Internet Engineering Task Force (IETF)
Request for Comments: 9479
Obsoletes: 8919
Category: Standards Track
ISSN: 2070-1721

L. Ginsberg
P. Psenak
Cisco Systems
S. Previdi
Huawei Technologies
W. Henderickx
Nokia
J. Drake
Juniper Networks

October 2023

IS-IS Application-Specific Link Attributes

Abstract

Existing traffic-engineering-related link attribute advertisements have been defined and are used in RSVP-TE deployments. Since the original RSVP-TE use case was defined, additional applications (e.g., Segment Routing Policy and Loop-Free Alternates) that also make use of the link attribute advertisements have been defined. In cases where multiple applications wish to make use of these link attributes, the current advertisements do not support application-specific values for a given attribute, nor do they support an indication of which applications are using the advertised value for a given link. This document introduces link attribute advertisements that address both of these shortcomings.

This document obsoletes RFC 8919.

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 7841.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at https://www.rfc-editor.org/info/rfc9479.

Table of Contents

1. Introduction

Advertisement of link attributes by the Intermediate System to Intermediate System (IS-IS) protocol in support of Traffic Engineering (TE) was introduced by [RFC5305] and extended by [RFC5307], [RFC6119], [RFC7308], and [RFC8570]. The use of these extensions has been associated with deployments supporting TE over Multiprotocol Label Switching (MPLS) in the presence of the Resource Reservation Protocol (RSVP), more succinctly referred to as RSVP-TE [RFC3209].

For the purposes of this document, an application is a technology that makes use of link attribute advertisements, examples of which are listed in Section 3.

In recent years, new applications that have use cases for many of the link attributes historically used by RSVP-TE have been introduced. Such applications include Segment Routing (SR) Policy [RFC9256] and Loop-Free Alternates (LFAs) [RFC5286]. This has introduced ambiguity in that if a deployment includes a mix of RSVP-TE support and SR Policy support, for example, it is not possible to unambiguously indicate which advertisements are to be used by RSVP-TE and which advertisements are to be used by SR Policy. If the topologies are fully congruent, this may not be an issue, but any incongruence leads to ambiguity.

An example of where this ambiguity causes a problem is a network

where RSVP-TE is enabled only on a subset of its links. A link attribute is advertised for the purpose of another application (e.g., SR Policy) for a link that is not enabled for RSVP-TE. As soon as the router that is an RSVP-TE head end sees the link attribute being advertised for that link, it assumes that RSVP-TE is enabled on that link, even though it is not. If such an RSVP-TE head-end router tries to set up an RSVP-TE path via that link, it will result in a setup failure for the path.

An additional issue arises in cases where both applications are supported on a link but the link attribute values associated with each application differ. Current advertisements do not support advertising application-specific values for the same attribute on a specific link.

This document defines extensions that address these issues. Also, as evolution of use cases for link attributes can be expected to continue in the years to come, this document defines a solution that is easily extensible to the introduction of new applications and new use cases.

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. Requirements Discussion

As stated previously, evolution of use cases for link attributes can be expected to continue. Therefore, any discussion of existing use cases is limited to requirements that are known at the time of this writing. However, in order to determine the functionality required beyond what already exists in IS-IS, it is only necessary to discuss use cases that justify the key points identified in the Introduction, which are:

1. Support for indicating which applications are using the link attribute advertisements on a link.

2. Support for advertising application-specific values for the same attribute on a link.

[RFC7855] discusses use cases and requirements for SR. Included among these use cases is SR Policy, which is defined in [RFC9256]. If both RSVP-TE and SR Policy are deployed in a network, link attribute advertisements can be used by one or both of these applications. There is no requirement for the link attributes advertised on a given link used by SR Policy to be identical to the link attributes advertised on that same link used by RSVP-TE; thus, there is a clear requirement to indicate independently which link attribute advertisements are to be used by each application.

As the number of applications that may wish to utilize link attributes may grow in the future, an additional requirement is that the extensions defined allow the association of additional applications to link attributes without altering the format of the advertisements or introducing backwards-compatibility issues.

Finally, there may still be many cases where a single attribute value can be shared among multiple applications, so the solution must minimize advertising duplicate link/attribute pairs whenever possible.

