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Label Switched Path (LSP) Ping/Traceroute for Segment Routing SIDs with MPLS Data-plane
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Abstract

RFC8402 introduces Segment Routing architecture that leverages source routing and tunneling paradigms and can be directly applied to the Multi Protocol Label Switching (MPLS) data plane. A node steers a packet through a controlled set of instructions called segments, by prepending the packet with Segment Routing header. SR architecture defines different types of segments with different forwarding semantics associated.

RFC8287 defines the extensions to MPLS LSP Ping and Traceroute for Segment Routing IGP-Prefix and IGP-Adjacency Segment Identifier (SIDs) with an MPLS data plane. RFC8287 defines the Target FEC Stack Sub-TLVs and the procedures to apply RFC8029 on SR architecture with MPLS data plane.

This document defines the Target FEC Stack Sub-TLVs and the extension required for other SR Segments.

Table of Contents

1. Introduction

[RFC8402] introduces and describes a Segment Routing architecture that leverages the source routing and tunneling paradigms. A node steers a packet through a controlled set of instructions called segments, by prepending the packet with Segment Routing header. A detailed definition of the Segment Routing architecture is available in [RFC8402]

As described in [RFC8402] and [I-D.ietf-spring-segment-routing-mpls], the Segment Routing architecture can be directly applied to an MPLS data plane, the Segment identifier (Segment ID) will be of 20-bits size and the Segment Routing header is the label stack.

[RFC8287] defines the mechanism to perform LSP Ping and Traceroute for Segment Routing with MPLS data plane. [RFC8287] defines the Target FEC Stack Sub-TLVs for IGP-Prefix Segment ID and IGP-Adjacency Segment ID.

There are various other Segment IDs proposed by different documents that are applicable for SR architecture.
[I-D.ietf-idr-bgp-prefix-sid] defines BGP Prefix Segment ID,
[I-D.ietf-idr-bgpls-segment-routing-epe] defines BGP Peering Segment ID such as Peer Node SID, Peer Adj SID and Peer Set SID.
[I-D.sivabalan-pce-binding-label-sid] defines Path Binding Segment ID.

As above Segment IDs get deployed in the field, operators require corresponding MPLS OAM procedures for the SIDs. This document describes the target FEC Stack Sub-TLVs and the procedure to use LSP Ping and Traceroute for the above defined Segment IDs to support path validation and fault isolation.

2. Requirements notation

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 [RFC2119].

3. Terminology

This document uses the terminologies defined in [RFC8402], [RFC8029], readers are expected to be familiar with it.

The term "BGP EPE node" is used to refer to node assigning and advertising BGP Peering Segment SIDs to steer traffic towards a BGP peer, as described in [I-D.ietf-spring-segment-routing-central-epe].

4. Segment ID sub-TLV

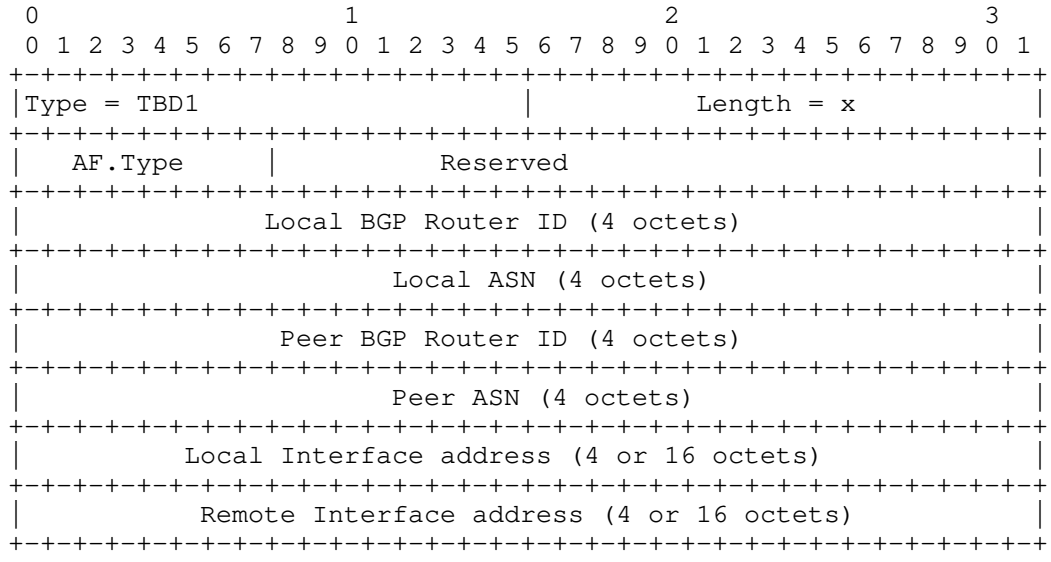
As defined in Section 5 of [RFC8287], the format of the following Segment ID sub-TLVs defined in this document follows the philosophy of Target FEC Stack TLV carrying FECs corresponding to each label in the label stack.

