

Network Working Group  
Internet Draft  
Intended status: Standards Track  
Expires: February 05, 2026

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August 04, 2025

IS-IS Extension to Advertise SRv6 SIDs using SID Block  
draft-cheng-lsr-isis-srv6-sid-block-04

Abstract

This document proposes a simplified method to advertise SRv6 SIDs in IS-IS. The SRv6 SID Block is composed of a number of continuous SIDs within the address range of a Locator. When a SID is assigned from the SID Block, it is described by an index based on the SID Block, instead of the whole 128-bit IPv6 address.

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## Table of Contents

1. Introduction.....	2
1.1. Requirements Language.....	4
2. SRv6 SID Block sub-TLV.....	4
3. SRv6 End.X SID Index sub-TLV.....	6
4. SRv6 LAN End.X SID Index sub-TLV.....	7
5. SRv6 End SID Index sub-TLV.....	8
6. Computations of SID Index.....	9
7. Rule-based SID Block for Large-Scale End.X SID Advertisement..	10
8. Advertising SRv6 SID Offset for Flex-Algorithm.....	13
8.1. Algorithm Offset for SRv6 Locator.....	13
8.2. Algorithm Offset for SRv6 SID Block.....	15
9. Backward Compatibility.....	16
10. Security Considerations.....	16
11. IANA Considerations.....	17
12. References.....	17
12.1. Normative References.....	17
12.2. Informative References.....	17
13. Acknowledgments.....	18
Contributors.....	18
Authors' Addresses.....	18

## 1. Introduction

The Segment Routing (SR) allows for a flexible definition of end-to-end paths by encoding paths as sequences of topological sub-paths, called "segments". As defined in [RFC8402] and [RFC8986], an SRv6 Segment Identifier (SID) is an IPv6 address explicitly associated

with the segment and consists of Locator, Function and Argument parts.

[RFC9352] defines the SRv6 End SID sub-TLV, the SRv6 End.X SID sub-TLV, and the SRv6 LAN End.X SID sub-TLV in IS-IS.

The SRv6 End SID sub-TLV is used to advertise an SRv6 SID with Endpoint behaviors which do not require a particular neighbor. The SRv6 End SID sub-TLV is used to advertise an SRv6 SID associated with a point to point adjacency. The SRv6 LAN End.X SID sub-TLV sub-TLV is used to advertise an SRv6 SID associated with a LAN adjacency. Each of these sub-TLVs contains a complete 128-bit SID and the sub-TLV length is quite long.

Multiple SRv6 End.X SIDs can be associated with the same point to point adjacency or the same physical LAN neighbor. Each SID is advertised in a single SRv6 End.X SID sub-TLV or SRv6 LAN End.X SID sub-TLV. These SIDs are possibly associated to the same Locator, therefore the main differences among the sub-TLVs may be a few bits in the Function part of SID and the Endpoint Behavior value indicating different flavors.

The number of End.X SIDs has a positive correlation with the number of neighbors. Assume that, each neighbor is assigned with End.X SIDs, and each End.X behavior has several different flavors, such as PSP, USP, USD, no PSP/USP/USD, etc. Then, the number of End.X SIDs will be at least the number of neighbors multiplied by the number of flavors.

If Flexible-Algorithm is applied on SRv6 forwarding plane as defined in [RFC9350], a node generally advertises a Flex-Algorithm specific locator for each Flex-Algorithm it participates in and also advertises associated SRv6 END.X SIDs for every link that has not been pruned from the Flex-Algorithm computation.

There may be other scenarios in which the number of End.X SIDs is quite large. Under these circumstances, advertising SRv6 SIDs needs considerable amounts of IS-IS LSPs and may be a burden of IS-IS nodes.

This document proposes a simplified method to advertise SRv6 SIDs in IS-IS. A number of continuous SIDs are assigned within the address range of a Locator, which is defined as the SRv6 SID Block. When a SID is assigned from the block, it is described by an index based on the block, instead of the whole 128-bit IPv6 address.