3. Legacy Advertisements

Existing advertisements used in support of RSVP-TE include sub-TLVs for TLVs Advertising Neighbor Information and TLVs for Shared Risk Link Group (SRLG) advertisements.

Sub-TLV values are defined in the "IS-IS Sub-TLVs for TLVs Advertising Neighbor Information" registry.

TLVs are defined in the "IS-IS TLV Codepoints" registry.

3.1. Legacy Sub-TLVs

Type	Description
3	Administrative group (color)
9	Maximum link bandwidth
10	Maximum reservable link bandwidth
11	Unreserved bandwidth
14	Extended Administrative Group
18	TE Default metric
33	Unidirectional Link Delay
34	Min/Max Unidirectional Link Delay
35	Unidirectional Delay Variation
36	Unidirectional Link Loss
37	Unidirectional Residual Bandwidth
38	Unidirectional Available Bandwidth
39	Unidirectional Utilized Bandwidth

Table 1

3.2. Legacy SRLG Advertisements

TLV 138 (GMPLS-SRLG):
Supports links identified by IPv4 addresses and unnumbered links.

TLV 139 (IPv6 SRLG):
Supports links identified by IPv6 addresses.

Note that [RFC6119] prohibits the use of TLV 139 when it is possible to use TLV 138.

4. Advertising Application-Specific Link Attributes

Two codepoints are defined to support Application-Specific Link Attribute (ASLA) advertisements:

1. Application-Specific Link Attributes sub-TLV for TLVs Advertising Neighbor Information (defined in Section 4.2).

2. Application-Specific SRLG TLV (defined in Section 4.3).

To support these advertisements, an application identifier bit mask is defined to identify the application(s) associated with a given advertisement (defined in Section 4.1).

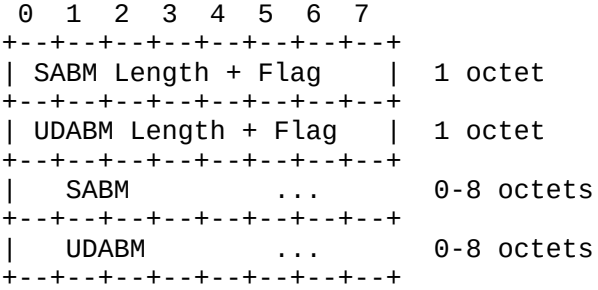
In addition to supporting the advertisement of link attributes used by standardized applications, link attributes can also be advertised for use by User-Defined Applications (UDAs). Such applications are not subject to standardization and are outside the scope of this document.

The following sections define the format of these advertisements.

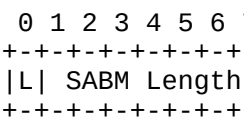
4.1. Application Identifier Bit Mask

Identification of the set of applications associated with link attribute advertisements utilizes two bit masks. One bit mask is for standard applications where the definition of each bit is defined in an IANA-controlled registry (see Section 7.4). A second bit mask is for non-standard UDAs.

The encoding defined below is used by both the Application-Specific Link Attributes sub-TLV and the Application-Specific SRLG TLV.



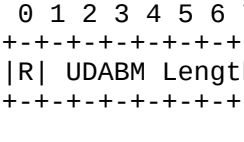
SABM Length + Flag (1 octet):
Standard Application Identifier Bit Mask Length + Flag



L-flag:
Legacy Flag. See Section 4.2 for a description of how this flag is used.

SABM Length:
This field indicates the length in octets (0-8) of the Standard Application Identifier Bit Mask. The length SHOULD be the minimum required to send all bits that are set.

UDABM Length + Flag (1 octet):
User-Defined Application Identifier Bit Mask Length + Flag



R:
Reserved. SHOULD be transmitted as 0 and MUST be ignored on receipt.

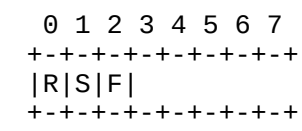
UDABM Length:
Indicates the length in octets (0-8) of the User-Defined Application Identifier Bit Mask. The length SHOULD be the

minimum required to send all bits that are set.

SABM (variable length):
Standard Application Identifier Bit Mask

(SABM Length * 8) bits

This field is omitted if SABM Length is 0.



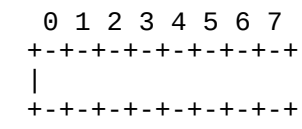
R-bit:
Set to specify RSVP-TE.