4.1. BGP Prefix Segment ID

Section 3.2.13 and 3.2.14 of [RFC8029] defines the Sub-TLV for BGP labeled IPv4 and IPv6 prefix respectively. This document proposes the use of the same Sub-TLV for IPv4 and IPv6 BGP Prefix SID without any change.

4.2. BGP Peering Segment - Peer-Node-SID

Peer-Node-SID identifies the peer node in the BGP Peering Segment. The sub-TLV format for Peer-Node-SID of BGP Peering Segment MUST be set as shown in the below TLV format:



AF.Type

Set to 4 if the address in Local/Remote Interface address field is IPv4 and set to 6 if the address in Local/Remote Interface address field is IPv6.

Reserved

MUST be set to 0 on send and MUST be ignored on receipt.

Local BGP Router ID

4-octet BGP Router ID of the node that assigns the Peer-Node-SID.

Local ASN

4-octet local ASN number of the node that assigns the Peer-Node-SID.

Peer BGP Router ID

4-octet BGP Router ID of the peer node.

Peer ASN

4-octet ASN number of the peer node.

Local Interface Address

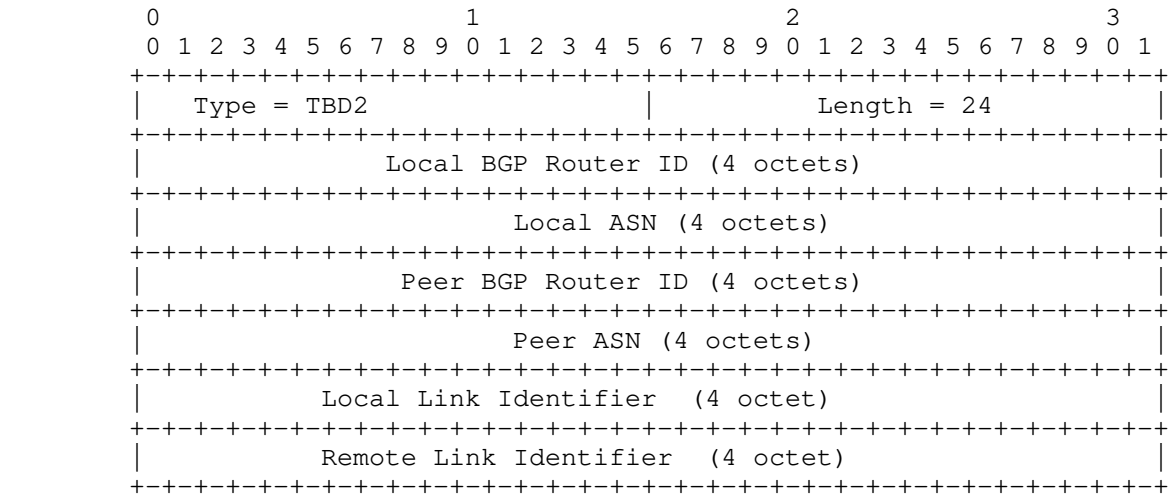
Set to the address used by the local node for BGP session peering. When AF.Type is set to 4, this address is 4-octet IPv4 address and when AF.Type is set to 6, this address is 16-octet IPv6 address.

Remote Interface Address

Set to the address used by the peer node for BGP session peering. When AF.Type is set to 4, this address is 4-octet IPv4 address and when AF.Type is set to 6, this address is 16-octet IPv6 address.

4.3. BGP Peering Segment - Peer-Adj-SID

Peer-Adj-SID identifies the underlying link to the BGP peer node. The sub-TLV format for Peer-Adj-SID of BGP Peering Segment MUST be set as shown in the below TLV format:



Local BGP Router ID

4-octet BGP Router ID of the node that assigns the Peer-Node-SID.

Local ASN

4-octet local ASN number of the node that assigns the Peer-Node-SID.

Peer BGP Router ID

4-octet BGP Router ID of the peer node.

Peer ASN

4-octet ASN number of the peer node.

