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OSPFv3 Extensions for SRv6
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Abstract

Segment routing architecture (refer to [I-D.ietf-spring-segment-routing]) can be implemented over a MPLS data plane, an IPv4 data plane, as well as an IPv6 data plane. [I-D.filsfils-spring-srv6-network-programming] introduces the network programming concept in IPv6 data plane using segment routing technology, called SRv6, and it also defines some basic functions. The SRv6 functions can be advertised by routing protocols including OSPFv3, IS-IS and BGP-LS. This draft proposes some extensions to OSPFv3 ([RFC5340]) required to support SRv6.

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].

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on April 22, 2018.

Table of Contents

1. Introduction

This document proposes some extensions to OSPFv3 in order to support SRv6 as defined in [I-D.filsfils-spring-srv6-network-programming], and they are as follows:

1. SRv6-Capabilities Sub-TLV: Refer to Section 2.1. This Sub-TLV is used to announce the capability of an OSPFv3 router for SRv6

support with a list of parameters. This Sub-TLV, if used, is included in OSPFv3 Router Information LSA TLV LSA([RFC7770]).

2. Maximum SL Sub-Sub-TLV: Refer to Section 2.1.1. This Sub-Sub-TLV carries the maximum value of the "SL" field in the SRH ([I-D.ietf-6man-segment-routing-header]) of a received packet before applying the function associated with a SID. It may be included in the SRv6-Capabilities Sub-TLV.

3. Maximum End Pop SRH Sub-Sub-TLV: Refer to Section 2.1.2. This Sub-Sub-TLV carries the maximum number of the SIDs in the top SRH in an SRH stack to which the router can apply "PSP" or "USP" flavors (refer to [I-D.filsfils-spring-srv6-network-programming]). It may be included in the SRv6-Capabilities Sub-TLV.

4. Maximum T.Insert SRH Sub-Sub-TLV: Refer to Section 2.1.3. This Sub-Sub-TLV carries the maximum number of the SIDs that can be inserted as part of the "T.insert" behavior (refer to [I-D.filsfils-spring-srv6-network-programming]). It may be included in the SRv6-Capabilities Sub-TLV.

5. Maximum T.Encap SRH Sub-Sub-TLV: Refer to Section 2.1.4. This Sub-Sub-TLV carries the maximum number of the SIDs that can be inserted as part of the "T.Encap" behavior (refer to [I-D.filsfils-spring-srv6-network-programming]). It may be included in the SRv6-Capabilities Sub-TLV.

6. Maximum End D SRH Sub-Sub-TLV: Refer to Section 2.1.5. This Sub-Sub-TLV carries the maximum number of the SIDs in an SRH when applying "End.DX6" and "End.DT6" function (refer to [I-D.filsfils-spring-srv6-network-programming]). It may be included in the SRv6-Capabilities Sub-TLV.

7. SRv6 SID TLV: Refer to Section 2.4. This TLV is used to advertise one or more SIDs along with their associated SRv6 functions. These SRv6 functions are well-known and defined in [I-D.filsfils-spring-srv6-network-programming], but may also be others defined in the future. This TLV is a top-level TLV and is included in OSPFv3 Router Information LSA([RFC7770]).

8. SRv6 Point-to-Point Adj-SID Sub-TLV: Refer to Section 2.5.1. This Sub-TLV is used to advertise one or more SIDs on an OSPFv3 point-to-point adjacency for the support of SRv6 along with their associated functions. These SRv6 functions are well-known and defined in [I-D.filsfils-spring-srv6-network-programming], but may also be others defined in the future. This Sub-TLV is

included in Router-Link TLV as defined in [I-D.ietf-ospf-ospfv3-lsa-extend].

9. SRv6 LAN SRv6 Adj-SID Sub-TLV: Refer to Section 2.5.2. This Sub-TLV is used to advertise one or more SIDs on an OSPFv3 LAN adjacency for the support of SRv6 along with their associated functions. These SRv6 functions are well-known and defined in [I-D.filsfils-spring-srv6-network-programming], but may also be others defined in the future. This Sub-TLV is included in Router-Link TLV as defined in [I-D.ietf-ospf-ospfv3-lsa-extend].