S-bit:
Set to specify SR Policy (this is data plane independent).

F-bit:
Set to specify an LFA (includes all LFA types).

UDABM (variable length):
User-Defined Application Identifier Bit Mask

(UDABM Length * 8) bits



This field is omitted if UDABM Length is 0.

| Note: SABM/UDABM Length is arbitrarily limited to 8 octets in order to ensure that sufficient space is left to advertise link attributes without overrunning the maximum length of a sub-TLV.

Standard Application Identifier Bits are defined and sent starting with bit 0.

User-Defined Application Identifier Bits have no relationship to Standard Application Identifier Bits and are not managed by IANA or any other standards body. It is recommended that bits be used starting with bit 0 so as to minimize the number of octets required to advertise all UDAs.

For both the SABM and UDABM, the following rules apply:

* Undefined bits that are transmitted MUST be transmitted as 0 and MUST be ignored on receipt.

* Bits that are not transmitted MUST be treated as if they are set to 0 on receipt.

* Bits that are not supported by an implementation MUST be ignored on receipt.

4.2. Application-Specific Link Attributes Sub-TLV

A sub-TLV for TLVs Advertising Neighbor Information is defined that supports specification of the applications and application-specific attribute values.

Type:

16

Length:
Variable (1 octet)

Value:
Application Identifier Bit Mask (as defined in Section 4.1)

Link Attribute sub-sub-TLVs -- format matches the existing formats defined in [RFC5305], [RFC7308], and [RFC8570]

If the SABM Length or UDABM Length in the Application Identifier Bit Mask is greater than 8, the entire sub-TLV MUST be ignored.

When the SABM Length or UDABM Length is non-zero and the L-flag is NOT set, all applications specified in the bit mask MUST use the link attribute advertisements in the sub-TLV.

When the L-flag is set in the Application Identifier Bit Mask, all of the applications specified in the bit mask MUST use the legacy advertisements for the corresponding link found in TLVs Advertising Neighbor Information. Link attribute sub-sub-TLVs for the corresponding link attributes MUST NOT be advertised for the set of applications specified in the Standard Application Identifier Bit Mask or the User-Defined Application Identifier Bit Mask, and all such sub-sub-TLVs MUST be ignored on receipt.

Multiple Application-Specific Link Attributes sub-TLVs for the same link MAY be advertised. When multiple sub-TLVs for the same link are advertised, they SHOULD advertise non-conflicting application/attribute pairs. A conflict exists when the same application is associated with two different values for the same link attribute for a given link. In cases where conflicting values for the same application/attribute/link are advertised, the first advertisement received in the lowest-numbered Link State Protocol Data Unit (LSP) MUST be used, and subsequent advertisements of the same attribute MUST be ignored.

For a given application, the setting of the L-flag MUST be the same in all sub-TLVs for a given link. In cases where this constraint is violated, the L-flag MUST be considered set for this application.

The end result of the set of rules defined above is that for a given application either the attribute values advertised in ASLA sub-sub-TLVs are used or the attribute values advertised in legacy sub-TLVs are used, but not both.

Link attributes MAY be advertised associated with zero-length Application Identifier Bit Masks for both standard applications and UDAs. Such link attribute advertisements MUST be used by standard applications and/or UDAs when no link attribute advertisements with a non-zero-length Application Identifier Bit Mask and a matching Application Identifier Bit set are present for a given link. Otherwise, such link attribute advertisements MUST NOT be used.

IANA has created a registry of sub-sub-TLVs to define the link attribute sub-sub-TLV codepoints (see Section 7.3). This document defines a sub-sub-TLV for each of the existing sub-TLVs listed in Section 3.1, except as noted below. The format of the sub-sub-TLVs matches the format of the corresponding legacy sub-TLV, and IANA has assigned the legacy sub-TLV identifier to the corresponding sub-sub-TLV.

4.2.1. Special Considerations for Maximum Link Bandwidth

Maximum link bandwidth is an application-independent attribute of the

link. When advertised using the Application-Specific Link Attributes sub-TLV, multiple values for the same link MUST NOT be advertised. This can be accomplished most efficiently by having a single advertisement for a given link where the Application Identifier Bit Mask identifies all the applications that are making use of the value for that link.

