Inter-Domain Routing
Internet-Draft
Intended status: Standards Track
Expires: December 27, 2017

S. Previdi, Ed.
P. Psenak
C. Filsfils
Cisco Systems, Inc.
H. Gredler
RtBrick Inc.
M. Chen
Huawei Technologies

June 25, 2017

# BGP Link-State extensions for Segment Routing draft-ietf-idr-bgp-ls-segment-routing-ext-02

## Abstract

Segment Routing (SR) allows for a flexible definition of end-to-end paths within IGP topologies by encoding paths as sequences of topological sub-paths, called "segments". These segments are advertised by the link-state routing protocols (IS-IS, OSPF and OSPFv3).

This draft defines extensions to the BGP Link-state address-family in order to carry segment information via BGP.

## 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.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at http://datatracker.ietf.org/drafts/current/.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on December 27, 2017.

Table of Contents

## 1. Introduction

Segment Routing (SR) allows for a flexible definition of end-to-end paths by combining sub-paths called "segments". A segment can represent any instruction, topological or service-based. A segment can have a local semantic to an SR node or global within a domain. Within IGP topologies an SR path is encoded as a sequence of topological sub-paths, called "IGP segments". These segments are advertised by the link-state routing protocols (IS-IS, OSPF and OSPFv3).

Two types of IGP segments are defined, Prefix segments and Adjacency segments. Prefix segments, by default, represent an ECMP-aware shortest-path to a prefix, as per the state of the IGP topology. Adjacency segments represent a hop over a specific adjacency between two nodes in the IGP. A prefix segment is typically a multi-hop path while an adjacency segment, in most of the cases, is a one-hop path. [I-D.ietf-spring-segment-routing].

When Segment Routing is enabled in a IGP domain, segments are advertised in the form of Segment Identifiers (SIDs). The IGP link-state routing protocols have been extended to advertise SIDs and other SR-related information. IGP extensions are described in: IS-IS [I-D.ietf-isis-segment-routing-extensions], OSPFv2 [I-D.ietf-ospf-segment-routing-extensions] and OSPFv3 [I-D.ietf-ospf-ospfv3-segment-routing-extensions]. Using these extensions, Segment Routing can be enabled within an IGP domain.

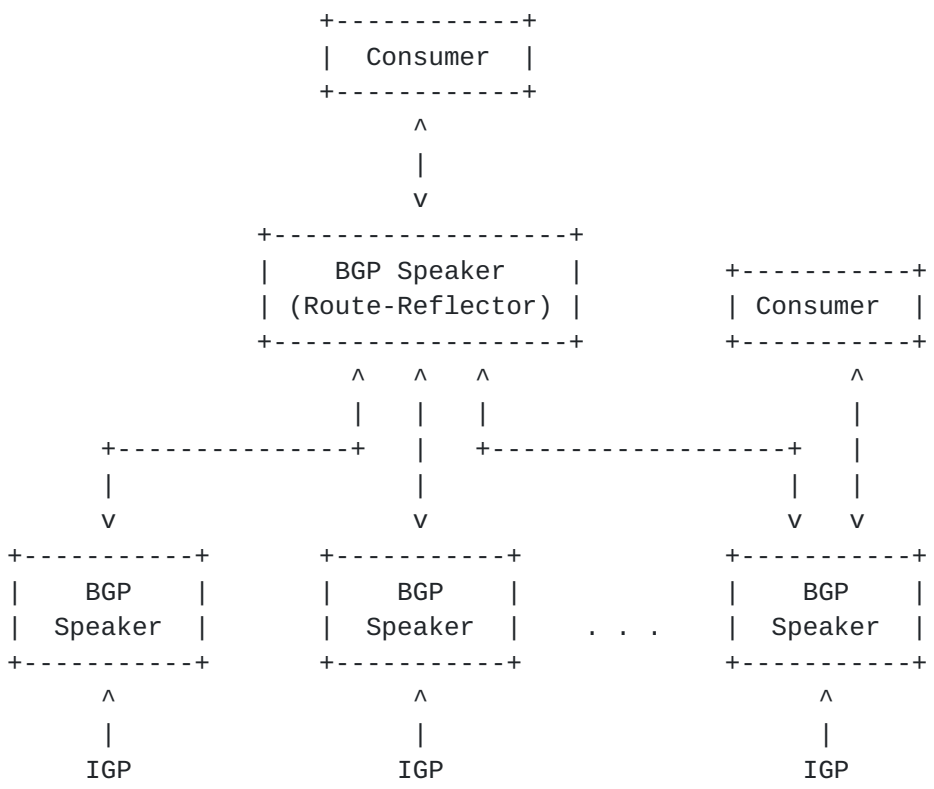



Figure 1: Link State info collection

Segment Routing (SR) allows advertisement of single or multi-hop paths. The flooding scope for the IGP extensions for Segment routing is IGP area-wide. Consequently, the contents of a Link State Database (LSDB) or a Traffic Engineering Database (TED) has the scope of an IGP area and therefore, by using the IGP alone it is not enough to construct segments across multiple IGP Area or AS boundaries.

In order to address the need for applications that require topological visibility across IGP areas, or even across Autonomous Systems (AS), the BGP-LS address-family/sub-address-family have been defined to allow BGP to carry Link-State information. The BGP Network Layer Reachability Information (NLRI) encoding format for BGP-LS and a new BGP Path Attribute called the BGP-LS attribute are defined in [RFC7752]. The identifying key of each Link-State object, namely a node, link, or prefix, is encoded in the NLRI and the properties of the object are encoded in the BGP-LS attribute. Figure Figure 1 describes a typical deployment scenario. In each IGP area, one or more nodes are configured with BGP-LS. These BGP speakers form an IBGP mesh by connecting to one or more route-reflectors. This way, all BGP speakers (specifically the route-reflectors) obtain Link-State information from all IGP areas (and from other ASes from EBGP peers). An external component connects to the route-reflector to obtain this information (perhaps moderated by

a policy regarding what information is or isn't advertised to the external component).

This document describes extensions to BGP-LS to advertise the SR information. An external component (e.g., a controller) then can collect SR information in the "northbound" direction across IGP areas or ASes and construct the end-to-end path (with its associated SIDs) that need to be applied to an incoming packet to achieve the desired end-to-end forwarding.

