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# IS-IS TE Attributes per application
# draft-ietf-isis-te-app-10

## 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 Traffic Engineering, Loop Free Alternate) have been defined which also make use of the link attribute advertisements. 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 indication of which applications are using the advertised value for a given link. This document introduces new link attribute advertisements which address both of these shortcomings.

## 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.

## Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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## 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], and [RFC8570]. Use of these extensions has been associated with deployments supporting Traffic Engineering 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 which makes use of link attribute advertisements - examples of which are listed in Section 3.

In recent years new applications have been introduced which have use cases for many of the link attributes historically used by RSVP-TE. Such applications include Segment Routing Traffic Engineering (SRTE) [RFC8402] and Loop Free Alternates (LFA) [RFC5286]. This has introduced ambiguity in that if a deployment includes a mix of RSVP-TE support and SRTE 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 SRTE. If the topologies are fully congruent this may not be an issue, but any incongruence leads to ambiguity.

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 which 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 which is easily extensible to the introduction of new applications and new use cases.

## 2. Requirements Discussion

As stated previously, evolution of use cases for link attributes can be expected to continue - so any discussion of existing use cases is limited to requirements which 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 which 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/requirements for SR. Included among these use cases is SRTE which is defined in [I-D.ietf-spring-segment-routing-policy]. If both RSVP-TE and SRTE are deployed in a network, link attribute advertisements can be used by one or both of these applications. As there is no requirement for the link attributes advertised on a given link used by SRTE to be identical to the link attributes advertised on that same link used by RSVP-TE, there is a clear requirement to indicate independently which link attribute advertisements are to be used by each application.

As the number of applications which 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 new 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

There are existing advertisements used in support of RSVP-TE. These advertisements include sub-TLVs for TLVs 22, 23, 25, 141, 222, and 223 and TLVs for Shared Risk Link Group(SRLG) advertisement.

Sub-TLV values are defined in https://www.iana.org/assignments/isis-tlv-codepoints/isis-tlv-codepoints.xhtml#isis-tlv-codepoints-22-23-25-141-222-223 and https://www.iana.org/assignments/isis-tlv-codepoints/isis-tlv-codepoints.xhtml .

### 3.1. Legacy sub-TLVs

Sub-TLVs for TLVs 22, 23, 25, 141, 222, and 223

| 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 |

### 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 new code points are defined in support of Application Specific Link Attribute Advertisements:

1) Application Specific Link Attributes sub-TLV for TLVs 22, 23, 25, 141, 222, and 223 (defined in Section 4.2 ).

2)Application Specific Shared Risk Link Group (SRLG) TLV (defined in Section 4.3).

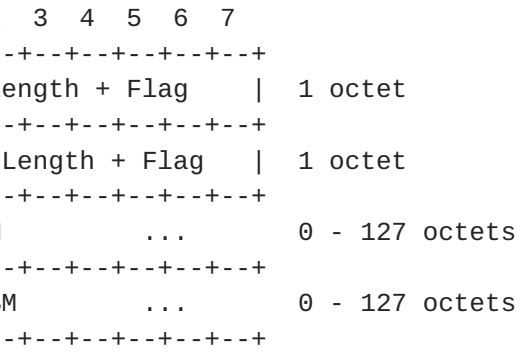
In support of these new advertisements, an application identifier bit mask is defined which identifies the application(s) associated with a given advertisement (defined in Section 4.1).

The following sections define the format of these new advertisements.

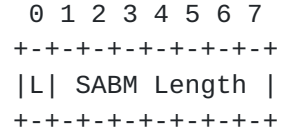
### 4.1. Application Identifier Bit Mask

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 a new IANA controlled registry. A second bit mask is for non-standard User Defined Applications (UDAs).

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



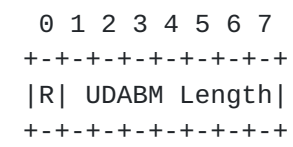

SABM Length + Flag (1 octet)
Standard Application Identifier Bit Mask
Length + Flag



L-flag: Legacy Flag.
See the following section for a description of how
this flag is used.

SABM Length: Indicates the length in octets (0-127) of the
Standard Application Identifier Bit Mask. The length SHOULD
be the minimum required to send all bits which are set.