It is also possible to advertise the same value for a given link multiple times with disjoint sets of applications specified in the Application Identifier Bit Mask. This is less efficient but still valid.

It is also possible to advertise a single advertisement with a zero-length SABM and UDABM so long as the constraints discussed in Sections 4.2 and 6.2 are satisfied.

If different values for maximum link bandwidth for a given link are advertised, all values MUST be ignored.

4.2.2. Special Considerations for Reservable/Unreserved Bandwidth

Maximum reservable link bandwidth and unreserved bandwidth are attributes specific to RSVP-TE. When advertised using the Application-Specific Link Attributes sub-TLV, bits other than the RSVP-TE bit (R-bit) MUST NOT be set in the Application Identifier Bit Mask. If an advertisement of maximum reservable link bandwidth or unreserved bandwidth is received with bits other than the R-bit set, the advertisement MUST be ignored.

4.2.3. Considerations for Extended TE Metrics

[RFC8570] defines a number of dynamic performance metrics associated with a link. It is conceivable that such metrics could be measured specific to traffic associated with a specific application. Therefore, this document includes support for advertising these link attributes specific to a given application. However, in practice, it may well be more practical to have these metrics reflect the performance of all traffic on the link regardless of application. In such cases, advertisements for these attributes will be associated with all of the applications utilizing that link. This can be done by either explicitly specifying the applications in the Application Identifier Bit Mask or using a zero-length Application Identifier Bit Mask. The use of zero-length Application Identifier Bit Masks is further discussed in Section 6.2.

4.3. Application-Specific SRLG TLV

A TLV is defined to advertise application-specific SRLGs for a given link. Although similar in functionality to TLV 138 [RFC5307] and TLV 139 [RFC6119], this single TLV provides support for IPv4, IPv6, and unnumbered identifiers for a link. Unlike TLVs 138 and 139, it utilizes sub-TLVs to encode the link identifiers in order to provide the flexible formatting required to support multiple link identifier types.

Type:
   238

Length:
   Number of octets in the value field (1 octet)

Value:
   Neighbor System-ID + pseudonode ID (7 octets)

   Application Identifier Bit Mask (as defined in Section 4.1)

Length of sub-TLVs (1 octet)

Link Identifier sub-TLVs (variable)

0 or more SRLG values (each value is 4 octets)

If the SABM Length or UDABM Length in the Application Identifier Bit Mask is greater than 8, the entire sub-TLV MUST be ignored.

When the SABM Length or UDABM Length is non-zero and the L-flag is NOT set, all applications specified in the bit mask MUST use SRLG advertisements in the Application-Specific SRLG TLV.

The following Link Identifier sub-TLVs are defined. The values chosen intentionally match the equivalent sub-TLVs from [RFC5305], [RFC5307], and [RFC6119].

Type	Description
4	Link Local/Remote Identifiers [RFC5307]
6	IPv4 interface address [RFC5305]
8	IPv4 neighbor address [RFC5305]
12	IPv6 Interface Address [RFC6119]
13	IPv6 Neighbor Address [RFC6119]

Table 2

At least one set of link identifiers (IPv4, IPv6, or Link Local/ Remote) MUST be present. Multiple occurrences of the same identifier type MUST NOT be present. TLVs that do not meet this requirement MUST be ignored.

Multiple TLVs for the same link MAY be advertised.

When the L-flag is set in the Application Identifier Bit Mask, SRLG values MUST NOT be included in the TLV. Any SRLG values that are advertised MUST be ignored. Based on the link identifiers advertised, the corresponding legacy TLV (see Section 3.2) can be identified, and the SRLG values advertised in the legacy TLV MUST be used by the set of applications specified in the Application Identifier Bit Mask.

For a given application, the setting of the L-flag MUST be the same in all TLVs for a given link. In cases where this constraint is violated, the L-flag MUST be considered set for this application.

5. Attribute Advertisements and Enablement

This document defines extensions to support the advertisement of ASLAs.

Whether the presence of link attribute advertisements for a given application indicates that the application is enabled on that link depends upon the application. Similarly, whether the absence of link attribute advertisements indicates that the application is not enabled depends upon the application.

In the case of RSVP-TE, the advertisement of ASLAs implies that RSVP is enabled on that link. The absence of RSVP-TE ASLAs in combination with the absence of legacy advertisements implies that RSVP is not

enabled on that link.