## 2. BGP-LS Extensions for Segment Routing

This document defines IGP SR extensions BGP-LS TLVs and sub-TLVs. Section 2.4 and Section 2.5 illustrates the equivalent TLVs and sub-TLVs in IS-IS, OSPF and OSPFv3 protocols.

BGP-LS [RFC7752] defines the BGP-LS NLRI that can be a Node NLRI, a Link NLRI or a Prefix NLRI. The corresponding BGP-LS attribute is a Node Attribute, a Link Attribute or a Prefix Attribute. BGP-LS [RFC7752] defines the TLVs that map link-state information to BGP-LS NLRI and the BGP-LS attribute. This document adds additional BGP-LS attribute TLVs in order to encode SR information.

### 2.1. Node Attributes TLVs

The following Node Attribute TLVs are defined:

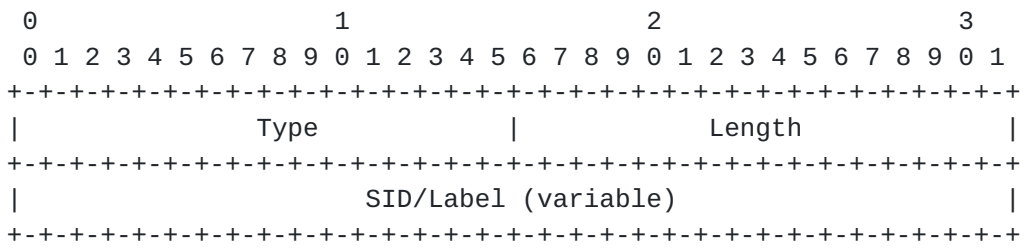
| TLV Code Point | Description | Length | Section |
|---|---|---|---|
| 1161 | SID/Label | variable | Section 2.1.1 |
| 1034 | SR Capabilities | variable | Section 2.1.2 |
| 1035 | SR Algorithm | variable | Section 2.1.3 |
| 1036 | SR Local Block | variable | Section 2.1.4 |
| 1037 | SRMS Preference | variable | Section 2.1.5 |

Table 1: Node Attribute TLVs

These TLVs can ONLY be added to the Node Attribute associated with the Node NLRI that originates the corresponding SR TLV.

#### 2.1.1. SID/Label Sub-TLV

The SID/Label TLV is used as sub-TLV by the SR-Capabilities (Section 2.1.2) and SRLB (Section 2.1.4) TLVs and has following format:




where:

Type: TBD, suggested value 1161.

Length: Variable, 3 or 4 bytes

SID/Label: If length is set to 3, then the 20 rightmost bits represent a label. If length is set to 4, then the value represents a 32 bit SID.

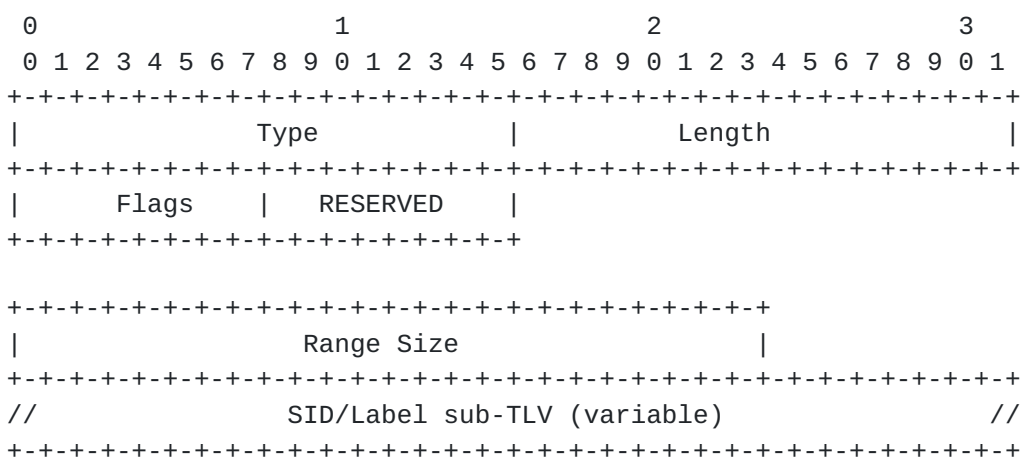
The receiving router MUST ignore the SID/Label sub-TLV if the length is other then 3 or 4.

### 2.1.2. SR-Capabilities TLV

The SR-Capabilities TLV is used in order to advertise the node's Segment Routing Global Base (SRGB) as originated in:

- IS-IS, as defined by the SR-Capabilities TLV in [I-D.ietf-isis-segment-routing-extensions].
- OSPF/OSPFv3, as defined by the SID/Label Range TLV in [I-D.ietf-ospf-segment-routing-extensions] and [I-D.ietf-ospf-ospfv3-segment-routing-extensions].

The SR Capabilities TLV has following format:



Type: TBD, suggested value 1034.

Length: Variable.

Flags: 1 octet of flags as defined in [I-D.ietf-isis-segment-routing-extensions].

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

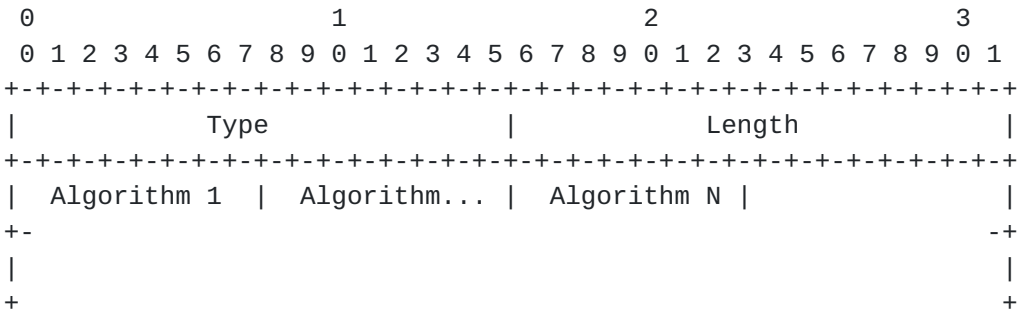
Range Size: 3 octet value indicating the number of labels in the range.

SID/Label sub-TLV (as defined in Section 2.1.1).

Multiple SRGB entries are encoded within the same SR Capabilities TLV.

### 2.1.3. SR-Algorithm TLV

The SR-Algorithm TLV has the following format:




where:

Type: TBD, suggested value 1035.

Length: Variable.