### 1.1. Requirements Language

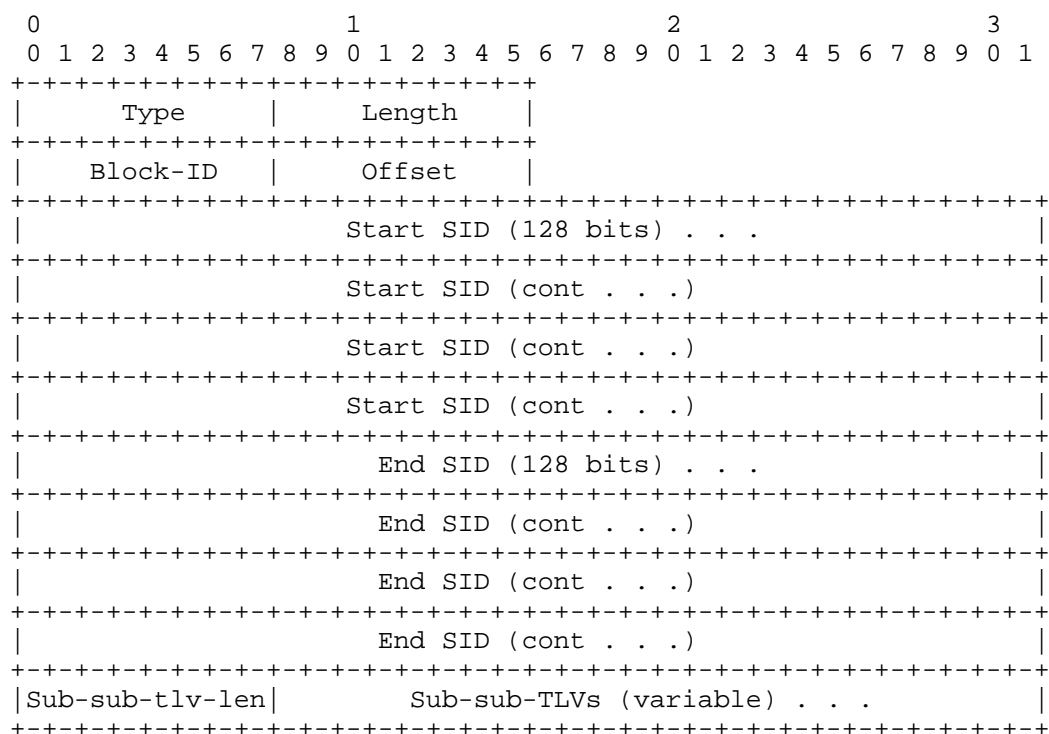
The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

## 2. SRv6 SID Block sub-TLV

An SRv6 SID Block is composed of a number of continuous SIDs within the address range of a Locator. When any SID assigned in an SRv6 SID Block is advertised in IS-IS, the new sub-TLVs defined in this document SHOULD be used, instead of the SRv6 End SID sub-TLV, the SRv6 End.X SID sub-TLV, and the SRv6 LAN End.X SID sub-TLV defined in [RFC9352].

The SRv6 SID Block sub-TLV is defined in this document to advertise an SRv6 SID Block. This new sub-TLV is carried in the SRv6 Locator TLV defined in [RFC9352].

The SRv6 SID Block sub-TLV has the following format:



- o Type: TBD.
- o Length: variable.
- o Block-ID: 1 octet. Identity of the advertised SRv6 SID Block. It MUST be unique in a node.
- o Offset: 1 octet. Number of shifting bits for the index of SIDs in this block.
- o Start SID: 16 octets. The smallest SID in this block.
- o End SID: 16 octets. The largest SID in this block.
- o Sub-sub-tlv-len: 1 octet. Number of octets used by sub-sub-TLVs.
- o Optional Sub-sub-TLVs.

The address range of an SRv6 SID Block, indicated by the Start SID and the End SID, must be covered by the associated Locator. Multiple

SRv6 SID Blocks can be associated to the same Locator, and their address ranges should not overlap.

### 3. SRv6 End.X SID Index sub-TLV

[RFC9352] defines SRv6 End.X SID sub-TLV to advertise an SRv6 SID associated with a point to point adjacency. If such SID is assigned in an SRv6 SID Block, it must be advertised by SRv6 End.X SID Index sub-TLV instead.

