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        **Segment Routing BGP Egress Peer Engineering BGP-LS Extensions**
                **draft-ietf-idr-bgpls-segment-routing-epe-09**

Abstract

   Segment Routing (SR) leverages source routing.  A node steers a
   packet through a controlled set of instructions, called segments, by
   prepending the packet with an SR header.  A segment can represent any
   instruction, topological or service-based.  SR allows to enforce a
   flow through any topological path and service chain while maintaining
   per-flow state only at the ingress node of the SR domain.

   The Segment Routing architecture can be directly applied to the MPLS
   dataplane with no change on the forwarding plane.  It requires minor
   extension to the existing link-state routing protocols.

   This document outline a BGP-LS extension for exporting BGP peering
   node topology information (including its peers, interfaces and
   peering ASs) in a way that is exploitable in order to compute
   efficient BGP Peering Engineering policies and strategies.

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

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## 1.  Introduction

   Segment Routing (SR) leverages source routing.  A node steers a
   packet through a controlled set of instructions, called segments, by
   prepending the packet with an SR header.  A segment can represent any
   instruction, topological or service-based.  SR allows to enforce a
   flow through any topological path and service chain while maintaining
   per-flow state only at the ingress node of the SR domain.

   The Segment Routing architecture can be directly applied to the MPLS
   dataplane with no change on the forwarding plane.  It requires minor
   extension to the existing link-state routing protocols.

   This document outline a BGP-LS extension for exporting BGP peering
   node topology information (including its peers, interfaces and
   peering ASs) in a way that is exploitable in order to compute
   efficient BGP Egress Peer Engineering (BGP-EPE) policies and
   strategies.

   This document defines new types of segments: a Peer Node segment
   describing the BGP session between two nodes; a Peer Adjacency
   Segment describing the link (one or more) that is used by the BGP
   session; the Peer Set Segment describing an arbitrary set of sessions
   or links between the local BGP node and its peers.

   While an egress point topology usually refers to eBGP sessions
   between external peers, there's nothing in the extensions defined in
   this document that would prevent the use of these extensions in the
   context of iBGP sessions.

## 2.  Segment Routing Documents

   The main reference for this document is the SR architecture defined
   in [I-D.ietf-spring-segment-routing].

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

3.  **BGP Peering Segments**

   As defined in [I-D.ietf-spring-segment-routing-central-epe], an BGP-
   EPE enabled Egress PE node MAY advertise segments corresponding to
   its attached peers.  These segments are called BGP peering segments
   or BGP Peering SIDs.  In case of eBGP, they enable the expression of
   source-routed inter-domain paths.

   An ingress border router of an AS may compose a list of segments to
   steer a flow along a selected path within the AS, towards a selected
   egress border router C of the AS and through a specific peer.  At
   minimum, a BGP-EPE policy applied at an ingress PE involves two
   segments: the Node SID of the chosen egress PE and then the BGP
   Peering Segment for the chosen egress PE peer or peering interface.

   This document defines the BGP-EPE Peering Segments:

   o  Peer Node Segment (Peer-Node-SID)

   o  Peer Adjacency Segment (Peer-Adj-SID)

   o  Peer Set Segment (Peer-Set-SID)

   Each BGP session MUST be described by a Peer Node Segment.  The
   description of the BGP session MAY be augmented by additional
   Adjacency Segments.  Finally, each Peer Node Segment and Peer
   Adjacency Segment MAY be part of the same group/set so to be able to
   group EPE resources under a common Peer-Set Segment Identifier (SID).

   Therefore, when the extensions defined in this document are applied
   to the use case defined in
   [I-D.ietf-spring-segment-routing-central-epe]:

   o  One Peer Node Segment MUST be present.

   o  One or more Peer Adjacency Segments MAY be present.

   o  Each of the Peer Node and Peer Adjacency Segment MAY use the same
      Peer-Set.