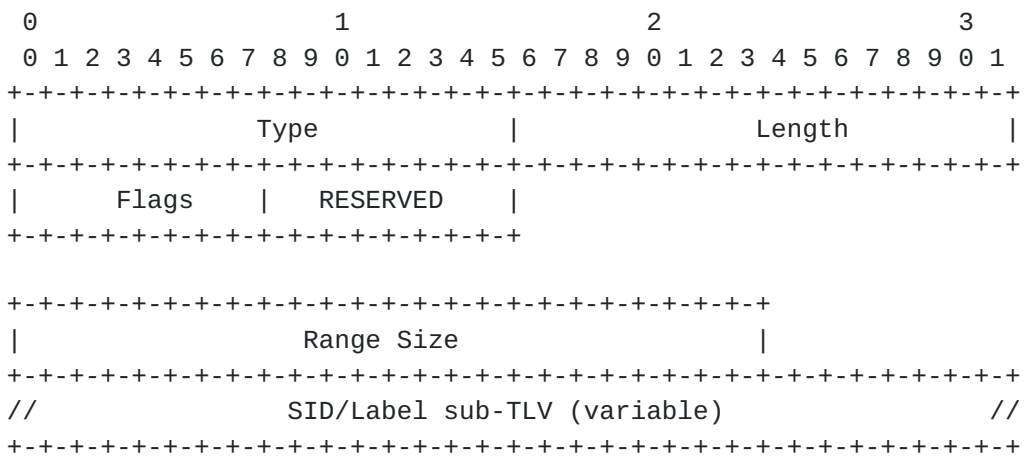
Algorithm: 1 octet identifying the algorithm.

### 2.1.4. SR Local Block TLV

The SR Local Block (SRLB) TLV contains the range of labels the node has reserved for local SIDs. Local SIDs are used, e.g., in IGP (IS-IS, OSPF) for Adjacency-SIDs, and may also be allocated by other components than IGP protocols. As an example, an application or a controller may instruct a node to allocate a specific local SID. Therefore, in order for such applications or controllers to know the

range of local SIDs available, it is required that the node advertises its SRLB.

The SRLB TLV has the following format:




Type: TBD, suggested value 1036.

Length: Variable.

Flags: 1 octet of flags. None are defined at this stage.

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

Range Size: 3 octet value indicating the number of labels in the range.

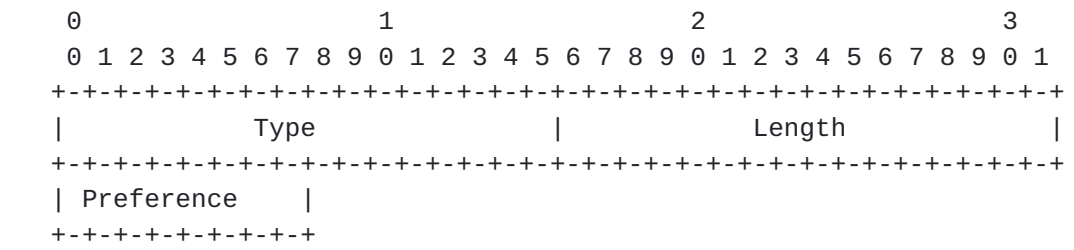
SID/Label sub-TLV (as defined in Section 2.1.1).

Multiple SRLB entries are encoded within the same SRLB TLV.

### 2.1.5. SRMS Preference TLV

The Segment Routing Mapping Server (SRMS) Preference TLV is used in order to associate a preference with SRMS advertisements from a particular source.

The SRMS Preference TLV has following format:




Type: TBD, suggested value 1037.

Length: 1.

Preference: 1 octet. Unsigned 8 bit SRMS preference.

The use of the SRMS Preference TLV is defined in [I-D.ietf-isis-segment-routing-extensions], [I-D.ietf-ospf-segment-routing-extensions] and [I-D.ietf-ospf-ospfv3-segment-routing-extensions].

## 2.2. Link Attribute TLVs

The following Link Attribute TLVs are are defined:

| TLV Code Point | Description | Length | Section |
|---|---|---|---|
| 1099 | Adjacency Segment Identifier (Adj-SID) TLV | variable | Section 2.2.1 |
| 1100 | LAN Adjacency Segment Identifier (Adj-SID) TLV | variable | Section 2.2.2 |
| 1172 | L2 Bundle Member TLV | variable | Section 2.2.3 |

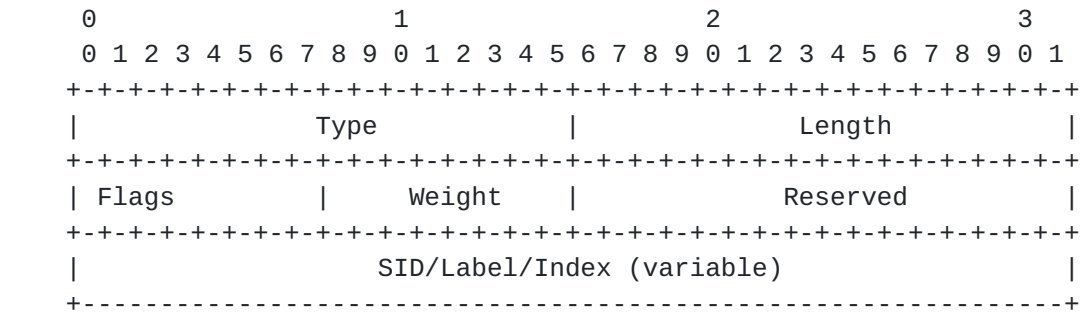
Table 2: Link Attribute TLVs

These TLVs can ONLY be added to the Link Attribute associated with the link whose local node originates the corresponding TLV.

For a LAN, normally a node only announces its adjacency to the IS-IS pseudo-node (or the equivalent OSPF Designated and Backup Designated Routers)[I-D.ietf-isis-segment-routing-extensions]. The LAN Adjecency Segment TLV allows a node to announce adjacencies to all other nodes attached to the LAN in a single instance of the BGP-LS Link NLRI. Without this TLV, the corresponding BGP-LS link NLRI would need to be originated for each additional adjacency in order to advertise the SR TLVs for these neighbor adjacencies.

### 2.2.1. Adjacency SID TLV

The Adjacency SID (Adj-SID) TLV has the following format:




where:

Type: TBD, suggested value 1099.

Length: Variable.