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



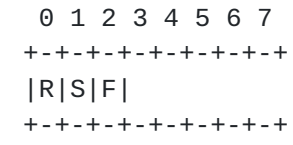

R: Reserved. SHOULD be transmitted as 0 and
MUST be ignored on receipt

UDABM Length: Indicates the length in octets (0-127) of the
User Defined Application Identifier Bit Mask. The length SHOULD
be the minimum required to send all bits which are set.

SABM (variable length)
Standard Application Identifier Bit Mask

(SABM Length * 8) bits

This field is omitted if SABM Length is 0.



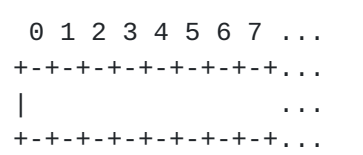

R-bit: Set to specify RSVP-TE

S-bit: Set to specify Segment Routing
Traffic Engineering (SRTE)

F-bit: Set to specify Loop Free Alternate (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.

Standard Application Identifier Bits are defined/sent starting with Bit 0. Undefined bits 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.

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 are used starting with Bit 0 so as to minimize the number of octets required to advertise all UDAs.

## 4.2. Application Specific Link Attributes sub-TLV

A new sub-TLV for TLVs 22, 23, 25, 141, 222, and 223 is defined which supports specification of the applications and application specific attribute values.

Type: 16 (temporarily assigned by IANA)
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] and [RFC8570]

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 22, 23, 25, 141, 222, and 223 or TLV 138 or TLV 139 as appropriate. Link attribute sub-sub-TLVs for the corresponding link attributes MUST NOT be advertised for the set of applications specified in the Standard/ User Application Identifier Bit Masks and all such advertisements MUST be ignored on receipt.

Multiple Application Specific Link Attribute 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 of the same link attribute for a given link. In cases where conflicting values for the same application/attribute/link are advertised all the conflicting values 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.

A new registry of sub-sub-TLVs is to be created by IANA which defines the link attribute sub-sub-TLV code points. 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 is requested to assign 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 which 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.

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 (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 RSVP-TE 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.