For consistency in IGP's behavior, ideas are borrowed from [I-D.bashandy-isis-srv6-extensions] including SRv6 functions supported and data format.

2. OSPFv3 Extensions for SRv6

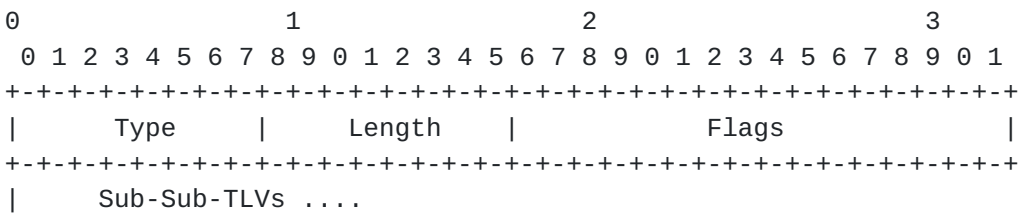
2.1. SRv6-Capabilities Sub-TLV

When apply Segment Routing to IPv6 data plane, the list of segments is stored in segment routing header, referred to as "SRH", which is defined in [I-D.ietf-6man-segment-routing-header].

A router that supports SRv6 MUST be able to process the segment routing header as described in [I-D.ietf-6man-segment-routing-header], as well as apply behaviors and flavors as described in [I-D.filsfils-spring-srv6-network-programming]. In either case, there exists a limit to which the router can perform according to its own ability that needs to be advertised to other routers in the same SR domain.

The OSPFv3-SRv6-Capbilities Sub-TLV is designed for an OSPFv3 router to make announcement in the SRv6 domain about its ability in the context of SRv6 support.

The format of OSPFv3-SRv6-Capabilities Sub-TLV is shown in Figure 1.



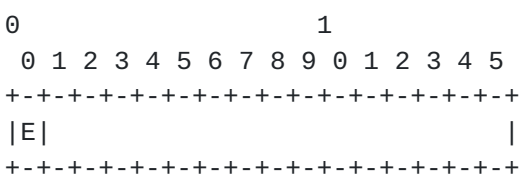


Figure 1

Type (one octet)

TBD-1

Length (one octet)

2 + length of sub-sub-TLVs

Flags (16 bits)

E-Flag: If set, the router is able to apply "T.Encap" operation.

2.1.1. Maximum SL Sub-Sub-TLV

The Maximum Segments Left Sub-Sub-TLV specifies the maximum value of the "SL" field (refer to [I-D.ietf-6man-segment-routing-header]) in the SRH of a received packet before applying the function associated with a SID.

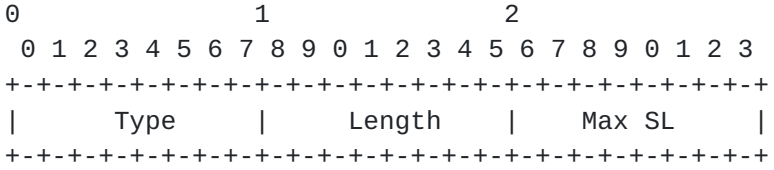


Figure 2

Type (one octet)

TBD-2

Length (one octet)

1

Max SL (8 bits)

SL Value

If the sub-sub-TLV is NOT advertised, the value is assumed to be 0.

2.1.2. Maximum End Pop SRH Sub-Sub-TLV

The Maximum End Pop SRH Sub-Sub-TLV specifies the maximum number of SIDs in the top SRH in an SRH stack to which the router can apply "PSP" or USP" flavors([I-D.filsfils-spring-srv6-network-programming]).

