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Application-Specific Attributes Advertisement with BGP Link-State
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Abstract

Various link attributes have been defined in link-state routing protocols like OSPF and IS-IS in the context of the MPLS Traffic Engineering (TE) and GMPLS. BGP Link-State (BGP-LS) extensions have been defined to distribute these attributes along with other topology information from these link-state routing protocols.

New 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 traditional MPLS Traffic Engineering (i.e., using RSVP-TE [[RFC3209](#)] or GMPLS [[RFC4202](#)]) applications. In recent years new 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 new (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 NLRI for the advertisement of links and their attributes using the BGP-LS Attribute. The Application-Specific Link Attributes (ASLA) TLV is a new 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.

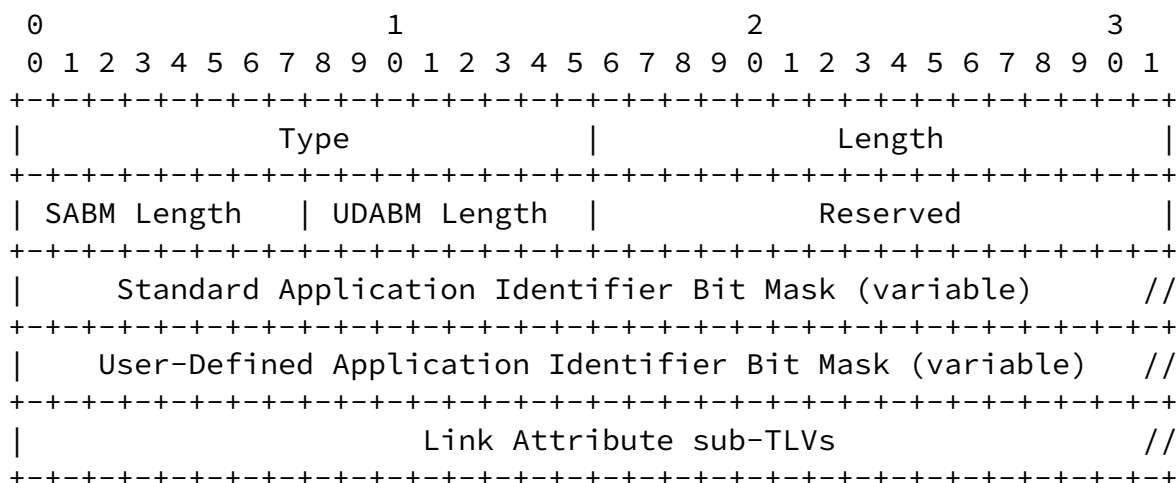


Figure 1: Application-Specific Link Attributes TLV

where:

- o Type: 1122
- o Length: variable.
- o SABM Length : Standard Application Identifier Bit Mask Length in octets as defined in [[RFC8920](#)].
- o UDABM Length : User-Defined Application Identifier Bit Mask Length in octets as defined in [[RFC8920](#)].
- o Standard Application Identifier Bit Mask : An optional set of bits

(of size 0, 4, or 8 octets as indicated by the SABML), where each bit represents a single standard application as defined in [\[RFC8920\]](#).

- o User-Defined Application Identifier Bit Mask : An optional set of bits (of size 0, 4, or 8 octets as indicated by the UDABML), where each bit represents a single user-defined application as defined in [\[RFC8920\]](#).
- 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.

As specified in [\[RFC8920\]](#), an ASLA TLV with both the SABM and UDABM lengths set to 0 (i.e. without any application identifier bit masks) indicates that the link attribute sub-TLVs that it encloses are applicable for all applications. However, the link attributes advertised within an ASLA TLV with such zero-length application bit

masks are not applicable for those applications for which at least one instance of ASLA TLV is present in the same advertisement with their specific application bit set.

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. The following types of link attributes are expected to be considered application-specific.

- o those that can have different values for different applications e.g., a different TE metric value used for RSVP-TE than for SR Policy
- o those that apply to multiple applications but are meant to be used

only by a specific application(s) in a given deployment e.g., Shared Risk Link Group (SRLG) values are configured on a node for use with RSVP-TE and are not meant to be used for LFA computation

When a new link attribute is introduced, the above guidelines help determine if that link attribute has application-specific semantics. Those attributes that have been determined to be, and advertised as application-specific in the underlying IGPs are also encoded in a similar manner in BGP-LS.

The following table lists the currently defined BGP-LS Attributes TLVs corresponding to Link NLRI that can have application-specific semantics. These were originally defined with semantics for RSVP-TE and GMPLS applications.

| TLV Code Point | Description | Reference 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 Delay | [RFC8571] |
| 1116 | Unidirectional Delay Variation | [RFC8571] |
| 1117 | Unidirectional Link Loss | [RFC8571] |
| 1118 | Unidirectional Residual Bandwidth | [RFC8571] |

| | | |
|------|------------------------------------|-----------|
| 1119 | Unidirectional Available Bandwidth | [RFC8571] |
| 1120 | Unidirectional Utilized Bandwidth | [RFC8571] |
| 1173 | Extended Administrative Group | [RFC9104] |

Table 1: Initial set of TLVs used as ASLA sub-TLVs

All the BGP-LS Attribute TLVs defined in the table above are REQUIRED to be advertised as a top-level TLV in the BGP-LS Attribute for carrying link attributes specific to RSVP-TE.

BGP-LS Attribute TLVs corresponding to Link NLRI that are defined in the future MUST specify if they are application-specific and hence 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. Receivers MUST ignore any non-application-specific attribute sub-TLVs 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.

A BGP-LS originator node that is advertising link-state information from the underlying IGP determines the protocol encoding of application-specific link attributes based on the following rules:

1. Application-specific link attributes received from an IGP node

using existing RSVP-TE/GMPLS encodings MUST be encoded using the respective BGP-LS top-level TLVs listed in Table 1.

2. Application-specific link attributes received from an OSPF node using ASLA sub-TLV or from an IS-IS node (except for (3)(F) and (3)(G) below) using either ASLA sub-TLV or ASLA SRLG TLV MUST be encoded in the BGP-LS ASLA TLV as sub-TLVs.
3. In the case of IS-IS, the following specific procedures are to be followed:
 - A. When application-specific link attributes are received from a node with the L bit set in the 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 MUST also be advertised in BGP-LS top-level TLVs listed in Table 1. The same procedure also applies for the advertisement of the SRLG values from the IS-IS ASLA SRLG TLV.
 - B. When the ASLA sub-TLV has the RSVP-TE application bit set, then the link attributes for the corresponding ASLA sub-TLV MUST be encoded using the respective BGP-LS top-level TLVs listed in Table 1. Similarly, when the 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).
 - 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

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 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 the receiver MUST ignore them when 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 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 or do not 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 receive 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. The application-specific attribute value received via sub-TLVs within

the ASLA TLV are preferred over the value received via the top-level TLVs.

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 applications such as RSVP-TE, SR Policy, and LFA.

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

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, not 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 | Length |
|------------|--|----------|
| 1122 | Application-Specific Link Attributes TLV | variable |

Table 2: ASLA TLV Code-Point Allocation

7. Manageability Considerations

The new 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](#)].

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](#)]) to prevent any security issues when propagating the TLVs into BGP-LS.

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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