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Segment Routing Prefix SID extensions for BGP  
draft-keyupate-idr-bgp-prefix-sid-03

## Abstract

Segment Routing (SR) architecture allows a node to steer a packet flow through any topological path and service chain by leveraging source routing. The ingress node prepends a SR header to a packet containing a set of "segments". Each segment represents a topological or a service-based instruction. Per-flow state is maintained only at the ingress node of the SR domain.

This document describes the BGP extension for announcing BGP Prefix Segment Identifier (BGP Prefix SID) information.

## 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](#)] only when they appear in all upper case. They may also appear in lower or mixed case as English words, without any normative meaning.

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## [1.](#) Segment Routing Documents

The main references for this document are the SR architecture defined in [[I-D.ietf-spring-segment-routing](#)] and the related use case illustrated in [[I-D.filsfils-spring-segment-routing-msdc](#)].

The Segment Routing Egress Peer Engineering architecture is described in [[I-D.filsfils-spring-segment-routing-central-epe](#)].

The Segment Routing Egress Peer Engineering BGPLS extensions are described in [[I-D.ietf-idr-bgpls-segment-routing-epe](#)].

## [2.](#) Introduction

Segment Routing (SR) architecture leverages the source routing paradigm. A group of inter-connected nodes that use SR forms a SR domain. The ingress node of the SR domain prepends a SR header containing "segments" to an incoming packet. Each segment represents a topological instruction such as "go to prefix P following shortest path" or a service instruction (e.g.: "pass through deep packet inspection"). By inserting the desired sequence of instructions, the ingress node is able to steer a packet via any topological path and/or service chain; per-flow state is maintained only at the ingress node of the SR domain.

Each segment is identified by a Segment Identifier (SID). As described in [[I-D.ietf-spring-segment-routing](#)], when SR is applied to the MPLS dataplane the SID consists of a label while when SR is applied to the IPv6 dataplane the SID consists of an IPv6 prefix (see [[I-D.previdi-6man-segment-routing-header](#)]).

A BGP-Prefix Segment (aka BGP-Prefix-SID), is a BGP segment attached to a BGP prefix. A BGP-Prefix-SID is always global within the SR/BGP domain and identifies an instruction to forward the packet over the ECMP-aware best-path computed by BGP to the related prefix. The BGP-Prefix-SID is the identifier of the BGP prefix segment.

This document describes the BGP extension to signal the BGP-Prefix-SID. Specifically, this document defines a new BGP attribute known as the BGP Prefix SID attribute and specifies the rules to originate, receive and handle error conditions of the new attribute.

As described in [[I-D.filsfils-spring-segment-routing-msdc](#)], the newly proposed BGP Prefix-SID attribute can be attached to prefixes from different AFI/SAFI:

Multiprotocol BGP labeled IPv4/IPv6 Unicast ([[RFC3107](#)]).

Multiprotocol BGP ([[RFC4760](#)]) unlabeled IPv4/IPv6 Unicast.

BGP4 ([[RFC4271](#)]).

[[I-D.filsfils-spring-segment-routing-msdc](#)] describes use cases where the Prefix-SID is used for all the above BGP flavors.

### [3.](#) BGP-Prefix-SID

The BGP-Prefix-SID attached to a BGP prefix P represents the instruction "go to Prefix P" along its BGP bestpath (potentially ECMP-enabled).

#### [3.1.](#) MPLS Prefix Segment

The BGP Prefix Segment is realized on the MPLS dataplane in the following way:

According to [[I-D.ietf-spring-segment-routing](#)], each BGP speaker is configured with a label block called the Segment Routing Global Block (SRGB). The SRGB of a node is a local property and could be different on different speakers.

As described in [[I-D.filsfils-spring-segment-routing-msdc](#)] the operator assigns a globally unique "index", L\_I, to a locally sourced prefix of a BGP speaker N which is advertised to all other BGP speakers in the SR domain.

The index L\_I is a 32 bit offset in the SRGB. Each BGP speaker

derives its local MPLS label, L, by adding L\_I to the start value of its own SRGB, and programs L in its MPLS dataplane as its incoming/local label for the prefix.

If the BGP speakers are configured with the same SRGB start value, they will all program the same MPLS label for a given prefix P. This has the effect of having a single label for prefix P across all BGP speakers despite that the MPLS paradigm of "local label" is preserved and this clearly simplifies the deployment and operations of traffic engineering in BGP driven networks, as described in [[I-D.filsfils-spring-segment-routing-msdc](#)].