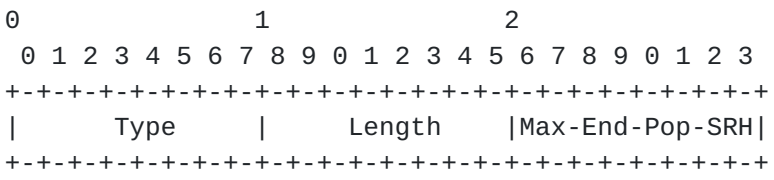


Figure 3

Type (one octet)

TBD-3

Length (one octet)

1

Max-End-Pop-SRH (8 bits)

Max End Pop SRH value Value

If the value is zero or the sub-sub-TLV is NOT advertised, then it is assumed that the router cannot apply PSP or USP flavors.

2.1.3. Maximum T.Insert SRH Sub-Sub-TLV

The Maximum T.Insert SRH Sub-Sub-TLV specifies the maximum number of SIDs that can be inserted as part of the "T.insert" behavior([I-D.filsfils-spring-srv6-network-programming]).

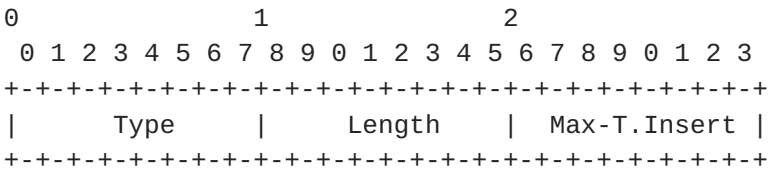


Figure 4

Type (one octet)

TBD-4

Length (one octet)

1

Max-T.Insert (8 bits)

Max-T.Insert Value

If the value is zero or the sub-sub-TLV is omitted, then the router is assumed not to support any variation of the "T.insert" behavior.

2.1.4. Maximum T.Encap SRH Sub-Sub-TLV

The Maximum T.Encap SRH Sub-Sub-TLV specifies the maximum number of SIDs that can be included as part of the "T.Encap" behavior([I-D.filsfils-spring-srv6-network-programming]).

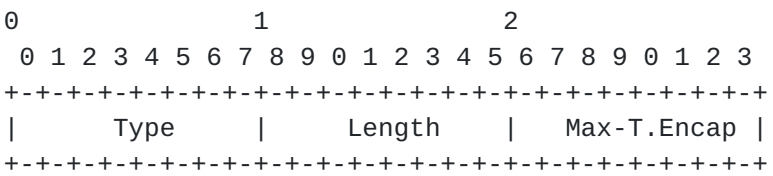


Figure 5

Type (one octet)

TBD-5

Length (one octet)

1

Max-T.Encap (8 bits)

Max-T.Encap Value

If this value is zero or the Sub-Sub-TLV is omitted and the "E" flag is set in the associated SRv6 Capabilities Sub-TLV, then it is assumed that the router can apply T.Encap by encapsulating the incoming packet in another IPv6 header without SRH the same way IPinIP encapsulation is performed. If the "E" flag is clear, then this Sub-Sub-TLV SHOULD NOT be transmitted and MUST be ignored on reception.

2.1.5. Maximum End D SRH Sub-Sub-TLV

The Maximum End D SRH sub-sub-TLV specifies the maximum number of SIDs in an SRH when applying "End.DX6" and "End.DT6" functions.

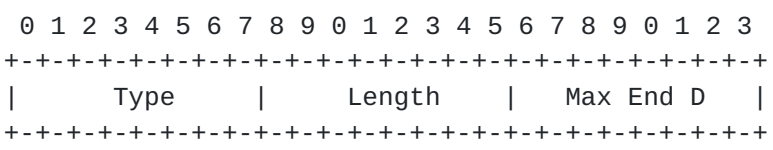


Figure 6

Type (one octet)

TBD-6

Length (one octet)

1

Max End D (8 bits)

Max End D Value

If this value is zero or the sub-sub-TLV is omitted, then it is assumed that the router cannot apply "End.DX6" or "End.DT6" functions

if the extension header right underneath the outer IPv6 header is an SRH.

2.2. SRv6 Function Descriptor

The SRv6 SID TLV (defined in Section 2.4), P2P SRv6 SID Sub-TLV (defined in Section 2.5.1), and LAN SRv6 SID Sub-TLV (defined in Section 2.5.2), MUST include one SRv6 function Descriptor.

