Application-Specific Attributes Advertisement with BGP Link-State
draft-ietf-idr-bgp-ls-app-specific-attr-12

Abstract

   Extensions have been defined for link-state routing protocols that
   enable distribution of application-specific link attributes for
   existing as well as newer applications such as Segment Routing. This
   document defines extensions to BGP-LS to enable the advertisement of
   these application-specific attributes as a part of the topology
   information from the network.

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1. Introduction

BGP Link-State [RFC7752] enables the distribution of the link-state topology information from link-state routing protocols (viz., IS-IS [RFC1195], OSPFv2 [RFC2328] and OSPFv3 [RFC5340]) to an application like a controller or Path Computation Engine (PCE) via BGP. The controller/PCE gets the end-to-end topology information across IGP domains so it can perform path computations for use cases like end-to-end traffic engineering (TE).

The link-state topology information distributed via BGP-LS includes link attributes that were originally defined for MPLS Traffic Engineering (i.e., using RSVP-TE [RFC3209]) or GMPLS [RFC4202]) applications. In recent years applications, such as Segment Routing (SR) Policy [RFC8402] and Loop-Free Alternates (LFA) [RFC5286], that also make use of link attributes have been introduced. [RFC8919] and [RFC8920] define extensions for IS-IS and OSPF respectively that enable advertising application-specific link attributes for these and other future applications. This has resulted in the need for a similar BGP-LS extension to include this additional link-state topology information from the link-state routing protocols.

This document defines the BGP-LS extensions for the advertisement of application-specific link attributes. It describes the advertisement of these link attributes as top-level TLVs (i.e., as TLVs of the BGP-LS Attribute) and as sub-TLVs of the (top-level) Application Specific

Link Attributes TLV. The document also describes the procedures for
the advertisement of these attributes from the underlying IGPs and
discusses their deployment aspects.

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

2. Application Specific Link Attributes TLV

The BGP-LS [RFC7752] specifies the Link Network Layer Reachability
Information (NLRI) for the advertisement of links and their
attributes using the BGP-LS Attribute. The Application-Specific Link
Attributes (ASLA) TLV is an optional top-level BGP-LS Attribute TLV
that is introduced for Link NLRIs. It is defined such that it may
act as a container for certain existing and future link attributes
that require application-specific definition.

