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                    User Plane Message Encoding
             draft-murakami-dmm-user-plane-message-encoding-05

Abstract

   This document defines the encoding of User Plane messages into
   Segment Routing Header (SRH). The SRH carries the User Plane
   messages over SRv6 Network.

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1. Introduction

   3GPP defines User Plane function (UPF) and the protocol messages that
   it supports. The User Plane messages support in-band signalling for
   path and tunnel management. Currently, User Plane messages are
   defined in TS 29.281 [TS29281].

   When applying SRv6 (Segment Routing IPv6) to the user plane of mobile
   networks, based on draft-ietf-dmm-srv6-mobile-uplane
   [I-D.ietf-dmm-srv6-mobile-uplane]. User Plane messages must be
   carried over SRv6 network. This document defines which User Plane
   message must be encoded to SRv6 and also defines how to encode the
   User Plane messages into SRH.

   In addition, SRH is mandatory at the ultimate segment upon carrying
   the User Plane messages because User Plane message is encoded into
   SRH. Hence, this document considers how to deal with the encoding of
   User Plane messages into SRH when PSP is applied that SRH is popped
   out at the penultimate segment.

2. 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].

3. Conventions and Terminology

SRv6:   Segment Routing IPv6.

GTP-U: GPRS Tunneling Protocol User Plane.

UPF: User Plane Function.

SRH: IPv6 Segment Routing Header.

PSP: Penultimate Segment POP of the SRH.

USP: Ultimate Segment Pop of the SRH.

4. Motivation

3GPP User Plane needs to support the user plane messages associated with a GTP-U tunnel defined in [TS29281]. In the case of SRv6 User Plane [I-D.ietf-dmm-srv6-mobile-uplane], those messages are also required when the user plane interworks with GTP-U.

IPv6 Segment Routing Header (SRH) [RFC8754] is used for SRv6 User Plane. SRH is able to associate additional information to the segments. The Tag field of SRH is capable to indicate different properties within a SID. SRH TLV is capable to provide meta-data to the endpoint node.

The above capability of SRH motivates us to map the user plane messages into it because of the same encapsulation with the packets of carrying client packets. It introduces no additional headers or extension headers to be chained in the packet just for carrying the user plane messages.

5. User Plane Message encoding into SRH

This section defines how to encode the User Plane messages into SRH in order to carry the User Plane messages over SRv6 network.

5.1. GTP-U Header format

   3GPP defines GTP-U Header format as shown below.

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | Ver |P|R|E|S|N| Message Type  |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                  Tunnel Endpoint Identifier                   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |        Sequence Number        |  N-PDU Number | Next-Ext-Hdr |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
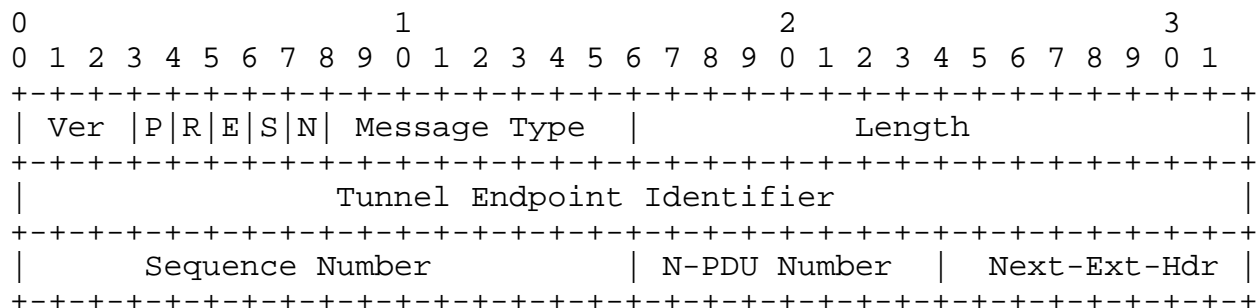
                   Figure 1: GTP-U Header format

   User Plane message type is encoded in Message Type field of GTP-U
   Header. The following User Plane messages must be carried over SRv6
   network at least. The value of each User Plane message type is
   defined as shown below.

   Echo Request: 1

   Echo Reply: 2

   Error Indication: 26

   End Marker: 254

5.2. Args.Mob.Upmsg

   draft-ietf-dmm-srv6-mobile-uplane [I-D.ietf-dmm-srv6-mobile-uplane]
   defines the format of Args.Mob.Session argument which is used in SRv6
   SID Mobility Functions in order to carry the PDU Session identifier.
   The format of Args.Mobs.Session is defined as shown below.

