SRv6 Path Egress Protection
draft-hu-rtgwg-srv6-egress-protection-02

Abstract

This document describes protocol extensions and procedures for
protecting the egress node of a Segment Routing for IPv6 (SRv6) path.

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].

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1. Introduction

Fast protection of a transit node of a Segment Routing (SR) path is described in [I-D.bashandy-rtgwg-segment-routing-ti-lfa] and [I-D.hu-spring-segment-routing-proxy-forwarding]. However, these documents do not discuss the procedures for fast protection of the egress node of a Segment Routing for IPv6 (SRv6) path.

[RFC8400] describes the fast protection of egress node(s) of an MPLS TE LSP tunnel including P2P TE LSP tunnel and P2MP TE LSP tunnel in details.

This document specifies protocol extensions and procedures for fast protection of the egress node of an SRv6 path. Egress node and egress as well as fast protection and protection will be used exchangeably.
2. Terminologies

The following terminologies are used in this document.

SR:  Segment Routing
SRv6:  SR for IPv6
SRH:  Segment Routing Header
SID:  Segment Identifier
LSP:  Label Switched Path
TE:  Traffic Engineering
P2MP:  Point-to-MultiPoint
P2P:  Point-to-Point
CE:  Customer Edge
PE:  Provider Edge
LFA:  Loop-Free Alternate
TI-LFA:  Topology Independent LFA
BFD:  Bidirectional Forwarding Detection
VPN:  Virtual Private Network
L3VPN:  Layer 3 VPN
VRF:  Virtual Routing and Forwarding
FIB:  Forwarding Information Base
PLR:  Point of Local Repair
BGP:  Border Gateway Protocol
IGP:  Interior Gateway Protocol
OSPF:  Open Shortest Path First
IS-IS:  Intermediate System to Intermediate System
3. SR Path Egress Protection

Figure 1 shows an example of protecting egress PE3 of a SR path, which is from ingress PE1 to egress PE3.

![Diagram of SR Path Egress Protection]

Node P1’s pre-computed TI-LFA backup path for PE3 is from P1 to PE4 via P2. In normal operations, after receiving a packet with destination PE3, P1 forwards the packet to PE3 according to its FIB. When PE3 receives the packet, it sends the packet to CE2.

When PE3 fails, P1 detects the failure through BFD and forwards the packet to PE4 via the backup path. When PE4 receives the packet, it sends the packet to the same CE2.

In Figure 1, CE2 is dual home to PE3 and PE4. PE3 has a locator A3:1::/64 and a VPN SID A3:1::B100. PE4 has a locator A4:1::/64 and a VPN SID A4:1::B100. A mirror SID A4:1::3 is configured on PE4 for protecting PE3 with locator A3:1::/64.

After the mirror SID is configured on a local PE (e.g., PE4), when the local PE (e.g., BGP on the local PE) receives a prefix whose VPN SID belongs to a remote PE (e.g., PE3) with the locator that is protected by the local PE through mirror SID, the local PE (e.g., PE4) creates a mapping from the remote PE’s (e.g., PE3’s) VPN SID and the mirror SID to the local PE’s (e.g., PE4’s) VPN SID. The remote PE is protected by the local PE.

For example, local PE4 has Prefix 1.1.1.1 with VPN SID A4:1::B100, when PE4 receives prefix 1.1.1.1 with remote PE3’s VPN SID A3:1::B100, it creates a mapping from remote PE3’s VPN SID and the mirror SID (i.e., "A3:1::B100, A4:1::3") to local PE4’s VPN SID (i.e., "A4:1::B100").
Node P1’s pre-computed TI-LFA backup path for destination PE3 having locator A3:1::/64 is from P1 to PE4 having mirror SID A4:1::3. It is installed as a T.Insert transit behavior. When P1 receives a packet destined to PE3’s VPN SID A3:1::B100, in normal operations, it forwards the packet with source A1:1:: and destination PE3’s VPN SID A3:1::B100 according to the FIB using the destination PE3’s VPN SID A3:1::B100.

When PE3 fails, node P1 protects PE3 through sending the packet to PE4 via the backup path pre-computed. P1 modifies the packet before sending it to PE4. The modified packet has destination PE4 with mirror SID A4:1::3, and SRH with PE3’s VPN SID A3:1::B100 and the mirror SID A4:1::3 (i.e., "A3:1::B100, A4:1::3; SL=1").

When PE4 receives the packet, it forwards the packet to CE2 through executing END.M instruction according to the local VPN SID (i.e., A4:1::B100).

4. Extensions to IGP for Egress Protection

This section describes extensions to IS-IS and OSPF for advertising the information about SRv6 path egress protection.