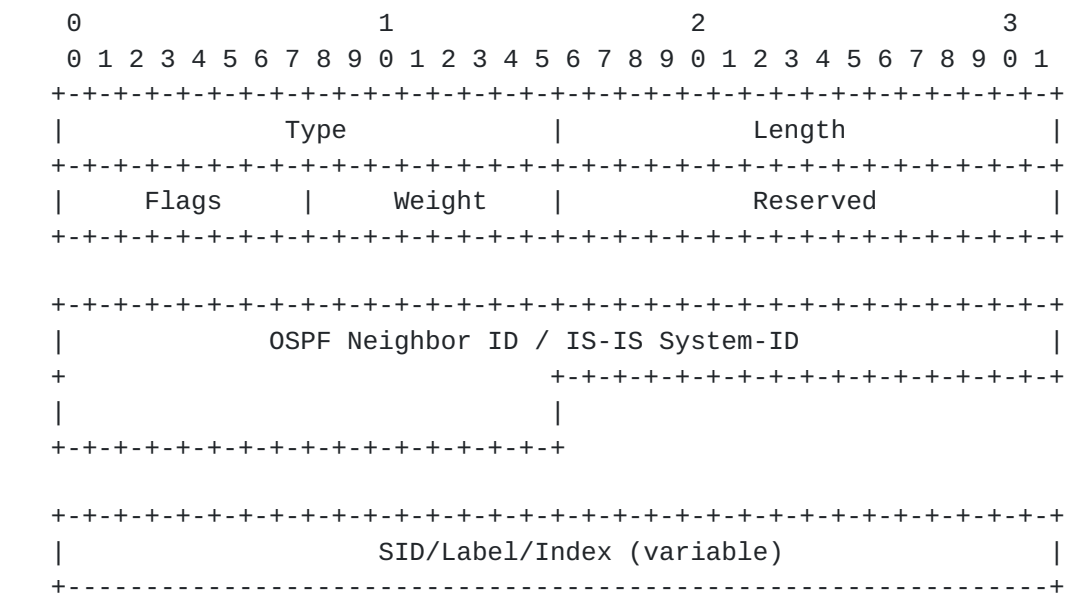
Flags. 1 octet field of following flags as defined in [I-D.ietf-isis-segment-routing-extensions], [I-D.ietf-ospf-segment-routing-extensions] and [I-D.ietf-ospf-ospfv3-segment-routing-extensions].

Weight: Weight used for load-balancing purposes.

SID/Index/Label: Label or index value depending on the flags setting as defined in [I-D.ietf-isis-segment-routing-extensions], [I-D.ietf-ospf-segment-routing-extensions] and [I-D.ietf-ospf-ospfv3-segment-routing-extensions].

### 2.2.2. LAN Adjacency SID TLV

The LAN Adjacency SID (LAN-Adj-SID-SID) TLV has the following format:




where:

Type: TBD, suggested value 1100.

Length: Variable.

Flags. 1 octet field of following flags as defined in [I-D.ietf-isis-segment-routing-extensions], [I-D.ietf-ospf-segment-routing-extensions] and [I-D.ietf-ospf-ospfv3-segment-routing-extensions].

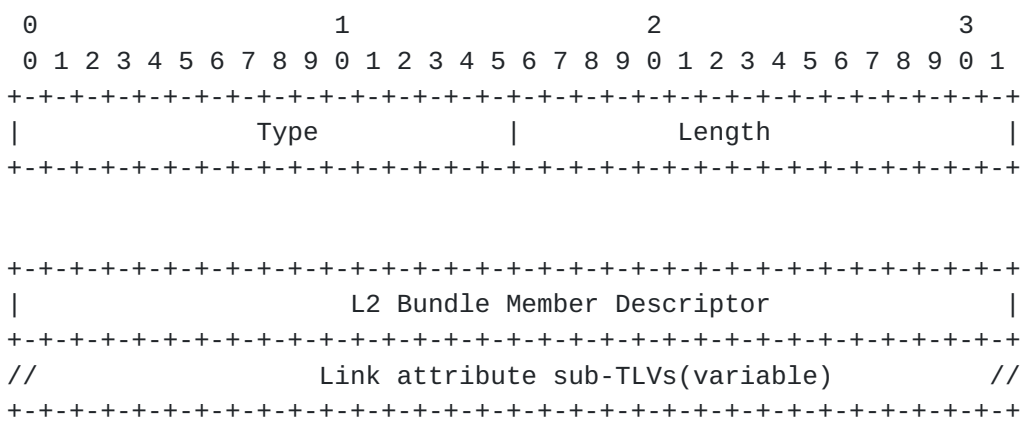
Weight: Weight used for load-balancing purposes.

SID/Index/Label: Label or index value depending on the flags setting as defined in [I-D.ietf-isis-segment-routing-extensions], [I-D.ietf-ospf-segment-routing-extensions] and [I-D.ietf-ospf-ospfv3-segment-routing-extensions].

### 2.2.3. L2 Bundle Member

The L2 Bundle Member Attribute TLV identifies an L2 Bundle Member link which in turn is associated with a parent L3 link. The L3 link is described by the Link NLRI defined in [RFC7752] and the L2 Bundle Member Attribute TLV is associated with the Link NLRI. The TLV MAY include sub-TLVs which describe attributes associated with the bundle member. The identified bundle member represents a unidirectional path from the originating router to the neighbor specified in the parent L3 Link. Multiple L2 Bundle Member Attribute TLVs MAY be associated with a Link NLRI.

The L2 Bundle Member Attribute TLV has the following format:




where:

Type: TBD, suggested value 1172.

Length: Variable.

L2 Bundle Member Descriptor: A Link Local Identifier as defined in [RFC4202].