If the BGP speakers cannot be configured with the same SRGB, the proposed BGP Prefix-SID attribute allows the advertisement of the SRGB so each node can advertise the SRGB it's configured with. The drawbacks of the use case where BGP speakers have different SRGBs are documented in [[I-D.filsfils-spring-segment-routing-msdc](#)].

In order to advertise the label index of a given prefix P and, optionally, the SRGB, a new extension to BGP is needed: the BGP Prefix SID attribute. This extension is described in subsequent sections.

### [3.2.](#) IPv6 Prefix Segment

As defined in [[I-D.previdi-6man-segment-routing-header](#)], in SR for the IPv6 dataplane, the SRGB consists of the set of IPv6 addresses used within the SR domain (as described in [[I-D.previdi-6man-segment-routing-header](#)]), therefore the BGP speaker willing to process SR IPv6 packets MUST advertise an IPv6 prefix with the attached Prefix SID attribute and related SR IPv6 flag (see subsequent section).

As described in [[I-D.filsfils-spring-segment-routing-msdc](#)], when SR is used over an IPv6 dataplane, the BGP Prefix Segment is instantiated by an IPv6 prefix originated by the BGP speaker.

Each node advertises a globally unique IPv6 address representing itself in the domain. This prefix (e.g.: its loopback interface address) is advertised to all other BGP speakers in the SR domain.

Also, each node MUST advertise its support of Segment Routing for IPv6 dataplane. This is realized using the Prefix SID Attribute defined here below.

#### 4. BGP-Prefix-SID Attribute

BGP Prefix SID attribute is an optional, transitive BGP path attribute. The attribute type code is to be assigned by IANA (suggested value: 40). The value field of the BGP-Prefix-SID attribute has the following format:

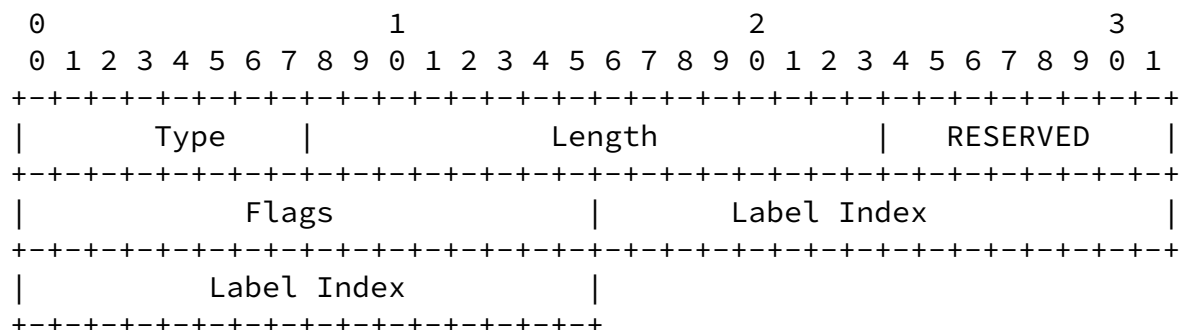
The value field of the BGP Prefix SID attribute is defined here to be a set of elements encoded as "Type/Length/Value" (i.e., a set of TLVs). Following TLVs are defined:

- o Label-Index TLV
- o Originator SRGB TLV
- o Neighbor SRGB TLV

Originator SRGB and Neighbor SRGB TLVs are used only when SR is applied to the MPLS dataplane.

##### 4.1. Label-Index TLV

The Label-Index TLV MUST be present in the Prefix-SID attribute and has the following format:



where:

- o Type is 1.
- o Length: is 7, the total length of the value portion of the TLV.
- o RESERVED: 8 bit field. SHOULD be 0 on transmission and MUST be ignored on reception.
- o Flags: 16 bits of flags. Following is defined:

```

      0                               1
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
+---+---+---+---+---+---+---+---+
|S|                                     |
+---+---+---+---+---+---+---+---+
```

where:

- \* S flag: if set then it means that the BGP speaker attaching the Prefix-SID Attribute to a prefix it originates is capable of processing the IPv6 Segment Routing Header (SRH, [[I-D.previdi-6man-segment-routing-header](#)]) for the segment corresponding to the originated IPv6 prefix. The use case leveraging the S flag is described in [[I-D.filsfils-spring-segment-routing-msdc](#)].

The other bits of the flag field SHOULD be clear on transmission an MUST be ignored at reception.

