Consideration of IPv6 Encapsulation for SFC and IFIT  
draft-li-6man-ipv6-sfc-ifit-00

Abstract

Service Function Chaining (SFC) and In-situ Flow Information Telemetry (IFIT) are important path services along with the packets. In order to support these services, several encapsulations have been defined. The document analyzes the problems of these encapsulations in the IPv6 scenario and proposes the possible optimized encapsulation for IPv6.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

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1. Introduction

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. Network Service Header (NSH) is defined in [RFC8300] as the encapsulation for SFC. For IFIT encapsulations, In-situ OAM (IOAM) Header is defined in [I-D.ietf-ippm-ioam-data] and 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 application scenario of IPv6, these encapsulations propose challenges for the data plane. The document analyzes the problems and proposes the possible optimized encapsulation for IPv6.

2. Terminology

SFC: Service Function Chaining

IFIT: In-situ Flow Information Telemetry

IOAM: In-situ OAM
3. Problem Statement

The problems posed by the current encapsulations for SFC and IFIT in the application scenarios of IPv6 and SRv6 include:

1. According to the encapsulation order recommended in [RFC8200], if the IOAM is encapsulated in the IPv6 Hop-by-Hop options header, in the trace mode of IOAM as the number of nodes traversed by the IPv6 packets increases, the recorded IOAM information will increase accordingly. This will increase the length of the Hop-by-Hop options header and cause increasing difficulties in reading the following Segment Routing Extension Header (SRH) [I-D.ietf-6man-segment-routing-header] and thereby reduce the forwarding performance of the data plane greatly.

2. With the introduction of SRv6 network programming [I-D.filfsils-spring-srv6-network-programming], the path services along with the IPv6 packets can be processed at all the IPv6 network nodes or only at the SRv6 enabled network nodes along the path. It is necessary to distinguish the encapsulations for the specific path service which should be processed by the IPv6 path or the SRv6 path.

3. Both NSH and IOAM need the Metadata field to record metadata information. However currently these metadata has to be recorded separately which may generate redundant metadata information or increase the cost of process.

4. There is unnecessary inconsistency in the current encapsulations for IOAM, IFA and PBT in the IPv6 scenario. Especially it seems unnecessary to define a new specific IPv6 header for IFA, i.e. IFA header.

5. [I-D.guichard-spring-nsh-sr] is proposed for the solution to encapsulate NSH in SRv6 to support SFC. But the encapsulation is not defined yet.

4. Design Consideration

To solve the problems stated above, in the application scenarios of IPv6 and SRv6, the encapsulations of SFC and IFIT can be optimized with the following design considerations:
To separate the SFC/IFIT path service into two parts, i.e. instruction and recording parts. The instruction part (normally with fixed length) can be placed in the front IPv6 extension headers including Hop-by-Hop options header, Destination options header, Routing header, etc. while the recording part can be placed in the back IPv6 extension headers such as being placed after IPv6 Routing Header. In this way the path service instruction in the IPv6 extension headers can be fixed as much as possible to facilitate hardware process to keep forwarding performance while 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.

To define SFC/IFIT path service instructions as IPv6 options uniformly which can be placed either in the Hop-by-hop options which indicates the path service processed by all IPv6 enabled nodes along the path or in the SRH option TLVs which indicates the path service processed only by the SRv6 nodes along the SRv6 path indicated by the Segment List in the SRH.

To define a unified IPv6 metadata header which can be used as a container to record the service metadata of SFC, IFIT and other possible path services.

According to the above design optimization consideration, in the application scenarios of IPv6 and SRv6 the encapsulations for SFC and IFIT can be defined as below.

### 4.1. Service Options

1. **NSH Service Option**

   ![IPv6 Options with NSH instructions](image)

   **Figure 1. IPv6 Options with NSH instructions**

   **Option Type**: TBD

   **Opt Data Len**: 8 octets.
2. IOAM Service Option

```
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 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Namespace-ID | NodeLen  | Flags | RemainingLen |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| IOAM-Trace-Type | Reserved     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Option Type: TBD
Opt Data Len: 8 octets.

Other fields: refer to [I-D.ietf-ippm-ioam-data].

3. PBT Service Option

```
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 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Next Header   | TIH Length   |   Reserved    |   Hop Count   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Flow ID       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Flow ID       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Sequence Number |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Data Set ID   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Option Type: TBD
Opt Data Len: 20 octets.

Other fields: refer to [I-D.song-ippm-postcard-based-telemetry].
4. IFA Service Option

<table>
<thead>
<tr>
<th>Option Type</th>
<th>Opt Data Len</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ver=2.0</td>
<td>GNS</td>
</tr>
<tr>
<td>NextHdr = IP_x</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>F</td>
</tr>
</tbody>
</table>

Figure 4. IPv6 Options with IFA instructions

Option Type: TBD

Opt Data Len: 4 octets.

Other fields: refer to [I-D.kumar-ippm-ifa].

These options can be put in the IPv6 Hop-by-Hop Options Header or SRH TLV.

4.2. IPv6 Metadata Header

IPv6 Metadata Header is defined as a new type of IPv6 extension header shown in Figure 5. The metadata is the information recorded by each hop for specific path services. The length of the metadata is variable.

<table>
<thead>
<tr>
<th>Next Header</th>
<th>Hdr Ext Len</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5. Metadata Header
For specific path service, i.e. SFC/IOAM, the corresponding metadata is defined as follows:

```
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
| Service Type |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
~                                                               ~
|                    Metadata (variable)                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
```

Figure 6. Service Metadata

- **Service Type**: 8-bit selector. Identifies the type of Service Metadata.
- **Length**: 16-bit unsigned integer. Length of the Service metadata in 8-octet units, not including the first 8 octets.
- **Metadata**: Variable-length field, of length such that the complete IPv6 metadata header is an integer multiple of 8 octets long.

5. IANA Considerations

TBD.

6. Security Considerations

TBD.
7. References

7.1. Normative References


7.2. Informative References

[I-D.filsfils-spring-srv6-network-programming]

[I-D.guichard-spring-nsh-sr]
Guichard, J., Song, H., Tantsura, J., Halpern, J., Henderickx, W., and M. Boucadair, "NSH and Segment Routing Integration for Service Function Chaining (SFC)", draft-guichard-spring-nsh-sr-00 (work in progress), September 2018.

[I-D.ietf-6man-segment-routing-header]

[I-D.ietf-ippm-ioam-data]

[I-D.kumar-ippm-ifia]

[I-D.song-ippm-postcard-based-telemetry]
[I-D.song-opsawg-ifit-framework]


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