In the case of SR Policy, the advertisement of ASLAs does not indicate enablement of SR Policy on that link. The advertisements are only used to support constraints that may be applied when specifying an explicit path. SR Policy is implicitly enabled on all links that are part of the SR-enabled topology independent of the existence of link attribute advertisements.

In the case of LFA, the advertisement of ASLAs does not indicate enablement of LFA on that link. Enablement is controlled by local configuration.

In the future, if additional standard applications are defined to use this mechanism, the specification defining this use MUST define the relationship between ASLA advertisements and enablement for those applications.

This document allows the advertisement of ASLAs with no application identifiers, i.e., neither the Standard Application Identifier Bit Mask nor the User-Defined Application Identifier Bit Mask is present (see Section 4.1). This supports the use of the link attribute by any application. In the presence of an application where the advertisement of link attributes is used to infer the enablement of an application on that link (e.g., RSVP-TE), the absence of the application identifier leaves ambiguous whether that application is enabled on such a link. This needs to be considered when making use of the "any application" encoding.

6. Deployment Considerations

This section discusses deployment considerations associated with the use of ASLA advertisements.

6.1. Use of Legacy Advertisements

Bit identifiers for standard applications are defined in Section 4.1. All of the identifiers defined in this document are associated with applications that were already deployed in some networks prior to the writing of this document. Therefore, such applications have been deployed using the legacy advertisements. The standard applications defined in this document may continue to use legacy advertisements for a given link so long as at least one of the following conditions is true:

* The application is RSVP-TE.

* The application is SR Policy or LFA, and RSVP-TE is not deployed anywhere in the network.

* The application is SR Policy or LFA, RSVP-TE is deployed in the network, and both the set of links on which SR Policy and/or LFA advertisements are required and the attribute values used by SR Policy and/or LFA on all such links are fully congruent with the links and attribute values used by RSVP-TE.

Under the conditions defined above, implementations that support the extensions defined in this document have the choice of using legacy advertisements or application-specific advertisements in support of SR Policy and/or LFA. This will require implementations to provide controls specifying which types of advertisements are to be sent and processed on receipt for these applications. Further discussion of the associated issues can be found in Section 6.3.

New applications that future documents define to make use of the advertisements defined in this document MUST NOT make use of legacy

advertisements. This simplifies deployment of new applications by eliminating the need to support multiple ways to advertise attributes for the new applications.

6.2. Use of Zero-Length Application Identifier Bit Masks

Link attribute advertisements associated with zero-length Application Identifier Bit Masks for both standard applications and UDAs are usable by any application, subject to the restrictions specified in Section 4.2. If support for a new application is introduced on any node in a network in the presence of such advertisements, the new application will use these advertisements, when the aforementioned restrictions are met. If this is not what is intended, then existing link attribute advertisements MUST be readvertised with an explicit set of applications specified before a new application is introduced.

6.3. Interoperability, Backwards Compatibility, and Migration Concerns

Existing deployments of RSVP-TE, SR Policy, and/or LFA utilize the legacy advertisements listed in Section 3. Routers that do not support the extensions defined in this document will only process legacy advertisements and are likely to infer that RSVP-TE is enabled on the links for which legacy advertisements exist. It is expected that deployments using the legacy advertisements will persist for a significant period of time. Therefore, deployments using the extensions defined in this document in the presence of routers that do not support these extensions need to be able to interoperate with the use of legacy advertisements by the legacy routers. The following subsections discuss interoperability and backwards-compatibility concerns for a number of deployment scenarios.

6.3.1. Multiple Applications: Common Attributes with RSVP-TE

In cases where multiple applications are utilizing a given link, one of the applications is RSVP-TE, and all link attributes for a given link are common to the set of applications utilizing that link, interoperability is achieved by using legacy advertisements and sending application-specific advertisements with the L-flag set and no link attribute values. This avoids duplication of link attribute advertisements.

6.3.2. Multiple Applications: All Attributes Not Shared with RSVP-TE

In cases where one or more applications other than RSVP-TE are utilizing a given link and one or more link attribute values are not shared with RSVP-TE, it is necessary to use application-specific advertisements as defined in this document. Attributes for applications other than RSVP-TE MUST be advertised using application-specific advertisements that have the L-flag clear. In cases where some link attributes are shared with RSVP-TE, this requires duplicate advertisements for those attributes.