## 4.3. Application Specific SRLG TLV

A new TLV is defined to advertise application specific SRLGs for a given link. Although similar in functionality to TLV 138 [RFC5307] and TLV 139 [RFC6119], a single TLV provides support for IPv4, IPv6, and unnumbered identifiers for a link. Unlike TLVs 138/139, 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 (Temporarily assigned by IANA)
Length: Number of octets in the value field (1 octet)
Value:
  Neighbor System-ID + pseudo-node 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)
```

The following Link Identifier sub-TLVs are defined. The values chosen are intentionally matching 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] |

At least one set of link identifiers (IPv4, IPv6, or Link Local/Remote) MUST be present. TLVs which 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 which 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 application specific link attributes.

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 application specific link attributes implies that RSVP is enabled on that link. The absence of RSVP-TE application specific link attributes in combination with the absence of legacy advertisements implies that RSVP is NOT enabled on that link.

In the case of SRTE, advertisement of application specific link attributes does NOT indicate enablement of SRTE. The advertisements are only used to support constraints which may be applied when specifying an explicit path. SRTE is implicitly enabled on all links which are part of the Segment Routing enabled topology independent of the existence of link attribute advertisements

In the case of LFA, advertisement of application specific link attributes does NOT indicate enablement of LFA on that link. Enablement is controlled by local configuration.

If, in the future, additional standard applications are defined to use this mechanism, the specification defining this use MUST define the relationship between application specific link attribute advertisements and enablement for that application.

This document allows the advertisement of application specific link attributes with no application identifiers i.e., both the Standard Application Identifier Bit Mask and the User Defined Application Identifier Bit Mask are not 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 attribute advertisements 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 discuss deployment considerations associated with the use of application specific link attribute 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 which 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 SRTE or LFA and RSVP-TE is not deployed anywhere in the network
- The application is SRTE or LFA, RSVP-TE is deployed in the network, and both the set of links on which SRTE and/or LFA advertisements are required and the attribute values used by SRTE and/or LFA on all such links is fully congruent with the links and attribute values used by RSVP-TE

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

New applications which 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

If link attributes are advertised associated with zero length Application Identifier Bit Masks for both standard applications and user defined applications, then any Standard Application and/or any User Defined Application is permitted to use that set of link attributes so long as there is not another set of attributes advertised on that same link which is associated with a non-zero length Application Identifier Bit Mask with a matching Application Identifier Bit set. If support for a new application is introduced on any node in a network in the presence of such advertisements, these advertisements are permitted to be used by the new application. If this is not what is intended, then existing 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, SRTE, and/or LFA utilize the legacy advertisements listed in Section 3. Routers which 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 must be able to co-exist with use of the legacy advertisements by routers which do not support the extensions defined in this document. The following sub-sections discuss interoperability and backwards compatibility concerns for a number of deployment scenarios.

Note that in all cases the defined strategy can be employed on a per link basis.

#### 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 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 which have the L-flag clear. In cases where some link attributes are shared with RSVP-TE, this requires duplicate advertisements for those attributes.

The discussion in this section applies 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 applications defined in this document, routers which do not support the extensions defined in this document will send and receive only legacy link attribute advertisements. So long as there is any legacy router in the network which has any of the applications enabled, all routers MUST continue to advertise link attributes using legacy advertisements. Once all legacy routers have been upgraded, migration from legacy advertisements to application specific advertisements can be achieved via the following steps:

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

2)Enable the use of the application specific advertisements on all routers

3)Remove legacy advertisements

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

The extensions defined in this document support RSVP-TE as one of the supported applications. This allows that RSVP-TE could eventually utilize the application specific advertisements. This can be done in the following step-wise manner:

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

2)Advertise all legacy link attributes using application specific advertisements with L-flag clear and R-bit set.

3)Remove legacy advertisements

Migrating RSVP-TE away from legacy advertisements could result in some implementation simplification as it allows the removal of code which encodes/decodes the legacy advertisements. Whether this is seen as desirable is something for the marketplace to determine.

## 7. IANA Considerations

This document defines a new sub-TLV for TLVs 22, 23, 25, 141, 222, and 223.

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

This document defines one new TLV:

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

This document requests a new IANA registry be created to control the assignment of sub-sub-TLV codepoints for the Application Specific Link Attributes sub-TLV. The suggested name of the new registry is "sub-sub-TLV code points for application specific link attributes". The registration procedure is "Expert Review" as defined in [RFC8126]. The following assignments are made by this document:

| Type | Description |
|---|---|
| 0-2 | Unassigned |
| 3 | Administrative group (color) |
| 4-8 | Unassigned |
| 9 | Maximum link bandwidth |
| 10 | Maximum reservable link bandwidth |
| 11 | Unreserved bandwidth |
| 12-13 | Unassigned |
| 14 | Extended Administrative Group |
| 15-17 | Unassigned |
| 18 | TE Default Metric |
| 19-32 | Unassigned |
| 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 |
| 40-255 | Unassigned |

Note to designated experts: If a link attribute can be advertised both as a sub-TLV of TLVs 22, 23, 25, 141, 222, and 223 and as a sub-sub-TLV of the Application Specific Link Attributes sub-TLV defined in this document, then the same numerical code should be assigned to the link attribute whenever possible.

This document requests a new IANA registry be created, under the category of "Interior Gateway Protocol (IGP) Parameters", to control the assignment of Application Identifier Bits. The suggested name of the new registry is "Link Attribute Applications". The registration policy for this registry is "Standards Action" ([RFC8126] and [RFC7120]). Bit definitions SHOULD be assigned in ascending bit order beginning with Bit 0 so as to minimize the number of octets that will need to be transmitted. The following assignments are made by this document:

| Bit # | Name |
|---|---|
| 0 | RSVP-TE (R-bit) |
| 1 | Segment Routing Traffic Engineering (S-bit) |
| 2 | Loop Free Alternate (F-bit) |

This document requests a new IANA registry be created to control the assignment of sub-TLV types for the application specific SRLG TLV. The suggested name of the new registry is "Sub-TLVs for TLV 238".

The registration procedure is "Expert Review" as defined in [RFC8126]. The following assignments are made by this document:

| Value | Description |
|---|---|
| 0-3 | Unassigned |
| 4 | Link Local/Remote Identifiers (see [RFC5307]) |
| 5 | Unassigned |
| 6 | IPv4 interface address (see [RFC5305]) |
| 7 | Unassigned |
| 8 | IPv4 neighbor address (see [RFC5305]) |
| 9-11 | Unassigned |
| 12 | IPv6 Interface Address (see [RFC6119]) |
| 13 | IPv6 Neighbor Address (see [RFC6119]) |
| 14-255 | Unassigned |

## 8. Security Considerations

Security concerns for IS-IS are addressed in [ISO10589, [RFC5304], and [RFC5310].

## 9. Acknowledgements

The authors would like to thank Eric Rosen and Acee Lindem for their careful review and content suggestions.

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