Link attributes for L2 Bundle Member Links are advertised as sub-TLVs of the L2Bundle Member Attribute TLV. The sub-TLVs are identical to existing BGP-LS TLVs as identified in the table below.

| TLV Code Point | Description | Reference Document |
|---|---|---|
| 1088 | Administrative group (color) | [RFC7752] |
| 1089 | Maximum link bandwidth | [RFC7752] |
| 1090 | Max. reservable link bandwidth | [RFC7752] |
| 1091 | Unreserved bandwidth | [RFC7752] |
| 1092 | TE default metric | [RFC7752] |
| 1093 | Link protection type | [RFC7752] |
| 1099 | Adjacency Segment Identifier (Adj-SID) TLV | Section 2.2.1 |
| 1100 | LAN Adjacency Segment Identifier (Adj-SID) TLV | Section 2.2.2 |
| 1104 | Unidirectional link delay | [I-D.ietf-idr-te-pm-bgp] |
| 1105 | Min/Max Unidirectional link delay | [I-D.ietf-idr-te-pm-bgp] |
| 1106 | Min/Max Unidirectional link delay | [I-D.ietf-idr-te-pm-bgp] |
| 1107 | Unidirectional packet loss | [I-D.ietf-idr-te-pm-bgp] |
| 1108 | Unidirectional residual bandwidth | [I-D.ietf-idr-te-pm-bgp] |
| 1109 | Unidirectional available bandwidth | [I-D.ietf-idr-te-pm-bgp] |
| 1110 | Unidirectional bandwidth utilization | [I-D.ietf-idr-te-pm-bgp] |

Table 3: L2 Bundle Member Link Attribute TLVs

## 2.3. Prefix Attribute TLVs

The following Prefix Attribute TLVs and sub-TLVs are defined:

| TLV Code Point | Description | Length | Section |
|---|---|---|---|
| 1158 | Prefix SID | variable | Section 2.3.1 |
| 1159 | Range | variable | Section 2.3.4 |
| 1170 | IGP Prefix Attributes | variable | Section 2.3.2 |
| 1171 | Source Router-ID | variable | Section 2.3.3 |

Table 4: Prefix Attribute TLVs

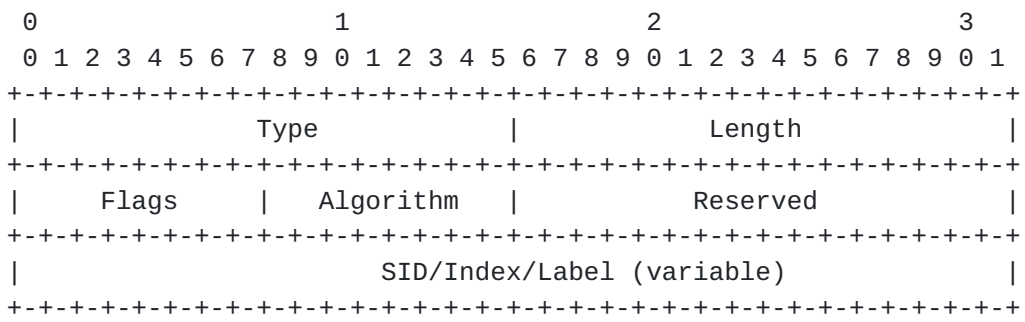
### 2.3.1. Prefix-SID TLV

The Prefix-SID TLV can ONLY be added to the Prefix Attribute whose local node in the corresponding Prefix NLRI is the node that originates the corresponding SR TLV.

The Prefix-SID TLV is used in order to advertise a Prefix-SID as originated in:

- IS-IS, as defined by the Prefix-SID TLV in [I-D.ietf-isis-segment-routing-extensions].
- OSPF/OSPFv3, as defined by the Prefix-SID TLV in [I-D.ietf-ospf-segment-routing-extensions] and [I-D.ietf-ospf-ospfv3-segment-routing-extensions].

The Prefix-SID has the following format:




where:

Type: TBD, suggested value 1158.

Length: Variable

Algorithm: 1 octet value identify the algorithm.

SID/Index/Label:

* IS-IS: Label or index value as defined in [I-D.ietf-isis-segment-routing-extensions],
* OSPF: Label or index value as defined in [I-D.ietf-ospf-segment-routing-extensions],
* OSPFv3: Label or index value as defined in [I-D.ietf-ospf-ospfv3-segment-routing-extensions],

The Prefix-SID TLV includes a Flags field. In the context of BGP-LS, the Flags field format and the semantic of each individual flag MUST be taken from the corresponding source protocol (i.e.: the protocol of origin of the Prefix-SID being advertised in BGP-LS).

IS-IS Prefix-SID flags are defined in [I-D.ietf-isis-segment-routing-extensions] section 2.1.

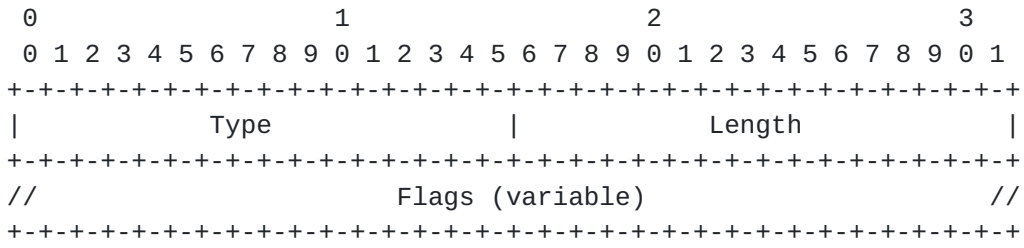
OSPF Prefix-SID flags are defined in [I-D.ietf-ospf-segment-routing-extensions] section 5.

OSPFv3 Prefix-SID flags are defined in [I-D.ietf-ospf-segment-routing-extensions] section 5.

### 2.3.2. IGP Prefix Attributes TLV

The IGP Prefix Attribute TLV carries IPv4/IPv6 prefix attribute flags as defined in [RFC7684] and [RFC7794].

The IGP Prefix Attribute TLV has the following format:




where:

Type: TBD, suggested value 1170.

Length: variable.

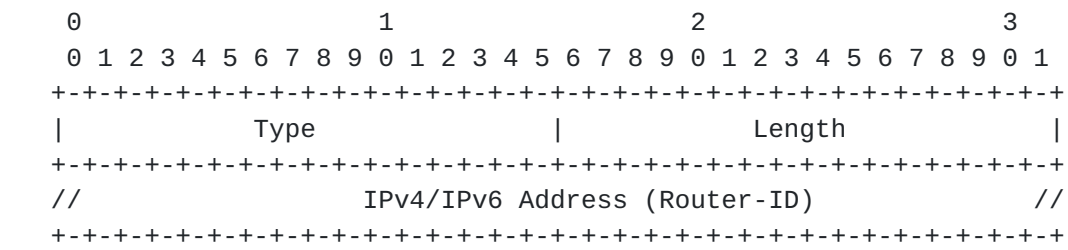
Flags: a variable length flag field (according to the length field). Flags are routing protocol specific (OSPF and IS-IS). OSPF flags are defined in [RFC7684] and IS-IS flags are defined in [RFC7794]. The receiver of the BGP-LS update, when inspecting the IGP Prefix Attribute TLV, MUST check the Protocol-ID of the NLRI and refer to the protocol specification in order to parse the flags.