These guidelines apply to cases where RSVP-TE is not using any advertised attributes on a link and to cases where RSVP-TE is using some link attribute advertisements on the link but some link attributes cannot be shared with RSVP-TE.

6.3.3. Interoperability with Legacy Routers

For the standard applications defined in this document, routers that do not support the extensions defined in this document will send and receive only legacy link attribute advertisements. In addition, the link attribute values associated with these applications are always shared, since legacy routers have no way of advertising or processing application-specific values. So long as there is any legacy router in the network that has any of the standard applications defined in

this document enabled, all routers MUST continue to advertise link attributes for these applications using only legacy advertisements. ASLA advertisements for these applications MUST NOT be sent. Once all legacy routers have been upgraded, migration from legacy advertisements to ASLA advertisements can be achieved via the following steps:

1. Send ASLA advertisements while continuing to advertise legacy advertisements (all advertisements are then duplicated). Receiving routers continue to use legacy advertisements.

2. Enable the use of the ASLA advertisements on all routers.

3. Remove legacy advertisements.

When the migration is complete, it then becomes possible to advertise incongruent values per application on a given link.

Note that the use of the L-flag is of no value in the migration.

Documents defining new applications that make use of the application-specific advertisements defined in this document MUST discuss interoperability and backwards-compatibility issues that could occur in the presence of routers that do not support the new application.

6.3.4. Use of Application-Specific Advertisements for RSVP-TE

The extensions defined in this document include RSVP-TE as one of the applications. It is therefore possible, in the future, for implementations to migrate to the use of application-specific advertisements in support of RSVP-TE. This could be done in the following stepwise manner:

1. Upgrade all routers to support the extensions in this document.

2. Advertise all legacy link attributes using ASLA advertisements with the L-flag clear and the R-bit set. At this point, both legacy and application-specific advertisements are being sent.

3. Remove legacy advertisements.

7. IANA Considerations

This section lists the protocol codepoint changes introduced by this document and the related IANA updates.

For the registries defined under the "IS-IS TLV Codepoints" group of registries with a registration procedure of "Expert Review" (see Sections 7.3 and 7.5), guidance for designated experts can be found in [RFC7370].

Note that in all cases where the registry reference was to RFC 8919, the registry has been updated to refer to this document.

7.1. Application-Specific Link Attributes Sub-TLV

IANA has registered the sub-TLV defined in Section 4.2 in the "IS-IS Sub-TLVs for TLVs Advertising Neighbor Information" registry.

Type	Description	22	23	25	141	222	223
16	Application-Specific Link Attributes	y	y	y(s)	y	y	y

Table 3

7.2. Application-Specific SRLG TLV

IANA has registered the TLV defined in Section 4.3 in the "IS-IS Top-Level TLV Codepoints" registry.

Value	Description	IIH	LSP	SNP	Purge
238	Application-Specific SRLG	n	y	n	n

Table 4

7.3. IS-IS Sub-Sub-TLV Codepoints for Application-Specific Link Attributes Registry

IANA has created a registry titled "IS-IS Sub-Sub-TLV Codepoints for Application-Specific Link Attributes" under the "IS-IS TLV Codepoints" registry to control the assignment of sub-sub-TLV codepoints for the Application-Specific Link Attributes sub-TLV defined in Section 7.1. The registration procedure is "Expert Review" as defined in [RFC8126]. The initial contents of this registry are as follows:

Type	Description	Reference
0-2	Unassigned	
3	Administrative group (color)	[RFC5305]
4-8	Unassigned	
9	Maximum link bandwidth	[RFC5305]
10	Maximum reservable link bandwidth	[RFC5305]
11	Unreserved bandwidth	[RFC5305]
12-13	Unassigned	
14	Extended Administrative Group	[RFC7308]
15-17	Unassigned	
18	TE Default metric	[RFC5305]
19-32	Unassigned	
33	Unidirectional Link Delay	[RFC8570]
34	Min/Max Unidirectional Link Delay	[RFC8570]
35	Unidirectional Delay Variation	[RFC8570]
36	Unidirectional Link Loss	[RFC8570]
37	Unidirectional Residual Bandwidth	[RFC8570]
38	Unidirectional Available Bandwidth	[RFC8570]
39	Unidirectional Utilized Bandwidth	[RFC8570]
40-255	Unassigned	

