Consideration of IPv6 Encapsulation for Path Services

draft-li-6man-ipv6-sfc-ifit-00

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Motivations

- Service Function Chaining (SFC) [RFC7665] and In-situ Flow Information Telemetry (IFIT) [I-D.song-opsawg-ifit-framework] are important path services along with the packets.
- In order to support these services, several encapsulations have been defined
  - For SFC encapsulations
    - Network Service Header (NSH) is defined in [RFC8300]
  - For IFIT encapsulations
    - In-situ OAM (iOAM) Header is defined in [I-D.ietf-ippm-ioam-data]
    - Postcard-Based Telemetry (PBT) Header is defined in [I-D.song-ippm-postcard-based-telemetry]
  - Inband Flow Analyzer (IFA) is also defined in [I-D.kumar-ippm-ifa]
    - to record flow specific information from an end station and/or switches across a network
- In the IPv6 scenario, these encapsulations propose challenges for the data plane
- The document analyzes the problems and proposes possible optimized IPv6 encapsulation
Problem Statements
Challenges for the IPv6 data plane proposed by the encapsulations

Pre-allocated and incremental trace option headers:

```
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Namespace-ID | [NodeLen | Flags | RemainingLen] |                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| IOAM-Trace-Type | Reserved |                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The trace option data MUST be 4-octet aligned:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  | node data list [0] |                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  | node data list [1] |                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  | node data list [n-1] |                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  | node data list [n] |                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

- The incremental IOAM data challenges the parsing depth if put in the HBH or DOH

- IPv6 path and SRv6 path distinguished

- Metadata recorded separately for IOAM, IFA
  - Maybe redundancy and inconsistency
  - Future extensibility

IPv6 Extension Header Order (recommended in RFC8200)

- IPv6 header
- Hop-by-Hop Options header
- Destination Options header (note 1)
- Routing header
- Fragment header
- Authentication header (note 2)
- Encapsulating Security Payload header (note 2)
- Destination Options header (note 3)
- Upper-Layer header
Design Considerations
- Optimization of path service encapsulations in IPv6 and SRv6

- To separate the path service encapsulation into two parts, i.e. instruction and recording
  - **Service Option**: The instruction part (uniform IPv6 service option)
    - Placed in the front IPv6 extension headers including HBH, RH, etc.
      - either in the HBH indicating the path service processed by **all IPv6 enabled nodes along the path**
      - or in the SRH TLVs indicating the path service processed only by **the SRv6 nodes along the SRv6 path**
    - fixed as much as possible to facilitate hardware process to keep forwarding performance
  
  - **IPv6 Metadata header**: The recording part (unified container)
    - to record the service metadata of SFC, IFIT and other possible path services
    - placed in the back IPv6 EXH such as being placed after IPv6 Routing Header
    - enables to stop recording when too much data carried to reach the hardware limitation
Service Options

### NSH Service Option

<table>
<thead>
<tr>
<th>Option Type</th>
<th>Opt Data Len</th>
</tr>
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</table>

### iOAM Service Option

<table>
<thead>
<tr>
<th>Option Type</th>
<th>Opt Data Len</th>
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### PBT Service Option

<table>
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<th>Option Type</th>
<th>Opt Data Len</th>
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### IFA Service Option

<table>
<thead>
<tr>
<th>Option Type</th>
<th>Opt Data Len</th>
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</table>

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The places for these service options

- IPv6 header
- Hop-by-Hop Options header
- Destination Options header (note 1)
- Routing header (SRH TLV)
- Fragment header
- Authentication header (note 2)
- Encapsulating Security Payload header (note 2)
- Destination Options header (note 3)
- Upper-Layer header
IPv6 Metadata Header

- IPv6 Metadata Header is defined as a new type of IPv6 EXH
  - The metadata is the information recorded by each hop for specific path service
  - The length of the metadata is variable.
Take-away Message

- The path service encapsulations are separated into two parts
  - **Service options** - Instruction (NSH, IOAM, PBT, IFA)
    - The length is relatively fixed, recommended to place in HBH (IPv6 path), SRH (SRv6 path)
  - **IPv6 Metadata Header** - Recording
    - The length is increasing along the path, recommended to place after the RH

- **Benefits**
  - The path service instruction in the IPv6 extension headers can be fixed as much as possible to facilitate hardware process to keep forwarding performance
  - The SFC/IFIT metadata recording part is placed afterwards which enables to stop recording when too much recording information has to be carried to reach the limitation of hardware process
Next steps

• Questions and Comments are welcome

• Consolidate comments

• Refine drafts
Thank you!