The SRv6 End.X SID Index sub-TLV has the following format:

```

      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      |
+-----+-----+-----+-----+
|      Flags      |      Algorithm      |      Weight      |
+-----+-----+-----+-----+
|      Block-ID   |      Index Num   |      Index Length   |
+-----+-----+-----+-----+
|      Index 0 (variable)      |      Endpoint Behavior 0      |
+-----+-----+-----+-----+
|      Index 1 (variable)      |      Endpoint Behavior 1      |
+-----+-----+-----+-----+
~                               ...                               ~
+-----+-----+-----+-----+
|      Index Num-1 (variable)  |      Endpoint Behavior Num-1  |
+-----+-----+-----+-----+

```

- o Type: TBD.
- o Length: variable.
- o Flags: 1 octet. Same as the Flags field in SRv6 End.X SID sub-TLV.
- o Algorithm: 1 octet. Same as the Algorithm field in SRv6 End.X SID sub-TLV.
- o Weight: 1 octet. Same as the Weight field in SRv6 End.X SID sub-TLV.
- o Block-ID: 1 octet. Indicating the associated SRv6 SID Block in which the SIDs are assigned.
- o Index Num: 1 octet. Number of the following indexes.

- o Index Length: 1 octet. Number of octets used by a single index.
- o Index N: variable. Index of a SID in the SRv6 SID Block.
- o Endpoint Behavior N: 2 octets. Behavior of the SID indicated by the preceding Index N field. Same as the Endpoint Behavior field in SRv6 End.X SID sub-TLV.

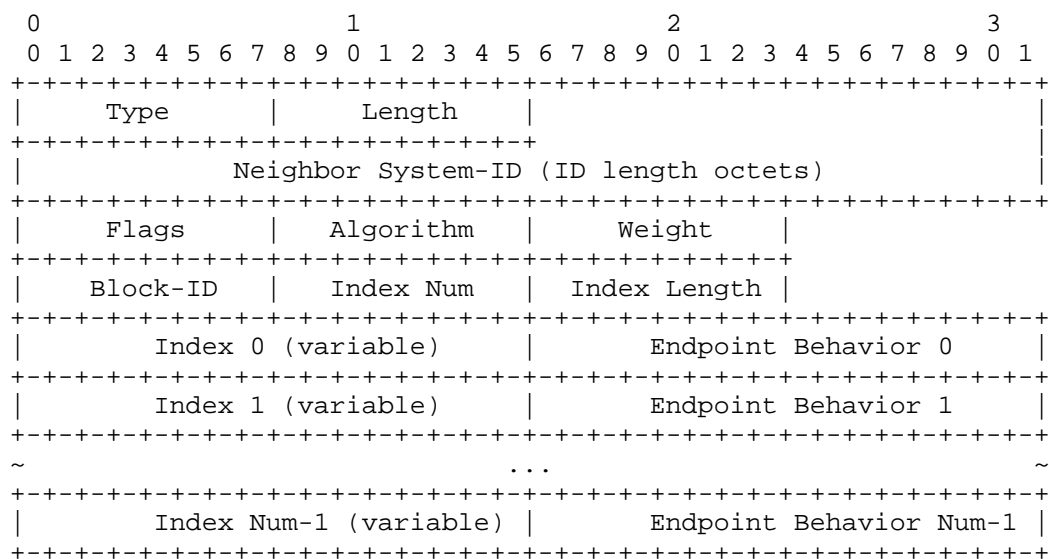
The SRv6 End.X SID Index sub-TLV can carry multiple SIDs which are assigned in an SRv6 SID Block identified by the Block-ID. These SIDs are indicated by the indexes in the SRv6 SID Block, instead of the whole 128-bit IPv6 addresses. They share the same Flags, Algorithm and Weight, but their Endpoint Behavior can be different.

The conversion from 128-bit SID into index, or vice versa, is described in Section 6.

#### 4. SRv6 LAN End.X SID Index sub-TLV

The SRv6 LAN End.X SID Index sub-TLV is used to advertise SRv6 SIDs associated with a LAN adjacency, as substitution of the SRv6 LAN End.X SID sub-TLV for SID Block. The main difference from the SRv6 End.X SID Index sub-TLV is that the SRv6 LAN End.X SID Index sub-TLV has to include the System ID of the physical neighbor on the LAN with which the SRv6 SIDs are associated.