4.1. Extensions to IS-IS

A new sub-TLV, called IS-IS SRv6 End.m SID sub-TLV, is defined. It is used in the SRv6 Locator TLV defined in [I-D.bashandy-isis-srv6-extensions] to advertise SRv6 Segment Identifiers (SIDs) with END.M function for SRv6 path egress protection. The SRv6 End.m SIDs inherit the topology/algorithm from the parent locator. The format of the sub-TLV is illustrated below.

```
+---------------------------------------------+ +---------------------------------------------+
| Type (TBD1) | Length | Flags | SRv6 Endpoint Function |
+---------------------------------------------+ +---------------------------------------------+
| SID (16 octets) | +---------------------------------------------+ +---------------------------------------------+
| sub-TLVs |
```

Figure 2: IS-IS SRv6 End.m SID sub-TLV
Type: TBD1 (suggested value 8) is to be assigned by IANA.

Length: variable.

Flags: 1 octet. No flags are currently defined.

SRv6 Endpoint Function: 2 octets. Add a new endpoint function 40 for end.m SID.

SID: 16 octets. This field contains the SRv6 end.m SID to be advertised.

Two sub-TLVs are defined. One is the protected locators sub-TLV, and the other is the protected SIDs sub-TLV.

A protected locators sub-TLV is used to carry the Locators to be protected by the SRv6 mirror SID. It has the following format.

```
  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   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Locator-Size  | Locator (variable) |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Locator-Size  | Locator (variable) |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 3: IS-IS Protected Locators sub-TLV

Type: TBD2 (suggested value 1) is to be assigned by IANA.

Length: variable.

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

Locator: 1-16 octets. This field encodes an SRv6 Locator to be protected by the SRv6 mirror SID. The Locator is encoded in the minimal number of octets for the given number of bits.

A protected SIDs sub-TLV is used to carry the SIDs to be protected by the SRv6 mirror SID. It 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 (TBD3)  |    Length     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         SID (16 octets)                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         SID (16 octets)                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

Figure 4: IS-IS Protected SIDs sub-TLV

Type:  TBD3 (suggested value 2) is to be assigned by IANA.

Length:  variable.

SID:  16 octets. This field encodes an SRv6 SID to be advertised.

4.2. Extensions to OSPF

Similarly, a new sub-TLV, called OSPF SRv6 End.m SID sub-TLV, is defined. It is used to advertise SRv6 Segment Identifiers (SIDs) with END.M function for SRv6 path egress protection. Its format 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            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Flags     |    SRv6 Endpoint Function     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         SID (16 octets)                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            sub-TLVs                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

Figure 5: OSPF SRv6 End.m SID sub-TLV

Type:  TBD4 (suggested value 8) is to be assigned by IANA.

Length:  variable.
Flags: 1 octet. No flags are currently defined.

SRv6 Endpoint Function: 2 octets. Add a new endpoint function 40 for end.m SID.

SID: 16 octets. This field contains the SRv6 end.m SID to be advertised.

Two sub-TLVs are defined. One is the protected locators sub-TLV, and the other is the protected SIDs sub-TLV.

A protected locators sub-TLV is used to carry the Locators to be protected by the SRv6 mirror SID. It has the following format.

```
0                   1                   2                   3
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Type (TBD5)           |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Locator-Size  |  Locator (variable)           ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Locator-Size  |  Locator (variable)           ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 6: OSPF Protected Locators sub-TLV

Type: TBD5 (suggested value 1) is to be assigned by IANA.

Length: variable.

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

Locator: 1-16 octets. This field encodes an SRv6 Locator to be protected by the SRv6 mirror SID. The Locator is encoded in the minimal number of octets for the given number of bits.

A protected SIDs sub-TLV is used to carry the SIDs to be protected by the SRv6 mirror SID. It has the following format.
Type: TBD6 (suggested value 2) is to be assigned by IANA.

Length: variable.

SID: 16 octets. This field encodes an SRv6 SID to be advertised.

5. Behavior for SRv6 Mirror SID

The "Endpoint with mirror protection to a vpn SID" function (End.M for short) is a variant of the End function. The End.M is used for SRv6 VPN egress protection. It is described below.

End.M: Mirror protection
When N receives a packet destined to S and S is a local End.M SID, N does:
IF NH=SRH and SL = 1 ;; Ref1
   SL--
   Map to a local VPN SID based on Mirror SID and SRH[SL] ;; Ref1
   forward according to the local VPN SID ;; Ref2
ELSE
   drop the packet

Ref1: An End.M SID must always be the penultimate SID.

Ref2: The rest forwarding behavior is the same as the corresponding VPN sid.

6. Security Considerations

TBD
7. IANA Considerations
TBD

8. Acknowledgements
TBD

9. References

9.1. Normative References

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