   While an egress point topology usually refers to eBGP sessions
   between external peers, there's nothing in the extensions defined in
   this document that would prevent the use of these extensions in the
   context of iBGP sessions.

4.  Link NLRI for BGP-EPE Connectivity Description

   This section describes the NLRI used for describing the connectivity
   of the BGP Egress router.  The connectivity is based on links and
   remote peers/ASs and therefore the existing Link-Type NLRI (defined
   in [RFC7752]) is used.  A new Protocol ID is used: BGP (codepoint to
   be assigned by IANA).

   The use of a new Protocol-ID allows separation and differentiation
   between the NLRIs carrying BGP-EPE descriptors from the NLRIs
   carrying IGP link-state information as defined in [RFC7752].  The
   Link NLRI Type uses descriptors and attributes already defined in
   [RFC7752] in addition to new TLVs defined in the following sections
   of this document.

   The extensions defined in this document apply to both internal and
   external BGP-LS EPE advertisements.

   [RFC7752] defines Link NLRI Type is as follows:

```
 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
+-+-+-+-+-+-+-+-+
|  Protocol-ID  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Identifier                            |
|                         (64 bits)                            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//       Local Node Descriptors                               //
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//       Remote Node Descriptors                              //
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//       Link Descriptors                                     //
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

      Node Descriptors and Link Descriptors are defined in [RFC7752].

4.1.  BGP Router ID and Member ASN

   Two new Node Descriptors Sub-TLVs are defined in this document:

   o  BGP Router Identifier (BGP Router-ID):

         Type: TBD2 (to be assigned by IANA from the registry "BGP-LS
         Node Descriptor, Link Descriptor, Prefix Descriptor, and
         Attribute TLVs").

         Length: 4 octets

          Value: 4 octet unsigned integer representing the BGP Identifier
          as defined in [RFC4271] and [RFC6286].

   o  Confederation Member ASN (Member-ASN)

          Type: TBD3 (to be assigned by IANA from the registry "BGP-LS
          Node Descriptor, Link Descriptor, Prefix Descriptor, and
          Attribute TLVs").

          Length: 4 octets

          Value: 4 octet unsigned integer representing the Member ASN
          inside the Confederation.[RFC5065].

## 4.2.  BGP-EPE Node Descriptors

   The following Node Descriptors Sub-TLVs MUST appear in the Link NLRI
   as Local Node Descriptors:

   o  BGP Router ID, which contains the BGP Identifier of the local BGP-
      EPE capable node.

   o  Autonomous System Number, which contains the local ASN or local
      confederation identifier (ASN) if confederations are used.

   o  BGP-LS Identifier.

   It has to be noted that [RFC6286] (section 2.1) requires the BGP
   identifier (router-id) to be unique within an Autonomous System.
   Therefore, the <ASN, BGP identifier> tuple is globally unique.

   The following Node Descriptors Sub-TLVs MAY appear in the Link NLRI
   as Local Node Descriptors:

   o  Member-ASN, which contains the ASN of the confederation member
      (when BGP confederations are used).

   o  Node Descriptors as defined in [RFC7752].

   The following Node Descriptors Sub-TLVs MUST appear in the Link NLRI
   as Remote Node Descriptors:

   o  BGP Router ID, which contains the BGP Identifier of the peer node.

   o  Autonomous System Number, which contains the peer ASN or the peer
      confederation identifier (ASN), if confederations are used.

The following Node Descriptors Sub-TLVs MAY appear in the Link NLRI
as Remote Node Descriptors:

o  Member-ASN, which contains the ASN of the confederation member
   (when BGP confederations are used).

o  Node Descriptors as defined in defined in [RFC7752].

## 4.3.  Link Attributes

The following BGP-LS Link attributes TLVs are used with the Link
NLRI:

```
+----------+----------------------------+----------+
| TLV Code | Description                |  Length  |
|  Point   |                            |          |
+----------+----------------------------+----------+
|    TBD4  | Peer Node Segment          | variable |
|          | Identifier (Peer-Node-SID) |          |
|    TBD5  | Peer Adjacency Segment     | variable |
|          | Identifier (Peer-Adj-SID)  |          |
|    TBD6  | Peer Set Segment           | variable |
|          | Identifier (Peer-Set-SID)  |          |
+----------+----------------------------+----------+
```

Figure 1: BGP-LS TLV code points for BGP-EPE

Peer-Node-SID, Peer-Adj-SID and Peer-Set-SID have all the same format
defined here 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              |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Flags         |    Weight     |             Reserved          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   SID/Label/Index (variable)                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

where:

Figure 2

o  Type: TBD4 or TBD5 or TBD6, to be assigned by IANA.

o  Length: variable.

o  Flags: following flags have been defined:

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

where:

   *  V-Flag: Value flag.  If set, then the Adj-SID carries a value.
      By default the flag is SET.

   *  L-Flag: Local Flag.  If set, then the value/index carried by
      the Adj-SID has local significance.  By default the flag is
      SET.

   *  Other bits: MUST be zero when originated and ignored when
      received.

o  Weight: 1 octet.  The value represents the weight of the SID for
   the purpose of load balancing.  An example use of the weight is
   described in [I-D.ietf-spring-segment-routing].

o  SID/Index/Label.  According to the TLV length and to the V and L
   flags settings, it contains either:

   *  A 3 octet local label where the 20 rightmost bits are used for
      encoding the label value.  In this case the V and L flags MUST
      be set.

   *  A 4 octet index defining the offset in the SID/Label space
      advertised by this router using the encodings defined in
      Section 3.1.  In this case V and L flags MUST be unset.

   *  A 16 octet IPv6 address.  In this case the V flag MUST be set.
      The L flag MUST be unset if the IPv6 address is globally
      unique.

The values of the Peer-Node-SID, Peer-Adj-SID and Peer-Set-SID Sub-
TLVs SHOULD be persistent across router restart.

The Peer-Node-SID MUST be present when BGP-LS is used for the use
case described in [I-D.ietf-spring-segment-routing-central-epe] and
MAY be omitted for other use cases.

The Peer-Adj-SID and Peer-Set-SID SubTLVs MAY be present when BGP-LS
is used for the use case described in

[I-D.ietf-spring-segment-routing-central-epe] and MAY be omitted for
other use cases.

In addition, BGP-LS Nodes and Link Attributes, as defined in
[RFC7752] MAY be inserted in order to advertise the characteristics
of the link.

## 5.  Peer Node and Peer Adjacency Segments

In this section the following Peer Segments are defined:

   Peer Node Segment (Peer-Node-SID)

   Peer Adjacency Segment (Peer-Adj-SID)

   Peer Set Segment (Peer-Set-SID)

The Peer Node, Peer Adjacency and Peer Set segments can be either a
local or a global segment (depending on the setting of the V and L
flags defined in Figure 2.  For example, when BGP-EPE is used in the
context of a SR network over the IPv6 dataplane, it is likely the
case that the IPv6 addresses used as SIDs will be global.

## 5.1.  Peer Node Segment (Peer-Node-SID)

The Peer Node Segment describes the BGP session peer (neighbor).  It
MUST be present when describing a BGP-EPE topology as defined in
[I-D.ietf-spring-segment-routing-central-epe].  The Peer Node Segment
is encoded within the BGP-LS Link NLRI specified in Section 4.

The Peer Node Segment, at the BGP node advertising it, has the
following semantic:

o  SR header operation: NEXT (as defined in