### 2.3.3. Source Router Identifier (Source Router-ID) TLV

The Source Router-ID TLV contains the IPv4 or IPv6 Router-ID of the originator as defined in [RFC7794]. While defined in the IS-IS

protocol, the Source Router-ID TLV may be used to carry the OSPF Router-ID of the prefix originator.

The Source Router-ID TLV has the following format:




where:

Type: TBD, suggested value 1171.

Length: 4 or 16.

IPv4/IPv6 Address: 4 octet IPv4 address or 16 octet IPv6 address.

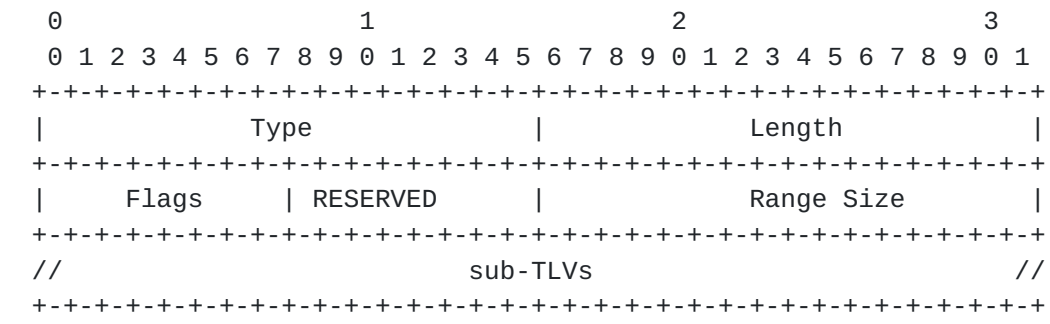
The semantic of the Source Router-ID TLV is defined in [RFC7794].

### 2.3.4. Range TLV

The Range TLV can ONLY be added to the Prefix Attribute whose local node in the corresponding Prefix NLRI is the node that originates the corresponding SR TLV.

When the range TLV is used in order to advertise a range of prefix-to-SID mappings as defined in [I-D.ietf-ospf-segment-routing-extensions], [I-D.ietf-ospf-ospfv3-segment-routing-extensions]and [I-D.ietf-isis-segment-routing-extensions]. The Prefix-NLRI the Range TLV is attached to MUST be advertised as a non-routing prefix where no IGP metric TLV (TLV 1095) is attached.

The format of the Range TLV is as follows:




where:

Figure 2: Range TLV format

Type: 1159

Length is 4.

Flags: as defined in [I-D.ietf-ospf-segment-routing-extensions], [I-D.ietf-ospf-ospfv3-segment-routing-extensions] and [I-D.ietf-isis-segment-routing-extensions].

Range Size: 2 octets as defined in [I-D.ietf-ospf-segment-routing-extensions].

Within the Range TLV, the Prefix-SID TLV (used as sub-TLV in this context) MAY be present.

## 2.4. Equivalent IS-IS Segment Routing TLVs/Sub-TLVs

This section illustrate the IS-IS Segment Routing Extensions TLVs and sub-TLVs mapped to the ones defined in this document.

The following table, illustrates for each BGP-LS TLV, its equivalence in IS-IS.

| TLV Code Point | Description | Length | IS-IS TLV /sub-TLV |
|---|---|---|---|
| 1034 | SR Capabilities | variable | 2 [1] |
| 1035 | SR Algorithm | variable | 19 [2] |
| 1099 | Adjacency Segment Identifier (Adj-SID) TLV | variable | 31 [3] |
| 1100 | LAN Adjacency Segment Identifier (LAN-Adj-SID) TLV | variable | 32 [4] |
| 1158 | Prefix SID | variable | 3 [5] |
| 1161 | SID/Label TLV | variable | 1 [6] |
| 1170 | IGP Prefix Attributes | variable | 4 [7] |
| 1171 | Source Router ID | variable | 11/12 [8] |
| 1172 | L2 Bundle Member TLV | variable | 25 [9] |

Table 5: IS-IS Segment Routing Extensions TLVs/Sub-TLVs

## 2.5. Equivalent OSPF/OSPFv3 Segment Routing TLVs/Sub-TLVs

This section illustrate the OSPF and OSPFv3 Segment Routing Extensions TLVs and sub-TLVs mapped to the ones defined in this document.

The following table, illustrates for each BGP-LS TLV, its equivalence in OSPF and OSPFv3.

| TLV Code Point | Description | Length | OSPF TLV /sub-TLV |
|---|---|---|---|
| 1034 | SR Capabilities | variable | 9 [10] |
| 1035 | SR Algorithm | variable | 8 [11] |
| 1099 | Adjacency Segment Identifier (Adj-SID) TLV | variable | 2 [12] |
| 1100 | LAN Adjacency Segment Identifier (Adj-SID) TLV | variable | 3 [13] |
| 1158 | Prefix SID | variable | 2 [14] |
| 1161 | SID/Label TLV | variable | 1 [15] |

Table 6: OSPF Segment Routing Extensions TLVs/Sub-TLVs

| TLV Code Point | Description | Length | OSPFv3 TLV /sub-TLV |
|---|---|---|---|
| 1034 | SR Capabilities | variable | 9 [16] |
| 1035 | SR Algorithm | variable | 8 [17] |
| 1099 | Adjacency Segment Identifier (Adj-SID) TLV | variable | 5 [18] |
| 1100 | LAN Adjacency Segment Identifier (Adj-SID) TLV | variable | 6 [19] |
| 1158 | Prefix SID | variable | 4 [20] |
| 1161 | SID/Label TLV | variable | 3 [21] |

Table 7: OSPFv3 Segment Routing Extensions TLVs/Sub-TLVs

## 3. Procedures

The following sections describe the different operations for the propagation of SR TLVs into BGP-LS.

### 3.1. Advertisement of a IS-IS Prefix SID TLV

The advertisement of a IS-IS Prefix SID TLV has following rules:

The IS-IS Prefix-SID is encoded in the BGP-LS Prefix Attribute Prefix-SID as defined in Section 2.3.1. The flags in the Prefix-SID TLV have the semantic defined in [I-D.ietf-isis-segment-routing-extensions] section 2.1.

