Open Shortest Path First IGP
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OSPFv3 Extensions for Segment Routing
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Abstract

Segment Routing (SR) allows 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 and OSPF).

This draft describes the OSPFv3 extensions required for Segment Routing with MPLS data plane.

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 BCP14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

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1. Introduction

Segment Routing (SR) allows 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 and OSPF). Prefix segments represent an ECMP-aware shortest-path to a prefix (or a node), 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 cases, is a one-hop path. SR's control-plane can be applied to both IPv6 and MPLS data-planes, and does not require any additional signalling (other than IGP extensions). The IPv6 data plane is out of the scope of this specification - OSPFv3 extension for SR with IPv6 data plane will be specified in a separate document. When used in MPLS networks, SR paths do not require any LDP or RSVP-TE signalling. However, SR can interoperate in the presence of LSPs established with RSVP or LDP.

This draft describes the OSPFv3 extensions required for Segment Routing with MPLS data plane.

Segment Routing architecture is described in [RFC8402].

Segment Routing use cases are described in [RFC7855].

2. Terminology

This section lists some of the terminology used in this document:

ABR - Area Border Router

Adj-SID - Adjacency Segment Identifier

AS - Autonomous System

ASBR - Autonomous System Boundary Router

DR - Designated Router

IS-IS - Intermediate System to Intermediate System

LDP - Label Distribution Protocol

LSP - Label Switched Path

MPLS - Multi Protocol Label Switching

OSPF - Open Shortest Path First

SPF - Shortest Path First

RSVP - Resource Reservation Protocol

SID - Segment Identifier

SR - Segment Routing

SRGB - Segment Routing Global Block

SRLB - Segment Routing Local Block

SRMS - Segment Routing Mapping Server

TLV - Type Length Value

3. Segment Routing Identifiers

Segment Routing defines various types of Segment Identifiers (SIDs): Prefix-SID, Adjacency-SID, and LAN Adjacency SID.

3.1. SID/Label Sub-TLV

The SID/Label Sub-TLV appears in multiple TLVs or Sub-TLVs defined later in this document. It is used to advertise the SID or label associated with a prefix or adjacency. The SID/Label Sub-TLV has 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           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      SID/Label (variable)                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

where:

Type: 7

Length: Either 3 or 4 octets

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 than 3 or 4.

4. Segment Routing Capabilities

Segment Routing requires some additional router capabilities to be advertised to other routers in the area.

These SR capabilities are advertised in the OSPFv3 Router Information Opaque LSA (defined in [RFC7770]) and specified in [I-D.ietf-ospf-segment-routing-extensions].

5. OSPFv3 Extended Prefix Range TLV

In some cases it is useful to advertise attributes for a range of prefixes in a single advertisement. The Segment Routing Mapping Server, which is described in [I-D.ietf-spring-segment-routing-ldp-interop], is an example of where SIDs for multiple prefixes can be advertised. To optimize such advertisement in case of multiple prefixes from a contiguous address range, OSPFv3 Extended Prefix Range TLV is defined."

The OSPFv3 Extended Prefix Range TLV is a top-level TLV of the following LSAs defined in [RFC8362]:

E-Intra-Area-Prefix-LSA

E-Inter-Area-Prefix-LSA

E-AS-External-LSA

E-Type-7-LSA

Multiple OSPFv3 Extended Prefix Range TLVs MAY be advertised in each LSA mentioned above. The OSPFv3 Extended Prefix Range 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            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Prefix Length |       AF      |         Range Size            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Flags      |                 Reserved                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Address Prefix (variable)                 |
|                            ...                                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Sub-TLVs (variable)                      |
+-                                                             -+
|                                                               |
```

where:

Type: 9

Length: Variable, in octets, dependent on Sub-TLVs.

Prefix length: Length of prefix in bits.

AF: Address family for the prefix.

AF: 0 - IPv4 unicast

AF: 1 - IPv6 unicast

Range size: Represents the number of prefixes that are covered by the advertisement. The Range Size MUST NOT exceed the number of prefixes that could be satisfied by the prefix length without including:

Addresses from the IPv4 multicast address range (224.0.0.0/3), if the AF is IPv4 unicast

Addresses other than the IPv6 unicast addresses, if the AF is IPv6 unicast

Flags: Reserved. MUST be zero when sent and are ignored when received.

Reserved: SHOULD be set to 0 on transmission and MUST be ignored on reception.

Address Prefix:

For the address family IPv4 unicast, the prefix itself is encoded as a 32-bit value. The default route is represented by a prefix of length 0.

For the address family IPv6 unicast, the prefix, encoded as an even multiple of 32-bit words, padded with zeroed bits as necessary. This encoding consumes ((PrefixLength + 31) / 32) 32-bit words.

Prefix encoding for other address families is beyond the scope of this specification.

The range represents the contiguous set of prefixes with the same prefix length as specified by the Prefix Length field. The set starts with the prefix that is specified by the Address Prefix field. The number of prefixes in the range is equal to the Range size.

If the OSPFv3 Extended Prefix Range TLVs advertising the exact same range appears in multiple LSAs of the same type, originated by the same OSPFv3 router, the LSA with the numerically smallest Instance ID MUST be used and subsequent instances of the OSPFv3 Extended Prefix Range TLVs MUST be ignored.

6. Prefix SID Sub-TLV

The Prefix SID Sub-TLV is a Sub-TLV of the following OSPFv3 TLVs as defined in [RFC8362] and in Section 5:

Intra-Area Prefix TLV

Inter-Area Prefix TLV

External Prefix TLV

OSPFv3 Extended Prefix Range TLV

It MAY appear more than once in the parent TLV and 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    |             Reserved          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       SID/Index/Label (variable)              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

where:

Type: 4

Length: 7 or 8 octets, dependent on the V-flag

Flags: Single octet field. The following flags are defined:

```
  0  1  2  3  4  5  6  7
+--+--+--+--+--+--+--+--+
|  |NP|M |E |V |L |  |  |
+--+--+--+--+--+--+--+--+
```

where:

NP-Flag: No-PHP flag. If set, then the penultimate hop MUST NOT pop the Prefix-SID before delivering packets to the node that advertised the Prefix-SID.

M-Flag: Mapping Server Flag. If set, the SID was advertised by a Segment Routing Mapping Server as described in [I-D.ietf-spring-segment-routing-ldp-interop].

E-Flag: Explicit-Null Flag. If set, any upstream neighbor of the Prefix-SID originator MUST replace the Prefix-SID with the Explicit-NULL label (0 for IPv4, 2 for IPv6) before forwarding the packet.

V-Flag: Value/Index Flag. If set, then the Prefix-SID carries an absolute value. If not set, then the Prefix-SID carries an index.

L-Flag: Local/Global Flag. If set, then the value/index carried by the Prefix-SID has local significance. If not set, then the value/index carried by this Sub-TLV has global significance.

Other bits: Reserved. These MUST be zero when sent and are ignored when received.

Reserved: SHOULD be set to 0 on transmission and MUST be ignored on reception.

Algorithm: Single octet identifying the algorithm the Prefix-SID is associated with as defined in [I-D.ietf-ospf-segment-routing-extensions].

A router receiving a Prefix-SID from a remote node and with an algorithm value that such remote node has not advertised in the SR-Algorithm Sub-TLV [I-D.ietf-ospf-segment-routing-extensions] MUST ignore the Prefix-SID Sub-TLV.

SID/Index/Label: According to the V-Flag and L-Flag, it contains:

V-flag is set to 0 and L-flag is set to 0: The SID/Index/Label field is a 4 octet index defining the offset in the SID/Label space advertised by this router

V-flag is set to 1 and L-flag is set to 1: The SID/Index/Label field is a 3 octet local label where the 20 rightmost bits are used for encoding the label value.

All other combinations of V-flag and L-flag are invalid and any SID advertisement received with an invalid setting for V and L flags MUST be ignored.

If an OSPFv3 router advertises multiple Prefix-SIDs for the same prefix, topology, and algorithm, all of them MUST be ignored.

When calculating the outgoing label for the prefix, the router MUST take into account, as described below, the E, NP, and M flags advertised by the next-hop router if that router advertised the SID for the prefix. This MUST be done regardless of whether the next-hop router contributes to the best path to the prefix.

The NP-Flag (No-PHP) MUST be set and the E-flag MUST be clear for Prefix-SIDs allocated to prefixes that are propagated between areas by an ABR based on intra-area or inter-area reachability, unless the advertised prefix is directly attached to such ABR.

The NP-Flag (No-PHP) MUST be set and the E-flag MUST be clear for Prefix-SIDs allocated to redistributed prefixes, unless the redistributed prefix is directly attached to the advertising ASBR.

If the NP-Flag is not set, then any upstream neighbor of the Prefix-SID originator MUST pop the Prefix-SID. This is equivalent to the penultimate hop popping mechanism used in the MPLS dataplane. If the NP-flag is not set, then the received E-flag is ignored.

If the NP-flag is set then:

If the E-flag is not set, then any upstream neighbor of the Prefix-SID originator MUST keep the Prefix-SID on top of the stack. This is useful when the originator of the Prefix-SID needs to stitch the incoming packet into a continuing MPLS LSP to the final destination. This could occur at an ABR (prefix propagation from one area to another) or at an ASBR (prefix propagation from one domain to another).

If the E-flag is set, then any upstream neighbor of the Prefix-SID originator MUST replace the Prefix-SID with an Explicit-NULL label. This is useful, e.g., when the originator of the Prefix-SID is the final destination for the related prefix and the originator wishes to receive the packet with the original Traffic Class field [RFC5462].

When the M-Flag is set, the NP-flag and the E-flag MUST be ignored on reception.

As the Mapping Server does not specify the originator of a prefix advertisement, it is not possible to determine PHP behavior solely based on the Mapping Server advertisement. However, PHP behavior SHOULD be done in following cases:

The Prefix is intra-area type and the downstream neighbor is the originator of the prefix.

The Prefix is inter-area type and the downstream neighbor is an ABR, which is advertising prefix reachability and is setting the LA-bit in the Prefix Options as described in [RFC8362].

The Prefix is external type and the downstream neighbor is an ASBR, which is advertising prefix reachability and is setting the LA-bit in the Prefix Options as described in [RFC8362].

When a Prefix-SID is advertised in the OSPFv3 Extended Prefix Range TLV, then the value advertised in the Prefix SID Sub-TLV is interpreted as a starting SID/Label value.

Example 1: If the following router addresses (loopback addresses) need to be mapped into the corresponding Prefix SID indexes:

```
Router-A: 2001:DB8::1/128, Prefix-SID: Index 1
Router-B: 2001:DB8::2/128, Prefix-SID: Index 2
Router-C: 2001:DB8::3/128, Prefix-SID: Index 3
Router-D: 2001:DB8::4/128, Prefix-SID: Index 4
```

then the Address Prefix field in the OSPFv3 Extended Prefix Range TLV would be set to 2001:DB8::1, the Prefix Length would be set to 128, the Range Size would be set to 4, and the Index value in the Prefix-SID Sub-TLV would be set to 1.

Example 2: If the following prefixes need to be mapped into the corresponding Prefix-SID indexes:

```
2001:DB8:1::0/120,   Prefix-SID: Index 51
2001:DB8:1::100/120, Prefix-SID: Index 52
2001:DB8:1::200/120, Prefix-SID: Index 53
2001:DB8:1::300/120, Prefix-SID: Index 54
2001:DB8:1::400/120, Prefix-SID: Index 55
2001:DB8:1::500/120, Prefix-SID: Index 56
2001:DB8:1::600/120, Prefix-SID: Index 57
```

then the Prefix field in the OSPFv3 Extended Prefix Range TLV would be set to 2001:DB8:1::0, the Prefix Length would be set to 120, the Range Size would be set to 7, and the Index value in the Prefix-SID Sub-TLV would be set to 51.

7. Adjacency Segment Identifier (Adj-SID)

An Adjacency Segment Identifier (Adj-SID) represents a router adjacency in Segment Routing.

7.1. Adj-SID Sub-TLV

The Adj-SID Sub-TLV is an optional Sub-TLV of the Router-Link TLV as defined in [RFC8362]. It MAY appear multiple times in the Router-Link TLV. The Adj-SID 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         |     Weight    |             Reserved          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   SID/Label/Index (variable)                  |
+---------------------------------------------------------------+
```

where:

Type: 5

Length: 7 or 8 octets, dependent on the V flag.

Flags: Single octet field containing the following flags:

```
 0 1 2 3 4 5 6 7
+-+-+-+-+-+-+-+-+
|B|V|L|G|P|     |
+-+-+-+-+-+-+-+-+
```

where:

B-Flag: Backup Flag. If set, the Adj-SID refers to an adjacency that is eligible for protection (e.g., using IPFRR or MPLS-FRR) as described in section 3.5 of [RFC8402].

The V-Flag: Value/Index Flag. If set, then the Adj-SID carries an absolute value. If not set, then the Adj-SID carries an index.

The L-Flag: Local/Global Flag. If set, then the value/index carried by the Adj-SID has local significance. If not set, then the value/index carried by this Sub-TLV has global significance.

The G-Flag: Group Flag. When set, the G-Flag indicates that the Adj-SID refers to a group of adjacencies (and therefore MAY be assigned to other adjacencies as well).

P-Flag. Persistent flag. When set, the P-Flag indicates that the Adj-SID is persistently allocated, i.e., the Adj-SID value remains the same across router restart and/or interface flap.

Other bits: Reserved. These MUST be zero when sent and are ignored when received.

Reserved: SHOULD be set to 0 on transmission and MUST be ignored on reception.

Weight: Weight used for load-balancing purposes. The use of the weight is defined in [RFC8402].

SID/Index/Label: as described in Section 6.

An SR-capable router MAY allocate an Adj-SID for each of its adjacencies and set the B-Flag when the adjacency is eligible for protection by an FRR mechanism (IP or MPLS) as described in [RFC8402].

An SR-capable router MAY allocate more than one Adj-SID to an adjacency.

An SR-capable router MAY allocate the same Adj-SID to different adjacencies.

When the P-flag is not set, the Adj-SID MAY be persistent. When the P-flag is set, the Adj-SID MUST be persistent.

7.2. LAN Adj-SID Sub-TLV

The LAN Adj-SID Sub-TLV is an optional Sub-TLV of the Router-Link TLV. It MAY appear multiple times in the Router-Link TLV. It is used to advertise a SID/Label for an adjacency to a non-DR router on a broadcast, NBMA, or hybrid [RFC6845] network.

```
 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     |     Weight    |             Reserved          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           Neighbor ID                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    SID/Label/Index (variable)                 |
+---------------------------------------------------------------+
```

where:

Type: 6

Length: 11 or 12 octets, dependent on V-flag.

Flags: same as in Section 7.1

Weight: Weight used for load-balancing purposes. The use of the weight is defined in [RFC8402].

Reserved: SHOULD be set to 0 on transmission and MUST be ignored on reception.

Neighbor ID: The Router ID of the neighbor for which the LAN-Adj-SID is advertised.

SID/Index/Label: as described in Section 6.

When the P-flag is not set, the LAN Adj-SID MAY be persistent.
When the P-flag is set, the LAN Adj-SID MUST be persistent.