   [I-D.ietf-spring-segment-routing]).

o  Next-Hop: the connected peering node to which the segment is
   related.

The Peer Node Segment is advertised with a Link NLRI, where:

o  Local Node Descriptors contains

   Local BGP Router ID of the BGP-EPE enabled egress PE.
   Local ASN.
   BGP-LS Identifier.

o  Remote Node Descriptors contains

Peer BGP Router ID (i.e.: the peer BGP ID used in the BGP session).
Peer ASN.

o  Link Descriptors Sub-TLVs, as defined in [RFC7752], contain the
   addresses used by the BGP session:

   *  IPv4 Interface Address (Sub-TLV 259) contains the BGP session
      IPv4 local address.

   *  IPv4 Neighbor Address (Sub-TLV 260) contains the BGP session
      IPv4 peer address.

   *  IPv6 Interface Address (Sub-TLV 261) contains the BGP session
      IPv6 local address.

   *  IPv6 Neighbor Address (Sub-TLV 262) contains the BGP session
      IPv6 peer address.

o  Link Attribute contains the Peer-Node-SID TLV as defined in
   Section 4.3.

o  In addition, BGP-LS Link Attributes, as defined in [RFC7752], MAY
   be inserted in order to advertise the characteristics of the link.

## 5.2.  Peer Adjacency Segment (Peer-Adj-SID)

The Peer Adjacency Segment, at the BGP node advertising it, has the
following semantic:

o  SR header operation: NEXT (as defined in
   [I-D.ietf-spring-segment-routing]).

o  Next-Hop: the interface peer address.

The Peer Adjacency Segment is advertised with a Link NLRI, where:

o  Local Node Descriptors contains

   Local BGP Router ID of the BGP-EPE enabled egress PE.
   Local ASN.
   BGP-LS Identifier.

o  Remote Node Descriptors contains

   Peer BGP Router ID (i.e.: the peer BGP ID used in the BGP session).
   Peer ASN.

o  Link Descriptors Sub-TLVs, as defined in [RFC7752], MUST contain
   the following TLVs:

   *  Link Local/Remote Identifiers (Sub-TLV 258) contains the
      4-octet Link Local Identifier followed by the 4-octet value 0
      indicating the Link Remote Identifier in unknown [RFC5307].

o  In addition, Link Descriptors Sub-TLVs, as defined in [RFC7752],
   MAY contain the following TLVs:

   *  IPv4 Interface Address (Sub-TLV 259) contains the address of
      the local interface through which the BGP session is
      established.

   *  IPv6 Interface Address (Sub-TLV 261) contains the address of
      the local interface through which the BGP session is
      established.

   *  IPv4 Neighbor Address (Sub-TLV 260) contains the IPv4 address
      of the peer interface used by the BGP session.

   *  IPv6 Neighbor Address (Sub-TLV 262) contains the IPv6 address
      of the peer interface used by the BGP session.

o  Link attribute used with the Peer-Adj-SID contains the TLV as
   defined in Section 4.3.

In addition, BGP-LS Link Attributes, as defined in [RFC7752], MAY be
inserted in order to advertise the characteristics of the link.

## 5.3.  Peer Set Segment

The Peer Adjacency Segment, at the BGP node advertising it, has the
following semantic:

o  SR header operation: NEXT (as defined in
   [I-D.ietf-spring-segment-routing]).

o  Next-Hop: load balance across any connected interface to any peer
   in the related set.

The Peer Set Segment is advertised within a Link NLRI (describing a
Peer Node Segment or a Peer Adjacency segment) as a BGP-LS attribute.

The Peer Set Attribute contains the Peer-Set-SID TLV, defined in
Section 4.3 identifying the set of which the Peer Node Segment or
Peer Adjacency Segment is a member.

6.  Illustration

6.1.  Reference Diagram

   The following reference diagram is used throughout this document.
   The solution is illustrated for IPv4 with MPLS-based segments and the
   BGP-EPE topology is based on eBGP sessions between external peers.

   As stated in Section 3, the solution illustrated hereafter is equally
   applicable to an iBGP session topology.  In other words, the solution
   also applies to the case where C, D, H, and E are in the same AS and
   run iBGP sessions between each other.