The format of this TLV is as follows and is similar to the
corresponding ASLA sub-TLVs defined for OSPF and IS-IS in [RFC8920]
and [RFC8919] respectively.

```
    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            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | SABM Length  | UDABM Length  |            Reserved           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      Standard Application Identifier Bit Mask (variable)     //
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     User-Defined Application Identifier Bit Mask (variable)  //
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                      Link Attribute sub-TLVs                 //
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

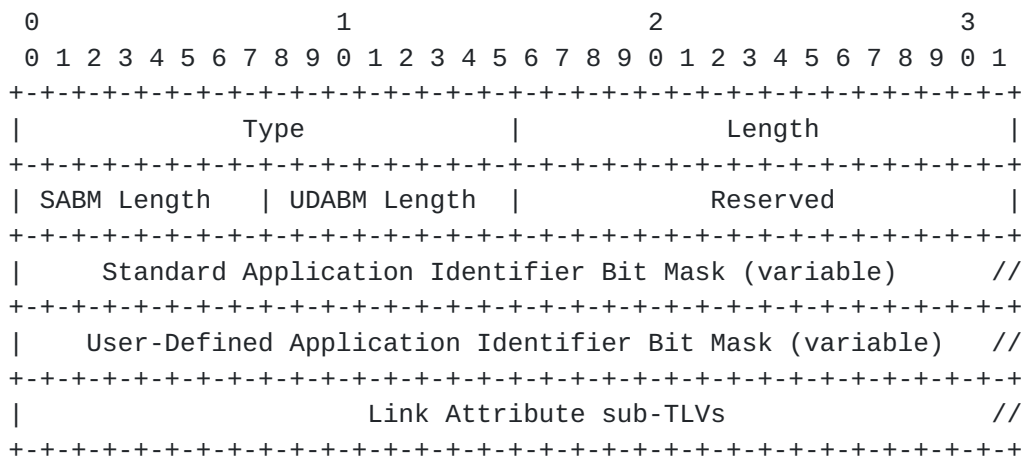   Figure 1: Application-Specific Link Attributes TLV

where:

o Type: 1122

o Length: variable.

o SABM Length : 1 octet field carrying the Standard Application
   Identifier Bit Mask Length in octets as defined in [RFC8920].

o UDABM Length : 1 octet field carrying the User-Defined Application
   Identifier Bit Mask Length in octets as defined in [RFC8920].

o Reserved: 2 octet field that MUST be set to zero on transmission
   and ignored on reception.

o Standard Application Identifier Bit Mask : An optional set of bits
   (of size 0, 4, or 8 octets as indicated by the SABM Length), where
   each bit represents a single standard application as defined in
   [RFC8919].

o User-Defined Application Identifier Bit Mask : An optional set of
   bits (of size 0, 4, or 8 octets as indicated by the UDABM Length),
   where each bit represents a single user-defined application as
   defined in [RFC8919].

o Link Attribute sub-TLVs : BGP-LS Attribute TLVs corresponding to
   the Link NLRI that are application-specific (including existing
   ones as specified in Section 3) are included as sub-TLVs of the
   ASLA TLV.

The semantics associated with the standard and user-defined bit masks
as well as the encoding scheme for application-specific attributes
are as specified in [RFC8920].

The ASLA TLV and its sub-TLVs can only be added to the BGP-LS
Attribute associated with the Link NLRI of the node that originates
the underlying IGP link attribute TLVs/sub-TLVs. The procedures for
originating link attributes in the ASLA TLV from underlying IGPs are
specified in Section 4.

3. Application-Specific Link Attributes

Several BGP-LS Attribute TLVs corresponding to the Link NLRI are
defined in BGP-LS and more may be added in the future. Those
attributes that have been determined to be, and advertised as
application-specific in the underlying IGPs are also encoded
similarly in BGP-LS.

The following table lists the currently defined BGP-LS Attributes
TLVs corresponding to Link NLRI that can have application-specific
semantics based on the underlying IGP specifications [RFC8919]
[RFC8920]. These were originally defined with semantics for RSVP-TE
and GMPLS applications in BGP-LS by the respective reference
documents.