When included in the SRv6 SID TLV, the descriptor is encoded as a Sub-TLV. When included in a P2P/LAN SRv6 SID sub-TLV, the descriptor is encoded as a Sub-Sub-TLV.

The SRv6-function Descriptor encodes the function (and its flavors) bound to the SRv6 SID advertised in the SRv6 dodmain ([I-D.filsfils-spring-srv6-network-programming]).

The format of OSPFv3 SRv6 Function Descriptor is shown in Figure 7.

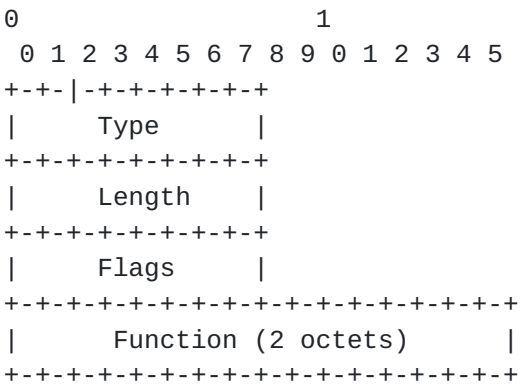


Figure 7

Type (one octet)

TBD-7

Length (one octet)

3

Flags

This document defines two flags to specify the flavor(s) ([I-D.filsfils-spring-srv6-network-programming]) associated with the SRv6 function specified in the "Function" field:

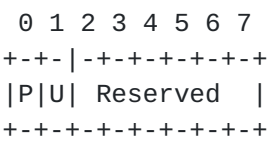


Figure 8

P bit

If set, then the PSP flavor ([I-D.filsfils-spring-srv6-network-programming]) is associated with the function encoded in the "function" field.

U bit

If set, then the USP flavor ([I-D.filsfils-spring-srv6-network-programming]) is associated with the function encoded in the "function" field.

Reserved

Reserved Bits SHOULD be transmitted as 0 and MUST be ignored on receipt.

The second two octets encode the function. Function code points are defined in Section 2.3.

2.3. SRv6 Function Code Points

This section defines the code points for supported functions associated with SRv6 SIDs. Refer [I-D.filsfils-spring-srv6-network-programming] for SRv6 functions.

0:

Reserved.

1:

End Function.

2:

End.X Function.

3:

End.DX6 Function.

4:

End.DT6 Function.

2.4. SRv6 SID TLV

A new top level TLV is introduced in OSPFv3 to advertise one or more SRv6 Segment Identifiers (SIDs) and each SID is associated one or more SRv6 functions. [I-D.filsfils-spring-srv6-network-programming] defined some basic functions. This document defines code points for some of the basic SRv6 functions in Section 2.3. SRv6 functions may also be defined in other documents or locally configured.

The format of OSPFv3 SRv6 SID TLV is shown in Figure 9.

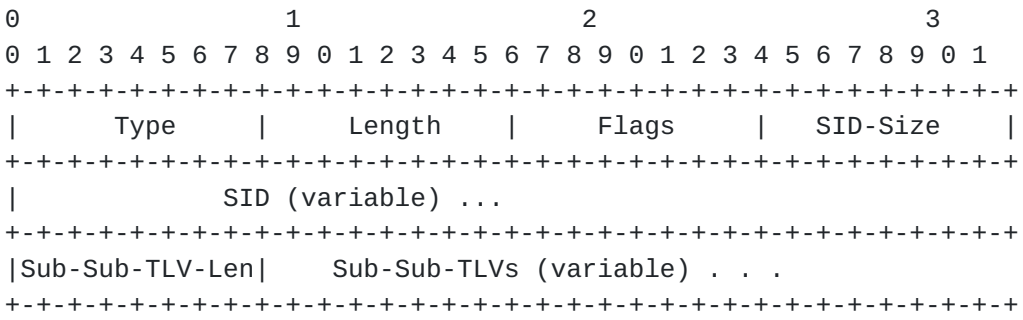


Figure 9

Type (one octet)

TBD-8

Length (one octet)

Variable

One or more SID entries, each of which has the following format:

Flags (One octet)

The following flags are defined:

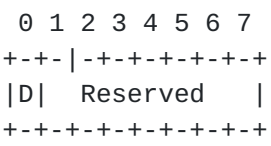


Figure 10

D bit:

When the SID is leaked from OSPFv3 backbone area to other areas, the D bit MUST be set. Otherwise, this bit MUST be clear. SIDs with the D bit set MUST NOT be leaked to OSPFv3 backbone area from others. This is to prevent looping.