```
                    +------+
                    |      |
                +---D      F
    +---------+ /     | AS 2 |\  +------+
    |    X    |/      +------+ \ |   Z  |---L/8
    A         C---+            \|      |
    |         |\\   \  +------+ /| AS 4 |---M/8
    |    AS1  | \\  +-H       |/ +------+
    |         |  \\   |        G
    +----P----+    +===E AS 3 |
         |               +--Q---+
         |               |
      +----------------+
```
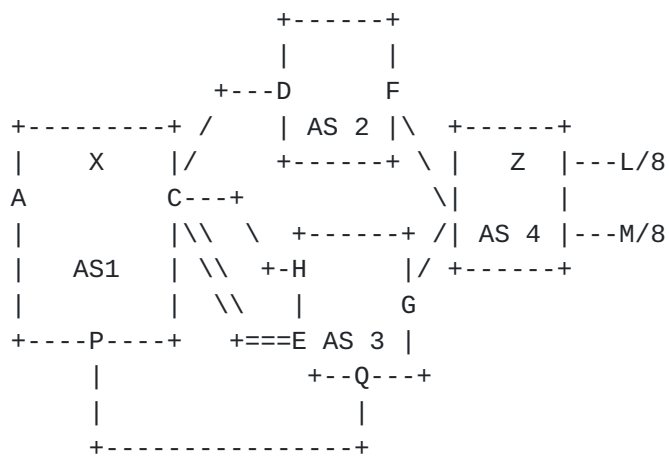
                  Figure 3: Reference Diagram

   IPv4 addressing:

   o  C's IPv4 address of interface to D: 1.0.1.1/24, D's interface:
      1.0.1.2/24

   o  C's IPv4 address of interface to H: 1.0.2.1/24, H's interface:
      1.0.2.2/24

   o  C's IPv4 address of upper interface to E: 1.0.3.1, E's interface:
      1.0.3.2/24

   o  C's local identifier of upper interface to E: 0.0.0.1.0.0.0.0

   o  C's IPv4 address of lower interface to E: 1.0.4.1/24, E's
      interface: 1.0.4.2/24

   o  C's local identifier of lower interface to E: 0.0.0.2.0.0.0.0

   o  Loopback of E used for eBGP multi-hop peering to C: 1.0.5.2/32

o  C's loopback is 3.3.3.3/32 with SID 64

BGP Router-IDs are C, D, H and E.

o  C's BGP Router-ID: 3.3.3.3

o  D's BGP Router-ID: 4.4.4.4

o  E's BGP Router-ID: 5.5.5.5

o  H's BGP Router-ID: 6.6.6.6

C's BGP peering:

o  Single-hop eBGP peering with neighbor 1.0.1.2 (D)

o  Single-hop eBGP peering with neighbor 1.0.2.2 (H)

o  Multi-hop eBGP peering with E on ip address 1.0.5.2 (E)

C's resolution of the multi-hop eBGP session to E:

o  Static route 1.0.5.2/32 via 1.0.3.2

o  Static route 1.0.5.2/32 via 1.0.4.2

Node C configuration is such that:

o  A Peer Node segment (Peer-Node-SID) is allocated to each peer (D,
   H and E).

o  An Peer Adjacency segment (Peer-Adj-SID) is defined for each
   recursing interface to a multi-hop peer (CE upper and lower
   interfaces).

o  A Peer Set segment (Peer-Set-SID) is defined to include all peers
   in AS3 (peers H and E).

Local BGP-LS Identifier in router C is set to 10000.

The Link NLRI Type is used in order to encode C's connectivity.  The
Link NLRI uses the new Protocol-ID value (to be assigned by IANA)

Once the BGP-LS update is originated by C, it may be advertised to
internal (iBGP) as well as external (eBGP) neighbors supporting the
BGP-LS EPE extensions defined in this document.

## 6.2.  Peer Node Segment for Node D

   Descriptors:

   o  Local Node Descriptors (BGP Router-ID, local ASN, BGP-LS
      Identifier): 3.3.3.3 , AS1, 10000

   o  Remote Node Descriptors (BGP Router-ID, peer ASN): 4.4.4.4, AS2

   o  Link Descriptors (BGP session IPv4 local address, BGP session IPv4
      neighbor address): 1.0.1.1, 1.0.1.2

   Attributes:

   o  Peer-Node-SID: 1012

   o  Link Attributes: see section 3.3.2 of [RFC7752]

## 6.3.  Peer Node Segment for Node H

   Descriptors:

   o  Local Node Descriptors (BGP Router-ID, ASN, BGPLS Identifier):
      3.3.3.3 , AS1, 10000

   o  Remote Node Descriptors (BGP Router-ID ASN): 6.6.6.6, AS3

   o  Link Descriptors (BGP session IPv4 local address, BGP session IPv4
      peer address): 1.0.2.1, 1.0.2.2

   Attributes:

   o  Peer-Node-SID: 1022

   o  Peer-Set-SID: 1060

   o  Link Attributes: see section 3.3.2 of [RFC7752]

## 6.4.  Peer Node Segment for Node E

   Descriptors:

   o  Local Node Descriptors (BGP Router-ID, ASN, BGP-LS Identifier):
      3.3.3.3 , AS1, 10000

   o  Remote Node Descriptors (BGP Router-ID, ASN): 5.5.5.5, AS3

o  Link Descriptors (BGP session IPv4 local address, BGP session IPv4
   peer address): 3.3.3.3, 1.0.5.2

Attributes:

o  Peer-Node-SID: 1052

o  Peer-Set-SID: 1060

## 6.5.  Peer Adjacency Segment for Node E, Link 1

Descriptors:

o  Local Node Descriptors (BGP Router-ID, ASN, BGP-LS Identifier):
   3.3.3.3 , AS1, 10000

o  Remote Node Descriptors (BGP Router-ID, ASN): 5.5.5.5, AS3

o  Link Descriptors (local interface identifier, IPv4 peer interface
   address): 0.0.0.1.0.0.0.0 , 1.0.3.2

Attributes:

o  Peer-Adj-SID: 1032

o  LinkAttributes: see section 3.3.2 of [RFC7752]

## 6.6.  Peer Adjacency Segment for Node E, Link 2

Descriptors:

o  Local Node Descriptors (BGP Router-ID, ASN, BGP-LS Identifier):
   3.3.3.3 , AS1, 10000

o  Remote Node Descriptors (BGP Router-ID, ASN): 5.5.5.5, AS3

o  Link Descriptors (local interface identifier, IPv4 peer interface
   address): 0.0.0.2.0.0.0.0 , 1.0.4.2

Attributes:

o  Peer-Adj-SID: 1042

o  LinkAttributes: see section 3.3.2 of [RFC7752]

7.  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 following values:

```
              +---------------------------------------+
              |  Codepoint | Description              |
              +---------------------------------------+
              |         7  | Protocol-ID BGP          |
              |       516  | BGP Router ID            |
              |       517  | BGP Confederation Member |
              |      1101  | Peer-Node-SID            |
              |      1102  | Peer-Adj-SID             |
              |      1103  | Peer-Set-SID             |
              +-----------+--------------------------+
```

   It will ease implementation interoperability and deployment if the
   value could be preserved.  However, when IANA-assigned values are
   available, implementations will be updated to use them.

## 8.  IANA Considerations

This document defines:

A new Protocol-ID: BGP.  The codepoint is from the "BGP-LS
Protocol-IDs" registry.

Two new TLVs: BGP-Router-ID and BGP Confederation Member.  The
codepoints are in the "BGP-LS Node Descriptor, Link Descriptor,
Prefix Descriptor, and Attribute TLVs" registry.

Three new BGP-LS Attribute TLVs: Peer-Node-SID, Peer-Adj-SID and
Peer-Set-SID.  The codepoints are in the "BGP-LS Node Descriptor,
Link Descriptor, Prefix Descriptor, and Attribute TLVs" registry.

### 8.1.  New BGP-LS Protocol-ID

This document defines a new value in the registry "BGP-LS Protocol-
IDs":

