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BGP Extensions for IDs Allocation

Abstract

This document describes extensions to the BGP for IDs allocation. The IDs are SIDs for segment routing (SR), including SR for IPv6 (SRv6). They are distributed to their domains if needed.

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

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1. Introduction

In a network with a central controller, the controller has the link state information of the network, including the resource such as traffic enginerring and SIDs information. It is valuable for the controller to allocate and manage the resources including SIDs of the network in a centralized way, especially for the SIDs representing network resources [I-D.ietf-teas-enhanced-vpn].

When BGP as a controller allocates an ID, it is natural and beneficial to extend BGP to send it to its corresponding network elements.

PCE may be extended to send IDs to their corresponding network elements after the IDs are allocated by a controller. However, when BGP is already deployed in a network, using PCE for IDs will need to deploy an extra protocol PCE in the network. This will increase the CapEx and OpEx.

Yang may be extended to send IDs to their corresponding network elements after the IDs are allocated by a controller. However, Yang progress may be slow. Some people may not like this.

There may not be these issues when BGP is used to send IDs. In addition, BGP may be used to distribute IDs into their domains easily when needed. It is also fit for the dynamic and static allocation of IDs.

This document proposes extensions to the BGP for sending Segment Identifiers (SIDs) for segment routing (SR) including SRv6 to their corresponding network elements after SIDs are allocated by the controller. If needed, they will be distributed into their network domains.

2. Terminology

The following terminology is used in this document.

SR: Segment Routing.

SRv6: SR for IPv6

SID: Segment Identifier.

IID: Indirection Identifier.

SR-Path: Segment Routing Path.

SR-Tunnel: Segment Routing Tunnel.

RR: Route Reflector.

MPP: MPLS Path Programming.

NAI: Node or Adjacency Identifier.

TED: Traffic Engineering Database.

3. Protocol Extensions

A new AFI and SAFI are defined: the Identifier AFI and the SID SAFI whose codepoints are to be assigned by IANA. A few new NLRI TLVs are defined for the new AFI/SAFI, which are Node, Link and Prefix SID NLRI TLVs. When a SID for a node, link or prefix is allocated by the controller, it may be sent to a network element in a UPDATE message containing a MP_REACH NLRI with the new AFI/SAFI and the SID NLRI TLV. When the SID is withdrawn by the controller, a UPDATE message containing a MP_UNREACH NLRI with the new AFI/SAFI and the SID NLRI TLV may be sent to the network element.

3.1. Node SID NLRI TLV

The Node SID NLRI TLV is used to represent the IDs such as SID associated with a node. Its format is illustrated in the Figure below, which is similar to the corresponding one defined in [RFC7752].

```
 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 (TBDa for Node SID)   |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Protocol ID   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           Identifier                          |
|                           (8 octets)                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Peer IP (4/16 bytes for IPv4/IPv6 Address)                   ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                     Local Node Descriptors TLV                ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                            Sub-TLVs                           ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Where:

Type (TBDa): It is to be assigned by IANA.

Length: It is the length of the value field in bytes.

Peer IP: 4/16 octet value indicates an IPv4/IPv6 peer. When receiving a UPDATE message, a BGP speaker processes it only if the peer IP is the IP address of the BGP speaker or 0.

Protocol-ID, Identifier, and Local Node Descriptor: defined in [RFC7752], can be reused.

Sub-TLVs may be some of the followings:

SR-Capabilities TLV (1034): It contains the Segment Routing Global Base (SRGB) range(s) allocated for the node.

SR Local Block TLV (1036): The SR Local Block (SRLB) TLV contains the range(s) of SIDs/labels allocated to the node for local SIDs.

SRv6 SID Node TLV (TBD1): A new TLV, called SRv6 Node SID TLV, contains an SRv6 SID and related information.

SRv6 Locator TLV (TBD2): A new TLV, called SRv6 Locator TLV, contains an SRv6 locator and related information.

The format of SRv6 SID Node TLV is illustrated 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 (TBD1)          |            Length             |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |    Reserved     |     Flags     |     SRv6 Endpoint Function    |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                        SRv6 Identifier                        |
 |                          (128 bits)                           |
 |                                                               |
 |                                                               |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                                                               |
 ~                        Optional sub-TLVs                      ~
 |                                                               |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

SRv6 Node SID TLV

Type: TBD1 for SRv6 Node SID TLV is to be assigned by IANA.

Length: Variable.

Flags: 1 octet. No flags are defined now.

SRv6 Endpoint Function: 2 octets. The function associated with SRv6 SID.

SRv6 Identifier: 16 octets. IPv6 address representing SRv6 SID.

Reserved: MUST be set to 0 while sending and ignored on receipt.

SRv6 node SID inherits the topology and algorithm from its locator.

The format of SRv6 locator TLV is illustrated 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 (TBD2)          |           Length              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|R|R|R|R|         MT-ID         |  Algorithm    |     Flags     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Metric                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Locator-Size | Locator (variable)...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                        Optional sub-TLVs                      ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

SRv6 Locator TLV

Type: TBD2 for SRv6 Locator TLV is to be assigned by IANA.

Length: Variable.

MT-ID: Multitopology Identifier as defined in [RFC5120].

Algorithm: 1 octet. Associated algorithm.

Flags: 1 octet. As described in [I-D.ietf-lsr-isis-srv6-extensions].

Metric: 4 octets. As described in [RFC5305].

Locator-Size: 1 octet. Number of bits in the Locator field (1 to 128).

Locator: 1 to 16 octets. SRv6 Locator encoded in the minimum number of octets for the given Locator-Size.

Reserved: MUST be set to 0 while sending and ignored on receipt.

3.2. Link SID NLRI TLV

The Link SID NLRI TLV is used to represent the IDs such as SID associated with a link. Its format is illustrated in the Figure below, which is similar to the corresponding one defined in [RFC7752].