Local Link Identifier

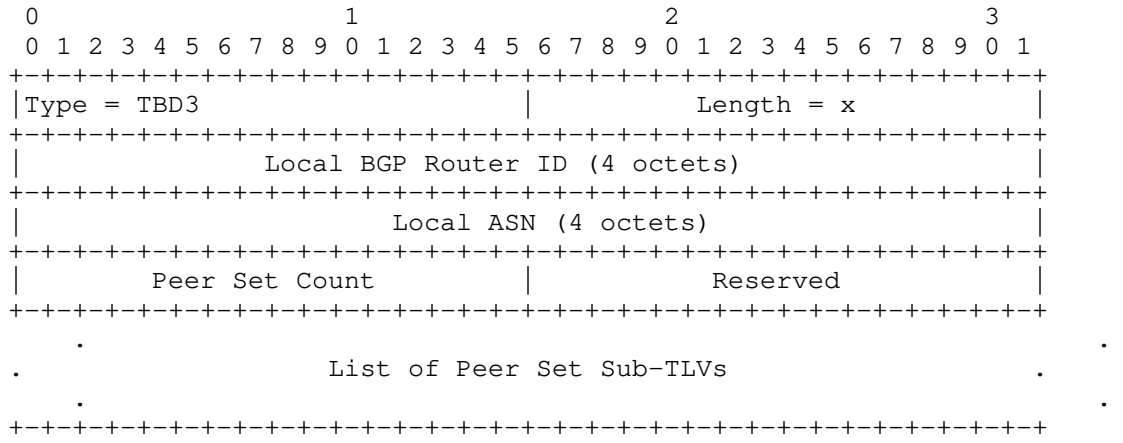
Set to 4-octet link identifier of the local interface to which Peer-Adj-SID is assigned to.

Remote Link Identifier

Set to 4-octet link identifier of the peer interface to which Peer-Adj-SID is assigned to. Set to all-zeros when this identifier is unknown.

4.4. BGP Peering Segment - Peer-Set-SID

The sub-TLV format for Peer-Node-SID of BGP Peering Segment MUST be set as shown in the below TLV format:



Local BGP Router ID

4-octet BGP Router ID of the node that assigns the Peer-Set-SID.

Local ASN

4-octet local ASN number of the node that assigns the Peer-Set-SID.

Peer Set Count

Set to the number of Peer Sub-TLVs included.

Sub-TLV Length

Total length in octets of the sub-TLVs associated with this TLV.

Peer Set Sub-TLV

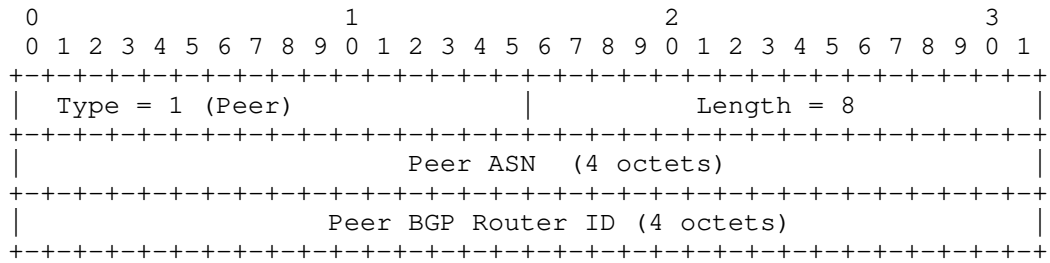
Carries the Sub-TLVs defined in section 4.4.1.

4.4.1. Peer Set Sub-TLV

As defined in section 5.3 of [I-D.ietf-idr-bgpls-segment-routing-epe], Peer-Set-SID can identify the set where the members can be Peer-Node or Peer-Adj from same or different ASN. The format of the Peer Set Sub-TLV will identify each such member.

4.4.1.1. Peer Node

The format for this sub-TLV MUST be set as below:



Peer ASN

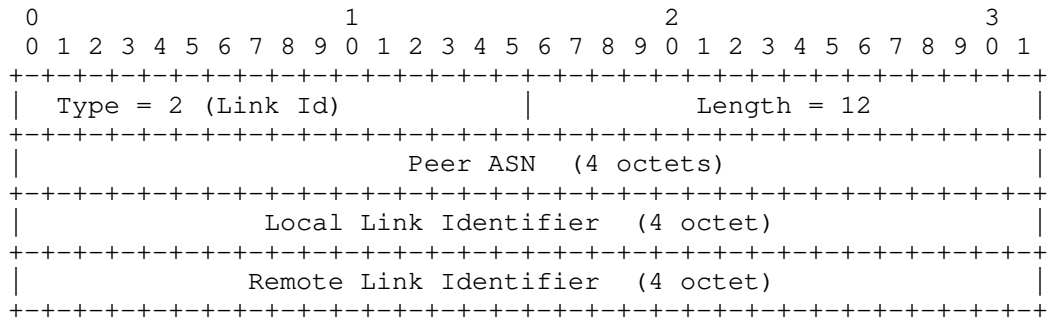
4-octet ASN number of the peer node.

Peer Router ID

4-octet BGP Router ID of the peer node.

4.4.1.2. Link Identifier

The format for this sub-TLV is as below:



Peer ASN

4-octet ASN number of the peer node.