The SRv6 LAN End.X SID Index sub-TLV has the following format:



o Type: TBD.

o Length: variable.

o Neighbor System-ID: IS-IS System-ID of length "ID Length" as defined in [ISO10589]. Same as the Neighbor System-ID field in SRv6 LAN End.X SID sub-TLV.

o Flags, Algorithm, Weight, Block-ID, Index Num, Index Length, Index N, Endpoint Behavior N: Same with the corresponding fields in SRv6 End.X SID Index sub-TLV.

## 5. SRv6 End SID Index sub-TLV

[RFC9352] defines SRv6 End SID sub-TLV to advertise SRv6 End SID. If such SID is assigned in an SRv6 SID Block, it must be advertised by SRv6 End SID Index sub-TLV instead.



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									Flags																	
Block-ID									Index Num									Index Length																	
Index 0 (variable)									Endpoint Behavior 0																										
Index 1 (variable)									Endpoint Behavior 1																										
~									...																		~								
Index Num-1 (variable)									Endpoint Behavior Num-1																										

o Type: TBD.

o Length: variable.

o Flags: 1 octet. Same as the Flags field in SRv6 End SID sub-TLV.

o Block-ID: 1 octet. Indicating the associated SRv6 SID Block in which the SIDs are assigned.

o Index Num: 1 octet. Number of the following indexes.

o Index Length: 1 octet. Number of octets used by a single index.

o Index N: variable. Index of a SID in the SRv6 SID Block.

o Endpoint Behavior N: 2 octets. Behavior of the SID indicating by the preceding Index N field. Used as the same as the Endpoint Behavior field in SRv6 End SID sub-TLV.

## 6. Computations of SID Index

When a SID is assigned from a SRv6 SID Block, its index can be computed in the following way:

Index = (SID - Start SID) right shift Offset bits

When a node receives any of the above-mentioned SID Index sub-TLVs, along with the SRv6 SID Block sub-TLV, it can convert the index to SID in the following way:

SID = (Index left shift Offset bits) + Start SID

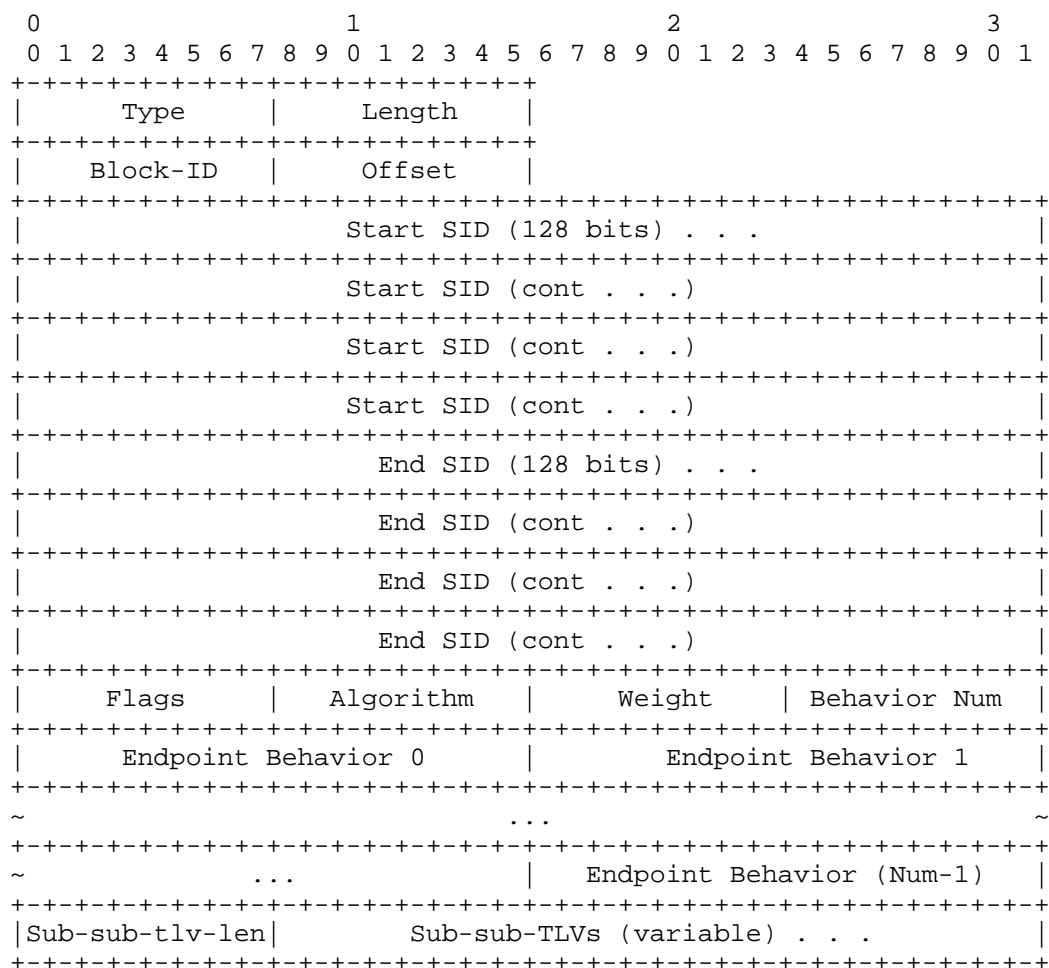
## 7. Rule-based SID Block for Large-Scale End.X SID Advertisement