8. Elements of Procedure

8.1. Intra-area Segment routing in OSPFv3

An OSPFv3 router that supports segment routing MAY advertise Prefix-SIDs for any prefix to which it is advertising reachability (e.g., a loopback IP address as described in Section 6).

A Prefix-SID can also be advertised by SR Mapping Servers (as described in [I-D.ietf-spring-segment-routing-ldp-interop]). A Mapping Server advertises Prefix-SIDs for remote prefixes that exist in the OSPFv3 routing domain. Multiple Mapping Servers can advertise Prefix-SIDs for the same prefix, in which case the same Prefix-SID MUST be advertised by all of them. The SR Mapping Server could use either area flooding scope or autonomous system flooding scope when advertising Prefix SIDs for prefixes, based on the configuration of the SR Mapping Server. Depending on the flooding scope used, the SR Mapping Server chooses the OSPFv3 LSA type that will be used. If the area flooding scope is needed, an E-Intra-Area-Prefix-LSA [RFC8362] is used. If autonomous system flooding scope is needed, an E-AS-External-LSA [RFC8362] is used.

When a Prefix-SID is advertised by the Mapping Server, which is indicated by the M-flag in the Prefix-SID Sub-TLV (Section 6), the route type as implied by the LSA type is ignored and the Prefix-SID is bound to the corresponding prefix independent of the route type.

Advertisement of the Prefix-SID by the Mapping Server using an Inter-Area Prefix TLV, External-Prefix TLV, or Intra-Area-Prefix TLV [RFC8362] does not itself contribute to the prefix reachability. The NU-bit [RFC5340] MUST be set in the PrefixOptions field of the LSA which is used by the Mapping Server to advertise SID or SID Range, which prevents the advertisement from contributing to prefix reachability.

An SR Mapping Server MUST use the OSPFv3 Extended Prefix Range TLVs when advertising SIDs for prefixes. Prefixes of different route-types can be combined in a single OSPFv3 Extended Prefix Range TLV advertised by an SR Mapping Server.

Area-scoped OSPFv3 Extended Prefix Range TLVs are propagated between areas, similar to propagation of prefixes between areas. Same rules that are used for propagating prefixes between areas [RFC5340] are used for the propagation of the prefix ranges.

8.2. Inter-area Segment routing in OSPFv3

In order to support SR in a multi-area environment, OSPFv3 MUST propagate Prefix-SID information between areas. The following procedure is used to propagate Prefix SIDs between areas.

When an OSPFv3 ABR advertises an Inter-Area-Prefix-LSA from an intra-area prefix to all its connected areas, it will also include the Prefix-SID Sub-TLV, as described in Section 6. The Prefix-SID value will be set as follows:

The ABR will look at its best path to the prefix in the source area and find the advertising router associated with the best path to that prefix.

The ABR will then determine if such router advertised a Prefix-SID for the prefix and use it when advertising the Prefix-SID to other connected areas.

If no Prefix-SID was advertised for the prefix in the source area by the router that contributes to the best path to the prefix, the originating ABR will use the Prefix-SID advertised by any other router when propagating the Prefix-SID for the prefix to other areas.

When an OSPFv3 ABR advertises Inter-Area-Prefix-LSA LSAs from an inter-area route to all its connected areas, it will also include the Prefix-SID Sub-TLV, as described in Section 6. The Prefix-SID value will be set as follows:

The ABR will look at its best path to the prefix in the backbone area and find the advertising router associated with the best path to that prefix.

The ABR will then determine if such router advertised a Prefix-SID for the prefix and use it when advertising the Prefix-SID to other connected areas.

If no Prefix-SID was advertised for the prefix in the backbone area by the ABR that contributes to the best path to the prefix, the originating ABR will use the Prefix-SID advertised by any other router when propagating the Prefix-SID for the prefix to other areas.

8.3. Segment Routing for External Prefixes

AS-External-LSAs are flooded domain wide. When an ASBR, which supports SR, originates an E-AS-External-LSA, it SHOULD also include a Prefix-SID Sub-TLV, as described in Section 6. The Prefix-SID value will be set to the SID that has been reserved for that prefix.