- o Label Index: 32 bit value representing the index value in the SRGB space. If the S flag is set, the index SHOULD be clear on transmission an MUST be ignored at reception.

#### [4.2.](#) Originator SRGB TLV

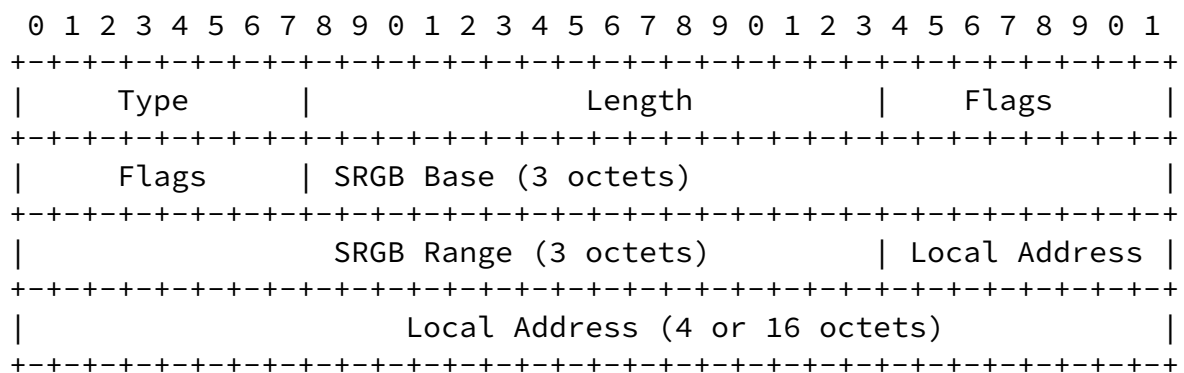
The Originator SRGB TLV is an optional TLV and has the following format:

```

      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
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
```







where:

- o Type is 3.
- o Length: is 12 or 24, the total length of the value portion of the TLV.
- o Flags: 16 bits of flags. None are defined in this document. Flags SHOULD be clear on transmission and MUST be ignored at reception.
- o SRGB Base: the value of the first label in the SRGB.
- o SRGB Range: the size of the SRGB (i.e.: number of labels).
- o Local Address: if "Length" is 12, then Local Address MUST contain a 4-octet IPv4 address. If "Length" is 24, then Local Address MUST contain a 16-octet IPv6 address.

The Neighbor SRGB TLV contains the local SRGB of the BGP speaker originating the Neighbor SRGB TLV.

The Neighbor SRGB TLV may only be present on Prefix-SID attribute attached to an unlabeled prefix: BGP4 ([RFC4271](#)) or SAFI 1.

The BGP speaker originating the Neighbor SRGB TLV MUST specify the local IPv4 or IPv6 address for the BGP session on which the corresponding NLRI is being advertised.

The Neighbor SRGB TLV has a significance only for the neighbors of the BGP speaker originating it. The Neighbor SRGB TLV MUST be rewritten at each hop during the advertisement/propagation of the prefix. At each hop the BGP speaker receiving a prefix with a Prefix-SID attached to it and with a "Local Address" MUST override the "Local Address" value.

The Neighbor SRGB TLV is only used when the dataplane is MPLS and the the BGP Prefix SID is associated with an NLRI propagated by unlabeled BGP signaling (BGP4 or SAFI 1). It allows the receiving BGP speaker to determine the outgoing label to program in the dataplane (see [\[I-D.filsfils-spring-segment-routing-msdc\]](#)).

In case of a labeled unicast IPv4 or IPv6 prefixes ([\[RFC3107\]](#)), the label value in the NLRI MUST be used as outgoing label value for the prefix the Prefix-SID attribute is attached to and the Neighbor SRGB TLV MUST NOT be used.

## 5. Receiving BGP-Prefix-SID Attribute

A BGP speaker may be locally configured with an SRGB=[GB\_S, GB\_E]. The preferred method for deriving the SRGB is a matter of local router configuration.

Given a label index L\_I, we call  $L = L\_I + GB\_S$  as the derived label. A BGP Prefix-SID attribute is called "unacceptable" for a speaker M if the derived label value L lies outside the SRGB configured on M. Otherwise the Label Index attribute is called "acceptable" to speaker M.

The mechanisms through which a given label\_index value is assigned to a given prefix are outside the scope of this document. The label-index value associated with a prefix is locally configured at the BGP router originating the prefix.