Reserved:

The remaining bits are reserved for future use. They SHOULD be set to zero on transmission and MUST be ignored on reception.

SID-Size (one octet)

Number of bits in the SID field.

SID (1-16 octet)

This field encodes the advertised SRv6 SID. The "SID-Size" field can have the value in the range of 1-128 and indicates the number of bits in the SID. The SRv6 SID is encoded in the minimal number of octets for the given number of bits.

Sub-Sub-TLV-Length(one octet)

Number of octets used by sub-TLVs.

Sub-Sub-TLVs (Variable)

One or more functions associated with the advertised SID is specified by the SRv6-Function Descriptor Sub-TLV specified in Section 2.2.

2.5. SRv6 Neighbor SID TLV

The advertising of some SRv6 functions must be associated with a particular neighbor. As described in [I-D.ietf-spring-segment-routing], there are two types of SR adjacencies, one is on point-to-point link and another is on a broadcast/mulcast LAN. This section defines OSPFv3 extensions in

order to advertise SRv6 SIDs and their associated functions for these two cases.

A single SRv6 Adj-SID may associate with one or more SRv6 functions. The SRv6 functions are defined in [I-D.filsfils-spring-srv6-network-programming], other documents, or locally configured.

This document specifies how to advertise End.X and End.DX6 defined in [I-D.filsfils-spring-srv6-network-programming] using OSPFv3 extersons.

2.5.1. Point to Popint SRv6 Adj-SID Sub-TLV

This Sub-TLV is used to advertise one or more SRv6 SIDs associated with End.X and End.DX6 SRv6 functions over a point-to-point adjacency.

The format of the "P2P SRv6 Adj-SID" Sub-TLV is shown in Figure 11.

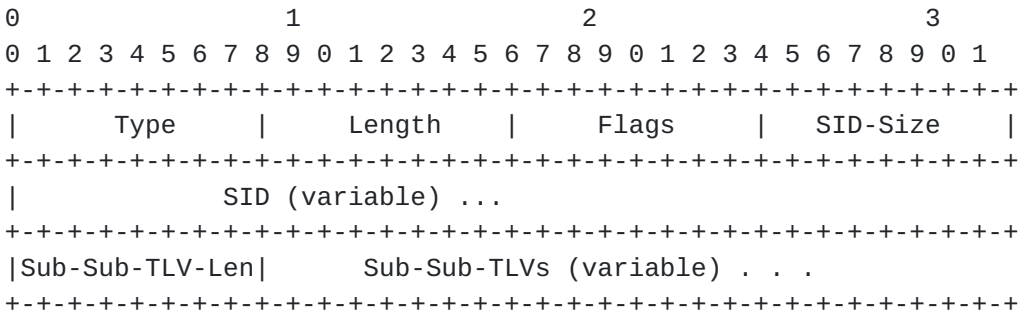


Figure 11

Type (one octet)

TBD-9

Length (one octet)

Variable

One or more SID entries, each of which has the following format:

Flags (One octet)

No flags defined in this document.

SID-Size (one octet)

Number of bits in the SID field.

SID (1-16 octet)

This field encodes the advertised SRv6 SID. The "SID-Size" field can have the value in the range of 1-128 and indicates the number of bits in the SID. The SRv6 SID is encoded in the minimal number of octets for the given number of bits.

Sub-Sub-TLV-Length(one octet)

Number of octets used by Sub-TLVs.