In this section, the rule-based SID Block is proposed to achieve greater compressibility for End.X SID advertisements in massive End.X SIDs scenarios.

Three new sub-TLVs are defined: the Rule-based End.X SID Block sub-TLV, the Rule-based End.X SID Index sub-TLV or the Rule-based LAN End.X SID Index sub-TLV.

The Rule-based End.X SID Block sub-TLV advertises a SID Block, along with the rule for assigning a series of End.X SIDs with different flavors in the SID Block. The Rule-based End.X SID Index sub-TLV or the Rule-based LAN End.X SID Index sub-TLV advertises a start index in the SID Block, indicating that End.X SIDs with different flavors are assigned following the start index: <Index 0 (start index), Endpoint Behavior 0>, <Index 1 (start index + 1), Endpoint Behavior 1>, ..., <Index N (start index + N), Endpoint Behavior N>. N is equal to (Behavior Num - 1).

The Rule-based End.X SID Block sub-TLV has the following format:



o Type: TBD.

o Length: variable.

o Block-ID: 1 octet. Identity of the advertised SRv6 SID Block. It MUST be unique in a node.

o Offset: 1 octet. Number of shifting bits for the index of SIDs in this block.

o Start SID: 16 octets. The smallest SID in this block.

o End SID: 16 octets. The largest SID in this block.

- o Flags: 1 octet. Same as the Flags field in SRv6 End.X SID sub-TLV or SRv6 LAN End.X SID sub-TLV. SIDs assigned in the same rule-based SID Block share the same Flags.
- o Algorithm: 1 octet. Same as the Algorithm field in SRv6 End.X SID sub-TLV or SRv6 LAN End.X SID sub-TLV. SIDs assigned in the same rule-based SID Block share the same Algorithm.
- o Weight: 1 octet. Same as the Weight field in SRv6 End.X SID sub-TLV or SRv6 LAN End.X SID sub-TLV. SIDs assigned in the same rule-based SID Block share the same Weight.
- o Behavior Num: 1 octet. Number of End.X SIDs with different flavors for the same neighbor.
- o Endpoint Behavior N: 2 octets. Behavior of the Nth End.X SID. Endpoint Behavior 0 to (Num-1) specify a series of End.X SIDs with different flavors.
- o Sub-sub-tlv-len: 1 octet. Number of octets used by sub-sub-TLVs.
- o Optional Sub-sub-TLVs.

The Rule-based End.X SID Index sub-TLV has the following format:

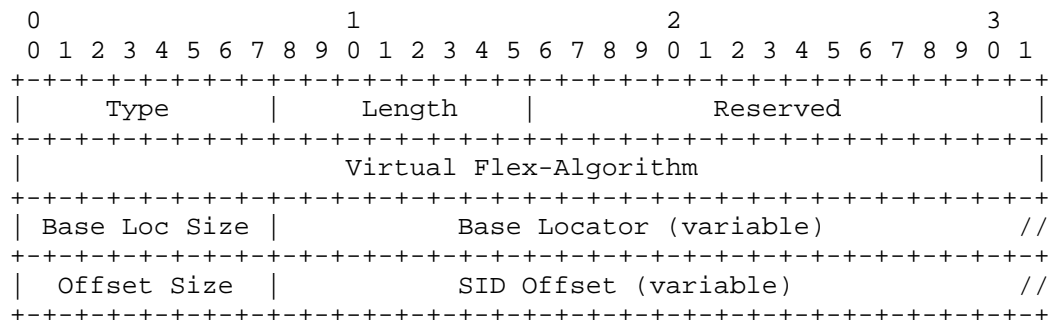
```

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      |
+++++
|      Block-ID   |      Index Length |      Start Index   (variable)   ~
+++++
```