### 3.2. Advertisement of a OSPF/OSPFv3 Prefix-SID TLV

The advertisement of a OSPF/OSPFv3 Prefix-SID TLV has following rules:

The OSPF (or OSPFv3) Prefix-SID is encoded in the BGP-LS Prefix Attribute Prefix-SID as defined in Section 2.3.1. The flags in the Prefix-SID TLV have the semantic defined in [I-D.ietf-ospf-segment-routing-extensions] section 5 or [I-D.ietf-ospf-ospfv3-segment-routing-extensions] section 5.

### 3.3. Advertisement of a range of prefix-to-SID mappings in OSPF

The advertisement of a range of prefix-to-SID mappings in OSPF has following rules:

The OSPF/OSPFv3 Extended Prefix Range TLV is encoded in the BGP-LS Prefix Attribute Range TLV as defined in Section 2.3.4. The flags

of the Range TLV have the semantic mapped to the definition in [I-D.ietf-ospf-segment-routing-extensions] section 4 or [I-D.ietf-ospf-ospfv3-segment-routing-extensions] section 4. The Prefix-SID from the original OSPF Prefix SID sub-TLV is encoded using the BGP-LS Prefix Attribute Prefix-SID as defined in Section 2.3.1 with the flags set according to the definition in [I-D.ietf-ospf-segment-routing-extensions] section 5 or [I-D.ietf-ospf-ospfv3-segment-routing-extensions] section 5.

### 3.4. Advertisement of a range of IS-IS SR bindings

The advertisement of a range of IS-IS Mapping Server bindings ([I-D.ietf-isis-segment-routing-extensions]) is encoded using the following TLV/sub-TLV structure:

Range TLV
   Prefix-SID TLV (used as a sub-TLV in this context)

where:

- The Range TLV is defined in Section 2.3.4.
- The Prefix-SID TLV (used as sub-TLV in this context) is defined in Section 2.3.1.

## 4. Implementation Status

Note to RFC Editor: Please remove this section prior to publication, as well as the reference to RFC 7942.

This section records the status of known implementations of the protocol defined by this specification at the time of posting of this Internet-Draft, and is based on a proposal described in [RFC7942]. The description of implementations in this section is intended to assist the IETF in its decision processes in progressing drafts to RFCs. Please note that the listing of any individual implementation here does not imply endorsement by the IETF. Furthermore, no effort has been spent to verify the information presented here that was supplied by IETF contributors. This is not intended as, and must not be construed to be, a catalog of available implementations or their features. Readers are advised to note that other implementations may exist.

According to [RFC7942], "this will allow reviewers and working groups to assign due consideration to documents that have the benefit of running code, which may serve as evidence of valuable experimentation and feedback that have made the implemented protocols more mature.

It is up to the individual working groups to use this information as they see fit".

Several early implementations exist and will be reported in detail in a forthcoming version of this document. For purposes of early interoperability testing, when no FCFS code point was available, implementations have made use of the values described in Table 8.

It will ease implementation interoperability and deployment if the value could be preserved also due to the large amount of codepoints this draft requires. However, when IANA-assigned values are available, implementations will be updated to use them.

## 5. IANA Considerations

This document requests assigning code-points from the registry for BGP-LS attribute TLVs based on table Table 8.

### 5.1. TLV/Sub-TLV Code Points Summary

This section contains the global table of all TLVs/sub-TLVs defined in this document.

| TLV Code Point | Description | Length | Section |
|---|---|---|---|
| 1034 | SR Capabilities | variable | Section 2.1.2 |
| 1035 | SR Algorithm | variable | Section 2.1.3 |
| 1036 | SR Local Block | variable | Section 2.1.4 |
| 1037 | SRMS Preference | variable | Section 2.1.5 |
| 1099 | Adjacency Segment Identifier (Adj-SID) TLV | variable | Section 2.2.1 |
| 1100 | LAN Adjacency Segment Identifier (Adj-SID) TLV | variable | Section 2.2.2 |
| 1158 | Prefix SID | variable | Section 2.3.1 |
| 1159 | Range | variable | Section 2.3.4 |
| 1161 | SID/Label TLV | variable | Section 2.1.1 |
| 1170 | IGP Prefix Attributes | variable | Section 2.3.2 |
| 1171 | Source Router-ID | variable | Section 2.3.3 |
| 1172 | L2 Bundle Member TLV | variable | Section 2.2.3 |

Table 8: Summary Table of TLV/Sub-TLV Codepoints

## 6. Manageability Considerations

This section is structured as recommended in [RFC5706].

### 6.1. Operational Considerations

#### 6.1.1. Operations

Existing BGP and BGP-LS operational procedures apply. No additional operation procedures are defined in this document.

## 7. Security Considerations

Procedures and protocol extensions defined in this document do not affect the BGP security model. See the 'Security Considerations' section of [RFC4271] for a discussion of BGP security. Also refer to [RFC4272] and [RFC6952] for analysis of security issues for BGP.

## 8. Contributors

The following people have substantially contributed to the editing of this document:

Les Ginsberg
Cisco Systems
Email: ginsberg@cisco.com

Acee Lindem
Cisco Systems
Email: acee@cisco.com

Saikat Ray
Individual
Email: raysaikat@gmail.com

Jeff Tantsura
Individual
Email: jefftant@gmail.com

## 9. Acknowledgements

The authors would like to thank Ketan Jivan Talaulikar for his review of this document.

## 10. References

### 10.1. Normative References

[I-D.ietf-idr-te-pm-bgp]
Previdi, S., Wu, Q., Gredler, H., Ray, S., jefftant@gmail.com, j., Filsfils, C., and L. Ginsberg, "BGP-LS Advertisement of IGP Traffic Engineering Performance Metric Extensions", draft-ietf-idr-te-pm-bgp-05 (work in progress), April 2017.

[I-D.ietf-isis-segment-routing-extensions]
Previdi, S., Filsfils, C., Bashandy, A., Gredler, H., Litkowski, S., Decraene, B., and j. jefftant@gmail.com, "IS-IS Extensions for Segment Routing", draft-ietf-isis-segment-routing-extensions-13 (work in progress), June 2017.

[I-D.ietf-ospf-ospfv3-segment-routing-extensions]
Psenak, P., Previdi, S., Filsfils, C., Gredler, H., Shakir, R., Henderickx, W., and J. Tantsura, "OSPFv3 Extensions for Segment Routing", draft-ietf-ospf-ospfv3-segment-routing-extensions-09 (work in progress), March 2017.