Sub-Sub-TLVs (Variable)

One or more functions associated with the advertised SID is specified by the SRv6 Function Descriptor Sub-TLV specified in Section 2.2. If the SRv6 Function Descriptor is encoded in the SRv6 P2P SID sub-TLV, the encoded SRv6 SID function MUST include only the code points of SRv6 SID functions that require the specification of a neighbor to be correctly applied.

2.5.2. LAN SRv6 Adj-SID sub-TLV

This Sub-TLV is used to advertise one or more SRv6 SIDs associated with End.X and End.DX6 SRv6 functions over a LAN adjacency.

The format of the "LAN SRv6 Adj-SID" Sub-TLV is shown in Figure 12.

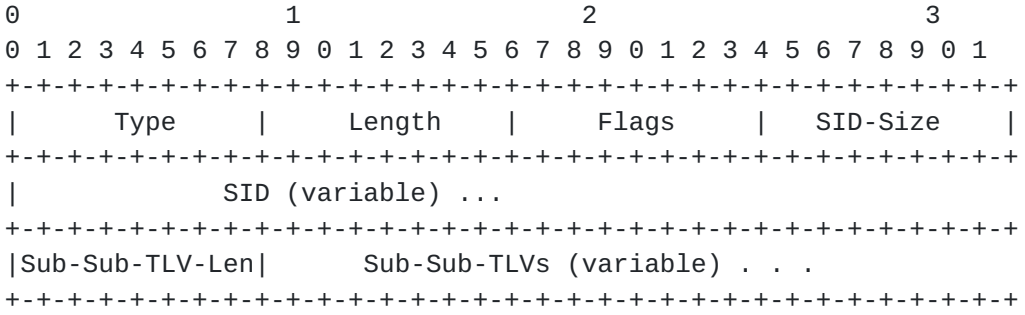


Figure 12

Type (one octet)

TBD-10

Length (one octet)

Variable

One or more SID entries, each of which has the following format:

Flags (One octet)

No flags defined in this document.

SID-Size (one octet)

Number of bits in the SID field.

SID (1-16 octet)

This field encodes the advertised SRv6 SID. The "SID-Size" field can have the value in the range of 1-128 and indicates the number of bits in the SID. The SRv6 SID is encoded in the minimal number of octets for the given number of bits.

Sub-Sub-TLV-Length(one octet)

Number of octets used by sub-TLVs.

Sub-Sub-TLVs (Variable)

One or more functions associated with the advertised SID is specified by the SRv6-Function Descriptor Sub-TLV specified in Section 2.2. If the SRv6 Function Descriptor is encoded in the SRv6 P2P SID Sub-TLV, the encoded SRv6 SID function MUST include only the code points of SRv6 SID functions that require the specification of a neighbor to be correctly applied.

3. Security Considerations

This document does not introduce any security issue.

4. IANA Considerations

This document proposes IANA considerations as described in the following sections.

4.1. OSPFv3 Extensions for SRv6 Support

This document proposes the following OSPFv3 Extensions in order to support SRv6:

1. SRv6-Capabilities Sub-TLV (Type TBD-1): Refer to Section 2.1.

2. Maximum SL Sub-Sub-TLV (Type TBD-2): Refer to Section 2.1.1.

3. Maximum End Pop SRH Sub-Sub-TLV (Type TBD-3): Refer to Section 2.1.2.

4. Maximum T.Insert SRH Sub-Sub-TLV (Type TBD-4): Refer to Section 2.1.3.

5. Maximum T.Encap SRH Sub-Sub-TLV (Type TBD-5): Refer to Section 2.1.4.

6. Maximum End D SRH Sub-Sub-TLV (Type TBD-6): Refer to Section 2.1.5.

7. SRv6 Function Descriptor (Type TBD-7): Refer to Section 2.2.

8. SRv6 SID TLV (Type TBD-8): Refer to Section 2.4.

9. SRv6 Point-to-Point Adj-SID Sub-TLV (Type TBD-9): Refer to Section 2.5.1.

10. SRv6 LAN SRv6 Adj-SID Sub-TLV (Type TBD-10): Refer to Section 2.5.2.

5. Acknowledgements

TBD.

6. References

6.1. Normative References

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6.2. Informative References

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