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |   QFI     |R|U|                 PDU Session ID                |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |PDU Sess(cont')|
   +-+-+-+-+-+-+-+-+
```
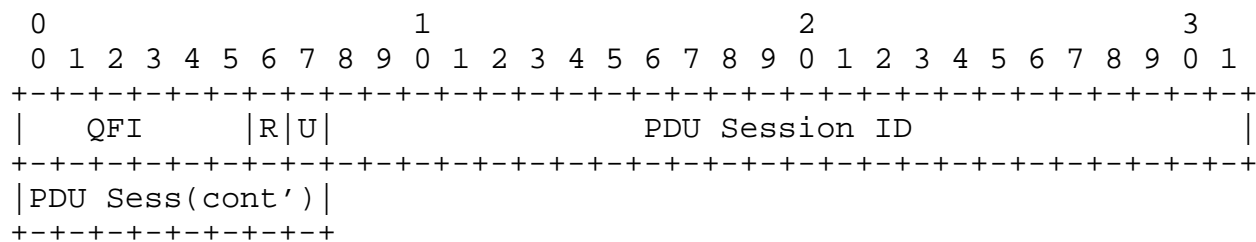
                 Figure 2: Args.Mob.Session format

   In case of Echo Request, Echo Reply and Error Indication, Sequence
   Number in GTP-U header needs to be carried. Similar to draft-ietf-

dmm-srv6-mobile-uplane [I-D.ietf-dmm-srv6-mobile-uplane], the new
arguments to carry Sequqnce number for Echo Request, Echo Reply and
Error Indication message needs to be defined. For this, the
following Args.Mobs.Upmsg should be defined newly to carry Sequence
number.

```
     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
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |    QFI      |R|U|        Sequence Number        |     Pad     |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |    Pad(cont')  |
    +-+-+-+-+-+-+-+-+
```
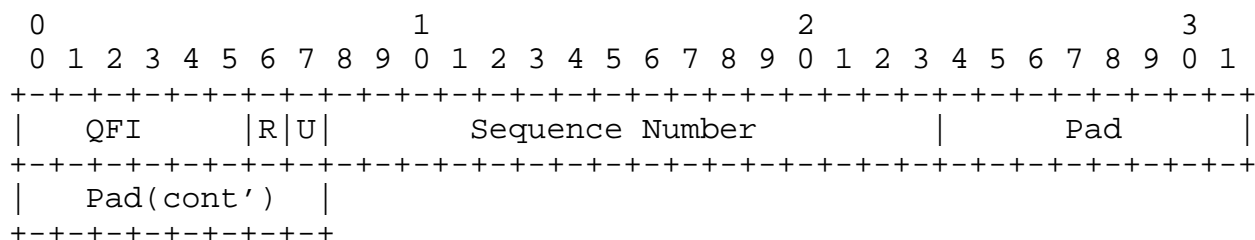
    Figure 3: Args.Mob.Upmsg format for Echo Request, Echo Reply and
                          Error Indication

QFI bit, R bit, U bit and 16-bit Sequence Number is encoded in
Args.Mobs.Upmsg. The remaining bits followed by Sequence Number must
be padded in 0.

In case of End Marker, TEID shall be used as PDU Session ID same as
draft-ietf-dmm-srv6-mobile-uplane [I-D.ietf-dmm-srv6-mobile-uplane].
Hence, for End Marker, Args.Mobs.Session should be used to carry TEID
as PDU Session ID.

5.3. Encoding of Tags Field

The Segment Routing Header is defined in IPv6 Segment Routing Header
(SRH) [RFC8754]. This draft defines 16 bits Tag field but does not
define the format or use of this Tag field in the Segment Routing
Header.

The User Plane message type encoding is defined in TS 29.281
[TS29281]. Based on this definition, the User Plane message type
must be encoded into the Tag field in the Segment Routing Header in
order to indicate the type of the user plane messages for at least
Echo Request, Echo Reply, Error Indication or End Marker.

Only UPF must process the Tag field where the user plane message is
encoded. In addition, when the user plane message is encoded in the
Tag field, the UPF should not encode any segments in the Segment
Routing Header whose function modifies the Tag field value. Any
other transport router implementing SRv6 must ignore the Tag field
upon processing the Segment Routing Header.

The user plane messages must be encoded into the Tag filed as shown
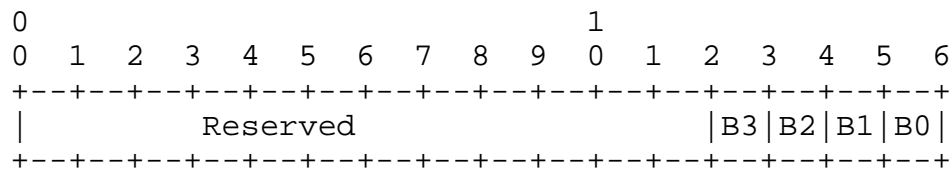below.