[I-D.ietf-ospf-segment-routing-extensions]
Psenak, P., Previdi, S., Filsfils, C., Gredler, H., Shakir, R., Henderickx, W., and J. Tantsura, "OSPF Extensions for Segment Routing", draft-ietf-ospf-segment-routing-extensions-17 (work in progress), June 2017.

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

[RFC4202] Kompella, K., Ed. and Y. Rekhter, Ed., "Routing Extensions in Support of Generalized Multi-Protocol Label Switching (GMPLS)", RFC 4202, DOI 10.17487/RFC4202, October 2005, <http://www.rfc-editor.org/info/rfc4202>.

[RFC4271] Rekhter, Y., Ed., Li, T., Ed., and S. Hares, Ed., "A Border Gateway Protocol 4 (BGP-4)", RFC 4271, DOI 10.17487/RFC4271, January 2006, <http://www.rfc-editor.org/info/rfc4271>.

[RFC7684] Psenak, P., Gredler, H., Shakir, R., Henderickx, W., Tantsura, J., and A. Lindem, "OSPFv2 Prefix/Link Attribute Advertisement", RFC 7684, DOI 10.17487/RFC7684, November 2015, <http://www.rfc-editor.org/info/rfc7684>.

[RFC7752] Gredler, H., Ed., Medved, J., Previdi, S., Farrel, A., and S. Ray, "North-Bound Distribution of Link-State and Traffic Engineering (TE) Information Using BGP", RFC 7752, DOI 10.17487/RFC7752, March 2016, <http://www.rfc-editor.org/info/rfc7752>.

[RFC7794] Ginsberg, L., Ed., Decraene, B., Previdi, S., Xu, X., and U. Chunduri, "IS-IS Prefix Attributes for Extended IPv4 and IPv6 Reachability", RFC 7794, DOI 10.17487/RFC7794, March 2016, <http://www.rfc-editor.org/info/rfc7794>.

## 10.2. Informative References

[I-D.ietf-spring-segment-routing]
Filsfils, C., Previdi, S., Decraene, B., Litkowski, S., and R. Shakir, "Segment Routing Architecture", draft-ietf-spring-segment-routing-12 (work in progress), June 2017.

[RFC4272] Murphy, S., "BGP Security Vulnerabilities Analysis", RFC 4272, DOI 10.17487/RFC4272, January 2006, <http://www.rfc-editor.org/info/rfc4272>.

[RFC5706] Harrington, D., "Guidelines for Considering Operations and Management of New Protocols and Protocol Extensions", RFC 5706, DOI 10.17487/RFC5706, November 2009, <http://www.rfc-editor.org/info/rfc5706>.

[RFC6952] Jethanandani, M., Patel, K., and L. Zheng, "Analysis of BGP, LDP, PCEP, and MSDP Issues According to the Keying and Authentication for Routing Protocols (KARP) Design Guide", RFC 6952, DOI 10.17487/RFC6952, May 2013, <http://www.rfc-editor.org/info/rfc6952>.

[RFC7942] Sheffer, Y. and A. Farrel, "Improving Awareness of Running Code: The Implementation Status Section", BCP 205, RFC 7942, DOI 10.17487/RFC7942, July 2016, <http://www.rfc-editor.org/info/rfc7942>.

## 10.3. URIs

[1] http://tools.ietf.org/html/draft-ietf-isis-segment-routing-extensions-05#section-3.1

[2] http://tools.ietf.org/html/draft-ietf-isis-segment-routing-extensions-05#section-3.2

[3] http://tools.ietf.org/html/draft-ietf-isis-segment-routing-extensions-05#section-2.2.1

[4] http://tools.ietf.org/html/draft-ietf-isis-segment-routing-extensions-05#section-2.2.2

[5] http://tools.ietf.org/html/draft-ietf-isis-segment-routing-extensions-05#section-2.1

[6] http://tools.ietf.org/html/draft-ietf-isis-segment-routing-extensions-05#section-2.3

[7] http://tools.ietf.org/html/RFC7794

[8] http://tools.ietf.org/html/RFC7794

[9] http://tools.ietf.org/html/draft-ietf-isis-l2bundles-05

[10] http://tools.ietf.org/html/draft-ietf-ospf-segment-routing-extensions-05#section-3.2

[11] http://tools.ietf.org/html/draft-ietf-ospf-segment-routing-extensions-05#section-3.1

[12] http://tools.ietf.org/html/draft-ietf-ospf-segment-routing-extensions-05#section-7.1

[13] http://tools.ietf.org/html/draft-ietf-ospf-segment-routing-extensions-05#section-7.2

[14] http://tools.ietf.org/html/draft-ietf-ospf-segment-routing-extensions-05#section-5

[15] http://tools.ietf.org/html/draft-ietf-ospf-segment-routing-extensions-05#section-2.1

[16] http://tools.ietf.org/html/draft-ietf-ospf-ospfv3-segment-routing-extensions-05#section-3.2

[17] http://tools.ietf.org/html/draft-ietf-ospf-ospfv3-segment-routing-extensions-05#section-3.1

[18] http://tools.ietf.org/html/draft-ietf-ospf-ospfv3-segment-routing-extensions-05#section-7.1

[19] http://tools.ietf.org/html/draft-ietf-ospf-ospfv3-segment-routing-extensions-05#section-7.2

[20] http://tools.ietf.org/html/draft-ietf-ospf-ospfv3-segment-routing-extensions-05#section-5

[21] http://tools.ietf.org/html/draft-ietf-ospf-ospfv3-segment-routing-extensions-05#section-2.1

## Authors' Addresses

Stefano Previdi (editor)
Cisco Systems, Inc.
Via Del Serafico, 200
Rome  00142
Italy

Email: stefano@previdi.net

Peter Psenak
Cisco Systems, Inc.
Apollo Business Center
Mlynske nivy 43
Bratislava  821 09
Slovakia

Email: ppsenak@cisco.com

Clarence Filsfils
Cisco Systems, Inc.
Brussels
Belgium

Email: cfilsfil@cisco.com

Hannes Gredler
RtBrick Inc.

Email: hannes@rtbrick.com

Mach(Guoyi) Chen
Huawei Technologies
Huawei Building, No. 156 Beiqing Rd.
Beijing  100095
China

Email: mach.chen@huawei.com