The Prefix-SID attribute MUST contain the Label-Index TLV and MAY contain the Originator SRGB and Neighbor SRGB TLVs. A BGP Prefix-SID attribute received without a Label-Index TLV MUST be considered as "unacceptable" by the receiving speaker.

When a BGP speaker receives a path from a neighbor with an acceptable BGP Prefix-SID attribute, it SHOULD program the derived label as the local label for the prefix in its MPLS dataplane. In case of any error, a BGP speaker MUST resort to the error handling rules specified in [Section 7](#). A BGP speaker MAY log an error for further analysis.

A BGP speaker receiving a BGP Prefix-SID attribute from an EBGp neighbor residing outside the boundaries of the SR domain, SHOULD discard the attribute unless it is configured to accept the attribute from the EBGp neighbor. A BGP speaker MAY log an error for further analysis when discarding an attribute.

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## [5.1.](#) MPLS Dataplane

### [5.1.1.](#) MPLS Dataplane: Labeled Unicast

When a BGP speaker receives a path from a neighbor with an unacceptable BGP Prefix-SID attribute, for the purpose of label allocation, it SHOULD treat the path as if it came without a Prefix-SID attribute. A BGP speaker MAY choose to assign a local (also called dynamic) label (non-SRGB) for such a prefix. A BGP speaker MAY log an error for further analysis.

A BGP speaker receiving a prefix with a Prefix-SID attribute and a label NLRI field of implicit-null from a neighbor MUST adhere to standard behavior and program its MPLS dataplane to pop the top label when forwarding traffic to the prefix. The label NLRI defines the outbound label that MUST be used by the receiving node. The Label Index gives a hint to the receiving node on which local/incoming label the BGP speaker SHOULD use.

### [5.1.2.](#) MPLS Dataplane: Unlabeled Unicast

When a BGP speaker receives a path from a neighbor with an unacceptable BGP Prefix-SID attribute, for the purpose of label allocation, it SHOULD treat the path as if it came without a Prefix-SID attribute. A BGP speaker MAY choose to assign a local (also called dynamic) label (non-SRGB) for such a prefix. A BGP speaker MAY log an error for further analysis.

When a BGP speaker receives a path from a neighbor with an unacceptable BGP Prefix-SID attribute, for the purpose of label allocation, it SHOULD treat the path as if it came without a Prefix-SID attribute and remove the Prefix-SID attribute from the prefix prior to advertising it to its neighbors. A BGP speaker MAY choose to assign a local (also called dynamic) label (non-SRGB) for such a prefix. A BGP speaker MAY log an error for further analysis.

A BGP speaker receiving an unlabeled prefix (IPv4 or IPv6) with a Prefix-SID attribute derives the outgoing label for the prefix by applying the received index to the received Neighbor SRGB TLV. Then,

it replaces the Neighbor SRGB TLV with its own local SRGB values (base, range) prior to advertising the prefix to its neighbors.

## [5.2.](#) IPv6 Dataplane

When a SR IPv6 BGP speaker receives a BGP Update with a prefix having the BGP Prefix SID attribute attached, it checks whether the S flag is set in the Index TLV. If the S flag is set, then the Index value MUST be ignored.

The Originator SRGB and Neighbor SRGB TLVs are ignored on reception.

A BGP speaker receiving a BGP Prefix-SID attribute from a EBGp neighbor residing outside the boundaries of the SR domain, SHOULD discard the attribute unless it is configured to accept the attribute from the EBGp neighbor. A BGP speaker MAY log an error for further analysis when discarding an attribute.

## [6.](#) Announcing BGP-Prefix-SID Attribute

The BGP Prefix-SID attribute MAY be announced with BGP Prefixes carried in either label and unlabeled BGP (or Multiprotocol BGP) updates (IPv4 and IPv6). In order to prevent distribution of the BGP Prefix-SID attribute beyond its intended scope of applicability, attribute filtering MAY be deployed.

### [6.1.](#) MPLS Dataplane

A BGP speaker that originates a prefix attaches the Prefix-SID attribute when it advertises the prefix to its neighbors. The value of the Label-Index in the Label-Index TLV is determined by configuration.

A BGP speaker that originates a Prefix-SID attribute MAY optionally announce Originator SRGB and Neighbor SRGB TLVs along with the mandatory Label-Index TLV. The content of the Originator SRGB and Neighbor SRGB TLVs is determined by the configuration.