- o Type: TBD.
- o Length: variable.
- o Block-ID: 1 octet. Indicating the associated Rule-based SID Block in which the SIDs are assigned.
- o Index Length: 1 octet. Number of octets used by the following Start Index field.
- o Start Index: variable. Index of the first SID in the Rule-based SID Block.

The Rule-based LAN End.X SID Index sub-TLV has the following format:





- o Type: TBD.
- o Length: variable.
- o Virtual Flex-Algorithm: 4 octets. Value 0 means that it is not VFA. Value >=256 means VFA identification number, and the base topology is denoted by Algorithm Value 128 to 255 are invalid. See [I-D.draft-chan-lsr-igp-adv-offset].
- o Base Loc Size: 1 octet. Number of bits in the Base Locator field, which MUST be from the range (1-128).
- o Base Locator: Indicating the base SRv6 Locator of Algorithm 0. Encoded in the minimal number of octets for the given number of bits.
- o Offset Size: 1 octet. Number of bits in the SID Offset field, which MUST be from the range (1-128).
- o SID Offset: variable. The offset of SID value between the Flex-Algorithm (or VFA) and Algorithm 0. Encoded in the minimal number of octets for the given number of bits.

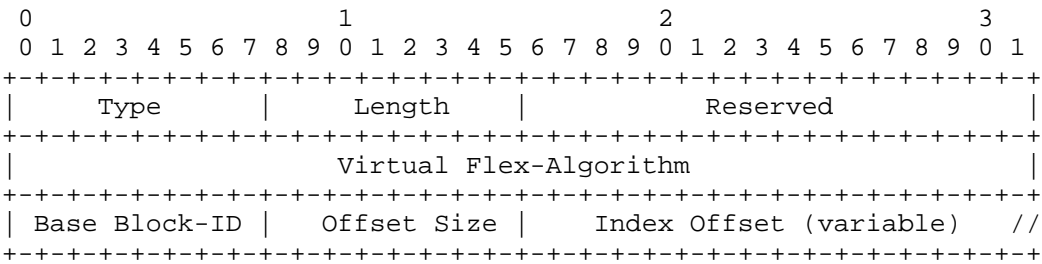
The SRv6 Locator of a Flex-Algorithm or Virtual Flex-Algorithm is associated with a base SRv6 Locator of Algorithm 0. When an SRv6 SID is assigned in that base SRv6 Locator of Algorithm 0 and advertised by SRv6 End.X SID sub-TLV, SRv6 LAN End.X SID sub-TLV, or SRv6 End SID sub-TLV, a corresponding SRv6 SID of that Flex-Algorithm or Virtual Flex-Algorithm is also assigned to the same point-to-point adjacency, LAN adjacency, or node.

The SID value is sum of (SID of Algorithm 0 - Base Locator + FA/VFA Locator + SID Offset).

8.2. Algorithm Offset for SRv6 SID Block

The SRv6 SID Block Algorithm Offset sub-sub-TLV advertises the algorithm offset for an SRv6 SID Block which belongs to a Locator associated with a Flex-Algorithm or Virtual Flex-Algorithm. It is carried as a sub-sub-TLV in SRv6 SID Block sub-TLV.

The SRv6 SID Block Algorithm Offset sub-sub-TLV has the following format:



- o Type: TBD.
- o Length: variable.
- o Virtual Flex-Algorithm: 4 octets. Value 0 means that it is not VFA. Value >=256 means VFA identification number, and the base topology is denoted by Algorithm Value 128 to 255 are invalid. See [I-D.draft-chan-lsr-igp-adv-offset].
- o Base Block-ID: 1 octet. Indicating the base SRv6 SID Block of Algorithm 0.
- o Offset Size: 1 octet. Number of bits in the Index Offset field, which MUST be from the range (1-128).
- o Index Offset: variable. The offset of index value between the Flex-Algorithm (or VFA) and Algorithm 0. Encoded in the minimal number of octets for the given number of bits.

