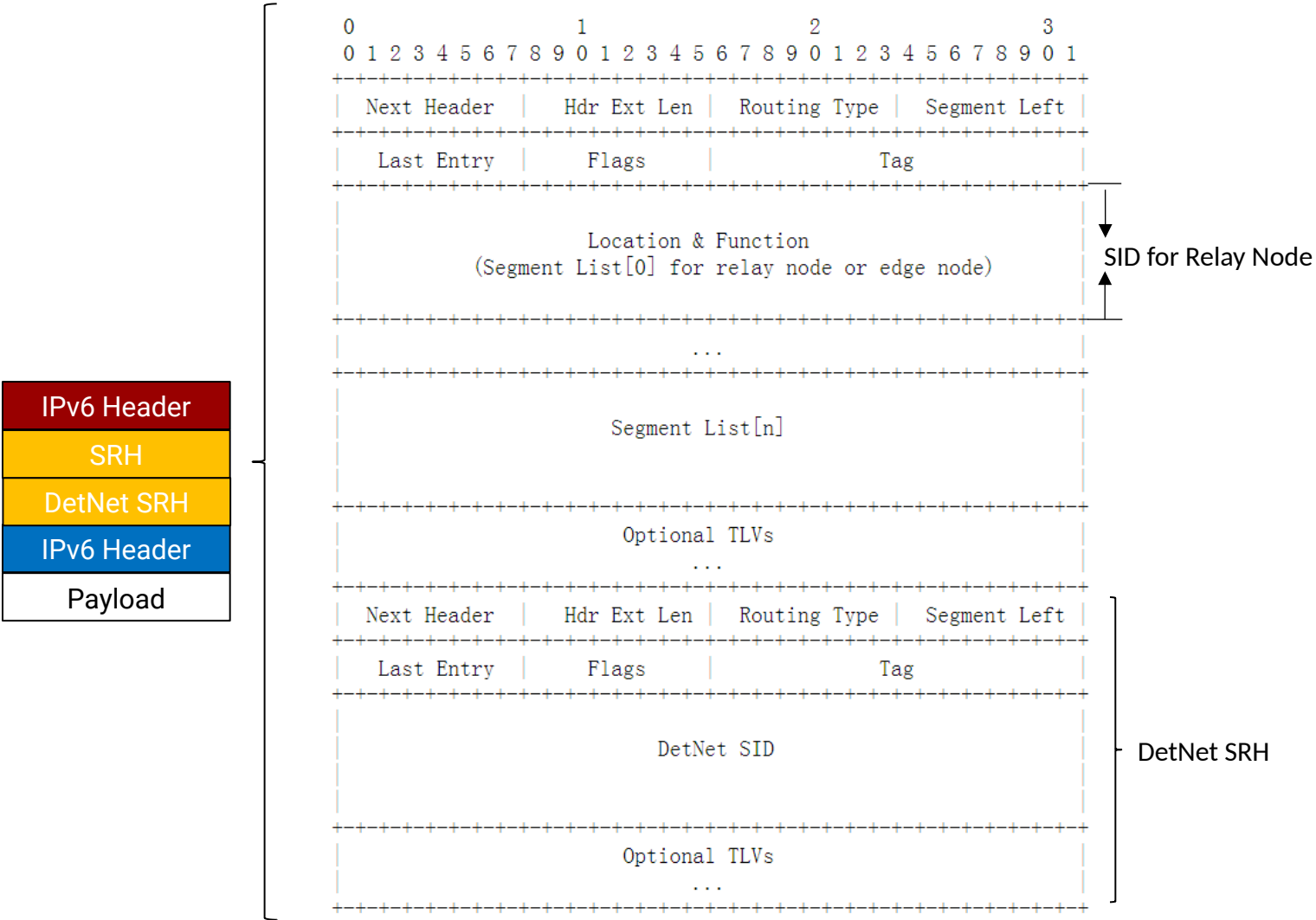 8. ELSE

  9.   drop the packet

SRv6 Data Plane Solution Option3-Encapsulation

- Flow Identification and Sequence Number are carried as in DetNet SID

SRv6 Data Plane Solution Option4-Encapsulation

- Flow Identification and Sequence Number are carried in DetNet SRH

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Next Header   | Hdr Ext Len   | Routing Type  | Segment Left  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Last Entry    |    Flags      |             Tag               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|                                                               |
|                   Location & Function                         |
|          (Segment List[0] for relay node or edge node)        |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             ...                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|                       Segment List[n]                         |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Optional TLVs                           |
|                             ...                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Next Header   | Hdr Ext Len   | Routing Type  | Segment Left  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Last Entry    |    Flags      |             Tag               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|                                                               |
|                         DetNet SID                            |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Optional TLVs                           |
|                             ...                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

SID for Relay Node

DetNet SRH

IPv6 Header
SRH
DetNet SRH
IPv6 Header
Payload

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DetNet SRv6 Data Plane Solution Example