When an NSSA [RFC3101] ABR translates an E-NSSA-LSA into an E-AS-External-LSA, it SHOULD also advertise the Prefix-SID for the prefix. The NSSA ABR determines its best path to the prefix advertised in the translated E-NSSA-LSA and finds the advertising router associated with that path. If the advertising router has advertised a Prefix-SID for the prefix, then the NSSA ABR uses it when advertising the Prefix-SID for the E-AS-External-LSA. Otherwise, the Prefix-SID advertised by any other router will be used.

8.4. Advertisement of Adj-SID

The Adjacency Segment Routing Identifier (Adj-SID) is advertised using the Adj-SID Sub-TLV as described in Section 7.

8.4.1. Advertisement of Adj-SID on Point-to-Point Links

An Adj-SID MAY be advertised for any adjacency on a P2P link that is in neighbor state 2-Way or higher. If the adjacency on a P2P link transitions from the FULL state, then the Adj-SID for that adjacency MAY be removed from the area. If the adjacency transitions to a state lower than 2-Way, then the Adj-SID advertisement MUST be withdrawn from the area.

8.4.2. Adjacency SID on Broadcast or NBMA Interfaces

Broadcast, NBMA, or hybrid [RFC6845] networks in OSPFv3 are represented by a star topology where the DR is the central point to which all other routers on the broadcast, NBMA, or hybrid network connect. As a result, routers on the broadcast, NBMA, or hybrid network advertise only their adjacency to the DR. Routers that do not act as DR do not form or advertise adjacencies with each other. They do, however, maintain 2-Way adjacency state with each other and are directly reachable.

When Segment Routing is used, each router on the broadcast, NBMA, or hybrid network MAY advertise the Adj-SID for its adjacency to the DR using the Adj-SID Sub-TLV as described in Section 7.1.

SR-capable routers MAY also advertise a LAN-Adj-SID for other neighbors (e.g., BDR, DR-OTHER) on the broadcast, NBMA, or hybrid network using the LAN-Adj-SID Sub-TLV as described in Section 7.2.

9. IANA Considerations

This specification updates several existing OSPFv3 registries.

9.1. OSPFv3 Extended-LSA TLV Registry

Following values are allocated:

o 9 - OSPFv3 Extended Prefix Range TLV

9.2. OSPFv3 Extended-LSA Sub-TLV registry

o 4 - Prefix SID Sub-TLV

o 5 - Adj-SID Sub-TLV

o 6 - LAN Adj-SID Sub-TLV

o 7 - SID/Label Sub-TLV

10. Security Considerations

With the OSPFv3 segment routing extensions defined herein, OSPFv3 will now program the MPLS data plane [RFC3031]. Previously, LDP [RFC5036] or another label distribution mechanism was required to advertise MPLS labels and program the MPLS data plane.

In general, the same types of attacks that can be carried out on the IP control plane can be carried out on the MPLS control plane resulting in traffic being misrouted in the respective data planes. However, the latter can be more difficult to detect and isolate.

Existing security extensions as described in [RFC5340] and [RFC8362] apply to these segment routing extensions. While OSPFv3 is under a single administrative domain, there can be deployments where potential attackers have access to one or more networks in the OSPFv3 routing domain. In these deployments, stronger authentication mechanisms such as those specified in [RFC4552] or [RFC7166] SHOULD be used.

Implementations MUST assure that malformed TLV and Sub-TLV defined in this document are detected and do not provide a vulnerability for attackers to crash the OSPFv3 router or routing process. Reception of a malformed TLV or Sub-TLV SHOULD be counted and/or logged for further analysis. Logging of malformed TLVs and Sub-TLVs SHOULD be rate-limited to prevent a Denial of Service (DoS) attack (distributed or otherwise) from overloading the OSPFv3 control plane.

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12.1. Normative References

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