Table 5

IANA has also added the following notes to this registry:

> Note: For future codepoints, in cases where the document that defines the encoding is different from the document that assigns the codepoint, the encoding reference MUST be to the document that defines the encoding.
>
> Note: If a link attribute can be advertised both as a sub-TLV of TLVs advertising neighbor information and as a sub-sub-TLV of the Application-Specific Link Attributes sub-TLV defined in RFC 9479, then the same numerical code should be assigned to the link attribute whenever possible.

7.4. Link Attribute Application Identifiers Registry

IANA has created a registry titled "Link Attribute Application Identifiers" within the "Interior Gateway Protocol (IGP) Parameters" group of registries to control the assignment of Application Identifier Bits. The registration policy for this registry is "Expert Review" as defined in [RFC8126]. Bit definitions SHOULD be assigned such that all bits in the lowest available octet are allocated before assigning bits in the next octet. This minimizes the number of octets that will need to be transmitted. The initial contents of this registry are as follows:

Bit	Name	
0	RSVP-TE (R-bit)	
1	Segment Routing Policy (S-bit)	
2	Loop-Free Alternate (F-bit)	
3-63	Unassigned	

Table 6

7.5. IS-IS Sub-TLVs for Application-Specific SRLG TLV

IANA has created a registry titled "IS-IS Sub-TLVs for Application-Specific SRLG TLV" under the "IS-IS TLV Codepoints" registry to control the assignment of sub-TLV types for the Application-Specific SRLG TLV (TLV 238). The registration procedure is "Expert Review" as defined in [RFC8126]. The initial contents of this registry are as follows:

Value	Description	Reference
0-3	Unassigned	
4	Link Local/Remote Identifiers	[RFC5307]
5	Unassigned	
6	IPv4 interface address	[RFC5305]
7	Unassigned	
8	IPv4 neighbor address	[RFC5305]

9-11	Unassigned	
12	IPv6 Interface Address	[RFC6119]
13	IPv6 Neighbor Address	[RFC6119]
14-255	Unassigned	

Table 7

IANA has also added the following note to this registry:

> Note: For future codepoints, in cases where the document that defines the encoding is different from the document that assigns the codepoint, the encoding reference MUST be to the document that defines the encoding.

8. Security Considerations

Security concerns for IS-IS are addressed in [ISO10589], [RFC5304], and [RFC5310]. While IS-IS is deployed under a single administrative domain, there can be deployments where potential attackers have access to one or more networks in the IS-IS routing domain. In these deployments, the stronger authentication mechanisms defined in the aforementioned documents SHOULD be used.

This document defines an improved way to advertise link attributes. Tampering with the information defined in this document may have an effect on applications using it, including impacting TE as discussed in [RFC8570]. As the advertisements defined in this document limit the scope to specific applications, the impact of tampering is similarly limited in scope.

9. Changes to RFC 8919

Discussion within the LSR WG indicated that there was confusion regarding the use of ASLA advertisements that had a zero-length SABM/UDABM. The discussion can be seen by searching the LSR WG mailing list archives for the thread "Proposed Errata for RFCs 8919/8920" starting on 15 June 2021.

Changes to Sections 4.2, 4.3, and 6.2 have been introduced to clarify normative behavior in the presence of such advertisements. In particular, the text in [RFC8919] used the word "permitted", suggesting that the use of such advertisements is "optional". Such an interpretation could lead to interoperability issues and is not what was intended.

The replacement text makes explicit the specific conditions when such advertisements MUST be used and the specific conditions under which they MUST NOT be used.

10. References

10.1. Normative References

[ISO10589] ISO, "Information technology - Telecommunications and information exchange between systems - Intermediate System to Intermediate System intra-domain routing information exchange protocol for use in conjunction with the protocol for providing the connectionless-mode network service (ISO 8473)", Second Edition, ISO/IEC 10589:2002, November 2002, <https://www.iso.org/standard/30932.html>.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

[RFC5304] Li, T. and R. Atkinson, "IS-IS Cryptographic Authentication", RFC 5304, DOI 10.17487/RFC5304, October 2008, <https://www.rfc-editor.org/info/rfc5304>.