```
 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 (TBDb for Link SID)   |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Protocol ID   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                   Identifier (8 octets)                       ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Peer IP (4/16 bytes for IPv4/IPv6 Address)                   ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                   Local Node Descriptors TLV                  ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                   Remote Node Descriptors TLV                 ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                       Link Descriptors TLV                    ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                           Sub-TLVs                            ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Where:

Type (TBDb): It is to be assigned by IANA.

Length: It is the length of the value field in bytes.

Peer IP: 4/16 octet value indicates an IPv4/IPv6 peer.

Protocol-ID, Identifier, Local Node Descriptors, Remote Node Descriptors and Link Descriptors:
defined in [RFC7752], can be reused.

The Sub-TLVs may be some of the followings:

Adj-SID TLV (1099): It contains the Segment Identifier (SID) allocated for the link/adjacency.

LAN Adj-SID TLV (1100): It contains the Segment Identifier (SID) allocated for the adjacency/link to a non-DR router on a broadcast, NBMA, or hybrid link.

SRv6 Adj-SID TLV (TBD3): A new TLV, called SRv6 Adj-SID TLV, contains an SRv6 Adj-SID and related information.

SRv6 LAN Adj-SID TLV (TBD4): A new TLV, called SRv6 LAN Adj-SID TLV, contains an SRv6 LAN Adj-SID and related information.

The format of an SRv6 Adj-SID TLV is illustrated 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 (TBD3)          |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Weight    |   Algorithm   |B|S|P|            Flags        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Reserved            |     SRv6 Endpoint Function    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         SRv6 Identifier                       |
|                           (128 bits)                          |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                         Optional sub-TLVs                     ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

SRv6 Adj-SID TLV

Type: TBD3 for SRv6 Adj-SID TLV is to be assigned by IANA.

Length: Variable.

Weight: 1 octet. The value represents the weight of the SID for the purpose of load balancing.

Algorithm: 1 octet. Associated algorithm.

Flags: 2 octets. Three flags are defined in [I-D.ietf-lsr-isis-srv6-extensions].

SRv6 Endpoint Function: 2 octets. The function associated with SRv6 SID.

SRv6 Identifier: 16 octets. IPv6 address representing SRv6 SID.

Reserved: MUST be set to 0 while sending and ignored on receipt.

The format of an SRv6 LAN Adj-SID TLV is illustrated 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 (TBD4)          |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Weight    |   Algorithm   |B|S|P|             Flags     |O|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Reserved            |     SRv6 Endpoint Function    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    neighbor Router ID (4 octets) / System ID (6 octets)       ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        SRv6 Identifier                        |
|                          (128 bits)                           |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                        Optional sub-TLVs                      ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

SRv6 LAN Adj-SID TLV

Type: TBD4 for SRv6 LAN Adj-SID TLV is to be assigned by IANA.