```
+---------------+------------------------------+------------------+
|   TLV Code    | Description                  | Reference        |
|    Point      |                              | Document         |
+---------------+------------------------------+------------------+
|      1088     | Administrative group (color) | [RFC7752]        |
|      1092     | TE Default Metric            | [RFC7752]        |
|      1096     | Shared Risk Link Group       | [RFC7752]        |
|      1114     | Unidirectional Link Delay    | [RFC8571]        |
|      1115     | Min/Max Unidirectional Link  | [RFC8571]        |
|               | Delay                        |                  |
|      1116     | Unidirectional Delay         | [RFC8571]        |
|               | Variation                    |                  |
|      1117     | Unidirectional Link Loss     | [RFC8571]        |
|      1118     | Unidirectional Residual      | [RFC8571]        |
|               | Bandwidth                    |                  |
|      1119     | Unidirectional Available     | [RFC8571]        |
|               | Bandwidth                    |                  |
|      1120     | Unidirectional Utilized      | [RFC8571]        |
|               | Bandwidth                    |                  |
|      1173     | Extended Administrative Group | [RFC9104]       |
+---------------+------------------------------+------------------+
```

Table 1: Existing BGP-LS TLVs identified as Application-Specific

All the BGP-LS Attribute TLVs listed in the table above are REQUIRED
to be advertised as a top-level TLV in the BGP-LS Attribute when used
to carry link attributes specific to RSVP-TE.

BGP-LS Attribute TLVs corresponding to Link NLRI that are identified
as application-specific are REQUIRED to be encoded within an ASLA
TLV.

Link attributes that do not have application-specific semantics MUST
NOT be advertised within the ASLA TLV.

When the same application-specific link attributes are advertised
both within the ASLA TLV and as top-level TLVs in the BGP-LS
Attribute, the attributes advertised within the ASLA TLV take
precedence for the applications indicated in the ASLA TLV encoding.

4. Procedures

The BGP-LS originator learns of the association of an application-
specific attribute to one or more applications from the underlying
IGP protocol LSA/LSPs from which it is advertising the topology
information. [RFC8920] and [RFC8919] specify the mechanisms for
advertising application-specific link attributes in OSPF and IS-IS
respectively.

Application-specific link attributes received from an IGP node
without the use of ASLA encodings continue to be encoded using the
respective BGP-LS top-level TLVs listed in Table 1 as specified in
their respective reference documents.

A BGP-LS originator node that is advertising link-state information
from the underlying IGP using ASLA encodings determines their BGP-LS
encoding based on the following rules:

1. Application-specific link attributes received from an OSPF node
    using ASLA sub-TLV or from an IS-IS node using either ASLA sub-
    TLV or ASLA SRLG TLV MUST be encoded in the BGP-LS ASLA TLV as
    sub-TLVs. Exceptions to this rule are specified in (2)(F) and
    (2)(G) below.

2. In the case of IS-IS, the following specific procedures are to be
    followed given the difference in the ASLA encoding (e.g., the
    L-bit) in IS-IS and BGP-LS:

    A. When application-specific link attributes are received from a
        node with the L bit set in the IS-IS ASLA sub-TLV and
        application bits other than RSVP-TE are set in the
        application bit masks then the application-specific link
        attributes advertised in the corresponding legacy IS-IS TLVs/
        sub-TLVs MUST be encoded within the BGP-LS ASLA TLV as sub-
        TLVs with the application bits, other than the RSVP-TE bit,
        copied from the IS-IS ASLA sub-TLV. The link attributes
        advertised in the legacy IS-IS TLVs/sub-TLVs are also
        advertised in BGP-LS top-level TLVs as per [RFC7752]
        [RFC8571] [RFC9104]. The same procedure also applies for the
        advertisement of the SRLG values from the IS-IS ASLA SRLG
        TLV.

    B. When the IS-IS ASLA sub-TLV has the RSVP-TE application bit
        set, then the link attributes for the corresponding IS-IS
        ASLA sub-TLVs MUST be encoded using the respective BGP-LS
        top-level TLVs as per [RFC7752] [RFC8571] [RFC9104].
        Similarly, when the IS-IS ASLA SRLG TLV has the RSVP-TE
        application bit set, then the SRLG values within it MUST be
        encoded using the top-level BGP-LS SRLG TLV (1096) as per
        [RFC7752].

    C. The SRLGs advertised in IS-IS SRLG ASLA TLVs and the other
        link attributes advertised in IS-IS ASLA sub-TLVs are
        REQUIRED to be collated, on a per-application basis, for all
        applications that have their bit set in the SABM/UDABM in at
        least one of the aforementioned TLV types. When performing
        this collation, only the TLVs with the application's bit set

in SABM/UDABM MUST be used when such TLVs are available from either TLV types. If the bit for an application is set in the SABM/UDABM of only one of the TLV types, then the attributes from the other TLV type with zero-length application bit mask MUST be also collated for that application, if such TLV is available. Such collated link attributes are advertised in a per-application instance of the BGP-LS ASLA TLV.

D. If the resulting set of collated link attributes and SRLG values is common across multiple applications, they MAY be advertised in a common BGP-LS ASLA TLV instance where the bits for all such applications would be set in the application bit mask.