Since the Label-index value must be unique within an SR domain, by default an implementation SHOULD NOT advertise the BGP Prefix-SID attribute outside an Autonomous System unless it is explicitly configured to do so.

#### [6.1.1.](#) MPLS Dataplane: Labeled Unicast

A BGP speaker that advertises a path received from one of its neighbors SHOULD advertise the Prefix-SID received with the path without modification regardless of whether the Prefix-SID was acceptable. If the path did not come with a Prefix-SID attribute, the speaker MAY attach a Prefix-SID to the path if configured to do so. The content of the TLVs present in the Prefix-SID is determined by the configuration.

In all cases, the label field of the NLRI ([\[RFC3107\]](#), [\[RFC4364\]](#)) MUST be set to the local/incoming label programmed in the MPLS dataplane for the given prefix. If the prefix is associated with one of the BGP speakers interfaces, this label is the usual MPLS label (such as the implicit or explicit NULL label).

#### [6.1.2.](#) MPLS Dataplane: Unlabeled Unicast

A BGP speaker that advertises a path received from one of its neighbors SHOULD advertise the Prefix-SID received with the path without modification only if the Prefix-SID is acceptable. If the path did not come with a Prefix-SID attribute, the speaker MAY attach a Prefix-SID to the path if configured to do so. The value of the TLVs present in the Prefix-SID is determined by the configuration.

When the Prefix SID attribute is attached to an unlabeled prefix, the BGP speaker MUST originate the Index and the Neighbor SRGB TLVs. The Index TLV MUST contain the globally unique index value allocated to the prefix. The Neighbor SRGB TLV MUST contain the SRGB of the speaker in the form of base and range.

#### [6.2.](#) IPv6 Dataplane

A BGP speaker that originates a prefix attaches the Prefix-SID attribute when it advertises the prefix to its neighbors. The value of the Label-Index is set to null and the S flag is set.

A BGP speaker that advertises a path received from one of its neighbors SHOULD advertise the Prefix-SID received with the path without modification regardless of whether the Prefix-SID was acceptable. If the path did not come with a Prefix-SID attribute,

the speaker MAY attach a Prefix-SID to the path if configured to do so. The value of the TLVs present in the Prefix-SID is determined by the configuration.

## 7. Error Handling of BGP-Prefix-SID Attribute

When a BGP Speaker receives a BGP Update message containing a malformed BGP Prefix-SID attribute, it MUST ignore the received BGP Prefix-SID attributes and not pass it to other BGP peers. This is equivalent to the -attribute discard- action specified in [\[I-D.ietf-idr-error-handling\]](#). When discarding an attribute, a BGP speaker MAY log an error for further analysis.

If the BGP Prefix-SID attribute appears more than once in an BGP Update message message, then, according to [\[I-D.ietf-idr-error-handling\]](#), all the occurrences of the attribute other than the first one SHALL be discarded and the BGP Update message shall continue to be processed.

When a BGP speaker receives an unacceptable Prefix-SID attribute, it MAY log an error for further analysis.

## 8. IANA Considerations

This document defines a new BGP path attribute known as the BGP Prefix-SID attribute. This document requests IANA to assign a new attribute code type (suggested value: 40) for BGP the Prefix-SID attribute from the BGP Path Attributes registry.

This document defines three new TLVs for BGP Prefix-SID attribute. These TLVs need to be registered with IANA. We request IANA to create a new registry for BGP Prefix-SID Attribute TLVs as follows:

Under "Border Gateway Protocol (BGP) Parameters" registry, "BGP Prefix SID attribute Types" Reference: [draft-keyupate-idr-bgp-prefix-side-03](#) Registration Procedure(s): Values 1-254 First Come, First Served, Value 0 and 255 reserved

Value	Type	Reference
0	Reserved	<a href="#">draft-keyupate-idr-bgp-prefix-side-03</a>

1	Label-Index	<a href="#">draft-keyupate-idr-bgp-prefix-side-03</a>
2	Originator SRGB	<a href="#">draft-keyupate-idr-bgp-prefix-side-03</a>
3	Neighbor SRGB	<a href="#">draft-keyupate-idr-bgp-prefix-side-03</a>
4-254	Unassigned	
255	Reserved	<a href="#">draft-keyupate-idr-bgp-prefix-side-03</a>

## [9.](#) Security Considerations

This document introduces no new security considerations above and beyond those already specified in [[RFC4271](#)] and [[RFC3107](#)].

## [10.](#) Acknowledgements

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## [11.](#) Change Log

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