```
              +--------------------------------------+
              | Codepoint | Description              |
              +--------------------------------------+
              |   TBD1    | BGP                      |
              +--------------------------------------+
```

### 8.2.  Node Descriptors and Link Attribute TLVs

This document defines 5 new TLVs in the registry "BGP-LS Node
Descriptor, Link Descriptor, Prefix Descriptor, and Attribute TLVs":

o  Two new node descriptor TLVs

o  Three new link attribute TLVs

All the new 5 codepoints are in the same registry: "BGP-LS Node
Descriptor, Link Descriptor, Prefix Descriptor, and Attribute TLVs".
However, the registry is organized in ranges (node descriptors, link
descriptors, node attributes, link attributes).  The allocation
should be done accordingly.

The following new Node Descriptors TLVs are defined:

```
                  +----------------------------------------+
                  |  Codepoint | Description               |
                  +----------------------------------------+
                  |    TBD2    | BGP Router ID             |
                  |    TBD3    | BGP Confederation Member  |
                  +------------+--------------------------+
```

   The following new Link Attribute TLVs are defined:

```
                  +----------------------------------------+
                  |  Codepoint | Description               |
                  +----------------------------------------+
                  |    TBD4    | Peer-Node-SID             |
                  |    TBD5    | Peer-Adj-SID              |
                  |    TBD6    | Peer-Set-SID              |
                  +------------+--------------------------+
```

## 9.  Manageability Considerations

   This BGP-LS ([RFC7752]) extensions that are described in this
   document consists of additional BGP-LS descriptors and TLVs that will
   follow the same manageability functions of BGP-LS, described in
   [RFC7752].

   The operator MUST be capable of configuring, enabling, disabling the
   advertisement of each of the Peer-Node-SID, Peer-Adj-SID and Peer-
   Set-SID as well as to control which information is advertised to
   which internal or external peer.  This is not different from what is
   required by a BGP speaker in terms of information origination and
   advertisement.  In addition, the advertisement of EPE information
   MUST conform to standard BGP advertisement and propagation rules
   (iBGP, eBGP, Route-Reflectors, Confederations).

## 10.  Security Considerations

   [RFC7752] defines BGP-LS NLRIs to which the extensions defined in
   this document apply.

   The Security Section of [RFC7752] also applies to:

   o  New Node Descriptors Sub-TLVs: BGP-Router-ID and BGP-
      Confederation-Member;

   o  New BGP-LS Attributes TLVs: Peer-Node-SID, Peer-Adj-SID and Peer-
      Set-SID.

## 11.  Contributors

Saikat Ray and Acee Lindem gave a substantial contribution to this
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## 13.  References

### 13.1.  Normative References

[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>.

[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>.

[RFC5065]  Traina, P., McPherson, D., and J. Scudder, "Autonomous
           System Confederations for BGP", RFC 5065,
           DOI 10.17487/RFC5065, August 2007,
           <http://www.rfc-editor.org/info/rfc5065>.

[RFC5307]  Kompella, K., Ed. and Y. Rekhter, Ed., "IS-IS Extensions
           in Support of Generalized Multi-Protocol Label Switching
           (GMPLS)", RFC 5307, DOI 10.17487/RFC5307, October 2008,
           <http://www.rfc-editor.org/info/rfc5307>.

[RFC6286]  Chen, E. and J. Yuan, "Autonomous-System-Wide Unique BGP
           Identifier for BGP-4", RFC 6286, DOI 10.17487/RFC6286,
           June 2011, <http://www.rfc-editor.org/info/rfc6286>.

### 13.2.  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-10 (work in progress), November
           2016.

[I-D.ietf-spring-segment-routing-central-epe]
          Filsfils, C., Previdi, S., Aries, E., and D. Afanasiev,
          "Segment Routing Centralized BGP Peer Engineering", draft-
          ietf-spring-segment-routing-central-epe-03 (work in
          progress), November 2016.

[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>.

[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>.

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