Length: Variable.

Weight: 1 octet. The value represents the weight of the SID for the purpose of load balancing.

Algorithm: 1 octet. Associated algorithm.

Flags: 2 octets. Three flags B, S and P are defined in [I-D.ietf-lsr-isis-srv6-extensions]. Flag O set to 1 indicating OSPF neighbor Router ID of 4 octets, set to 0 indicating IS-IS neighbor System ID of 6 octets.

SRv6 Endpoint Function: 2 octets. The function associated with SRv6 SID.

SRv6 Identifier: 16 octets. IPv6 address representing SRv6 SID.

Reserved: MUST be set to 0 while sending and ignored on receipt.

3.3. Prefix SID NLRI TLV

The Prefix SID NLRI TLV is used to represent the IDs such as SID associated with a prefix. Its format is illustrated in the Figure below, which is similar to the corresponding one defined in [RFC7752].

```
 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 (TBDc for Prefix SID)  |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Protocol ID   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                      Identifier (8 octets)                    ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Peer IP (4/16 bytes for IPv4/IPv6 Address)                   ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                   Local Node Descriptors TLV                  ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                       Prefix Descriptors TLV                  ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                            Sub-TLVs                           ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Where:

Type (TBDc): It is to be assigned by IANA.

Length: It is the length of the value field in bytes.

Peer IP: 4/16 octet value indicates an IPv4/IPv6 peer.

Protocol-ID, Identifier, Local Node Descriptors and Prefix Descriptors:
defined in [RFC7752], can be reused.

Sub-TLVs may be some of the followings:

Prefix-SID TLV (1158): It contains the Segment Identifier (SID) allocated for the prefix.

Prefix Range TLV (1159): It contains a range of prefixes and the Segment Identifier (SID)s allocated for the prefixes.

3.4. Capability Negotiation

It is necessary to negotiate the capability to support BGP Extensions for sending and receiving Segment Identifiers (SIDs). The BGP SID Capability is a new BGP capability [RFC5492]. The Capability Code for this capability is to be specified by the IANA. The Capability Length field of this capability is variable. The Capability Value field consists of one or more of the following tuples:

Address Family Identifier (2 octets)
Subsequent Address Family Identifier (1 octet)
Send/Receive (1 octet)

BGP SID Capability

The meaning and use of the fields are as follows:

Address Family Identifier (AFI): This field is the same as the one used in [RFC4760].

Subsequent Address Family Identifier (SAFI): This field is the same as the one used in [RFC4760].

Send/Receive: This field indicates whether the sender is (a) willing to receive SID from its peer (value 1), (b) would like to send SID to its peer (value 2), or (c) both (value 3) for the <AFI, SAFI>.

4. IANA Considerations

This document requests assigning a new AFI in the registry "Address Family Numbers" as follows:

Code Point	Description	Reference
TBDx	Identifier AFI	This document

This document requests assigning a new SAFI in the registry "Subsequent Address Family Identifiers (SAFI) Parameters" as follows:

Code Point	Description	Reference
TBDy	SID SAFI	This document

This document defines a new registry called "SID NLRI TLVs". The allocation policy of this registry is "First Come First Served (FCFS)" according to [RFC8126].

Following TLV code points are defined:

Code Point	Description	Reference
1 (TBDa)	Node SID NLRI	This document
2 (TBDb)	Link SID NLRI	This document
3 (TBDc)	Prefix SID NLRI	This document

This document requests assigning a code-point from the registry "BGP-LS Node Descriptor, Link Descriptor, Prefix Descriptor, and Attribute TLVs" as follows:

TLV Code Point	Description	Reference
TBD1	SRv6 Node SID	This document
TBD2	SRv6 Allocator	This document
TBD3	SRv6 Adj-SID	This document
TBD4	SRv6 LAN Adj-SID	This document

5. Security Considerations

Protocol extensions defined in this document do not affect the BGP security other than those as discussed in the Security Considerations section of [RFC7752].

6. Acknowledgements

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