[RFC5305] Li, T. and H. Smit, "IS-IS Extensions for Traffic Engineering", RFC 5305, DOI 10.17487/RFC5305, October 2008, <https://www.rfc-editor.org/info/rfc5305>.

[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, <https://www.rfc-editor.org/info/rfc5307>.

[RFC5310] Bhatia, M., Manral, V., Li, T., Atkinson, R., White, R., and M. Fanto, "IS-IS Generic Cryptographic Authentication", RFC 5310, DOI 10.17487/RFC5310, February 2009, <https://www.rfc-editor.org/info/rfc5310>.

[RFC6119] Harrison, J., Berger, J., and M. Bartlett, "IPv6 Traffic Engineering in IS-IS", RFC 6119, DOI 10.17487/RFC6119, February 2011, <https://www.rfc-editor.org/info/rfc6119>.

[RFC7308] Osborne, E., "Extended Administrative Groups in MPLS Traffic Engineering (MPLS-TE)", RFC 7308, DOI 10.17487/RFC7308, July 2014, <https://www.rfc-editor.org/info/rfc7308>.

[RFC7370] Ginsberg, L., "Updates to the IS-IS TLV Codepoints Registry", RFC 7370, DOI 10.17487/RFC7370, September 2014, <https://www.rfc-editor.org/info/rfc7370>.

[RFC8126] Cotton, M., Leiba, B., and T. Narten, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 8126, DOI 10.17487/RFC8126, June 2017, <https://www.rfc-editor.org/info/rfc8126>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <https://www.rfc-editor.org/info/rfc8174>.

[RFC8570] Ginsberg, L., Ed., Previdi, S., Ed., Giacalone, S., Ward, D., Drake, J., and Q. Wu, "IS-IS Traffic Engineering (TE) Metric Extensions", RFC 8570, DOI 10.17487/RFC8570, March 2019, <https://www.rfc-editor.org/info/rfc8570>.

10.2. Informative References

[RFC3209] Awduche, D., Berger, L., Gan, D., Li, T., Srinivasan, V., and G. Swallow, "RSVP-TE: Extensions to RSVP for LSP Tunnels", RFC 3209, DOI 10.17487/RFC3209, December 2001, <https://www.rfc-editor.org/info/rfc3209>.

[RFC5286] Atlas, A., Ed. and A. Zinin, Ed., "Basic Specification for IP Fast Reroute: Loop-Free Alternates", RFC 5286, DOI 10.17487/RFC5286, September 2008, <https://www.rfc-editor.org/info/rfc5286>.

[RFC7855] Previdi, S., Ed., Filsfils, C., Ed., Decraene, B., Litkowski, S., Horneffer, M., and R. Shakir, "Source Packet Routing in Networking (SPRING) Problem Statement and Requirements", RFC 7855, DOI 10.17487/RFC7855, May

2016, <https://www.rfc-editor.org/info/rfc7855>.

[RFC8919] Ginsberg, L., Psenak, P., Previdi, S., Henderickx, W., and J. Drake, "IS-IS Application-Specific Link Attributes", RFC 8919, DOI 10.17487/RFC8919, October 2020, <https://www.rfc-editor.org/info/rfc8919>.

[RFC9256] Filsfils, C., Talaulikar, K., Ed., Voyer, D., Bogdanov, A., and P. Mattes, "Segment Routing Policy Architecture", RFC 9256, DOI 10.17487/RFC9256, July 2022, <https://www.rfc-editor.org/info/rfc9256>.

Acknowledgements

RFC 8919 included the following acknowledgements:

| Eric Rosen and Acee Lindem for their careful review and content
| suggestions.

For the new version (this document), the authors would like to thank Bruno Decraene.

Authors' Addresses

Les Ginsberg
Cisco Systems
United States of America
Email: ginsberg@cisco.com

Peter Psenak
Cisco Systems
Slovakia
Email: ppsenak@cisco.com

Stefano Previdi
Huawei Technologies
Email: stefano@previdi.net

Wim Henderickx
Nokia
Copernicuslaan 50
2018 94089 Antwerp
Belgium
Email: wim.henderickx@nokia.com

John Drake
Juniper Networks
Email: jdrake@juniper.net