```
                    0                             1
                    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6
                    +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
                    |          Reserved           |B3|B2|B1|B0|
                    +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
```

Figure 4: Tag Field Encoding

Bit 0 [B0]:   End Marker

Bit 1 [B1]:   Error Indication

Bit 2 [B2]:   Echo Request

Bit 3 [B3]:   Echo Reply

End Marker, Echo Request and Echo reply messages do not require any
additional information elements. However, Error Indication message
requires the additional information elements like Tunnel Endpoint
Identifier Data IE, GSN Address, etc. These additional information
elements can be encoded into the SRH TLV that is defined in the next
section.

5.4. User Plane message Information Element Support

End Maker, Echo Request and Echo Reply messages do not require any
additional information elements. However, Error Indication message
requires additional 3GPP IEs (Information Element). These additional
information elements must be carried over SRv6 network as well.
However SRv6 SID has limited space only. Hence it cannot carry a lot
of information elements.

In order to carry more information elements, SRH TLV shall be
leveraged. SRH TLV is defined in IPv6 Segment Routing Header (SRH)
[RFC8754] in order to carry the meta-data for the segment processing.
In order to carry additional User Plane messages like 3GPP IEs, the
new type named as "User Plane Container" must be defined as the new
SRH TLV. The "User Plane Container" can carry additional User Plane
messages which includes multiple 3GPP IEs with 1 sub-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
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       |      Type       |      Length     | User Plane message sub-TLV |
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       //            User Plane message sub-TLV                       //
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

                      User Plane Container TLV

   Type: to be assigned by IANA

   Length: Length of User Plane message sub-TLV

   User Plane message sub-TLV: User Plane message sub-TLV defined
                     below

```
        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      |           Value          //
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

                      User Plane message sub-TLV

   Type: Type of User Plane message sub-TLV

                     3GPP IE sub-TLV: 0x01

   Length: Length of Value

   Value: User Plane Message data

                     3GPP IE sub-TLV: multiple 3GG IEs

5.5. SID flavor consideration

   This section considers SID flavor of where the SRH is popped out at
   either the penultimate or the ultimate segment.

   In order to carry User Plane message over SRv6 network, SRH must be
   sustained over entire SRv6 network because User Plane message type
   and required information elements are encoded into SRH. If the

penultimate segment is popping out SRH, i.e., PSP, User Plane message
can not be carried in entire SRv6 network.

In order to avoid this problem, USP is recommended in SRv6 Mobile
network. In this case, SRH is never popped out and User Plane
message can be sustained over entire SRv6 network.

However, if PSP needs to be enabled in SRv6 network, it is also a
possible solution to encap another SRH which carries User Plane
message along with the outer IPv6 or SRH.

6. Security Considerations

This document does not raise any additional security issues. This
document just define the mechanisms for mapping between user plane
message (GTP-U message) and SRH in SRv6. Basically, since this
document is using SRH defined in [RFC8754] to carry user plane
message, same security consideration stated in [RFC8754] shall be
applied.

7. IANA Consideration

The type value of SRH TLV for User Plane Container must be assigned
by IANA.

8. Acknowledgements

9. References

9.1. Normative References

   [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate
              Requirement Levels", BCP 14, RFC 2119,
              DOI 10.17487/RFC2119, March 1997,
              <https://www.rfc-editor.org/info/rfc2119>.

   [RFC2460] Deering, S. and R. Hinden, "Internet Protocol, Version 6
              (IPv6) Specification", RFC 2460, DOI 10.17487/RFC2460,
              December 1998, <https://www.rfc-editor.org/info/rfc2460>.

   [RFC4291] Hinden, R. and S. Deering, "IP Version 6 Addressing
              Architecture", RFC 4291, DOI 10.17487/RFC4291, February
              2006, <https://www.rfc-editor.org/info/rfc4291>.

9.2. Informative References

   [I-D.ietf-dmm-srv6-mobile-uplane]
             Matsushima, S., Filsfils, C., Kohno, M., Garvia, P. C.,
             Voyer, D., and C. E. Perkins, "Segment Routing IPv6 for
             Mobile User Plane", draft-ietf-dmm-srv6-mobile-uplane-18
             (work in progress), February 2022.

   [RFC1918] Rekhter, Y., Moskowitz, B., Karrenberg, D., de Groot, G.,
             and E. Lear, "Address Allocation for Private Internets",
             BCP 5, RFC 1918, DOI 10.17487/RFC1918, February 1996,
             <https://www.rfc-editor.org/info/rfc1918>.

   [RFC3513] Hinden, R. and S. Deering, "Internet Protocol Version 6
             (IPv6) Addressing Architecture", RFC 3513,
             DOI 10.17487/RFC3513, April 2003,
             <https://www.rfc-editor.org/info/rfc3513>.

   [RFC8754] Filsfils, C., Ed., Dukes, D., Ed., Previdi, S., Leddy, J.,
             Matsushima, S., and D. Voyer, "IPv6 Segment Routing Header
             (SRH)", RFC 8754, DOI 10.17487/RFC8754, March 2020,
             <https://www.rfc-editor.org/info/rfc8754>.

   [TS29281] 3GPP, "General Packet Radio System (GPRS) Tunnelling
             Protocol User Plane (GTPv1-U)", 2019,
             <http://www.3gpp.org/ftp//Specs/
             archive/29_series/29.281/29281-f60.zip>.

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