E. Both the SRLG values from IS-IS ASLA SRLG TLVs and the link attributes from IS-IS ASLA sub-TLVs, with the zero-length application bit mask, MUST be advertised into a BGP-LS ASLA TLV with a zero-length application bit mask, independent of the collation described above.

F. [RFC8919] allows the advertisement of the Maximum Link Bandwidth within an IS-IS ASLA sub-TLV even though it is not an application-specific attribute. However, when originating the Maximum Link Bandwidth into BGP-LS, the attribute MUST be encoded only in the top-level BGP-LS Maximum Link Bandwidth TLV (1089) and MUST NOT be advertised within the BGP-LS ASLA TLV.

G. [RFC8919] also allows the advertisement of the Maximum Reservable Link Bandwidth and the Unreserved Bandwidth within an IS-IS ASLA sub-TLV even though these attributes are specific to RSVP-TE application. However, when originating the Maximum Reservable Link Bandwidth and Unreserved Bandwidth into BGP-LS, these attributes MUST be encoded only in the BGP-LS top-level Maximum Reservable Link Bandwidth TLV (1090) and Unreserved Bandwidth TLV (1091) respectively and not within the BGP-LS ASLA TLV.

These rules ensure that a BGP-LS originator performs the advertisement for all application-specific link attributes from the IGP nodes that support the ASLA extension. Furthermore, it also ensures that the top-level BGP-LS TLVs defined for RSVP-TE and GMPLS applications continue to be used for advertisement of their application-specific attributes.

A BGP-LS speaker would normally advertise all the application-specific link attributes corresponding to RSVP-TE and GMPLS

applications as existing top-level BGP-LS TLVs while for other
applications they are encoded in ASLA TLV(s) with appropriate
applicable bit mask setting. An application-specific attribute value
received via a sub-TLV within the ASLA TLV has precedence over the
value received via a top-level TLV.

5. Deployment Considerations

BGP-LS sources the link-state topology information (including the
extensions introduced by this document) from the underlying link-
state IGP protocols. The various deployment aspects related to the
advertisement and use of application-specific link attributes are
discussed in the Deployment Considerations sections of [RFC8920] and
[RFC8919]. The IGP backward compatibility aspects described in those
documents associated with application-specific link attributes along
with the BGP-LS procedures specified in this document enable backward
compatibility in deployments of existing implementations of [RFC7752]
[RFC8571] [RFC9104] for applications such as RSVP-TE, SR Policy, and
LFA.

It is recommended that only nodes supporting this specification are
selected as originators of BGP-LS information when advertising the
link-state information from the IGPs in deployments supporting
application-specific link attributes.

BGP-LS consumers that do not support this specification can continue
to use the existing top-level TLVs for link attributes for existing
applications as discussed above. They would, however, be able to
support neither the application-specific link attributes nor newer
applications that may be encoded only using the ASLA TLV.

6. IANA Considerations

IANA has assigned, through the early allocation process, the
following code-point from the "BGP-LS Node Descriptor, Link
Descriptor, Prefix Descriptor, and Attribute TLVs" registry. This
document requests that the allocation be made permanent. The column
"IS-IS TLV/Sub-TLV" defined in the registry does not require any
value and should be left empty.

Code Point	Description	Reference
1122	Application-Specific Link Attributes	this document

Table 2: ASLA TLV Code-Point Allocation

7. Manageability Considerations

The protocol extensions introduced in this document augment the existing IGP topology information defined in [RFC7752]. Procedures and protocol extensions defined in this document do not affect the BGP protocol operations and management other than as discussed in the Manageability Considerations section of [RFC7752]. Specifically, the malformed NLRIs attribute tests in the Fault Management section of [RFC7752] now encompasses the BGP-LS TLVs defined in this document.

The extensions specified in this document do not specify any new configuration or monitoring aspects in BGP or BGP-LS. The specification of BGP models is an ongoing work based on [I-D.ietf-idr-bgp-model].

8. Security Considerations

Security considerations for acquiring and distributing BGP-LS information are discussed in [RFC7752]. Specifically the considerations related to topology information related to traffic engineering apply.

The TLVs introduced in this document are used to propagate the application-specific link attributes IGP extensions defined in [RFC8919] and [RFC8920]. It is assumed that the IGP instances originating these TLVs will support all the required security (as described in [RFC8919] and [RFC8920]).

This document defines a new way to advertise link attributes. Tampering with the information defined in this document may affect applications using it, including impacting traffic engineering, which uses various link attributes for its path computation. As the advertisements defined in this document limit the scope to specific applications, the impact of tampering is similarly limited in scope. The advertisement of the link attribute information defined in this document presents no significant additional risk beyond that associated with the existing link attribute information already supported in [RFC7752].

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