The SRv6 SID Block of a Flex-Algorithm or Virtual Flex-Algorithm is associated with a base SRv6 SID Block of Algorithm 0. When an SRv6 SID is assigned in that base SRv6 SID Block of Algorithm 0 and advertised by SRv6 End.X SID Index sub-TLV in Section 3, SRv6 LAN End.X SID Index sub-TLV in Section 4, or SRv6 End SID Index sub-TLV in Section 5, a corresponding SRv6 SID of that Flex-Algorithm or Virtual Flex-Algorithm is also assigned to the same point-to-point adjacency, LAN adjacency, or node.

The SID value is sum of (Block Start SID + Index in Base Block + Index Offset).

## 9. Backward Compatibility

To achieve backward compatibility, routers supporting the feature described in this document MUST advertise an IS-IS Router Capability TLV-242 that includes the following SRv6 SID Block 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										Reserved																					

Upon detecting the presence of a reachable TLV-242 without an SRv6 SID Block Sub-TLV, all routers MUST advertise SRv6 SIDs using the SRv6 End SID sub-TLV, the SRv6 End.X SID sub-TLV, and the SRv6 LAN End.X SID sub-TLV defined in [RFC9352]. Besides, an implementations MAY only advertise SRv6 SIDs in the new way when it is clearly configured to do so.

In order to realize the goal of reducing SRv6 SID advertisements, it is recommended that the operator should make sure that all routers in the same network have been upgraded to support the simplified advertisement method defined in this document.

## 10. Security Considerations

TBD



## 11. IANA Considerations

Type	Description
-----	-----
TBD	SRv6 SID Block sub-TLV
TBD	SRv6 End.X SID Index sub-TLV
TBD	SRv6 LAN End.X SID Index sub-TLV
TBD	SRv6 End SID Index sub-TLV
TBD	Rule-based End.X SID Block sub-TLV
TBD	Rule-based End.X SID Index sub-TLV
TBD	Rule-based LAN End.X SID Index sub-TLV
TBD	SRv6 SID Block Algorithm Offset sub-sub-TLV

## 12. References

### 12.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.
- [RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, May 2017
- [RFC9352] Psenak, P., Ed., Filsfils, C., Bashandy, A., Decraene, B., and Z. Hu, "IS-IS Extensions to Support Segment Routing over the IPv6 Data Plane", RFC 9352, DOI 10.17487/RFC9352, February 2023, <<https://www.rfc-editor.org/info/rfc9352>>.
- [I-D.draft-chan-lsr-igp-adv-offset] Louis, C. and S. Krzysztof, "IGP extensions for Advertising Offset for Flex-Algorithm", draft-chan-lsr-igp-adv-offset-02 (work in progress), March 2023.
- [ISO10589] International Organization for Standardization, "Intermediate system to Intermediate system intra-domain routeing information exchange protocol for use in conjunction with the protocol for providing the connectionless-mode Network Service (ISO 8473)", Nov 2002.

### 12.2. Informative References

- [RFC8402] Filsfils, C., Ed., Previdi, S., Ed., Ginsberg, L., Decraene, B., Litkowski, S., and R. Shakir, "Segment Routing Architecture", RFC 8402, DOI 10.17487/RFC8402, July 2018, <<https://www.rfc-editor.org/info/rfc8402>>.

- [RFC8986] Filsfils, C., Ed., Camarillo, P., Ed., Leddy, J., Voyer, D., Matsushima, S., and Z. Li, "Segment Routing over IPv6 (SRv6) Network Programming", RFC 8986, DOI 10.17487/RFC8986, February 2021, <<https://www.rfc-editor.org/info/rfc8986>>.
- [RFC9350] Psenak, P., Ed., Hegde, S., Filsfils, C., Talaulikar, K., and A. Gulko, "IGP Flexible Algorithm", RFC 9350, DOI 10.17487/RFC9350, February 2023, <<https://www.rfc-editor.org/info/rfc9350>>.

### 13. Acknowledgments

The authors would like to thank the following for their valuable contributions of this document:

TBD

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