Local Link Identifier

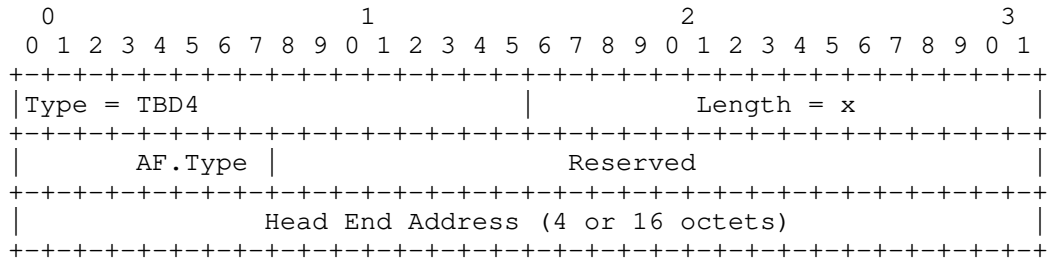
Set to 4-octet link identifier of the local interface to which Peer-Adj-SID is assigned to.

Remote Link Identifier

Set to 4-octet link identifier of the peer interface to which Peer-Adj-SID is assigned to. Set to all-zeros when this identifier is unknown.

4.5. Path Binding SID

Path Binding SID identifies the Binding Segment Identifier associated with an RSVP-TE or SR-TE path. The format for this sub-TLV is as below:



AF.Type

Set to 4 if the address in Head End Address field is IPv4 and set to 6 if the address in Head End address field is IPv6.

Reserved

MUST be set to 0 on send and MUST be ignored on receipt.

Head End Address

Set to the address of the head end node to which the policy is assigned. When AF.Type is 4, this address is IPv4 and when AF.Type is 6, it is IPv6.

4.6. Multicast Replication

[I-D.voyer-spring-sr-p2mp-policy] describes Segment Routing Multicast Replication Policy and introduces the notion of Tree SID to achieve this. A future version of this document will describe LSP Ping and Traceroute Target FEC Stack sub-TLV and procedures for Tree SID validation.

5. Procedures

This section describes the aspects of LSP Ping and Traceroute operations that require further considerations beyond [RFC8029] and [RFC8287].

5.1. BGP Prefix SID

The procedures described in [RFC8029] are sufficient for MPLS Ping and Traceroute operations for BGP Prefix SID using the FEC definitions from Section 3.2.13 and 3.2.14 of [RFC8029].

5.2. BGP Peering Segment Sub-TLVs

BGP Peering Segment sub-TLVs (BGP-Node-SID, BGP-Adj-SID, Peer-Set-SID) are assigned by BGP EPE node for a particular BGP neighbor, and advertised to the peer nodes. Any LSP Ping and Traceroute operation MUST be performed on the BGP EPE node, and not the remote neighbor node, as only the BGP EPE node can validate the contents of BGP Peering Segment sub-TLVs. Additionally, leaking the echo packet to the peer node may not be desirable for network operators.

5.2.1. Initiator Node Procedures

If the bottom-most label in the label stack is BGP Peer Segment label, the initiating node MUST set the TTL of the bottom-most label to 1 to ensure that MPLS TTL expires at the BGP EPE node, and the

echo packet does not leak to the BGP peer node. Echo packet MUST include one of BGP-Node-SID, BGP-Adj-SID, or Peer-Set-SID sub-TLV in the Target FEC Stack TLV corresponding to the BGP Peer Segment label. Operator MAY push one or more transport labels on top of the BGP Peer Segment label to forward the echo packet to the BGP EPE node.

5.2.2. Responder Node Procedures

In addition to procedures defined in [RFC8029], the responding node, upon TTL expiry of the echo packet, MUST process the incoming BGP Peer Segment sub-TLV of the Target FEC Stack. It MUST validate that contents of the sub-TLV and ensure the incoming label is advertised for the processed BGP Peer Segment sub-TLV.

5.3. Path Binding SID

5.3.1. Initiator Node Procedures

Similar to BGP Peering Segment sub-TLVs, Path Binding SID sub-TLV MUST be validated at the node assigning and advertising the Binding SID, instead of the endpoint of the path associated with the Binding SID. The initiating node MUST set the TTL of the Binding SID label to 1 and include the associated Path Binding SID TLV in the Target FEC Stack TLV of the echo request. Operator MAY push one or more transport labels on top of Binding SID label to forward echo packet from initiating node to the assigning node.

5.3.2. Responder Node Procedures

In addition to procedures defined in [RFC8029], the responding node, upon TTL expiry of the echo packet, MUST process the incoming Path Binding SID sub-TLV of the Target FEC Stack. The responding node MUST ensure that it is the advertising node specified in the Path Bindng SID sub-TLV, and the incoming Binding SID label matches the advertised label value.

6. IANA Considerations

To be Updated.

7. Security Considerations

To be Updated

8. Acknowledgement

TBD

9. Contributors

TBD

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